# The Impacts of Mortgage Regulations on Households' Life-cycle Housing Decisions

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*The views expressed here are those of the authors and do not represent the views of the Bank of Canada.*

# Introduction I

- Strong interest in using macroprudential policy to improve financial and macroeconomic stability after the global financial crisis
- Housing finance regulations are considered as important measures to deal with mortgage credit expansion and housing price growth
  Lim *et al* (2011), Cerutti *et al* (2015)
- Impact of housing finance regulations still not well understood
  Information is limited and mainly lies in the aggregate level

# Introduction II

- Study the impacts of a set of mortgage regulations on households' demand for housing and their mortgage decisions
  - Debt-service ratio (DSR)
  - Loan-to-value (LTV) ratio
- Life-cycle model calibrated to the Canadian economy
- We investigate the long-run effects across income groups and age groups

# Main Findings

- Tightening DSR or LTV limit has small effects on household's overall home ownership decisions
- Stronger impacts on loan-to-income ratio (LTI)
  and % of highly-indebted households (LTI$>=$4.0)
- Regulations on DSR and LTV have heterogeneous effects:
  DSR affects low-income households more
  LTV affects young households more

# Related Literature

- Various degrees of success in coping house price growth and mortgage credit expansion in empirical literature
  - Most studies present cross-country evidence
    Vandenbussche et al (2012), Arregui et al (2013), Kuttner and Shim (2013), Zhang and Zoli (2014), Akinci and Olmstead-Rumsey (2015), Cerutti et al (2015)
  - Very few papers use micro-level (household) data
    Igan and Kang (2011), Campbell et al (2015), Allen et al (2016)

- Housing finance regulation and mortgage default
  Campbell and Cocco (2015), Corbae and Quintin (2015)

- Housing literature using life-cycle models
  Gervais (2002), Li and Yao (2007), Chambers et al (2009), Halket and Vasudev (2014)

# Model: Key Features

- Life-cycle model with idiosyncratic income shocks and aggregate house price and interest rate shocks
- Housing services: renting or owning
- Long-term mortgage arrangement
- Mortgage regulation
- Households make decisions on:
  (1) consumption, (2) house size, (3) housing tenure choice, (4) down payment

# Preferences

- Stochastic lifetime and at most live for $J$ periods
- Households' preferences are represented by

$$E_1 \sum_{j=1}^{J} \beta^{j-1} \left( \Pi_{t=1}^{j-1} s_t \right) \left\{ s_j \frac{\left( c_j^{1-\omega} h_j^{\omega} \right)^{1-\gamma}}{1-\gamma} + (1-s_j) \frac{(W_j)^{1-\gamma}}{1-\gamma} \right\} \quad (1)$$

$s_j$: conditional survival probability in period $j$
$\beta$: discount factor
$\gamma$: relative risk aversion
$\omega$: preference for housing

# Income Process

- Households supply labor inelastically to work in first R periods of life
- Household $i$ at age $j$ receives stochastic labor income $Y_{ij}$ such that

$$\ln(Y_{ij}) = f_{ij} + \varepsilon_{ij} \tag{2}$$

  $f_{ij}$: deterministic hump-shape age earnings profile (by education)
  $\varepsilon_{ij}$: idiosyncratic persistent shock
- After $R$ working periods, households retire and receive retirement income

# Housing

- Housing services: renting or owning

$$h_j \in \begin{cases} \{H_1, H_2, H_3, H_4\} & \text{if } DR = 1 \text{ (renter)} \\ \{H_3, H_4, H_5, H_6, H_7, H_8\} & \text{if } DR = 0 \text{ (owner)} \end{cases} \tag{3}$$

- House price is stochastic and jointly determined with interest rate

$$r_j = \alpha^r + \beta_0^r p_j + \beta_1^r r_{j-1} + \beta_2^r p_{j-1} + \epsilon_j^r \tag{4}$$

$$p_j = \alpha^p + \beta_0^p r_j + \beta_1^p r_{j-1} + \beta_2^p p_{j-1} + \epsilon_j^p \tag{5}$$

- Transaction costs ($\theta^B$ and $\theta^S$), maintenance costs ($\delta$), property taxes ($\tau$)

# Mortgage Contract

- Amortization: $N$ periods
  Mortgage rate offered in each period: $r_j^m = \beta^m + r_j$
  Contracted mortgage rate ($rr_j$): renewed every $\hat{N}$ period
- Home buyers can choose their down payments

$$\theta^D \begin{cases} \in \{0.05, 0.1, 0.15, 0.2, 0.35, 0.5, 0.75, 1.0\} & \text{if } n \leq R \\ = 1 & \text{if } n > R \end{cases} \tag{6}$$

- Home buyers with less than 20% down payment are required to purchase a mortgage insurance.
- Mortgage regulation: DSR and LTV

# Financial Assets and Taxation

- Financial assets at the beginning of a period

$$a_{j+1} = (1+r)\left[a_j + Y_j - x_j - \Gamma_j - c_j\right] \tag{7}$$

- Housing expenditure

$$x_j = \begin{cases} \phi P_j h & \text{if } DR_{j-1} = DR_j = 1 \\ \phi P_j h_j + LL_{j-1} - (1-\theta^S) P_j h_{j-1} & \text{if } DR_{j-1} = 0 \text{ and } DR_j = 1 \\ M_j + \left(\theta^B + \theta_j^D + \tau + \delta\right) P_j h_j & \text{if } DR_{j-1} = 1 \text{ and } DR_j = 0 \\ M_j + (\tau + \delta) P_j h_j & \text{if } DR_{j-1} = DR_j = 0 \text{ and } h_j = h_{j-1} \\ M_j + \left(\theta^B + \theta_n^D + \tau + \delta\right) P_j h_j & \\ \quad + LL_{j-1} - (1-\theta^S) P_j h_{j-1} & \text{if } DR_{j-1} = DR_j = 0 \text{ and } h_j \neq h_{j-1} \end{cases} \tag{8}$$

