# Optimal Credit Market Policy

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# Optimal Credit Market Policy: Motivation

- The Great Recession was caused by sharp housing price declines exacerbated by collateral constraints.

- Policies were insufficient to:
  - prevent risk increase before crisis: ex-ante regulation
  - prevent fire sales and house price slumps during crisis: ex-post intervention.

# What We Do

- Analyze optimal credit market policy in an infinite-horizon quantitative DSGE model with housing and financial frictions.
- Savers and Borrowers cannot trade freely due to collateral constraints tied to house prices
- Collateral constraints amplify movements in consumption and economic fluctuations.
- Solve the model with global solution methods: collateral constraint can be binding or slack.
- Analyze the role of state-contingent taxes in improving welfare.

# Preview of Results

- Optimal credit market policy leans against the wind.
- A procyclical housing tax can improve welfare.
- The policy reduces the volatility of house prices and dampens house price reductions in recessions.
- Collateral constraints get loosened in recessions.
- Downside risks are mitigated. Average house prices increase on average, further loosening collateral constraints.
- Welfare gains with optimal tax are comparable to eliminating business cycle fluctuations.

# Literature Review

- **Credit and Collateral Constraints**
  - Kiyotaki and Moore (1997), Iacoviello (2005),
- **Pecuniary Externalities**
  - Lorenzoni (2008), Bianchi (2011), Davila and Korinek (2017), Kehoe and Levine (1993), Geanakoplos and Polemarchakis (1986).
- **Housing, Collateral, and Business Cycles**
  - Aoki (2004), Guerrieri and Iacoviello (2017), Mendoza (2010), Garriga et al. (2017).
- **Macroeconomic Stability, Lean Against the Wind**
  - Goodhart and Hofmann (2010), Galí (2014), Svensson (2017), Bijlsma and Ewijk (2021), Jeanne and Korinek (2020).
- **Computational Methods**
  - Dynare's team; den Haan and Marcet (1990), Reiter (2009), Judd, Maliar, and Maliar (2011), Christiano and Fisher (2000), Grand and Ragot (2024).

# Outline

- **The Model**
  - Savers
  - Borrowers
  - Equilibrium
  - The Tax
  - Implications of Collateral Constraints
- **Results**
  - Taxes and Welfare
  - Decomposing Welfare Effects of Taxes
- **Conclusions**

# Savers' Problem

**Maximization Problem:**

$$E_0 \sum_{t=0}^{\infty} \beta'^t \log c'_t,$$

subject to:

$$c'_t + k'_t + q_t h'_t - R_{t-1} b'_{t-1} = y'_t + q_t h'_{t-1} - b'_t + (1-\delta)\, k'_{t-1}.$$
$$y'_t = A_t h'^{\gamma}_{t-1} k'^{\alpha}_{t-1},$$

**First Order Conditions:**

$$\begin{aligned}
\frac{1}{c'_t} &= \beta' R_t E_t \frac{1}{c'_{t+1}}, \\
\frac{1}{c'_t} &= \beta' E_t \frac{1}{c'_{t+1}} \left( \alpha \frac{y'_{t+1}}{k'_t} + 1 - \delta \right), \\
\frac{q_t}{c'_t} &= \beta' E_t \frac{1}{c'_{t+1}} \left( q_{t+1} + \gamma \frac{y'_{t+1}}{h'_t} \right).
\end{aligned}$$

# Borrowers' Problem

**Maximization Problem:**

$$E_0 \sum_{t=0}^{\infty} \beta^t \log c_t.$$

subject to:

$$\begin{aligned} c_t + q_t h_t + R_{t-1} b_{t-1} &= y_t + b_t + q_t h_{t-1}, \\ y_t &= A_t h_{t-1}^{\gamma} \\ b_t &\leq m q_t h_t. \end{aligned}$$

**First Order Conditions:**

$$\begin{aligned} \frac{1}{c_t} &= \beta R_t E_t \frac{1}{c_{t+1}} + \lambda_t \\ \frac{q_t}{c_t} &= \beta E_t \frac{1}{c_{t+1}} \left( q_{t+1} + \gamma \frac{y_{t+1}}{h_t} \right) + \lambda_t m q_t \\ \lambda_t &\geq 0, \; b_t \leq m q_t h_t, \; \lambda_t \left( b_t - m q_t h_t \right) = 0, \end{aligned}$$

