Housing over the Life Cycle and Across Countries: A Structural Analysis

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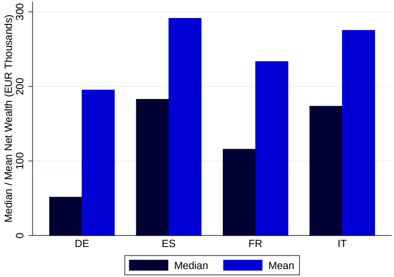
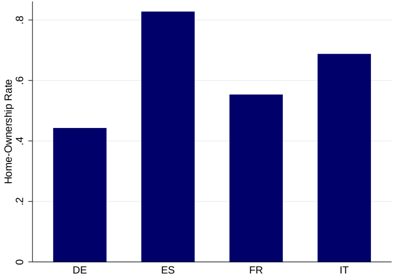
Motivation

- Striking differences in household wealth across countries
- Driven substantially by housing (real assets $\approx$ 80% of total assets)
  $\Rightarrow$ **Important to have quantitative model of housing**

Median / mean net wealth

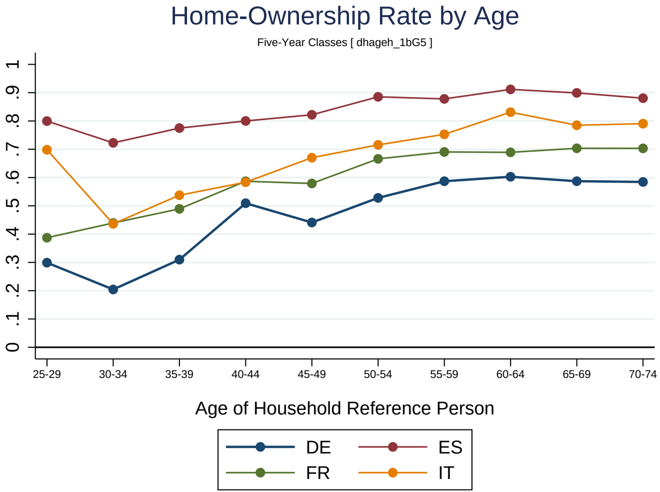


Home-ownership rate



Source: Eurosystem Household Finance and Consumption Survey

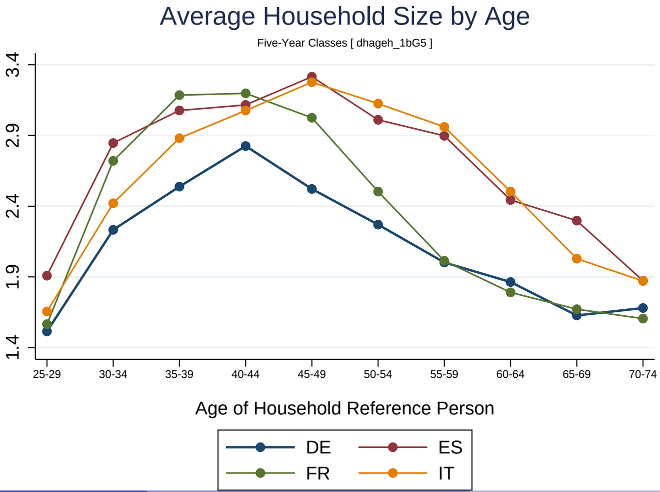
Home-ownership rate by age



Source: Eurosystem Household Finance and Consumption Survey

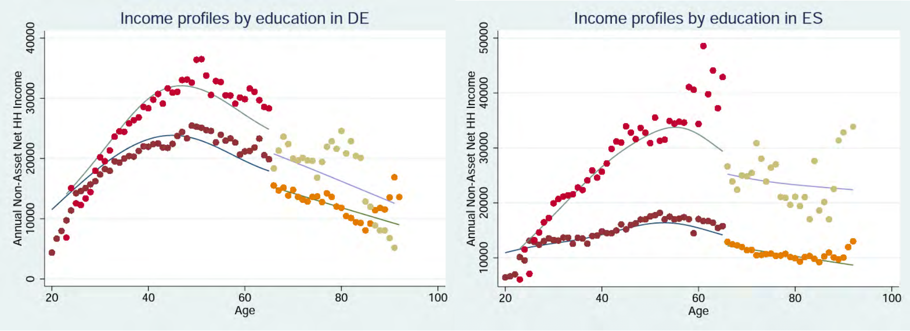
Household size N: Germany: 2.0 vs Spain: 2.7

$$u(C_t, H_t) = N_t^{\gamma} (C_t^{1-\omega} H_t^{\omega})^{1-\gamma} / (1-\gamma)$$



