Multi-Dimensional Monetary Policy

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Monetary Policy Before the Crisis

- Common to view monetary policy as **uni-dimensional:**
  - a single policy decision (operating target for an **overnight interest rate**)

    — other aspects of policy (e.g., supply of reserves, interest rates paid on CB balances or at which CB lends) simply details of implementation

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    — other aspects of policy (e.g., supply of reserves, interest rates paid on CB balances or at which CB lends) simply details of implementation
  - with a single end in view: control of **nominal aggregate demand** (key to both price stability and more stable economic activity)

New Dimensions of Policy

- **New tools** of policy: much greater emphasis on **balance-sheet policy**
  - balance sheet size much larger than required simply to implement interest-rate policy, manage payments system
  - new tools for policy implementation (IOER, RRP facility at Fed) allow decoupling of balance-sheet size from interest-rate target

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- **New goals** as well: increased attention to possible consequences of monetary policy for **financial stability**

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1. Is QE just an alternative way of achieving the same thing as **cutting short-term interest rates**

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2. Does an increase in CB liabilities stimulate AD by **relaxing constraint on short-term debt issuance** by banks

   — so equivalent to relaxing reserve requirements, or other macro-prudential policy?

Goals

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- Model needs to include:
  - real effects of monetary policy
  - endogenous term premia
  - endogenous degree of financial fragility
  - conventional interest-rate policy, CB balance sheet, and restrictions on short-term debt finance by banks as alternative policy levers, the effects of which can be compared

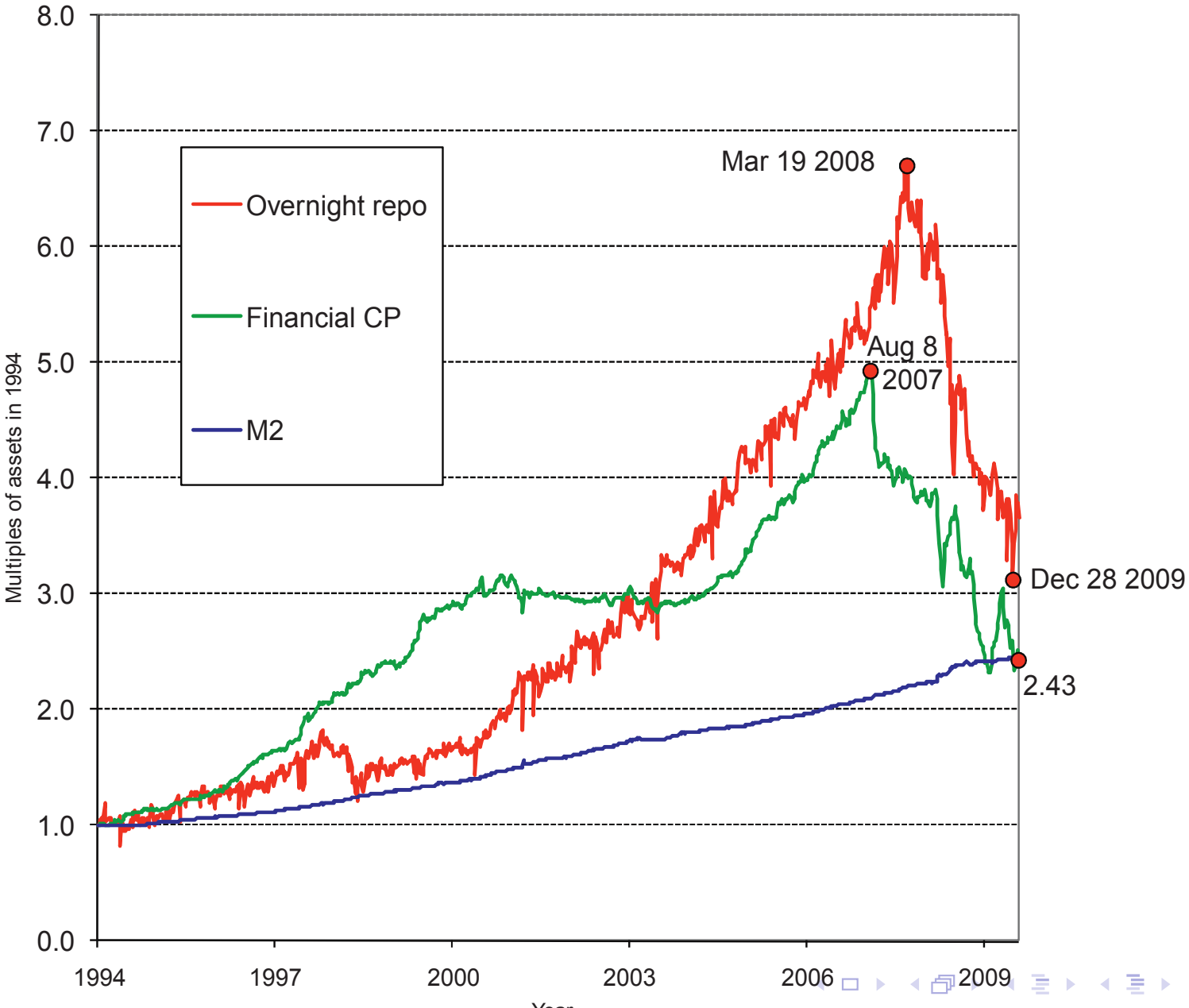
Modeling Approach

- Financial fragility: results from excessive reliance on **collateralized short-term debt** in capital structure of banks

