

Assessing affordability using random effects models of income and consumption growth

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Credit Scoring and Credit Control XIII

28-30 August 2013, Edinburgh

Outline

- Introduction
- Income change model
- Consumption change model
- Simulation
- Affordability assessment
- Example based on artificial data
- Conclusions

Affordability assessment

- Anderson, R. (2007) “The Credit Scoring Toolkit”, p. 633:
 - “Affordability assessments are a key component of responsible lending, but can be difficult.”
- Office of Fair Trading (2011) “Irresponsible lending – OFT guidance for creditors”, p.36:

'Assessing affordability', in the context of this guidance, is a 'borrower-focussed test' which involves a creditor assessing a borrower's ability to undertake a specific credit commitment, or specific additional credit commitment, in a sustainable manner, without the borrower incurring (further) financial difficulties and/or experiencing adverse consequences.

Affordability assessment

- The Lending Code (2011), Section 4: Credit assessment:
 - “50. Before lending any money, granting or increasing an overdraft or other borrowing, subscribers should assess whether the customer will be able to repay it in a sustainable manner.”
- Codes and guidelines on responsible lending and affordability assessment
 - very general
 - no recommendation of any specific approach or model

Affordability assessment

- Affordability/overindebtedness models
 - offered by credit bureaus (e.g. Experian, Callcredit)
 - used by large banks to calculate mortgage loan amounts
- The implemented approaches are usually **static**
- **Need for including time**, e.g. FSA (2010) Mortgage Market Review: Responsible Lending, consultation paper (p. 21 & 29):
 - “We do propose to require that the lender considers the variability of income over time in their assessment”
 - “When assessing affordability, lenders should consider the applicant’s ability to repay over the life of the loan”

Dynamic affordability assessment

- The aim of this research is to propose a theoretical framework for **dynamic affordability assessment**
 - **income and consumption vary in time** and their changes are modelled with random effects models
 - the estimated models are applied in a simulation
 - each possible instalment amount is assigned with a probability of default **over the life of the loan**
- In practice, this could help assess affordability and determine the maximum affordable instalment

Proposed definitions

- **affordability** – a function $A(x)$ that assigns to each possible instalment amount $x \in X$ a probability of the applicant defaulting over the loan repayment period
- **affordability assessment** – estimation of this function
- **maximum affordable instalment (MAI)** – the highest possible instalment amount $x \in X$ for which affordability is less or equal to the cut-off, e.g.:

$$MAI = \max\{x \in X: A(x) \leq 0.05\}$$

Panel data models

- **panel data** – time-series cross-sections
- **individual effects** – components that are specific to individuals and constant over time
- **fixed effects (FE) models**
 - individual effects are estimated like the other parameters
 - cannot be used to predict outside the training sample
- **random effects (RE) models**
 - individual effects are part of the error term

Income models in economic literature

- Auten and Carroll (1999)
- Etienne (2006)
- Guiso, Jappelli and Terlizzese (1992)
- Jappelli and Pistaferri (2006)
- Lillard and Willis (1978)
- Lusardi (1992)
- Miles (1997)
- Skinner (1988)

Income models in economic literature

- net labour income
- log transformation of income
- individual or household level
- income or income change
- if income change:
 - individual's characteristics or their changes
- if individual effects:
 - FE or RE models

Income determinants

- age
- cohort
- sex
- education level
- occupation
- industry/sector
- region
- macroeconomic conditions

Macroeconomic conditions

- In panel data models, macroeconomic conditions can be taken into account by using:
 - macroeconomic variables (e.g. GDP)
 - random time effects
 - require data covering long time periods
 - **fixed time effects (time dummies)**
 - can capture the combined effect of macroeconomic variables that are not used as regressors in the model
 - describe the macroeconomic environment as a whole

Income change model

$$\Delta \ln Y_{it+1} = \sum_{s=1}^{T-1} \gamma_s D_{t+1}^{(s)} + \alpha_0 + \alpha_1 \text{age}_{it} + \alpha_2 \text{cohort}_i + \alpha_3 \text{sex}_i + \alpha_4 \text{education}_i \\ + \alpha_5 \text{occupation}_i + \alpha_6 \text{sector}_i + \alpha_7 \text{region}_i + \mu_i + \varepsilon_{it+1}$$

- RE model
 - **random individual effects** μ_i
 - **fixed time effects**: time dummies $D_{t+1}^{(s)}$
- All characteristics but age are coded as sets of dummies

Consumption models in economic literature

- Hall and Mishkin (1982)
- Jappelli and Pistaferri (2000)
- Lusardi (1992)
- Runkle (1991)
- Zeldes (1989)

Consumption models in economic literature

- nondurable consumption
- log transformation of consumption
- individual or household level
- consumption change
- if individual effects:
 - FE or RE models

Consumption change determinants

- age
- change in the number of children/in the number of children in different age groups
- change in the number of adults/in the family size
- macroeconomic conditions

Income is normally not included: according to the Permanent Income Hypothesis, current consumption does not depend on current income!

