Foreign fees and customers' cash withdrawals

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Abstract

In this paper, we evaluate the impact of foreign fees, paid by consumers when they withdraw cash at banks that are not their own, on their withdrawals. We take advantage of a natural experiment whereby (non linear) payment fees for withdrawing cash at foreign ATMs were introduced at one point in time. We also use this experiment to evaluate the substitutions between foreign withdrawals and various other means of payment such as own bank or desk withdrawals, payments by card or cheque. Using panel data on accounts at one specific bank, we first estimate reduced form treatment effect models before carrying on with the estimation of a structural model. The latter allows us to compute the counterfactual impacts of changing the non linear schedule of foreign fees. Impacts are sizeable and in particular on bank profits.

Keywords: Cash holding, policy evaluation, costs of means of payment, treatment effects

JEL codes: C21, D12, G21

1 Introduction[1]

Transactions are costly and these costs differ across means of payments and across agents. Bank customers use their deposit accounts to pay daily or weekly expenses in cash, cheques, payment cards or transfers. Each of those means of payments generate specific costs for those customers, shops and banks (i.e. fixed costs of card use, interchange fees etc). For instance, the costs of cash payments for customers arise from losses of interest payments on deposit accounts or risks of theft but also from withdrawing cash at ATMs. Even if banks installed ATMs in most countries because the withdrawal cost was much lower at ATMs than at the bank desks, they did that within bank networks (for instance, Hannan, Kiser, Prager and McAndrews, 2003 in which the earlier literature is also reviewed). In those networks, cash can be withdrawn not only from customers' own bank ATMs but also from foreign bank ATMs. Yet, foreign cash withdrawals by customers is significantly more costly for banks since they are charged interchange fees. This is why in most countries banks owning ATM charge foreign fees, and even surchages in countries like the United States (since 1996) or the Netherlands. Both fees and surcharges are typically of the order of 1$ or 1.50$ (for instance, Knittel & Stango, 2009). Moreover, there could also be positive incentives through loyalty programs (Humphreys, 2010).

Customers are negatively affected by foreign fees and surcharging if all other things remain the same and in particular the number of ATMs. The main tradeoff for customers for using home or foreign ATMs is between distance and fees so that ATM density matters and overall the cost is much lower in urban areas. Nonetheless, banks get profits out of foreign fees and surcharges (keeping prices of deposit accounts constant) so that increases in fees tend to make them deploy more ATMs. This favors customers. In total, effects can be negative or positive. A small empirical and theoretical litterature has developed on these premises (Hannan et al., 2003, Knittel and Stango, 2009, or Donze and Dubec, 2011). Empirical evidence points out that consumers are likely to gain more in urban areas (Gowrisankaran & Krainer, 2011).

A key parameter in these evaluations is the elasticity of foreign withdrawals with respect to

[1]This paper results from a collaboration with a European bank whose proprietary and confidential data were used for this analysis. The agreement that was signed explains why some characteristics of the experiment like its exact timing are "anonymized" in this paper. This is also true for names of collaborators and research assistants at this bank whose help is gratefully acknowledged. The usual disclaimer applies.

foreign fees since it describes how consumers substitute away from cash withdrawals at other banks' ATMs. This is what we do first in this paper by estimating this elasticity using microdata on bank accounts. Parameters of derived interest are the substitution elasticities between foreign withdrawals and other means of payments like cash withdrawals at home ATMs or at the bank desk, card payments or cheques. We can also look at the way amounts which are withdrawn or paid for all means of payments are affected by the change in foreign fees. In other words, the main contribution of this paper is to estimate the treatment impact of foreign fees on foreign ATM withdrawals and other means of payment at both extensive and intensive margins.

The large sample of accounts that we follow over a 28 month period in the last ten years is drawn from the population of accounts managed by a large deposit bank operating in Europe. The "treatment" consisted in the introduction of a fee, p_0, for each foreign cash withdrawal out of a deposit account, beyond an allowance of a positive threshold, n_0, of foreign withdrawals per month. This natural experiment occurred at around the mid period in our sample. The data are original since most of the data used until now to our knowledge consist in bank level information or household surveys. In particular, Kalckreuth, Schmidt and Stix (2014) find a significant but small effect of fees using German household data. Our empirical strategy have drawbacks however since confidentiality of what can be publicly released is required.[2]

The first reduced form method that is used consists in contrasting the behaviour of those customers who are not (or very mildly) impacted by the new piecewise linear price schedule – for instance those who usually withdraw cash at a foreign ATM a number of times per month less than the threshold n_0 – and the customers who are impacted – withdrawing more than n_0 times per month at a foreign ATM. We use pretreatment information to define what a "usual" foreign withdrawal behavior means. The second more structural method allows to go further and compute the impacts of hypothetical scenarios such as a modification in the fee p_0 and the threshold n_0.

The main results are the following. Foreign withdrawals of intensive users decrease by around 25 or 30% because of the increase in the foreign fee. Those withdrawals are not compensated by additional home ATMs or desk withdrawals although the amount withdrawn moderately increases. The counterfactual analysis allows to show that doubling the fee would have increased expected

[2] For instance,it was requested that p_0 and n_0 should not be revealed lest the bank be identified. We give indices about their magnitudes below.

profits by 85% and to show that decreasing the threshold by one (respectively two) unit, would have increased profits by 40% (resp. 140%) with respect to the original experiment.

We present the data and the reduced form evaluation in Section 2 and then turn to the structural model in Section 3. Results of the structural estimation as well as counterfactual *scenarii* are presented in Section 4 and Section 5 concludes.

2 Data and treatment evaluation

The treatment schedule is the following. We denote $t = 1, ., 28$ the monthly index and distinguish 5 periods because of the specific structure of the natural experiment.

- *Pretreatment period*: $t = 1, ., 13$: Foreign fees are equal to zero.
- *First interim period*: $t = 14, ., 17$: It is announced during month $t = 14$ (with media coverage) that foreign fees would be set to p_0 (slightly above half of the value charged by the competitors in the market) for any foreign ATM withdrawal beyond n_0 per month (one unit above the largest value used in the market) and that this would be starting in month $t = 18$. In month $t = 16$, customers were informed by mail.
- *Second interim period*: $t = 18, ., 20$: It is announced at period $t = 17$ that foreign fees would remain set at zero until month $t = 21$.
- *First treatment period*: $t = 21, 22$: Foreign fees are increased to the announced p_0 beyond n_0 foreign ATM withdrawals per month in month $t = 21$ and fees are charged in the invoice sent at month $t = 22$.
- *Second treatment period*: $t = 23, ., 28$: Foreign fees remain at level p_0 beyond n_0 foreign ATM withdrawals per month for the whole period without any announcement of future changes.

