Using Microdata to analyse Macroprudential Policy and Financial Stability: the effort in Austria

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26th May 2015
Introduction

1. Information at the micro level essential for the analysis of macroprudential policy and financial stability
   - ... distribution matters
   - ... many indicators not available from macro statistics (LTV, DTI)
   - ... micro level information supplements other data

2. Presentation based on work over the last years

3. Wider context of micro and macro data integration
Introduction

Austria

Domestic Banks

Joint Distributions (e.g. Assets&Liabilities)
Household Vulnerability
LTV, LTI, DSTI, FM, EAD, LGD

Equity Capital, Portfolio Risk, Network and Contagion Effects, ...

Equity Capital, Debt, Network and Contagion Effects, ...

Branches/Foreign Banks

Equity Capital, Portfolio Risk, Network and Contagion Effects, ...

Equity Capital, Debt, Network and Contagion Effects, ...

Households

Firms

Branches/Foreign Banks

Foreign Countries

Households

Firms

Equity Capital, Portfolio Risk, Network and Contagion Effects, ...

Equity Capital, Debt, Network and Contagion Effects, ...

Albacete, Lindner (Economic Analysis Division, OeNB)

Microdata for Macropru and Financial Stab

26th May 2015
Introduction

Figure: Credit Level Data (Loans > 350,000 Euro):

- Close to full loan volume to companies covered
- About 18% of loan volume to households covered, and about 25% with regard to mortgage loans
- 350,000 threshold crossed at P98 of HFCS mortgage loans, so roughly 12,000 such loans covered, but in lower area (largest about 700,000)
Problems on the macro-side

1. Sparse information on households. In Austria
   - Nothing on some measures, e.g. LTV, DTI, etc.
   - Data from banks come in bins, full distribution is not available
   - Additional information like income or wealth of household missing (at least partly)
   - Usually circumvent with crude assumptions
   - Individuals might use different banks

⇒ Survey data supplement information from administrative sources.
Difficulties on the survey-side

- (Sub-)sample size.
- Information from memory of households (recollection bias).
- Missing information.

⇒ Integrated approach necessary.
Literature
Literature I


Household Finance and Consumption Survey (HFCS)
HFCS → Basics

- Household Finance and Consumption Survey → HFCS
- Euro area wide effort to collect micro data on household finances (Decision of the Governing Council in December 2006)
- 1st wave 2010/2011 with 15 countries
- Ongoing project with intention to collect data every 3 years
- 2nd wave under way (publishing of the data in summer 2016)
- Ex-ant harmonization not only of the questionnaire but the whole data production process
- Computer Assisted Personal Interviews (CAPI, exception: the Netherlands, Finland to some extent)
- Harmonized Bayesian-based multiple Imputation procedure (state of the art)
- ECB coordinates project and checks the quality
- First wave net sample 62,521 households in the euro area, 2,380 in Austria (SCF in the USA: 6,500)
- Role model for the HFCS is the SCF of the US Federal Reserve
Very wide usage of the HFCS in the research community. For the ESCB particularly important with respect to:

- Monetary Policy (transmission mechanism, distributional effect of monetary policy, etc.)
- Macroprudential policy and financial stability (distribution of debt and assets, analyses on vulnerability, etc.)

Importance of cross country comparability due to harmonization

⇒ Analyses can be done at the euro area level.
HFCS → Household’s Balance Sheet

**HOUSEHOLDS’ BALANCE SHEET**

**ASSETS**
- **Real assets:**
  - Main residence
  - Other real estate property
  - Investments in self-employed businesses
  - Vehicles
  - Valuables
- **Financial assets:**
  - Sight accounts
  - Savings deposits
  - Savings plans with building and loan associations
  - Life insurance policies
  - Mutual funds
  - Debt securities
  - Publicly traded stocks
  - Money owned to household
  - Other

**LIABILITIES**
- **Collateralized debt:**
  - by main residence
  - by other real estate property

+ **Uncollateralized debt:**
  - Bank overdrafts
  - Credit card debt
  - Other uncollateralized loans

**GROSS WEALTH**

**DEBT**

**GROSS WEALTH minus DEBT = NET WEALTH**
Additional information on

- Income
- Consumption (expenditures)
- Employment
- Age
- Education
- etc.
HFCS $\rightarrow$ Specific information on liabilities

Information on each loan (up to three for every category) on:

- year when it was taken out
- level of amount at the time the contract was signed and outstanding at the time of the interview
- interest rates (level and fixed vs. variable)
- maturity
- repayment
- purpose
- bullet loan (in AT)
- foreign currency loan (in AT)
- some information on renegotiation and additional money taken out

Very few households with more than three loans in a category.
Household Debt Participation and Shares of Debt Types

**Debt Participation**
As a percentage of all Austrian households

- No debt: 64%
- Mortgage debt only: 17%
- Mortgage and nonmortgage debt: 14%
- Nonmortgage debt only: 4%

**Shares of Debt Types**
As a percentage of aggregated total debt

- Main residence mortgages: 73%
- Mortgages on other property: 11%
- Nonmortgage debt: 16%

Source: HFCS Austria 2010, OeNB.
Debt Participation and Debt Level across Gross Wealth and Income Distributions

Debt Participation across Gross Wealth Quintiles

% 60 50 40 30 20 10 0
1st quintile 2nd quintile 3rd quintile 4th quintile 5th quintile
Has debt Has mortgage debt Has nonmortgage debt

