Credit Crunches and Credit Allocation in a Model of Entrepreneurship

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Introduction

- Large debate about "credit crunch"
- Perception that small firms are particularly vulnerable
- Output losses may be more persistent

Our Questions and our Goal

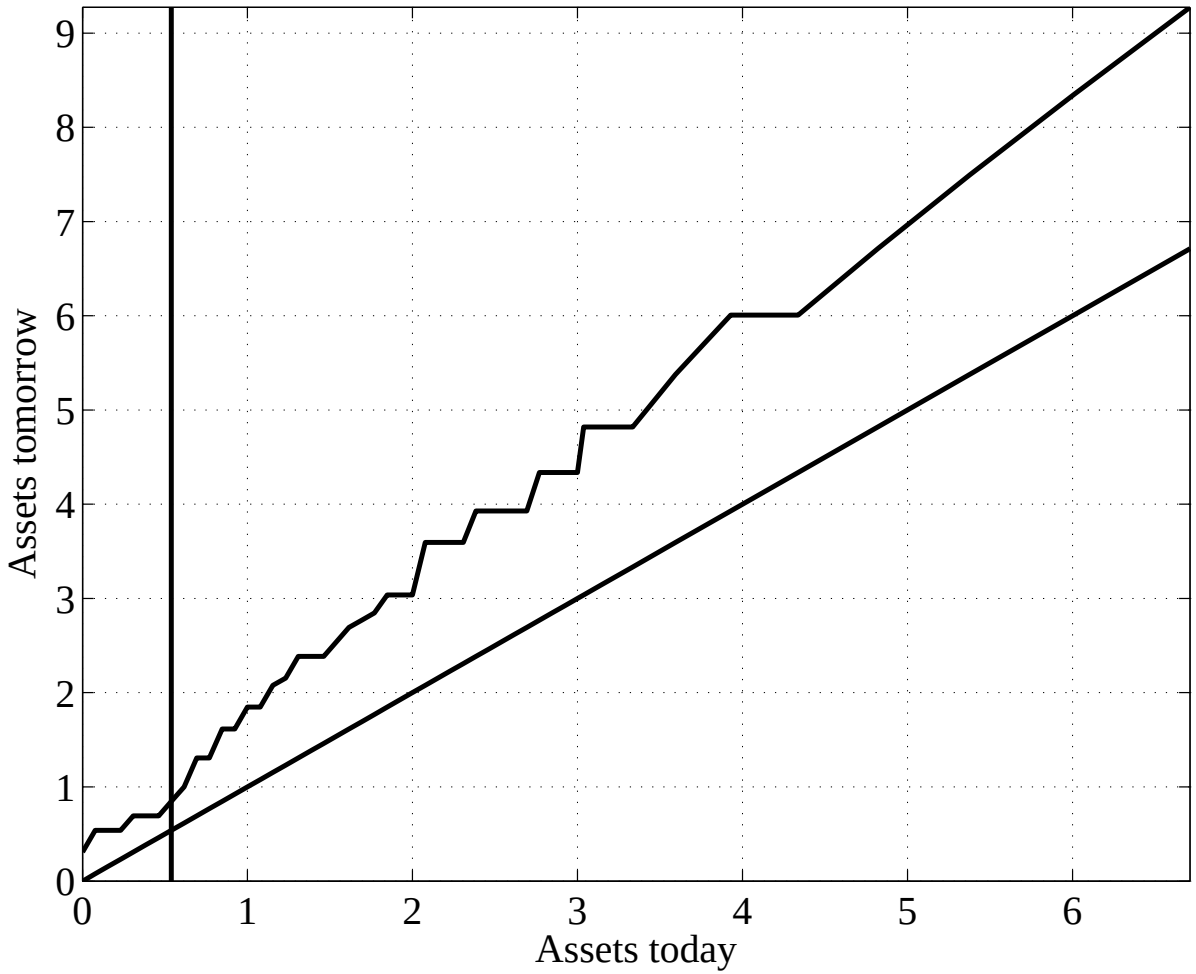
Can a shock to an economy's financial sector generate a large and lasting recession?

- Start from a model that matches well:
  - distribution of wealth
  - size of entr. firms
  - Entry and exit
- Analyze effects of financial shocks

The Economics of the Model

- Good entrepreneurial types very productive, need capital
- Need to pledge collateral, growth limited by own assets
- High implicit return on saving
- Shocks to entrepreneurial assets affect firm size for a long time

Asset Accumulation by Potential Entrepreneurs



Go to full graph

Summary of the Actors

- Households (entrepreneurs and workers)
- Corporate firms
- Financial intermediaries
- Government
- No aggregate uncertainty

Household Preferences and Demographics

- Young households: prob $1 - \pi_y$ become old
- Old households: prob $1 - \pi_o$ die, reborn as young (full altruism)
- Period utility: $\frac{c_t^{1-\sigma}}{1-\sigma}$
- Discount factor: β

Household Occupational Choice

- As workers (young): supply y_t units of effective labor
- As entrepreneurs (young and old): can use k_t and n_t to produce
$$\theta_t(k_t^{\gamma}(1+n_t)^{(1-\gamma)})^{\nu}$$
- As retirees (old): collect social security benefits (irreversible choice)
- Markov process for (y_t, θ_t)

Credit Friction: Entrepreneurs

- k_t in excess of own assets must be borrowed from intermediaries
- Entrepreneur can run away with $f_t k_t$, be worker for one period

Young Household Problem: Value Function

Optimal occupation choice:

$$V_t(a_t, y_t, \theta_t) = \max\{V_t^e(a_t, y_t, \theta_t), V_t^w(a_t, y_t, \theta_t)\},$$

Value function as entrepreneur:

$$V_t^e(a_t, y_t, \theta_t) = \max_{c_t, k_t, n_t, a_{t+1}} \{u(c_t) + \beta\pi_y E_t V_{t+1}(a_{t+1}, y_{t+1}, \theta_{t+1}) + \beta(1-\pi_y) E_t W_{t+1}(a_{t+1}, \theta_{t+1})\}$$

Value function as worker:

$$V_t^w(a_t, y_t, \theta_t) = \max_{c_t, a_{t+1}} \{u(c_t) + \beta\pi_y E_t V_{t+1}(a_{t+1}, y_{t+1}, \theta_{t+1}) + \beta(1-\pi_y) W_{t+1}^r(a_{t+1})\}$$

Young Household Problem: Constraints

Gross income as entrepreneur:

$$Y_t^e = \theta(k_t^\gamma(1+n_t)^{(1-\gamma)})^\nu - \delta k_t - (k_t - a_t)(r_t I_{k_t > a_t} + i_t I_{k_t < a_t}) - w_t n_t;$$

Gross income as worker:

$$Y_t^w = w_t\, y_t + i_t\, a_t;$$

Asset evolution

$$a_{t+1} = Y_t^i - T_t^i(Y_t^i) + a_t - (1+\tau_t^c)c_t, \quad i = e, w;$$

Credit limit

$$u(c_t) + \beta\pi_y E_t V_{t+1}(a_{t+1}, y_{t+1}, \theta_{t+1}) + \\ \beta(1-\pi_y)E_t W_{t+1}(a_{t+1}, \theta_{t+1}) \geq V_t^w(f \cdot k_t, y_t, \theta_t);$$

nonnegativity constraints $a_t \geq 0$, $k_t \geq 0$, $n_t \geq 0$.

Go to value functions of the old

Corporate Sector

- Neoclassical production function:

$$F(K_t^c, L_t^c) = A(K_t^c)^{\alpha}(L_t^c)^{1-\alpha}$$

Corporate Sector

- Neoclassical production function:

$$F(K_t^c, L_t^c) = A(K_t^c)^{\alpha}(L_t^c)^{1-\alpha}$$

- Needs outside financing for fraction ξ_t (exogenous)

Go to corporate firm's problem

Optimality Conditions for Corporate Firms

Labor:

$$F_L(\hat{K}_t^C, \hat{L}_t^C) = w_t,$$

Capital (except possibly period 0):

$$F_K(\hat{K}_t^C, \hat{L}_t^C) = \delta + (1-\xi)i_t + \xi r_t, \quad t > 0$$

Financial Intermediaries

- Competitive, CRS technology
- Requires (exogenous) ϕ_t units of goods to intermediate 1 unit of capital
- $$r_t = i_t + \phi_t$$

Government

- Spends a constant amount
- Pays a constant fraction of wages as pensions
- Levies taxes on income (labor+capital) and consumption