- Total tax liability

$$\Gamma_j = T(INC_j) + \min(\tau_{ss} * Y_j,\ \tau_{ss} * Y_{ss}). \tag{9}$$

# Household Problem

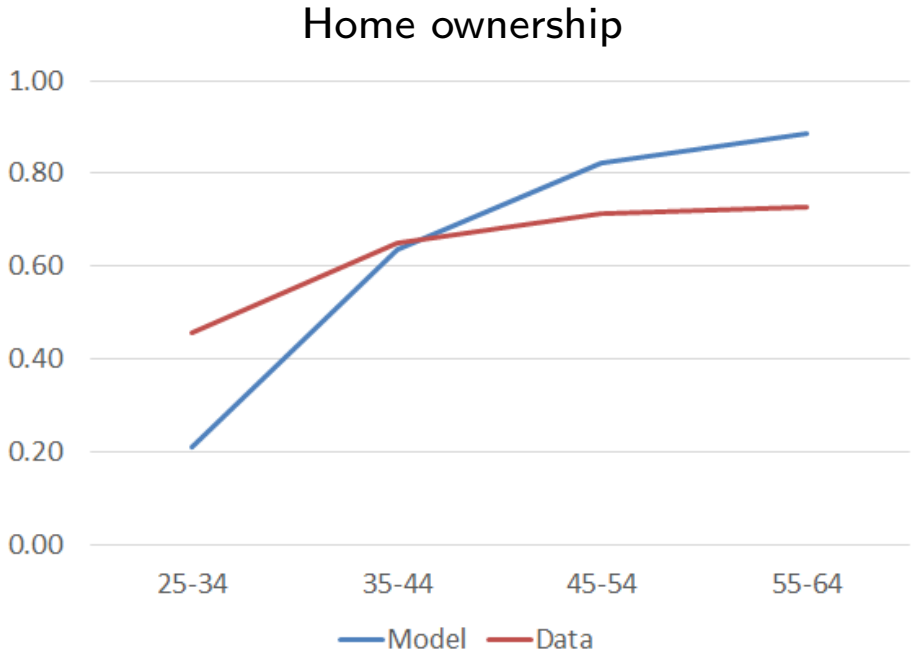
A household's decision problem in recursive form is written as

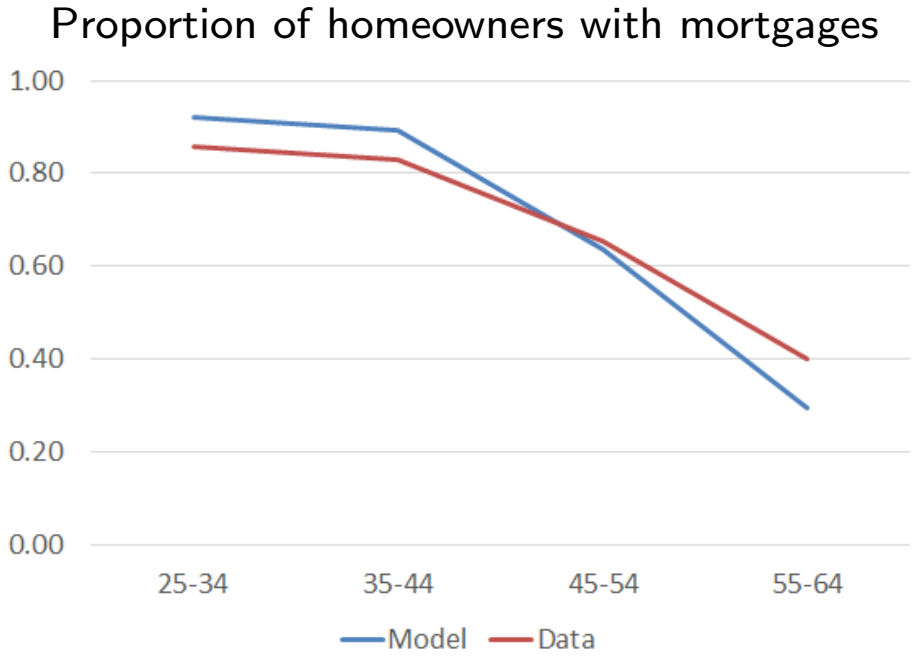
$$
\begin{aligned}
& V(j, r_j, \tilde{p}_j, \varepsilon_j, a_j, DR_{j-1}, h_{j-1}, n, \tilde{p}_n, \theta^D, rr_j) \\
= & \max_{c_j, DR_j, h_j, \theta^D} \frac{\left(c_j^{1-\omega} h_j^{\omega}\right)^{1-\gamma}}{1-\gamma} \\
& + \beta s_{j+1} E_j \left[ V(j+1, r_{j+1}, \tilde{p}_{j+1}, \varepsilon_{j+1}, a_{j+1}, DR_j, h_j, n, \tilde{p}_n, \theta^D, rr_{j+1}) \right] \\
& + \beta (1 - s_{j+1}) \frac{(W_{j+1})^{1-\gamma}}{1-\gamma} \qquad (10)
\end{aligned}
$$