Debt Participation across Gross Income Quintiles

% 60 50 40 30 20 10 0
1st quintile 2nd quintile 3rd quintile 4th quintile 5th quintile

Conditional Median Debt across Gross Wealth Quintiles

EUR thousand 60 50 40 30 20 10 0
1st quintile 2nd quintile 3rd quintile 4th quintile 5th quintile
Median debt Median mortgage debt Median nonmortgage debt

Conditional Median Debt across Gross Income Quintiles

EUR thousand 60 50 40 30 20 10 0
1st quintile 2nd quintile 3rd quintile 4th quintile 5th quintile
Median debt Median mortgage debt Median nonmortgage debt

Source: HFCS Austria 2010, OeNB.
Definitions
Definitions → Probability of default (PD)

• In the supervisory framework, the PD of a household/loan refers to the probability that a household defaults within one year. A loan is defaulted if one of the default criteria under Basel II are met: full repayment unlikely and/or interest or principal payments on a material exposure more than 90 days past due. If $PD_i = 1$, the household has already defaulted. For non-defaulted households the PD lies in the open interval $(0, 1)$ and is assigned by the bank to all indebted households / loans.

• Micro / household (HH) level literature: binary classification used, with PD(HH) defined as follows:

  $$PD_i = 1 \text{ if household } i \text{ is classified as vulnerable. If not vulnerable }$$
  $$PD_i = 0.$$
**Definitions → Exposure at Risk / Default (SEvH, EAD)**

Discrepancy of "exposure at default" (supervisory term) and "exposure at risk/default" (micro-literature):

- **Supervisory**: All on-balance credit and some part of the (off balance) credit lines
- **Micro-level**: Share of debt held by households classified as vulnerable (denote this set by \( V \)):

\[
SEvH = \frac{\sum_{i \in V} Debt_i}{\sum_{i \in D} Total Debt_i}
\]

where D is the set of indebted households.
**Definitions → Loss given Default (LGD)**

Discrepancy of LGD in the micro-literature and as supervisory term

- **Supervisory**: specifies the proportion of a loan exposure that will be lost (i.e. will not be recoverable) under the assumption that the borrower defaults. The LGD represents a credit risk parameter that is used for determining a bank’s capital requirement under the advanced internal ratings-based (IRB) approach of Basel II.

- **Micro-level**: estimated loss for banks caused by vulnerable households share of debt held by households classified as vulnerable and have negative equity (denote this set by $A$):

\[
LGD = \frac{\sum_{i \in A} (Debt_i - Assets_i)}{\sum_{i \in D} Total\ Debt_i}
\]
Definitions → Standard definitions of vulnerability

Three (four) definitions of vulnerability:

- Negative financial margin \((FM)\): \(FM_i = Y_i - BC_i - DS_i\) where \(Y_i\) is income of household \(i\), \(BC_i\) is basic consumption of household \(i\), and \(DS_i\) is debt service of household \(i\) ⇒ Household \(i\) is vulnerable if \(FM_i < 0\)

- Debt to asset ratio: \(DA_i = \frac{Total\,Debt_i}{Total\,Assets_i}\) ⇒ Household \(i\) is vulnerable if \(DA_i \geq 75\%\)

- Debt service to income: \(DSI_i = \frac{Debt\,Service_i}{Y_i}\) ⇒ Household \(i\) is vulnerable if \(DSI_i \geq 40\%\)

- Direct question: "Expenses above income" and being indebted.
Vulnerability → Preview of the some results

**Distribution of Debt Burden Measures across Percentiles**

- **Ratio**
  - 250
  - 200
  - 150
  - 100
  - 50
  - 0

- **Percentiles**:
  - P0
  - P10
  - P20
  - P30
  - P40
  - P50
  - P60
  - P70
  - P80
  - P90
  - P100

- **Lines**:
  - Blue: Debt to asset
  - Brown: Debt service to income

**Source**: HFCS Austria 2010, OeNB.
## Vulnerability Measures across Household Groups

<table>
<thead>
<tr>
<th>Variables</th>
<th>Debt to asset ≥75%</th>
<th>Debt service to income ≥40%</th>
<th>Expenses above income</th>
</tr>
</thead>
<tbody>
<tr>
<td>All</td>
<td>18.8</td>
<td>5.0</td>
<td>18.9</td>
</tr>
<tr>
<td>1–20 gross income pct</td>
<td>40.1</td>
<td>20.2</td>
<td>27.2</td>
</tr>
<tr>
<td>21–40 gross income pct</td>
<td>22.4</td>
<td>3.8</td>
<td>21.9</td>
</tr>
<tr>
<td>41–60 gross income pct</td>
<td>20.0</td>
<td>6.1</td>
<td>13.7</td>
</tr>
<tr>
<td>61–80 gross income pct</td>
<td>14.2</td>
<td>2.5</td>
<td>21.4</td>
</tr>
<tr>
<td>81–100 gross income pct</td>
<td>9.3</td>
<td>1.9</td>
<td>14.5</td>
</tr>
<tr>
<td>1–20 gross wealth pct</td>
<td>60.2</td>
<td>8.5</td>
<td>26.4</td>
</tr>
<tr>
<td>21–40 gross wealth pct</td>
<td>25.2</td>
<td>.</td>
<td>20.5</td>
</tr>
<tr>
<td>41–60 gross wealth pct</td>
<td>10.4</td>
<td>4.2</td>
<td>17.8</td>
</tr>
<tr>
<td>61–80 gross wealth pct</td>
<td>6.6</td>
<td>4.7</td>
<td>17.4</td>
</tr>
<tr>
<td>81–100 gross wealth pct</td>
<td>3.2</td>
<td>5.6</td>
<td>14.9</td>
</tr>
</tbody>
</table>
Indebtedness of Vulnerable Households
### Debt Holding, Indebtedness and Negative Wealth of Vulnerable Households