# Equilibrium

**Market Clearing:**

$$nb_t = (1-n)b'_t, \quad \text{(Debt Market Clearing)}$$
$$nh_t + (1-n)h'_t = 1, \quad \text{(Housing Market Clearing)}$$

**Shock Process:**

$$\ln A_t = \rho \ln A_{t-1} + \sigma\varepsilon_t, \quad \varepsilon_t \sim N(0,1).$$

**Competitive Equilibrium:**
A competitive equilibrium consists of sequences $\{c_t, h_t, b_t, c'_t, h'_t, b'_t, q_t, R_t\}$ satisfying the agents' optimality conditions, budget constraints, and market clearing conditions.

# Implications of Binding Collateral Constraint

- The current consumption of the borrowers $c_t$ is too low. The borrower would like to increase $b_t$ and $c_t$.

$$\beta' R_t E_t \frac{c_t'}{c_{t+1}'} = 1 > \beta R_t E_t \frac{c_t}{c_{t+1}}.$$

- Inefficiency: Borrowers' marginal benefit of housing investment is higher than the marginal cost of funds.

$$\beta E_t \frac{c_t}{c_{t+1}} \frac{1}{q_t} \left( q_{t+1} + \gamma \frac{A_{t+1}}{h_t^{1-\gamma}} \right) > \beta E_t R_t \frac{c_t}{c_{t+1}}.$$

  - Borrowers would like to obtain additional funds and invest in housing.
  - Alternatively, the price of housing $q_t$ is too low.
  - The collateral constraint would be alleviated if $q_t$ increases. This is one of the mechanisms that will lead to welfare gains.

# Calibration

| Parameter | Value | Description |
|---|---|---|
| $\beta$ | 0.985 | Discount factor of borrowers |
| $\beta'$ | 0.99 | Discount factor of savers |
| $\alpha'$ | 0.2 | Capital share in production |
| $\gamma$ | 0.3 | Housing share in borrowers' production |
| $\gamma'$ | 0.1 | Housing share in savers' production |
| $\delta$ | 0.025 | Capital depreciation rate |
| $m$ | 0.8 | Collateral requirement parameter |
| $n$ | 0.5 | Share of borrowers |
| $\rho$ | 0.95 | Persistence of shock |
| $\sigma$ | 0.0165 | Standard deviation of shock |

| Annual Target | Value |
|---|---|
| Wealth/Annual GDP | 5 |
| Debt/Annual GDP | 2 |
| Stdev log GDP | 6 percent |
| Stdev log C | 5 percent |
| Stdev C borrowers | 9 percent |
| Stdev C savers | 4 percent |
| Frequency of binding constraint | 41 percent |

# Solution Method

- **A**pproximate conditional expectations as polynomial functions of state variables:
  - Previous period housing stock ($h_{t-1}$)
  - Previous period capital stock ($k_{t-1}$)
  - Previous period debt level ($b_{t-1}$)
  - Current productivity shocks ($A_t$)
- **Solution Process**:
  1. Initialize polynomial coefficients $\eta^0$ using the solution from Dynare+OccBin as a candidate solution
  2. Solve and simulate nonlinear equilibrium conditions for large T periods
  3. Generate a new set of time series conditional expectations
  4. Update polynomial coefficients via OLS
  5. Iterate until $\|\eta^j - \eta^{j-1}\| < \zeta$
- Euler equation errors quite small

# The Tax

- Tax Rule:

$$\tau_t = \varepsilon \ln A_t. \tag{1}$$

- The tax is levied on the housing holdings of borrowers.
- The tax revenue is rebated lump-sum, ensuring revenue neutrality:

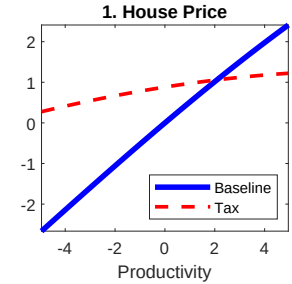
$$c_t + q_t h_t (1 + \tau_t) = b_t - R_{t-1} b_{t-1} - y_t + q_t h_{t-1} + T_t. \tag{2}$$