This timing is slightly unusual since there could be announcement effects whereby consumers would adapt their behavior prior to the exact date of implementation. Customers could also be confused because the implementation date was postponed and might act in the second interim period as if the reform would actually be implemented. This is why we define two interim periods in which (1) the announcement was made (2) the exact date of implementation might have been confusing for consumers and we analyse the possible impact on behavior at these periods. Conversely, other customers could have also been surprised by the implementation of the reform and this is why we distinguish two treatment periods in order to let them, or a fraction of them, adapt to the new set of prices.

2.1 Data

The main working sample consists of 60,000 individual accounts from which there has been at least one foreign withdrawal during the period $t = 1$ to 12. Variables include the number and amount of foreign ATM withdrawals, own ATM withdrawals, debit card payments, bank desk withdrawals & cheque payments. We also have access to another sample of 60,000 accounts from which 6 foreign withdrawals have been carried out during at least one month during the period $t = 1$ to 12. The second sample includes more treated accounts at the cost of losing the interpretation of our parameters as parameters concerning the general population of reference. It will mainly be used as a check on our results using our main working sample.

Summary statistics for variables are described in Table 1. The average number of withdrawals from an ATM per month is 3.42, 45% of which are from an ATM at a foreign bank (1.58). Yet, average amounts withdrawn at foreign ATMs are lower and comprise roughly one third of all ATM withdrawals. Indeed, amounts withdrawn at the bank desk are on par with foreign withdrawals while the latter is six times lower in terms of numbers. It thus seems that ATM foreign withdrawals are used for small withdrawals responding to immediate needs and might not be as planned as home ATM withdrawals. The number of card payments is much higher (11.43 on average) and the amounts paid by cards or cheques are comparable (around 430 euros per month).[3]

Raw frequencies of the number of cash withdrawals at foreign ATMs over the full time span are given in Table 2. We distinguish across columns the Pretreatment, Interim and Treatment periods as defined above. We also distinguish observations grouped by the number of foreign withdrawals per month in which the main cutoff is the threshold n_0 beyond which each additional foreign withdrawal pays the fee p_0. We also use finer groupings as shown in the Table. In the

[3] This bank proposes only debit cards as credit cards in the US sense are not very much used in this market.

pretreatment period, 7.2% of accounts per month were withdrawing stricly more than n_0 units at foreign ATMs. In the final treatment period, this goes down to 5.4% which indicates a quite strong treatment effect. This raw effect is almost zero in the two Interim periods (respectively 6.8% and 7.4%) and not very large in the first Treatment period (6.6%). Rather unexpectedly, the number of accounts making no foreign withdrawals increase from the Pretreatment period (44.8%) to the full Treatment period (50.9%) which might indicate that some consumers adapt their behavior in a more extensive than intensive way. Note that if this was the case, it would lead to underestimate the treatment effects and would make our further results conservative.

At this aggregate level though, we cannot distinguish macro shocks from treatment effects and our further analysis aims at precisely doing this. The aggregate behavior of foreign ATM cash withdrawals seems to have changed over this period and the market level number of cash withdrawals is going upward. Aggregate numbers might also be misleading since a fraction of customers – those who withdraw cash from a foreign ATM relatively little – is not likely to be harmed by the reform. In addition, there are a few exemptions from paying the fee for holders of the best quality cards. It is thus dubious that the treament effect on the treated is identifiable at the aggregate level.

2.2 Empirical strategy

2.2.1 Construction of control and treatment groups

The principle followed in the empirical strategy is to contrast the behaviour of customers according to their revealed preferences before the reform. For this, we adopt the framework of policy evaluations distinguishing treated and control accounts in the population. Broadly speaking:

- accounts in the treated group are the ones from which cash from a foreign ATM strictly is withdrawn more than n_0 times per month,
- accounts in the control group are the ones from which cash is withdrawn from foreign ATMs less than n_0 times per month or have a specific card exempting them from paying fees.

This construction cannot be exact though, since consumers adapt their behavior in the treatment period and this is why we use the outcome in the pretreatment period i.e. the number of foreign ATM withdrawals from the account between $t = 1$ and $t = 9$ to construct what we call the intensity of use. A full blown structural strategy based on an economic model is presented and estimated in the following Section and defines the intensity of use in a less ad-hoc way.

Specifically, preferences are assumed to be stable over time (allowing still for aggregate effects) and we use the mean of foreign ATM withdrawals from each account between $t = 1$ and $t = 9$ as a measure of the intensity of use of foreign ATM cash withdrawals. We denote this variable $y_i^{(0)}$. We thus build our empirical strategy on the presumption that if this variable is close to zero the impact of the reform is zero while if this variable is significantly above n_0 the reform has a full impact. We test below that results are insensitive if we replace the mean by the median or the third quartile of foreign ATM cash withdrawals in the pretreatment period. We also tested that results are insensitive to the number of periods we use to construct these variables in the pretreatment period (e.g. between $t = 1$ and $t = 6$ or $t = 12$).

2.2.2 Treatment effect parameters

To carry out this empirical strategy, denote y_{it} the number of foreign withdrawals during month t for account i and specify that:

$$y_{it} = \delta_t + \beta y_i^{(0)} + \sum_{P=1}^{4} \gamma_P y_i^{(0)} * \{\text{Treatment period } = P\} + \varepsilon_{it}, \text{ if } t > 9, \tag{1}$$

in which δ_t are monthly dummies and γ_P are our parameters of interest that are the average relative treatment effects on the treated. They are equal to the relative reduction of average foreign withdrawals for the treated since the treatment time dummies are interacted with the intensity of use $y_i^{(0)}$. The coefficients of treatment dummies, γ_P, therefore contrast outcomes before and after treatment and between groups defined by the intensity of use. In this sense, it is a difference in difference parameter (Blundell and Costa-Dias, 2011). Note also that we used only periods after $t = 10$ since pretreatment $y_i^{(0)}$ is constructed using information between $t = 1$ and 9. We also checked that using fixed effect methods instead of controling for the variable $y_i^{(0)}$ in levels, does not change results.

There are four treatment dummies ($P = 1, ., 4$) corresponding to the two Interim periods and the two Treatment periods. There are additional twists. In particular, there exist premium cards which dispense cardholders with paying foreign fees. We take this into account in the estimation by imposing that those accounts belong to the control group.[4] We also use additional controls

[4]It could well be that the decision of holding those cards depend on the intensity of use of foreign withdrawals.

describing month characteristics, such as the number of business days, interacted with y_{i0} to disentangle specific characteristics of the month from treatment efffects.