<table>
<thead>
<tr>
<th>Vulnerability measure</th>
<th>Participation (%)</th>
<th>Indebtedness (EUR)</th>
<th>Has Negative Net Wealth (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Has mortgage debt</td>
<td>Has nonmort-gage debt</td>
<td>Median debt</td>
</tr>
<tr>
<td>Debt to asset ≥75%</td>
<td>18.8</td>
<td>87.6</td>
<td>18,400</td>
</tr>
<tr>
<td>Debt service to income ≥40%</td>
<td>58.7</td>
<td>61.4</td>
<td>51,301</td>
</tr>
<tr>
<td>Expenses above income</td>
<td>39.0</td>
<td>75.0</td>
<td>13,473</td>
</tr>
</tbody>
</table>

Source: HFCs Austria 2010, OeNB.

Note: Cells that cannot be estimated because of no observations in some of the multiple imputation implicates are marked with “..”.
## How Vulnerable Households Avoid Default

<table>
<thead>
<tr>
<th>Source of extra income to meet expenses</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Savings, assets</td>
<td>65.5</td>
</tr>
<tr>
<td>Credit card debt/overdraft</td>
<td>22.3</td>
</tr>
<tr>
<td>Another loan</td>
<td>27.9</td>
</tr>
<tr>
<td>Help from relatives/friends</td>
<td>26.0</td>
</tr>
<tr>
<td>Leaving bills unpaid</td>
<td>5.0</td>
</tr>
<tr>
<td>Other</td>
<td>6.0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Comparison of past 12 months’ expenses with average expenses</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expenses higher than average</td>
<td>60.5</td>
</tr>
<tr>
<td>Expenses lower than average</td>
<td>6.8</td>
</tr>
<tr>
<td>Expenses just about average</td>
<td>32.7</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Ability to get financial assistance from friends or relatives</th>
<th>51.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Able to get EUR 5,000 from friends</td>
<td></td>
</tr>
</tbody>
</table>

*Source: HFCS Austria 2010, OeNB.*

*Notes: Vulnerable households are defined according to the expenses-above-income vulnerability measure.*
### Exposure at Default and Loss Given Default according to Vulnerability Measures

<table>
<thead>
<tr>
<th>Vulnerability measure</th>
<th>Exposure at default (EAD)</th>
<th>Loss given default (LGD)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Any debt</td>
<td>Mortgage debt</td>
</tr>
<tr>
<td>Debt to asset ≥75%</td>
<td>29.3</td>
<td>24.0</td>
</tr>
<tr>
<td>Debt service to income ≥40%</td>
<td>11.9</td>
<td>9.5</td>
</tr>
<tr>
<td>Expenses above income</td>
<td>16.5</td>
<td>14.6</td>
</tr>
<tr>
<td>Inability to meet income</td>
<td>0.8</td>
<td>0.8</td>
</tr>
</tbody>
</table>

Source: HFCS Austria 2010, OeNB.

Notes: Cells that cannot be estimated because of no observations in some of the multiple imputation implicates are marked with “..”.
Stress Testing Households
Stress Testing Households → Basics

Four (six) shocks are modelled:

- Employment shock ← changes in the rate of unemployment
- Income shock
- Shocks in the interest rate: short term as well as long term interest rate
- Exchange rate shock
- (Change of asset prices)
- (Change of repayment vehicle development)
Stress Testing Households $\rightarrow$ Unemployment I

$$Pr(\text{unemployed}|X) = \Gamma(\beta'X) = \frac{1}{1 + e^{-\beta'X}}$$

where the explanatory factors $X$ are:

- Gender
- Education
- Income
- Interaction between partner in the household and employment status of the partner
- Region
- Number of adult household members
- Number of children
- Age and age squared

For some indicators the references person / financial knowledgeable person has to be defined.
Stress Testing Households → Unemployment II

- Based on the predicted probability of becoming unemployed and a random number, we generate randomly chosen new unemployed persons, i.e. households whose reference person newly became unemployed.

- According to Austrian regulation household income drops by 45%.

- Monte Carlo simulation with 1,000 replications yield 1,000 changes of the parameters under investigation.

- Average over the simulations gives us the estimate.

Potential extensions:

- Incorporate all (adult) household members.

