# Estimating the lock-in effects of switching costs from firm-level data

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# Introduction

- The presence of switching costs is likely to
  1. give a profitable possibility for ex-post price increases by existing firms
  2. increase barriers to entry and expansion of new firms
- Identifying&quantifying switching cost is important but not easy
  1. Conceptual problems (dynamic choice problem)
  2. Data requirements (ideal consumer-level data are rare)
- Our contributions
  1. A simple intuitive method for estimating the **lock-in effects** of switching costs
  2. Using **firm-level data** that might be requested by a competition or regulatory authority
  3. Application: estimating the lock-in effects of switching costs on the Hungarian personal loan market

# The intuition of the method

- Compare the price responsiveness of **new consumers** and **old consumers**
- New consumers represent the behavior of old consumers if there are no switching costs
  - a counterfactual logic
- The difference in the price responsiveness is a measure of the lock-in effects
- In essence, it measures the effect of switching costs on the residual demand
  - closely connected to market power
- Since the behavior of new and old consumers is not directly observed from firm-level data, we use proxy variables
  - we derive the bias due to using proxy variables and correct the estimates for it
- We estimate that on the Hungarian personal loan market old consumers' price responsiveness is 70% lower because of switching costs

# Previous works with aggregate data

- Structural form approaches
  1. Shy (2002): static equilibrium model of switching costs, leading to stable market shares and different prices
     Estimates for Finnish bank deposit market: switching costs are between 0 to 11% of average balance
  2. Kim et al (2003): dynamic equilibrium model of consumer transitions and firms' intertemporal pricing
     Estimates for Norwegian loan market: switching costs are around 4% of average loan
- Reduced form approaches
  1. NERA (2003) idea: if with homogenous goods you estimate small cross-price elasticity, then it can be due to switching costs
     It is not the magnitude of switching costs that is estimated, but whether their presence has a visible impact on consumers' decisions
- All of these papers use prices and one firm-level aggregate at most (sales-per-period or overall market share)

# Assumptions on consumer choice

- Firm $j$, time $t$
- Two consumers: $N$ and $O$, ex ante identical, 0-1 demand
  1. Consumer $N$ is new, probability of choosing $j$ at time $t$ is $n_{jt}$
  2. Consumer $O$ is old (choice in $t-1$ was $j$), probability of choosing $j$ at time $t$ (the probability of staying loyal to $j$) is $l_{jt}$
- Now suppose a price increase for $j$
  1. $n_j$ decreases: $\partial n_{jt} / \partial p_{jt} < 0$
  2. If no switching costs, $l_j$ would decrease the same way
  3. If switching costs have lock-in effects, $\partial n_{jt} / \partial p_{jt} < \partial l_{jt} / \partial p_{jt} \leq 0$

# Two measures to capture the lock-in effects of switching costs

- *1st measure for switching costs:*

$$\delta = \partial l_{jt}/\partial p_{jt} - \partial n_{jt}/\partial p_{jt} = |\partial n_{jt}/\partial p_{jt}| - |\partial l_{jt}/\partial p_{jt}|$$

  How much more likely to turn away from $i$ if new than if old? Interpretation with heterogenous consumers: what fraction of consumers remain locked-in who would have switched otherwise?

- *2nd measure for switching costs:*

$$\theta = \frac{\partial n_{jt}/\partial p_{jt} - \partial l_{jt}/\partial p_{jt}}{\partial n_{jt}/\partial p_{jt}} = \frac{|\partial n_{jt}/\partial p_{jt}| - |\partial l_{jt}/\partial p_{jt}|}{|\partial n_{jt}/\partial p_{jt}|}$$

  How smaller is old consumers' responsiveness to price changes than new ones'? - Better to compare different consumer groups or markets

