

Estimating price elasticities on the Hungarian consumer lending and deposit markets: demand effects and possible consequences*

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This draft November 2008

Abstract

In this paper, we estimate a random-coefficient logit model (RCL) to calculate price elasticities on the Hungarian consumer lending and deposit markets, in line with the most recent developments in the literature on discrete choice demand estimation. The results suggest that consumers' price sensitivity differs, in that wealthier clients are less sensitive to lending and deposit interest rate fluctuations than customers located in the lower end of the income distribution. The findings also indicate that there is an asymmetric substitution effect towards foreign currency denominated loans as a result of the price increase of domestic currency denominated credits (i.e. the rise in domestic interest rates increases demand for FX loans more than vice versa). The results also show that the demand reaction of both credit and deposit products to the price change of a 'closer' substitute is stronger than the reaction to the price change of a 'far' substitute. Furthermore, the findings suggest that, on average, demand for domestic currency denominated credit is more price sensitive than demand for FX loans. Finally, due to the substitution effects among credits denominated in different currencies, the strength of the two main monetary transmission channels (i.e. the interest rate and exchange rate channels) and financial stability can also be affected, as the portfolio share of FX debt reacts to the price change of HUF-denominated loans.

JEL: L10, G21, E52

Keywords: demand elasticity, random coefficient logit model, monetary policy, financial stability

* I wish to thank Balázs Vonnák for his helpful comments and excellent discussion. The author assume sole responsibility for any remaining errors.

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1 Introduction

Banks play a significant role in economic processes, but their function is especially important in countries where economic agents have limited opportunities to access other forms of financing (i.e. underdeveloped capital markets). In such economies, the pricing decisions of financial institutions may considerably influence the consumption and investment behaviour of depositors and borrowers, and finally the evolution of GDP and inflation. However the intensity of real economic impacts of banks' pricing decisions depends on the strength of the price sensitivity effects on the loan and deposit markets.

In this paper, we examine the most recent developments in the discrete choice demand estimation literature¹ – e.g. Berry (1994), Berry, Levinsohn and Pakes (1995) (hereinafter BLP), Nevo (2001), Ho (2007), and Zhou (2007) – and estimate a random-coefficient logit model (RCL) to calculate own and cross-price elasticities on the Hungarian consumer lending and deposit markets, and investigate the possible monetary policy and financial stability implications of these price sensitivity effects.

Banks' decisions on the interest rates on their assets and liabilities influence the real economy through three main mechanisms. The first is the so called own and cross-price elasticity effect; that is the effect of price changes on the 'own' deposit/loan product level demand, demand for substitutes and their real economic consequences (i.e. less price sensitive deposit/loan demand does not significantly influence the consumption and investment behaviour of economic agents). The second mechanism is the income effect, meaning changes in the earnings and expenditures of agents as a result of varying interest rates. As a direct income effect, the change in realised yields on deposits and debt servicing costs can be mentioned, while as an indirect effect one can cite those multiplier mechanisms which are induced by consumption and investment financed from credit (i.e. inflation and real incomes are also affected through the effect on aggregate demand). Finally, the last mechanism is the wealth effect: changes in the value of real and financial assets of economic agents.

Loan and deposit interest rates can vary from several reasons. The evolution of loan interest rates are influenced by changing funding costs, credit risk and the degree of competition on the credit market for instance, while deposit rates are also affected by the degree of deposit market competition and the availability of alternative (external) funding possibilities (i.e. domestic and/or foreign interbank and capital markets). In this study we do not analyse what factors are behind product level deposit and/or loan interest rates changes (i.e. monetary policy,² varying credit risk, changing market structure, etc.); we treat these factors as exogenous. Nevertheless, we try to look at the possible monetary policy and financial stability implications of product level interest rate changes.³

In respect of the monetary policy consequences of interest rate changes, we primarily consider how the strength of the two main monetary transmission channels (i.e. the interest rate and exchange rate channel) might be affected by the intensity of own-price sensitivity of loan demand and substitution between domestic and foreign currency denominated loans.⁴ The less price sensitive loan demand is, the less the evolution of interest rates affects the consumption and investment decisions of economic agents, and aggregate demand and inflation.

¹ The roots of discrete choice demand estimation go back to the logit demand model of McFadden (1973), further developed by Goldberg (1995), Berry (1994), Berry, Levinsohn and Pakes (1995) and Nevo (2001).

² According to Horváth et al. (2004), about 80 percent of money market rate fluctuations is built into the interest rates of consumer loans.

³ It has to be noted that, irrespectively of the source of 'price variation', the same conclusion can apply regarding monetary policy and financial stability.

⁴ Factors that might influence the effectiveness of monetary policy are the share of foreign currency denominated credits within the consumer loan stock or the level of competition, which has an impact on the speed of adjustment.

One consequence of substitution between domestic and foreign currency denominated loans may be a portfolio realignment effect in favour of foreign currency denominated loans as a result of the ‘price’ increase of domestic currency denominated credits (i.e. the relative prices, and as a result demand for domestic currency denominated and FX loans changes).⁵ The substitution between domestic and foreign currency denominated credits can react to the effectiveness of both the interest and exchange rate channels. The interest rate channel is directly influenced by the increasing portfolio share of FX debt, while over the short run the exchange rate channel can weaken as well. For instance, restrictive monetary actions can result in exchange rate appreciation, decreasing the debt servicing costs of FX debt holders and expanding their consumption possibilities, which can entail short-term inflation risks.

The implications for financial stability are not independent of the aforementioned factors, namely the substitutability between domestic and foreign currency denominated products. On the one hand, Holló and Papp (2007) showed that Hungarian household loan portfolio quality is sensitive to exchange rate depreciation, as a result of the denomination structure of the portfolio.⁶ On the other hand, the relatively large share of FX debt can be further increased by strong substitution towards FX-type products, thereby further increasing the exposure of the portfolio to direct exchange rate risk and indirect credit risk (i.e. changes in households’ debt servicing costs as a result of exchange rate movements).

The novelty of this study is that it employs – for the first time to our knowledge – the random coefficient logit (RCL) methodology to calculate substitution patterns between various consumer credit and deposit products. The main reason for the application of this framework lies not in its computational simplicity, but rather in its other important and favourable properties, which are often neglected in demand estimations. These are as follows:

- It handles the problem of ‘representative agent’ models⁷ in the ‘product’ space, namely using the RCL methodology consumer’s utility is determined not by the product *per se*, but by its characteristics;
- It is possible to aggregate up individual purchases from the observed distribution of consumer characteristics without observing ‘true’ individual purchase decisions. That is, we allow different consumers to have different income, age, education, etc. Then we formulate the demand system (i.e. RCL) conditional on consumers’ characteristics and parameter vectors which determines the relationship between the selected attributes and preferences over product characteristics;

⁵ It is well known that the effectiveness of monetary policy is weakened by the increasing share of FX debt within the loan stock. But it should be noted that the portfolio share of FX debt might increase not just as a result of substitution effects between domestic and foreign currency denominated loans, as the share of FX debt can rise even when the cross-price effects are zero. This latter might happen if it is administratively assessed not to take credit in domestic currency.

⁶ In relation to the effects of the exchange rate risk it is important to mention that it represents a significant risk, if exchange rate depreciation is substantial and long-lasting. The underlying explanation is that households can more or less withstand the effects of temporary significant exchange rate depreciation by reducing consumption expenditure, which may entail a restructuring of consumption (substitution effect, shift towards consuming cheaper products) or a reduction of the volume of consumption and the use of financial reserves, while maintaining an unchanged structure of consumption. Regarding the denomination structure, the domestic/foreign currency composition by end-2007 was approximately 41/59 per cent. However, in the case of new loans an over 90 per cent dominance of foreign currency denomination can be observed.

⁷ As noted by Spence (1976), neoclassical demand models do not capture the heterogeneity in consumer tastes and often assume that consumers are either identical or an ‘average’ consumer exist which has a demand function that satisfies the conditions specified by economic theory. However, the homogeneity assumption seems to be quite restrictive and has often proven to be empirically questionable. Moreover, the economic and policy implications of a model, which does not reflect individual heterogeneity and one that explicitly captures individual heterogeneity might be substantially different as consumer tastes for product attributes will necessarily affect demand at the company level, and as a result market and aggregate demand.

- It handles the dimensionality problem⁸ in the earlier literature on differentiated product demand systems by projecting the products onto a space of characteristics, making the relevant size the dimension of this space and not the square of the number of products;
- Finally, and most importantly it produces more realistic demand elasticities (i.e. demand elasticities are driven by the similarity in product characteristics) when compared to standard neoclassical differentiated product demand models.

In addition to its favourable attributes, the weaknesses of the RCL should also be mentioned, as these might be restrictive in some cases. The two main shortcomings of the model relate to multiple choices and dynamic demand. The impact of these, however, depends on the market being analysed and the issues the researcher is focusing on.

Regarding the first point, we do not think that it imposes a true restriction for the issue being analysed, as neither credit nor deposit services are typically products, of which more than one is 'consumed' at a time. Although there might be situations in which a client takes multiple credit products either if he or she has payment problems, or if new claims arise, from our viewpoint it is the timing of these actions which matters, and usually this does not coincide with the date when the 'first' credit is taken.

The problem of dynamic demand usually occurs with either durable, storable or experience goods. Models that are appropriate for dynamic demand estimation can become quite complex, since they often require forward-looking consumers, whose behaviour depends on the possible distribution of future as well as current offerings. In addition, these future offerings would, in turn depend on producers' perceptions of consumer demand (for an application of dynamic demand estimation, see Hendel and Nevo (2002) for instance).

In our case, neglecting dynamics – especially the dynamic pricing behaviour of banks – is the main drawback of the employed framework. However, whether it is a 'true' limitation or not depends on the share of forward-looking agents (i.e. banks and customers), which is a conundrum. Furthermore, it is important to note that the model provides valuable information on the structural realignment of the credit and deposit markets, which occurs via substitution effects as a result of product price changes.