Euler equation of consumption

- A condition for the consumer's optimisation problem
- If their consumption choices are optimal, then their current marginal utility is equal to the present value of the expected future marginal utility corrected for the time preference rate:

$$U'(C_{it}, \theta_{it}) = E_t \left[\frac{U'(C_{it+1}, \theta_{it})(1 + r_i)}{(1 + d_i)} \right]$$

- Marginal utilities ratio (for $t + 1$ and t) can be log-linearized (Zeldes, 1989; Runkle, 1991; Lusardi, 1992) to produce e.g.:

$$\Delta \ln C_{it+1} = \beta_0 + \beta_1 \text{age}_{it} + \beta_2 \Delta X_{it+1} + v_i + \lambda_{t+1} + \zeta_{it+1}$$

Consumption change model

$$\Delta \ln C_{it+1} = \sum_{s=1}^{T-1} \delta_s D_{t+1}^{(s)} + \beta_0 + \beta_1 \text{age}_{it} + \beta_2 \Delta \text{children}_{it+1}^{(0-3)} + \beta_3 \Delta \text{children}_{it+1}^{(4-15)} \\ + \beta_4 \Delta \text{children}_{it+1}^{(16-19)} + \nu_i + \zeta_{it+1}$$

- RE model
 - **random individual effects** ν_i
 - **fixed time effects:** time dummies $D_{t+1}^{(s)}$
- Changes in the number of children in three age groups

Using income and consumption models

- Once the models are developed, there are estimates of:
 - model parameters
 - variances of the individual effects
 - variances of the idiosyncratic components
- The applicant's income and consumption
 - are known at the time of application
 - can be predicted for future months by using the models
 - simulation for the applicant

Simulation

- A simulation is run to take into account
 - random components (individual effects and idiosyncratic components)
 - **randomly drawn** from normal distributions with zero means and the estimated variances
 - unknown future macroeconomic conditions (time effects)
 - it is assumed that each future month is similar to one of the months in the training sample
 - for each future month one of the time dummies is **randomly selected**

Affordability check

- Simulation products
 - pairs of the predicted income and consumption time series
- For each pair the applicant's ability to repay is checked
 - based on the predicted income and consumption, existing debts and a new instalment amount
 - over the loan repayment period
 - with a default/no default result
 - default – failing to pay in any three consecutive months