- Move out of unemployment (would only improve financial situation of households).
**Stress Testing Households → Results based on Albacete and Fessler (2010)**

### Effects of a Rise in the Unemployment Rate

<table>
<thead>
<tr>
<th></th>
<th>Baseline scenario</th>
<th>1 percentage point</th>
<th>2 percentage points</th>
<th>3 percentage points</th>
</tr>
</thead>
<tbody>
<tr>
<td>% of vulnerable households (mean)</td>
<td>9.2</td>
<td>9.3</td>
<td>9.3</td>
<td>9.4</td>
</tr>
<tr>
<td>Mean EAD</td>
<td>14.3</td>
<td>14.4</td>
<td>14.5</td>
<td>14.6</td>
</tr>
<tr>
<td>Mean LGD₁</td>
<td>2.6</td>
<td>2.6</td>
<td>2.6</td>
<td>2.6</td>
</tr>
<tr>
<td>Mean LGD₂</td>
<td>2.1</td>
<td>2.1</td>
<td>2.1</td>
<td>2.1</td>
</tr>
</tbody>
</table>

*Source: Authors’ calculations.*
Stress Testing Households $\rightarrow$ Income

Very simple approach:

$\rightarrow$ Income of every households changes by ex ante specified percent

Difference to unemployment:

$\rightarrow$ All households are affected

Reason:

$\rightarrow$ Using information from macro level disposable income forecast (see below)

Once more waves of the HFCS become available, a potential improvement is to model different changes over the income distribution based on past changes.
Idea: Change in the interest rates affects repayments $R_i$ a household has to make.

Short term:
  → only loans with variable interest rates are affected.

Long term:
  → both loans with variable and fixed interest rates are affected.
Stress Testing Households → Interest rates

Bullet loan:

→ immediate repayment is just interest and thus change in repayment only directly are affected:

\[ R_i = S_{t-1} * i \]

where \( S \) is the outstanding amount.

Other loans:

→ repayment is estimated by

\[ R_i = S_{t-1} \frac{i * (1 + i)^{n-t}}{(1 + i)^{n-t} - 1} \]

where \( n \) is the term of the loan and \( t \) is the time elapsed since the loan was taken out.
### Short- and Long-Term Effects of Interest Rate Increases

<table>
<thead>
<tr>
<th>Interest rate increase by</th>
<th>Baseline scenario</th>
<th>1 percentage point</th>
<th>2 percentage points</th>
<th>3 percentage points</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Short-term</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% of vulnerable households</td>
<td>9.2</td>
<td>9.8</td>
<td>11.1</td>
<td>12.0</td>
</tr>
<tr>
<td>EAD</td>
<td>14.3</td>
<td>16.8</td>
<td>19.8</td>
<td>21.4</td>
</tr>
<tr>
<td>LGD₁</td>
<td>2.6</td>
<td>3.7</td>
<td>3.9</td>
<td>4.1</td>
</tr>
<tr>
<td>LGD₂</td>
<td>2.1</td>
<td>2.9</td>
<td>2.9</td>
<td>2.9</td>
</tr>
<tr>
<td><strong>Long-term</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% of vulnerable households</td>
<td>9.2</td>
<td>10.1</td>
<td>11.9</td>
<td>13.0</td>
</tr>
<tr>
<td>EAD</td>
<td>14.3</td>
<td>17.6</td>
<td>21.3</td>
<td>23.5</td>
</tr>
<tr>
<td>LGD₁</td>
<td>2.6</td>
<td>4.0</td>
<td>4.3</td>
<td>4.4</td>
</tr>
<tr>
<td>LGD₂</td>
<td>2.1</td>
<td>3.2</td>
<td>3.3</td>
<td>3.3</td>
</tr>
</tbody>
</table>

*Source: Authors’ calculations.*
Stress Testing Households → Results Short Term
Simulation based on the HFCS I

<table>
<thead>
<tr>
<th>Stress Test: General Results</th>
<th>Baseline</th>
<th>Interest rate increase by...</th>
<th>Change(^1)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>0.7 percentage points</td>
<td>1.3 percentage points</td>
</tr>
<tr>
<td>Households with a negative financial margin (% of debtors)</td>
<td>8.5</td>
<td>8.9</td>
<td>9.5</td>
</tr>
<tr>
<td>Debt of these households (% of total household debt)</td>
<td>21.3</td>
<td>22.0</td>
<td>23.2</td>
</tr>
<tr>
<td>Debt of these households not covered by their total wealth (% of total household debt)</td>
<td>3.2</td>
<td>3.2</td>
<td>3.6</td>
</tr>
<tr>
<td>Debt of these households not covered by their real assets (% of total household debt)</td>
<td>4.6</td>
<td>4.6</td>
<td>5.0</td>
</tr>
</tbody>
</table>

Source: HFCS Austria 2010, OeNB.

\(^1\) Difference between scenario 3 (+2.9 percentage points) and the baseline scenario, given in percentage points.
Stress Testing Households → Results Short Term Simulation based on the HFCS II
Stress Testing Households \(\rightarrow\) Exchange Rate

- Shock on the exchange rate very similar to the interest rates shocks.
- Development in the exchanges rates affect
  - outstanding amount, and
  - indirectly also interest payments of FX loan holders.
- All FX loans are affected identically.