All in all, we believe that the favourable attributes of the RCL more than offset its weaknesses, which is also supported by the following policy-relevant main empirical findings:

- The results show that consumers' price sensitivity differs, namely wealthier clients are less sensitive to lending and deposit interest rate fluctuations than customers located in the lower end of the income distribution.
- Empirical evidence is found that there is an asymmetric substitution effect towards foreign currency loans as a result of the price increase of domestic currency denominated credits (i.e. the rise in domestic interest rates increases demand for FX loans more than vice versa). In addition, the results also show that the demand reaction of both credit and deposit products to the price change of a 'closer' substitute is stronger than to the price change of a 'far' substitute. Furthermore, the findings suggest that, on average, demand for domestic currency denominated credit is more price sensitive than demand for FX loans.
- Finally, due to substitution effects between credits denominated in different currencies, the strength of the two main monetary transmission channels (i.e. the interest rate and

⁸ To see the dimensionality problem, consider a constant elasticity demand system in which quantities are linear functions of own price and price of competitive products and no other covariates are included. If we have 50 differentiated products; then without additional restrictions this implies estimating at least 2500 parameters (demand equations for each product, with 50 prices in each).

exchange rate channels) and financial stability can also be affected, since the share of FX debt rises as a result of the price increase of HUF-denominated loans.

The remainder of the paper is organised as follows. In Section 2 we provide the theoretical setup. Section 3 presents the empirical analysis and, finally Section 4 offers a concluding summary.

2 Model setup

In this section, we provide a technical overview of the employed random coefficient logit demand (RCL) model. First, we describe the ‘ancestor’ of the RCL, namely the logit demand specification of McFadden (1973), which serves the purpose of presenting the ‘general’ idea behind discrete choice demand models, and by estimating it we are able to check its restrictiveness over the RCL specification.

2.1 The logit demand specification

Consider a market (or time period) with J different products, each product j has observed x_j and unobserved (by the econometrician) ξ_j characteristics and price p_j . Unobserved characteristics can include unobserved promotional activity, brand/firm equity or systemic demand shocks for instance. Depending on the data structure, some unobserved components can be captured by product and/or market (time) specific dummy variables.⁹ The conditional indirect utility of consumer i from consuming one unit of product j in market (or time period) t is as follows:

$$(1) \quad u_{ijt} = x_{jt}\beta - \alpha p_{jt} + \xi_{jt} + \varepsilon_{ijt}, \text{ or equivalently } u_{ijt} = \delta_{jt} + \varepsilon_{ijt},$$

where $\delta_{jt} = x_{jt}\beta - \alpha p_{jt} + \xi_{jt}$ is the mean utility, ε_{ijt} is an i.i.d. random variable from the extreme value distribution $\exp(-\exp(-\varepsilon))$. Consumer i chooses product j such that:

$$(2) \quad j = \arg \max(u_{i0t}, u_{i1t}, u_{i2t}, \dots, u_{iJt})$$

where u_{i0t} denotes the ‘utility’ from choosing the outside option, i.e. choosing services of other financial institutions. The existence of the outside option allows us to model aggregate demand for the market’s (or time period’s) products; in particular, it allows market demand to decline if all within-market prices rise.

When ε_{ijt} is from Type I extreme value distribution, the probability that consumer i chooses product j can be calculated as follows:

$$(3) \quad \Pr(i \text{ chooses } j) = \frac{\exp(x_{jt}\beta - \alpha p_{jt} + \xi_{jt})}{1 + \sum_{m=1}^J \exp(x_{mt}\beta - \alpha p_{mt} + \xi_{mt})}$$

As a firm’s pricing decision is based on its expectation about demand for its products, the expected aggregate demand can be equivalently expressed analytically as the sum of the firm’s probability assessment that consumers obtain the j^{th} product from the firm, that is:

⁹ The specification assumes that all consumers face the same product characteristics and are offered the same price. If this is not the case then this might lead to measurement error bias. However, this restriction in our specific problem is of no relevance, since for retail customers it is difficult to credibly show their creditworthiness, and if they can do so this usually cannot be validated in the pricing of the loan.

$$(4) s_{jt} = \frac{\exp(x_{jt}\beta - \alpha p_{jt} + \xi_{jt})}{1 + \sum_{m=1}^J \exp(x_{mt}\beta - \alpha p_{mt} + \xi_{mt})}, \text{ where } j = 1, \dots, J$$

The market share of the ‘outside option’ is:

$$(5) s_{0t} = \frac{1}{1 + \sum_{m=1}^J \exp(x_{mt}\beta - \alpha p_{mt} + \xi_{mt})}$$

By inserting expression (5) into expression (4), we get:

$$(6) s_{jt} = \exp(x_{jt}\beta - \alpha p_{jt} + \xi_{jt}) * s_{0t}$$

Taking the log of both sides of equation (6) and rearranging them yields:

$$(7) \log(s_{jt}) - \log(s_{0t}) = x_{jt}\beta - \alpha p_{jt} + \xi_{jt}$$

Estimation

The parameters to be estimated are β and α ; x_{jt} and p_{jt} (price) are observed ξ_{jt} are unobserved characteristics and are treated as an error term. As the price variable is likely to be correlated with unobserved product characteristics ($Cov(p, \xi) \neq 0$), instrumental variable estimation is necessary, which provides that $Cov(p, z) \neq 0$ and $Cov(\xi, z) = 0$, where z is the vector of instrumental variables. Equation (7) can be easily estimated by ordinary least squares regressions. In order to avoid the potential endogeneity problem of the price variable, the general method of moments (GMM) estimator is employed. In Section 2.3 details can be found on the employed instrument list.

Elasticities

The main advantage of the logit framework is its computational simplicity; it does, however, restrict the own- and cross-price elasticities to depend only on market shares.

The price elasticities from the logit specification can be computed as follows:

$$(8) \eta_{jkt} = \frac{\partial s_{jt} p_{kt}}{\partial p_{kt} s_{jt}} = -\alpha p_{jt} (1 - s_{jt}) \text{ if } i = j \text{ and } \eta_{jkt} = \frac{\partial s_{jt} p_{kt}}{\partial p_{kt} s_{jt}} = \alpha p_{kt} s_{kt} \text{ if } i \neq j$$

To see how restrictions occur, consider the factor $\alpha(1 - s_{jt})$ which is nearly constant as market shares are usually small. This means that own-price elasticities are proportional to the own price of the product (i.e. the lower (the higher) the price, the lower (the higher) the elasticity in absolute value). In addition, there are also problems with the logit model implied cross-price elasticities. To see this, consider a consumer loan market with three products: overdraft, foreign currency denominated home equity loans and domestic currency denominated home equity loans and further assume that the first two have similar market shares. Then, if the price of domestic currency denominated home equity loans increases, substitution towards either of the two other products will be the same. However, we expect that if the price of the domestic currency denominated home equity loans goes up, more consumers will substitute to another type of secured loan, because of the similar risk characteristics and the related price advantage compare to unsecured loans.

The problem stems from the i.i.d. structure of the random shock ε_{ijt} . This can be clarified through a simple example. Let us again consider a price increase in domestic currency

denominated home equity loans. The price increase negatively influences the utility of clients who previously chose this product. If the utility from this credit type decreases enough, the utility from the second choice (i.e. the second product in the preference ranking) will be higher. In the logit specification, the differences in rankings are due to the i.i.d. shock. As a result, the proportion of consumers who rank each product as their second choice is equal to the population average, which is the market share of each product. This problem can be solved by introducing ‘utility shocks’, which are correlated across products. This will ensure that the second choice of the consumer deciding to no longer take out a domestic currency denominated home equity loan will be different that of the average consumer. In other words, the correlation of utility shocks will ensure that the borrower in question will be more likely to take out a loan with similar attributes as the first choice. We return to the question of how to generate these correlations in the ‘elasticity’ part of the RCL description.

2.2 The random coefficient logit demand specification

In the logit demand specification above, it was assumed that consumer heterogeneity is captured by ε_{ijt} , the i.i.d. random variable. This means the presumption that the sources of variation in tastes are independent across individuals for a given product, and across products for given individuals. In the random coefficient logit (RCL) specification, we relax this restrictive assumption by taking into account the interactions between both observed and unobserved product and consumer characteristics.

Following Nevo’s (2001) notation, the conditional indirect utility of consumer i from consuming one unit of product j at market (or time period) t in the RCL framework can be expressed as follows:

$$(9) \quad u_{ijt} = x_{jt}\beta_i - \alpha_i p_{jt} + \xi_{jt} + \varepsilon_{ijt}$$

where x_{jt} and p_{jt} (price) are observed product characteristics, ξ_{jt} are unobserved characteristics, and ε_{ijt} is a mean-zero stochastic term. Finally, α_i and β_i are individual-specific coefficients.

Observed characteristics vary with the product being analysed. The model also describes how consumer preferences vary as a function of individual characteristics, which means that the distribution of individual taste parameters must be modelled. Similarly to brand characteristics, individual characteristics can be either observed or unobserved. We refer to demographic characteristics as observed, denoted by D_i , and additional attributes as unobserved, denoted by v_i . In respect of observed demographics, we can either have information about the distribution of the selected attributes from population/consumer surveys or if such information is not available, but we know the important moments of these demographics such as the mean and standard deviation, a parametric distribution can be assumed. In the case of unobserved demographics such information is not available. Unobserved attributes v_i might include things that can influence the decision-making of the consumer, but are unobserved by the econometrician (such attributes can include the individual’s relation to risk or the general financial situation of the individual that influence his or her credit market participation, etc.).

