Outside and Inside Liquidity

Patrick Bolton, Tano Santos and José A. Scheinkman

Figure 3. Market Based and Bank Based Holding of Home Mortgages
(Source: US Flow of Funds, Federal Reserve)

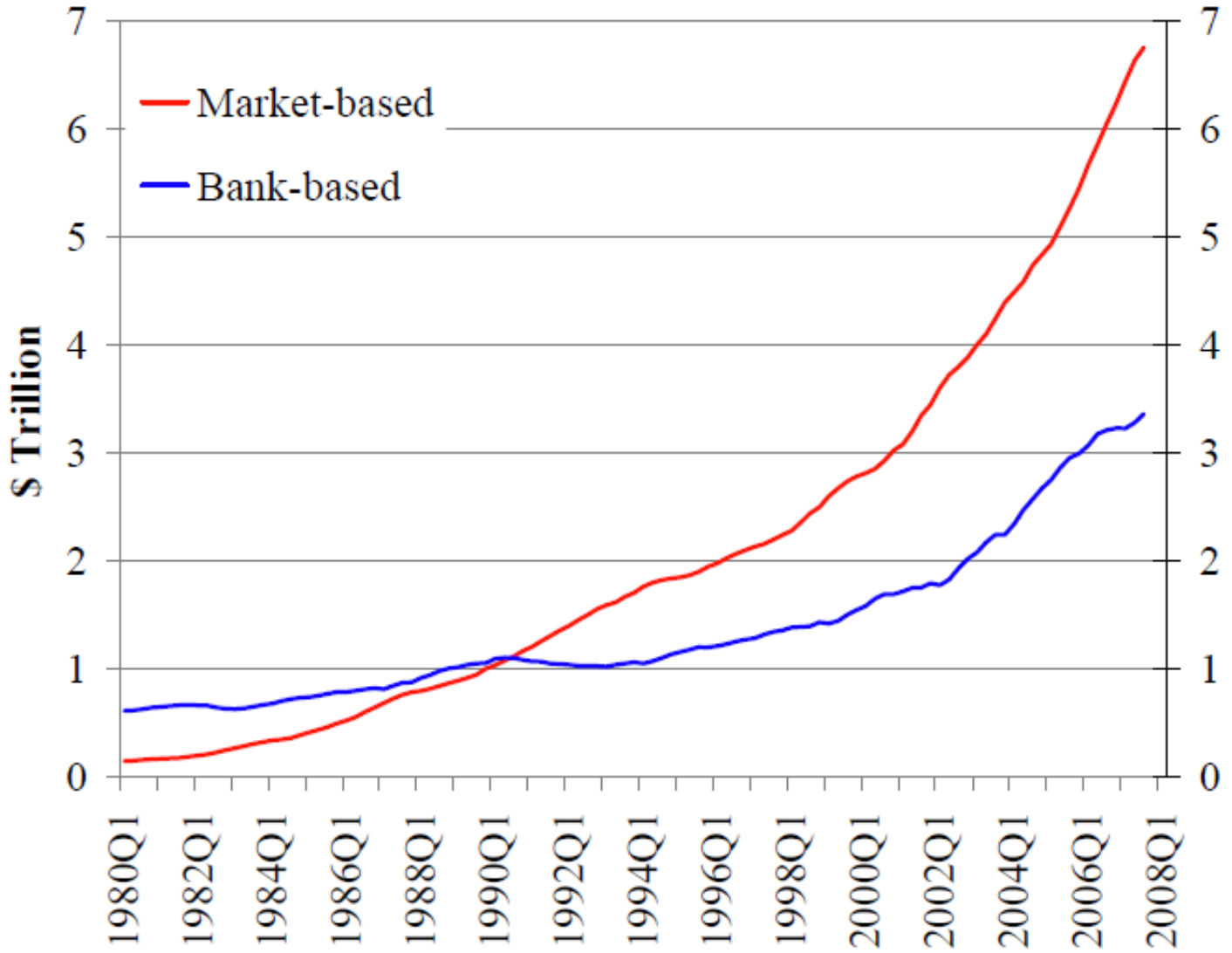
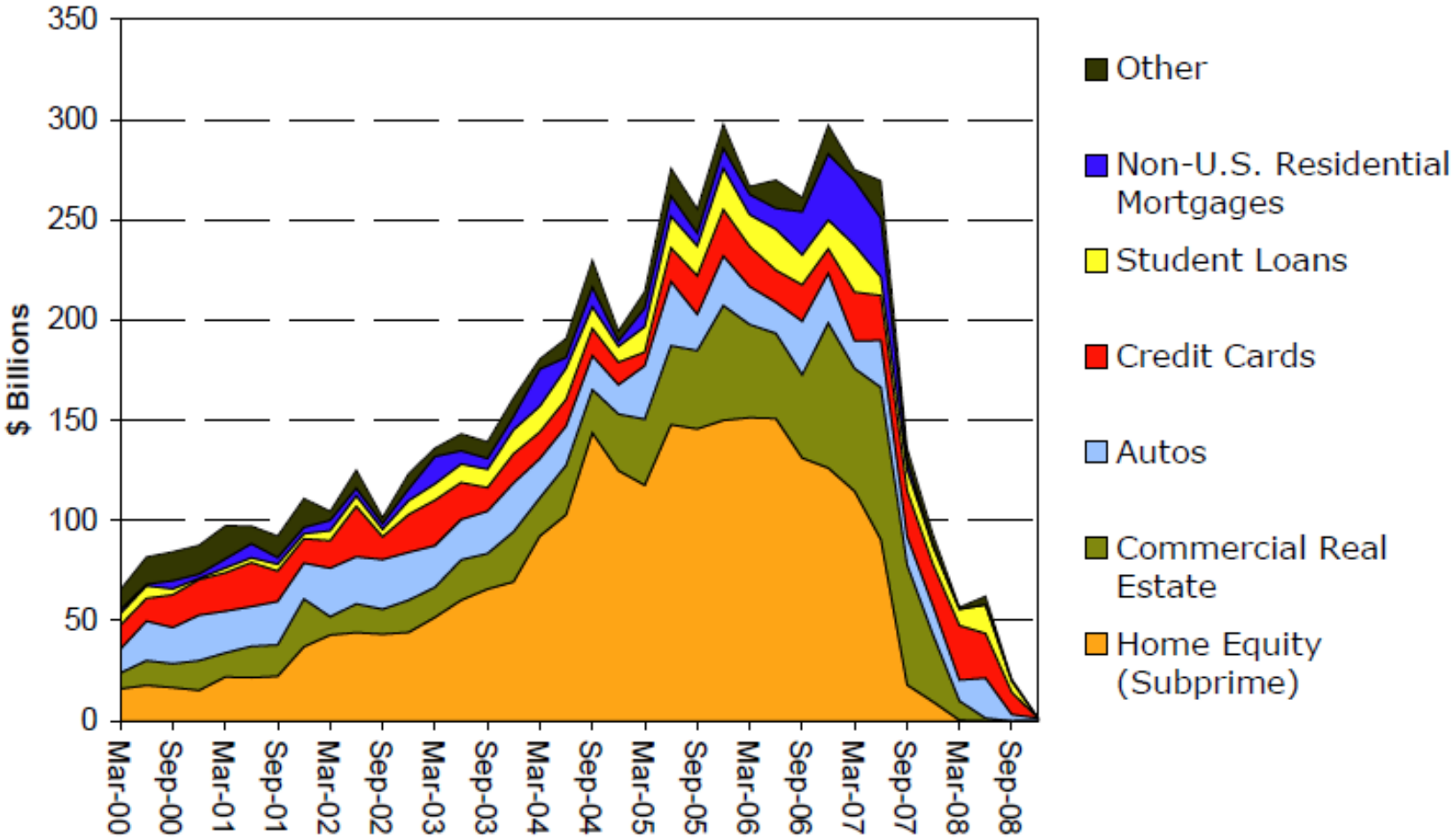