2.2.3 Substitution effects

As we observe other outcomes related to those accounts, we can take advantage of the introduction of this fee on foreign ATM withdrawals to measure substitution effects between means of payments either in terms of numbers or amounts paid. Let w_{it} such a variable describing, say, the number of payments by card during the month or the amount withdrawn from a home ATM during the month. We write the following fixed effect regression:

$$w_{it} = \alpha y_{it} + u_i + \eta_{it},$$

in which y_{it} is the number of foreign withdrawals and usual assumptions about the error terms are made. The right-hand side term, y_{it}, however, is endogenous and we instrument it by using equation (1) above in which the intensity of use, y_{i0}, is interacted with treatment period dummies. We thus use the exogenous variation in foreign ATM cash withdrawals triggered by the increase in fees to infer estimates of substitution effects between foreign withdrawals and other means of payment or amounts paid.

2.3 Results

Table 3 presents the main results of the estimation of the reduced form. In the first two columns, the variable summarizing the intensity of use between $t = 1$ and 9 is taken to be the mean while in the third and fourth columns, the median and the third quartile are used. The first column reports OLS estimates while in the second column, arbitrary serial correlation is allowed and Feasible GLS estimates are reported. Standard errors are robust and clustered at the level of the account (Cameron and Miller, 2012). Overall, these various estimation procedures show that results are qualitatively robust. The most noticeable effect of these variations in methods is that treatment effect estimates tend to be slightly smaller when the third quartile is used as a proxy for the intensity of use.

Nonetheless, the cost of those cards is substantially higher than the level of these fees since they offer other services than complimentary foreign fees.

The medium-run treatment effect estimate is negative as expected, lies between 18.5 and 24.8% and is very significant. It means that the number of withdrawals at foreign ATMs decreases by around 20% for the treated after period $t = 23$. The short-run treatment effect is slightly lower (around 15%) in the first two months of implementation of the program ($t = 21/22$). More surprisingly, there are also effects of the treatment in anticipation of the program. In the periods $t = 14/18$ in which the treatment was announced, the number of foreign withdrawals decreases by around 5% while in the months in which there was a possible confusion about the exact date of implementation the effect is around 7%. All those results are significant at levels well below 1%.

Ending with controls, we used month characteristics such as the number of business days or whether the month begins or ends a day between Monday and Thursday. Namely, withdrawals and other banking operations impact the account with a delay of one or two business days and this is why, for instance, months ending a Friday or a weekend might see fewer operations than a month ending an earlier weekday. This is confirmed by results presented in Table 3.

Results are also robust to other changes of specification and samples. In Table 4, Column 1, we report OLS estimates when the summary for the intensity of use is constructed from $t = 1$ to 12 and the sample used is between $t = 13$ to 28. In column 2, we use the alternative sample in which the number of foreign withdrawals by account is much larger. Results described above are marginally affected by these sizeable changes. The permanent treatment effect on the treated estimate stays put at around 25%.

Table 5 presents the estimates of substitution effects between the number of banking operations which are realized within a month. We only report the estimated coefficient of the impact of the number of foreign withdrawals on the number of operations although the same controls than in the analyses before are also used as covariates in those regressions.

We used three estimation methods whose results are reported in rows: the first one is a standard fixed effect estimation which should be biased if the number of foreign withdrawals is not weakly exogenous. Unobserved shocks that affect foreign withdrawals might affect at the same time the shocks acting on other banking operations. This is indeed what we find by contrasting fixed effect results with those obtained by using instrumental variables (IVs) with fixed effect in which IVs are the 4 pretreatment and treatment periods interacted with the summary of the intensity of use. There are strong differences between estimates across the first two rows and Hausman tests reject the assumption of exogeneity (except for the number of cheques for which the substitution effect is at the margin of significance). We also contrast these IV estimates shown in the second row of Table 5 with estimates using a more restricted set of IVs and fixed effects, reported in the third row. The only excluded variable from the outcome equation left is the permanent treatment period ($t = 23/28$) interacted with the summary of the intensity of use and this model is just identified. There are no significant differences with the second row estimates and additional IVs are thus valid instruments.

In terms of economic effects, the number of foreign ATM withdrawals seems to be a substitute to the number of ATM withdrawals in customers' home bank although the effect is very small (around 0.03). Other behavior like the number of desk withdrawals and cheques are insignificantly or marginally impacted by the number of foreign withdrawals. More intriguingly, the fewer foreign withdrawals are, the fewer card payments are made. A decrement of one unit in foreign ATM withdrawals decreases the number of card payments by 0.5. This seems to be at variance with what is observed in household surveys as reported by Kalckreuth et al. (2014). It might be that the announcement of a fee on foreign withdrawals might have triggered the false anticipation by customers that card payments would also be taxed. There is some evidence of it in the data in which the response of card payments in the first period of treatment ($t = 21/22$) is stronger than in the second treatment period ($t = 23/28$). Yet, the decrease in card payments in the latter period ($t = 23/28$) is impacted negatively in a significant way. This could mean that some customers give up using the card for both uses, foreign withdrawals and card payments, and for instance leave their card at home. This is confirmed by the results in the next Table.

Table 6 indeed reports the effect of the number of foreign withdrawals on the amounts concerned by the various banking operations. More importantly, it shows that the amounts withdrawn at foreign ATMs increase significantly when the number of such withdrawals decreases. Customers rationally expect that those withdrawals are more expensive and decreases the marginal cost of withdrawing by adapting amounts. Some withdrawals are also reported on home withdrawals whose number increases (see Table 5) and whose amount decreases. Amounts paid by payment cards increase as well, confirming that foreign withdrawals and card payments are complements.

Finally, from results of Table 3, we can compute expected profits that the bank gained by implementing this treatment. If we do not allow for any behavioral response to the fee imposed on foreign withdrawals the expected profit per month and per account is between 0.12€ and 0.20€ depending on the month. Allowing for behavioral response, expected profit per month and per account is thus estimated to be between 0.09€ and 0.15€. To this profit, should be added the savings in terms of interchange fees which are roughly equal to the behavioural effects since the interchange fee is of the same order of magnitude than the fee that was implemented. The implementation of this fee is thus seen to have a significant impact on profits and the behavioral response of customers to avoid paying these fees is significant. Incentivizing customers to refrain from foreign withdrawals has thus a significant impact on bank profits.