Consumers’ taste parameters for the characteristics can be modelled as follows:

$$(10) \quad \begin{pmatrix} \alpha_i \\ \beta_i \end{pmatrix} = \begin{pmatrix} \alpha \\ \beta \end{pmatrix} + \Pi D_i + \Sigma v_i \quad v_i \sim P_v^*(v) \quad D_i \sim \hat{P}_D^*(D)$$

where D_i is a $d \times 1$ vector of demographic variables, v_i is the unobserved demographics discussed above $P_v^*(v)$ is a parametric distribution (usually Type I extreme value as in the logit model's case) and $\hat{P}_D^*(D)$ is either a parametric or a nonparametric distribution, Π is a $(K+1) \times d$ matrix of coefficients and measures how the taste characteristics vary with demographics and Σ is a scaling matrix. The demand system specification is completed with the introduction of the outside good as in the logit specification above; consumers may decide not to purchase any of the products or to choose the services of other financial institutions. The indirect utility from this option is as follows:

$$(11) \quad u_{i0t} = \xi_0 + \pi_0 D_i + \sigma_0 v_{i0} + \varepsilon_{i0t}$$

The mean utility (i.e. ξ_0) of the outside good is normalised to zero. The advantage of normalisation is that it does not change the order of preferences over goods. The coefficients π_0 and σ_0 are not separately identified from the individual specific constant term in equation (9). Let $\theta = (\theta_1, \theta_2)$ be a vector containing all the model parameters. θ_1 includes the linear ones α , β and θ_2 contains the non-linear parameters Π and Σ . After combining equations (9) and (10), we obtain the following:

$$(12) \quad \begin{aligned} u_{ijt} &= \delta_{jt}(x_{jt}, p_{jt}, \xi_{jt}; \alpha, \beta) + \mu_{ijt}(x_{jt}, p_{jt}, v_i, D_i; \Pi, \Sigma) + \varepsilon_{ijt} \\ \delta_{jt} &= x_{jt}\beta - \alpha p_{jt} + \xi_{jt}, \mu_{ijt} = [p_{jt}, x_{jt}](\Pi D_i + \Sigma v_i) \end{aligned}$$

Based on equation (12), the indirect utility is expressed as a sum of the mean utility level which is common to all consumers δ_{jt} (i.e. it is independent of consumer characteristics), and the last two terms $\mu_{ijt} + \varepsilon_{ijt}$ represent the mean-zero heteroskedastic deviation from the mean utility, which captures the effects of the random coefficients.

Consumers are, by assumption, purchasing one unit of a good, which provides the highest utility. As within this framework, the individual is defined as a vector of demographics and product specific shocks, the set of individual attributes leading to the choice of product j can be formulated as follows:

$$(13) \quad A_{jt}(x_t, p_t, \delta_t; \Pi, \Sigma) = \left\{ \begin{array}{l} (D_i, v_i, \varepsilon_{i0t}, \dots, \varepsilon_{iJt}) | u_{ijt} \geq u_{ilt} \\ \forall l = 0, 1, \dots, J \end{array} \right\}$$

where $x_t = (x_{1t}, \dots, x_{Jt})'$, $p_t = (p_{1t}, \dots, p_{Jt})'$ and $\delta_t = (\delta_{1t}, \dots, \delta_{Jt})'$ are observed product characteristics, prices and mean utilities of all the products. The market share of product j is just an integral over the mass of consumers in the region A_{jt} :

$$(14) \quad s_{jt}(x_t, p_t, \delta_t; \Pi, \Sigma) = \int_{A_{jt}} dP^*(D, v, \varepsilon) = \int_{A_{jt}} dP^*(\varepsilon | D, v) dP^*(v | D) dP_D^*(D) = \int_{A_{jt}} dP_\varepsilon^*(\varepsilon) dP_v^*(v) d\hat{P}_D^*(D)$$

where $P^*(\cdot)$ denotes the population distribution function. In expression (14), Bayes' rule is applied, that is the independence of D , v and ε is assumed. For a given parameter set, the integral predicts the market share of each product in each market (or time period) as a function of product characteristics, prices and other unknown parameters. The integral is a generalisation of equation (4) in the logit specification above, that is it can be computed either analytically or numerically by making assumptions on the distribution of the individual attributes $(D_i, v_i, \varepsilon_{it})$.

Analytical evaluation of the integral presumes that consumer heterogeneity enters only through the separable additive random shocks ε_{ijt} (i.i.d. Type I extreme value) as noted above, which implies that $\Pi = 0$, $\Sigma = 0$, $\beta_i = \beta$, $\alpha_i = \alpha$ (i.e. the random coefficient model reduces to the simple logit described in Section 2.1).

Estimation

The appropriate estimation technique used to estimate the RCL depends on data availability and the market being modelled. If product level demand data and consumer survey information (either explicit survey data or summary statistics) on the selected demographics are available, the steps of the RCL estimation can be summarised as follows:

- **Step I:** Draw vectors of selected consumer characteristics from population or consumer surveys (if survey data are not available, but important moments of selected demographics are known a parametric distribution can be assumed); this must be done prior to estimation;
- **Step II:** Determine the choice that each of the selected individuals would make for a given value of the parameter vector;
- **Step III:** Aggregate those choices into a prediction of aggregate demand conditional on the parameter vector;
- **Step IV:** Apply a search routine that finds the parameter values, which ensure that these aggregate quantities match the observed market level demand as close as possible. (We have solved for the unobserved product characteristics ξ_{jt} as a function of the parameters, the data and the simulation draws.);
- **Step V:** Interact ξ_{jt} with the function of instruments Z and find the value of θ that makes the sample moments as close as possible to zero. (A general procedure of GMM estimation).

In the estimation, we search for a set of parameters $\theta_2 = (\Pi, \Sigma)$, which matches the observed market share $s(\delta_t; \theta_2) = S_t$ $t = 1, \dots, T$ to the model predicted market share, where S is the observed market share and $s(\delta_t; \theta_2)$ are the market shares given by equation (14). In order to compute the ‘predicted market shares’, the integral given in equation (14) must be computed numerically. By following BLP (1995), the integral can be approximated as follows:

Steps II-III

$$(15) \quad s_{jt}(x_t, p_t, \delta_t; \Pi, \Sigma) = \sum_{i=1}^{ns} \frac{\exp\left(\delta_{jt} + \sum_{k=1}^K x_{jt}^k (\sigma_k v_i^k + \pi_{k1} D_{i1} + \dots + \pi_{kd} D_{id})\right)}{1 + \sum_{m=1}^J \exp\left(\delta_{mt} + \sum_{k=1}^K x_{mt}^k (\sigma_k v_i^k + \pi_{k1} D_{i1} + \dots + \pi_{kd} D_{id})\right)}$$

where (v_i^1, \dots, v_i^K) and (D_{i1}, \dots, D_{id}) $i = 1, \dots, ns$ are draws¹⁰ from $\hat{P}_v^*(v)$ and $P_D^*(D)$ respectively and x_{jt}^k $k = 1, \dots, K$ are the variables that have random slope coefficients. Note that the simulation introduces simulation error, the variance of which decreases with ns .

¹⁰ In the numerical calculation of the integral we have simulated 500 individuals both on the consumer credit and deposit markets. The accuracy of the results were also checked by simulating 800 and 1,100 individuals, respectively. However, except for the running time, the parameter estimates did not show substantial quantitative differences.

Step IV

Steps IV finds the unique values of δ_{jt} (i.e. the mean utility level) that makes the predicted market shares for a given θ and a set of simulation draws equal to the ‘observed’ market shares as close as possible. BLP (1995) show iterating on the system of equations

$$(16) \quad \delta_{jt}^{h+1} = \delta_{jt}^h + \ln(S_{.t}) - \ln\left(s(p_{.t}, x_{.t}, \delta_{.t}^h, P_{ns}; \theta_2)\right) \quad t = 1, \dots, T \quad h = 0, \dots, H$$

where h is the smallest integer such that $\|\delta_{.t}^h - \delta_{.t}^{h-1}\|$ is smaller than some tolerance level and $\delta_{.t}^h$ is the approximation to $\delta_{.t}$. The model in (12) then implies that

$$(17) \quad \omega_{jt} = \delta_{jt}(S_{.t}; \theta_2) - (x_{jt}\beta + \alpha p_{jt}) \equiv \xi_{jt}$$

That is, we have solved for the unobserved product characteristics ξ_{jt} as a function of the parameters, the data and the simulation draws. In the estimation, we included bank-product dummy variables as product characteristics and time dummies to capture changes in macroeconomic conditions, which affect all banks at time t . Therefore, we decompose the unobserved product characteristics as follows: $\xi_{jt} = \xi_t + \zeta_{jt}$, where ξ_t and ζ_{jt} refer to time and bank-product dummies respectively. The inclusion of these dummies helps to improve the fit of the model and is especially useful when the researcher is unsure about which observed characteristics capture the true factors that determine utility.¹¹

Step V

The General Method of Moments (GMM) procedure is used to estimate the model. Formally we define a set of instruments $Z = [z_1, \dots, z_M]$ such that

$$(18) \quad E[Z_m \omega(\theta^*)] = 0 \quad m = 1, \dots, M \quad \text{or equivalently} \quad E[Z_m \xi(\theta^*)] = 0 \quad m = 1, \dots, M$$

where ω is the function of model parameters defined by equation (17), and θ^* denotes the ‘true’ parameter values. The GMM estimator utilising the moment conditions is defined as:

$$(19) \quad \hat{\theta} = \arg \min_{\theta} \omega(\theta)' Z \Phi^{-1} Z' \omega(\theta)$$

where Φ^{-1} is the optimal weighting matrix. In Section 2.3 details can be found on the employed instrument list.

Elasticities

As mentioned in Section 2.1, the main drawback of the logit demand specification is the restrictive substitution patterns it produces. In order to solve this problem, we need utility shocks to be correlated across products, which will ensure that the borrower in question will be more likely to take a loan with similar attributes compared to the first choice, if the price of the first choice increases. By examining equation (12), this correlation can be generated either through ε_{ijt} or through μ_{ijt} . The latter captures the effect of both observed D_i and unobserved v_i demographics. We turn our attention to modelling correlation between choices obtained through the observed demographics in μ_{ijt} . That is, we assume that the correlation of ‘utility shocks’ is a function of product and borrower characteristics, which will ensure that products with similar

¹¹ The inclusion of these dummies modifies to a small degree the estimation of the taste coefficients β . This means that in order to retrieve the taste coefficients the estimated brand effects were regressed on product characteristics, as in the minimum distance procedure of Chamberlain (1982). For details, see Nevo (2001).

attributes and borrowers with similar demographics will have similar product rankings and therefore substitution patterns.

