Introduction

- Rise in home foreclosures
  - Subprime mortgage crises
- Housing finance affecting financial markets and global economy
- Mortgage credit risk determined by outstanding LTV
- Key questions:
  - What determines borrowing propensity?
  - What are determinants of outstanding LTV?
  - What is the role of mortgage type?
  - What is the link between homeownership and housing finance?
Data

- DNB Household Survey carried out by CentERdata (Tilburg University)
- Period: 1992–2005
- Rotating panel of 8,867 representative Dutch households (30,803 obs.)

Why Netherlands?
- High level of financial sophistication of Dutch households (Alessie, Hochguertel and van Soest (2002))
- Very well developed mortgage market (Kuijpers and Schotman (2006))
- Broad scope and high quality of the data (cf. Campbell (2006))
- Homogenous w.r.t. economic and legal factors

Holland and Housing Trends

[Graph showing housing trends over the years]
Some facts and observations

- Increasing house prices – declining affordability
- Mortgage debt counting for 94% of homeowners’ external financing; real estate about 80% of assets
- Primarily fixed rate debt
- Many different mortgage types
- Unlike firms: no stationary LTV target
- Wide variation: $LTV_{it} = 0.479$ (St. dev. = 0.275)
- 20% of homeowners having no mortgage debt
- LTV dispersion increasing with time

Some facts and observations

- LTV declining over mortgage life-cycle:
  - Amortization (influenced by mortgage type)
  - House price appreciation (if no equity release)
- Repayment versus non-repayment mortgages:
  - Outstanding LTV on average higher for non-repayment mortgages (NRPMT)
  - LTV declining faster for repayment mortgages (RPMT)
Some facts and observations

- Mortgage to income ratio:
  - RPMT: constant at 1.7

- Outstanding loan to initial loan ratio:
  - RPMT: 0.77
  - NRPMT: 0.96 to 1.05

- Proliferation of NRPMT in recent years:
  - Interest-only mortgages: up from 0% to 36%
  - RPMT: down from 37% to 13%

Regression analysis

1. Model of borrowing propensity: \( \text{Prob} (LTV_{it} > 0) \)
   - Controlling for sample selection (subsample of owners)

2. Model of outstanding \( LTV_{it} \) (for mortgage holders)

3. Model of mortgage type: \( \text{Prob} (\text{NRPTM} = 1) \)
Regression analysis
Borrowing Propensity: \( \text{Prob}(LTV_{it} > 0) \)

- Endogeneity of sample selection taken into account (financing decisions relevant only to owners)
  - Problem modelled using Heckman probit methodology

Model specification:

\[
\begin{align*}
OWN^*_{it} &= X_{1it} \alpha + \epsilon_{it} \\
BORROW^*_{it} &= X_{2it} \beta + \zeta_{it},
\end{align*}
\]

with

\[
OWN_{it} \equiv \begin{cases} 
1 & \text{if } OWN^*_{it} > 0 \\
2 & \text{if } OWN^*_{it} \leq 0
\end{cases}
\]

and

\[
BORROW_{it} \equiv \begin{cases} 
1 & \text{if } BORROW^*_{it} > 0 \\
0 & \text{if } BORROW^*_{it} \leq 0 \\
\text{Not observed} & \text{if } OWN^*_{it} \leq 0
\end{cases}
\]

\( \epsilon_{it}, \zeta_{it} \) – error term drawn from bivariate normal distribution
\( y^*_{it} \) – non-observable, \( y_{it} \) – observable
Regression analysis
Borrowing Propensity: \( Prob(LTV_{it} > 0) \)

- \( \varepsilon_{it} (\zeta_{it}) \) are iid *between* different households over time, but not necessarily for different observations *within* the same household
- Covariance between \( \varepsilon_{it} \) and \( \zeta_{it} \) is non-zero
- Adjustment for sample selection is needed (and made)

Outstanding \( LTV_{it} \) and mortgage type (\( Prob(NRPMT = 1) \))

- Outstanding \( LTV_{it} \):
  - Fixed effects model (to control for unobserved heterogeneity across households)
  - \( LTV_{it} \) at any time \( t \)

\[
LTV_{it} = \gamma X_{3it} + \eta_{it}
\]

- Mortgage type: \( Prob(NRPMT = 1) \)
  - Probit model
Results
Sample selection model (Homeownership)

- Dependent variable: Homeownership dummy

<table>
<thead>
<tr>
<th>Variable</th>
<th>Unit</th>
<th>( \Delta \text{Prob} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Income</td>
<td>EUR 10000</td>
<td>0.015</td>
</tr>
<tr>
<td>Net worth</td>
<td>EUR 10000</td>
<td>0.019</td>
</tr>
<tr>
<td>Benefits</td>
<td>EUR 10000</td>
<td>-0.052</td>
</tr>
<tr>
<td>2nd household member</td>
<td>dummy</td>
<td>0.061</td>
</tr>
<tr>
<td>3rd (or more) member</td>
<td>dummy</td>
<td>0.069</td>
</tr>
<tr>
<td>Education</td>
<td>dummy</td>
<td>0.032</td>
</tr>
<tr>
<td>Low urbanization</td>
<td>dummy</td>
<td>0.039</td>
</tr>
<tr>
<td>Housing type</td>
<td>dummy</td>
<td>-0.071</td>
</tr>
<tr>
<td>Relative cost of renting</td>
<td>0.1</td>
<td>0.003</td>
</tr>
<tr>
<td>Calendar time</td>
<td>year</td>
<td>0.003</td>
</tr>
</tbody>
</table>