3 Structural model

Previous results concern the observed impact of the increase in foreign ATM fees as they appear in the data. Those results cannot be used however as a guide for formulating the best policy of the bank. In contrast, constructing a structural model allows us to assess the impact of hypothetical scenarios on foreign withdrawals in which the fee p_0 would be increased or the threshold n_0 changed. In this sense, the structural analysis allows to extrapolate the natural experimental data that we observe to estimate the effects of counterfactual experiments. This is obtained by setting up assumptions on the economic structure that we now detail.

3.1 Uniform prices

We start by constructing the baseline scenario under which fees are zero since this represents the pretreatment period behaviour. As before, let the number of foreign ATM withdrawals be y_{it}. Utility is assumed to be given by:

$$u(y_{it}) = y_{it} - \frac{(y_{it})^2}{2\gamma_{it}}.$$

In this specification, $\frac{\gamma_{it}}{2}$ is the bliss point and is always what is preferred by the consumer when foreign withdrawals are free. It is the result of a cost and benefit analysis of cash withdrawing by customers as detailed for instance by Alvarez and Lippi (2009) in an admittedly more general continuous time framework. We do not exclude regions in which marginal utility is decreasing since they are never chosen at the optimum. Note that we neglect the discreteness of the dependent variable y_{it} for simplicity.

If withdrawals are priced at a uniform price p_{it}, marginal utility is equal to the price p_{it} multiplied by the marginal utility of money λ_{it}:

$$u'(y_{it}) = \lambda_{it} p_{it} \Longrightarrow (1 - \frac{y_{it}}{\gamma_{it}}) = \lambda_{it} p_{it}$$

which yields a linear demand function:

$$y_{it} = \gamma_{it} - p_{it}\alpha_{it},$$

in which $\alpha_{it} = \gamma_{it}\lambda_{it}$. Nonetheless, the current experiment implements a two-part schedule in which withdrawals are costly if they are above a threshold only. This makes demand non linear in this simple model.

3.2 Piecewise linear pricing

Let now assume that the price is set to p_0, only when $y_{it} > n_0$ so that:

$$p_{it} = p_0(y_{it} - n_0)\mathbf{1}\{y_{it} > n_0\}.$$

There are two solutions:

$$\begin{cases} y_{it} = \gamma_{it} \text{ if } \gamma_{it} \leq n_0, \\ y_{it} = \gamma_{it} - \alpha_{it} p_0 (y_{it} - n_0)\mathbf{1}\{y_{it} > n_0\} \text{ if } \gamma_{it} > n_0. \end{cases}$$

Indeed, the second regime can also be rewritten:

$$(1 + \alpha_{it} p_0 \mathbf{1}\{y_{it} > n_0\})(y_{it} - n_0) = \gamma_{it} - n_0$$

which validates that $\mathbf{1}\{y_{it} > n_0\} = \mathbf{1}\{\gamma_{it} > n_0\}$. Replacing and recomposing, we have:

$$y_{it} = \gamma_{it} - (\gamma_{it} - n_0)\frac{\alpha_{it} p_0}{1 + \alpha_{it} p_0}\mathbf{1}\{\gamma_{it} > n_0\}. \tag{2}$$

This result allows to contrast the pretreatment behavior and the behavior under treatment. In the pretreatment period, demand is equal to γ_{it} and this depends only on the needs for cash by customers as well as on their costs of going to the nearest ATM. Introducing a piecewise linear pricing schedule as was done at period $t = 21$ in our data has now an effect which is equal to

$$(\gamma_{it} - n_0)\mathbf{1}\{\gamma_{it} > n_0\}\frac{\alpha_{it} p_0}{1 + \alpha_{it} p_0} = (\gamma_{it} - n_0)\mathbf{1}\{\gamma_{it} > n_0\}\delta_{it}, \tag{3}$$

and this is the structural effect that we want to estimate. We specify in the next subsection the term δ_{it} as a function of parameters whose estimation leads to estimates of α_{it} and of counterfactual treatment effects in which p_0 and n_0 are varied. Note also that equation (2) allows to focus on price effects while non price effects such as the announcement of the increase of fees are now captured by shocks on the redefined intensity of use, γ_{it}.

3.3 Specification

Write first the unobserved propensity to withdraw at foreign ATMs as:

$$\gamma_{it} = \tau_t + \gamma_i(1 + g(t, \theta)) + \varepsilon_{it}$$

in which τ_t are time dummies, $g(t, \theta)$ a function of month characteristics and γ_i is an individual effect. We set:

$$g(t, \theta) = z_t \theta \tag{4}$$

in which z_t are characteristics of the month (number of business days, the month ends between Monday and Thursday etc). This specification retains some non stationary aggregate components τ_t that can accomodate the actual aggregate increase in withdrawals over this period and a permanent intensity of use, γ_i, as in the reduced form model. This permanent effect is also interacted with the characteristics of the month since the number of business days for instance is assumed to affect multiplicatively the resulting number of withdrawals. Variables z_t can also include the indicators of the periods after the announcement of the introduction of the fee in order to capture the informational impact of such an announcement. It thus takes into account that tastes can permanently change when such a fee is announced as was suggested by the reduced form estimates even in the absence of any price change.

For simplicity, we also posit that

$$\varepsilon_{it} \rightsquigarrow N(0, \sigma_t^2).$$

Turning to the term describing the treatment effect, we need to specify the additional term that appears in equation (3) and we write that:[5]

$$\delta_{it} = d_{0t} + d_1(\gamma_{it} - n_0), \tag{5}$$

[5]The data would be sufficiently rich to allow for a more semi-parametric and non linear functional form than this one although we keep this for future work.

The treatment effect is made dependent on time through d_{0t} to allow for learning for instance as in the reduced form section. We also specify that the treatment effect depends on the level of the individual intensity of use, γ_{it} to allow for non linear effects. The impact of the treatment for heavy users of foreign withdrawals might differ from the impact for light users.

Given these specifications, the estimation of equation (2) requires to solve two methodological issues. We first rewrite equation (2) as an estimating function of the variables observed in the data since the treatment effect in equation (3) is random and should thus be integrated out and be written as a function of observables only. This task is performed in Appendix A.1. Second, we use an iterative algorithm to estimate the parameters of this estimating equation and this algorithm is presented in Appendix A.2. If this algorithm converges (and it always converged in models we estimated), it necessarily points to a solution of the estimating equation. The uniqueness of such a solution follows from using arguments about the quasi-bilinearity of the estimating equation (Blundell and Robin, 1999). Standard errors are also easily constructed by bootstrapping results and paying attention to the clustering of the data at the level of accounts.

