Managing Mortgages

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Arrow Lecture 1
Stanford University
April 18, 2017
Introduction

Arrow as a Founder of Finance

- It is a great honor to deliver the Arrow Lectures in 2017.
  - Although a great sadness to do so in the year of Kenneth Arrow’s death.

- Arrow is a founder not of one field but many.

- In my own field of asset pricing, there are two possible starting points:
  - Portfolio choice with risky and safe assets.
  - Complete financial markets and absence of arbitrage.

- Each starting point has Arrow’s name on it!
  - Arrow-Pratt.
  - Arrow-Debreu.
Arrow as a Founder of Finance

Financial Decisions and Markets:
A Course in Asset Pricing

John Y. Campbell
February 2017

I Static Portfolio Choice and Asset Pricing

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### Heterogeneity in Economics

- Arrow pioneered the formal study of heterogeneity.
  - For example in preferences, information, or social connections.
- Today heterogeneity can be measured with unprecedented precision.
  - From small surveys to nationwide administrative datasets to records of global e-commerce.
- Within financial economics, this has stimulated the development of household finance.
  - “How households use financial instruments to attain their objectives”.
  - We are learning far more about heterogeneity in household financial behavior.
  - And are trying to explain it from underlying heterogeneity in preferences, constraints, information, and financial competence.
Characteristic Features of Household Finance

- Relative to textbook portfolio choice and asset pricing,
  - HF problems have additional features that complicate solutions and often push towards numerical analysis (nontradable labor income, borrowing constraints, fixed costs, real options, taxes, etc.)
  - Households often behave in ways that are hard to rationalize using any plausible optimizing model: “mistakes”.
  - This is particularly true for poorer households, and HF does not overweight wealthy households as asset pricing does.

- Relative to other fields of applied microeconomics,
  - Financial theory often provides clear rational benchmarks.
  - These benchmarks define natural units for measuring behavioral deviations (analogous to measuring option prices in implied-volatility units rather than dollars).
  - Market efficiency implies that excess returns on risky assets are unpredictable shocks, providing a sequence of natural experiments that affect all households not just a few.
While many HF studies use identical methods to studies in labor economics or public finance, others do not because they exploit unique features of HF problems. In these lectures, I will present two such studies of nationwide household behavior and will relate them to the HF literature. Each study tries to navigate between Scylla and Charybdis.

- **Scylla**: excessive commitment to a particular model.
- **Charybdis**: unstructured “data tourism”.
Arrow Lectures 2017

**Arrow Lecture 1: Managing Mortgages**
- Joint work with Steffen Andersen, Kasper Nielsen, and Tarun Ramadorai.
- Refinancing by all fixed-rate mortgage borrowers in Denmark.
- Deviations from a rational benchmark vary cross-sectionally along two dimensions.

**Arrow Lecture 2: The Cross-Section of Household Preferences**
- Joint work with Laurent Calvet, Francisco Gomes, and Paolo Sodini.
- Portfolio choice and savings decisions by all middle-aged stock market participants in Sweden.
- Benchmark rational model assumes Epstein-Zin preferences, with three parameters (relative risk aversion, elasticity of intertemporal substitution, and time discount factor).
- We ask how to identify these parameters and how heterogeneous they are across households.
Managing Mortgages: Outline

- **Background on mortgage systems**
  - Alternative systems
  - The problem of slow refinancing
  - Why Denmark?

- **A first look at the Danish data**
  - Rational refinancing benchmark
  - Errors of omission and commission

- **Modeling deviations from rational refinancing**
  - Inattention: a lower probability of refinancing at any incentive
  - Inertia: a higher incentive needed to trigger refinancing
  - Inattention and inertia in the Danish data

- **Implications for mortgage policy**
The Importance of Mortgages

![Table of International Comparison of the Allocation of Household Wealth]

Alternative Mortgage Systems

- **Contract form:**
  - Adjustable rate (UK, southern Europe).
  - Fixed rate with refinancing penalty (Germany).
  - Fixed rate with no refinancing penalty (US, Denmark).

- **Funding:**
  - Deposits (everywhere).
  - Mortgage-backed securities (US).
  - Covered bonds (many European countries).