Main Target Moments

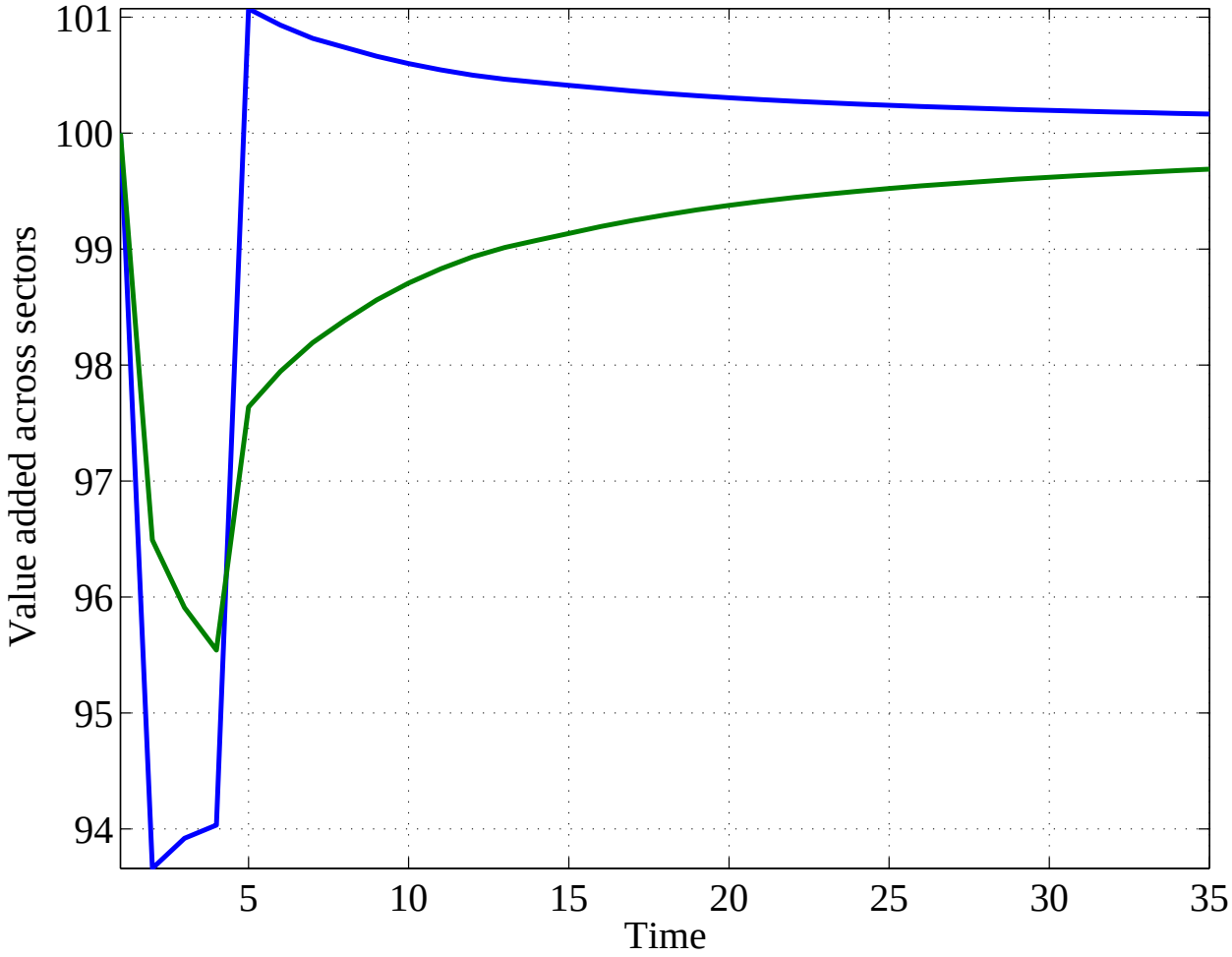
Target Moment	Target	Model
Capital-output ratio	2.9-3.0	3.0
% Entrepreneurs	7.5-7.6	7.7
% Exiting Entrepreneurs	22.0-24.0	22.4
% Workers Entering Entrepreneurship	2.0-3.0	2.4
Median Net Worth of Entr. to Workers	5.3-6.5	6.2
% People at Zero Wealth	7-13	11.9
% Entrepreneurs Hiring on the Labor Market	57.4-64.6	58.8

Complete details on calibration

First Experiment

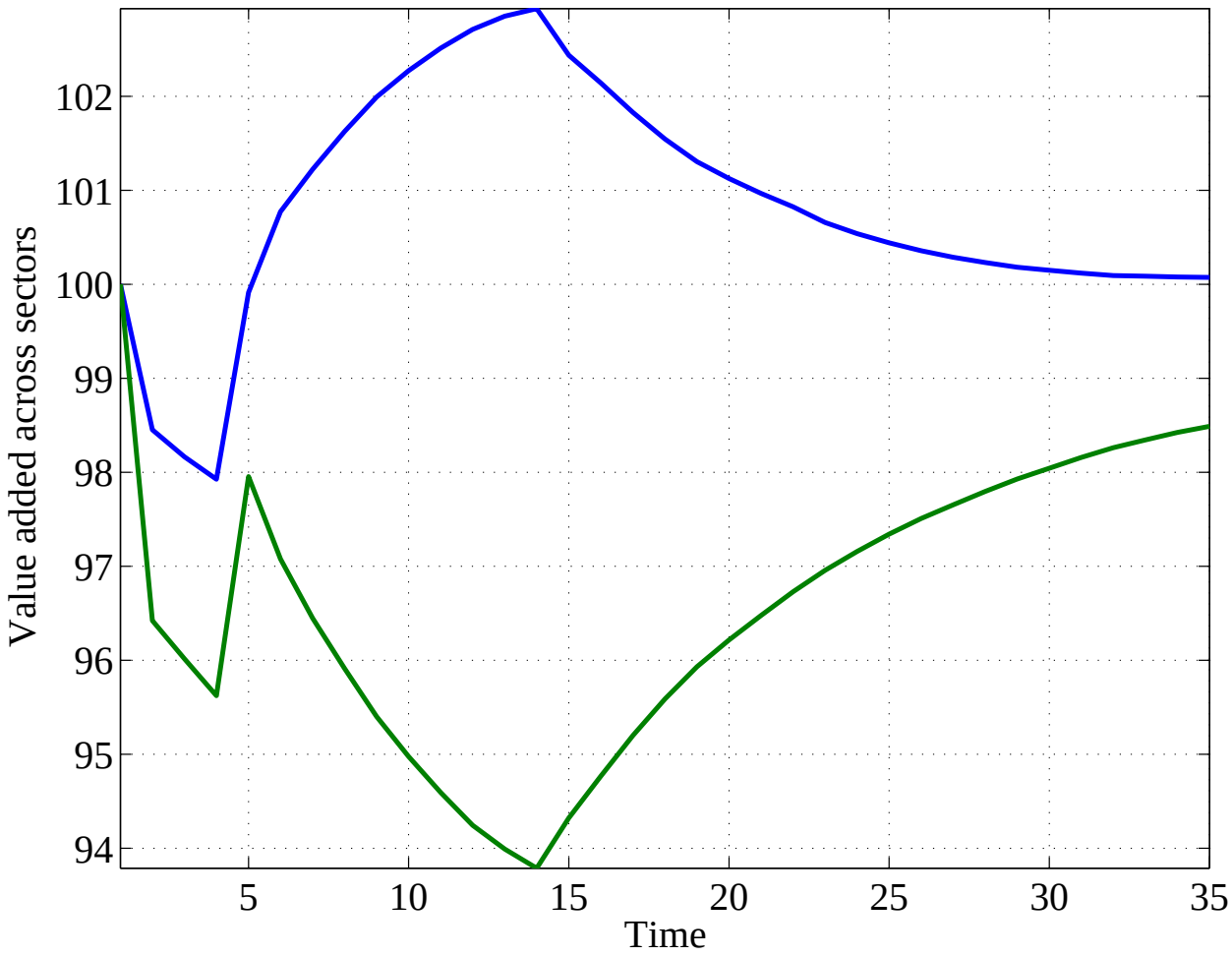
- Start from SS in period 1, 1.5% intermediation spread
- Surprise in period 2, perfect foresight from period 2
- $\phi_2 = \phi_3 = \phi_4 = 3.5\%$ for three years, then back to 1.5%
- Possible settings:
  - Partial vs. general equilibrium (fixed interest rate for savers in PE);
  - g adjusts vs. τ adjusts to clear gov't budget

Value added across sectors, PE with g adjusting



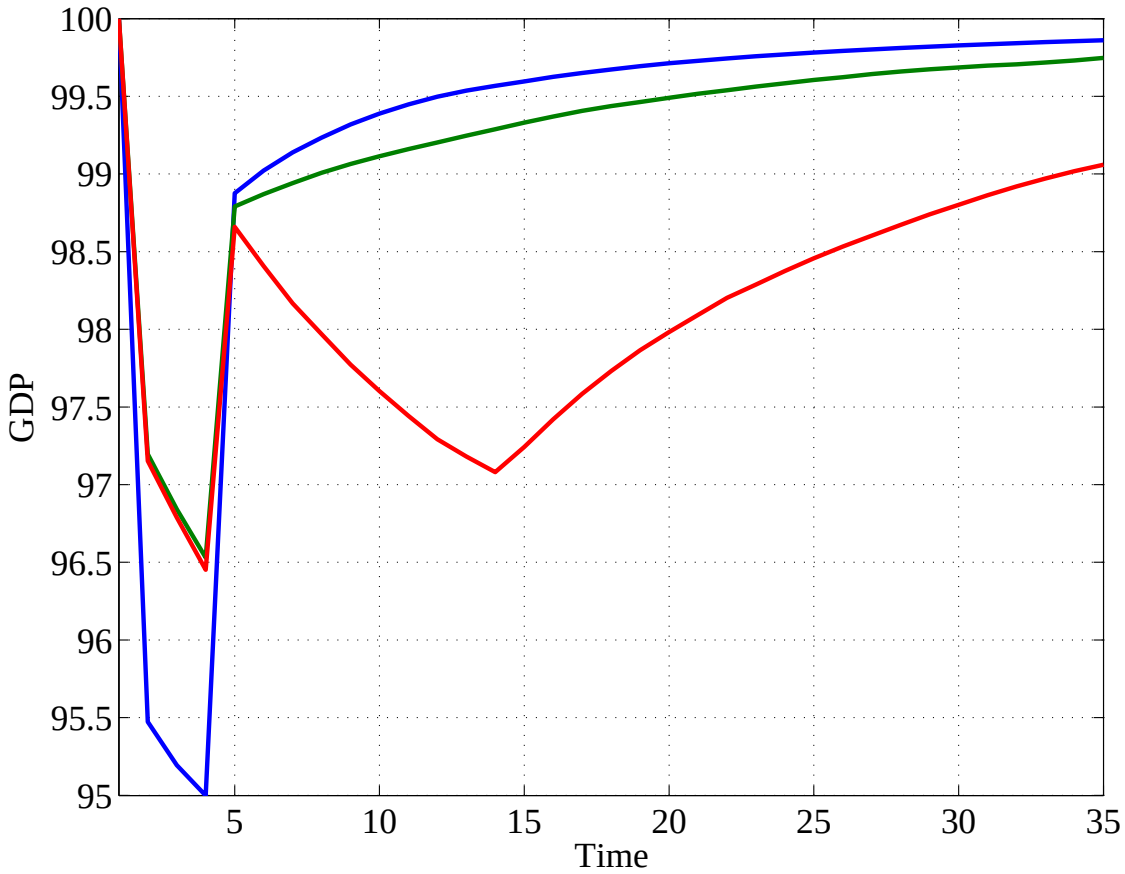
Entrepreneurial sector (green), corporate (blue), SS=100