3.4 Counterfactuals

For the hypothetical scenarios described below, we present various summaries of demand, profit and costs. We report these summaries obtained by recomputing demand for each account in the sample over the whole period $t = 1$ to 28 using the new parameters in terms of fee and threshold. The way we perform those experiments are described in Appendix A.3 in which it is explained how we construct for each i a sequence of reconstructed intensity of use or bliss points, $\hat{\gamma}_{it}$.

We estimate the counterfactual impacts under several *scenarii*. First, we contrast several summaries of demand and profits in the (partly) counterfactual situation in which no foreign fees ($p_0 = 0$) would have been imposed with the summaries obtained when the fee p_0 and the threshold n_0 take their actual values in the treatment during the whole period. This allows to evaluate roughly the goodness of fit of the model. This is not far from what is observed in the data although this information is partly counterfactual since no account can be treated and non treated at the same time.

We also use two scenarii under which the fee is increased by 50% or by 100%, the threshold remaining fixed at n_0. We use the following method. Recall that the deep parameter α_{it} in equation

(2) is given by:

$$\frac{\alpha_{it}p_0}{1+\alpha_{it}p_0} = d_{0t} + d_1(\gamma_{it} - n_0),$$

If this quantity is between 0 and 1 – this is the case for all accounts in our estimation – we get:

$$\alpha_{it} = \frac{1}{p_0}\frac{d_{0t} + d_1(\gamma_{it} - n_0)}{1 - d_{0t} - d_1(\gamma_{it} - n_0)}.$$

This allows to compute the counterfactual treatment effect for a fee p_1 because the treatment parameter becomes:

$$\frac{\alpha_{it}p_1}{1+\alpha_{it}p_1} = \frac{(d_0 + d_1(\gamma_{it} - n_0))\frac{p_1}{p_0}}{1 + (\frac{p_1}{p_0} - 1)(d_0 + d_1(\gamma_{it} - n_0))}.$$

Demand is thus obtained by equation (2) as:

$$y_{it} = \gamma_{it} - (\gamma_{it} - n_0)\mathbf{1}\{\gamma_{it} > n_0\}\frac{\alpha_{it}p_1}{1+\alpha_{it}p_1}$$

in which unknown parameters are replaced by their estimates in the structural model.

In the last two hypothetical scenarii, we change the threshold of the piece-wise linear schedule by decrementing the threshold by either one unit or two units and keeping the fee at its original level. By setting the threshold to k, we now have the counterfactual equation:

$$y_{it} = \gamma_{it} - (\gamma_{it} - k)\mathbf{1}\{\gamma_{it} > k\}\frac{\alpha_{it}p_0}{1+\alpha_{it}p_0} = \gamma_{it} - (\gamma_{it} - k)\mathbf{1}\{\gamma_{it} > k\}(d_{0t} + d_1(\gamma_{it} - n_0)),$$

that is estimated easily using structural estimates. We then compute summaries of counterfactual demands and profits.

4 Results

Table 7 reports estimates of the parameters of the structural model using two specifications. As shown in equations (4) et (5), there are two types of parameters, the parameters interacted with the individual mean intensity of use γ_i and the parameters related to the treatment, d_0 and d_1. The two specifications differ in the number of interactive parameters: one of them interacts the intensity of use with a trend (Time) and the indicators of the periods after $t = 14$ at which the announcement of the treatment was made. In contrast with what we obtained in the reduced form estimation those parameters are not significant. Announcements of the treatment do not seem to have significant effects when a complete structural model is estimated. This is why we also report results without including those interactions. In contrast, other characteristics of the month like the number of business days and whether the month starts or ends a week day before Friday are significant. Their magnitudes are less significant than in the reduced form but effects are qualitatively similar.

Turning to the treatment effects, we also obtain qualitatively similar results. The permanent treatment effect is negative and estimated to lie between 30 and 40% (i.e. the 95% confidence interval) while the short-run effect is also negative albeit slightly lower (between 5 and 16%). Furthermore, there is some evidence of decreasing treatment effects with the intensity of use. When the number of withdrawals reaches the maximum number of foreign withdrawals per month in the sample, treatment effects become roughly equal to zero. This might mean that a large intensity of use signal customers who use their account in a slightly different ways than others.

Table 8 reports the results of counterfactuals by summarizing demand (i.e. the number of foreign withdrawals) by the number of treated accounts i.e. the number of accounts above the threshold. We also report summaries of two profit components: the profit earned from imposing the fee and the costs of interchange due to foreign withdrawals by bank customers and they are reported as profits per account and per month. First, the proportion of treated remains the same across experiments in which fees change since only observations for which the intensity of use is above the threshold are affected by the reform (see equation (2)). Its level at 4% is marginally less than what is observed in the data for the treatment periods ($t = 23/28$). In contrast, the number of treated accounts is strongly increasing when the threshold is decremented by one or two units and in particular in the latter case, the number of treated accounts reaches 17%. This explains why expected profits increase more when the threshold is affected than when the fee is increased. Expected profit when the threshold is decreased by 2 units reaches almost two thirds of the costs in interchange fees that the bank pays to other banks for their customers' foreign withdrawals. As said, increasing the fee has a more modest ccontribution since the proportion of treated remains low at 4%. Doubling the fee makes expected profit increase by less than 100 % (87%) and this is due to the decreasing demand because of the higher fee but for the treated only. It is indeed much more profitable to tax a larger base of customers than to impose higher fees on a small group of them.

5 Conclusion

In this paper, we adopted a two-stage empirical strategy. We first show with the help of a reduced form exercise how strong behavioral responses on foreign withdrawals are elicited in the natural experiment defined by the introduction of foreign fees. We also report that substitution effects across means of payment in terms of numbers or amounts are small except intriguingly for card payments. Second, we estimate a structural model that allows us to reconstruct the effect of hypothetical scenarii in which we change the level of fees or of thresholds used in the pricing schedule. It shows that decreasing thresholds of payments increases expected profits much more than increasing fees since the tax base is much larger.

This paper does not adress normative issues and in particular the issue of inefficiency of cash with respect to card payments. We would need to evaluate parameters which, to our knowledge, do not seem to be available in the current literature. It is also limited in the sense that it focusses on the short run impacts of increasing fees and neglects what could be the long run effects of installing new ATMs as in Gowrisankaran and Krainer (2011) or Donze and Dubec (2011). Nonetheless, in this period, the ATM market was already quite mature and the number of ATMs was if anything decreasing in this market.