Affordability assessment

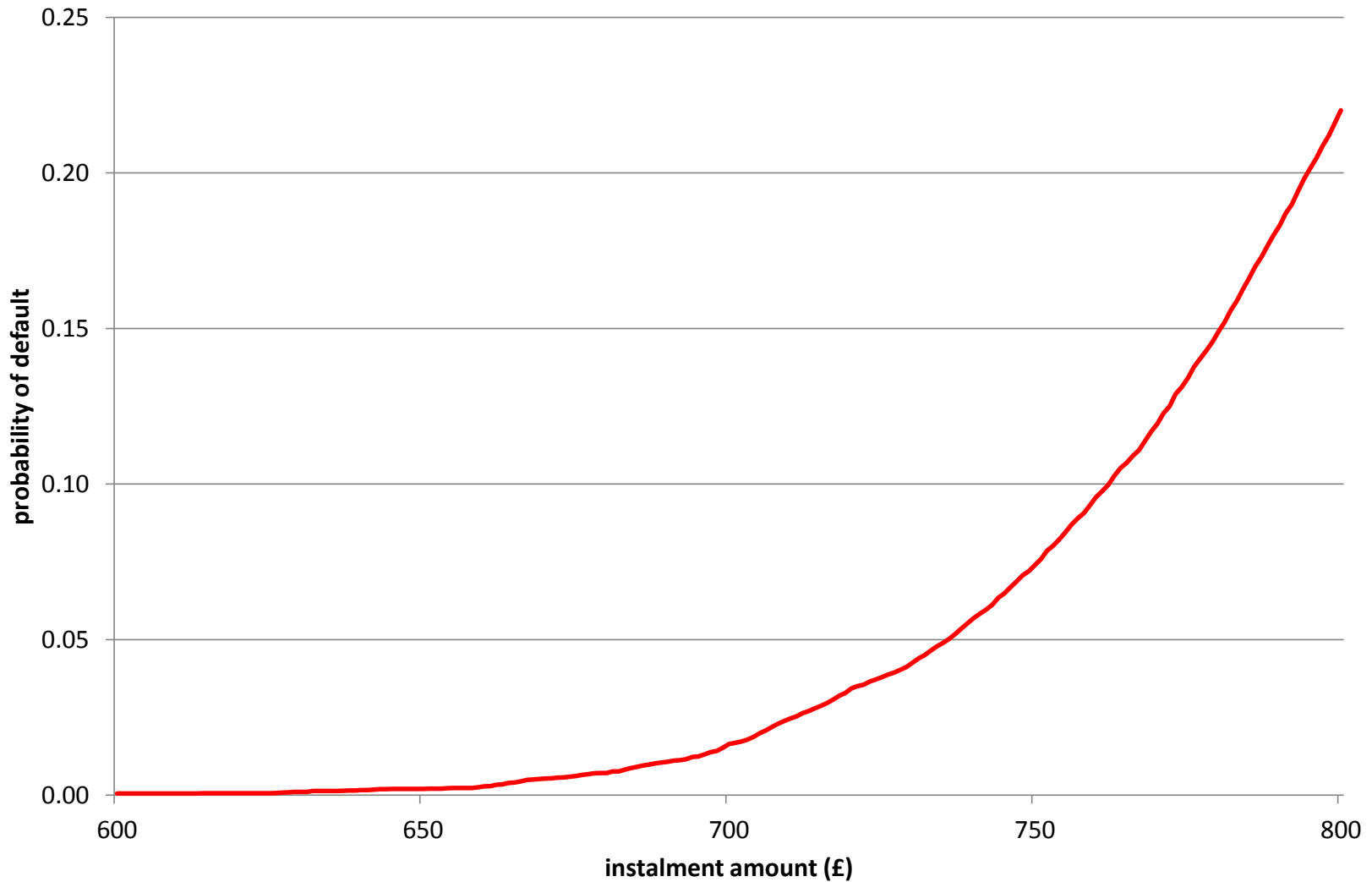
- Estimate of the probability of default over the life of the loan
 - proportion of the pairs where there are predicted defaults
- Assessing affordability
 - repeating affordability checks for all pairs of time series and all possible instalment amounts
 - assigning each of these amounts with an estimate of the probability of default over the life of the loan

Example based on artificial data

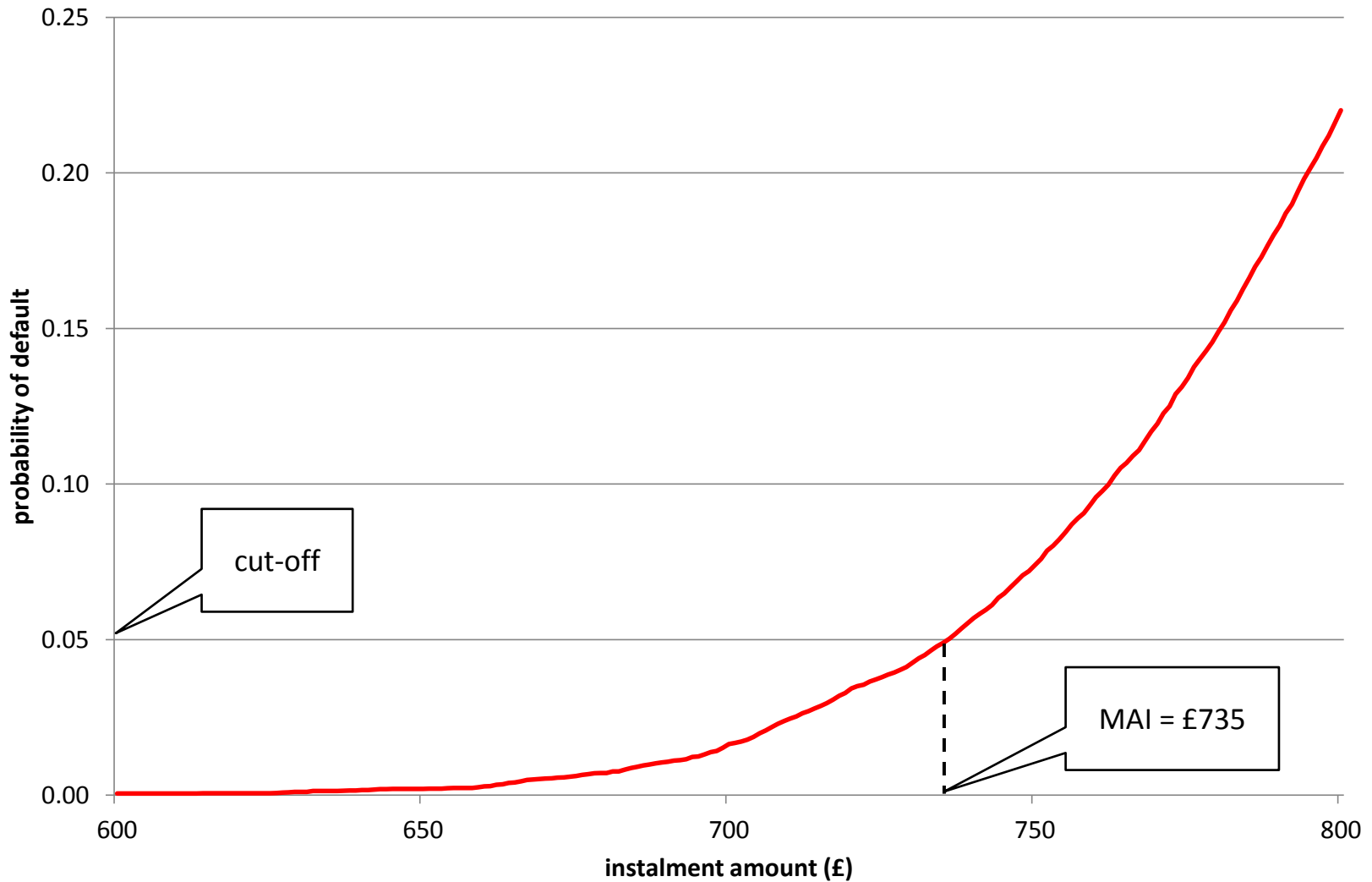
- Assumptions: the estimated models (a 5-year training sample)
- A hypothetical applicant (45, no children etc.)
 - is applying for a loan with a 2-year repayment period
 - income: £2300
 - consumption: £1500
 - credit card limit: £1000
 - no other loans
- Simulation
 - 10000 iterations