# Measurement

- Let us have a panel of $J$ firms and $T$ time periods
- Evaluation of consumers' stock for firm $j$ in $t$ :

$$S_{jt} = S_{jt-1} + \underbrace{IN_{jt}}_{\text{incoming}} - \underbrace{OUT_{jt}}_{\text{terminating}} - \underbrace{X_{jt}}_{\text{expiring}} =$$

$$S_{jt-1} + \left[ \underbrace{N_{jt}}_{\text{new}} + \underbrace{F_{jt}}_{\text{from others}} \right] - \left[ \underbrace{Q_{jt}}_{\text{quitters}} + \underbrace{T_{jt}}_{\text{to others}} + \right] - X_{jt}$$

- Realized probability of choosing $j$ in $t$ if new:

$$n_{jt} = N_{jt} / \Sigma_i N_{jt}$$

- Realized probability of staying loyal to $j$ in $t$ if old:

$$l_{jt} = 1 - \frac{T_{jt}}{S_{jt-1} - Q_{jt} - X_{jt}}$$

- Data problem: ideally we want to measure $N_{jt}$ and $T_{jt}$, but we usually have data only on $S_{jt}, IN_{jt}, OUT_{jt}$ and $X_{jt}$

# Ideal estimation

- Our goal is to estimate $\partial n_{jt}/\partial p_{jt}$ and $\partial l_{jt}/\partial p_{jt}$

$$\begin{aligned}\Delta n_{jt} &= \alpha_n + \beta_n \Delta p_{jt-1} + u_{njt} \\ \Delta l_{jt} &= \alpha_l + \beta_l \Delta p_{jt-1} + u_{ljt}\end{aligned}$$

- The reason we use lagged prices:
  1. transactions follow after some time of price changes
  2. might take care of endogeneity (can be controlled more by adding $\Delta p_{jt}$)
- OLS estimators for the lock-in measures of interest

$$\hat{\delta} = \hat{\beta}_l - \hat{\beta}_l \text{ and } \hat{\theta} = \frac{\hat{\beta}_n - \hat{\beta}_l}{\hat{\beta}_n} \text{ if}$$

- these are consistent if
  1. new and old consumers would have the same reaction if all were new (e.g. their characteristics would be the same on average)
  2. price changes are exogenous to demand
- Use of cross-section and time fixed effect can control for firm-specific trends and common shocks

# Applied estimation

- Estimate the previous system with proxies

$$\begin{aligned}\Delta m_{jt} &= \alpha_m + \beta_m \Delta p_{jt-1} + u_{mjt}, \text{ where } m_{jt} = \frac{IN_{jt}}{\Sigma_i IN_{jt}} \\ \Delta k_{jt} &= \alpha_k + \beta_k \Delta p_{jt-1} + u_{kjt}, \text{ where } k_{jt} = 1 - \frac{OUT_{jt}}{S_{jt-1} - X_{jt}}\end{aligned}$$

- Additional sufficient condition for $\hat{\beta}_m$ and $\hat{\beta}_k$ to be consistent if

$$\begin{aligned}Cov\left(\Delta m_{jt} - \Delta n_{jt}, \Delta p_{jt-1}\right) &= 0 \text{ and} \\ Cov\left(\Delta k_{jt} - \Delta l_{jt}, \Delta p_{jt-1}\right) &= 0\end{aligned}$$

# Applied estimation, cont.

- $Cov\left(\Delta k_{jt} - \Delta l_{jt}, \Delta p_{jt-1}\right) = 0$ is satisfied approximately:

$$
\begin{aligned}
l_{jt} &= 1 - \frac{T_{jt}}{S_{jt-1} - Q_{jt} - X_{jt}} \\
k_{jt} &= 1 - \frac{OUT_{jt}}{S_{jt-1} - X_{jt}} = 1 - \frac{T_{jt} + Q_{jt}}{S_{jt-1} - Q_{jt} - X_{jt} + Q_{jt}}
\end{aligned}
$$