On the methodological side, other improvements might be in order for future work. Models that we develop use standard linear techniques while the number of withdrawals is a discrete variable. Expected profits given the piece-wise linear price schedule is also driven by behavior at the extremes of the distribution and linear models might need to be adapted to capture these effects. It would be interesting in particular to develop econometric tools that dispense with parametric assumptions altogether, as in Pakes, Ho, Ishii and Porter (2011) in which it is shown that a similar set up leads to partial identification of the parameters of interest.

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A Structural estimation

A.1 Estimating equation

Define:

$$m_{it} = n_0 - \tau_t - \gamma_i g(t, \theta)$$

and write:

$$\begin{aligned} E((\gamma_{it} - n_0)\mathbf{1}\{\gamma_{it} > n_0\}\delta_{it} \mid \gamma_{it}) = & \quad d_{0t} E((\gamma_{it} - n_0)\mathbf{1}\{\gamma_{it} > n_0\} \mid \gamma_{it}) \\ + & \quad d_1 E((\gamma_{it} - n_0)^2 \mathbf{1}\{\gamma_{it} > n_0\} \mid \gamma_{it}). \end{aligned}$$

Define:

$$\begin{aligned} h_0(m_{it}, \sigma_t) &= E((\gamma_{it} - n_0)\mathbf{1}\{\gamma_{it} \geq n_0\} \mid m_{it}) = E((-m_{it} + \varepsilon_{it})\mathbf{1}\{\varepsilon_{it} \geq m_{it}\} \mid m_{it}), \\ &= -m_{it}\Phi(-m_{it}/\sigma_t) + \int_{\varepsilon_{it} \geq m_{it}} \frac{1}{\sqrt{2\pi}\sigma_t} \varepsilon_{it} \exp(-\varepsilon_{it}^2/2\sigma_t^2) d\varepsilon_{it}, \\ &= -m_{it}\Phi(-m_{it}/\sigma_t) - \frac{\sigma_t}{\sqrt{2\pi}} \left[\exp(-\varepsilon_{it}^2/2\sigma_t^2)\right]_{\varepsilon_{it} \geq m_{it}}, \\ &= -m_{it}\Phi(-m_{it}/\sigma_t) + \frac{\sigma_t}{\sqrt{2\pi}} \exp(-m_{it}^2/2\sigma_t^2). \end{aligned}$$

We can also write:

$$\begin{aligned} h_1(m_{1t}, \sigma_t) &= E((\gamma_{it} - n_0)^2 \mathbf{1}\{\gamma_{it} > n_0\} \mid \gamma_{it}) = E((-m_{it} + \varepsilon_{it})^2 \mathbf{1}\{\varepsilon_{it} \geq m_{it}\} \mid m_{it}), \\ &= m_{it}^2 \Phi(-m_{it}/\sigma_t) - 2m_{it} \frac{\sigma_t}{\sqrt{2\pi}} \exp(-m_{it}^2/2\sigma_t^2) + A. \end{aligned}$$

in which by integration by parts

$$\begin{aligned} A &= \int_{\varepsilon_{it} \geq m_{it}} \frac{1}{\sqrt{2\pi}\sigma_t} \varepsilon_{it}^2 \exp(-\varepsilon_{it}^2/2\sigma_t^2) d\varepsilon_{it} \\ &= -\left[\frac{\sigma_t}{\sqrt{2\pi}} \varepsilon_{it} \exp(-\varepsilon_{it}^2/2\sigma_t^2)\right]_{\varepsilon_{it} \geq m_{it}} + \int_{\varepsilon_{it} \geq m_{it}} \frac{\sigma_t}{\sqrt{2\pi}} \exp(-\varepsilon_{it}^2/2\sigma_t^2) d\varepsilon_{it}, \\ &= m_{it} \frac{\sigma_t}{\sqrt{2\pi}} \exp(-m_{it}^2/2\sigma_t^2) + \sigma_t^2 \Phi(-m_{it}/\sigma_t). \end{aligned}$$

Summarizing:

$$E((\gamma_{it} - n_0)^2 \mathbf{1}\{\gamma_{it} > n_0\} \mid \gamma_{it}) = (m_{it}^2 + \sigma_t^2)\Phi(-m_{it}/\sigma_t) - m_{it} \frac{\sigma_t}{\sqrt{2\pi}} \exp(-m_{it}^2/2\sigma_t^2).$$

The final equation is thus:

$$E(y_{it} \mid m_{it}) = m_{it} - \mathbf{1}\{t \geq T\} h(m_{it}, \sigma_t),$$

in which :

$$h(m_{it}, \sigma_t) = d_{0t} h_0(m_{it}, \sigma_t) + d_1 h_1(m_{it}, \sigma_t).$$

A.2 Iterative Algorithm

A possible strategy is to follow these steps:

1. *Initialization:* Using $t < T_D$ the date of the treatment, estimate γ_i, and σ_t. Specifically:

   (a) Take deviations with respect to time means of y_{it} and deviations of z_t and set

   $$\hat{\tau}_t^{(0)} = y_{.t} = \frac{1}{n}\sum_{i=1}^{n} y_{it}.$$

   (b) Average over 1 to $T_D - 1$, to get:

   $$\hat{\gamma}_i^{(0)} = y_{i.} = \frac{1}{n}\sum_{t=1}^{T} y_{it}.$$

   (c) In $g(t, \theta) = 1 + z_t\theta$, set $\hat{\theta}^{(0)} = 0$ and:

   $$(\hat{\sigma}_t^{(0)})^2 = \frac{1}{n}\sum_i (y_{it} - \hat{\gamma}_i^{(0)} - \hat{\tau}_t^{(0)})^2.$$

2. From step k estimates, $\hat{\gamma}_i^{(k)}, \hat{\theta}^{(k)}, \hat{\sigma}_t^{(k)}, \hat{\tau}_t^{(k)}$ and using the full sample, estimate step $k+1$ parameters $\hat{\gamma}_i^{(k+1)}, \hat{\theta}^{(k+1)}, \hat{\sigma}_t^{(k+1)}, \hat{\tau}_t^{(k+1)}$, $\hat{d}_0^{(k+1)}$ and $\hat{d}_1^{(k+1)}$ in the following way.

   (a) Compute the estimated $\hat{m}_{it}^{(k)} = n_0 - \hat{\tau}_t^{(k)} - \hat{\gamma}_i^{(k)} g(t, \hat{\theta}^{(k)})$ and estimates of functions $h_0(\hat{m}_{it}^{(k)}, \hat{\sigma}_t^{(k)})$ and $h_1(\hat{m}_{it}^{(k)}, \hat{\sigma}_t^{(k)})$.

