The Power of Forward Guidance Revisited

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November 2015

FORWARD GUIDANCE

- Guiding expectations about future evolution of policy is key part of modern central banking (even before ZLB!)
- Examples from FOMC statements:
  - 2003-04: "considerable period"
  - 2004-05: "pace that is likely to be measured"
  - 2008-09: "some time"; "an extended period".
  - 2011-12: "mid 2013"; "late 2014"; "mid 2015".
  - Dec 2012: while U above 6.5%, π below 2.5%, $E\pi$ anchored
  - 2014-15: "considerable time", "patient"
- Most news about future evolution of fed fund rate (Gurkaynak-Sack-Swanson 05, Campbell et al. 12)

FORWARD GUIDANCE IN STANDARD MODELS

- Far future forward guidance has immense effects on current outcomes
  - Eggertsson-Woodford 03: Modest far future forward guidance can eliminate huge recession at ZLB
  - Carlstrom-Fuerst-Paustian 12: Standard monetary models “blow up” when interest rates are held low for about 2 years
- Del Negro-Giannoni-Patterson 13 call this “forward guidance puzzle”

WHAT WE DO

- Power of forward guidance highly sensitive to complete markets
  - Model with uninsurable income risk and borrowing constraints (i.e., Aiyagari type model)
  - The output effect of real rate shock at a 5-year horizon is 40% of the complete markets benchmark
  - Forward guidance less effective at eliminating recession at ZLB

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What We Do

- Power of forward guidance highly sensitive to complete markets
  - Model with uninsurable income risk and borrowing constraints (i.e., Aiyagari type model)
  - The output effect of real rate shock at a 5-year horizon is 40% of the complete markets benchmark
  - Forward guidance less effective at eliminating recession at ZLB
  - Two crucial issues: precautionary savings motive and possibility of hitting a borrowing constraint
- Extension with aggregate shocks
  - Market incompleteness has important consequences for the business cycle in new Keynesian model.
  - Not true when prices are flexible (as in Krusell-Smith '98).

Why is forward guidance so powerful
in standard monetary models?

Why So Powerful?

- Textbook New Keynesian model:

$$x_t = E_t x_{t+1} - \sigma(i_t - E_t \pi_{t+1} - r_t^n)$$

$$\pi_t = \beta E_t \pi_{t+1} + \kappa x_t$$

Here x_t is output gap and π_t is inflation

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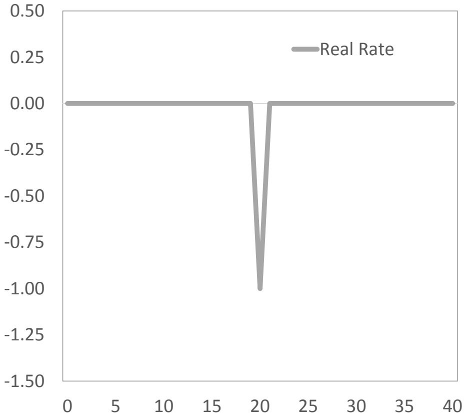
- Steady state absent monetary shocks:

$$E_t(i_{t+j} - E_{t+j}\pi_{t+j+1}) = E_t r_{t+j}^n$$

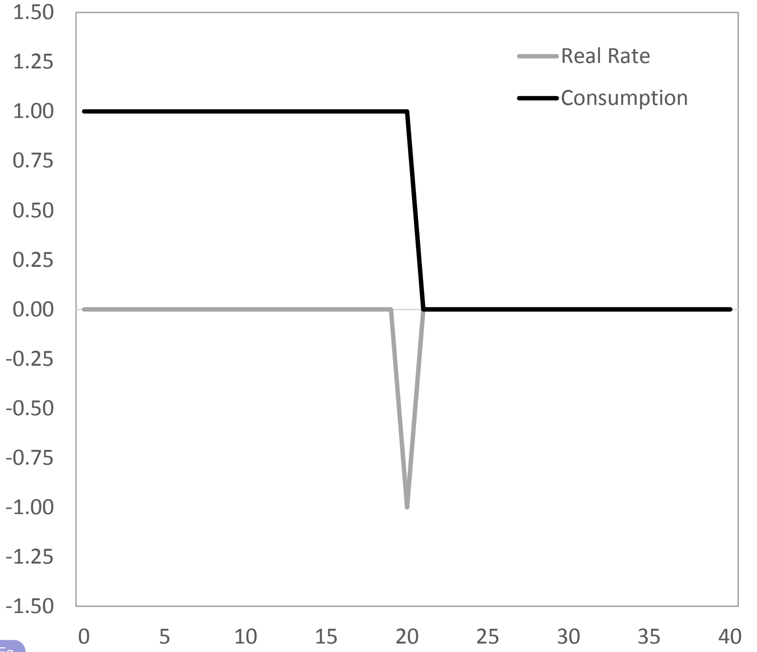
$$x_t = 0, \qquad \pi_t = 0$$

Illustrative Experiment

- Suppose central bank promises to lower real rates by 1% for 1 quarter 5 years from now



- How do consumers react in standard model? (assuming $\sigma = 1$)


Real Rate
Consumption
1.50
1.25
1.00
0.75
0.50
0.25
0.00
-0.25
-0.50
-0.75
-1.00
-1.25
-1.50
0
5
10
15
20
25
30
35
40

Partial Eq

RESPONSE OF CONSUMPTION

- Raise consumption today by 1% and keep it high for 5 years
- Solve forward Euler equation:

$$x_t = -\sum_{j=0}^{\infty} E_t(i_{t+j} - E_{t+j}\pi_{t+j+1} - r^n_{t+j})$$

- Undiscounted sum of future interest rate gaps
- Response is large in that it lasts for a long time (large integral)

Response of Inflation

- How does this affect inflation?
- Solve Phillips curve forward:

$$\pi_t = \kappa \sum_{j=0}^{\infty} \beta^j E_t x_{t+j}$$

- Entire integral of change in expected output (with some discounting) feeds into inflation immediately
- Contemporaneous response gets bigger and bigger the further out in the future the forward guidance
- At ZLB, inflation change feeds back onto real rates.

▸ Figure

Is Consumption Response Realistic?

Response of c_t to r_t the same as response of c_t to $E_t r_{t+40}$

- Is this realistic?

IS CONSUMPTION RESPONSE REALISTIC?

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  - Planning horizon shortened by possibility of hitting constraint
  - Precautionary motive for saving rises as buffer stock falls

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Motives for Saving:

1. Intertemporal substitution motive
   - Lower interest rate, less savings
2. Precautionary motive
   - Lower assets raise precautionary benefits of savings
   - Planning horizon effectively shorter due to risk of hitting constraint

Incomplete markets model

INCOMPLETE MARKETS MODEL: HOUSEHOLDS

Households maximize:

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left[\frac{c_{it}^{1-\gamma}}{1-\gamma} - \frac{\ell_{it}^{1+\psi}}{1+\psi} \right]$$

subject to:

$$\frac{b_{it+1}}{1+r_t} + c_{it} = b_{it} + w_t z_{it} \ell_{it} - \tau_t(z_{it}) + d_t,$$

$$b_{it} \geq 0$$

- Stochastic individual productivity z_{it} (finite state Markov process)
- Idiosyncratic income risk uninsurable (no state contingent assets)
- Save in risk-free real bond subject to debt limit $b_{it} \geq 0$

Incomplete Markets Model: Firms

- Final good production function

$$y_t = \left(\int_0^1 y_t(j)^{1/\mu} dj \right)^{\mu}$$

- Intermediate good production function

$$y_t(j) = N_t(j)$$

- Market for final good competitive
- Markets for intermediate goods monopolistically competitive with Calvo-style sticky prices
- Dividends distributed evenly to households

Incomplete Markets Model: Government

Fiscal authority:

- Fixed real value B of government debt outstanding
  (hence balanced budget)
- Taxes a function of productivity: $\tau_t \bar{\tau}(z_{it})$
  (only high productivity households pay taxes)

Monetary authority:

- Sets path for real interest rate

CALIBRATION

- Steady state annual interest rate equal to 2% ($\beta = 0.986$)
- CRRA = 2 ($\gamma = 2$)
- Frisch elasticity of labor supply equal to 0.5 ($\psi = 2$)
- Average markup of 20% ($\mu = 1.2$)
- 15% of price change per quarter ($\theta = 0.85$)

CALIBRATION

Productivity Process:

