НАЦИОНАЛЬНЫЙ ИССЛЕДОВАТЕЛЬСКИЙ УНИВЕРСИТЕТ

Estimation of Demand for Mortgage Loans Using Loan-level Data

Perm Winter School 2013

Ozhegov, Evgeniy M.

National Research University Higher School of Economics

Center for Empirical Analysis of Industrial Organization

Outline

- Demand for loans
- Background
- Econometric model
- Discussion

Demand for Loans

- Probability of credit contract agreement;
- Credit contract terms when agreed:
  - Loan amount (or Loan-to-Value);
  - Interest rate;
  - Maturity;
  - Downpayment.
- All are functions of:
  - Socio-demographic characteristics of borrower;
  - Terms of credit program (contract terms limits);
  - Desired property;
  - Macrovariables;
  - Expected loan performance:
    - Probabilty of default and loss given default for borrower;
    - Probabilty of prepayment and loss given prepayment for borrower.

Background

Mortgage borrowing as a simultaneous decision-making process of borrower and credit organization generates **endogeneity**.

Follain (1990):

1. How much to borrow;
2. If and when to refinance;
3. Choice of mortgage instrument.

Rachlis, Yezer (1993):

1. Borrower's application;
2. Borrowers's selection of mortgage terms;
3. Lender's endorsement;
4. Borrower's default.

Background

Sequential process generates **sample selection**.

Plillips, Yezer (1996), Ross (2000):

1. Borrower’s application and selection of mortgage terms;
2. Lender’s endorsement;
3. Borrower’s default.

Econometric Model

1. Instumental variables for endogenous demographics:

$$D^{en} = Z_D \beta_D + e_D$$

D^{en} – vector of endogenous socio-demographic characteristics,
Z_D – Instrumental variables for demographics.

2. Modeling the probability of application:

$$y_1 = \begin{cases} 1, if\ D\beta_D^1 + M\beta_M^1 + e_1 \geq \alpha_1 \\ 0, if\ D\beta_D^1 + M\beta_M^1 + e_1 < \alpha_1 \end{cases}$$

$y_1 = 1$ is an application decision,
$D = (D^{ex}, \widehat{D}^{en})$ – vector of exogenous demographics and fitted endogenous demographics,
M – macrovariables.

Econometric Model

3. Modeling the probability of endorsement for all applied:

$$y_2 = \begin{cases} 1, if\ D\beta_D^2 + M\beta_M^2 + E[e_2|y_1 = 1] \geq \alpha_2 \\ 0, if\ D\beta_D^2 + M\beta_M^2 + E[e_2|y_1 = 1] < \alpha_2 \end{cases}$$

$y_1 = 1$ is an endorsement decision.

4. Choice of loan amount limit for all endorsed:

$$\bar{L} = D\beta_D^{\bar{L}} + M\beta_M^{\bar{L}} + E[e_{\bar{L}}|y_2 = 1]$$

$\bar{L}$ is a decision on loan limit.

Econometric Model

5. Modeling the probability of contract agreement:

$$y_3 = \begin{cases} 1, if\ D\beta_D^3 + M\beta_M^3 + \hat{\bar{L}}\beta_{\bar{L}}^3 + E[e_3|y_2 = 1] \geq \alpha_3 \\ 0, if\ D\beta_D^3 + M\beta_M^3 + \hat{\bar{L}}\beta_{\bar{L}}^3 + E[e_3|y_2 = 1] < \alpha_3 \end{cases}$$

$y_3 = 1$ is an agreement decision;
$\hat{\bar{L}}$ is a fitted value of loan amount limit.

6. Choice of credit terms and property:

$$\begin{cases} \mathrm{C}_i = D\beta_D^{C_i} + M\beta_M^{C_i} + \mathrm{C}_{-i}\beta_{C_{-i}}^{C_i} + V\beta_V^{C_i} + F\beta_F^{C_i} + E\left[e_{C_i}\middle|y_3 = 1, C \in \bar{C}\right] \\ V = D\beta_D^V + M\beta_M^V + C\beta_C^V + F\beta_F^V + E[e_V|y_3 = 1, C \in \bar{C}] \end{cases}$$

$\mathrm{C} = (\mathrm{C}_i, \mathrm{C}_{-i})$ is a vector of contract terms (Loan amount, Maturity, Downpayment, Interest rate),
$\bar{C}$ is a feasible set of contract terms determined by credit program,
V is a property value,
F is a property characteristics.

Econometric Model

7. Modeling the probability of contract events:

$$y_4 = k, if \;\; D\beta_D^4 + M\beta_M^4 + \hat{C}\beta_C^4 + \hat{V}\beta_V^4 + A\beta_A^4 + E[e_4|y_3 = 1] \in \mathcal{L}_k$$

$y_4 = k$ is a fact of k-th credit event,
$\hat{C}$ and $\hat{V}$ are fitted values of credit terms and property value,
A is a loss given k-th event.

Approaches to Sample Selection Correction

Sequential decisions

$$y_1 = \begin{cases} 1, if\ X\beta_X^1 + e_1 \geq \alpha_1 \\ 0, if\ X\beta_X^1 + e_1 < \alpha_1 \end{cases}$$

$$y_2 = Z\beta_Z^2 + E[e_2|y_1 = 1]$$

Since $y_1 = g(X\beta_X^1, F(e_1))$ then

$$E[e_2|y_1 = 1] = \psi\left(X\beta_X^1, F(e_1), F(e_2)\right)$$

Since e_1 and e_2 are independent then

$$y_2 = Z\beta_Z^2 + \psi\left(X\beta_X^1, F(e_1)\right) + e_2$$

Approaches to Sample Selection Correction

Depends on $F(e_1)$:

If $e_1 \sim N(0, \sigma_1)$ then standart Heckman:

- $y_2 = Z\beta_Z^2 + \rho * IMR\left(\widehat{X\beta_X^1}\right) + e_2$

If $F(e_1)$ is undefined then use semi-parametrics:

- ψ is a function on $\widehat{X\beta_X^1}$ (polynomial or etc.);
- difference-in-difference.

Discussion

1. Full rationality of agents causes simultaneity in all decisions.
2. Credit history is unobservable.

НАЦИОНАЛЬНЫЙ ИССЛЕДОВАТЕЛЬСКИЙ УНИВЕРСИТЕТ

Thank you for attention

E-mail: tos600@gmail.com