Value added across sectors, GE with τ adjusting



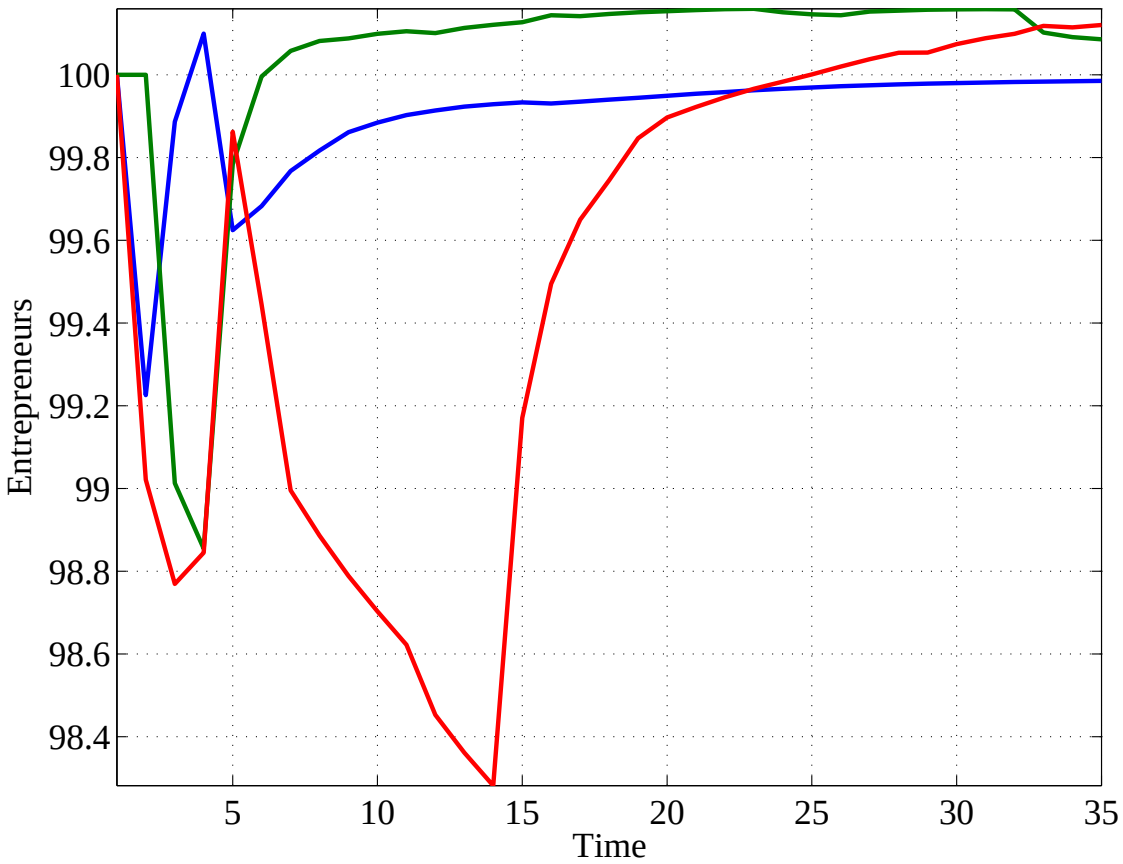
Entrepreneurial sector (green), corporate (blue), SS=100

GDP



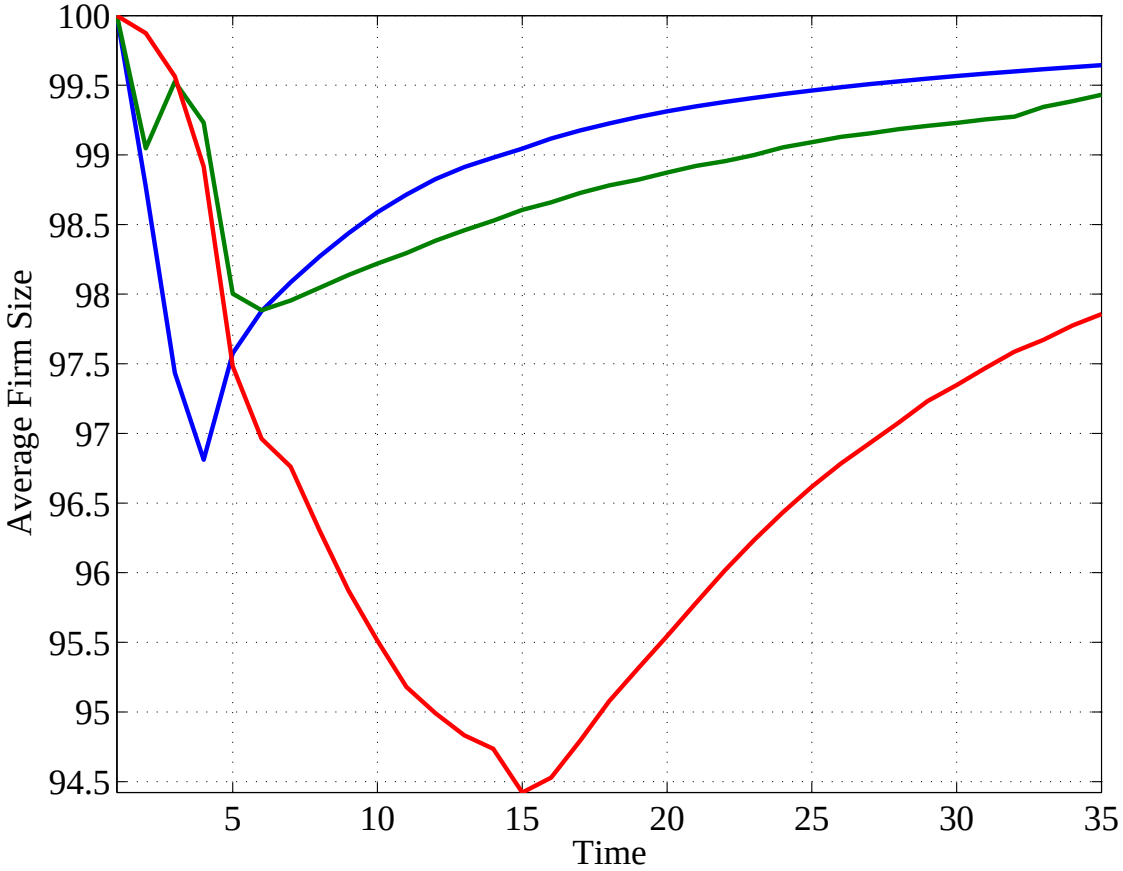
PE with g adjusting (blue), GE with g adjusting (green), GE with τ adjusting (red), SS=100

Number of Entrepreneurs



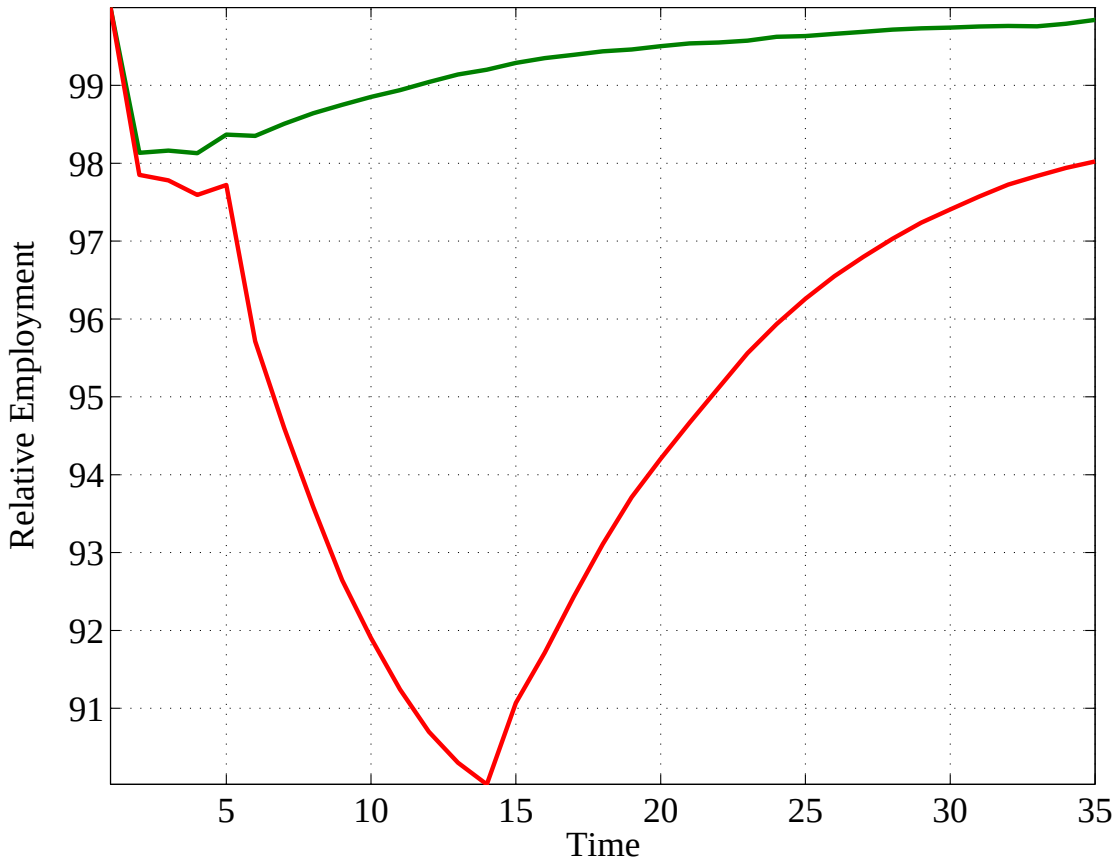
PE with g adjusting (blue), GE with g adjusting (green), GE with τ adjusting (red), SS=100

Average Capital Employed by an Entrepreneur



PE with g adjusting (blue), GE with g adjusting (green), GE with τ adjusting (red), SS=100