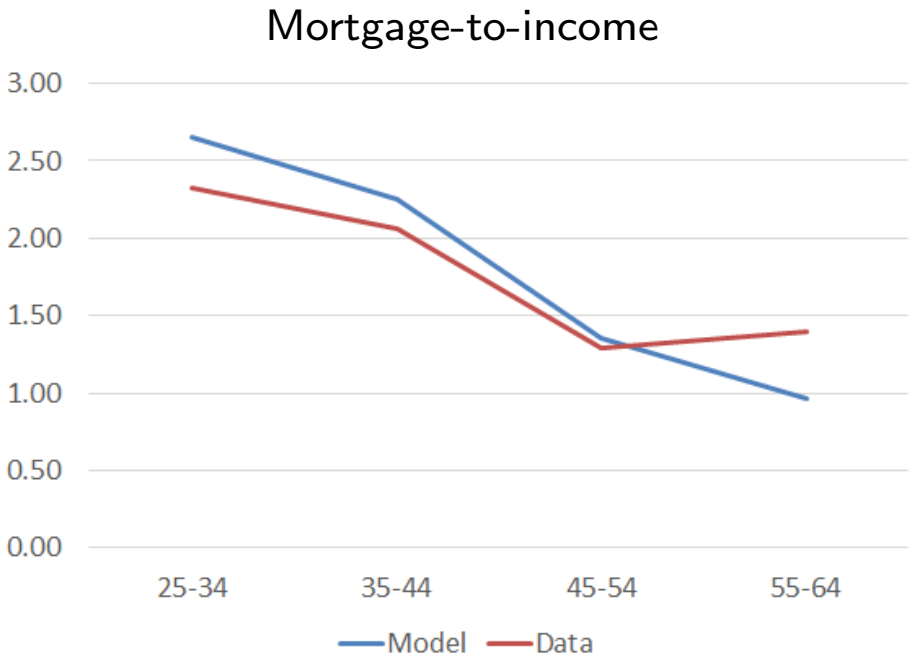
# Benchmark Model

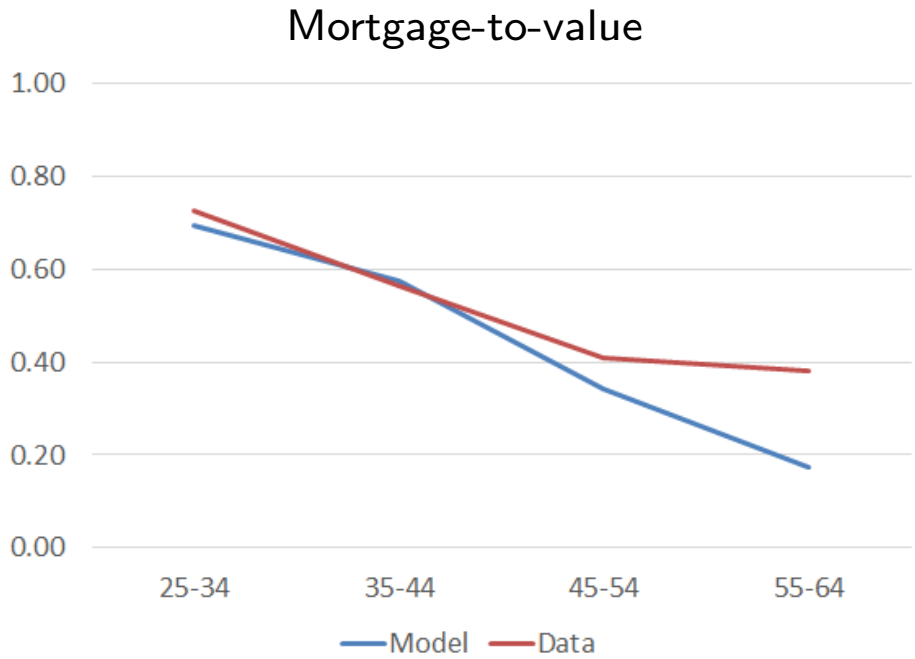
| | Age Group | | | | |
|---|---|---|---|---|---|
| | 25-34 | 35-44 | 45-54 | 55-64 | Overall |
| Home ownership | | | | | |
| Model | 0.209 | 0.636 | 0.823 | 0.884 | 0.634 |
| Data | 0.455 | 0.650 | 0.712 | 0.727 | 0.642 |
| % of owners with mortgage | | | | | |
| Model | 0.921 | 0.891 | 0.637 | 0.294 | 0.611 |
| Data | 0.856 | 0.828 | 0.652 | 0.399 | 0.660 |
| Mortgage-to-Income | | | | | |
| Model | 2.651 | 2.250 | 1.358 | 0.963 | 1.790 |
| Data | 2.328 | 2.065 | 1.292 | 1.394 | 1.818 |
| Mortgage-to-Value | | | | | |
| Model | 0.693 | 0.574 | 0.344 | 0.174 | 0.445 |
| Data | 0.727 | 0.565 | 0.409 | 0.380 | 0.536 |

▸ Parametrization


Home ownership
1.00
0.80
0.60
0.40
0.20
0.00
25-34
35-44
45-54
55-64
Model
Data


Proportion of homeowners with mortgages
1.00
0.80
0.60
0.40
0.20
0.00
25-34
35-44
45-54
55-64
Model
Data

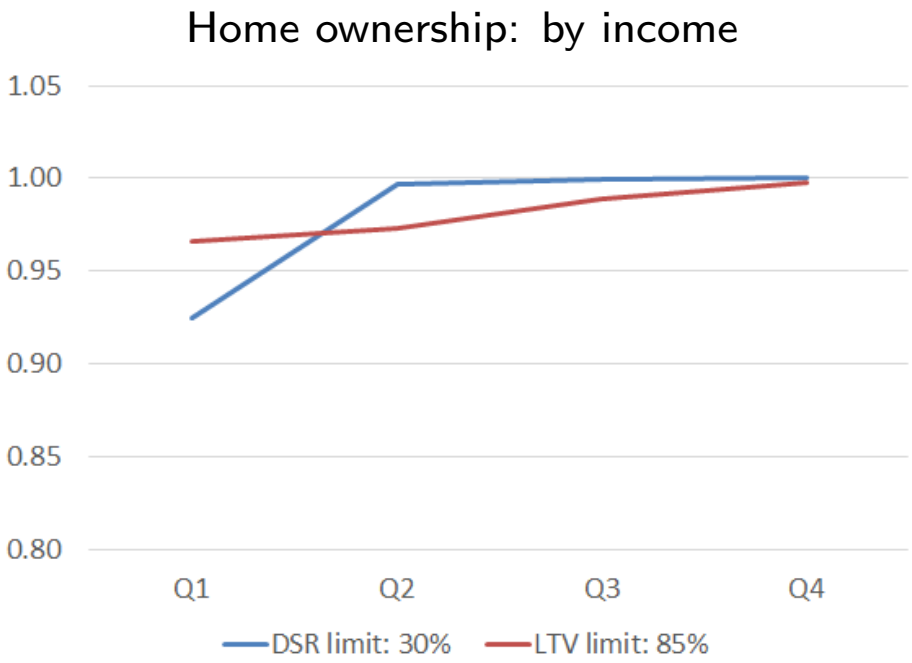

Mortgage-to-income
3.00
2.50
2.00
1.50
1.00
0.50
0.00
25-34
35-44
45-54
55-64
Model
Data