  — recent crisis followed particular growth in importance of

  - overnight repo financing (investment banks)
  - asset-backed CP (SIVs)

Short-Term Liabilities (Adrian and Shin, 2010)



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  — recent crisis followed particular growth in importance of

  - overnight repo financing (investment banks)
  - asset-backed CP (SIVs)

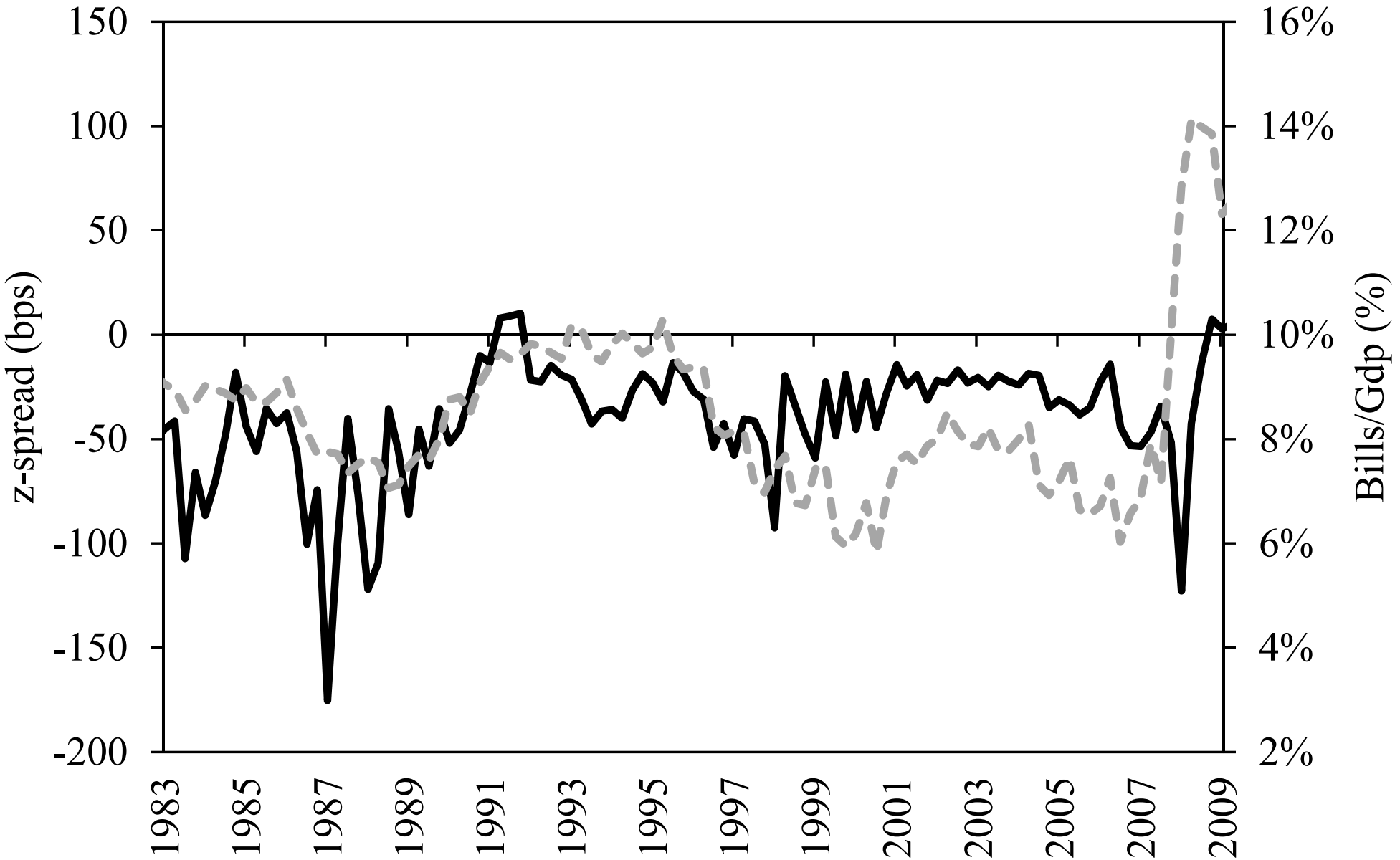
- This is dangerous, because it exposes banks to **funding risk,** which may require abrupt de-leveraging through a **"fire sale"** of assets

Modeling Approach

- Why fragile financial structures are tempting:

  — owing to shortage of alternative safe assets, investors will pay a premium for private liabilities with this feature **("money premium")** (Greenwood *et al.*, 2010; Krishnamurthy and Vissing-Jorgensen, 2012)

T-Bills and Money Premium (Greenwood *et al.*, 2016)



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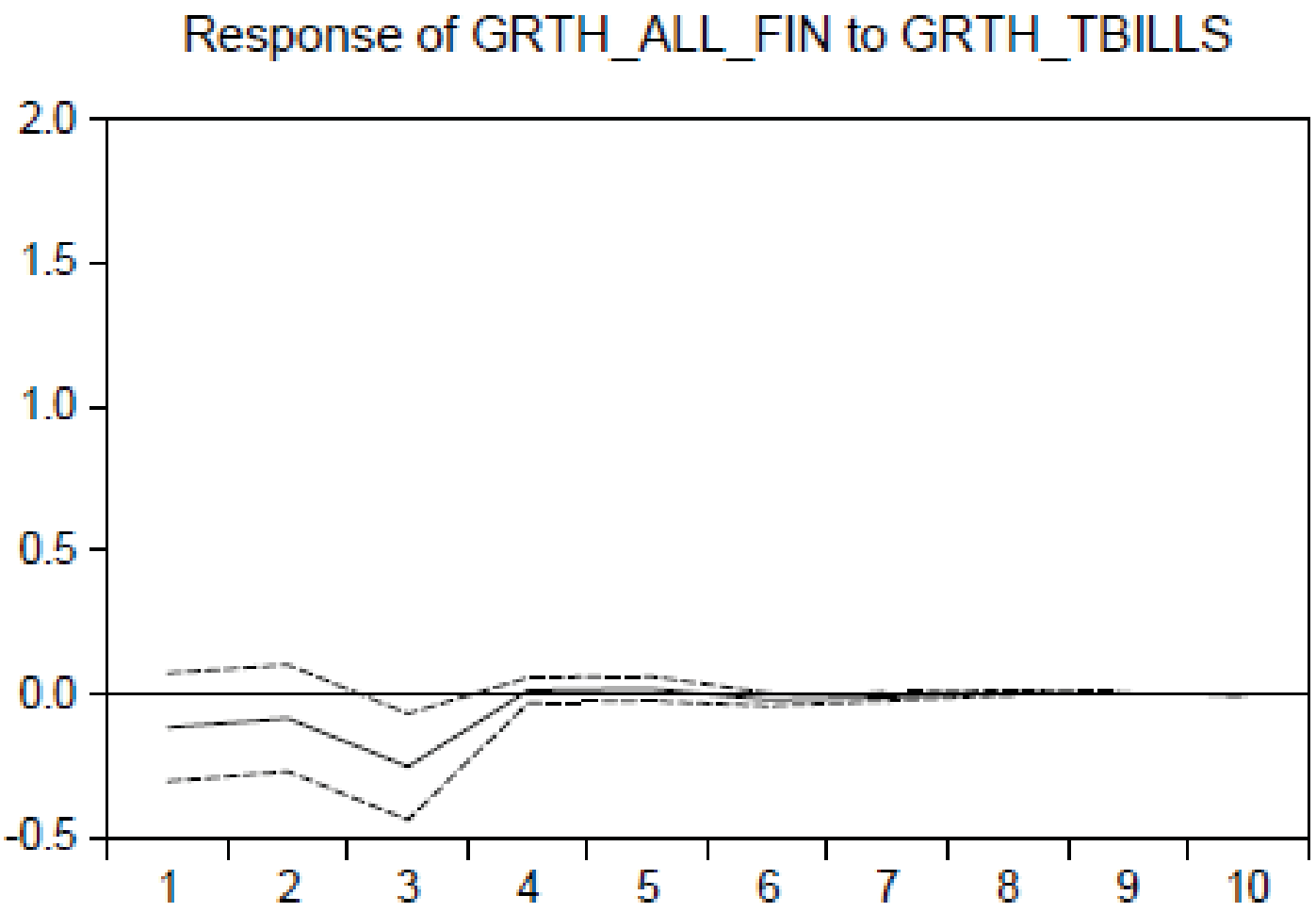
- But this means that **public supply** of safe assets should be an important determinant of the strength of such incentives

  — evidence: increased supply of T-bills reduces private issuance of CP (Carlson *et al.*, 2014)

Effect of Increased T-Bill Supply (Carlson *et al.*, 2014)



Modeling Approach

- **Funding risk** and possibility of "fire sale" of assets modeled as in Stein (2012)

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  — but embedded in an intertemporal monetary equilibrium model, in order to consider interaction with monetary policy

- **Demand for safe assets** modeled using a "cash-in-advance" structure as in Lucas and Stokey (1987)

  — but here interpret the "cash" that can be used to satisfy CIA constraint as interest-earning short-term safe instruments such as T-bills, CB liabilities (reserves, reverse repos), or asset-backed CP