- Log productivity follows discretized AR(1)
- Parameters chosen to match estimates from Floden and Lindé (2001)
  - Quarterly persistence 0.966
  - Innovation variance 0.017

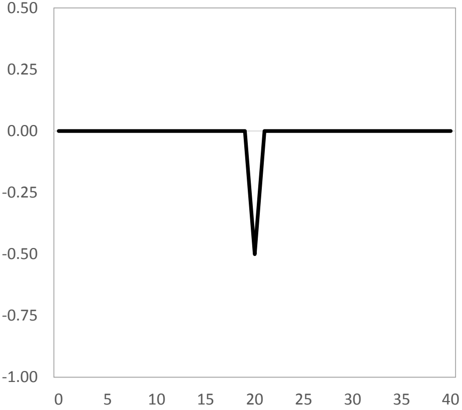
Assets in the economy:

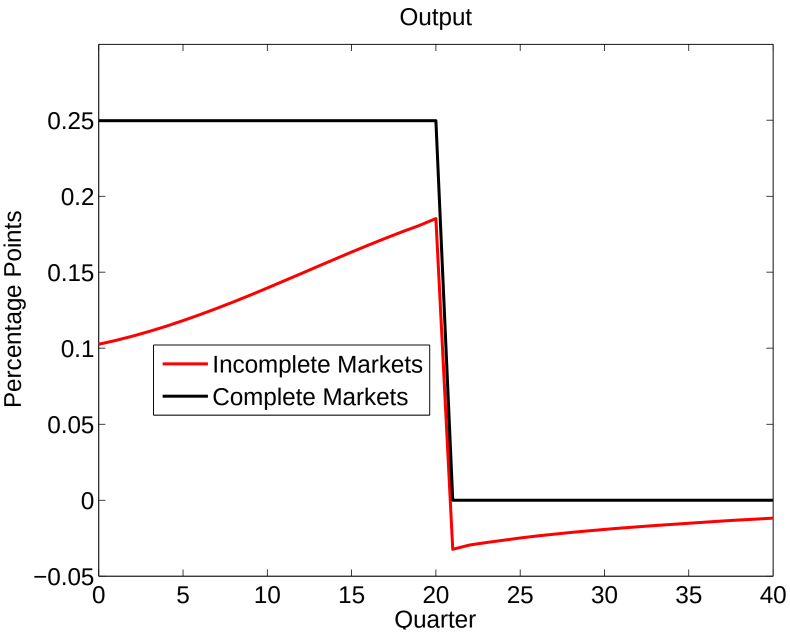
- Match ratio of liquid assets to annual GDP of 1.4 from Flow of Funds

POLICY EXPERIMENT

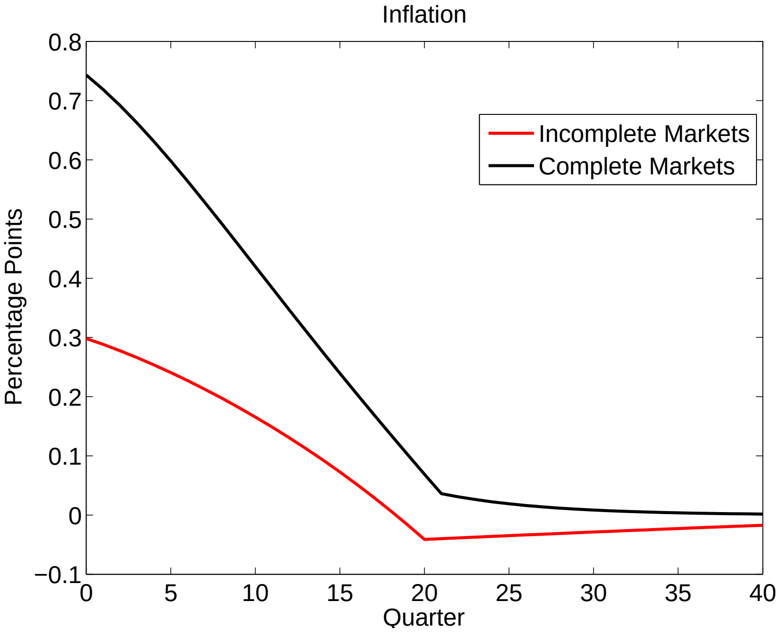
Monetary authority announces in quarter 0 that:

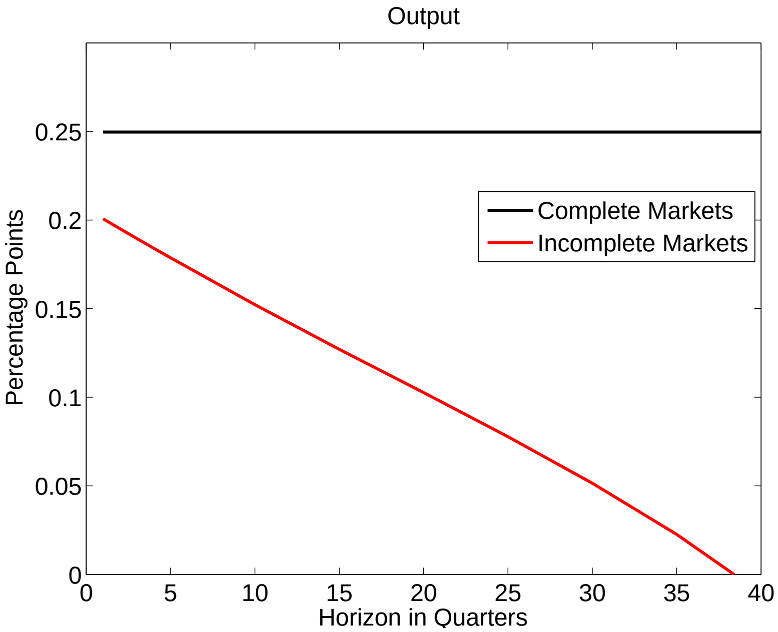
- Real interest rate in quarter 20 will be 50 bps lower
- Real rates at all other times unchanged

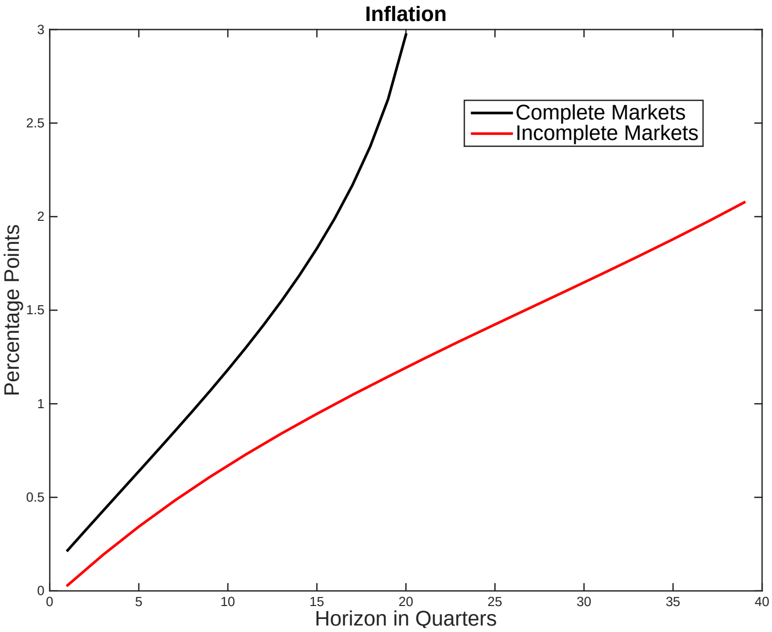




Redistribution


Inflation
Incomplete Markets
Complete Markets
Percentage Points
Quarter
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
−0.1
0
5
10
15
20
25
30
35
40


Output
0.25
0.2
0.15
0.1
0.05
0
Percentage Points
0
5
10
15
20
25
30
35
40
Horizon in Quarters
Complete Markets
Incomplete Markets


Inflation
Complete Markets
Incomplete Markets
Percentage Points
Horizon in Quarters
0
0.5
1
1.5
2
2.5
3
0
5
10
15
20
25
30
35
40

Alternative Calibrations

High Asset Case:

- Match ratio of total assets to annual GDP of 3.8 from Flow of Funds

High Risk Case:

- Guvenen et al. 14: variance of 5-year earnings growth rates is much larger than implied by our baseline calibration
  Model: 0.54, Data: 0.73.
- Increase the variance of individual productivity shocks from 0.017 to 0.033 to match this moment.