Only a relative small fraction of households is affected, but usually large principal.
**Stress Testing Households → Results based on Albacete and Fessler (2010)**

**Effects of an Appreciation of the Loan Currency against the Euro**

<table>
<thead>
<tr>
<th></th>
<th>Baseline scenario</th>
<th>1%</th>
<th>2%</th>
<th>5%</th>
</tr>
</thead>
<tbody>
<tr>
<td>% of vulnerable</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>households</td>
<td>9.2</td>
<td>9.4</td>
<td>9.4</td>
<td>9.8</td>
</tr>
<tr>
<td>EAD</td>
<td>14.3</td>
<td>14.6</td>
<td>14.6</td>
<td>15.1</td>
</tr>
<tr>
<td>LGD$_1$</td>
<td>2.6</td>
<td>2.7</td>
<td>2.7</td>
<td>2.7</td>
</tr>
<tr>
<td>LGD$_2$</td>
<td>2.1</td>
<td>2.2</td>
<td>2.2</td>
<td>2.2</td>
</tr>
</tbody>
</table>

*Source: Authors’ calculations.*
Stress Testing Households → Results based on Albacete and Fessler (2010)
Stress Testing Households → Asset Prices

- Asset prices also affect net positions of households and hence LGD.
- Both real as well as financial assets can be affected.
- Exposure at risk (SEvH, EAD) is not affected.
- Depending on definition of vulnerability, share of households that are vulnerable may be affected.
- (Via the repayment vehicle for bullet loans share of vulnerable households may be affected indirectly.)
- Approach: assets prices change by X% (exogenous).

This approach only taken in early papers.
**Stress Testing Households → Asset Prices:**
Results on LGD from Albacete and Fessler (2010)

### Effects of Asset Price Changes

<table>
<thead>
<tr>
<th>Decrease in real estate wealth by</th>
<th>0%</th>
<th>10%</th>
<th>20%</th>
<th>30%</th>
</tr>
</thead>
<tbody>
<tr>
<td>0%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Decrease in total financial wealth by</th>
<th>0%</th>
<th>10%</th>
<th>20%</th>
<th>30%</th>
</tr>
</thead>
<tbody>
<tr>
<td>0%</td>
<td>2.1</td>
<td>2.3</td>
<td>2.6</td>
<td>2.9</td>
</tr>
<tr>
<td>10%</td>
<td>2.1</td>
<td>2.4</td>
<td>2.7</td>
<td>3.0</td>
</tr>
<tr>
<td>20%</td>
<td>2.1</td>
<td>2.4</td>
<td>2.7</td>
<td>3.1</td>
</tr>
<tr>
<td>30%</td>
<td>2.2</td>
<td>2.5</td>
<td>2.8</td>
<td>3.1</td>
</tr>
</tbody>
</table>

*Source: Authors’ calculations.*
Stress Testing Households → Repayment vehicle

- Change of the repayment vehicle affects only bullet loan holders.
- Assumption: A change affects the amount that is paid into the repayment vehicle immediately.
- Assumption: Term of loan contract is held constant.
- All indicators are affected:
  - Share of vulnerable households
  - Exposure (SEvH, EAD)
  - Loss given default (LGD)
- Modelling over a change of the yield of the repayment vehicle.

This approach only taken in early papers.
Stress Testing Households  →  Repayment vehicle: Results from Albacete and Fessler (2010)

### Effects of a Decrease in the Assumed Yield of Repayment Vehicles for Bullet Loans

<table>
<thead>
<tr>
<th></th>
<th>Decrease in yield by</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Baseline scenario</td>
</tr>
<tr>
<td>% of vulnerable households</td>
<td>9.2</td>
</tr>
<tr>
<td>EAD</td>
<td>14.3</td>
</tr>
<tr>
<td>LGD₁</td>
<td>2.6</td>
</tr>
<tr>
<td>LGD₂</td>
<td>2.1</td>
</tr>
</tbody>
</table>

Source: Authors' calculations.
Stress Testing Households → First results of combined analysis based on Albacete and Fessler (2010)

Change in percentage points of...

... the share of vulnerable households
Households with negative financial margin*

- Shock by 1 standard deviation
- Shock by 2 standard deviations
- Shock by 3 standard deviations

... their debt (exposure at default)
As a share of total household debt

- IR: Interest rate rise
- FC: Appreciation of foreign currency
- RV: Decrease in the yield of repayment vehicles
- UR: Increase in unemployment rate
- AP: Asset price decrease

Source: OeNB.

* Financial margin = Income - (Basic Consumption + Debt Service)
Integration of Micro and Macro Information/Tools
Sparse information on the households in the administrative records.

Change in probability of default in the FSAP-Stress Tests taken from the model for business.

For some parameters very crude assumptions, e.g. debt service to disposable income.

Household sector modelled at the micro level.

Change of appropriate estimates from the micro model applied to regulatory information/data.

Models from the survey data provide an input to FSAP-Stress Tests.
Integration of Micro and Macro Information/Tools → Basics

At the micro level four shocks are modelled (due to the available development of aggregate inputs to the FSAP):

- Change in unemployment rates.
- Change in income.
- Change in short term and long term interest rates.
- Change in the exchange rate.