Employment in the Entrepreneurial Sector Relative to Corporate

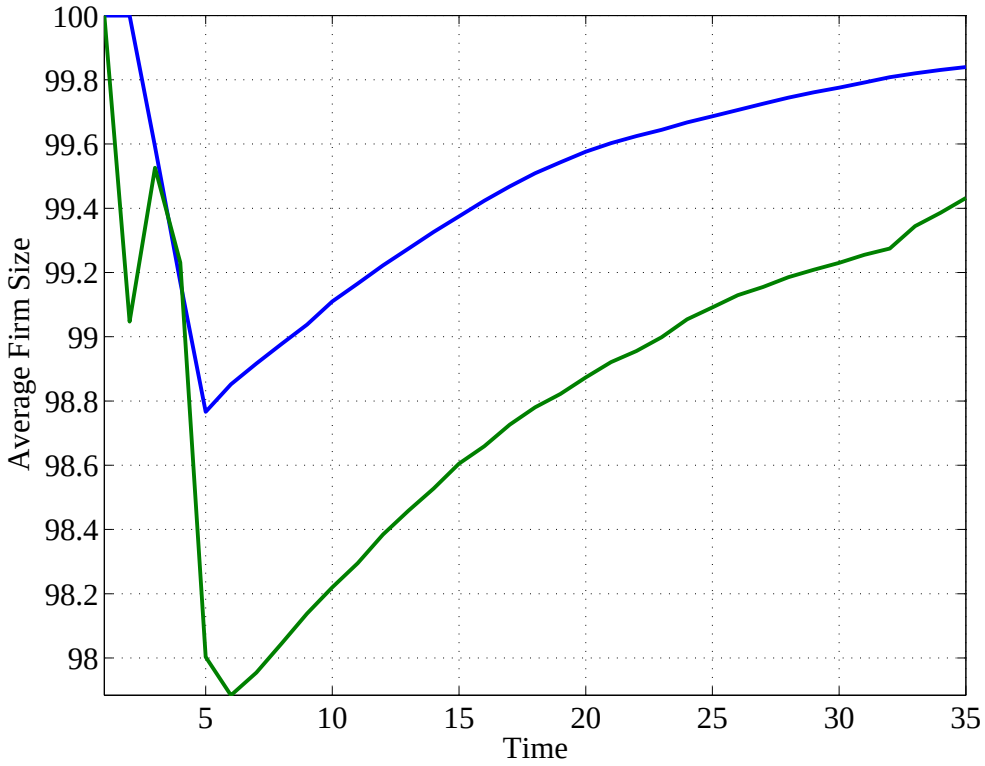


GE with g adjusting (green), GE with τ adjusting (red), SS=100

The role of endogenous credit constraints

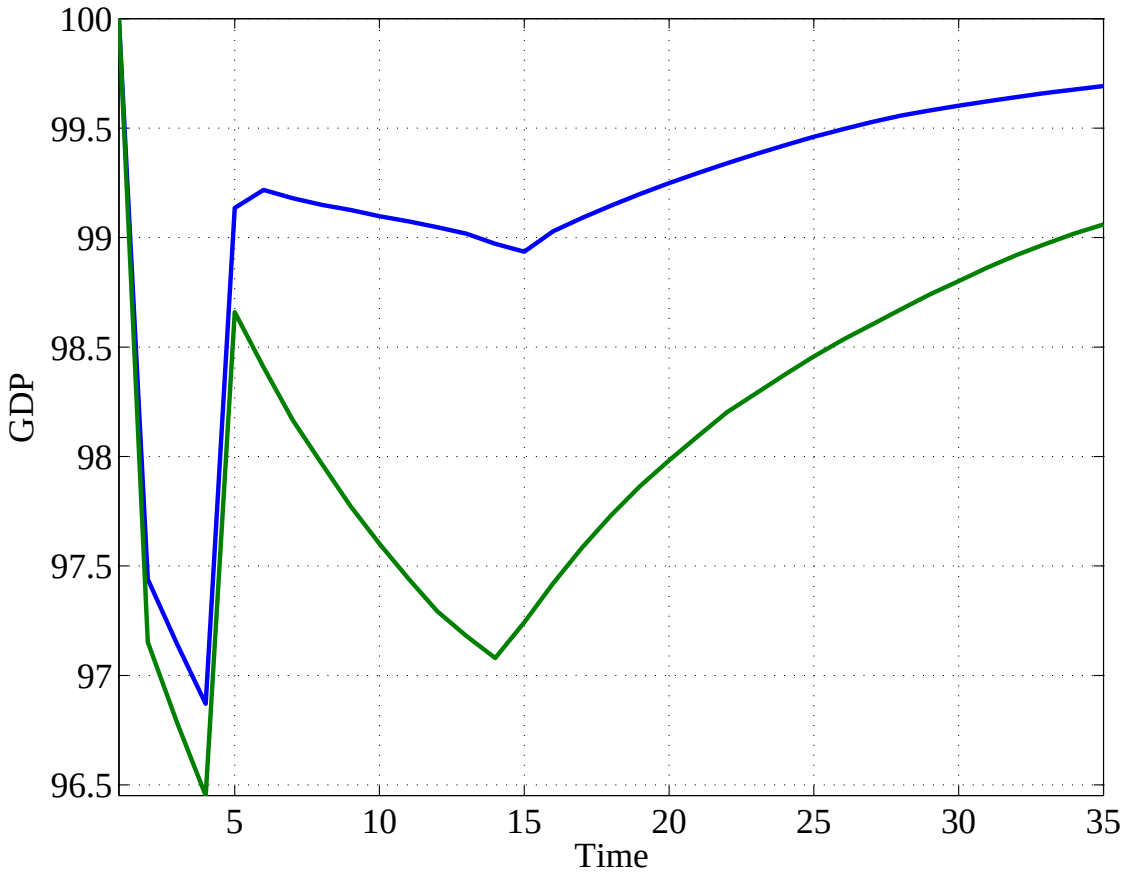
- Our shock hits ϕ_t...
- but it also endogenously tightens borrowing limits!

Avg. Capital Employed by an Entrepreneur, PE, g adjusts



Endogenous borrowing constraints (green), fixed borrowing limits (blue), SS=100

GDP, GE with τ adjusting

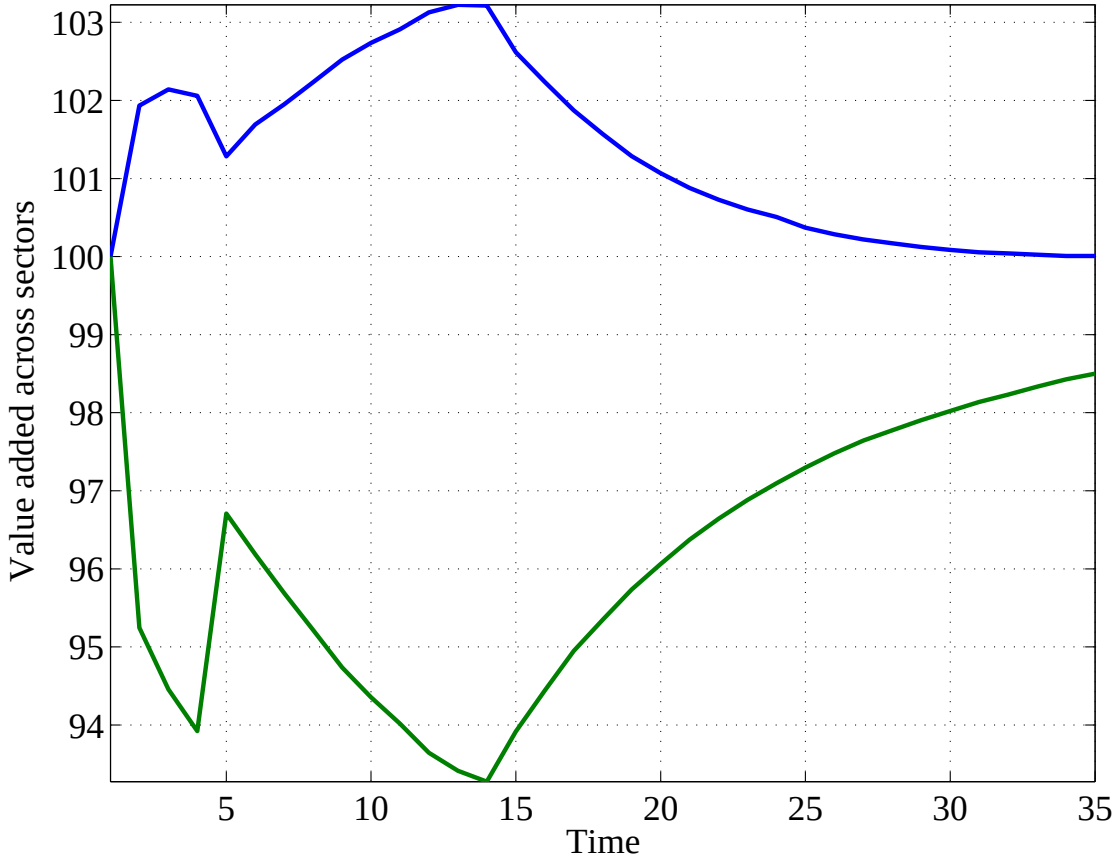


Endogenous borrowing constraints (green), fixed borrowing limits (blue), SS=100

Second Experiment

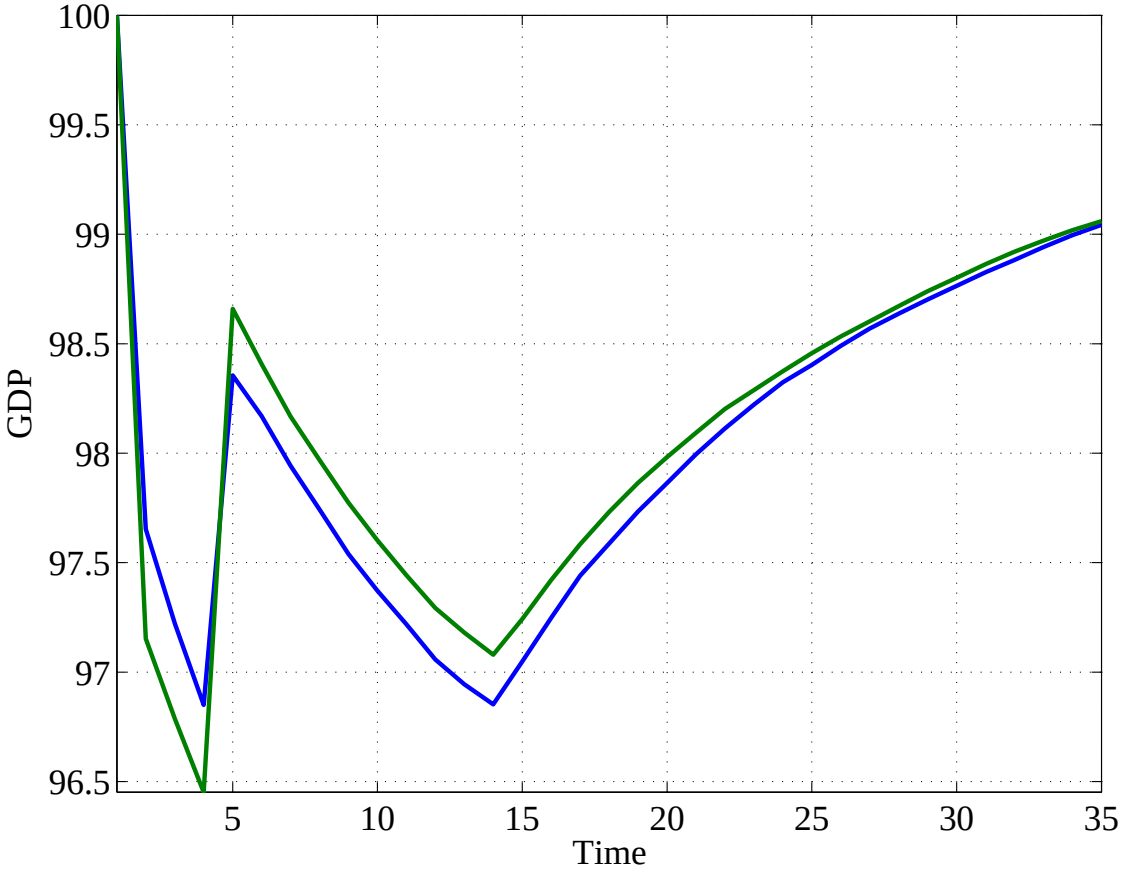
- Timing as first experiment
- ξ_t varies so as to shield corporate sector from shock
- This means $\xi_t \phi_t$ constant