The price elasticities of the market shares defined by equation (14) can be calculated as follows:

$$(20) \quad \eta_{jkt} = \frac{\partial s_{jt} p_{kt}}{\partial p_{kt} s_{jt}} = -\frac{p_{jt}}{s_{jt}} \int \alpha_i s_{ijt} (1-s_{ijt}) d\hat{P}_D^*(D) dP_v^* \quad \text{if } i = j \quad \text{and}$$

$$\eta_{jkt} = \frac{\partial s_{jt} p_{kt}}{\partial p_{kt} s_{jt}} = \frac{p_{kt}}{s_{jt}} \int \alpha_i s_{ijt} s_{ikt} d\hat{P}_D^*(D) dP_v^*(v) \quad \text{if } i \neq j$$

where $s_{ijt} = \frac{\exp(\delta_{jt} + \mu_{ijt})}{1 + \sum_{k=1}^K \exp(\delta_{kt} + \mu_{ikt})}$ is the probability that individual i purchasing product j .

Now elasticities are determined by the price sensitivity of each borrower, which will be averaged to mean price sensitivity using the individual specific probabilities as purchase weights. This also denotes that the price sensitivity of various products will be different. Since the model allows for flexible substitution patterns (i.e. the composite random shock $\mu_{ijt} + \varepsilon_{ijt}$ is not independent of product and consumer characteristics), this will ensure that in the event of a product price change, borrowers are more likely to switch to products with similar characteristics.

2.3 Demand instruments

Since equilibrium prices depend on observed and unobserved product characteristics, the price variable p_{jt} is correlated with the unobservable and might bias the parameter estimates. This problem can be handled by the instrumental variable or IV approach. In order to estimate the demand equation on both the consumer credit and deposit markets, the following set of instruments is used to identify the price coefficients:

$$(21) \quad Z = (\text{Administrative cost/Asset, Credit risk, Liquidity, Rival employee per branch, Rival branch number, Rival salary per employee})$$

The instruments consist of several cost shifters, which are valid instruments because they affect prices, but are not related to unobserved product characteristics. The first cost shifter is the ratio of administrative cost (includes all non-interest expenses) to total assets. Credit risk can be also considered as a cost shifter as high credit risk may require higher cost of operation due to monitoring and auditing, which shift up the cost function. Credit risk is proxied by the ratio of loan loss provisions to total loans. Furthermore, liquidity variables might be informative about credit risk and thus the cost function. Liquidity of banks is proxied by the ratio of cash and negotiable instruments to total assets.

Mark-up shifters were also used as instruments, which include other banks' characteristics such as the rival's employee per branch, rival's branch number, rival's salary per employee.¹² Given that the product characteristics are exogenous, these instruments are orthogonal to unobserved product characteristics.

¹² The rival banks' salary per employee indicator might reflect service quality through an indirect channel, namely employee's quality. If a bank pays high salaries it can be expected that the best prepared employees might choose to work there.

3 Empirical analysis¹³

In this section, we first describe the data set and define the variables used. We then present the empirical results of the demand estimations, namely the results obtained from the logit demand and the random coefficient demand/full model¹⁴ are presented for the consumer credit and deposit markets, respectively.

3.1 Data and variable description

In order to estimate the models previously described, product level data are necessary, which include market shares, prices of consumer loans, deposits and product characteristics (in our case bank characteristics) such as the number of branches and the age of the banks. These data come from the MNB banking database and cover the period between March 2004 and August 2007 for consumer loans,¹⁵ and January 2003 and August 2007 for deposits. In the analysis, we defined 15 lending and 3 deposit sub-markets, as follows: hire purchase HUF-denominated loans with short, maximum 5-year maturity, personal HUF- and CHF-denominated loans with short, maximum 5-year maturity and maturity over 5 years, overdraft, home equity HUF- and CHF-denominated loans with short, maximum 5-year maturity and maturity over 5 years, demand deposit, short-term and long-term deposits.¹⁶ Descriptive statistics on the consumer loan and deposit products can be found in Table A in the appendix.

As price proxies for the various loan products, the monthly interest rate on stocks is employed,¹⁷ while for deposits the prices are calculated as the difference between monthly deposit interest rates on stocks and service fees for deposits. This latter is approximated by the ratio of revenues from fees and commissions to the deposit stock.

Market shares are usually defined by using a quantity variable and its definition depends on the specific problem being analysed. Regarding the market share, the most important consideration in choosing the quantity variable is to define the market share of the outside good. The outside option is usually defined as the difference between the total market size and the shares of the inside good. The total market size in the case of the consumer loan and deposit markets are the total consumer loan¹⁸ and deposit amount of all the monetary financial institutions. Therefore,

¹³ The calculations were performed in MATLAB and STATA.

¹⁴ The term 'full model' is used as it allows the interactions between both observed and unobserved individual and product characteristics.

¹⁵ In the analysis of the consumer credit market, the period between March 2004 and August 2007 is covered, since the denomination composition of the various loan products is only available from March 2004.

¹⁶ It should be mentioned that as a result of the changing structure of the Hungarian banking sector and the strengthening of retail lending competition, both the number of banks and products varied over time. There were two mergers between 2003 and 2007, one in 2003 (Postabank and ERSTE) and one in 2005 (Konzumbank and MKB). Increasing competition on the retail lending market forced banks towards product innovation that mainly emerged in the introduction of new credit types (home equity type loans were mainly introduced in 2005 for instance) and the occurrence of FX type loans. FX products were adjusted for the exchange rate effect.

¹⁷ It has to be noted that the chosen price variable in the case of consumer credits does not show the 'real price' of loans. Loan prices are better approximated by APRs of newly originated products. We had a 'technical reason' of selecting the interest rates on stocks instead of the APRs for approximating the 'credit price'. The 'technical reason' was that APRs are only available for newly granted credits from which the outside option cannot be calculated, since data on new loans provided by all the MFIs are not available. As the outside option was computed by using the stock data, to be consistent the interest rates on stocks were employed. Furthermore, the interest rates are part of APRs, just their level differ, therefore using the latter might not influence the results (relative prices as well as consumer decisions remain unchanged).

¹⁸ The total consumer loan amount of monetary financial institutions also includes vehicle loans. In Hungary, vehicle loans are mainly distributed by financial enterprises. As it is not a 'typical banking product' including it in the calculations has no relevance. However, we have determined the market size in two ways; with and without vehicle loans to check the sensitivity of the results. This robustness check is especially important in the RCL model's case as the high share of the outside option might induce computational (i.e. convergence) problems. With vehicle loans, the mean share of the outside option was 37 percent (the share of the inside goods varies between 0.091 and 17.9

the market share was calculated as the ratio of the stock of credit and deposit amounts at the end of a month of a certain bank and the whole market size in all sub-markets separately.

An important part of the required data set consists of the product characteristics. Product characteristics play an important role in the estimation as, on the one hand, they explain the mean utility level $\delta(\cdot)$ and drive the substitution patterns $\mu(\cdot)$ in equation (12). We choose bank attributes based on data availability and observability to consumers as observed characteristics, namely banks' branch number and age. These characteristics represent the service quality provided by banks, such as the convenience of local branches and capture factors such as reputation, experience and reliability.

Finally, information about the distribution of demographics \hat{P}_D^* is important for the random coefficient logit demand estimation. Regarding the selected individual attributes, survey evidence such as that gathered by the MNB in 2007 and 2008, for instance, might tell us about the joint distribution of disposable income, age and education. Table A in the appendix includes descriptive statistics on the employed product and bank specific variables.

3.2 Estimation results: the consumer credit market

Logit demand

Estimating the logit demand model has the advantage that we can analyse the explanatory power of selected bank characteristics on market shares and examine the usefulness of the instruments. The results from the OLS and IV estimations on logit demand are reported in Table 1. The goodness of fit of the OLS estimation (0.81) indicates that the mean utility is explained by the observed bank characteristics, price and other control variables. However, the price (interest rate) coefficient becomes substantially larger in absolute value and is significant when IV estimation is used to control for endogeneity. This shows that unobserved product characteristics create endogeneity for interest rates in the OLS estimation and if we do not account for that, this might significantly bias the parameter estimates.¹⁹

Table 1 Coefficient estimates of the logit credit demand model

Logit credit demand specification		
Variable	OLS	IV
Dependent variable	$\log(s_{jt}) - \log(s_{0t})$	$\log(s_{jt}) - \log(s_{0t})$
Interest rate	-0.58 (0.56)	-16.03 (4.07)
Number of branches	0.008 (0.0003)	0.01 (0.00)
Age of the bank	-0.02 (0.0018)	-0.02 (0.00)
Constant	-5.55 (0.15)	-4.02 (0.44)
Bank-product dummies	included	included
Time dummies	included	included
R2	0.81	0.96
Number of observation (size of the panel)	4778	4778
Hansen J-stat (overidentification test of all instruments)		4.88
P-value		0.43

Note: standard errors are in parentheses.

percent), while without vehicle loans the mean outside option share was 29 percent (the share of the inside goods varies between 1.03 and 20.25 percent). The results of the parameter estimates based on the two market definitions can be found in Table C in the appendix. The results presented in the main body of the paper were computed by subtracting vehicle loans from the 'consumer market size' (i.e. total consumer lending market: total loans provided by MFIs-vehicle loans provided by MFIs).

¹⁹ The higher R2 in the IV estimates is due to the substantially downward biased (in absolute value) interest rate coefficient of the OLS model. This can be easily seen from the following coefficient of determination

formula: $R^2 = \frac{b'X'M^0Xb}{y'M^0y}$ (Greene 2003 pp. 33), where b is the coefficient vector, X and y are the vectors of the

explanatory and dependent variables respectively, M is the idempotent matrix that transforms observations into deviations.

Random coefficients model (Full model)

To allow for more flexible substitution patterns among products, the random coefficient demand specification described in Section 2.2 is used. Predicted market shares are calculated using equation (14) and based on the empirical distribution of observed and Type I extreme value distribution for the unobserved demographics. Estimation results for the preferred specification can be found in Table 2.

Table 2 Coefficient estimates of the random coefficient logit credit demand model (Full model)

Random coefficient logit credit demand specification (Full Model)					
Variable	Mean (beta's)	Standard Deviations (sigma's)	Interaction terms		
			Income	Age	Education
Interest rate	-33.05 (13.56)	1.83 (9.07)	16.58 (8.20)	-0.63 (1.29)	-0.06 (0.025)
Number of branches	1.36 (0.28)	0.01 (1.84)	0.02 (0.89)	-	3.28 (0.21)
Age of the bank	1.15 (0.07)	0.004 (1.79)	-1.29 (0.99)	-	0.60 (0.64)
Constant	-7.04 (0.28)	0.49 (2.76)	13.33 (7.81)	-	-

Note: The regression includes bank-product and time dummy variables. Asymptotically robust standard errors are given in parentheses.