Modelling approach as described above.
Integration of Micro and Macro Information/Tools → Scenarios from the aggregate forecasts for the 2013 FSAP

### Scenarios for Changes in Households’ Vulnerability

<table>
<thead>
<tr>
<th></th>
<th>GDP</th>
<th>URX</th>
<th>PYR</th>
<th>STIR</th>
<th>LTIR</th>
<th>EX SFr</th>
<th>EX JPY</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Annual growth rates in %</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Scenario 1: baseline</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>First year</td>
<td>1.1</td>
<td>2.5</td>
<td>1.9</td>
<td>41.1</td>
<td>18.4</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Second year</td>
<td>2.0</td>
<td>-0.1</td>
<td>1.3</td>
<td>86.5</td>
<td>15.6</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td><strong>Scenario 2: stress scenario I</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>First year</td>
<td>-0.8</td>
<td>7.5</td>
<td>1.6</td>
<td>304.2</td>
<td>23.1</td>
<td>-7.9</td>
<td>-17.4</td>
</tr>
<tr>
<td>Second year</td>
<td>1.1</td>
<td>4.0</td>
<td>1.3</td>
<td>30.2</td>
<td>15.0</td>
<td>-3.4</td>
<td>-7.6</td>
</tr>
<tr>
<td><strong>Scenario 3: stress scenario II</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>First year</td>
<td>-2.7</td>
<td>7.9</td>
<td>-2.3</td>
<td>57.7</td>
<td>10.7</td>
<td>-7.9</td>
<td>-17.4</td>
</tr>
<tr>
<td>Second year</td>
<td>0.2</td>
<td>12.1</td>
<td>1.6</td>
<td>45.5</td>
<td>6.8</td>
<td>-3.4</td>
<td>-7.6</td>
</tr>
</tbody>
</table>

Source: OeNB.

Note: This table shows the growth rates of specific indicators in various scenarios used in stress tests. The columns display the growth rates of GDP (real), the unemployment rate (URX), private sector disposable income (PYR), short- and long-term nominal interest rates (STIR and LTIR, respectively) and the euro exchange rates against the Swiss franc (EX SFr) and the Japanese yen (EX JPY).
Integration of Micro and Macro Information/Tools ↔ Combined results based on micro data

### Micro Simulation of Stress Scenarios Using HFCS Data

<table>
<thead>
<tr>
<th></th>
<th>PD (HH)</th>
<th>LGD (HH)</th>
<th>LGD2 (HH)</th>
</tr>
</thead>
<tbody>
<tr>
<td>All debt holders</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mortgage debt holders</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Current situation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.99</td>
<td>12.71</td>
<td>7.39</td>
<td>3.60</td>
</tr>
<tr>
<td>11.42</td>
<td>4.98</td>
<td>4.94</td>
<td>18.61</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>All debt holders</th>
<th>Mortgage debt holders</th>
<th>Non-mortgage debt holders</th>
<th>All debt holders</th>
<th>Mortgage debt holders</th>
<th>Non-mortgage debt holders</th>
<th>All debt holders</th>
<th>Mortgage debt holders</th>
<th>Non-mortgage debt holders</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current situation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.99</td>
<td>12.71</td>
<td>7.39</td>
<td>3.60</td>
<td>11.42</td>
<td>4.98</td>
<td>4.94</td>
<td>18.61</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Scenario 1: baseline

<table>
<thead>
<tr>
<th></th>
<th>All debt holders</th>
<th>Mortgage debt holders</th>
<th>Non-mortgage debt holders</th>
<th>All debt holders</th>
<th>Mortgage debt holders</th>
<th>Non-mortgage debt holders</th>
<th>All debt holders</th>
<th>Mortgage debt holders</th>
<th>Non-mortgage debt holders</th>
</tr>
</thead>
<tbody>
<tr>
<td>First year</td>
<td>9.32</td>
<td>13.27</td>
<td>7.80</td>
<td>4.21</td>
<td>4.28</td>
<td>11.45</td>
<td>5.61</td>
<td>5.66</td>
<td>18.64</td>
</tr>
<tr>
<td>Second year</td>
<td>9.21</td>
<td>13.08</td>
<td>7.77</td>
<td>4.21</td>
<td>4.28</td>
<td>11.42</td>
<td>5.60</td>
<td>5.66</td>
<td>18.61</td>
</tr>
</tbody>
</table>

#### Scenario 2: stress scenario I

<table>
<thead>
<tr>
<th></th>
<th>All debt holders</th>
<th>Mortgage debt holders</th>
<th>Non-mortgage debt holders</th>
<th>All debt holders</th>
<th>Mortgage debt holders</th>
<th>Non-mortgage debt holders</th>
<th>All debt holders</th>
<th>Mortgage debt holders</th>
<th>Non-mortgage debt holders</th>
</tr>
</thead>
<tbody>
<tr>
<td>First year</td>
<td>9.58</td>
<td>13.72</td>
<td>7.85</td>
<td>4.24</td>
<td>4.30</td>
<td>11.45</td>
<td>5.63</td>
<td>5.69</td>
<td>18.66</td>
</tr>
<tr>
<td>Second year</td>
<td>9.46</td>
<td>13.45</td>
<td>7.88</td>
<td>4.23</td>
<td>4.30</td>
<td>11.45</td>
<td>5.63</td>
<td>5.69</td>
<td>18.65</td>
</tr>
</tbody>
</table>

#### Scenario 3: stress scenario II

<table>
<thead>
<tr>
<th></th>
<th>All debt holders</th>
<th>Mortgage debt holders</th>
<th>Non-mortgage debt holders</th>
<th>All debt holders</th>
<th>Mortgage debt holders</th>
<th>Non-mortgage debt holders</th>
<th>All debt holders</th>
<th>Mortgage debt holders</th>
<th>Non-mortgage debt holders</th>
</tr>
</thead>
<tbody>
<tr>
<td>First year</td>
<td>11.23</td>
<td>15.40</td>
<td>9.47</td>
<td>4.29</td>
<td>4.30</td>
<td>11.86</td>
<td>5.70</td>
<td>5.69</td>
<td>19.10</td>
</tr>
<tr>
<td>Second year</td>
<td>11.49</td>
<td>15.76</td>
<td>9.78</td>
<td>4.31</td>
<td>4.30</td>
<td>11.93</td>
<td>5.72</td>
<td>5.69</td>
<td>19.21</td>
</tr>
</tbody>
</table>

Source: HFCS Austria 2010, OeNB.