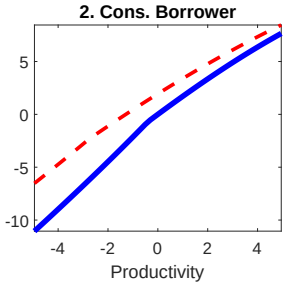
- The borrower's housing Euler equation becomes:

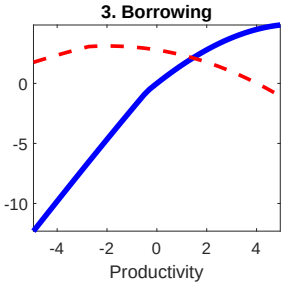
$$\frac{q_t (1 + \tau_t)}{c_t} = \beta E_t \frac{1}{c_{t+1}} \left( q_{t+1} + \gamma \frac{y_{t+1}}{h_t} \right) + \lambda_t m q_t. \tag{3}$$

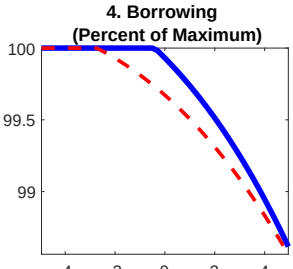
- Importantly, the tax does not directly affect the collateral constraint.

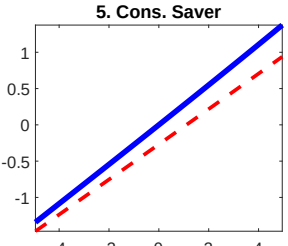
# Policy Functions with Housing Tax

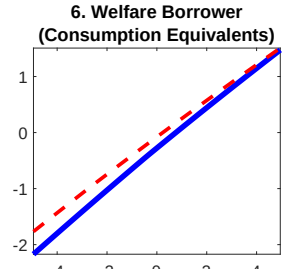


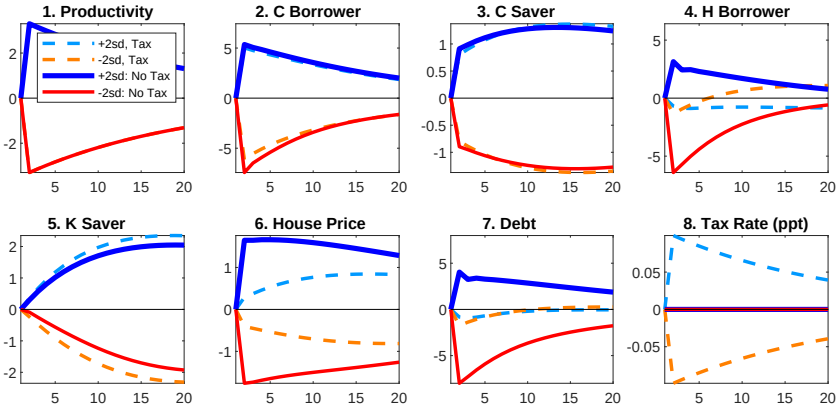



# Impulse Responses

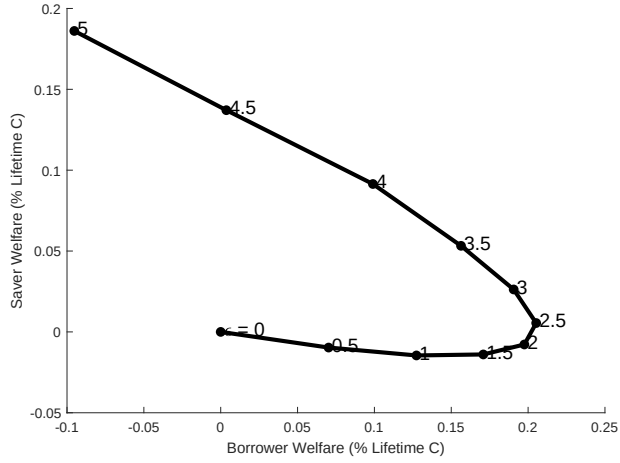



All variables start at their respective risk-adjusted steady state.