ALTERNATIVE CALIBRATIONS

TABLE 1
Power of 20 Quarter Ahead Forward Guidance

	Initial Responses of	
	Output	Inflation
Baseline	10.3	29.8
Higher Risk	4.8	23.8
Higher Assets	14.5	36.2
Higher Risk and Assets	11.6	33.8
Complete Markets	25.0	74.3

GENERAL EQUILIBRIUM EFFECTS

Countervailing force: general equilibrium increase in income mitigates the reduction in buffer stock when households raise consumption.

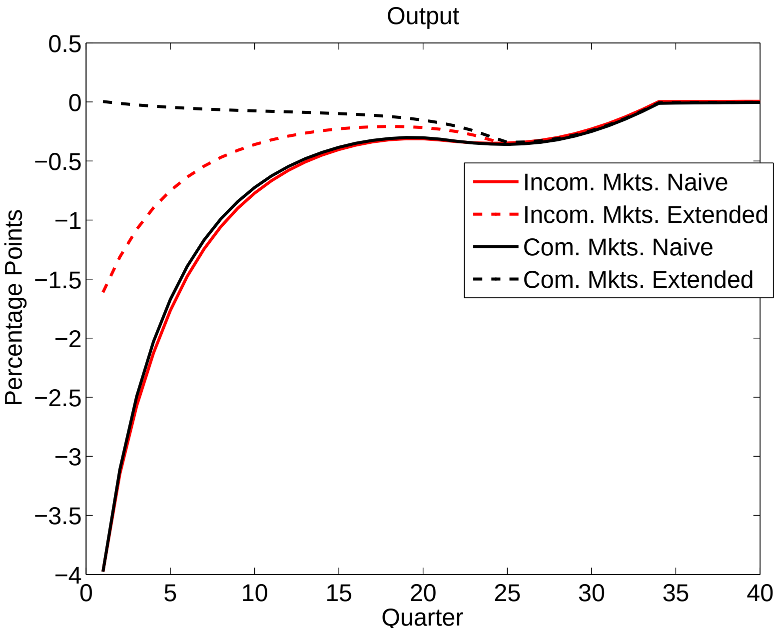
Three things that limit its strength in our setting:

- B/Y falls as Y rises
- High-skill households gain the most from increase in wages
  - Akin to redistribution towards low MPC households
- Wages multiply uninsurable productivity— $w_t z_{it} \ell_{it}$ —so risk rises with wage

Forward Guidance at ZLB

Experiment:

- Aggregate patience shock
- Calibrated to generate same initial effect on output (4%) in complete and incomplete markets model
- Compare naive vs. extended monetary policy
  - Naive: $i_t = \max[0, \bar{r} + \phi\pi_t], \phi = 1.5$
  - Extended: $i_t = 0$ for long enough to eliminate output gap under complete markets, then Taylor rule.


Output
0.5
0
−0.5
−1
−1.5
−2
−2.5
−3
−3.5
−4
Percentage Points
0
5
10
15
20
25
30
35
40
Quarter
Incom. Mkts. Naive
Incom. Mkts. Extended
Com. Mkts. Naive
Com. Mkts. Extended

Business Cycle Analysis

EXTENSION WITH AGGREGATE SHOCKS

- Krusell-Smith (1998): Heterogeneity and incomplete markets have little importance for business cycle dynamics
    - Is this the case in our setting?

Equations

Extension with aggregate shocks

- Krusell-Smith (1998): Heterogeneity and incomplete markets have little importance for business cycle dynamics
  - Is this the case in our setting?
- Key modifications
  - Additional shocks: TFP, markups, time-preference, nominal rates
  - More realistic business cycle features:
    - Real rigidity: Kimball demand so prices are strategic complements
    - Inflation inertia: Price indexation
    - Interest rate smoothing

Equations

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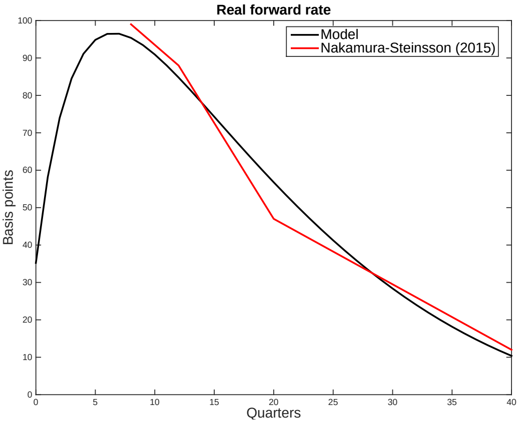
    - Interest rate smoothing
- Solve with Reiter (2009) method: representation of incomplete markets households that is linear in aggregate states

▸ Equations

Extended model calibration

- Interest rate smoothing and real rigidity calibrated to match inflation and real rate response to monetary shock as in Nakamura-Steinsson 15.