1. PD (HH) = share of vulnerable households as a percentage of indebted households.
2. LGD (HH) = sum of vulnerable households’ debt that is not covered by their total wealth divided by total debt of all households.
3. LGD2 (HH) = sum of vulnerable households’ debt that is not covered by their housing wealth divided by total debt of all households.

Note: The number of simulations is 1,000.
Integration of Micro and Macro Information/Tools

Using the changes of the PDs in the FSAP gives for the household sector:

Path of PDs in Stress Scenario II\(^1\)

\(PD\text{ in }\%\)

- Stress test initiation
- End of first year
- End of second year

Performing exposures
Nonperforming exposures

Source: OeNB.

\(^1\) Based on the household vulnerability model, anchored at the unconsolidated average retail portfolio PD of IRB banks.
The FSAP stress tests conduct a sensitivity analysis of the results with respect to FX loans.

Key parameter: debt repayment obligation $D$ over (disposable) income after deducting debt repayment and total consumption $I$.

This parameter was initially set to around 2.

With the survey data the parameter can be estimated.

We estimated quintiles and the median within these quintiles as an input to the sensitivity analyses.
## Integration of Micro and Macro Information/Tools → FX sensitivity analyses

<table>
<thead>
<tr>
<th>Percentile</th>
<th>Debt share</th>
<th>Repayment</th>
<th>Income after repayment and total consumption</th>
<th>Amount outstanding</th>
<th>D/I according to Income after repayment and total consumption</th>
<th>Remaining Maturity of the first loan</th>
<th>Collateral Value</th>
<th>Other assets</th>
<th>Repayment vehicle value</th>
</tr>
</thead>
<tbody>
<tr>
<td>D/I quintiles</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1-20pct</td>
<td>0.109</td>
<td>272</td>
<td>2.665</td>
<td>32.482</td>
<td>0.101</td>
<td>7</td>
<td>287.070</td>
<td>114.119</td>
<td>3.096</td>
</tr>
<tr>
<td>20-40pct</td>
<td>0.199</td>
<td>400</td>
<td>1.883</td>
<td>61.783</td>
<td>0.202</td>
<td>9</td>
<td>230.212</td>
<td>58.785</td>
<td>25.920</td>
</tr>
<tr>
<td>40-60pct</td>
<td>0.288</td>
<td>580</td>
<td>1.596</td>
<td>121.849</td>
<td>0.352</td>
<td>8</td>
<td>315.000</td>
<td>79.068</td>
<td>42.000</td>
</tr>
<tr>
<td>60-80pct</td>
<td>0.224</td>
<td>754</td>
<td>1.160</td>
<td>100.646</td>
<td>0.661</td>
<td>8</td>
<td>325.604</td>
<td>115.309</td>
<td>46.800</td>
</tr>
<tr>
<td>80-100pct</td>
<td>0.180</td>
<td>588</td>
<td>12</td>
<td>66.451</td>
<td>12.113</td>
<td>10</td>
<td>172.022</td>
<td>14.059</td>
<td>1.200</td>
</tr>
</tbody>
</table>
Integration of Micro and Macro Information/Tools → FX sensitivity analyses

Share of Estimated Losses across Debt Repayment Obligation-to-Income Ratio Quintiles

Source: OeNB.

¹ Loss estimation based on the model used in the FSAP 2013 sensitivity analysis.
Further Analyses
Loan to Value Ratio → Problem and Idea

Problem:
(Almost) no information in loan-to-value-ratios before the FSR 25 (2013)

Solution:
- HFCS includes necessary information to calculate LTV.
- Use the initial LTV taking into account the year when the loan was taken into account.
- → gives LTV-ratios for various years.
- Take a 8-year moving average to estimate the development of the LTV over time.
- Sample size becomes an issue for early years (data from the second wave extend the information).
Loan to Value Ratio → Initial LTV over time

Development of the Median Initial LTV Ratio during the Past Decades

%  

Year when first mortgage was taken out or refinanced

Source: HFCS Austria 2010, OeNB.

Note: Ratios are eight-year moving averages.
Loan to Value Ratio ➔ Distribution of LTV

Median Initial LTV Ratio across Debt Service-to-Gross Income Ratio Quintiles

Initial LTV ratio in %

<table>
<thead>
<tr>
<th>Quintile</th>
<th>1st quintile</th>
<th>2nd quintile</th>
<th>3rd quintile</th>
<th>4th quintile</th>
<th>5th quintile</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value</td>
<td>32</td>
<td>44</td>
<td>53</td>
<td>74</td>
<td>87</td>
</tr>
</tbody>
</table>

Source: OeNB.
Relatively many households hold (large) FX loans:

- Macro-data do not tell us much about the distribution and risk bearing capacity of these households.
- Micro-data can fill this gap, paper in the forthcoming financial stability report of the OeNB.
Households with debt in FX versus euro-denominated debt: percentiles and mean