Income age profiles

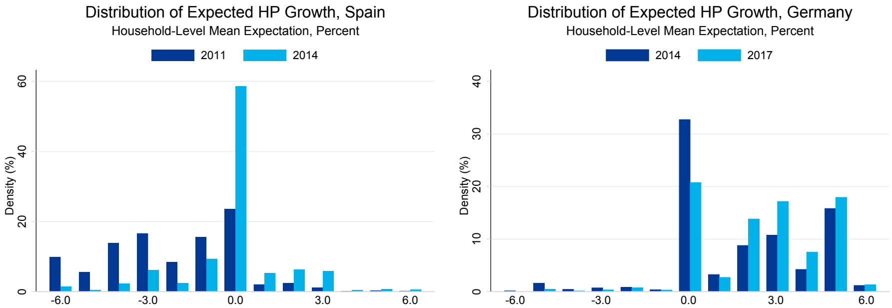
- DE income peaks at around 45 years, much earlier than ES (55)
- Transitory variance twice larger in ES: 0.096 vs 0.048



Source: European Community Household Panel 1994–2001

Expectations about house prices

- Available at household-level (for some countries)
- Distribution increases in DE, ES



Distribution of one-year ahead expected growth

Source: Encuesta Financiera de las Familias (EFF), Banco de España; Panel on Household Finances (PHF), Deutsche Bundesbank

Plan of the paper

Structural life-cycle model

We solve rich model with:

- Discrete house owning–renting choice
- Illiquid housing (adjustment cost)
- Idiosyncratic house price shocks
- Idiosyncratic perm & transitory income shocks
- Collateral constraints

Partial equilibrium

Literature—Saving / housing across countries

- Reduced-form: Chiuri and Jappelli (2003), Calza et al. (2013), . . .
- Structural: Carroll and Dunn (1997), Gourinchas and Parker (1997), Cagetti (2003), . . .
- Computational—Extensions of Endogenous Grid Method to Discrete Choice: Carroll (2006), Fella (2014), Druedahl (2017), Iskhakov et al. (2017)
- **Modelling housing over life cycle:**
  - US: Cocco (2004), Cocco et al. (2005), Li and Yao (2007), Yao et al. (2015), Landvoigt (2017), . . .
  - Other countries: Kaas et al. (2017), . . .
  - Cross-country: Kindermann & Kohls (2017), Hintermaier & Koeniger (2018)

Typically, some features of existing models differ from our setup: discrete choice, stochastic HP, income process, . . .

Model—Preferences

- Maximize

$$\mathbf{E}_0 \left\{ \sum_{t=0}^{T} \beta^t \prod_{s=0}^{t} \widehat{p}_s \left(\widehat{p}_t u(C_t, H_t; N_t) + (1 - \widehat{p}_t) B(W_t) \right) \right\}$$

$\widehat{p}$ conditional prob of alive; N household size;
W net wealth—includes housing (net of selling cost and debt)

- CRRA utility, Cobb–Douglas aggregate of C and H:

$$u(C_t, H_t) = N_t^{\gamma} \frac{(C_t^{1-\omega} H_t^{\omega})^{1-\gamma}}{1-\gamma}$$

- Warm-glow bequest:

$$B(W_t) = L^{\gamma} \frac{W_t^{1-\gamma}}{1-\gamma}$$

Model—Housing

- Dual role of housing: asset and durable consumption good
- **Housing is illiquid**
  Cost of selling house: $\phi \times P_t^H \bar{H}_t$
- Collateral constraint
  Downpayment at least: $\delta \times P_t^H H_t$
- House Prices
  Geometric random walk:

$$P_t^H = P_{t-1}^H \times \tilde{R}_t^H, \qquad \tilde{R}_t^H \sim \mathcal{N}(\mu_H, \sigma_H^2)$$

Model—Income

- Permanent–transitory household income process:

$$\begin{aligned} Y_t &= P_t \theta_t, \\ P_t &= \Gamma_t P_{t-1} \psi_t, \end{aligned}$$