Elements of the Model: Agents

- Infinite-lived representative household can be thought of as made up of several "members" with separate budgets within the period, though all funds pooled at end of each period:
  - "worker": supplies inputs used to produce all final goods; receives income available to household at end of period
  - "shopper": buys "regular" final goods [both "cash goods" and "credit goods"]; cash must be set aside earlier

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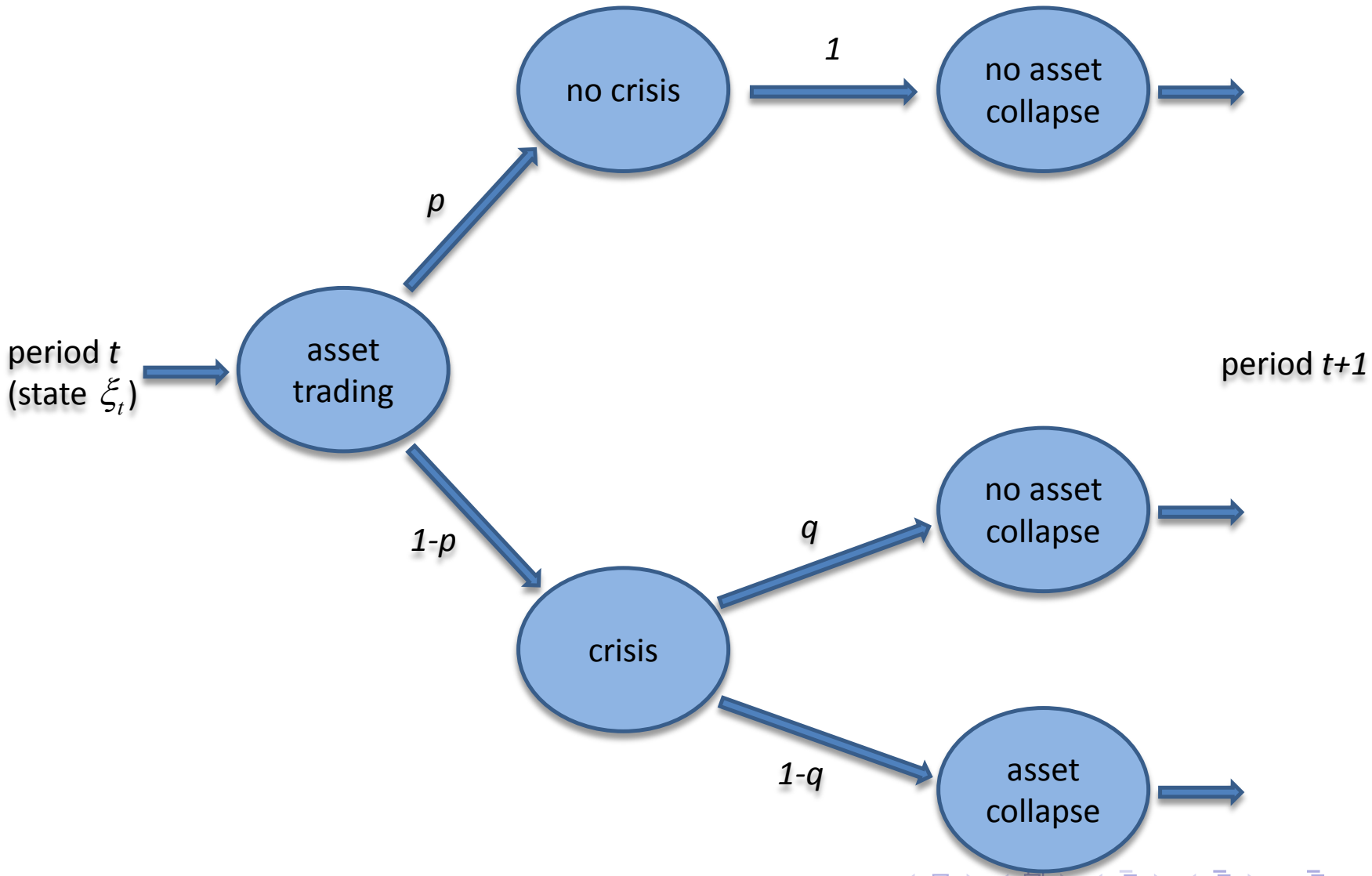
  - "shopper": buys "regular" final goods [both "cash goods" and "credit goods"]; cash must be set aside earlier
  - "investor": buys "special" final goods, using line of credit set up earlier in period; can also bid for risky durables in "fire sale"
  - "banker": buys risky durables, financed from equity investment by household and issuance of short-term debt

Resolution of Within-Period Uncertainty



Elements of the Model: Preferences

Preferences of the representative household:

$$E_t \sum_{\tau=t}^{\infty} \beta^{\tau-t} \left[u(c_{1\tau}, c_{2\tau}) + \tilde{u}(c_{3\tau}) + \gamma \underline{s}_\tau - v(Y_\tau) - w(x_\tau) \right]$$

where

$$\begin{aligned}
c_{1t} &= \text{consumption of ``cash goods''} \\
c_{2t} &= \text{consumption of ``credit goods''} \\
c_{3t} &= \text{consumption of ``special goods''} \\
\underline{s}_t &= \text{services from [intact] old durables} \\
Y_t &= \text{supply of ``normal goods''} \\
x_t &= \text{supply of ``special goods''}
\end{aligned}$$