GDP across sectors, GE, τ adjusts



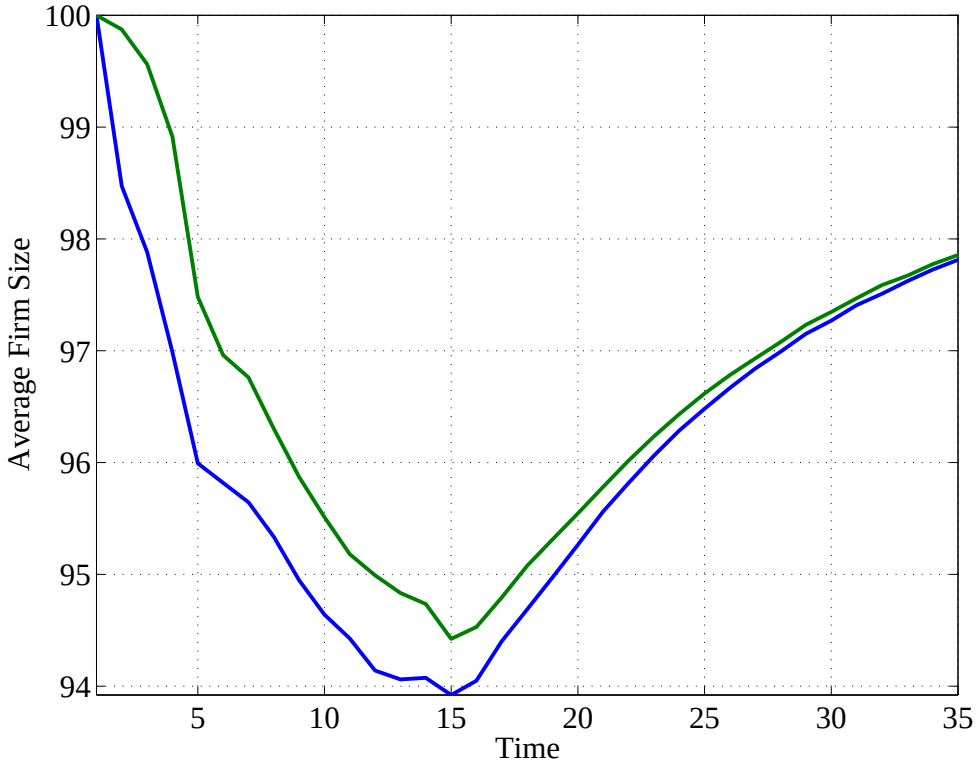
Entrepreneurial sector (green), corporate (blue), SS=100

GDP, GE, τ adjusts



Shock to ϕ (green), shock to ϕ and ξ (blue), SS=100

Avg. Capital Employed by an Entrepreneur, GE, τ adjusts

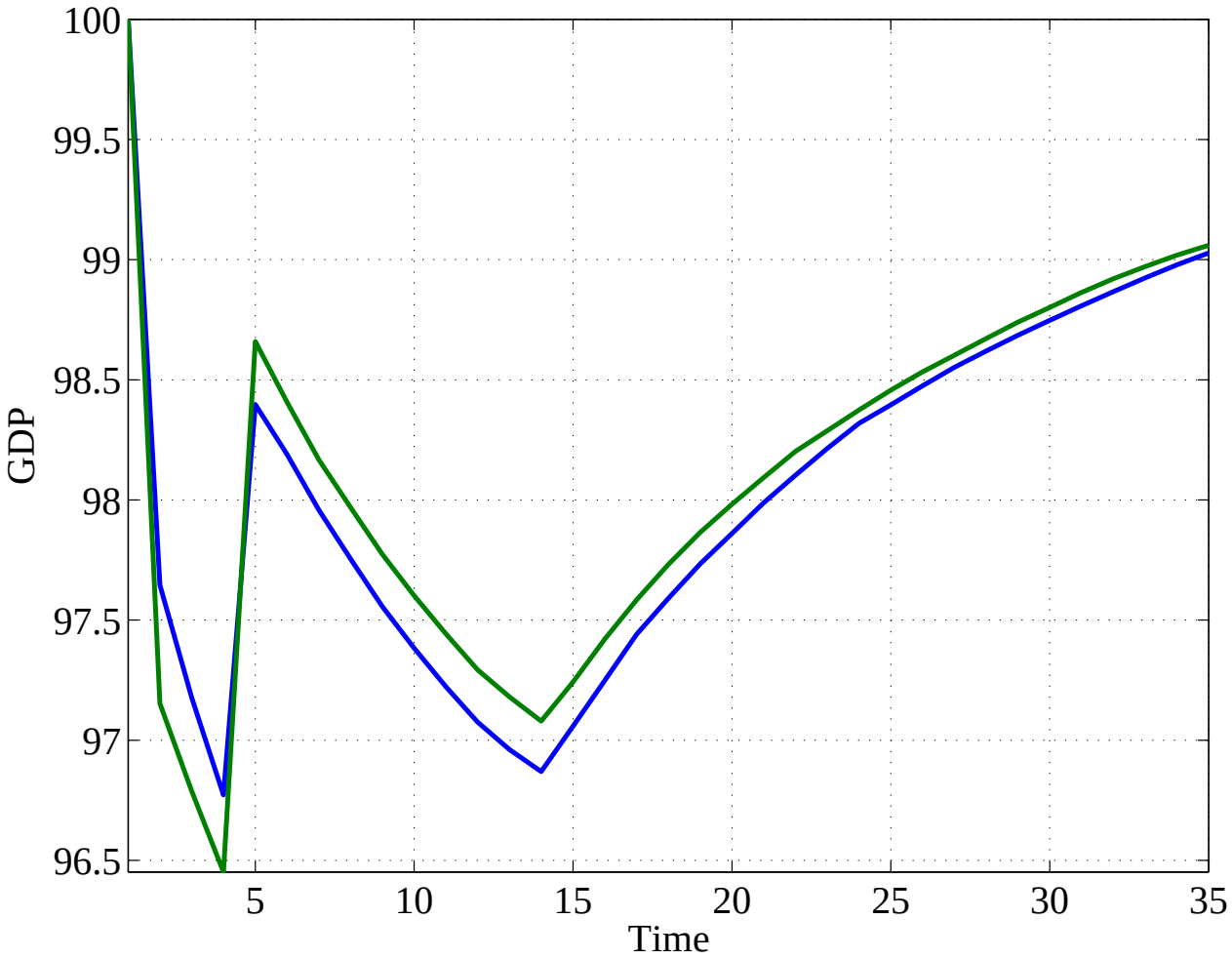


Shock to ϕ (green), shock to ϕ and ξ (blue), SS=100

Varying f

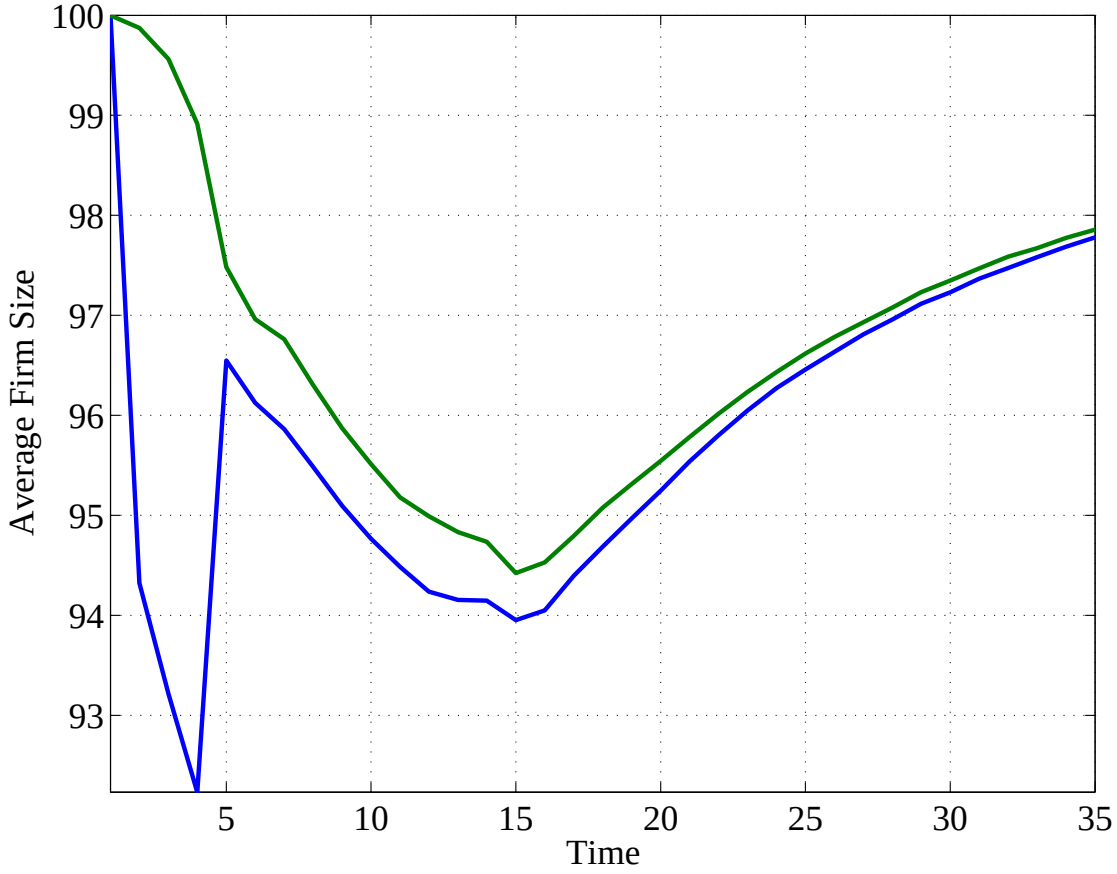
- Timing as first experiment
- f increases, tightening borrowing constraints for entrepreneurs only (from $f = 0.75$ to $f = 0.8$)
- Magnitude such that it roughly matches output in period 5 (after shock, before taxes)