θ contains (transitory) unemployment shock

- Deterministic exogenous retirement:

$$Y_t = \tau P_K \text{ for } t > K$$

τ: retirement replacement rate

Normalization

- State and choice variables normalized with P_t
- Value function normalized with $\left(P_t/(P_t^H)^\omega\right)^{1-\gamma}$
- Express normalized variables in small letters, eg $c_t \equiv C_t/P_t$

Model—Normalized problem

Budget constraints depend on **housing status**

$$
\begin{aligned}
v_t(m_t, h_t) &= \max_{\{c_t, h_t\}} \Big\{ u(c_t, h_t) + \widehat{p}_t \beta \mathbf{E}_t \Big[v_{t+1}(m_{t+1}, h_{t+1}) \big(\frac{\Gamma_{t+1}\psi_{t+1}}{(\tilde{R}^H_{t+1})^\omega} \big)^{1-\gamma} \Big] \\
&+ (1-\widehat{p}_t) B(w_t) \Big\}
\end{aligned}
$$

s.t.

$$
a_t = \begin{cases} m_t - c_t - \alpha h_t & \textbf{Renter} \\ m_t - c_t - \lambda h_t & \textbf{Stayer} \quad h_t = \bar{h}_t \\ w_t - c_t - (1+\lambda) h_t & \textbf{Mover} \quad w_t = m_t + (1-\phi)\bar{h}_t \end{cases}
$$

α: rental cost, λ: maintenance cost, ϕ: selling cost, δ: downpayment

m: market resources, h: housing wealth, w: net wealth

$$
m_{t+1} = \frac{R}{\Gamma_{t+1}\psi_{t+1}} a_t + \theta_{t+1}, \qquad h_{t+1} = \frac{\tilde{R}^H_{t+1}}{\Gamma_{t+1}\psi_{t+1}} h_t,
$$

$$
a_t \geq -(1-\delta) h_t \qquad \text{collateral constraint}
$$

Solution: Discrete-choice EGM

- Substantial complication b/c of discrete owning–renting choice
- Solve 3 choice-specific problems (renter/stayer/mover) with Endogenous Gridpoints Method (Carroll, 2006)
- Extend EGM to multiple states, discrete choice and constraints:
  - **Renter R**: $v^R(m_t)$ – **1D problem**; c and h linearly related
  - **Stayer S**: $v^S(m_t, \bar{h}_t)$ – **2D problem**; chooses c for a given $h = \bar{h}$, 2 state variables
  - **Mover M**: $v^M(m_t + (1-\phi)h_t)$ – **2D problem**; chooses c and h (pays selling cost $\phi\bar{h}_t$), only 1 state at time t ($w_t = m_t + (1-\phi)\bar{h}_t$)
- **Discrete ownership choice—max over 3 value functions:**

$$v(m_t, h_t) = \max\left\{v^R(m_t), v^S(m_t, \bar{h}_t), v^M(m_t + (1-\phi)\bar{h}_t)\right\}$$

Mechanics of the model: Renting vs owning

Benefits / Costs of renters / Homeowners

Renters

- Costless adjustment of housing $\Rightarrow h_t = \omega/\alpha(1-\omega) \times c_t$

Homeowners

- Capital gains (losses) on housing: $P_t^H = P_{t-1}^H \times \tilde{R}_t^H$
- Cost of selling house: $\phi \times \bar{h}_t$
- Subject to collateral constraint: $a_t \geq -(1-\delta)h_t$

Cost view

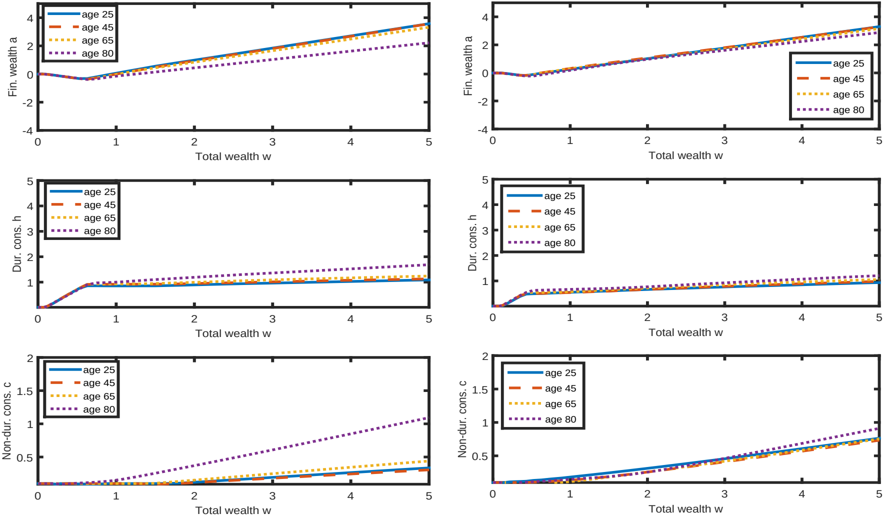
- Renters: Young frequently adjust housing — costless if they rent
- Owners: Transaction cost generates inertia, prevents from upgrading too frequently; h_{t-1} is state (for stayer)