# Taxes and Welfare

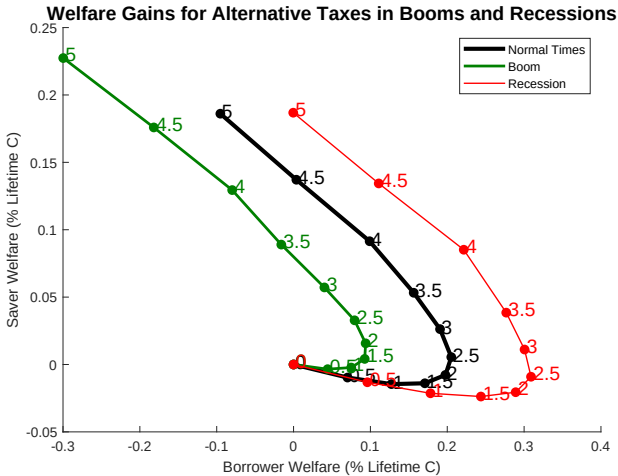
- Tax policies could enhance welfare by offsetting the absence of state-contingent securities.
- However, such welfare gains are typically small, akin to findings in open economy macroeconomics, where a one-period bond nearly completes the market.
- The presence of collateral constraints that affect and are affected by asset prices makes the welfare effects more relevant.
- We adopt a conditional welfare criterion reported as lifetime consumption equivalent compensation.
- We guess the model's policy functions using Dynare (and OccBin), and solve the model globally using Parameterized Expectations.

# Pareto Frontier for the Benchmark Model




Welfare gains (in % lifetime consumption) from moving from zero to procyclical housing taxes.

# Pareto Frontier for the Benchmark Mode: Boom vs Recession




Welfare gains (in % lifetime consumption) from moving from zero to procyclical housing taxes, starting in different stages of the business cycle.

# Taxes and Welfare: Discussion

- $\epsilon = 3 \rightarrow$ For a \$350,000 house (median US house price), a 3% negative TFP shock yields a subsidy of about 300 dollars per year.
- House prices respond less to shocks.
- Average house price increases, even though tax policy is revenue neutral.
  - House prices do not decrease as much in downturns. Fire sales avoided.
  - House prices at $t$ are higher since future fire sales are avoided.
- This allows for more borrowing during downturns and on average.
- Welfare gains larger the larger borrowers' consumption volatility and the larger the discount factor gap.

# Decomposing Welfare Effects of Taxes

- The **total effect** of taxation on welfare is decomposed into three components:

$$\Delta W \approx \Delta W_{SR} + \Delta W_{LR} + \Delta W_{VAR}. \tag{4}$$

- **Short-run mean term** captures level effects early in the transition:

$$\Delta W_{SR} = \sum_{t=0}^{T} \beta^t \log E_0(c_t^{tax}) - \sum_{t=0}^{T} \beta^t \log E_0(c_t^{no\_tax}). \tag{5}$$

- The **Long-run mean term** captures long-run mean effects:

$$\Delta W_{LR} = \sum_{t=T+1}^{\infty} \beta^t \log E_0(c_t^{tax}) - \sum_{t=T+1}^{\infty} \beta^t \log E_0(c_t^{no\_tax}). \tag{6}$$

- The **variance component** measures effects from changes in volatility:

$$\Delta W_{VAR} = -\left( \sum_{t=0}^{\infty} \beta^t \frac{E_0\left(c_t^{tax} - E_0 c_t^{tax}\right)^2}{2(E_0(c_t^{tax}))^2} - E_0 \sum_{t=0}^{\infty} \beta^t \frac{E_0\left(c_t^{no\_tax} - E_0 c_t^{no\_tax}\right)^2}{2(E_0 c_t^{no\_tax})^2} \right). \tag{7}$$