GDP (full GE)



Shock to ϕ (green), shock to f (blue), SS=100

Avg. Capital Employed by an Entrepreneur (full GE)

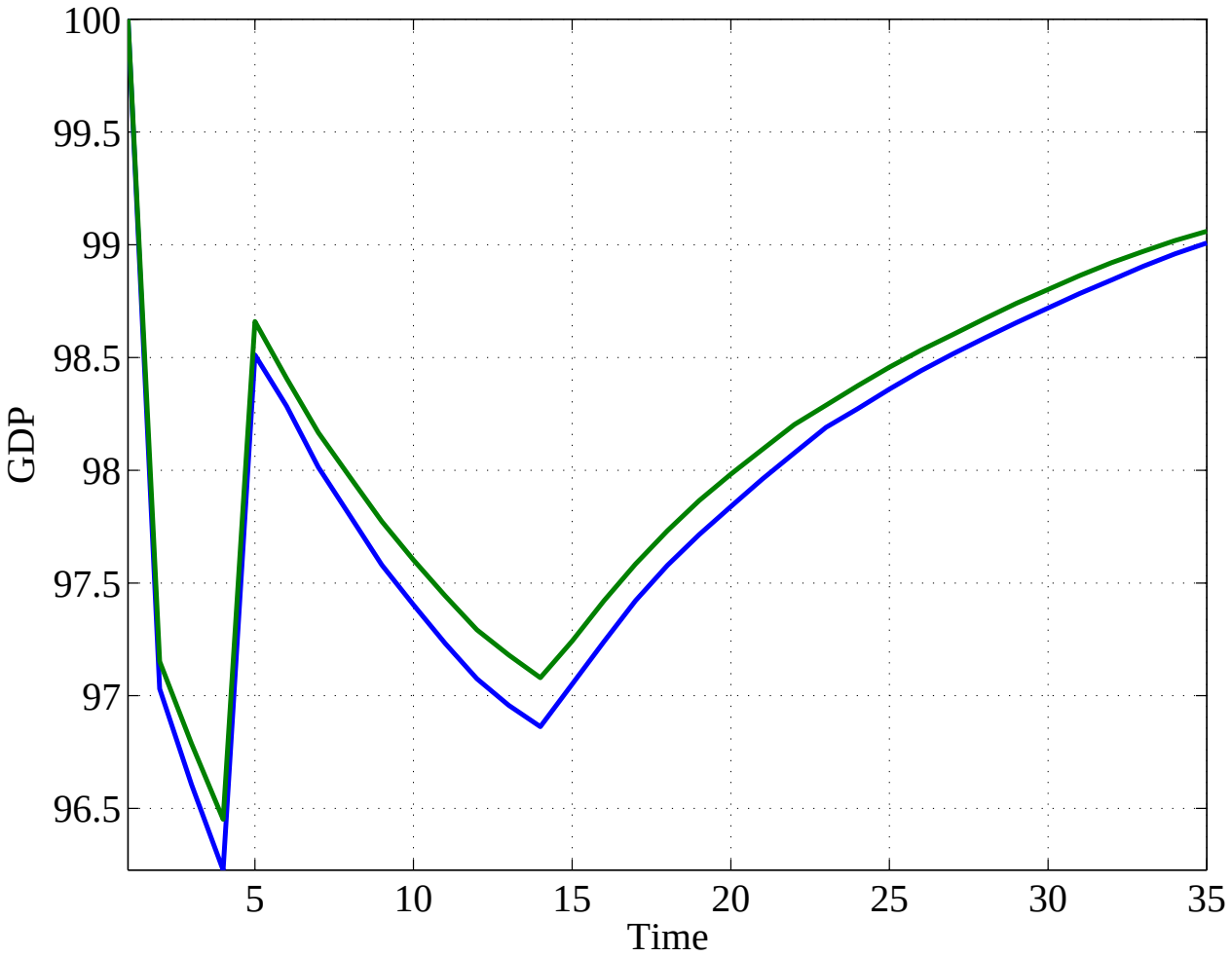


Shock to ϕ (green), shock to f (blue), SS=100

Varying TFP

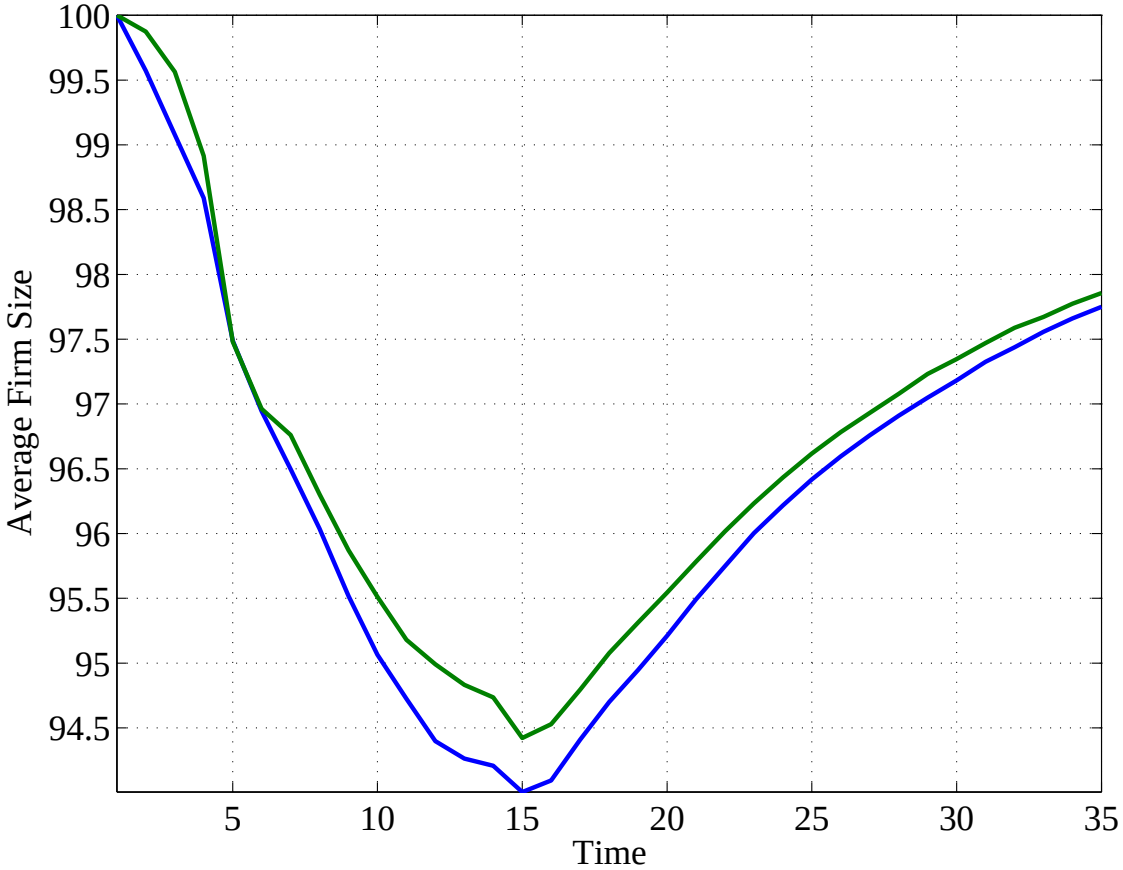
- Timing as first experiment
- TFP drops for three years

GDP, (full GE)