The means of the distribution of marginal utilities (β 's), are presented in the second column. All of the coefficients are statistically significant. Estimates of heterogeneity around these means are presented in columns 3-6. In terms of the interactions with demographics, the interest rate and income, interest rate and education, number of branches and education prove to be significant. The price variable has the expected sign, that is the increase in the product price decreases the quantity purchased and the market share of the bank. The size of the branch network as well as the age of the financial institution positively influences the utility of an average consumer. The former can be explained by the significant role branches still play as a distribution channel. The latter might indicate that people trust 'old', safe and experienced financial institutions more and as a result clients may resort to financial services with a higher probability from these 'older' banks.

The interpretation of parameter estimates is straightforward. The marginal valuation of price (i.e. interest rate) for example, increases with income denoting that wealthier consumers are less price sensitive, but decreases with education, which suggests that more educated people are more sensitive to loan interest rate fluctuations than less qualified ones. It may be true that better-educated people are more able to collect and synthesise information and as a result are more conscious in their decision-making (react more sensitively to product price fluctuations for instance). Furthermore, the estimate of the standard deviation (i.e. sigma is not statistically significant) suggests that most of the heterogeneity is explained by the selected demographics. The distribution of individual price sensitivity is depicted in Chart 1.

Chart 1 Frequency distribution of price coefficient

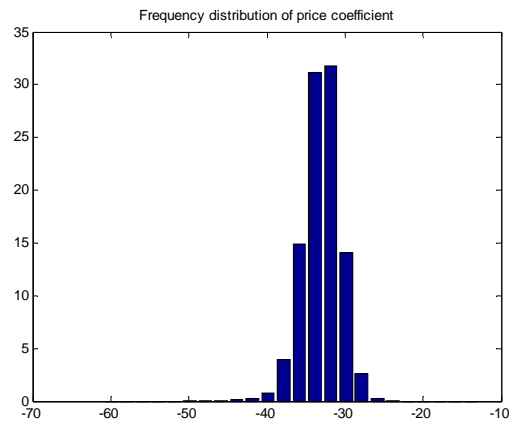


Chart 1 show that the distribution of individual price sensitivity does not seem to be normal, which is the result of the empirical distribution of demographics. Moreover, the results indicate that all of the consumers value price negatively implying that the higher the price the lower the utility, but as noted above the utility of wealthier consumers is less influenced by price changes.

Chart 2 Frequency distribution of branch coefficient

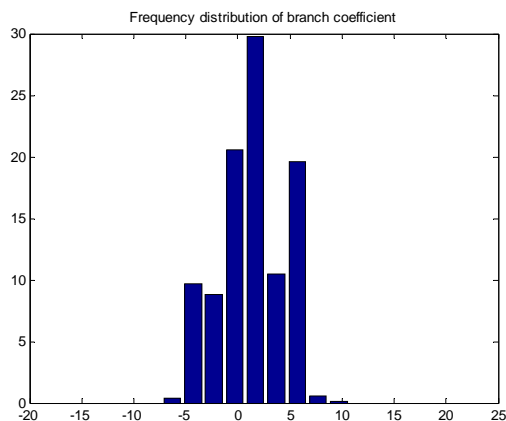


Chart 2 depicts the frequency distribution of the branch coefficient. The figure shows that approximately 63 percent of consumers value extensive branch networks and service quality positively. However, for some 37 percent of consumers it negatively influences utility.

Consumers' relation to the age of the financial institution (i.e. the frequency distribution of the bank's age coefficient on the consumer credit market) is portrayed in Chart 3 and indicates that more than 90 percent of clients positively value a bank's age as a possible indicator of safety, reliability and experience.

Chart 3 Frequency distribution of bank age coefficient

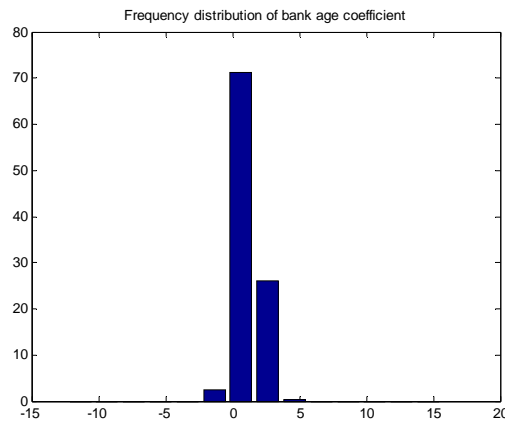


Table 3 presents the own-price elasticities by loan product categories between 2004 and 2007.²⁰ Own-price elastic loan demand can be observed in all cases (demand elasticities are greater than one in absolute value). However, price sensitivity is asymmetric in the sense that demand for domestic currency denominated credits is more price elastic on average than demand for FX loans (the own-price elasticity in the case of HUF loans is on average -3.78 percent and -3.55 percent in the case of CHF-denominated credits). From the viewpoint of banks' pricing decisions, this means that raising interest rates might go in hand with declining credit demand and deteriorating profitability, although the price increase of FX-type credit decreases earnings to a lesser degree.²¹ During the analysed period, elastic loan demand was mainly driven by the supply side; namely retail lending competition, which prompted banks to ease credit standards and boost product innovation. This latter aspect is especially important in the 'creation' of price sensitive lending markets, since the more substitutes a given product has, the more intensively its demand reacts to the price change.

²⁰ Price elasticities were computed based on the alternative market size definition as well (i.e. vehicle loans are part of the market). Results can be found in Table D in the appendix.

²¹ It should be mentioned that higher interest rates might affect the decision (pay/do not pay, enter/do not enter the credit market) of potential new and existing clients and as a result banking profits in a different manner. On the one hand, higher interest rates increase banking revenues, since there will be a substantial share of existing clients who are willing and are able to pay the higher interest rates. On the other hand, there will be clients who are unable, or are unwilling to pay. The result of these two cross-effects determines how the profitability of the given period is affected. At the same time the 'price' increase of the various credit products can affect the decision of potential new clients (to enter or not) and as a consequence the banks' future profitability, the size of which depends on the price sensitivity of demand.

Table 3 Own price elasticities on the consumer credit market between 2004-2007 (median values)

Own price elasticities on the consumer lending market	
	Year
Credit product	2004-2007
Hire purchase loan (HUF short maturity)	-3.635
Hire purchase loan (HUF max. 5 year maturity)	-3.592
Personal loan (HUF short maturity)	-4.233
Personal loan (HUF max. 5 year maturity)	-4.201
Personal loan (HUF maturity over 5 years)	-4.189
Personal loan (CHF short maturity)	-3.581
Personal loan (CHF max. 5 year maturity)	-3.579
Personal loan (CHF maturity over 5 years)	-3.575
Overdraft (HUF)	-4.171
Home equity (HUF short maturity)	-3.569
Home equity (HUF max. 5 year maturity)	-3.566
Home equity (HUF maturity over 5 years)	-2.953
Home equity (CHF short maturity)	-3.523
Home equity (CHF max. 5 year maturity)	-3.548
Home equity (CHF maturity over 5 years)	-3.548

Note: Median own-price elasticities are depicted in the table. The numbers denote percent.

From the point of view of monetary policy, price sensitive loan demand denotes that, all other things being equal (i.e. credit risk, degree of competition, etc.), the interest rate channel of monetary transmission might be effective, since it can modify the clients' consumption and investment decisions. However, it is not only the direct loan demand effect and its real economic consequences that deserve to be mentioned, as the indirect impacts are significant as well. Namely, one consequence of substitution among domestic and foreign currency denominated loans may be a portfolio realignment effect towards FX debt as a result of the 'price' increase of domestic currency denominated credit (i.e. the relative prices and as a result the demand for domestic currency denominated and FX loans changes). This can weaken the effectiveness of the interest rate channel due to the rising share of FX debt, and at the same time financial stability may also be influenced. The reason for this is that exchange rate developments directly impact the debt servicing cost of FX debt holders and their payment ability (i.e. direct FX risk transforms into indirect credit risk).

Table 4 presents a sample of estimated own- and cross-price elasticities for the most relevant consumer loan products, which have a dominant share within the consumer loan category. These are as follows: hire purchase loans (denominated in HUF with short, maximum 5-year maturity), personal loans (denominated in HUF with maturity over 5 years), overdraft and home equity loans (denominated in HUF with maturity over 5 years, and denominated in CHF with short and over 5-year maturity).²² Own- and cross-price elasticities for all the consumer credits included in the estimation can be found in Table B in the appendix. Each i, j combination where i is the row and j is the column index, gives the elasticity of brand j with respect to changes in the price of brand i . Since the markets are defined in the time space, rather than choosing a particular value, the median of each entry by time period and product type (i.e. overdraft, foreign currency denominated home equity, etc.) is calculated. This means that the median price elasticities in August 2007 for example are calculated as the median of all the banks having the respective type of product in August 2007. The estimated elasticities indicate that as a result of a price increase in

²² These products amount to approximately 80-90 percent of the total consumer loan stock.

HUF-denominated loans, substitution can be observed towards CHF-denominated credits. The results also show that this effect is asymmetric; the rise in domestic interest rates increases demand for FX loans more (0.28 percent on average) than vice versa (0.2 percent on average). Furthermore, substitution operates not only among products with different denominations and types, but between products with different maturities as well. For example, a CHF-denominated home equity loan with maturity over 5 years is most sensitive to the price change of a HUF-denominated home equity loan with maturity over 5 years and a CHF-denominated home equity loan with short maturity. At the same time, it is least sensitive to a change in the price of hire purchase loans denominated in HUF with short maturity.²³

Beside the interest rate channel, the exchange rate channel is of particular importance in the Hungarian monetary transmission (Vonnák 2007). But the effectiveness of the exchange rate channel might also be affected by the increasing share of FX debt. A restrictive monetary policy, for instance, can lead to appreciation of the exchange rate. Exchange rate appreciation is favourable both in terms of the long-run inflation prospects and the evolution of debt servicing costs of FX debt holders. But over the short term such appreciation might induce inflation pressure as it expands the consumption possibilities of FX debtors (exchange rate appreciation directly mitigates the debt servicing costs of FX debtors).