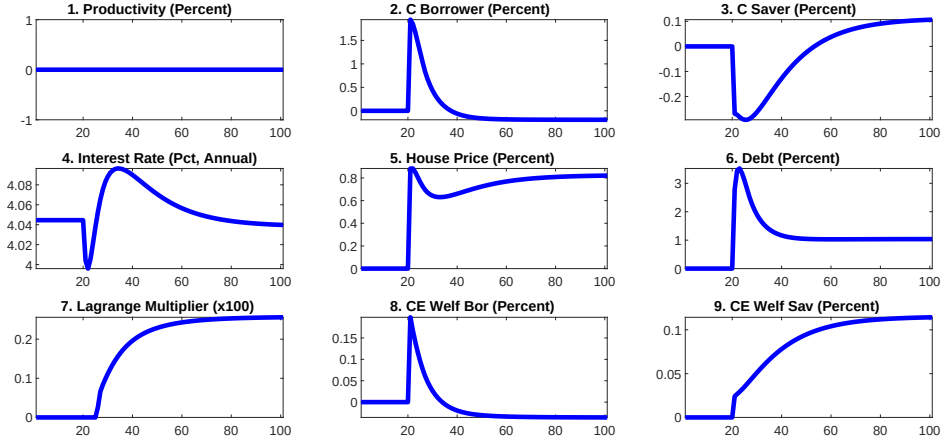
# Decomposing Welfare Effects of Taxes

Consider that there were no tax interventions, and the economy is at its risk-adjusted steady state. The tax intervention kicks in:

- Higher asset prices $\rightarrow$ higher debt which allows for more consumption...
  ... and higher asset prices reduce downside consumption risk. $\Delta W_{SR} > 0$
- In the long term, debt and debt service costs increase; hence, borrowers' consumption settles at a lower level in the new steady state. $\Delta W_{LR} < 0$
- The lower volatility of consumption $\Delta W_{VAR} > 0$ contributes to the overall welfare gain for the borrower.

The effects of these changes on the saver are nearly a wash...

# Full Simulation



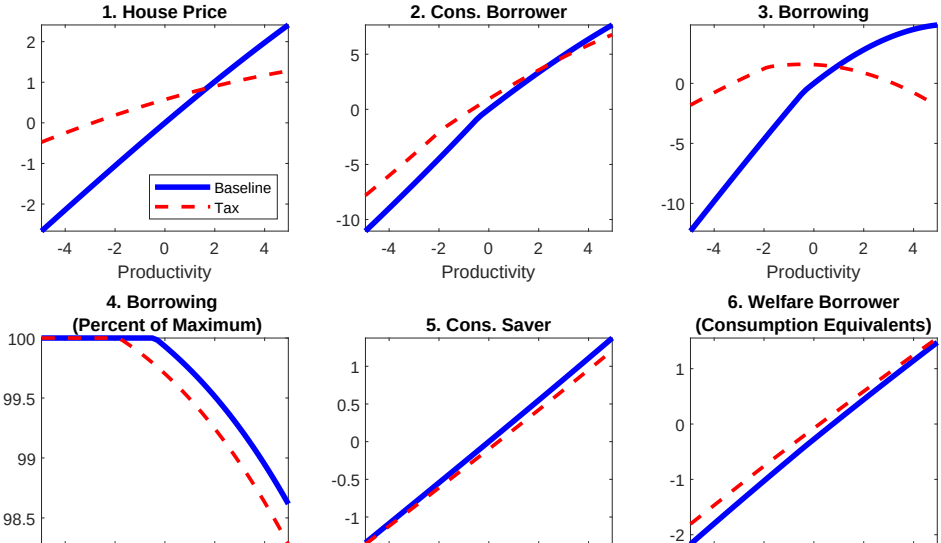

Model transition when agents receive news of new housing tax in period 20, starting from the risk-adjusted steady state of model without tax.

# Welfare Decomposition

| | | Welfare Change Decomposition | | |
|---|---|---|---|---|
| | **Total** | **SR Mean (1)** | **LR Mean (2)** | **Variance (3)** |
| Borrower | 0.19 | 0.18 | -0.06 | 0.06 |
| Saver | 0.02 | -0.03 | 0.06 | -0.01 |

Total change in conditional welfare (measured in % change in consumption equivalents) from introducing a tax. Welfare calculated starting at the risk-adjusted steady state of the model without tax.