Shock to ϕ (green), shock to TFP (blue), SS=100

Avg. Capital Employed by an Entrepreneur, full GE



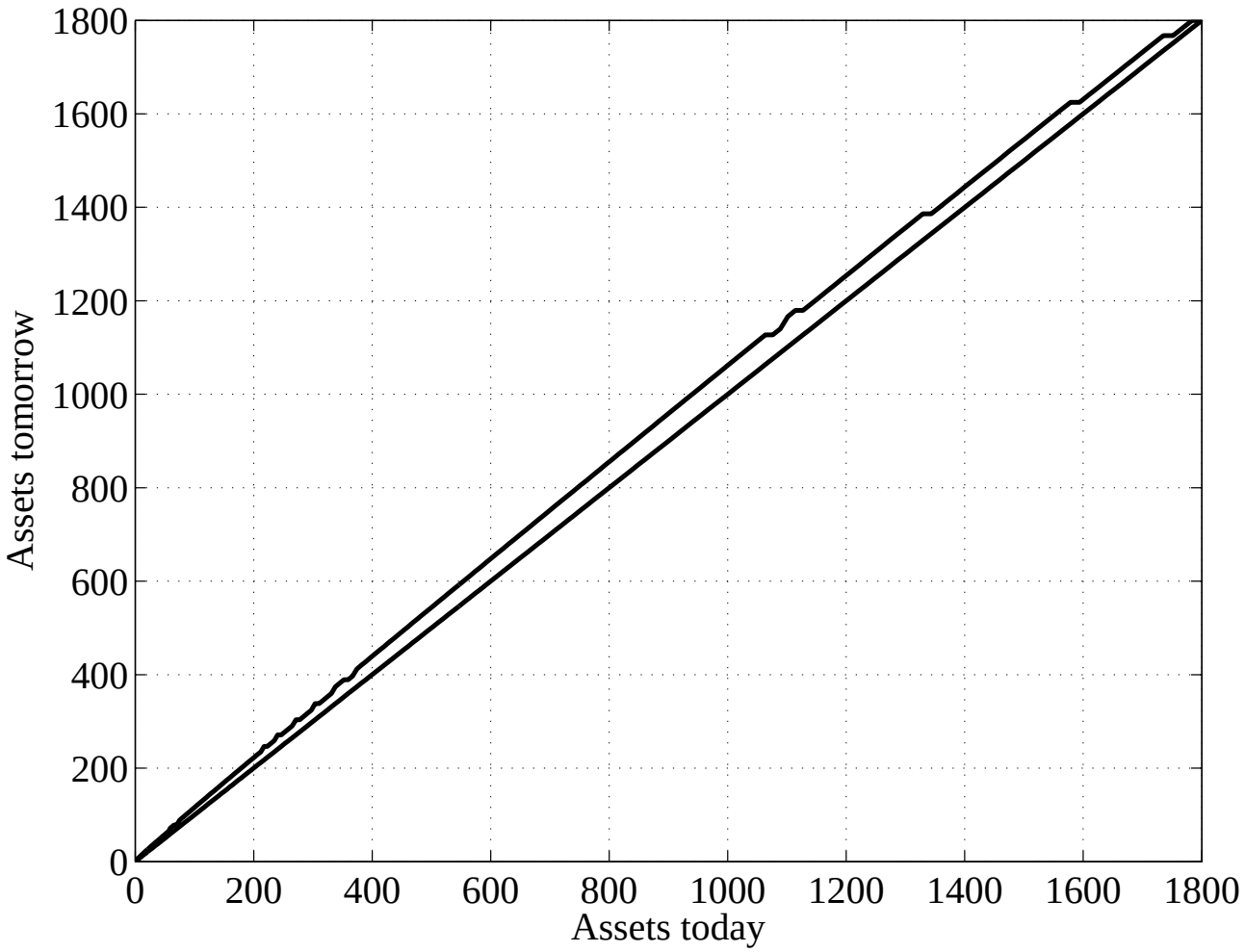
Shock to ϕ (green), shock to TFP (blue), SS=100

Conclusion

- Recessions starve small entrepreneurs of funding
- Long-lasting echo
- When recessions cause tax increases, echo much more prolonged

Thank you!

Asset Accumulation by Potential Entrepreneurs



Back to main talk

Old Household Problem: Value function

Option to continue existing firm:

$$W_t(a_t, \theta_t) = \max\{W_t^e(a_t, \theta_t), W_t^r(a_t)\},$$

Value function of entrepreneur:

$$W_t^e(a_t, \theta_t) = \max_{c_t, k_t, n_t, a_{t+1}} \{u(c_t) + \beta \pi_o E_t W_{t+1}(a_{t+1}, \theta_{t+1}) + \beta(1 - \pi_o) E_t V_{t+1}(a_{t+1}^n, y_{t+1}, \theta_{t+1})\}$$

Value function of retiree:

$$W_t^r(a_t) = \max_{c_t, a_{t+1}} \{u(c_t) + \beta \pi_o W_{t+1}^r(a_{t+1}) + \beta(1 - \pi_o) E_t V_{t+1}(a_{t+1}^n, y_{t+1}, \theta_{t+1})\}$$

Old Household Problem: Constraints

Gross income as entrepreneur (same as before):

$$Y_t^e = \theta(k_t^\gamma(1+n_t)^{(1-\gamma)})^\nu - \delta k_t - (k_t - a_t)(r_t I_{k_t > a_t} + i_t I_{k_t < a_t}) - w_t n_t;$$

Gross income as retiree:

$$Y_t^r = p_t + i_t\, a_t;$$

Asset evolution (same as before):

$$a_{t+1} = Y_t^i - T_t^i(Y_t^i) + a_t - (1+\tau_t^c)c_t, \quad i = e, r;$$

Credit limit

$$u(c_t) + \beta\pi_o E_t W_{t+1}(a_{t+1}, \theta_{t+1}) + \\ \beta(1-\pi_o)E_t V_{t+1}(a_{t+1}^n, y_{t+1}, \theta_{t+1}) \geq W_t^r(f \cdot k_t).$$

nonnegativity constraints $a_t \geq 0$, $k_t \geq 0$, $n_t \geq 0$.

Back to value function of the young

Corporate sector: Optimization Problem

Firm owns its capital and can use some retained earnings:

$$J_t(A_t^C) = \max_{K_t^C, L_t^C, B_t, A_{t+1}^C} F(K_t^C, L_t^C) + (A_t^C + B_t - K_t^C)(1 + i_t) -$$
$$w_t L_t^C - (1 + r_t) B_t - \delta K_t^C - A_{t+1}^C + \frac{1}{1 + i_{t+1}} J_{t+1}(A_{t+1}^C),$$

subject to

$$K_t^C \leq A_t^C + B_t$$

and minimum external financing

$$B_t \geq \xi_t K_t^C.$$

Back to main talk

Preferences, Technology, and Demographics

σ	1.5	Attanasio et al (1999)
δ	.06	Stokey and Rebelo (1995)
α	.33	Gollin (2002)
ϕ	.015	Baa-Treasury spread
ξ	.33	Flow of funds
π_y	.98	average working life: 45 years
π_o	.91	average retirement life: 11 years

Back to main talk

Labor-Income Process and Social Security Payments

- 5 income states;
- Tauchen-Hussey approximation to AR(1) with autocorrelation .95 (Huggett, 1996, Lillard et al., 1978);
- Replacement ratio: 40% of avg. income (Kolitkoff et al., 1999)

Public expenditure, government debt, and taxes

- Govt spending/GDP: 18.7% (NIPA)
- Govt debt: so that SS interest payments are 3% of GDP (Altig et al., 2001)
- Consumption tax: 11% (Altig et al., 2001)
- Marginal income taxes for workers (income in $25,000):

$$T'(Y) = 0.32[1 - (.22Y^{.76} + 1)^{-1/.76}] + \tau^y$$

  Marginal income taxes for entrepreneurs:

$$T'(Y) = 0.26[1 - (.42Y^{1.4} + 1)^{-1/1.4}] + \tau^y$$

  (Functional form: Gouveia and Strauss, 1994; parameter estimates: Cagetti and De Nardi, 2009)
- τ^y adjusted to meet govt budget constraint: $\approx 1\%$

Back to main talk

Target Moments (complete)

Target Moment	Target	Model
Capital-output ratio	2.9-3.0	3.0
% Entrepreneurs	7.5-7.6	7.7
% Exiting Entrepreneurs	22.0-24.0	22.4
% Workers Entering Entrepreneurship	2.0-3.0	2.4
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% People at Zero Wealth	7-13	11.9
% Entrepreneurs Hiring on the Labor Market	57.4-64.6	58.8
Revenue from Estate Taxes (% of GDP)	0.2-0.3	0.27
% Estates Paying Estate Taxes	1.5-2.0	1.9

Back to main talk

Remaining Parameters to Match Target Moments

- Discount factor: $\beta = 0.91$
- Entrepreneurial talent levels: $\theta \in \{0, 1.16\}$
- Prob. of switching from low to high: 2.3%
- Prob. of switching from high to low: 22%
- Decreasing returns limits to span of control: $\nu = 0.88$
- Returns to capital in the entrepreneurial sector: $\gamma = 0.80$
- Fraction of working capital that can be absconded: $f = 0.75$
- Tax on bequests: 16% above $ 5.4 Million

Back to main talk

Outcomes of the model not matched by construction

- Fit the distribution of wealth for both workers and entrepreneurs very well.
- Match that about 50% of total capital is invested in the entr. sector.
- About 35% of efficiency units of labor employed in the entr. sector (data: 50% of bodies)

Labor hiring	25%	50%	75%	90%	95%
SCF, # workers	0	1	5	18	49
Model, efficiency units	0	0.4	2.9	8.8	16

Table: Workers hiring in the SCF data and in the model.

Levels of efficiency for each worker in the economy: $[0.25, 0.44, 0.77, 1.31, 2.37]$