Figure 4. New Issuance of Asset Backed Securities in Previous Three Months (Source: JP Morgan Chase)



Market liquidity

- Inside liquidity carried by financial intermediaries
- Outside liquidity carried by other investors that are willing to exchange this cash for assets carried by intermediaries
- *Originate and contingent distribution*
- Standard argument
  - Outside liquidity has difficulty flowing to financial intermediaries during crisis, because the latter have superior information about the quality of their assets
  - Effectively, adverse selection is a barrier to outside liquidity.

- The model assume limits to outside liquidity
  - Ex ante: outside liquidity has an opportunity cost (knowledge)
  - Ex post: limited outside liquidity produces cash in the market pricing
- Cash in the market pricing = liquidity problems
- Market and Public liquidity

Some questions and flavor of results

- What determines the amount of liquidity provided in equilibrium and the severity of the liquidity problem
  - Key: Timing of liquidation decision by parties in need of liquidity
  - The more one party waits to raise liquidity
    - the more severe the adverse selection problem
    - the more outside liquidity is brought in to absorb fire-sales
    - the more "risk" will be supported.

- Does the market provide an efficient amount of liquidity and the efficient mix of outside and inside liquidity?
  - Multiple equilibria
    - one equilibrium involves early trading (before the asymmetric information occurs)
    - another equilibrium involves late trading under adverse selection
  - Late equilibria are more efficient.