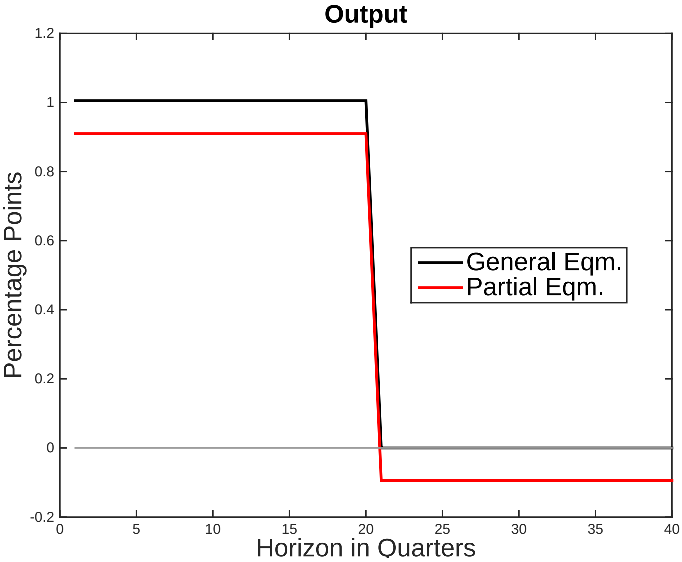
Volatility in Incomplete Markets Model
Relative to Complete Markets

	Output			
	Monetary	Pref.	Markup	Tech.
Baseline	0.62	0.78	0.64	1.21
Flexible prices	–	–	0.92	0.97

CONCLUSIONS

- In standard models, forward guidance is very powerful
- We present an incomplete markets model in which a precautionary savings effect counteracts the intertemporal substitution effect
- Power of forward guidance reduced considerably
- Market incompleteness can have important implications for business cycle dynamics when new Keynesian features incorporated

Partial equilibrium



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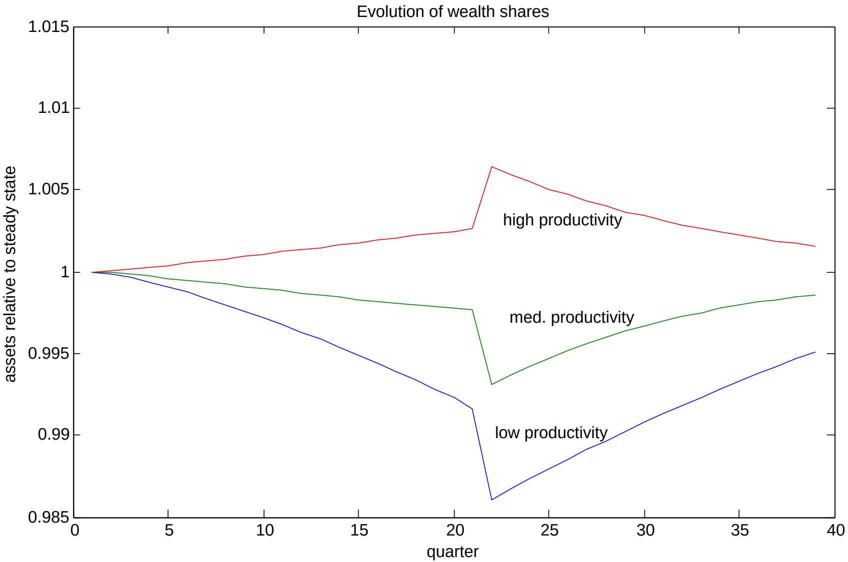
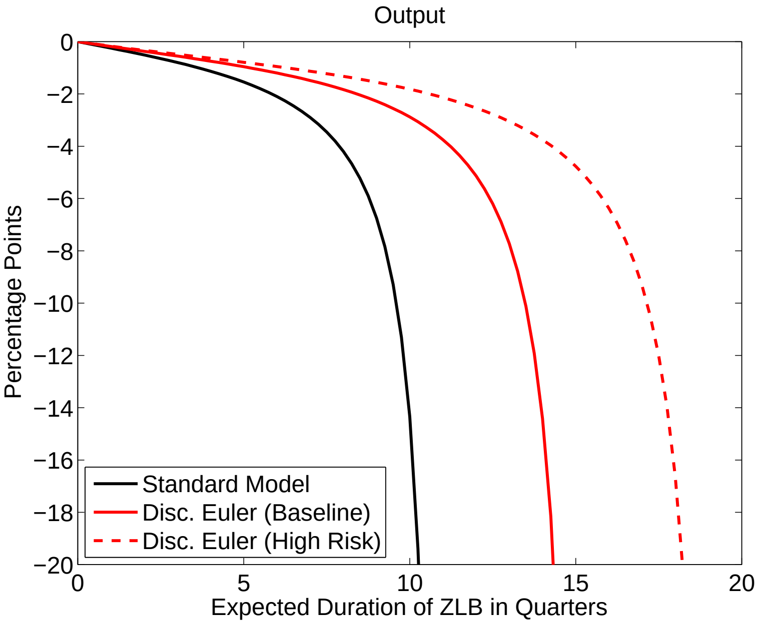