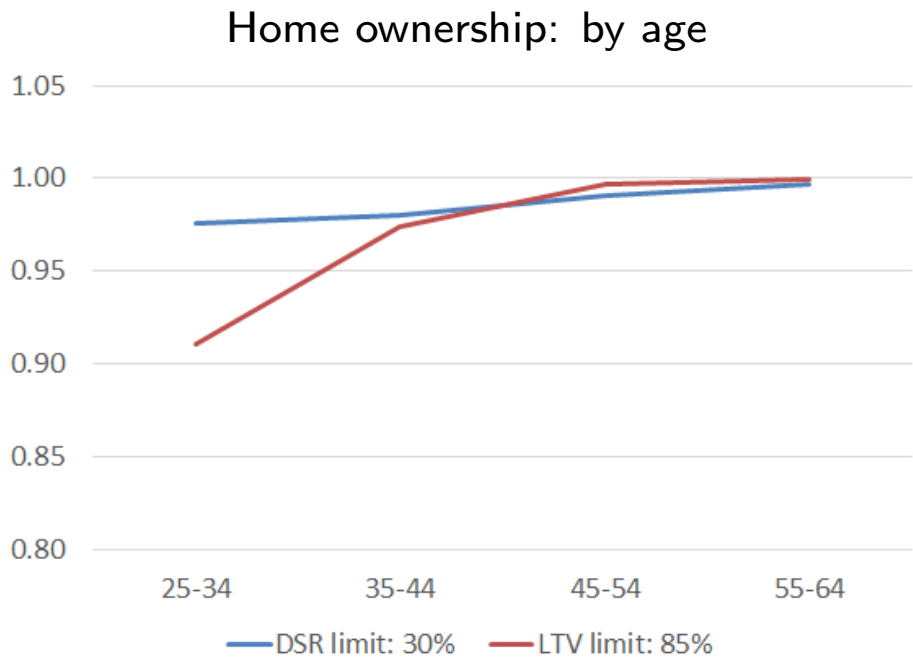

Mortgage-to-value
1.00
0.80
0.60
0.40
0.20
0.00
25-34
35-44
45-54
55-64
Model
Data

# Simple Comparison between DSR and LTV

DSR $\leq$ 30% vs. LTV $\leq$ 85%

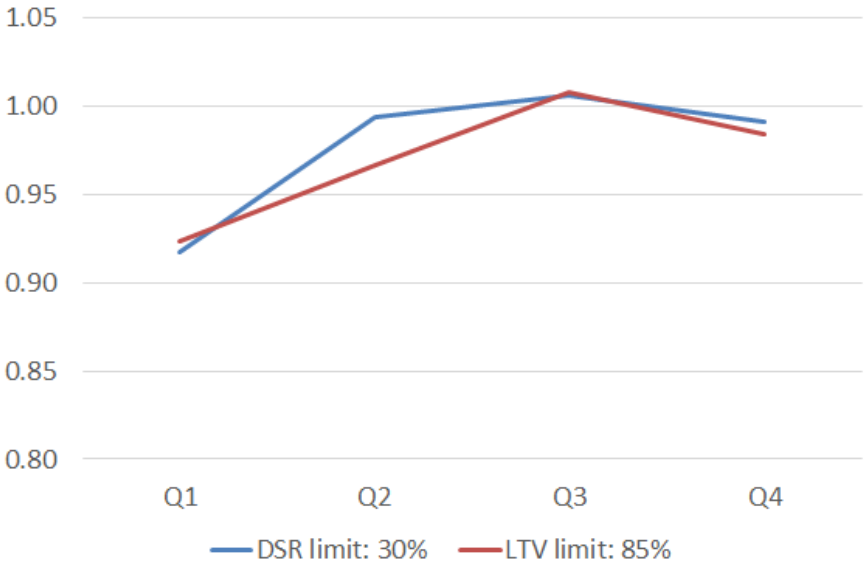
Both results in 2% decrease in the median loan-to-income ratio