Source: HFCS Austria 2010, OeNB.
### Debt in FX vs euro by household characteristics

<table>
<thead>
<tr>
<th></th>
<th>Share in households with debt in FX</th>
<th>Debt in FX</th>
<th>Share in households with debt in euro</th>
<th>Debt in euro</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>%</td>
<td>Median</td>
<td>Mean</td>
<td>Median</td>
</tr>
<tr>
<td>Gross income percentile</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1–50</td>
<td>16.9</td>
<td>EUR</td>
<td>..¹</td>
<td>39.3</td>
</tr>
<tr>
<td>51–100</td>
<td>83.1</td>
<td>EUR</td>
<td>65,119</td>
<td>60.7</td>
</tr>
<tr>
<td>Gross wealth percentile</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1–50</td>
<td>3.1</td>
<td>EUR</td>
<td>..¹</td>
<td>42.2</td>
</tr>
<tr>
<td>51–100</td>
<td>96.9</td>
<td>EUR</td>
<td>72,178</td>
<td>57.8</td>
</tr>
<tr>
<td>Household size</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 hh member</td>
<td>18.0</td>
<td>EUR</td>
<td>..¹</td>
<td>29.8</td>
</tr>
<tr>
<td>2 hh members</td>
<td>29.1</td>
<td>EUR</td>
<td>71,046</td>
<td>29.7</td>
</tr>
<tr>
<td>3+ hh members</td>
<td>52.9</td>
<td>EUR</td>
<td>76,992</td>
<td>40.5</td>
</tr>
</tbody>
</table>

Source: HFCS Austria 2010. OeNB.

¹ “..” indicates that the estimation result had to be suppressed due to an estimation sample of fewer than 15 observations.

Note: The regions in Austria are based on the NUTS-1-level codes. Eastern Austria: Burgenland, Lower Austria and Vienna; southern Austria: Carinthia and Styria; western Austria: Upper Austria, Salzburg, Tyrol and Vorarlberg. The household’s reference person is defined as the household member with the highest income.
Risk indicators for households with FX debt and households with euro debt

<table>
<thead>
<tr>
<th>Household characteristics</th>
<th>Households with debt in FX</th>
<th>Households with debt only in euro</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gross income (EUR, median)</td>
<td>63,102</td>
<td>38,633</td>
<td>24,469</td>
</tr>
<tr>
<td>Net wealth (EUR, median)</td>
<td>212,794</td>
<td>87,234</td>
<td>125,559</td>
</tr>
<tr>
<td>Part of top 5% wealth class</td>
<td>6.8</td>
<td>6.0</td>
<td>0.9</td>
</tr>
<tr>
<td>Has negative net wealth</td>
<td>7.8</td>
<td>15.7</td>
<td>-7.8</td>
</tr>
<tr>
<td>Unemployed household reference person</td>
<td>5.6</td>
<td>5.7</td>
<td>-0.1</td>
</tr>
<tr>
<td>Risk averse household</td>
<td>50.4</td>
<td>57.7</td>
<td>-7.3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Properties of highest loan</th>
<th>Households with debt in FX</th>
<th>Households with debt only in euro</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interest rate (median)</td>
<td>2.274</td>
<td>2.900</td>
<td>-0.626</td>
</tr>
<tr>
<td>Proportion with adjustable interest rate</td>
<td>76.2</td>
<td>66.4</td>
<td>9.8</td>
</tr>
<tr>
<td>Total maturity (median)</td>
<td>20</td>
<td>19</td>
<td>1</td>
</tr>
<tr>
<td>Remaining maturity (median)</td>
<td>16</td>
<td>12</td>
<td>4</td>
</tr>
</tbody>
</table>

Source: HFCS Austria 2010, OeNB.

1 The reference person is defined as the household member with the highest income.

Note: Households whose highest loan was not a mortgage are excluded from the computation of interest rate and remaining maturity. Households without loans but with other nonmortgage debt are excluded from the computation of the proportion with adjustable interest rates and total maturity.
FX Loan Holder → Integration of Micro and Macro Information

<table>
<thead>
<tr>
<th>Market price developments relevant for households with FX debt</th>
</tr>
</thead>
<tbody>
<tr>
<td>At the time the highest FX loan was taken out (household level)</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>CHF/EUR(^1) exchange rate</td>
</tr>
<tr>
<td>3m EURIBOR(^2) – 3m LIBOR (CHF)</td>
</tr>
<tr>
<td>Austrian 10y bonds</td>
</tr>
<tr>
<td>ATX index</td>
</tr>
<tr>
<td>Eurostoxx</td>
</tr>
</tbody>
</table>

Source: HFCS Austria 2010, OeNB, Thomson Reuters.

\(^1\) Up to end-1998: ATS.
\(^2\) Up to end-1998: VIBOR.

Note: Households whose highest loan was not a mortgage are excluded from the computation.
Concluding Remarks
Concluding Remarks → The Way Forward (wishlist)

- Integrated use of available information, e.g. making use of the credit registry.
- Collect additional information from bank, e.g. LTV-ratios, and evaluate results from survey data.
- Model in more detail shocks to households:
  - Move into and out of employment for all household members.
  - More precise shock of income.
  - Empirical foundation of other assumptions.
- Try to incorporate behavioural responses to these shocks at the household level.
- Use results from micro data in the standard FSAP stress tests.
- Integrated approach using both waves of the HFCS once data are available.