Elements of the Model: Demand for Liquidity

- purchases of "cash goods" subject to a "cash-in-advance constraint" (as in Lucas-Stokey, 1987)

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- cash includes riskless nominal liabilities of the government (Treasury bills)

- can also be short-term debt issued by bankers, if **collateralized** to ensure completely riskless
  - but to be acceptable as cash, holders of debt must have right to **force liquidation** of the collateral, if necessary in order to ensure that banker can pay them in full

Elements of the Model: Banks

- A banker can purchase shares s_t of the risky asset, subject to budget constraint

$$Q_t s_t \leq equity_t + D_t$$

where Q_t = price of asset in initial period-t market,
D_t = issuance of short-term debt

Elements of the Model: Banks

- A banker can purchase shares s_t of the risky asset, subject to budget constraint

$$Q_t s_t \leq equity_t + \xi_t D_t$$

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- More generally: may suppose that only **fraction** $0 \leq \xi \leq 1$ of the funds raised by issuing collateralized debt can be used to purchase risky asset

— allows an instrument of **macro-prudential policy**

— could be implemented by a **reserve requirement,** if reserves satisfying the requirement earn a **below-market** rate

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where Q_t = price of asset in initial period-t market,
D_t = issuance of short-term debt

- Short-term debt can be marketed as riskless only if

$$D_t \leq \Gamma_t s_t,$$

where Γ_t = price of asset in event of fire sale

Elements of the Model: "Fire Sale" Distortions

- If crisis state occurs, banker must offer s_t^{*s} units of the durable for sale, sufficient to allow redemption of short-term debt:

$$D_t \leq \Gamma_t s_t^{*s} \leq \Gamma_t s_t$$

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- Each investor bids for s_t^{*d} units of the durables in the fire sale

- Investor's purchases of "special" goods must then satisfy

$$\tilde{P}_t c_{3t} + \eta_t \Gamma_t s_t^{*d} \leq F_t$$

where $\tilde{P}_t$ is price of special goods, η_t is crisis indicator, and credit limit F_t has been pre-determined in real terms

Elements of the Model: Supply of Durables

- Investment demand at end of period: household purchases I_t units of investment goods on credit, produces $F(I_t)$ units of new risky durables, which yield services in period $t+1$

  — durables produced in period $t-1$ depreciate completely at end of period t

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  - markets clear:

$$M_t = \tilde{M}_t + D_t$$

$$s_t = F(I_{t-1})$$

$$s_t^{*d} = s_t^{*s}$$

$$c_{1t} + c_{2t} + I_t = Y_t$$

$$c_{3t} = x_t$$

$\tilde{M}_t =$ **outside** supply of safe instruments: T-bills in hands of public + safe liabilities of CB

Dimensions of Monetary Policy

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[each of the above variables is set in subperiod 2 of period t]

Two Versions of the Model

- **Flexible-price model:** voluntary supply of "normal goods" by price-taking households, P_t (along with other prices) endogenously determined so as to ensure that

$$c_{1t} + c_{2t} + I_t = Y_t$$

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  — price P_t fixed at level that is **expected** to clear market as of end of period $t-1$, but may not ex post

  — other prices all determined in competitive spot markets

Stationary Equilibrium

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- Stationary values of **real** variables are independent of Π
- One-parameter family of stationary equilibria indexed by $\tilde{m}$

Stationary Equilibrium

- Greater scarcity of safe assets (lower $\tilde{m}$) implies
  - lower real return R^m/Π on cash
  - larger **"money premium"**
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  - greater **under-valuation** of durables in "fire sale"
  - greater under-production of special goods in crisis state

Lessons

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- Larger balance sheet **reduces long-run distortions** in each of 3 respects:
  - less under-production of cash goods (as share of nondurable normal goods)
  - less over-production of durables
  - less under-production of special goods in crisis state, less over-production in non-crisis state

Macroprudential Policy in the Long Run

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- Effects of tightening macro-pru policy (e.g., increasing reserve requirement) NOT equivalent to shrinking monetary liabilities of CB

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Macroprudential Policy in the Long Run

Effects of tightening macro-pru policy (for fixed $\tilde{m}$):

- In some ways, more similar to effects of **increasing** $\tilde{m}$:
  - reduced incentive for private issuance of safe instruments $\Rightarrow$ smaller fire-sale distortions
  - less undervaluation of durables in fire sale, less overvaluation at time of production
  - less distortion of production/consumption of special goods; less over-supply of durables

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  - less undervaluation of durables in fire sale, less overvaluation at time of production
  - less distortion of production/consumption of special goods; less over-supply of durables
- But like a reduction of $\tilde{m}$ in that supply of cash is reduced
  - increasing money premium, reducing steady-state R^m/Π
  - greater distortion of cash/credit composition of demand