- so that $\beta_k \approx \beta_l$

# Applied estimation, cont.

- $Cov\left(\Delta m_{jt} - \Delta n_{jt}, \Delta p_{jt-1}\right) = 0$ is not satisfied

$$
\begin{aligned}
n_{jt} &= \frac{N_{jt}}{\Sigma_i N_{jt}} \\
m_{jt} &= \frac{IN_{jt}}{\Sigma_j IN_{jt}} = \frac{N_{jt} + F_{jt}}{\Sigma_j \left(N_{jt} + F_{jt}\right)}
\end{aligned}
$$

  - $IN_{jt}$ may include switchers $\left(F_{jt}\right)$
  - an increase in $p_j$ might discourage switchers to $j$ so that $Cov\left(p_j, F_j\right) < 0$
  - as a result, $\beta_m$ can show a stronger (more negative) reaction than the true $\beta_n$

- However, we can derive an upper bound for this bias $a\beta_l \approx a\beta_k$
- So the lower bound for bias-corrected estimations are

$$
\hat{\delta}_{corr} = \hat{\beta}_k - \hat{\beta}_m + a\hat{\beta}_k \text{ and } \hat{\theta}_{corr} = \frac{\hat{\beta}_m - a\hat{\beta}_k - \hat{\beta}_k}{\hat{\beta}_m - a\hat{\beta}_k}
$$

# Our application: market of personal loans

- Market shares (stocks over all consumers)

| Loan type | 2002 | 2003 | 2004 | 2005 | 2006 |
|---|---|---|---|---|---|
| Home currency, unsecured | 44 | 56 | 53 | 39 | 28 |
| Foreign currency, unsecured | 0 | 0 | 4 | 10 | 10 |
| Home currency, secured | 56 | 44 | 17 | 6 | 4 |
| Foreign currency, secured | 0 | 0 | 26 | 44 | 58 |

- Concentrate on home unsecured segment: smaller changes, most "mature" segment
- Our database
  1. 10 banks having at least 1% market share each
  2. quarterly data for 5 years (monthly data are very noisy)
  3. $S_{jt}, IN_{jt}, OUT_{jt}, X_{jt}$ for both number and value of contracts
  4. prices on the modal product: APR already including entry costs

# Estimation results

| | in consumer number | in loan value |
|---|---|---|
| Response of new consumers $\hat{\beta}_m$ | $-0.61$ | $-0.74$ |
| (confidence interval) | $(-0.93, -0.14)$ | $(-0.99, -0.22)$ |
| Response of old consumers $\hat{\beta}_k$ | $-0.13$ | $-0.18$ |
| (confidence interval) | $(-0.18, -0.01)$ | $(-0.24, -0.00)$ |
| Switching costs: $\hat{\delta}$ upper bound | 0.48 | 0.56 |
| (confidence interval) | $(0.13, 0.87)$ | $(0.22, 0.81)$ |
| Switching costs: $\hat{\theta}$ upper bound | 0.79 | 0.76 |
| (confidence interval) | $(0.66, 1.00)$ | $(0.68, 1.00)$ |
| Switching costs: $\hat{\delta}_{corr}$ lower bound | 0.33 | 0.31 |
| (confidence interval) | $(0.03, 0.80)$ | $(0.10, 0.61)$ |
| Switching costs: $\hat{\theta}_{corr}$ lower bound | 0.70 | 0.63 |
| (confidence interval) | $(0.35, 1.00)$ | $(0.41, 1.00)$ |

- Estimated value of the proportional correction factor is $a = 1.4$
- Block-bootstrap confidence intervals ($5^{th}$ & $95^{th}$ percentile) with 2000 runs

# Conclusion

- Developed a simple method to identify the lock-in effects of switching costs
  - using prices and two firm-level aggregates
  - correcting for bias in not measuring exactly what we want
- Estimated the model on personal loans in Hungary
  - old consumers' responsiveness is 70% lower because of switching costs
  - implying significant lock-in effects

THANK YOU FOR YOUR ATTENTION