- **In the event of default:**
  - Foreclosures (everywhere).
  - Recourse (Europe, some US states).
  - Public credit guarantees (most countries).
Average Fixation Periods By Country

Adjustable-Rate vs. Fixed-Rate Mortgages

- US conventional wisdom is that ARMs are risky.
  - Contradicts standard finance theory since an ARM is a floating-rate note with a stable market value.
  - But an ARM has income risk to a borrowing-constrained household (Campbell and Cocco 2003).
  - A rise in inflation increases monthly payments, accelerating the repayment of debt in real terms. This effect can be offset only by extra borrowing.

- US conventional wisdom is that FRMs are safe.
  - But they have a volatile market value. Capital losses to lenders if rates rise, gains if rates fall.
  - In the US system, FRMs can be refinanced at face value at a cost that does not vary with the interest rate. This protects borrowers if rates fall, but increases the equilibrium mortgage rate.
  - Countries with a history of inflation volatility tend to rely more on ARMs because non-refinanceable FRMs are too risky while refinanceable FRMs are too expensive for borrowers.
ARM Share and Historical Inflation Volatility

Source: Campbell (2013).
Slow Refinancing

- In the US, refinanceable FRMs are popular and supported by public policy. But many people refinance slowly or not at all.
  - This can result from inadequate home equity, credit score, or income which are barriers to refinancing under US rules.
  - But this is not the only problem, because there are low takeup rates even for pre-approved refinancing offers (Johnson, Meier, and Toubia 2015, Keys, Pope, and Pope 2016).
  - Slow refinancers ("woodheads") are important in prepayment models and MBS pricing (Stanton 1995, Deng, Quigley, and Van Order 2000, Gabaix, Krishnamurthy, and Vigneron 2007).
  - Slow refinancing lowers mortgage rates, subsidizing prompt refiners (Miles 2004, Campbell 2006, Gabaix and Laibson 2006).

- Slow refinancing weakens the transmission of monetary policy to household budgets via mortgage rates.
  - Refinancing barriers motivated the US government’s HARP program.
  - US counties with a higher ARM share respond more strongly to declining interest rates (Di Maggio et al. 2016).
We would like to better understand slow refinancing.

- To what extent does it result from constraints vs. household mistakes?
- Which households are most likely to make mistakes?

To answer these questions we will exploit unique features of the Danish mortgage system:

- Mortgages are funded with covered bonds, fixed-rate maturity-matched bonds with integer coupons.
- Refinancing involves buying back the underlying mortgage bond, either at market value or face value.
- When buying back at face value, the refinancing incentive is the bond’s coupon rate less the current mortgage yield.
- Refinancing does not require positive home equity or a credit check provided there is no cash-out.

Denmark also has comprehensive administrative data so we know exactly who fails to refinance.
Danish Data

Administrative Data from Denmark

- All outstanding mortgages in the period 2009–2014 from the Association of Danish Mortgage Banks via Danish National Bank.
- Matched to household demographics, income and wealth, and education.
  - Including higher education in economics! (“Financial literacy”)
- Mortgage data are annual but we use reported origination dates to create a quarterly dataset.
  - Our data include all households with single FRMs: 5.6 million household-quarters and 247,000 refinancings in 2010–14.
  - Average mortgage size DKK 926,000 (about $140,000), average maturity 23 years, average LTV 59%.
Refinancing History (Figure 1)
Who Refinances? (Table 2)