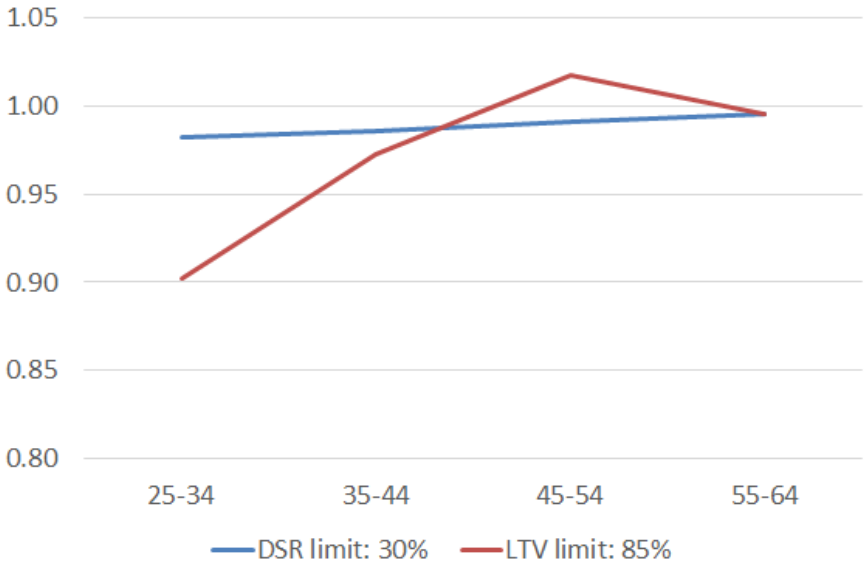




All results are relative to the benchmark

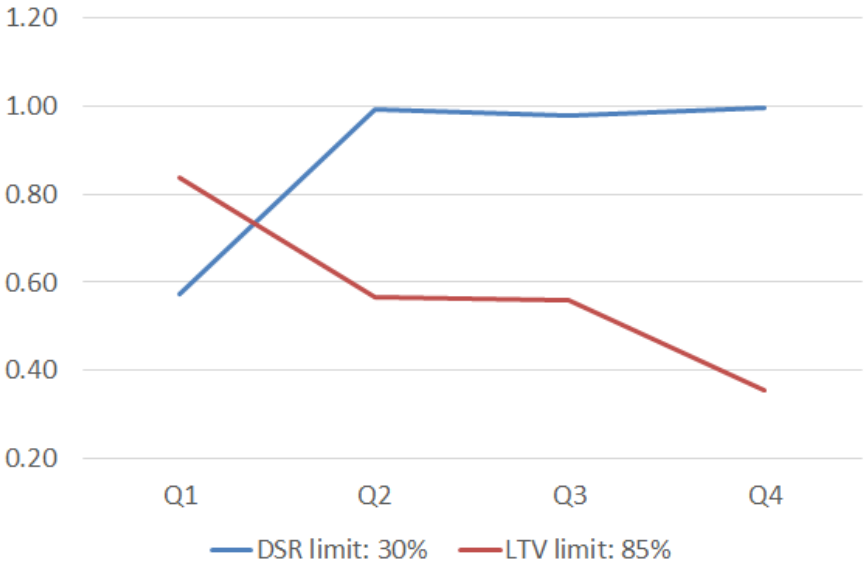
## Mortgage-to-income: by income



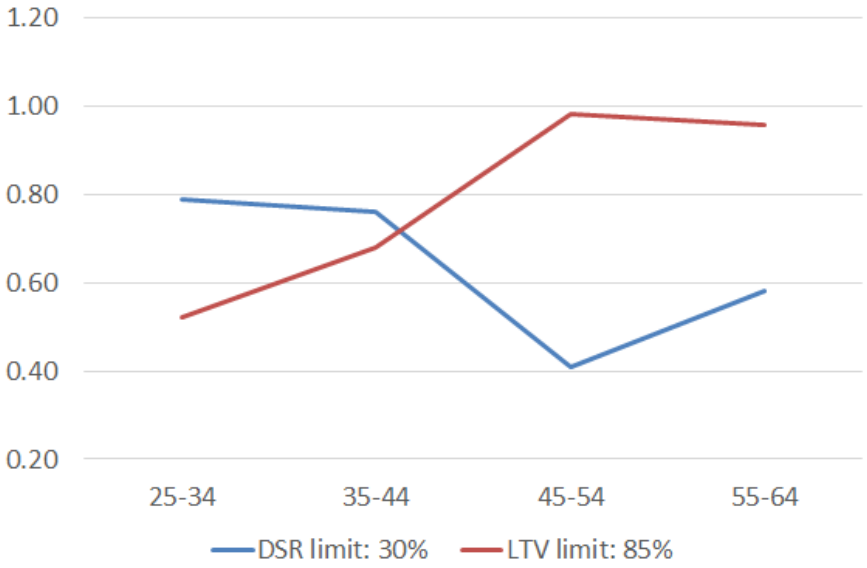

## Mortgage-to-income: by age




## High-debt households: by income

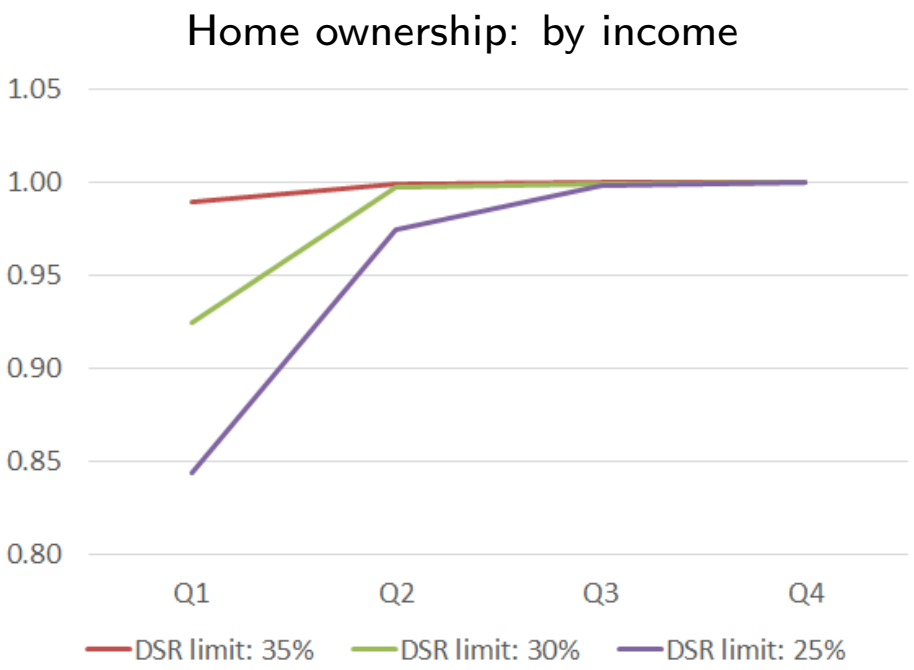


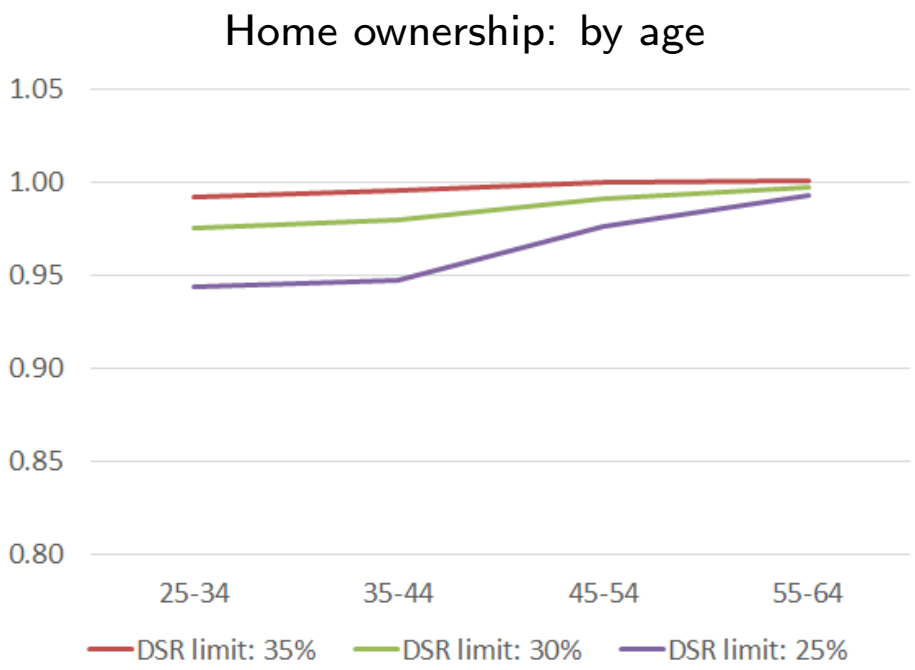

## High-debt households: by age



# Reducing the Debt-Service Ratio (DSR)

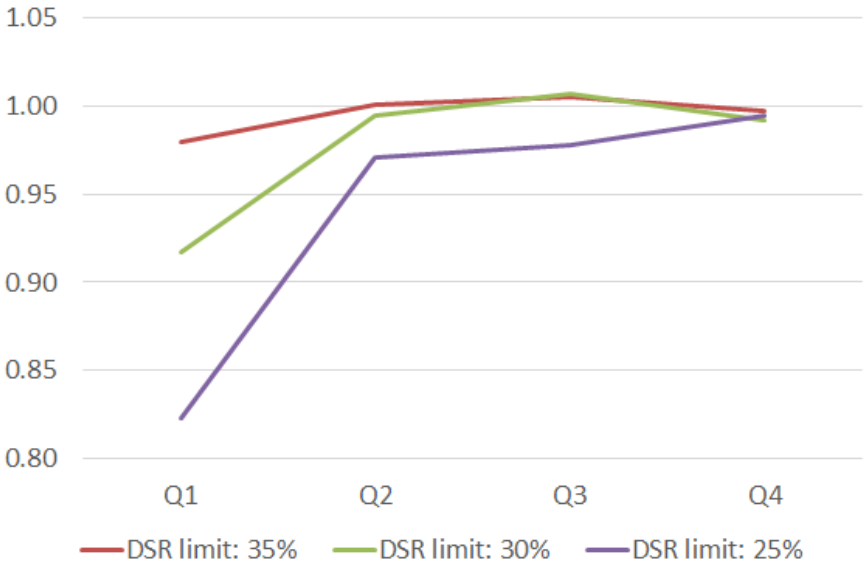
Reduce the debt-service ratio to 35%, 30%, and 25%