   (b) Regress $y_{it} - \hat{\gamma}_i^{(k)} g(t, \hat{\theta}^{(k)}) - \hat{\tau}_t^{(k)}$ on h_0 and h_1 interacted with treatment dummies to get $\hat{d}_0^{(k+1)}$ and $\hat{d}_1^{(k+1)}$.

   (c) Predict the residual of this regression and add to it $(\hat{\gamma}_i^{(k)} g(t, \hat{\theta}^{(k)}) + \hat{\tau}_t^{(k)})$. Set $\hat{\tau}_t^{(k+1)}$ to the time means of this variable and denote $\hat{y}_{it}$ the deviation of this variable wrt to the time means.

   (d) Average $\hat{y}_{it}$ over 1 to T, to get:

   $$\hat{\gamma}_i^{(k+1)} = \hat{y}_{i.}.$$

   (e) Construct the interactions $z_t\hat{\gamma}_i^{(k+1)}$ and estimate the equation:

   $$\hat{y}_{it} = \hat{\gamma}_i^{(k+1)} + z_t\hat{\gamma}_i^{(k+1)}\theta + \tilde{\varepsilon}_{it}$$

   and retrieve estimates $\hat{\theta}^{(k+1)}$.

   (f) Predict the residuals of this regression and from them compute an estimate $\hat{\sigma}_t^{(k+1)}$.

3. Repeat the previous step until convergence in terms of parameters.

If this converges, this is the final estimate. We can then do a Newton-Raphson step to get an efficient estimate.

A.3 Simulating residuals

Given estimates of the model, we simulate residuals conditional on residuals observed in the data. For the periods before treatment this is easy since:

$$y_{it} = \gamma_{it} = \tau_t + \gamma_i(1 + z_t\theta) + \sigma_t u_{it}.$$

Therefore we use estimates of τ_t, σ_t, γ_i and θ to derive residuals $\hat{u}_{it}$ for $t = 1$ to 20. For the periods after treatment, we use a different strategy. Using equation (2) we have that:

$$y_{it} = \gamma_{it} - (\gamma_{it} - n_0)\mathbf{1}\{\gamma_{it} > n_0\}(d_{0t} + d_1(\gamma_{it} - n_0)). \tag{6}$$

and thus

$$E(y_{it} \mid \tau_t, \gamma_i(1+z_t\theta), \sigma_t) = \tau_t + \gamma_i(1+z_t\theta) - d_{0t}h_0(n_0 - \tau_t - \gamma_i(1+z_t\theta), \sigma_t) - d_1 h_1(n_0 - \tau_t - \gamma_i(1+z_t\theta), \sigma_t).$$

Denote:

$$\hat{v}_{it} = y_{it} - \hat{E}(y_{it} \mid \tau_t, \gamma_i(1 + z_t\theta), \sigma_t) \tag{7}$$

in which $\hat{E}$ is obtained by replacing parameters by their estimates. By using equations (6) and (7), we get an evaluation of residuals $\hat{u}_{it}$ which are given by:

$$\hat{v}_{it} = \hat{\sigma}_t\hat{u}_{it} + (\hat{\sigma}_t\hat{u}_{it} - \hat{m}_{it})\mathbf{1}\{\hat{\sigma}_t\hat{u}_{it} > \hat{m}_{it}\}(\hat{d}_{0t} + \hat{d}_1(\hat{\sigma}_t\hat{u}_{it} - \hat{m}_{it})),$$

if we set

$$\hat{m}_{it} = \hat{\tau}_t + \hat{\gamma}_i(1 + z_t\hat{\theta}).$$

This yields under some conditions that are verified in our data:

$$\begin{cases} \hat{u}_{it} = \frac{\hat{v}_{it}}{\hat{\sigma}_t} & \text{if } \hat{v}_{it} \leq \hat{m}_{it}, \\ \hat{u}_{it} = \frac{-(1+\hat{d}_{0t}) + \sqrt{(1+\hat{d}_{0t})^2 - 4\hat{d}_1(\hat{m}_{it} - \hat{v}_{it})}}{2\hat{d}_1\hat{\sigma}_t} & \text{if } \hat{v}_{it} > \hat{m}_{it}, \end{cases}$$

for all $t = 21$ to 28. We thus have a sequence of residuals $\{\hat{u}_{it}\}_{t=1,.,28}$ that we use for simulation purposes by drawing into this distribution. To obtain standard errors, we bootstrap the whole process by clustering at the account level.

TABLES

Table 1: Summary Statistics

	Mean	Std. Dev.	Min	Max
Nb Foreign ATM Withdrawals	1.57	2.43	0	49
Nb Own bank ATM Wdwls	1.84	3.01	0	89
Nb ATM Withdrawals	3.43	4.10	0	94
Nb Card Payments	11.43	11.06	0	509
Nb Desk Withdrawals	.252	.797	0	31
Nb Cheques	2.33	4.06	0	145
Amount Foreign ATM Wdwls	83.21	140.98	0	4500
Amount Own bank ATM Wdwls	155.29	283.14	0	11200
Amount ATM Withdrawals	238.50	322.20	0	12000
Amount Card Payments	433.37	500.66	0	21606.33
Amount Desk Withdrawals	89.96	600.47	0	310000
Amount Cheques	430.84	2652.65	0	619041

Source: 60000 accounts. Notes: Amounts are in current euros.

Table 2: Frequency of Foreign ATM withdrawals per period

Foreign w.	T = 1-13	T = 14-17	T = 18-20	T = 21-22	T = 23-28	Total
0	44.84	46.32	45.73	48.02	50.91	46.67
1 to n0-2	39.55	38.93	38.42	37.60	36.55	38.56
n0-1 to n0	8.39	7.91	8.50	7.75	7.19	8.03
n0+1 to n0+4	5.43	5.12	5.49	4.98	4.12	5.08
Over n0+4	1.79	1.72	1.87	1.66	1.23	1.66
Total	100.00	100.00	100.00	100.00	100.00	100.00

Source: 60000 accounts

Notes: T = 1-13 denotes the pre-treatment period, T = 14-17 and T = 18-20 the two interim periods and T = 21-22 and T = 23-28 the two treatment periods