Evolution of wealth shares
1.015
1.01
1.005
1
0.995
0.99
0.985
assets relative to steady state
0
5
10
15
20
25
30
35
40
quarter
high productivity
med. productivity
low productivity

Back Back2



Output
0
−2
−4
−6
−8
−10
−12
−14
−16
−18
−20
Percentage Points
0
5
10
15
20
Expected Duration of ZLB in Quarters
Standard Model
Disc. Euler (Baseline)
Disc. Euler (High Risk)

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Extended model equations

$$\pi_t - \pi_{t-1} = \beta \mathbb{E}_t \left[\pi_{t+1} - \pi_t\right] + \kappa\xi\left(\hat{W}_t - \hat{A}_t\right) + \mu_t$$

$$\kappa = (\theta(1 - \beta(1 - \theta)))/(1 - \theta)$$

$$\xi = 1/(1 + \mu\Omega/(\mu - 1)$$

$$i_t = \rho_i i_{t-1} + (1 - \rho_i)(\bar{r} + \phi\pi_t) + \epsilon_t$$

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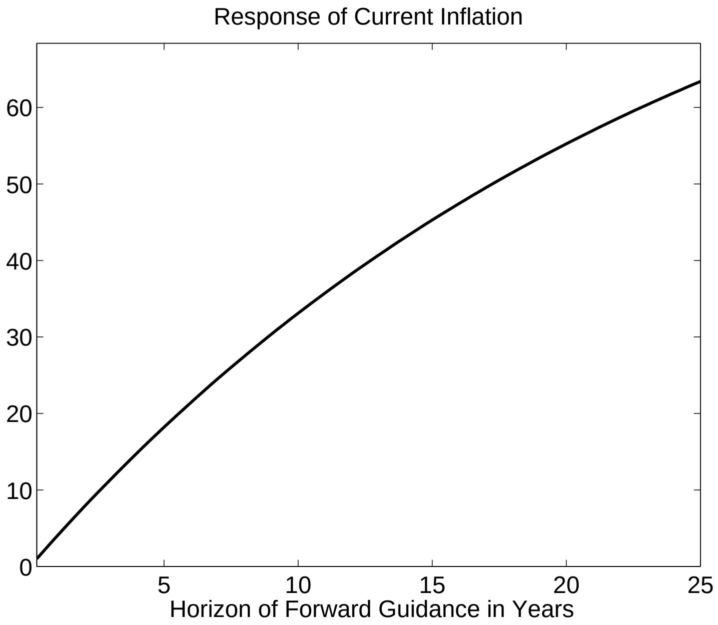

Response of Current Inflation
60
50
40
30
20
10
0
5
10
15
20
25
Horizon of Forward Guidance in Years