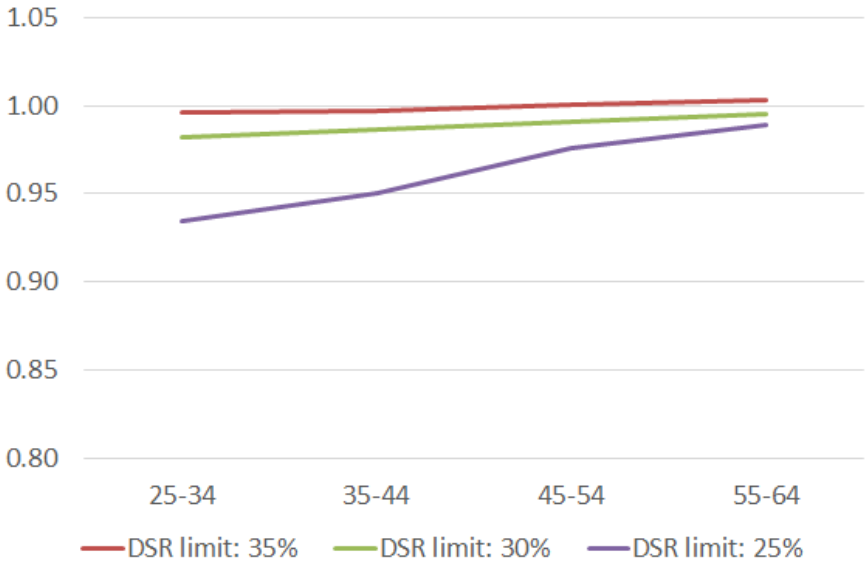




All results are relative to the benchmark

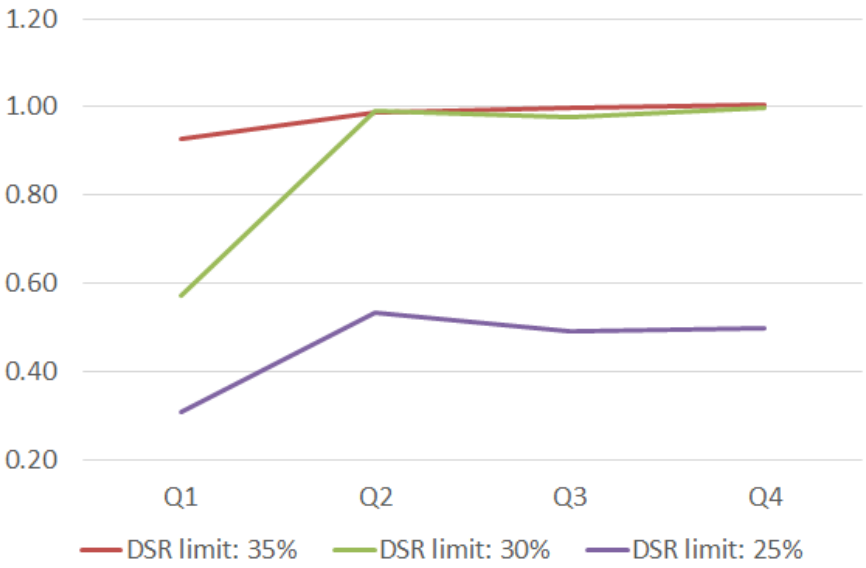
## Mortgage-to-income: by income



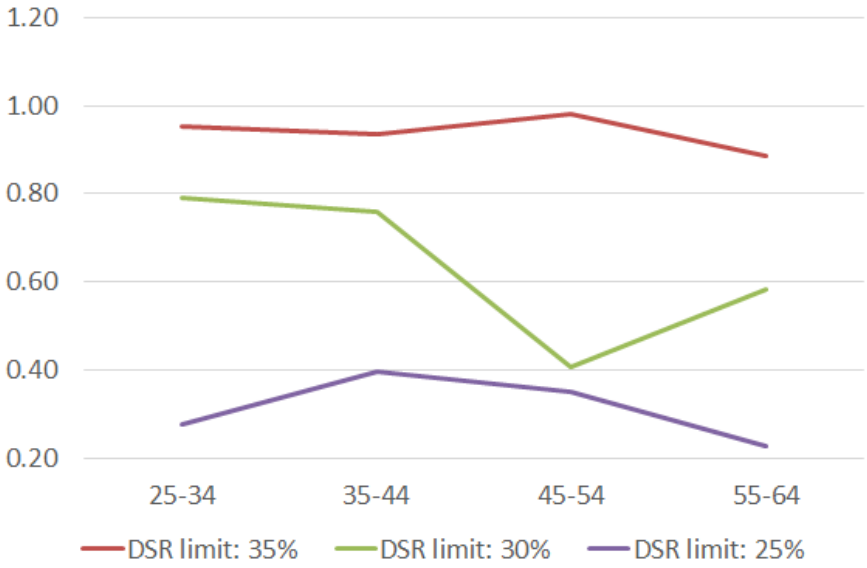

## Mortgage-to-income: by age




## High-debt households: by income

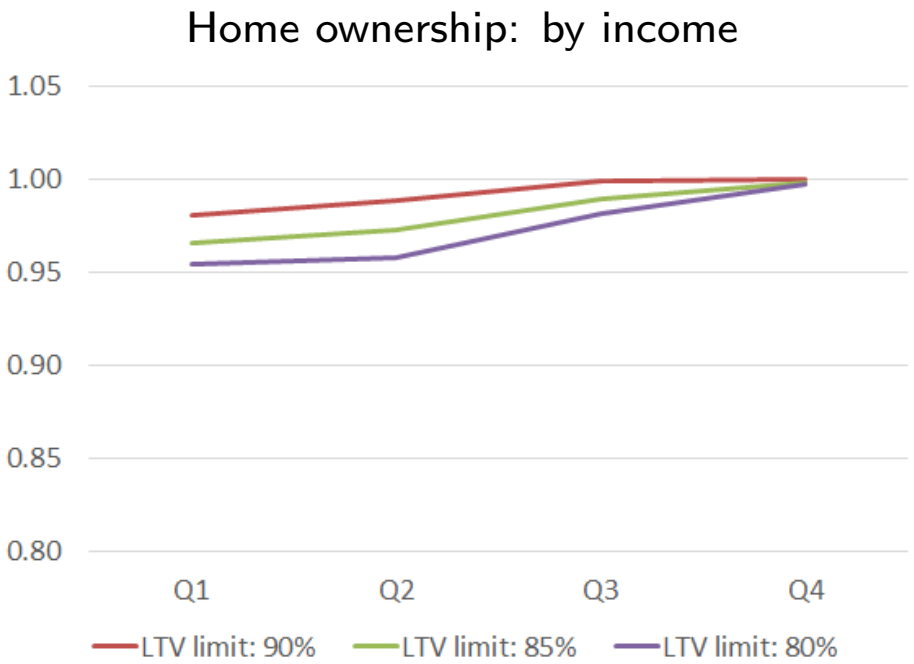


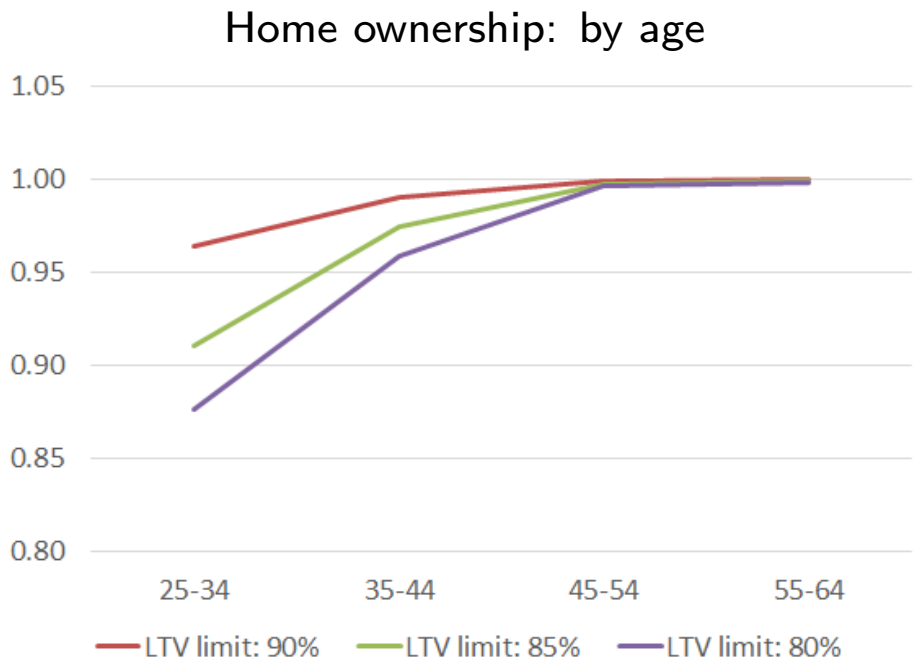

## High-debt households: by age



# Reducing the Loan-to-Value Ratio (LTV)

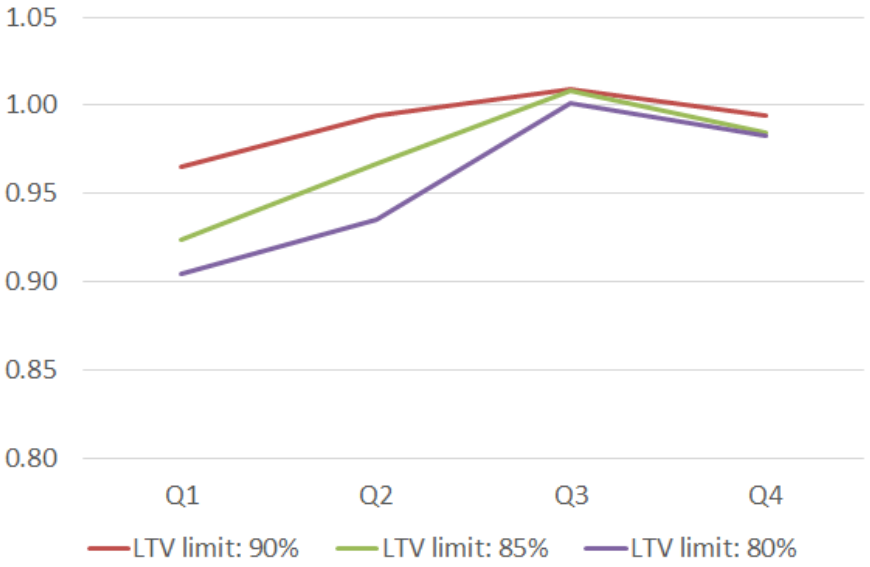
Reduce the loan-to-value ratio to 90%, 85%, and 80%