As mentioned in Chapter 2.1, the logit model restricts all the elasticities within a column to being equal. An additional diagnostic of how far the results are from the restrictive logit substitution patterns is given by analysing the cross-price elasticities in each column. A possible indicator of how the random coefficient model overcomes these restrictions is to examine the variation in the estimated elasticities. One such measure is suggested by Nevo (2001), who analysed the ratio of the maximum and minimum cross-price elasticity within a column. In the case of the logit specification, the model implies that all cross-price elasticities within a column are equal and therefore the ratio is equal to one. This ratio calculated on the values of Table 3 varies between 2 (hire purchase loan HUF-denominated with short maturity) and 4.6 (hire purchase loan HUF-denominated with maximum 5-year maturity).

²³ A simple numerical example can be found in Table E in the appendix about how the estimated own and cross-price elasticities can be used to compute aggregate credit demand movements as a result of interest rate changes.

Table 4 Median own- and cross-price elasticities on the consumer credit market in August 2007

	H. P. L. (HUF s. mat)	H. P. L. (HUF max. 5 year mat)	P. L. (HUF mat. over 5 y.)
Hire purchase loan (HUF short maturity)	-2.30	0.46	0.40
Hire purchase loan (HUF max. 5 year maturity)	0.20	-2.12	0.20
Personal loan (HUF maturity over 5 years)	0.30	0.30	-2.52
Overdraft (HUF)	0.32	0.30	0.30
Home equity (HUF maturity over 5 years)	0.22	0.20	0.21
Home equity (CHF short maturity)	0.40	0.10	0.10
Home equity (CHF maturity over 5 years)	0.24	0.21	0.24
	Overdraft (HUF)	H. E. (HUF mat. over 5 y.)	H. E. (CHF s. mat.)
Hire purchase loan (HUF short maturity)	0.41	0.35	0.40
Hire purchase loan (HUF max. 5 year maturity)	0.20	0.17	0.39
Personal loan (HUF maturity over 5 years)	0.30	0.30	0.20
Overdraft (HUF)	-2.23	0.29	0.26
Home equity (HUF maturity over 5 years)	0.21	-2.37	0.30
Home equity (CHF short maturity)	0.10	0.10	-1.41
Home equity (CHF maturity over 5 years)	0.22	0.24	0.43
	H. E. (CHF mat. over 5 y.)	H. E. (CHF max. 5 y. mat.)	P. L. (CHF max. 5 year mat)
Hire purchase loan (HUF short maturity)	0.20	0.25	0.28
Hire purchase loan (HUF max. 5 year maturity)	0.25	0.30	0.16
Personal loan (HUF maturity over 5 years)	0.24	0.24	0.40
Overdraft (HUF)	0.30	0.29	0.40
Home equity (HUF maturity over 5 years)	0.40	0.40	0.29
Home equity (CHF short maturity)	0.51	0.49	0.10
Home equity (CHF maturity over 5 years)	-1.12	0.44	0.29

Note: Cell entries i, j , where i indexes row and j column, show the percent change in market share of brand j with a one percent change in the price of brand i . The entries represent the median of the individual price elasticities of banks with the selected products in August 2007. The bold numbers in row i and column j denote the strongest demand reaction of the price increase of brand i on brand i . Numbers in italics show the own-price elasticities of the products in the first column.

In sum, the consumer credit demand estimation arrives at the following conclusions: (1) the results show that the 'loan price' negatively influences consumer's utility, albeit to a different degree since wealthier clients are less sensitive to loan interest rate fluctuations; (2) the estimated price elasticities indicate that there is an asymmetric substitution effect towards foreign currency denominated products as a result of the price increase in domestic currency denominated credits (i.e. the rise in domestic interest rates increase the demand for FX loans more (0.28 percent on average) rather than vice versa (0.2 percent on average)); (3) the results also show that substitution operates not only among products with different denomination and type, but between products with different maturities as well; (4) the demand reaction of credit products to the price change of a 'closer' substitute is stronger than to the price change of a 'far' substitute; (5) the findings indicate that, on average, demand for domestic currency denominated credits is more price sensitive than demand for FX loans (-3.78 and -3.55 percent, respectively); (6) due to substitution among domestic and foreign currency denominated loans, the strength of the two main monetary transmission channels (i.e. the interest rate and exchange rate channels) and financial stability can also be affected, since the portfolio share of FX debt react to the price change of HUF-denominated loans.

3.3 Estimation results: the deposit market

Logit demand

Similarly to the consumer loan market, the logit demand model is also estimated for the deposit market (parameter estimates are reported in Table 5). The results of the OLS estimation suggest (the model's R^2 is 0.93) that the selected bank attributes, price and other control variables do explain the mean utility level. It should also be mentioned that controlling for endogeneity of the price variable is important, in order to avoid the bias in the parameter estimates which is visibly present in the interest rate coefficient. The estimated effect of other observed bank characteristics on mean utility is not changed substantially by the IV estimation.

Table 5 Coefficient estimates of the logit deposit demand model

Logit deposit demand specification		
Variable	OLS	IV
Dependent variable	log(sjt)-log(s0t)	log(sjt)-log(s0t)
Interest rate	6.35 (0.51)	11.87(3.34)
Number of branches	0.018 (0.001)	0.02(0.001)
Age of the bank	-0.10 (0.004)	-0.11(0.007)
Constant	-2.23 (0.22)	-2.07(0.23)
Bank-product dummies	included	included
Time dummies	included	included
R2	0.93	0.93
Number of observation (size of the panel)	3063	3063
Hansen J-stat (overidentification test of all instruments)		6.53
P-value		0.16

Note: standard errors are in parentheses.

The random coefficient demand model is also estimated on the deposit market (Table 6). The means of the distribution of marginal utilities (β 's), can be found in the second column and estimates of heterogeneity around these are presented in columns 3-6.

Table 6 Coefficient estimates of the random coefficient logit deposit demand model (Full model)

Random coefficient logit deposit demand specification (Full Model)					
Variable	Mean (beta's)	Standard Deviations (sigma's)	Interaction terms		
			Income	Age	Education
Interest rate	60.47 (23.24)	3.51 (21.68)	0.99 (0.31)	-1.19 (0.62)	2.28 (27.97)
Number of branches	3.62 (0.028)	0.016 (0.35)	-0.22 (0.48)	0.05 (0.012)	-
Age of the bank	-0.29 (0.036)	0.075 (0.25)	1.62 (0.29)	0.14 (0.017)	-
Constant	1.24 (0.028)	0.26 (0.29)	7.23 (1.72)	-	-

Note: The regression includes bank-product and time dummy variables. Asymptotically robust standard errors are given in parentheses.

Among the interactions with demographics, the interest rate and income, branch number and individual's age, bank's age and income and finally the bank's age and the individual's age prove to be significant. The sign of the price variable indicates that an increase in the deposit interest rates increases demand for these services and thereby increases the bank's market share on these markets. The size of the branch network positively influences, while the bank's age negatively influences the average consumer's utility. This latter might indicate that when opening a deposit account at a bank, average consumers mainly base their decision on the deposit interest rates offered.

The marginal valuation of the deposit interest rate increases with income, suggesting that wealthier consumers are less sensitive to deposit interest rate fluctuations than poorer ones. Another interpretation can be given for this, namely that wealthier clients are less hit by a substantial deposit interest rate decline than consumers with limited financial resources. The estimate of the standard deviation (i.e. sigma) is insignificant, indicating the relevant role the selected demographics played in the explanation of heterogeneity. The distribution of individual deposit interest rate sensitivity is depicted in Chart 4.

Chart 4 Frequency distribution of price coefficient

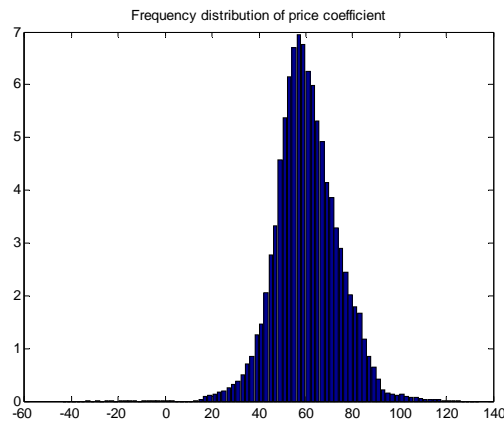


Chart 4 shows that all consumers value deposit interest rates positively, which implies that the higher the deposit interest rate the higher the utility is, but as noted the utility of wealthier consumers is less influenced by price changes.

Chart 5 Frequency distribution of branch coefficient

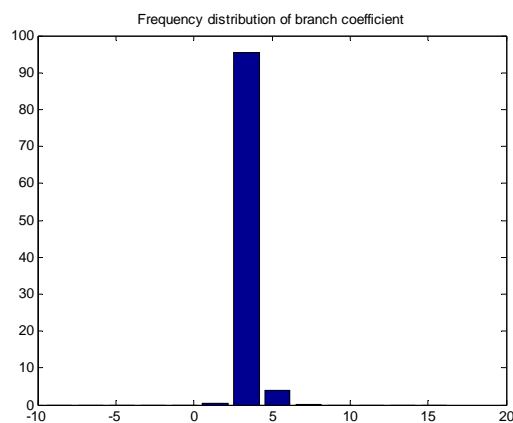
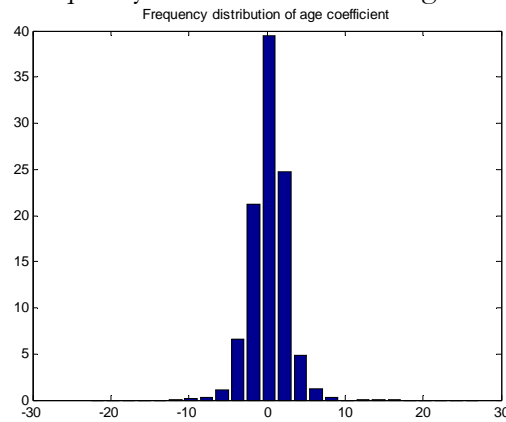


Chart 5 shows the frequency distribution of the branch coefficient. The figure indicates that consumers using deposit services value the branch network size in a positive way, that is clients prefer to manage their deposit operations via branches. This finding also reveals that the larger the branch network size, the higher the probability of 'consuming' deposit and other services such as asset management, security and foreign currency trading. When evaluating the results it also has to be mentioned that not just the branch network size matters, as the regional distribution within a country is important as well. As we do not have this kind of data, this effect cannot be captured directly, but it can be expected that in those cities or regions where either the population density is higher and/or the per capita income is larger the demand for financial services in general might be higher, therefore extending the branch network in these areas might have a positive impact on profitability.