# Comparison: Policy Functions with Borrowing Tax



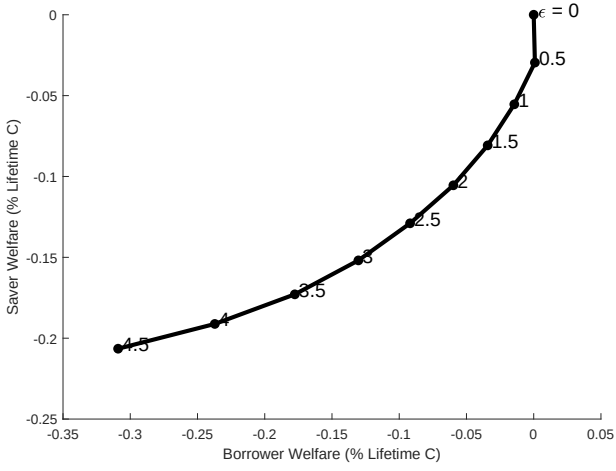
# Conclusions

- Procyclical housing tax can generate Pareto improvements by mitigating financial frictions and downside risks.
- The tax stabilizes house prices over the business cycle, preventing severe downturns.
- This leads to higher expected future house prices, relaxing borrowing constraints, and improving credit availability.
- Borrowers benefit from higher short-term consumption and reduced consumption volatility.
- Savers experience long-term welfare gains due to increased asset values and long-term consumption.
- These results are based on a revenue-neutral tax policy, focusing solely on efficiency improvements without bypassing the collateral constraint or being driven by redistribution motives.

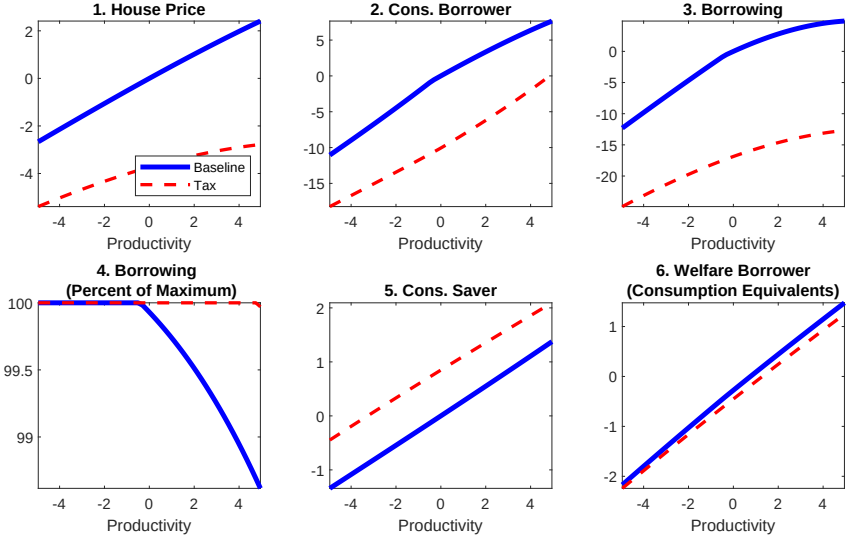
# Appendix

# Impulse Responses, Baseline Model

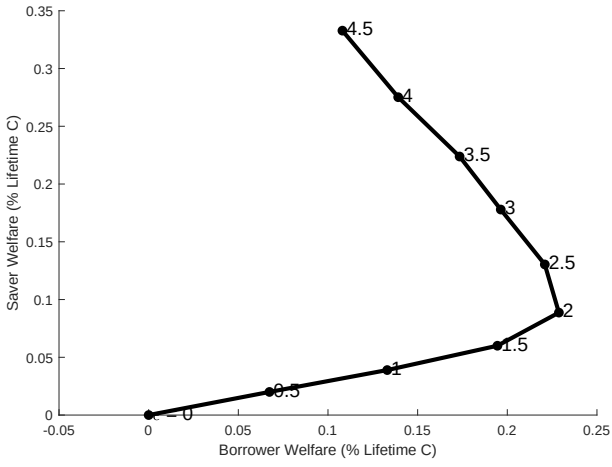
# Model with Tax only in Expansions: Frontier