<table>
<thead>
<tr>
<th></th>
<th>Average</th>
<th>All</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single male household</td>
<td>0.130</td>
<td>-0.034</td>
</tr>
<tr>
<td>Single female household</td>
<td>0.125</td>
<td>-0.024</td>
</tr>
<tr>
<td>Married household</td>
<td>0.629</td>
<td>0.035</td>
</tr>
<tr>
<td>Children in family</td>
<td>0.402</td>
<td>0.082</td>
</tr>
<tr>
<td>Immigrant</td>
<td>0.077</td>
<td>-0.001</td>
</tr>
<tr>
<td>No educational information</td>
<td>0.007</td>
<td>-0.003</td>
</tr>
<tr>
<td>Financially literate</td>
<td>0.046</td>
<td>0.011</td>
</tr>
<tr>
<td>Family financially literate</td>
<td>0.133</td>
<td>0.026</td>
</tr>
<tr>
<td>Getting married</td>
<td>0.010</td>
<td>0.005</td>
</tr>
<tr>
<td>Having children</td>
<td>0.043</td>
<td>0.020</td>
</tr>
<tr>
<td>Rank of age</td>
<td>0.000</td>
<td>-0.061</td>
</tr>
<tr>
<td>Rank of education</td>
<td>0.003</td>
<td>0.039</td>
</tr>
<tr>
<td>Rank of income</td>
<td>0.002</td>
<td>0.059</td>
</tr>
<tr>
<td>Rank of financial wealth</td>
<td>-0.001</td>
<td>-0.055</td>
</tr>
<tr>
<td>Rank of housing value</td>
<td>0.000</td>
<td>0.048</td>
</tr>
<tr>
<td>Region North Jutland</td>
<td>0.125</td>
<td>0.000</td>
</tr>
<tr>
<td>Region Middle Jutland</td>
<td>0.238</td>
<td>0.018</td>
</tr>
<tr>
<td>Region Southern Denmark</td>
<td>0.228</td>
<td>-0.009</td>
</tr>
<tr>
<td>Region Zealand</td>
<td>0.186</td>
<td>-0.021</td>
</tr>
<tr>
<td>Region Copenhagen</td>
<td>0.222</td>
<td>0.014</td>
</tr>
<tr>
<td># of observations</td>
<td>5,648,323</td>
<td>5,648,323</td>
</tr>
</tbody>
</table>
The Incentive to Refinance

\[ I_{it} = C_{it}^{old} - Y_{it}^{new} - O_{it}. \] (1)

- The threshold saving \( O_{it} \) that triggers refinancing is given by a formula of Agarwal, Driscoll, and Laibson (ADL 2013).
  - Assumes a random walk for the interest rate (sensible given bond market efficiency).
  - Takes account of the option value of delaying refinancing.
The ADL Formula

\[ O_{it} = \frac{1}{\psi_{it}} \left[ \phi_{it} + W(-\exp(-\phi_{it})) \right] . \]  

(2)

\[ \psi_{it} = \sqrt{\frac{2(\rho + \lambda_{it})}{\sigma}} \]  

(3)

\[ \phi_{it} = 1 + \psi_{it}(\rho + \lambda_{it}) \frac{\kappa(m_{it})}{m_{it}(1 - \tau)} \]  

(4)

- \( W \) is the Lambert \( W \) function.
- Marketwide parameters \( \rho \) (discount rate 0.05), \( \sigma \) (interest rate volatility 0.0074), \( \tau \) (tax benefit of mortgage interest deductions 0.33).
- Household-specific parameters \( m_{it} \) (mortgage size) and \( \lambda_{it} \) (rate of decline in real mortgage value, which reflects estimated moving probability).
- \( \kappa(m_{it}) \) is the monetary refinancing cost. Bank handling fees DKK 3,000 — 7,000 plus mortgage bond trading fee 10 basis points of mortgage value, winsorized at DKK 10,000.
Refinancing Costs and ADL Threshold

![Graph showing the relationship between fixed costs in 1000 DKK and threshold in basis points. The graph includes lines for average mortgage characteristics, half average mortgage principal, and half average mortgage maturity.](image)
Cross-Sectional Distribution of Refinancing Costs and ADL Threshold
Errors of Omission and Commission

- Measure all mortgages with interest savings above the ADL threshold by $k\%$ or more.
  - Failure to refinance such a mortgage is an “error of omission” (Agarwal, Rosen, and Yao 2016).

- Measure all mortgages with interest savings below the ADL threshold by $k\%$ or more.
  - Refinancing such a mortgage is an “error of commission” (Agarwal, Rosen, and Yao 2016).

- As $k$ increases, we isolate more serious errors.
- In the Danish data, errors of commission are very rare relative to errors of omission.
## Errors of Omission and Commission (Table 3)

<table>
<thead>
<tr>
<th></th>
<th>Level of Cutoff</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
</tr>
<tr>
<td># Observations (incentives+cutoff&lt;0)</td>
<td>3,334,598</td>
</tr>
<tr>
<td># Observations, refinancing</td>
<td>57,974</td>
</tr>
<tr>
<td># Observations, cash out or extend maturity</td>
<td>22,182</td>
</tr>
<tr>
<td># Observations, errors of commission</td>
<td>35,792</td>
</tr>
<tr>
<td>Fraction with error of commission</td>
<td>0.011</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Level of Cutoff</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
</tr>
<tr>
<td># Observations (incentives-cutoff&gt;=0)</td>
<td>2,313,725</td>
</tr>
<tr>
<td># Observations, errors of omission</td>
<td>2,124,652</td>
</tr>
<tr>
<td>Fraction with error of omission</td>
<td>0.918</td>
</tr>
</tbody>
</table>
Costs of Errors of Omission