Chart 6 Frequency distribution of bank age coefficient



Consumers' relation to the age of the bank (i.e. the frequency distribution of the bank's age coefficient on the deposit market) is depicted in Chart 6. The results show that approximately 75 percent of clients value the bank's age on the deposit market positively. This means that in contrast to the 'average' client for whom the interest rate matters when 'consuming' deposit services there are a substantial part of consumers for which safety, reliability, experience as relevant bank attributes captured by the bank's age variable play an important role in making investment decisions.

Table 7 shows the own-price elasticities by deposit product categories between 2003 and 2007. Similarly to the consumer credit market, demand for deposit services is also price elastic signifying that clients react to changing deposit interest rates.

Table 7 Median own-price elasticities by year

Own price elasticities on the deposit market	
Year	
Deposit product	2003-2007
Demand deposit (HUF)	1.49
Short-term deposit (HUF)	3.24
Long-term deposit (HUF)	3.96

Note: Median own-price elasticities are depicted in the table. The numbers denote percent.

In Table 8, the median of the estimated own- and cross-price elasticities are shown for the three deposit products in August 2007. Each i, j combination in Table 8 where i is the row and j is the column index, gives the elasticity of brand j with respect to changes in the price of brand i .

Not surprisingly, the own-price elasticities of various deposit products are positive while the cross-price elasticities are negative, indicating that the rise in deposit interest rates positively affects own demand and decreases demand of the substitutes, albeit to a different degree. It can be observed that the demand reaction of long-term deposits to the 'price increase' of short-term deposits is larger in terms of the absolute value than that of demand deposits, which can be explained by the fact that short-term and long-term deposits are closer substitutes.

In order to analyse the 'restrictiveness' of the logit specification over the random coefficient logit model, the measure (the ratio of the maximum and minimum cross-price elasticities within a column) suggested by Nevo (2001) is calculated similarly as above. The calculated ratio based on the values of Table 8 varies between 0.74 (short-term deposit) and 0.8 (demand deposit) suggesting that the 'restrictiveness' of the logit demand specification is less obvious on the

deposit market than on the consumer credit market (the ratio is equal to one in the case of the logit model).

Table 8 Median own- and cross-price elasticities on the deposit market in August 2007

	Demand deposit	Short-term deposit	Long-term deposit
Demand deposit	<i>1.62</i>	-0.34	-0.35
Short-term deposit	-0.30	<i>4.42</i>	-0.44
Long-term deposit	-0.24	-0.25	<i>5.32</i>

Note: Cell entries i, j , where i indexes row and j column, give the percent change in market share of brand j with a one percent change in price of brand i . The entries represent the median of the individual price elasticities of banks with the selected products in August 2007. The bold numbers in row i and column j denote the strongest demand reaction of the price increase of brand i on brand i . Numbers in italics show the own-price elasticities of the products in the first column.

In sum, the consumer credit demand estimation arrives at the following conclusions: (1) the results show that a deposit interest rate increase positively influences consumer's utility, albeit to a varying degree, as wealthier clients are less sensitive to deposit interest rate fluctuations; (2) the rise in the deposit interest rates of the selected deposit products has a positive effect on own demand and decreases demand for substitutes; (3) price elastic deposit demand indicates that clients react to deposit interest rate fluctuations; although the magnitude of demand reaction differs by product categories; it is the strongest in the case of long-term deposits.

4 Summary and conclusion

In this paper, we estimate a random coefficient logit model (RCL) to calculate demand elasticities on the Hungarian consumer lending and deposit markets, in line with the most recent developments in the literature on discrete choice demand estimation, and try to discover the possible monetary policy and financial stability implications of these price sensitivity effects.

The paper has several policy-relevant empirical findings. First, the results show that the price sensitivity of consumers differs: namely, wealthier clients are less sensitive to lending and deposit interest rate fluctuations than customers located in the lower end of the income distribution.

Second, empirical evidence is found that there is an asymmetric substitution effect towards foreign currency denominated products as a result of the price increase of domestic currency denominated credits (i.e. the rise in domestic interest rates increases the demand for FX loans more (0.28 percent on average) than vice versa (0.2 percent on average)).

The results also show that the demand reaction of both credit and deposit products to the price change of a 'closer' substitute is stronger than to the price change of a 'far' substitute. Furthermore, the findings suggest that, on average, demand for domestic currency denominated credit is more price sensitive than demand for FX loans (-3.78 and 3.55 percent, respectively).

Finally, due to the substitution effects among credits denominated in different currencies, the strength of the two main monetary transmission channels (i.e. the interest rate and exchange rate channels) and financial stability can also be affected, since the share of FX debt rises as a result of the price increase of HUF-denominated loans.

References

- Ackelberg, D., L. Benkard, S. Berry, and A. Pakes (2006), 'Econometric Tools for Analyzing Market Outcomes', prepared for the Handbook of Econometrics
- Berry, S. (1994), 'Estimating Discrete-Choice Models of Product Differentiation', *Rand Journal of Economics*, 25, pp. 242-262.
- Berry, S., J. Levinsohn, and A. Pakes (1995), 'Automobile Prices in Market Equilibrium', *Econometrica*, 63, pp. 841-890.
- Chamberlain, G. (1982), 'Multi Variate Regression Models for Panel Data', *Journal of Econometrics*, 18, pp. 5-46.
- Greene, W. H. (2003), 'Econometric Analysis', 5th Edition, Prentice Hall.
- Goldberg, P.K. (1995), 'Product Differentiation and Oligopoly in International Markets: The Case of the U.S. Automobile Industry', *Econometrica* 63(4):891-951.
- Hendel, I., and A. Nevo, (2002), 'Sales and Consumer Inventory', NBER working paper No. 9048
- Ho, C-Y. (2007), 'Market Structure, Welfare and Banking Reform in China', mimeo
- Holló, D. and M. Papp (2007), 'Assessing Household Credit Risk: Evidence from a Household Survey', MNB Occasional Papers 70.
- Horváth, Cs., J. Krekó, and A. Naszódi (2004), 'Interest Rate Pass-Through in Hungary', MNB Working Papers, 2004/8.
- Nevo, A. (2001), 'Measuring Market Power in the Ready-to-Eat Cereal Industry', *Econometrica*, 69, pp. 307-342.
- McFadden, D. (1973), 'Conditional Logit Analysis of Qualitative Choice Behavior', in *Frontiers of Econometrics*, ed. by P. Zarembka. New York: Academic Press.
- Report on Financial Stability (2008); http://english.mnb.hu/Engine.aspx?page=mnben_stabil&ContentID=10898
- Spence, A. M. (1976), 'Product Selection, Fixed Costs and Monopolistic Competition', *Review of Economic Studies*, 43 pp. 217-235.
- Vonnák, B. (2007), 'The Hungarian Monetary Transmission Mechanism: An Assessment', MNB Working Papers, 2007/3.
- Zhou, X. (2007), 'Estimation of the Impact of Mergers in the Banking Industry', (Job market paper)

Appendix

Tables

Table A Descriptive statistics on consumer loan, deposit products and selected bank characteristics 2003-2007

Loans (in millions of HUF)	Mean	Standard deviation	Min	Max
Hire purchase loan (HUF short maturity)	1023	1559	1	6700
Hire purchase loan (HUF max. 5 year maturity)	7689	13471	1	46519
Personal loan (HUF short maturity)	395	1203	1	5394
Personal loan (HUF max. 5 year maturity)	11624	27878	3	128749
Personal loan (HUF maturity over 5 years)	4914	10802	1	57376
Personal loan (CHF short maturity)	35	43	1	187
Personal loan (CHF max. 5 year maturity)	7049	10423	1	37921
Personal loan (CHF maturity over 5 years)	5568	7376	1	40309
Overdraft (HUF)	8190	16349	1	100764
Home equity (HUF short maturity)	77	107	1	336
Home equity (HUF max. 5 year maturity)	340	436	2	2644
Home equity (HUF maturity over 5 years)	2559	3758	7	17950
Home equity (CHF short maturity)	334	1108	1	4641
Home equity (CHF max. 5 year maturity)	809	976	1	5060
Home equity (CHF maturity over 5 years)	33165	38856	10	170669
Deposits (in millions of HUF)	Mean	Standard deviation	Min	Max
Demand deposit	52451	114935	4	660446
Short-term deposit	132035	241145	6	1236703
Long-term deposit	10516	22908	1	110389
Bank characteristics	Mean	Standard deviation	Min	Max
Branch number (N)	94	116	1	432
Age (year)	29	21	6	85
Loan interest rates (percent)	Mean	Standard deviation	Min	Max
Hire purchase loan (HUF short maturity)	22.47	11.99	1.23	45.19
Hire purchase loan (HUF max. 5 year maturity)	22.78	10.75	5.96	40.04
Personal loan (HUF short maturity)	20.05	6.00	3.82	30.11
Personal loan (HUF max. 5 year maturity)	20.47	4.83	8.29	31.57
Personal loan (HUF maturity over 5 years)	19.86	5.04	6.86	30.23
Personal loan (CHF short maturity)	15.26	4.82	5.97	23.80
Personal loan (CHF max. 5 year maturity)	12.75	4.18	2.39	24.79
Personal loan (CHF maturity over 5 years)	11.15	2.82	4.66	15.43
Overdraft (HUF)	17.62	7.26	3.36	35.92
Home equity (HUF short maturity)	16.73	5.02	6.22	27.95
Home equity (HUF max. 5 year maturity)	14.66	2.88	8.29	20.73
Home equity (HUF maturity over 5 years)	15.45	3.23	8.29	22.00
Home equity (CHF short maturity)	4.76	1.09	2.72	7.91
Home equity (CHF max. 5 year maturity)	4.62	1.01	3.00	7.65
Home equity (CHF maturity over 5 years)	4.41	1.08	1.49	6.85
Deposit interest rates (percent)	Mean	Standard deviation	Min	Max
Demand deposit	3.08	1.95	0.03	10.28
Short-term deposit	7.18	2.05	2.38	12.11
Long-term deposit	6.90	2.21	1.71	13.03