Macroprudential Policy in the Long Run

- Hence for fixed $\tilde{m}$ [below the satiation level], the optimal stationary value of $\tilde{\xi}$ is an interior value

- Contrary to either of two familiar (extreme) proposals:

  1. should tax "outside money" creation out of existence (Simons)
  2. should eliminate taxation of outside money creation (Friedman)

Short-Term Policy Tradeoffs

- Simple case analyzed here: **one-time shock** (e.g., shock to aggregate demand) in some period t, with constant fundamentals thereafter

  — shock is completely **unexpected:** prior to subperiod 2 of period t (and when P_t is set), stationary eq'm (constant inflation rate Π, constant values $R^m, \tilde{m}, \xi$) is expected to continue

  — after shock occurs, no further such shocks expected $\Rightarrow$ P_τ still expected to clear market in all periods $\tau > t$

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- Consider **only** effects of possible responses of $R^m_{t+1}, \tilde{m}_{t+1}, \xi_{t+1}$ to shock in period t

  — policy thereafter in accordance with previous steady state

Short-Run Equilibrium

- Two key measures of **financial conditions:**
  - expected one-period **real return on longer-term bonds:**

$$1 + \bar{r}^b_{t+1} \equiv E_{t+1}\left[R^b_{t+1}\frac{P_t}{P_{t+1}}\right] = \frac{\lambda_t}{\beta\bar{\lambda}}$$

[the measure of financial conditions that is relevant for **aggregate demand** for non-durable normal goods]

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  - **"money premium"** earned by cash:

$$\frac{E_{t+1}[R^b_{t+1}]}{R^m_{t+1}} = \tilde{\varphi}_{1,t+1},$$

Lagrange multiplier assoc. to subperiod-1 budget constraint

[measure of financial conditions that determines incentive for **short-term debt issuance** by banks]

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- Financial conditions and **aggregate demand** for "normal goods":

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  - $I(\lambda; \tilde{m})$ is investment demand consistent with Euler equation

    — decreasing function of λ_t

    — also decreasing function of $\tilde{m}_t$: less scarcity of liquidity reduces demand for collateral

Short-Run Equilibrium

Two relations to determine the money premium:

1. Money premium depends on **supply of safe assets,** which is increasing in both outside supply $\tilde{m}_{t+1}$ and supply by banks [dependent on available collateral]

$$\tilde{\varphi}_{1,t+1} = \hat{\varphi}_1(l_t, \tilde{m}_{t+1})$$

   - decreasing in both $\tilde{m}_{t+1}$ and l_t

["LM curve" with endogenous money supply]

Short-Run Equilibrium

Two relations to determine the money premium:

2. Money premium corresponds to spread between expected **return on investment** [decreasing function of I_t] and **return on cash**

$$\tilde{\varphi}_{1,t+1} = \bar{\varphi}_1(I_t, R^m_{t+1})$$

- decreasing in both R^m_{t+1} and I_t

[connection between money premium in "LM curve" and riskless rate]

Short-Run Equilibrium: Summary

Two relations between supply of durables and the money premium:

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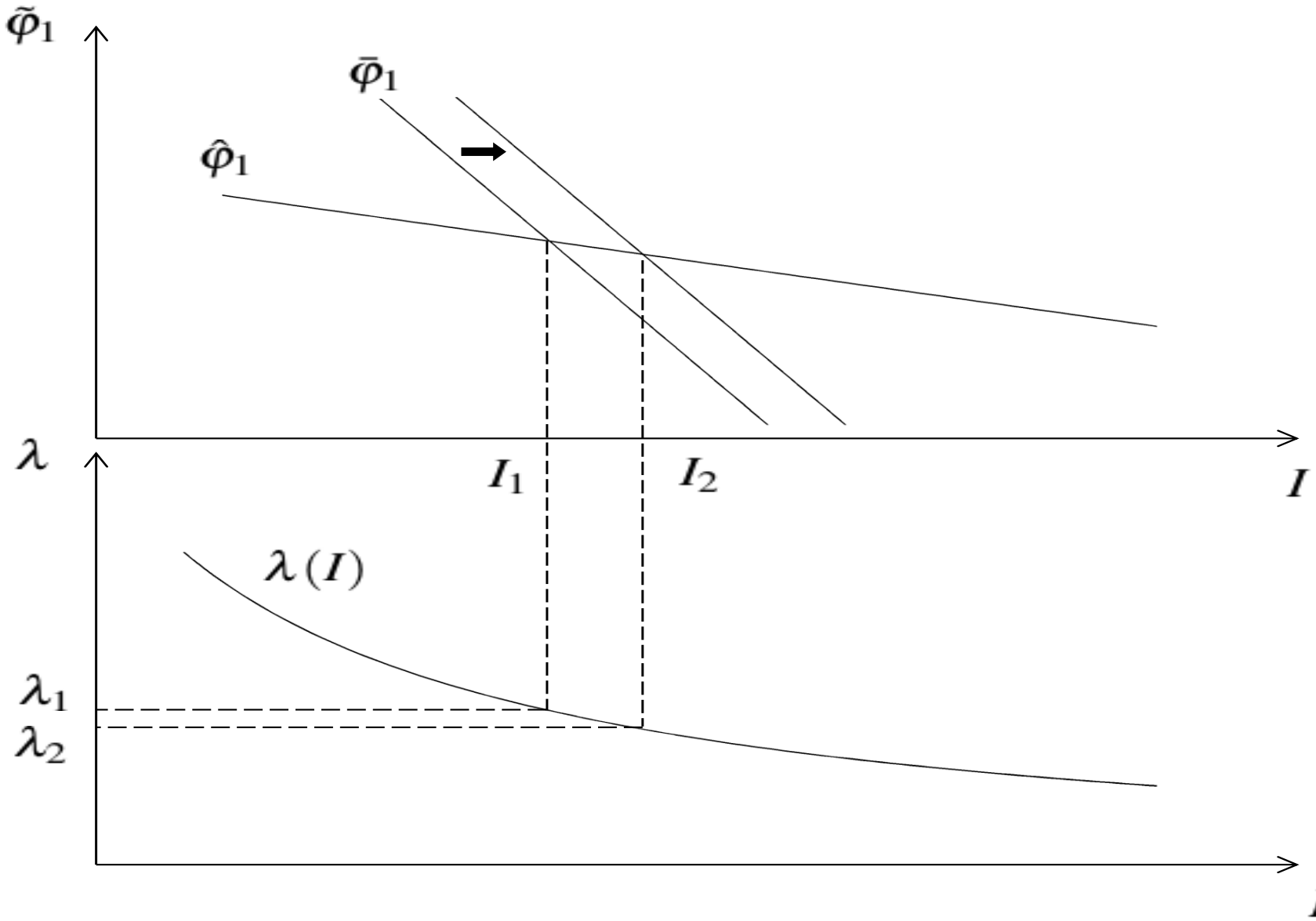
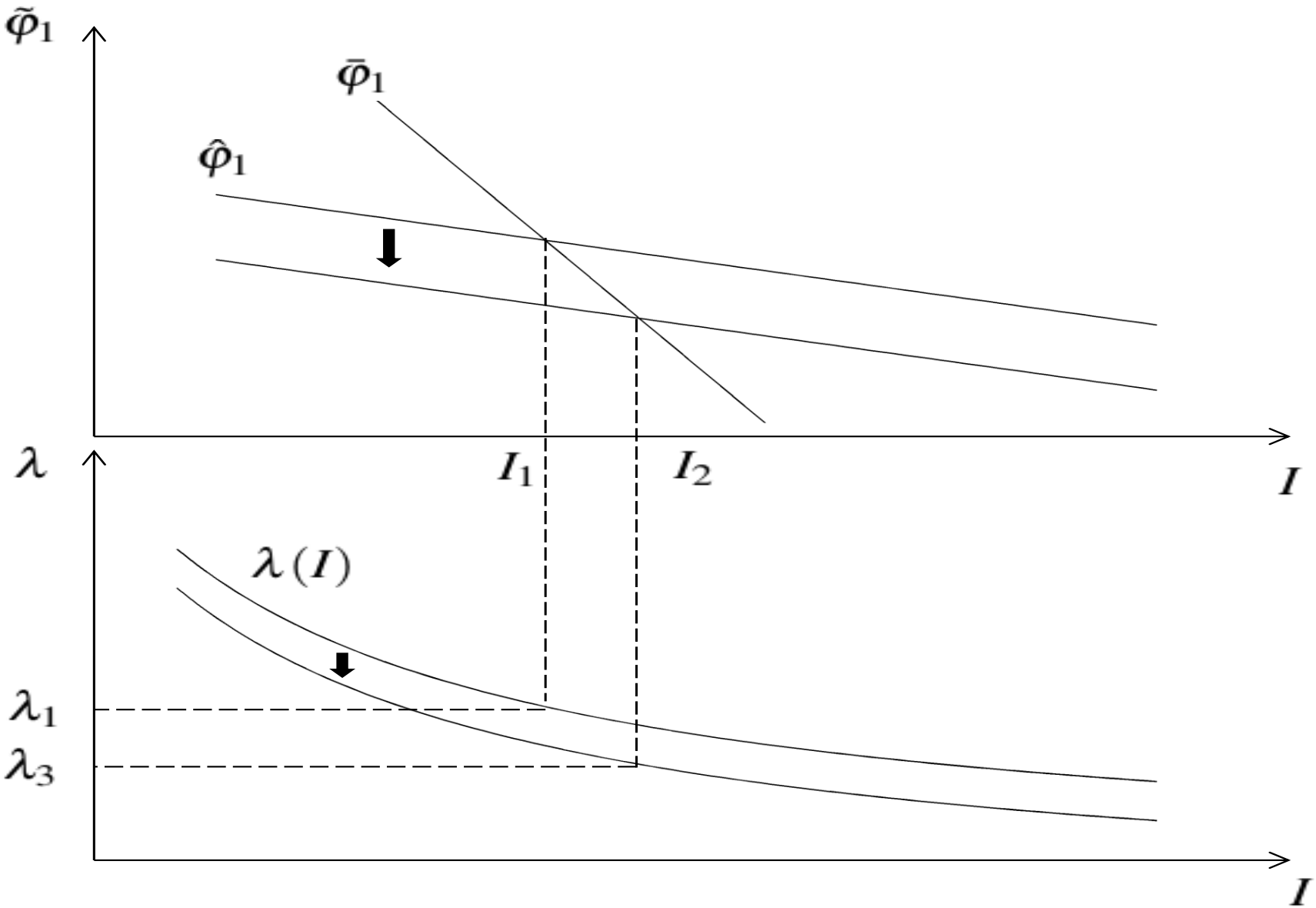
- Solve these for $\varphi_{1,t+1}, I_t$ for given $R^m_{t+1}, \tilde{m}_{t+1}$
- Then LT real rate λ_t and aggregate demand Y_t determined by