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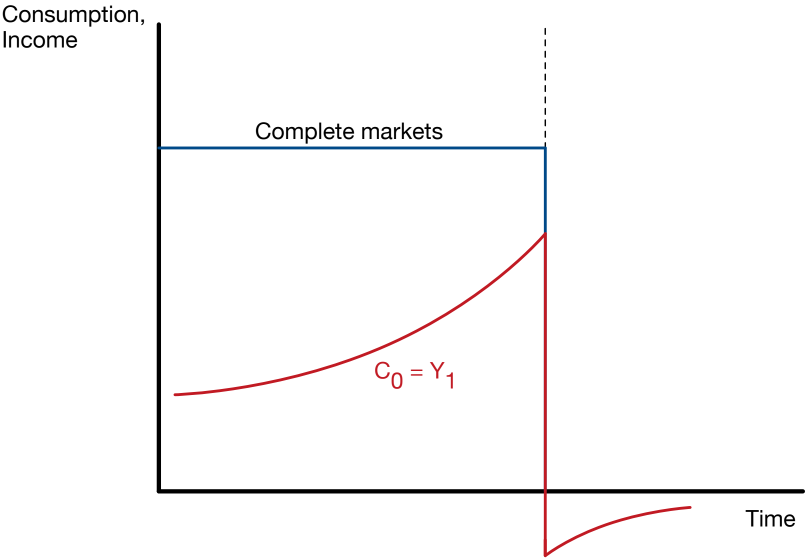
▸ Section 3 ▸ Section 5

General equilibrium effects



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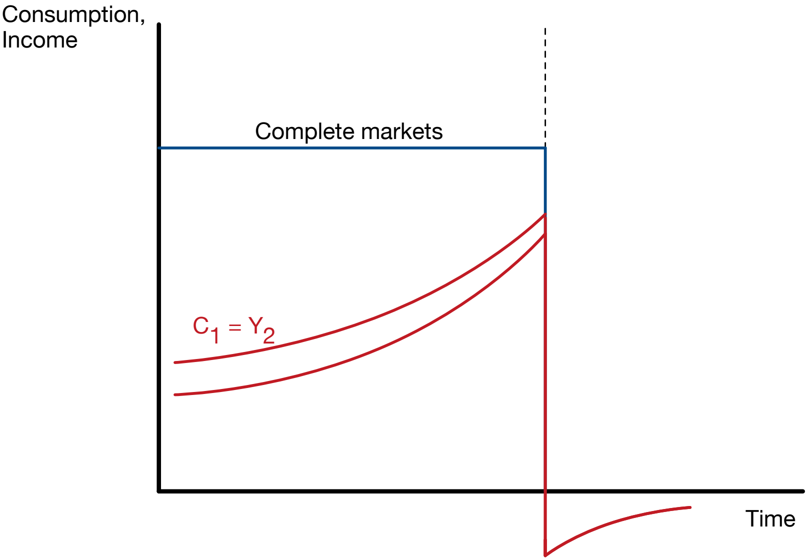
GENERAL EQUILIBRIUM EFFECTS



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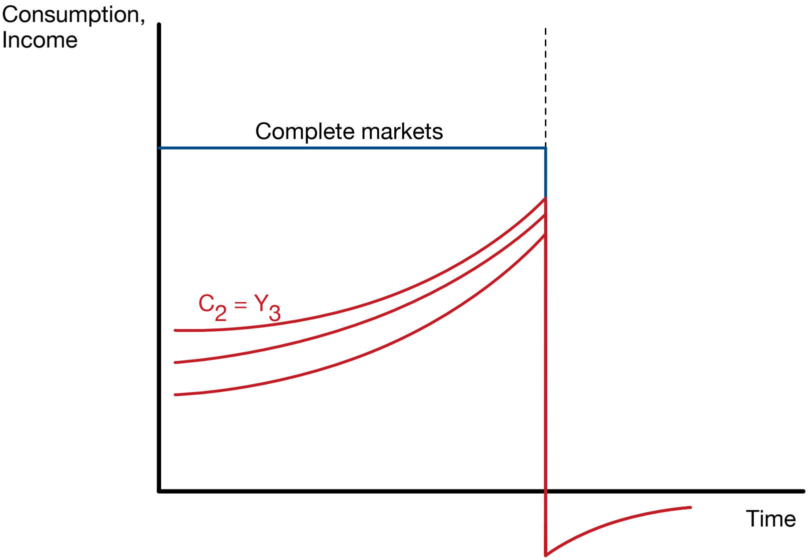

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