Table B Median own- and cross-price elasticities on the consumer credit market in August 2007

	H. P. L. (HUF s. mat.)	H. P. L. (HUF max. 5 year mat.)	P. L. (HUF s. mat.)	P. L. (HUF max. 5 year mat.)	P. L. (HUF mat. over 5 y.)
Hire purchase loan (HUF short maturity)	-2.30	0.46	0.37	0.40	0.40
Hire purchase loan (HUF max. 5 year maturity)	0.20	-2.12	0.19	0.19	0.20
Personal loan (HUF short maturity)	0.20	0.20	-2.52	0.20	0.20
Personal loan (HUF max. 5 year maturity)	0.29	0.27	0.30	-2.59	0.31
Personal loan (HUF maturity over 5 years)	0.30	0.30	0.30	0.30	-2.52
Personal loan (CHF short maturity)	0.20	0.20	0.20	0.15	0.20
Personal loan (CHF max. 5 year maturity)	0.40	0.38	0.35	0.32	0.31
Personal loan (CHF maturity over 5 years)	0.32	0.35	0.10	0.36	0.39
Overdraft (HUF)	0.32	0.30	0.30	0.27	0.30
Home equity (HUF short maturity)	0.30	0.15	0.25	0.11	0.11
Home equity (HUF max. 5 year maturity)	0.10	0.10	0.17	0.20	0.20
Home equity (HUF maturity over 5 years)	0.22	0.20	0.21	0.20	0.21
Home equity (CHF short maturity)	0.40	0.10	0.10	0.10	0.10
Home equity (CHF max. 5 year maturity)	0.25	0.24	0.26	0.28	0.27
Home equity (CHF maturity over 5 years)	0.24	0.21	0.28	0.22	0.24
	P. L. (CHF s. mat.)	P. L. (CHF max. 5 y. mat.)	P. L. (CHF mat. over 5 y.)	Overdraft (HUF)	H. E. (HUF s. mat.)
Hire purchase loan (HUF short maturity)	0.37	0.28	0.30	0.41	0.30
Hire purchase loan (HUF max. 5 year maturity)	0.16	0.16	0.14	0.20	0.18
Personal loan (HUF short maturity)	0.20	0.13	0.10	0.20	0.20
Personal loan (HUF max. 5 year maturity)	0.30	0.30	0.29	0.30	0.31
Personal loan (HUF maturity over 5 years)	0.29	0.30	0.30	0.30	0.24
Personal loan (CHF short maturity)	-2.61	0.20	0.20	0.20	0.10
Personal loan (CHF max. 5 year maturity)	0.31	-2.20	0.31	0.40	0.34
Personal loan (CHF maturity over 5 years)	0.36	0.36	-2.34	0.34	0.39
Overdraft (HUF)	0.27	0.40	0.34	-2.23	0.29
Home equity (HUF short maturity)	0.10	0.30	0.20	0.20	-2.72
Home equity (HUF max. 5 year maturity)	0.20	0.10	0.10	0.14	0.20
Home equity (HUF maturity over 5 years)	0.19	0.29	0.28	0.21	0.22
Home equity (CHF short maturity)	0.10	0.10	0.10	0.10	0.10
Home equity (CHF max. 5 year maturity)	0.27	0.24	0.25	0.25	0.30
Home equity (CHF maturity over 5 years)	0.24	0.29	0.28	0.22	0.26
	H. E. (HUF max. 5 y. mat.)	H. E. (HUF mat. over 5 y.)	H. E. (CHF s. mat.)	H. E. (CHF max. 5 y. mat.)	H. E. (CHF mat. over 5 y.)
Hire purchase loan (HUF short maturity)	0.30	0.35	0.40	0.25	0.20
Hire purchase loan (HUF max. 5 year maturity)	0.14	0.17	0.39	0.30	0.25
Personal loan (HUF short maturity)	0.16	0.20	0.10	0.10	0.10
Personal loan (HUF max. 5 year maturity)	0.30	0.31	0.23	0.20	0.21
Personal loan (HUF maturity over 5 years)	0.30	0.30	0.20	0.24	0.24
Personal loan (CHF short maturity)	0.20	0.20	0.10	0.10	0.10
Personal loan (CHF max. 5 year maturity)	0.30	0.35	0.26	0.24	0.26
Personal loan (CHF maturity over 5 years)	0.35	0.36	0.17	0.21	0.21
Overdraft (HUF)	0.27	0.29	0.26	0.29	0.30
Home equity (HUF short maturity)	0.20	0.30	0.10	0.15	0.10
Home equity (HUF max. 5 year maturity)	-2.24	0.10	0.10	0.10	0.10
Home equity (HUF maturity over 5 years)	0.22	-2.37	0.30	0.40	0.40
Home equity (CHF short maturity)	0.10	0.10	-1.41	0.49	0.51
Home equity (CHF max. 5 year maturity)	0.26	0.27	0.17	-1.39	0.18
Home equity (CHF maturity over 5 years)	0.22	0.24	0.43	0.44	-1.12

Note: Cell entries i, j , where i indexes row and j column, give the percent change in market share of brand j with a one percent change in price of brand i . The entries represent the median of the individual price elasticities of banks with the selected products in August 2007. The bold numbers in row i and column j denote the strongest demand reaction of the price increase of brand i on brand i . Numbers in italics show the own-price elasticities of the products in the first column.

Table C Coefficient estimates of the credit demand models, with two alternative ‘market definitions’

Logit credit demand specification					
Total market	without vehicle loans		with vehicle loans		
Variable	IV		IV		
Dependent variable	log(s _{jt})-log(s _{0t})		log(s _{jt})-log(s _{0t})		
Interest rate	-16.03 (4.07)		-16.01 (3.88)		
Number of branches	0.01 (0.00)		0.01 (0.00)		
Age of the bank	-0.02 (0.00)		-0.01 (0.00)		
Constant	-4.02 (0.44)		-3.79 (0.47)		
Bank-product dummies	included		included		
Time dummies	included		included		
R ²	0.96		0.97		
Random coefficient logit credit demand specification (Full Model), total market without vehicle loans					
Interaction terms					
Variable	Mean (beta's)	Standard Deviations (sigma's)	Income	Age	Education
Interest rate	-33.05 (13.56)	1.83 (9.07)	16.58 (8.20)	-0.63 (1.29)	-0.06 (0.025)
Number of branches	1.36 (0.28)	0.01 (1.84)	0.02 (0.89)	-	3.28 (0.21)
Age of the bank	1.15 (0.07)	0.004 (1.79)	-1.29 (0.99)	-	0.60 (0.64)
Constant	-7.04 (0.28)	0.49 (2.76)	13.33 (7.81)	-	-
Random coefficient logit credit demand specification (Full Model), total market with vehicle loans					
Interaction terms					
Variable	Mean (beta's)	Standard Deviations (sigma's)	Income	Age	Education
Interest rate	-33.02 (12.95)	1.72 (8.66)	16.56 (7.83)	-0.51 (1.23)	-0.05 (0.022)
Number of branches	1.44 (0.28)	0.01 (1.83)	0.02 (0.92)	-	3.52 (0.20)
Age of the bank	0.34 (0.023)	0.002 (0.89)	-1.22 (0.85)	-	0.63 (0.68)
Constant	-6.64 (0.30)	0.46 (2.96)	12.57 (8.39)	-	-

Table D Effect of ‘market definition’ on the own price elasticities of consumer credit products

Own price elasticities on the consumer lending market (median values 2004-2007)		
Credit product	Total market without vehicle loans	Total market with vehicle loans
Hire purchase loan (HUF short maturity)	-3.635	-3.632
Hire purchase loan (HUF max. 5 year maturity)	-3.592	-3.596
Personal loan (HUF short maturity)	-4.233	-4.231
Personal loan (HUF max. 5 year maturity)	-4.201	-4.216
Personal loan (HUF maturity over 5 years)	-4.189	-4.192
Personal loan (CHF short maturity)	-3.581	-3.583
Personal loan (CHF max. 5 year maturity)	-3.579	-3.581
Personal loan (CHF maturity over 5 years)	-3.575	-3.575
Overdraft (HUF)	-4.171	-4.176
Home equity (HUF short maturity)	-3.569	-3.571
Home equity (HUF max. 5 year maturity)	-3.566	-3.568
Home equity (HUF maturity over 5 years)	-2.953	-2.952
Home equity (CHF short maturity)	-3.523	-3.525
Home equity (CHF max. 5 year maturity)	-3.548	-3.545
Home equity (CHF maturity over 5 years)	-3.548	-3.557

Table E Effect of price changes on the size and composition of a hypothetical loan portfolio

Numerical example				
Products	Elasticities (percent)		Starting volumes	Starting portfolio shares
	A (domestic currency denominated credit)	B (foreign currency denominated credit)		
A (domestic currency denominated credit)	-2.2	0.4	100	50%
B (foreign currency denominated credit)	0.2	-1.9	100	50%
Effects of price changes on portfolio level and composition; examples			Total volume:	200
Example 1: price of product A increases by 1%			Volumes after price change	Portfolio shares after price change
	Product A		$100 \times (1 - 0.022) = 97.8$	49.34%
	Product B		$100 \times (1 + 0.004) = 100.4$	50.66%
	Total volume:		198.2	100%
Example 2: price of product B increases by 1%			Volumes after price change	Portfolio shares after price change
	Product A		$100 \times (1 + 0.002) = 100.2$	50.53%
	Product B		$100 \times (1 - 0.019) = 98.1$	49.47%
	Total volume:		198.3	100%
Example 3: prices of both product A and B increase by 1%			Volumes after price change	Portfolio shares after price change
	Product A		$100 \times (1 - 0.022 + 0.002) = 98$	49.87%
	Product B		$100 \times (1 - 0.019 + 0.004) = 98.5$	50.13%
	Total volume:		196.5	100%