Table 3: Treatment effects using month controls

	OLS	FGLS	OLS	OLS
Intensity of use	Mean T=1/9	Mean T=1/9	Median T=1/9	Q3 T=1/9
T = 14/17	-0.061***	-0.057***	-0.055***	-0.045***
	(0.006)	(0.006)	(0.005)	(0.004)
T = 18/20	-0.083***	-0.095***	-0.076***	-0.062***
	(0.007)	(0.007)	(0.007)	(0.006)
T = 21/22	-0.175***	-0.174***	-0.163***	-0.130***
	(0.009)	(0.009)	(0.009)	(0.007)
T = 23/28	-0.248***	-0.243***	-0.229***	-0.184***
	(0.008)	(0.007)	(0.007)	(0.006)
Begin Mon/Thu	0.014***	0.017***	0.013***	0.010***
	(0.003)	(0.003)	(0.003)	(0.002)
End Mon/Thu	-0.037***	-0.027***	-0.033***	-0.029***
	(0.004)	(0.004)	(0.004)	(0.003)
Nb BusinessDays	0.006***	0.008***	0.006***	0.004***
	(0.001)	(0.001)	(0.001)	(0.001)
R2	0.340		0.316	0.318
Number of obs.	1140000	1140000	1140000	1140000

Source: 60000 accounts, Periods = 10-28.

Notes: Treatments are defined as periods, T = 14-17 and T = 18-20 are the two interim periods and T = 21-22 and T = 23-28 the two treatment periods

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 4: Treatment effects: Two samples

	Working sample	Sample 2
Intensity of use	Mean T=1/12	Mean T=1/12
T = 14/17	-0.041***	-0.064***
	(0.008)	(0.008)
T = 18/20	-0.094***	-0.132***
	(0.009)	(0.010)
T = 21/22	-0.171***	-0.180***
	(0.011)	(0.012)
T = 23/28	-0.251***	-0.257***
	(0.010)	(0.010)
Begin_Mon/Thu	0.018***	0.017***
	(0.003)	(0.003)
End_Mon/Thu	-0.023***	-0.005
	(0.004)	(0.004)
Nb_BusinessDays	0.011***	0.015***
	(0.002)	(0.002)
N	960000	960000

Source: Two working samples, T=13/28

Notes: Treatments are defined as periods, T = 14-17 and T = 18-20 are the two interim periods and T = 21-22 and T = 23-28 the two treatment periods

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 5: Substitution effects between number of operations

	Nb Home ATM Wtdrwals.	Nb Card Paymts	Nb Desk W.	Nb Cheques
Fixed effect	0.100***	0.852***	-0.006***	0.023***
	(0.003)	(0.009)	(0.001)	(0.002)
IV(1) Fixed effect	-0.038***	0.520***	0.001	0.022*
	(0.009)	(0.030)	(0.003)	(0.010)
IV(2) Fixed effect	-0.027**	0.505***	-0.001	0.029*
	(0.010)	(0.033)	(0.003)	(0.011)
Nb of obs.	1140000	1140000	1140000	1140000

Source: Sample 1, Periods = 10-28.

Notes: The same control variables as in Table 4 are also included as covariates.

IV(1): The four treatment period dummies interacted with mean foreign withdrawals from t=1 to 9.

IV(2): "Permanent" treatment period dummy, t=23 to 28, interacted with mean foreign withdrawals from t=1 to 9.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 6: Impacts of treatment on amounts

	Foreign ATM Wtdrwals.	Home ATM Wtdrwals.	Card Paymts	Desk W.	Cheques
Fixed Effect	-43.623***	-3.266***	-25.235***	-1.397***	-4.750***
	(0.172)	(0.201)	(0.325)	(0.341)	(1.036)
IV(1) Fixed effect	-15.227***	4.718***	-7.626***	5.407*	11.911
	(0.431)	(0.962)	(1.587)	(2.475)	(12.371)
IV(2) Fixed effect	-5.204***	4.193***	-7.697***	6.359*	15.647
	(0.520)	(1.052)	(1.735)	(2.707)	(13.527)
N	1140000	1140000	1140000	1140000	

Source: Sample 1, Periods = 10-28.

Notes: The same control variables as in Table 4 are also included as covariates.

IV(1): The four treatment period dummies interacted with mean foreign withdrawals from t=1 to 9.

IV(2): "Permanent" treatment period dummy, t=23 to 28, interacted with mean foreign withdrawals from t=1 to 9.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 7: Structural model

Structural model	Model 1	Model 2
Treatment t= 21-22	-0.102	-0.105
	[-0.167, -0.0431]	[-0.168, -0.0422]
Treatment t= 23-28	-0.352	-0.358
	[-0.431, -0.292]	[-0.419, -0.302]
Intensity	0.00924	0.00982
	[0.00275, 0.022]	[0.0036, 0.0202]
Begin Mon/Thu	0.0189	0.0189
	[0.0131, 0.0245]	[0.0132, 0.0248]
End Mon/Thu	-0.0166	-0.0167
	[-0.0238, -0.0102]	[-0.0239, -0.0103]
Nb BusinessDays	0.0207	0.0203
	[0.0182, 0.0228]	[0.0181, 0.0225]
Time	-0.000431	
	[-0.00172, 0.000863]	
Period t=14-28	0.00794	
	[-0.0141, 0.0257]	

Source: Sample of 60000 accounts, Periods = 1-28.
Parameters are defined as in equations (4) and (5): The first three coefficients are d_{0t}, d_1 in (4) and the following coefficients refer to the z variables in (5). Standard errors are computed by bootstrap (399 replications) and confidence intervals are constructed using 2.5 and 97.5 percent bootstrap quantiles.

Table 8: Counterfactuals

Counterfactuals	Proportion of treated	Profit from Fee	Costs of Interchange
No treatment			-0.727
			[-0.743, -0.71]
Current treatment	0.0404	0.188	-0.708
	[0.0387, 0.0418]	[0.175, 0.197]	[-0.717, -0.697]
Fee: +50 percent	0.0404	0.271	-0.702
	[0.0387, 0.0418]	[0.256, 0.283]	[-0.71, -0.692]
Fee: +100 percent	0.0404	0.351	-0.697
	[0.0387, 0.0418]	[0.333, 0.364]	[-0.705, -0.689]
Threshold: -1	0.0796	0.288	-0.697
	[0.0766, 0.0839]	[0.276, 0.301]	[-0.705, -0.688]
Threshold: -2	0.172	0.472	-0.67
	[0.169, 0.175]	[0.461, 0.48]	[-0.677, -0.661]

Parameter estimates are taken from Table 7, column 1

Standard errors are computed by bootstrap (399 replications) and confidence intervals are constructed using 2.5 and 97.5 percent bootstrap quantiles.