- We measure costs by following households over time and comparing interest savings from actual refinancing with those from optimal refinancing.
  - Difference is “missed savings”.
- Refinancing efficiency is actual interest savings divided by savings from optimal refinancing.
  - We compare refinancing efficiency of different types of households.
Costs of Errors of Omission (Table 4)

<table>
<thead>
<tr>
<th></th>
<th>Actual</th>
<th>Missed</th>
<th></th>
<th>Actual</th>
<th>Missed</th>
<th></th>
<th>Actual</th>
<th>Missed</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>%</td>
<td>%</td>
<td>1,000 DKK</td>
<td>% of income</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All</td>
<td>0.30</td>
<td>0.39</td>
<td>3.2</td>
<td>2.6</td>
<td>0.60</td>
<td>0.53</td>
<td>1,444,973</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2010</td>
<td>0.09</td>
<td>0.36</td>
<td>1.1</td>
<td>3.0</td>
<td>0.18</td>
<td>0.53</td>
<td>330,563</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2011</td>
<td>0.15</td>
<td>0.40</td>
<td>1.9</td>
<td>3.1</td>
<td>0.31</td>
<td>0.57</td>
<td>297,573</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2012</td>
<td>0.34</td>
<td>0.37</td>
<td>3.8</td>
<td>2.0</td>
<td>0.72</td>
<td>0.48</td>
<td>277,462</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2013</td>
<td>0.43</td>
<td>0.33</td>
<td>4.7</td>
<td>1.8</td>
<td>0.88</td>
<td>0.42</td>
<td>274,553</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2014</td>
<td>0.53</td>
<td>0.49</td>
<td>5.7</td>
<td>2.9</td>
<td>1.06</td>
<td>0.67</td>
<td>264,858</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Actual vs. missed interest rate savings from refinancing by year*
Refinancing Efficiency (Figure 2)
Slow Mortgage Refinancing: Inattention or Inertia?

- **Inattention**: fixed intervals of time between decisions, or constant probability of decision in any period.

- **Inertia**: continuous decisionmaking, but action only when a threshold benefit is reached (S,s model).
  - Household inertia can be modeled as implicit refinancing costs that increase the threshold.
Implications of Inattention and Inertia

- Inattention and inertia can coexist.
  - Empirical model in this paper.

- They can be separately identified given a sufficiently wide range of incentives.

- They have different implications for refinancing dynamics when interest rates fall.
  - Inattention implies a delayed response to a rate decline of any size.
  - Inertia implies no response to a small rate decline, large response to a sufficiently large one.

- We use our model to simulate responses of different demographic groups to alternative policies that encourage refinancing.
Refinancing with Inertia

- Probability of refinancing \((y_{it} = 1)\) is

\[
p_{i,t}(y_{i,t} = 1 \mid z_{it}; \varphi, \beta) = p(\exp(\beta)I^*(z_{it}; \varphi) + \epsilon_{it} > 0).
\]  \hfill (5)

- \(z_{it}\) are household and mortgage characteristics, refinancing incentive \(I^*\) is determined by \(z_{it}\) and the inertia parameter vector \(\varphi\).
- Parameter \(\beta\) governs household’s responsiveness to the incentive.
  - For simplicity this is a scalar and does not depend on household characteristics.

- \(\epsilon_{it}\) is a standard logistic error.
- Incentive is given by ADL formula with modified refinancing cost:

\[
\kappa^*(m_{it}, z_{it}; \varphi) = \kappa(m_{it}) + \exp(\varphi'z_{it}).
\]  \hfill (6)
Effect of Inertia

Inertia (rightward shift)
A Mixture Model of Inattention

- Households are “asleep” with probability $w_{it}$ or “awake” with probability $1 - w_{it}$.
- Awake households refinance with probability given by (5).
- Asleep households refinance with probability zero.
- Asleep probability is related to characteristics and the inattention parameter vector $\chi$:

$$w_{it}(\chi) = \frac{\exp(\chi' z_{it})}{1 + \exp(\chi' z_{it})}.$$  \hspace{1cm} (7)
Effect of Inattention