Calibration

		Value	
Parameter	Symbol	Germany	Spain
Discount Rate	β	0.94	0.94
CRRA	γ	2	2
Bequest Strength	L	**3**	**7**
Weight on Housing	ω	0.1	0.1
Variance of Permanent Income Shock	$\text{var}(\psi)$	0.018	0.018
Variance of Transitory Income Shock	$\text{var}(\theta)$	**0.048**	**0.096**
Unemployment Insurance—Replacement Rate	μ_U	0.50	0.40
Income Replacement Ratio After Retirement	τ	**0.55**	**0.80**
Mandatory Retirement Period	J	45	45
Maximum Life Cycle Period	T	65	65
Risk-Free Interest Rate	r	0.01	0.03
Mean Growth Rate of House Prices	μ_H	**–0.001**	**0.023**
Variance of Growth Rate of House Prices	σ_H^2	**0.010**	**0.075**
Correlation b/w Perm Income and Housing Return	$\rho_{P,H}$	**–0.17**	**0.47**
Downpayment Requirement	δ	**0.40**	**0.20**
House-Selling Cost	ϕ	0.11	0.12
Maintenance Cost	λ	0.02	0.02
Rental Cost	α	0.025	0.025

Wealth profiles of optimal policy functions

Germany versus Spain



Explaining results: How does calibration matter?

Germany

Saving

- Steeper income profile & much less risky HP: HHs get large mortgage
- Stricter downpayment restriction $\Rightarrow$ binding for most wealth levels
- Weaker bequest motive: Older HHs decumulate wealth faster than in ES

Durable consumption

- Steeper income profile & less risky HP: HHs buy larger houses

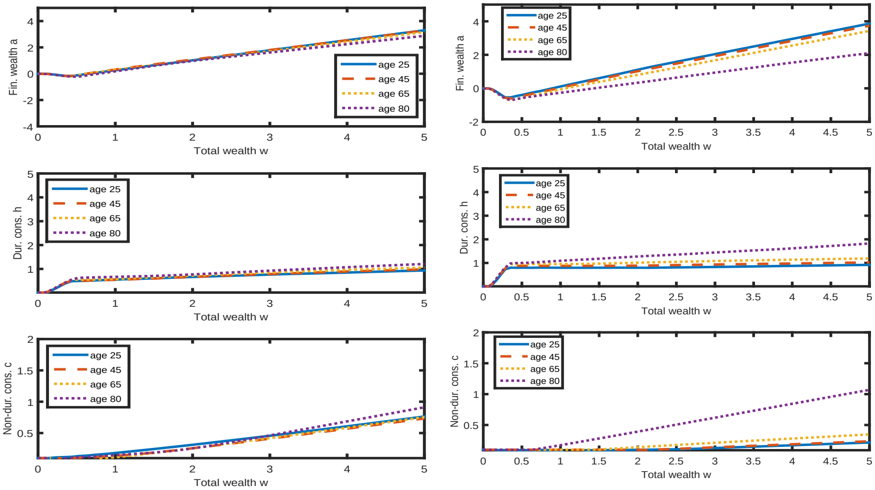
Nondurable consumption

- Lower consumption
- Only at later age bequest motive comes in

House price bubble (Spain 1997–2007)

HP growth μ_H increases from 2.3% to 7.45%, σ_H^2 decreases by 2/3

- Housing gets more attractive
- Indebtedness increases as HHs want to upgrade as much as possible