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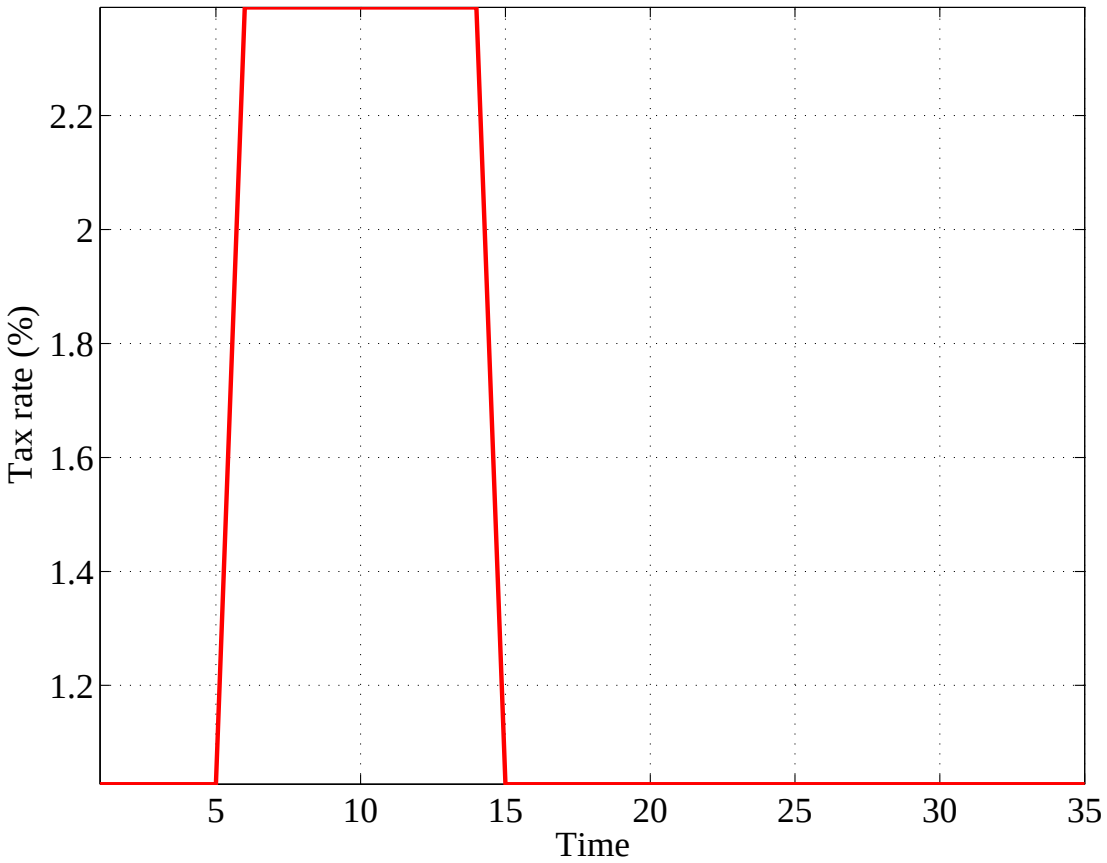
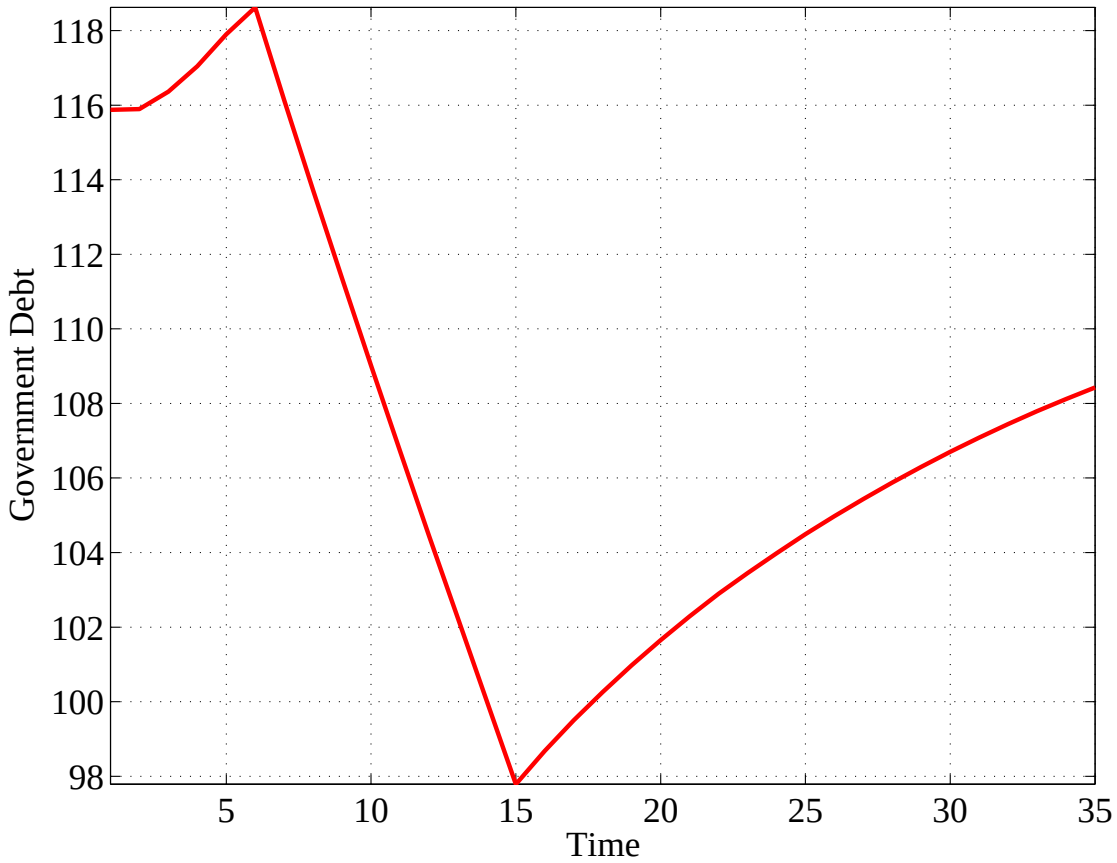
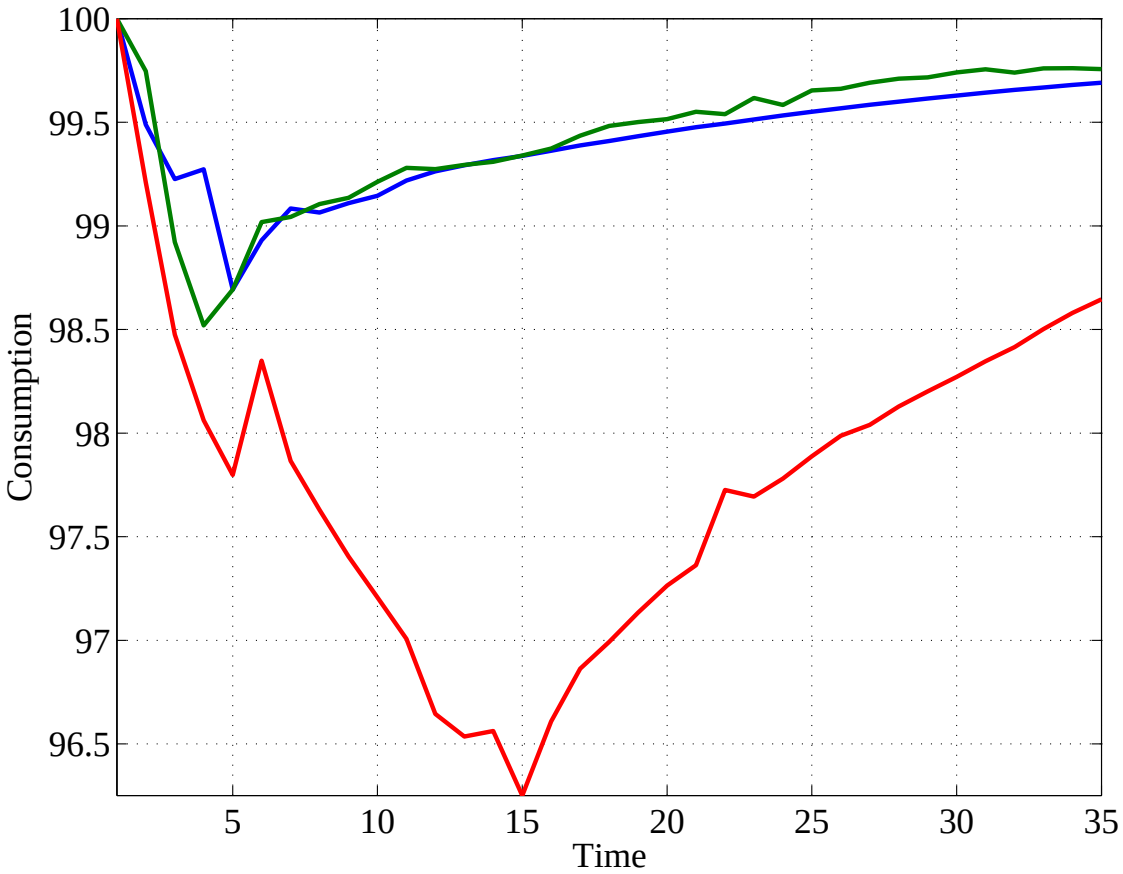
Adjusting the Tax Rate (GE)



Government Debt (GE)

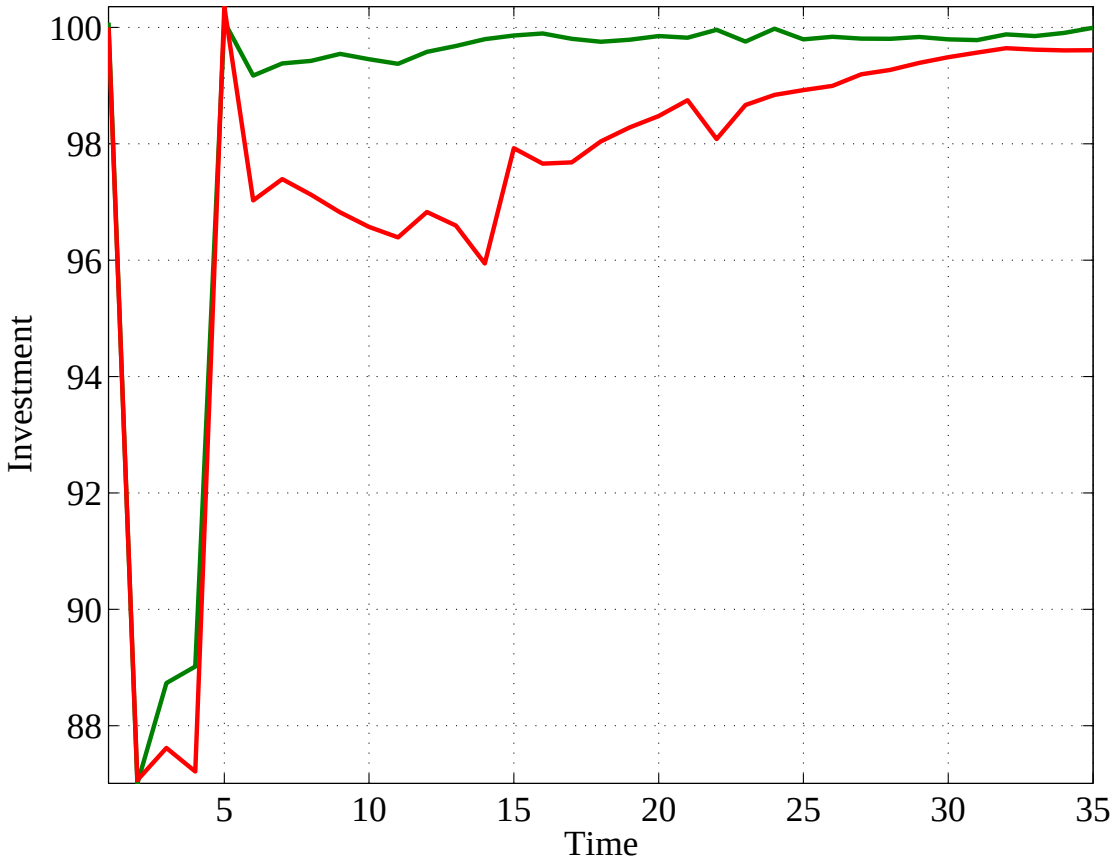


Aggregate Consumption of Goods



PE with g adjusting (blue), GE with g adjusting (green), GE with τ adjusting (red), SS=100

Aggregate Investment



GE with g adjusting (green), GE with τ adjusting (red), SS=100

Go to exogenous borrowing constraints