$$I_t = I(\lambda_t; \tilde{m}_{t+1})$$
$$Y_t = c(\lambda_t) + I_t$$

Effects of Interest-Rate Policy



Effects of Quantitative Easing



Comparing Alternative Policy Tools

- QE vs interest-rate policy: for policies that increase I_t by same amount, QE **lowers LT real rate more**

  $\Rightarrow$ smaller fraction of AD increase is financed by safe debt issuance

  $\Rightarrow$ less increase in risk to financial stability

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  — but the $\lambda - I$ schedule **shifts up** [a given value of λ_t associated with greater investment demand]

  — so that in this case an **even larger** fraction of AD increase is financed by safe debt issuance, than in the case of an interest-rate cut

Alternative Monetary Policy Responses: Summary

- All three policies
  - reducing R^m_{t+1}
  - increasing $\tilde{m}_{t+1}$
  - increasing ξ_{t+1}

  are ways to **increase aggregate demand** in short run:

  — relax financial conditions (lower $\lambda_t \Leftrightarrow$ lower $\bar{r}^b_{t+1}$)
  — increase demand for credit goods
  — increase investment demand

Alternative Monetary Policy Responses: Summary

- All three policies
  - reducing R^m_{t+1}
  - increasing $\tilde{m}_{t+1}$
  - increasing ξ_{t+1}

  are ways to **increase aggregate demand** in short run:

  — relax financial conditions (lower $\lambda_t \Leftrightarrow$ lower $\bar{r}^b_{t+1}$)
  — increase demand for credit goods
  — increase investment demand

- But all also increase **risks to financial stability:**

  — increase short-term debt issuance by banks
  — increase Q_{t+1}, lower Γ_{t+1}
  — increase suboptimality of special goods consumption

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- However, they can be **ordered:** for a given size increase in aggregate demand Y_t,
  - among the 3 policies, QE (increasing $\tilde{m}_{t+1}$) increases demand for durables and short-term debt issuance by banks **the least,**
  - interest-rate policy (reducing R^m_{t+1}) does so to an intermediate extent, and
  - relaxation of macroprudential policy (raising ξ_{t+1}) increases demand for durables and risks to financial stability **the most**

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  — may be useful to act on **multiple** dimensions, to better achieve **multiple goals** simultaneously

- Large CB supply of safe liabilities desirable in steady state **[in absence of other costs],** to minimize risk to financial stability

  — then allowing interest-rate policy to be used purely for traditional stabilization objectives

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- Can still ask how to optimally use balance-sheet policy in this second-best case

- Should assign a shadow **cost of increasing balance sheet** [not a simple cap on feasible size]

  — then optimal balance-sheet size will vary depending on the urgency of stabilization objectives

  — active use of balance-sheet policy appropriate

How to Use Multiple Dimensions?

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  - but **not** if the two dimensions of policy are interest-rate policy and balance sheet

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- But if instruments are R^m and $\tilde{m}$:

  — the unique policy mix that achieves it is instead to **expand balance sheet** while **raising riskless interest rate** enough to offset effect on private issuance of STSIs

How to Use Multiple Dimensions?

- A similar conclusion if the goal of policy is to **reduce risk to financial stability** [by reducing investment financed by private money issuance], but **without contracting AD:**

  — if instruments are R^m and $\tilde{m}$, unique policy mix that achieves this is to **raise riskless interest rate** while **expanding balance sheet** enough to offset effect on AD

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- The policy US needed in the mid-2000s?

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- **Not equivalent** to interest-rate policy in its effects: hence a potential role in stabilization policy even when not at the ZLB

- Ideal use of balance-sheet policy is furthermore not simply to amplify whatever one is also trying to achieve through interest-rate policy

  — under some circumstances, should adjust the two instruments in **opposite** directions, to simultaneously achieve goals for aggregate demand management, control of financial cycle