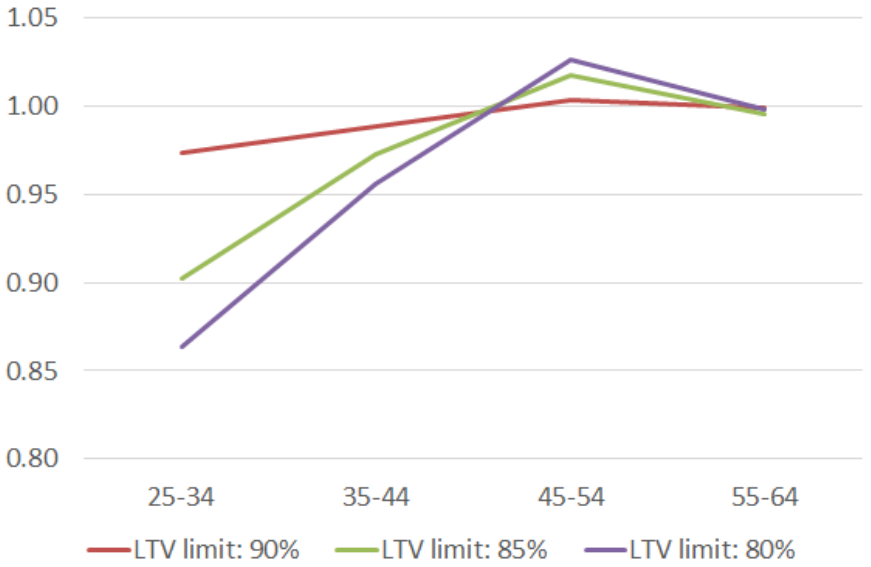




All results are relative to the benchmark

## Mortgage-to-income: by income




## Mortgage-to-income: by age

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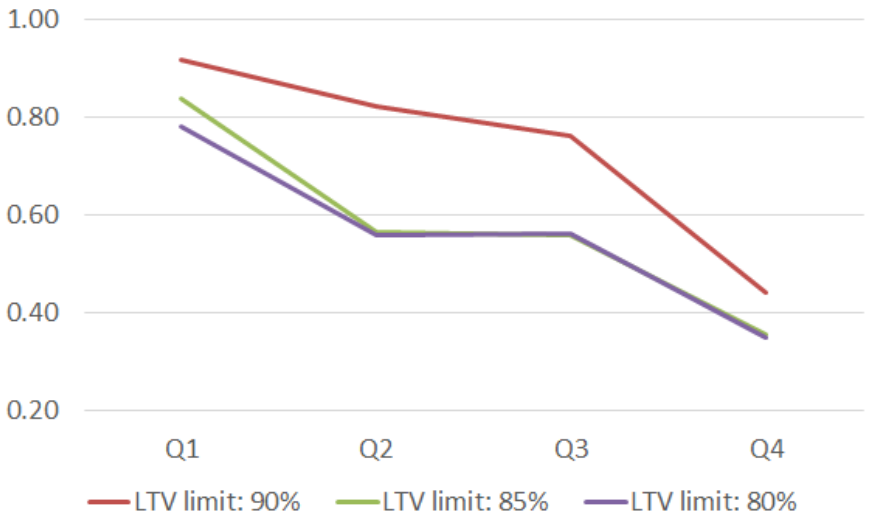
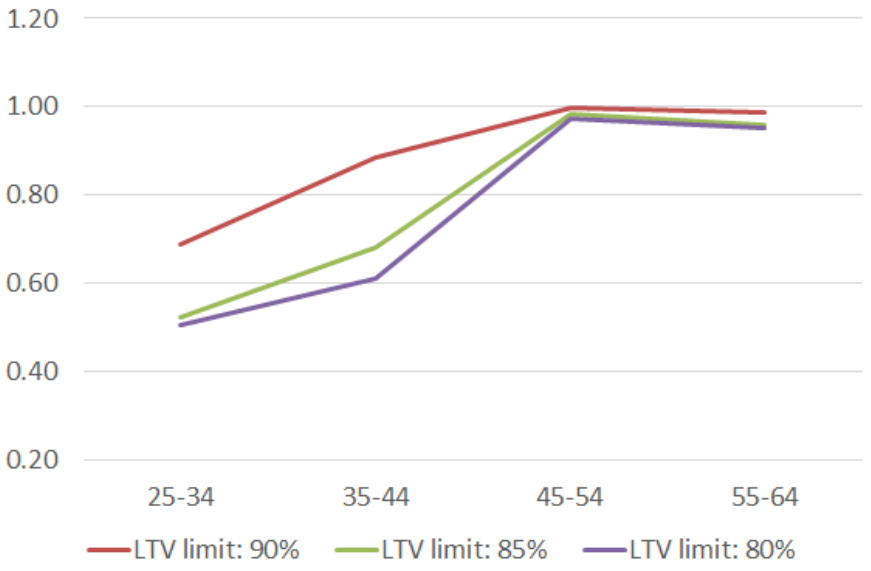



## High-debt households: by age



# Conclusion

- A quantitative life-cycle model to study the long-run impacts of changes in mortgage regulations (DSR and LTV)
- Investigate households' decisions on housing and their mortgage use
- Model is calibrated to the Canadian economy
- DSR and LTV affect household decisions via different channels
- Policy implications?
- Future work:
  - Investigate the short-run effects
  - How changes in mortgage regulations affect households' consumption in respond to interest rate and housing price shocks?
  - Implications on inplementing LTI regulations

# Parametrization I

Table: Summary of Parameter Values

| Parameters | Values | Description |
|---|---|---|
| Demographics | | |
| $J$ | 71 | Lifespan (age 25–95 ) |
| $R$ | 40 | Working periods (work until age 64 ) |
| $s$ | see text | Survival probability (life table in year 2000-2002) |
| Preferences | | |
| $\gamma$ | 2 | Relative risk aversion |
| $\beta$ | 0.97 | Discount factor |
| $\omega$ | 0.28 | Preferences on housing |
| Income | | |
| $f$ | see text | Age earnings profile (2 education groups) |
| $\rho$ | 0.97 | Persistence of idiosyncratic shock |
| $\sigma_\xi$ | 0.16 | s.d. idiosyncratic income shock |
| $\lambda$ | 0.5 and 0.7 | Pension replacement rate for 2 education groups |

# Parametrization II

Table: Summary of Parameter Values

| Parameters | Values | Description |
|---|---|---|
| Interest rate | | |
| $r$ | 1%, 2%, 3% | Returns on savings |
| $\beta^m$ | 1.2% | Mortgage premium |
| Housing | | |
| $N$ | 25 | Mortgage length |
| $\theta^D$ | see text | Down payment ratios |
| $H$ | see text | House size |
| $g$ | 0.5% | House price growth rate |
| $\theta^S$ | 5.0% | Transaction cost for seller |
| $\theta^B$ | 1.0% | Transaction cost for buyer |
| $\tau$ | 1.0% | Property tax rate |
| $\delta$ | 1.0% | Housing maintenance cost |
| $\phi$ | $3.2\% + r$ | Rental cost of housing |
| Tax code | | |
| $\tau_{ss}$ | 4.95% | CPP contribution rate for employees |
| $Y_{ss}$ | 2.18 | Maximum taxable earnings for payroll |

# Parametrization III

- $30,000 in 2012 is normalized to 1
- We use year 2012 income tax code

| Taxable Income | Normalized Income | Marginal Tax Rate |
|---|---|---|
| ($0, $42,706] | (0, 1.424] | 15% |
| ($42,707, $85,413] | (1.424, 2.847] | 22% |
| ($85,414, $132,405] | (2.847, 4.414] | 26% |
| $> $132,406 | $> 4.414 | 29% |

- Mortgage regulations
  - LTV cap: 95%
  - DSR cap: 39%

Back