Example: affordability



Example: maximum affordable instalment



Conclusions

- In this research a theoretical framework for dynamic affordability assessment is proposed that allows for the identification of the maximum affordable instalment
 - ability to repay is assessed **over the life of the loan**
 - possible future **changes in income and consumption** are taken into account
 - a loan is affordable if the applicant is able to repay it while also meeting consumption costs and repayments of all other debts month after month until the loan is paid in full
- ...which is in line with recommendations of the OFT and FSA

Conclusions

- Needed to build the models in practice
 - monthly panel data on income and consumption for a few thousand consumers and covering a few years (ideally: the whole economic cycle)
 - sources: surveys or current account transactions
- Further analysis
 - liquidity constraints or precautionary saving
 - permanent and transitory income shocks

References

- Auten, G., Carroll, R. (1999) The effect of income taxes on household income, “The Review of Economics and Statistics”, 81(4), pp. 681-693.
- Etienne, J.-M. (2006) Health and Socio-Economic Status: Is it Measured Income or Permanent Income that Matters?, XX Annual Conference of the European Society for Population Economics, 22-24 June 2006, Verona.
- Guiso, L., Jappelli, T., Terlizzese, D. (1992) Earnings uncertainty and precautionary saving, “Journal of Monetary Economics”, 30(2), pp. 307-337.
- Hall, R.E., Mishkin, F.S. (1982) The Sensitivity of Consumption to Transitory Income: Estimates from Panel Data on Households, “Econometrica”, 50(2), pp. 461-481.
- Jappelli, T., Pistaferri, L. (2000) Using subjective income expectations to test for excess sensitivity of consumption to predicted income growth, “European Economic Review”, 44(2), pp. 337-358.
- Jappelli, T., Pistaferri, L. (2006) Intertemporal Choice and Consumption Mobility, “Journal of the European Economic Association”, 4(1), pp. 75-115.

References

- Lillard, L.A., Willis, R.J. (1978) Dynamic aspects of earning mobility, “Econometrica”, 46(5), pp. 985-1012.
- Lusardi, A. (1992) Permanent income, current income and consumption: Evidence from panel data, CentER for Economic Research Discussion Paper No. 9253, Tilburg University.
- Miles, D. (1997) A Household Level Study of the Determinants of Incomes and Consumption, “The Economic Journal”, 107(440), pp. 1-25.
- Runkle, D.E. (1991) Liquidity constraints and the permanent-income hypothesis: Evidence from panel data, “Journal of Monetary Economics”, 27(1), pp. 73-98.
- Skinner, J. (1988) Risky income, life cycle consumption, and precautionary savings, “Journal of Monetary Economics”, 22(2), pp. 237-255.
- Zeldes, S.P. (1989) Consumption and Liquidity Constraints: An Empirical Investigation, “Journal of Political Economy”, 97(2), pp. 305-346.

Thank you!