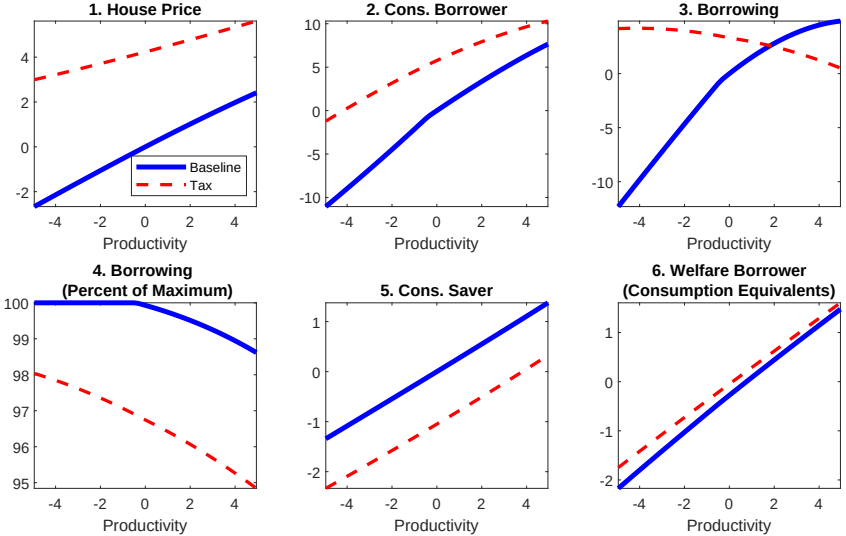
# Model with Tax only in Expansions: Policy Functions



# Model with Tax only in Recessions: Frontier

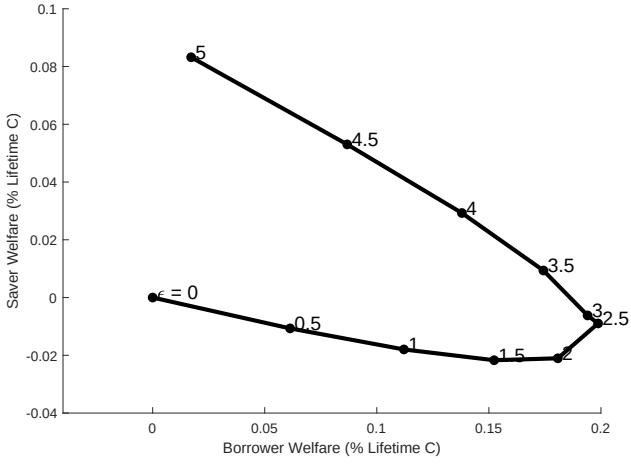


# Model with Tax only in Recessions: Policy Functions

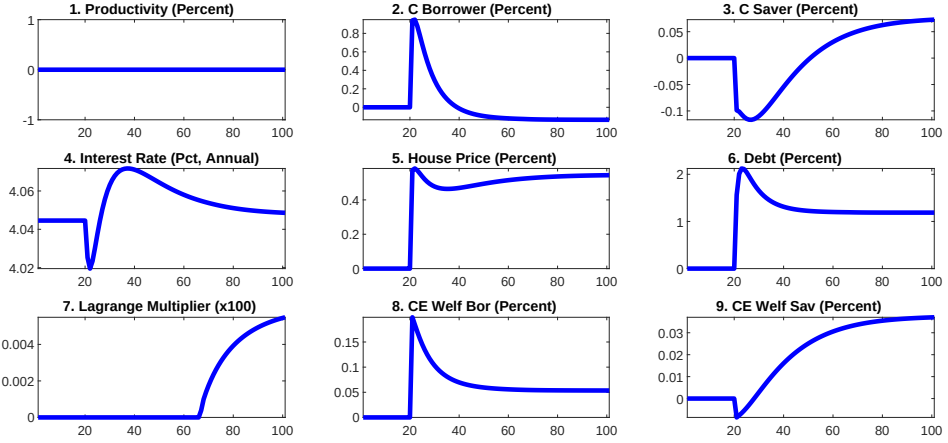


# Model with Borrowing Tax: Impulse Response

# Model with Borrowing Tax: Frontier



# Model with Borrowing Tax: Transition



# Euler Equation Errors, Baseline Model