Inattention (proportional reduction)
### Coefficient Estimates on Dummy Variables (Table 5)

<table>
<thead>
<tr>
<th></th>
<th>$\chi$</th>
<th>$\varphi$</th>
<th>$\beta$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>1.877***</td>
<td>2.502***</td>
<td>0.641***</td>
</tr>
<tr>
<td>Single male household</td>
<td>-0.032</td>
<td>-0.009</td>
<td></td>
</tr>
<tr>
<td>Single female household</td>
<td>-0.115***</td>
<td>-0.041***</td>
<td></td>
</tr>
<tr>
<td>Married household</td>
<td>-0.029**</td>
<td>0.070***</td>
<td></td>
</tr>
<tr>
<td>Children in family</td>
<td>0.098***</td>
<td>0.088***</td>
<td></td>
</tr>
<tr>
<td>Immigrant</td>
<td>0.176***</td>
<td>-0.101***</td>
<td></td>
</tr>
<tr>
<td>No education information</td>
<td>0.192***</td>
<td>0.022***</td>
<td></td>
</tr>
<tr>
<td>Financially literate</td>
<td>-0.012</td>
<td>-0.155***</td>
<td></td>
</tr>
<tr>
<td>Family financially literate</td>
<td>-0.084***</td>
<td>-0.009***</td>
<td></td>
</tr>
<tr>
<td>Getting married</td>
<td>-0.054</td>
<td>-0.249***</td>
<td></td>
</tr>
<tr>
<td>Having children</td>
<td>-0.112***</td>
<td>-0.068***</td>
<td></td>
</tr>
<tr>
<td>Region of Northern Jutland</td>
<td>-0.368***</td>
<td>0.161***</td>
<td></td>
</tr>
<tr>
<td>Region of Middle Jutland</td>
<td>-0.326***</td>
<td>0.114***</td>
<td></td>
</tr>
<tr>
<td>Region of Southern Denmark</td>
<td>-0.176***</td>
<td>0.030***</td>
<td></td>
</tr>
<tr>
<td>Region of Zealand</td>
<td>0.074***</td>
<td>0.052***</td>
<td></td>
</tr>
</tbody>
</table>
### Coefficient Estimates on Ranked Variables (Table 5)

<table>
<thead>
<tr>
<th>Demeaned rank of:</th>
<th>( \chi )</th>
<th>( \phi )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>0.703***</td>
<td>-0.246***</td>
</tr>
<tr>
<td>Length of education</td>
<td>-0.257***</td>
<td>0.070**</td>
</tr>
<tr>
<td>Income</td>
<td>-0.741***</td>
<td>1.034***</td>
</tr>
<tr>
<td>Financial wealth</td>
<td>-0.280***</td>
<td>1.021***</td>
</tr>
<tr>
<td>Housing wealth</td>
<td>-0.762***</td>
<td>0.646***</td>
</tr>
</tbody>
</table>

**Non-linear transformation** \( f(x) \), \( x \) is the demeaned rank of:

<table>
<thead>
<tr>
<th></th>
<th>( \chi )</th>
<th>( \phi )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>-0.170***</td>
<td>-1.174***</td>
</tr>
<tr>
<td>Length of education</td>
<td>0.074***</td>
<td>0.322***</td>
</tr>
<tr>
<td>Income</td>
<td>0.599***</td>
<td>-0.514***</td>
</tr>
<tr>
<td>Financial wealth</td>
<td>0.070***</td>
<td>-0.794***</td>
</tr>
<tr>
<td>Housing wealth</td>
<td>0.373***</td>
<td>-0.667***</td>
</tr>
</tbody>
</table>

- **Current quarter dummies**: Yes
- **Mortgage age dummies**: Yes

**Pseudo \( R^2 \)**: 0.083
**Log likelihood**: -864,175
**Observations**: 5,648,323
Predicted Refinancing in Relation to Incentives (Figure 3)
Cross-Sectional Distribution of Inertia (Figure 4)
There is an important difference between psychological refinancing costs in DKK and the effects these have on the refinancing threshold.

Households with smaller, older mortgages have thresholds that are higher and more sensitive to DKK refinancing costs.