Conclusions

Model generates substantial differences

- Young HHs rent and save for downpayment
- Collateral constraint binds for poor households over entire LC
- HHs sell and upgrade when additional utility exceeds adjustment cost
- HHs with strong bequest motive reduce C as they age

Next steps

- Solution & simulation of full model
- Estimation

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Backup Slides

Motivation

So far,

- Not enough structural work on cross-country differences in wealth
- Limited quantitative modeling of housing
- Because of data and computational limitations

But now both data and computational tools available

Our contribution

Computational

- Solve rich model with discrete choice
- Apply extension of **Endogenous Gridpoints Method**
- Eventually, estimate model some parameters (using SMM)

Empirical

- Calibrate the model carefully using micro data sources
- Interpret **quantitatively** role of key factors for **wealth accumulation across countries**
- Simulate counterfactual scenarios
  - 'House price bubble'
  - Tightening of credit constraints
  - Changes in incomes

Plan of the paper

Effects on wealth accumulation

Investigates quantitatively role of:

- House prices
- Housing market institutions (LTV ratio, rental protection, taxation of mortgages, . . .)
- Expectations
- Demographics
- Income risk
- Bequest motive

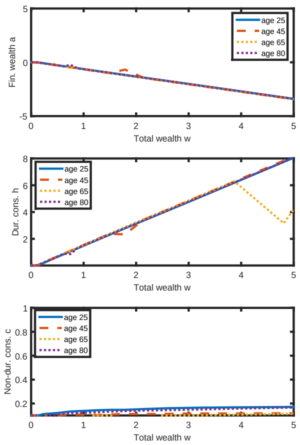
. . . on **wealth accumulation across countries** and life cycle

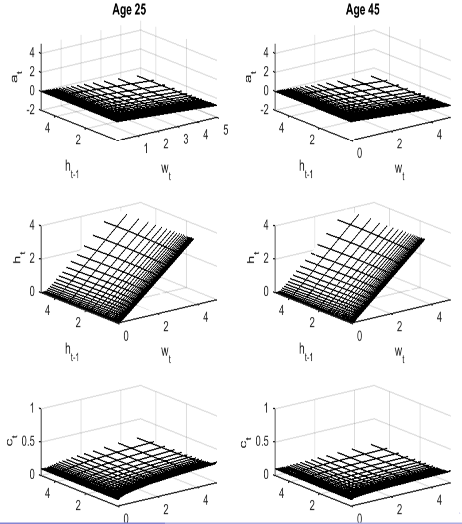
Mechanics of the model: Life cycle

- **Young**
  - Increasing income profile mimics safe asset (as in Cocco et al. (2005))
  - Down payment restriction prevents young from buying
  - Take mortgage to balance portfolio composition:
    risky (housing) vs safe assets / future income
- **Old**
  - As HHs age, they reduce leverage and hold positive liquid assets
  - Saving vs consumption depends on strength of bequest motive

Check: No adjustment cost

Owners upgrade without incurring a fixed cost





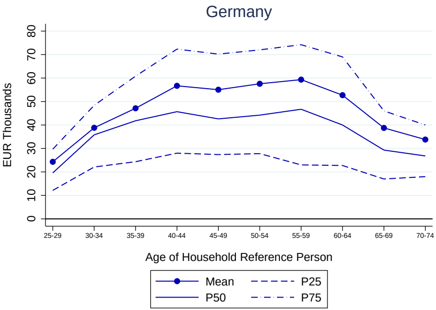
Explaining counterfactual results: ES house price bubble

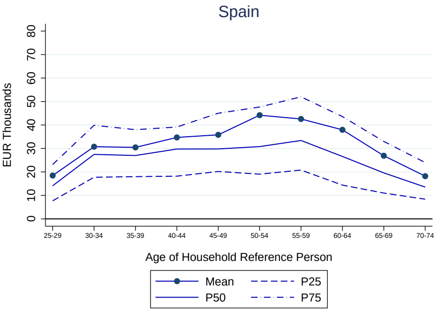
- Housing gets more attractive.
- Indebtedness increases as HHs want to upgrade as much as possible.

Explaining counterfactual results: No adjustment cost

- Homeowners purchase house only for one period.
- Only wealth and income are states; housing revised every period.