Ownership propriety is:
- Inverted U curve of age (max. at 40)
- Increasing in average tax rate
- Lower the highly-urbanized areas
Results
Borrowing model (Prob($LTV > 0$))

- Dependent variable: Borrowing dummy

<table>
<thead>
<tr>
<th>Variable</th>
<th>Unit</th>
<th>∆ Prob</th>
</tr>
</thead>
<tbody>
<tr>
<td>Income</td>
<td>0.1</td>
<td>-0.014</td>
</tr>
<tr>
<td>Net worth EUR 10000</td>
<td></td>
<td>-0.010</td>
</tr>
<tr>
<td>Benefits</td>
<td>0.1</td>
<td>-0.038</td>
</tr>
<tr>
<td>2nd household member dummy</td>
<td>dummy</td>
<td>0.108</td>
</tr>
<tr>
<td>3rd (or more) member dummy</td>
<td>dummy</td>
<td>0.121</td>
</tr>
<tr>
<td>Education dummy</td>
<td>dummy</td>
<td>0.076</td>
</tr>
<tr>
<td>Low urbanization dummy</td>
<td>dummy</td>
<td>0.037</td>
</tr>
<tr>
<td>Effective tax rate (until '97)</td>
<td>0.1</td>
<td>0.056</td>
</tr>
</tbody>
</table>

- Income and benefits are scaled by house value
- Borrowing propensity is an inverted U-shaped function of age
- Error terms of both regressions are positively correlated
Results

LTV regression (for $LTV_{it} > 0$)

▶ Dependent variables: Loan to value ratio

<table>
<thead>
<tr>
<th>Variable</th>
<th>Unit</th>
<th>Sensitivity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Net worth</td>
<td>EUR 10000</td>
<td>-0.011</td>
</tr>
<tr>
<td>Benefits (RPMT)</td>
<td>1</td>
<td>0.592</td>
</tr>
<tr>
<td>Benefits (NRPMT)</td>
<td>1</td>
<td>0.369</td>
</tr>
<tr>
<td>2nd household member</td>
<td>Dummy</td>
<td>0.022</td>
</tr>
<tr>
<td>3rd (or more) member</td>
<td>Dummy</td>
<td>0.022</td>
</tr>
<tr>
<td>Education</td>
<td>Dummy</td>
<td>-0.005</td>
</tr>
<tr>
<td>Effective tax rate (until ’97)</td>
<td>1</td>
<td>0.046</td>
</tr>
<tr>
<td>Calendar time</td>
<td>year</td>
<td>-0.005</td>
</tr>
<tr>
<td>NRPMT</td>
<td>Dummy</td>
<td>0.047</td>
</tr>
</tbody>
</table>

▶ Repayment schedule is compulsory (discretionary) for repayment (non-repayment) mortgages

▶ Marginal effect of income values with mortgage type:
  ▶ RPMT: 18 cent more debt per extra 10k euro of income
  ▶ NRPMT: 12 cent less debt per extra 10k euro of income
  ▶ RPMT: constant marginal effect over time
  ▶ NRPMT: decreasing marg. effect (-0.056 at T=0; -0.339 at T=30)
  ▶ RPMT: income only determines initial debt level
  ▶ NRPMT: extra income accelerates repayment (which is discretionary)
Results
LTV regression (for $LTV_{it} > 0$)

- LTV is a convex decreasing function of mortgage elapsed time:
  - Effect of house price appreciation
  - RPMT: 1.09% decline per year
  - NRPMT: 0.81% decline per year

- LTV significantly higher for non-repayment mortgages:
  - Results also hold for individual mortgage types
  - Difference increases with time elapsed since mortgage commencement

Results
LTV regression (for $LTV_{it} > 0$)

- Indication that their relatively high LTV may be associated with a selection of non-compulsory principal repayment types
- Non-repayment mortgages are riskier
- What caused proliferation of non-repayment mortgages?
### Results

Probit model for mortgage type ($Prob(NRPMT = 1)$)

- **Dependent variable: Mortgage type ($NRPMT = 1$)**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Unit</th>
<th>(\Delta) Prob</th>
</tr>
</thead>
<tbody>
<tr>
<td>Income</td>
<td>0.1</td>
<td>-0.009</td>
</tr>
<tr>
<td>Net worth</td>
<td>EUR 10000</td>
<td>-0.0003</td>
</tr>
<tr>
<td>2nd household member</td>
<td>dummy</td>
<td>0.109</td>
</tr>
<tr>
<td>3rd (or more) member</td>
<td>dummy</td>
<td>0.112</td>
</tr>
<tr>
<td>Age</td>
<td>year</td>
<td>-0.017</td>
</tr>
<tr>
<td>Effective tax rate (until ‘97)</td>
<td>0.01</td>
<td>0.004</td>
</tr>
<tr>
<td>Calendar time</td>
<td>year</td>
<td>0.028</td>
</tr>
<tr>
<td>Affordability</td>
<td>0.1</td>
<td>-0.018</td>
</tr>
</tbody>
</table>

NRPMT mortgages chosen by households that are more likely to be financially constrained (low net worth, large family)

- Proliferation of non-repayment mortgages driven by:
  - Declining affordability
  - Tax advantages
  - Increased banking competition
Conclusions

- Mortgage financing being practically the only source of external financing
- Loan-to-value ratio decreasing much faster for contracts with compulsory principal repayment
- Potential implications of the prevalence of non-compulsory repayment mortgages for future homeownership rates
- Endogeneity of sample selection taken into account