The cross-sectional correlation between the ADL threshold and the psychological refinancing cost in DKK is very close to zero.

The cross-sectional correlation between the ADL threshold and the increment to the threshold caused by psychological refinancing costs is 0.87.
The Distribution of Inattention (Figure 5)
The Correlation Between Inattention and Inertia (Figure 6)

- Correlation is strongly negative when inertia is measured by DKK refinancing costs, and almost zero when inertia is measured by the increment to the threshold.
Who Is Inattentive? (Figure 8)
Who Has Inertia? (Figure 8)
What Have We Learned About Inattention and Inertia?

- Inattentive households are older and have lower education, income, financial wealth, and housing wealth (socioeconomic status).

- Inertia in DKK is highest for middle-aged households and those with higher socioeconomic status.
  - This may be picking up the value of time spent planning and executing a refinancing.

- Increment to refinancing threshold caused by inertia is highest for middle-aged households and those with high financial wealth.
  - These households tend to have smaller and older mortgages that are more sensitive to refinancing costs.

- Inattention and DKK inertia are negatively correlated, inattention and threshold inertia are uncorrelated.

- Inattention must be responsible for the lower refinancing efficiency of older households and those with lower socioeconomic status.
Simulating Alternative Mortgage Policies

- We use our model to explore the determinants of refinancing in response to a large decline in interest rates.
  - 2010 Danish initial conditions, 1.72% cut in mortgage rates that would induce 90% of rational households to refinance.

- We consider alternative policies to encourage refinancing by households with lower socioeconomic status.
  - Rebate fixed component of refinancing cost, remove caps to make financial costs proportional to mortgage size.
  - Advertise refinancing to wake up half of asleep households.
  - Combine both the above policies.

- For each policy, we measure cumulative refinancing rates over time and a simplified measure of refinancing efficiency:
  - Cumulative refinancing rate after 2 years as a fraction of rational cumulative refinancing rate, for households sorted by age and income.
Alternative Policies: Cumulative Refinancing (Figure 10)
Alternative Policies: Refinancing Efficiency (Figure 10)
What Have We Learned About Mortgage Policy?

- In the Danish system, home equity, credit scores, and income are irrelevant but refinancing efficiency is still low, particularly for households with low socioeconomic status.
  - We should be concerned about these households both for distributional reasons, and because their marginal propensity to consume out of budget relief will be particularly high if lower mortgage payments relax their borrowing constraints.
  - Programs like HARP that lower refinancing barriers are inadequate to address this problem.

- Our results suggest that inattention is the key issue for these households.
  - They do not respond rapidly even to strong refinancing incentives.
  - To improve their refinancing efficiency requires effectively advertising refinancing opportunities, or moving to an automatically refinancing mortgage system.
What Have We Learned About Mortgage Policy?

- Automatically refinancing FRMs (Kalotay “ratchet mortgages”) are appealing in principle but face difficulties in practice.
  - Even if coded to mimic ADL refinancing at standard refinancing costs, they must have higher initial rates than standard FRMs because they eliminate slow refinancing.
  - Sophisticated borrowers will find them more expensive than standard FRMs, unsophisticated borrowers may find them too hard to understand.
  - Public policy may be needed to promote such mortgages.

- An easier alternative may be to start from the other end of the problem and add caps to ARMs to limit the maximum extent and speed of rate increases.
  - A gradually adjusting ARM limits the risk of an upward rate shock to constrained mortgage borrowers.
  - But the possibility of some rate increases helps to pay for the downward flexibility when rates fall.
Will Tomorrow’s Problem be the Same as Today’s?

- Refinancing efficiency is a problem in an environment of declining interest rates.
- When interest rates rise, a new problem arises: Households are reluctant to give up old, cheap mortgages which they have to do if they move in the US system.
  - This can cause “lock-in”, reducing mobility and hence the efficiency of the labor market.
  - Uncertainty about the strength of the lock-in effect creates prepayment risk, and may create asymmetric information and illiquidity in mortgage-backed securities markets.
- The Danish system avoids lock-in through two mechanisms:
  - Mortgages are normally assumable (like FHA-insured and VA-guaranteed mortgages in the US).
  - Mortgages can be refinanced by buying back mortgage bonds at market prices, which is advantageous when interest rates are rising.
- Denmark has much to teach scholars and policymakers!