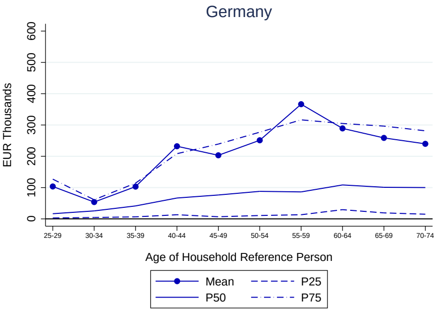
Distribution of Household Income by Age

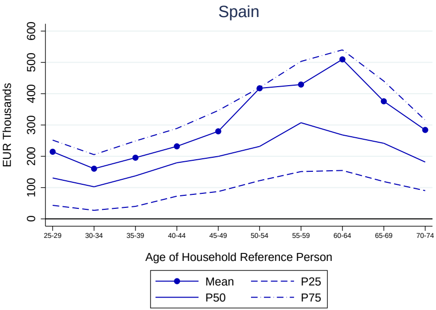




Source: Eurosystem Household Finance and Consumption Survey

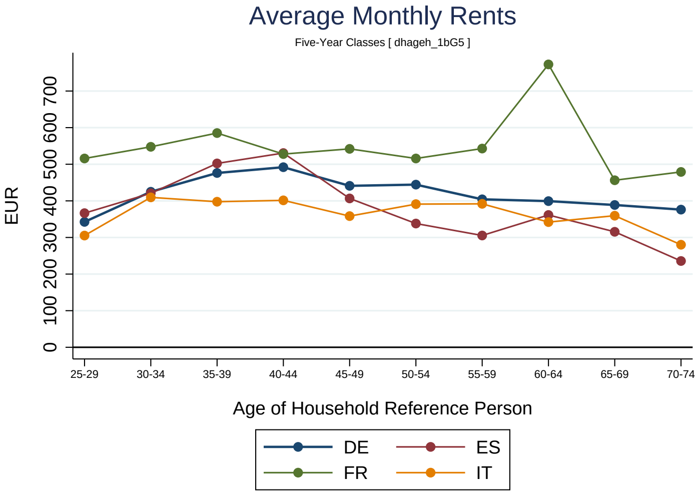
Distribution of Household Net Wealth by Age





Source: Eurosystem Household Finance and Consumption Survey

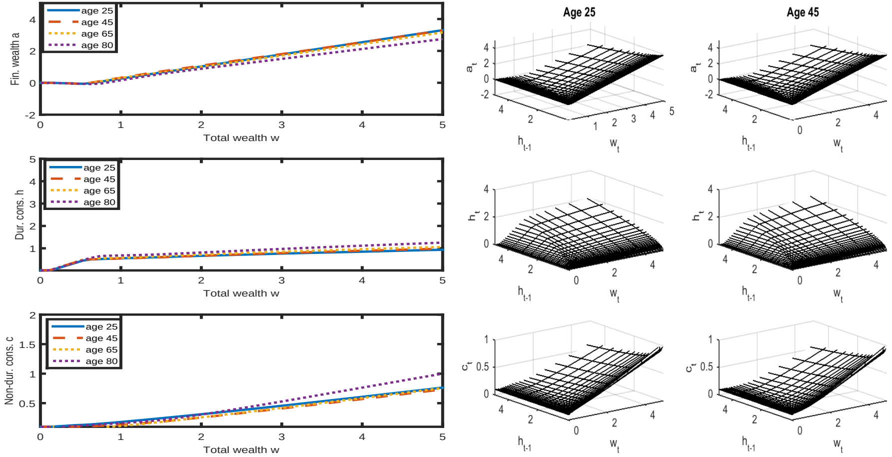
Rents



Source: Eurosystem Household Finance and Consumption Survey

Counterfactual experiment: Tighter constraints

Increase in δ from 0.2 to 0.5



Explaining counterfactual results: Tighter constraints

- Constraints deter HHs from owning too much too quickly.
- HHs consume more non-durable goods.

Outlook: Structural estimation

- Simulate model using the calibrated values.
- Use moments from the cross-sectional data (homeownership, LTI, LTV).
- Estimate $\theta \equiv \{\beta, \gamma, L, \omega\}$ by SMM, minimizing distance of model from data:

$$\big(G_Q - G_{\hat{Q}}(\theta)\big)' D \big(G_Q - G_{\hat{Q}}(\theta)\big)$$

- Need to recompute model for each estimation and simulation loop.