- If equilibrium is not efficient what can authorities do to improve efficiency
  - Timing of intervention is crucial
  - Public liquidity may substitute or complement private liquidity and can lower efficiency if it encourages parties not to liquidate
- Relate these points to interventions and regulation
  - Extension of repo facilities
  - Merging of institutions
  - Marking to market
  - Bolton, Santos and Scheinkman (AER-PP, 2009)

Literature Review

- Maturity transformation and liquidity demand: Diamond and Dybvig (1983)
- Interbank liquidity: Bhattacharya and Gale (1986)
- Contagion: Allen and Gale (2000), Freixas, Parigi and Rochet (2000), Aghion, Bolton and Dewatripont (2000).
- Public versus Private liquidity: Holmstron and Tirole (1998), Gorton and Huang (2004).
- Securitization and liquidity: Parlour and Plantin (2007)

- Liquidity, margins and prices: Brunnermeier and Pedersen (2008), Kyle and Xiong (2001), Xing (2001), Gromb and Vayanos (2002), Kondor (2007).
- Innovations
  - Outside liquidity provided by agents with different horizons (hedge funds, sovereign funds)
  - Timing of liquidity crisis.

The Model

- Four periods $0, 1, 2, 3$. An unit interval of each of 2 types of agents, short and long run investors.
- Short Run Investors (SRs):

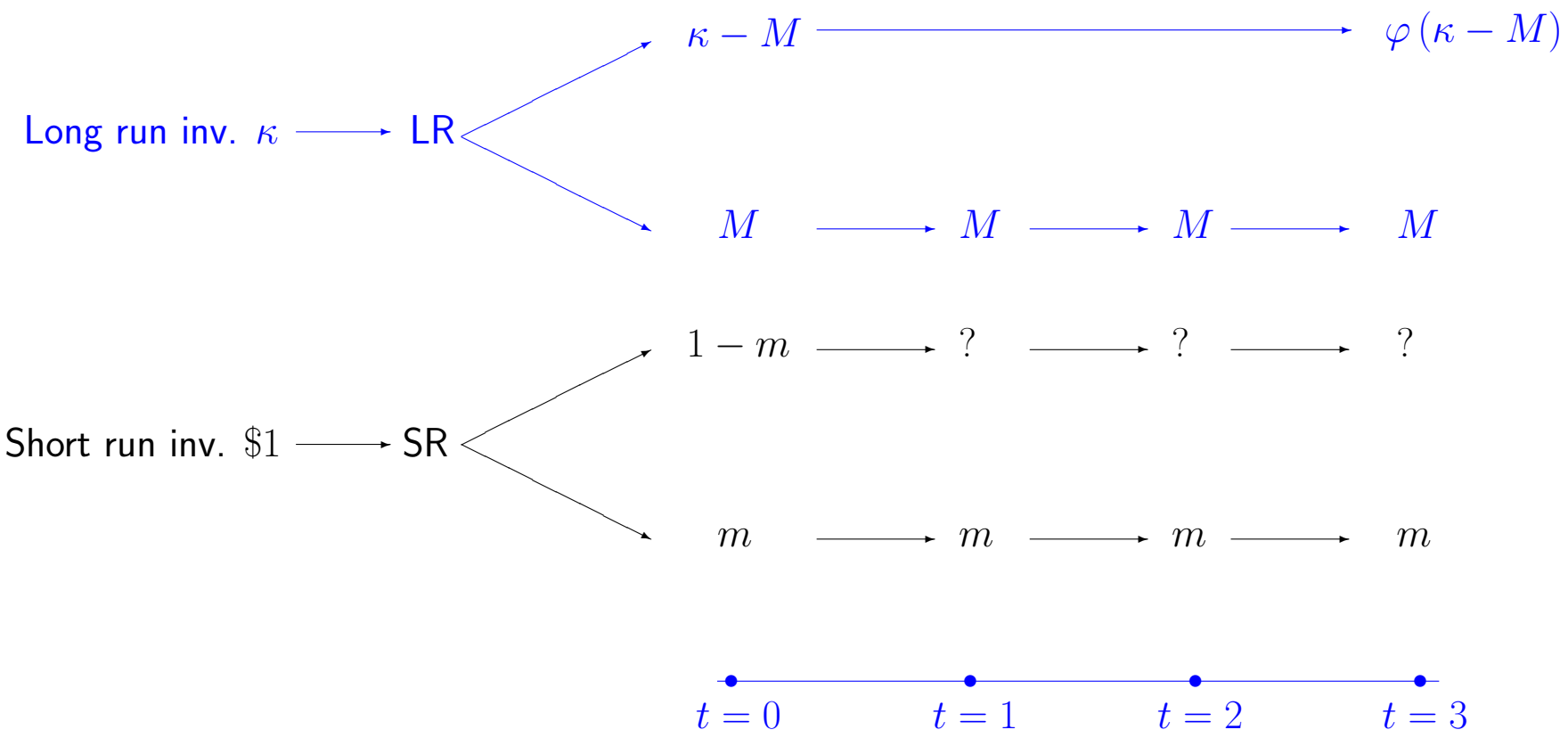
$$u(C_1, C_2, C_3) = C_1 + C_2 + \delta C_3 \qquad \text{with} \quad 0 < \delta < 1$$

- Long Run Investors (LRs):

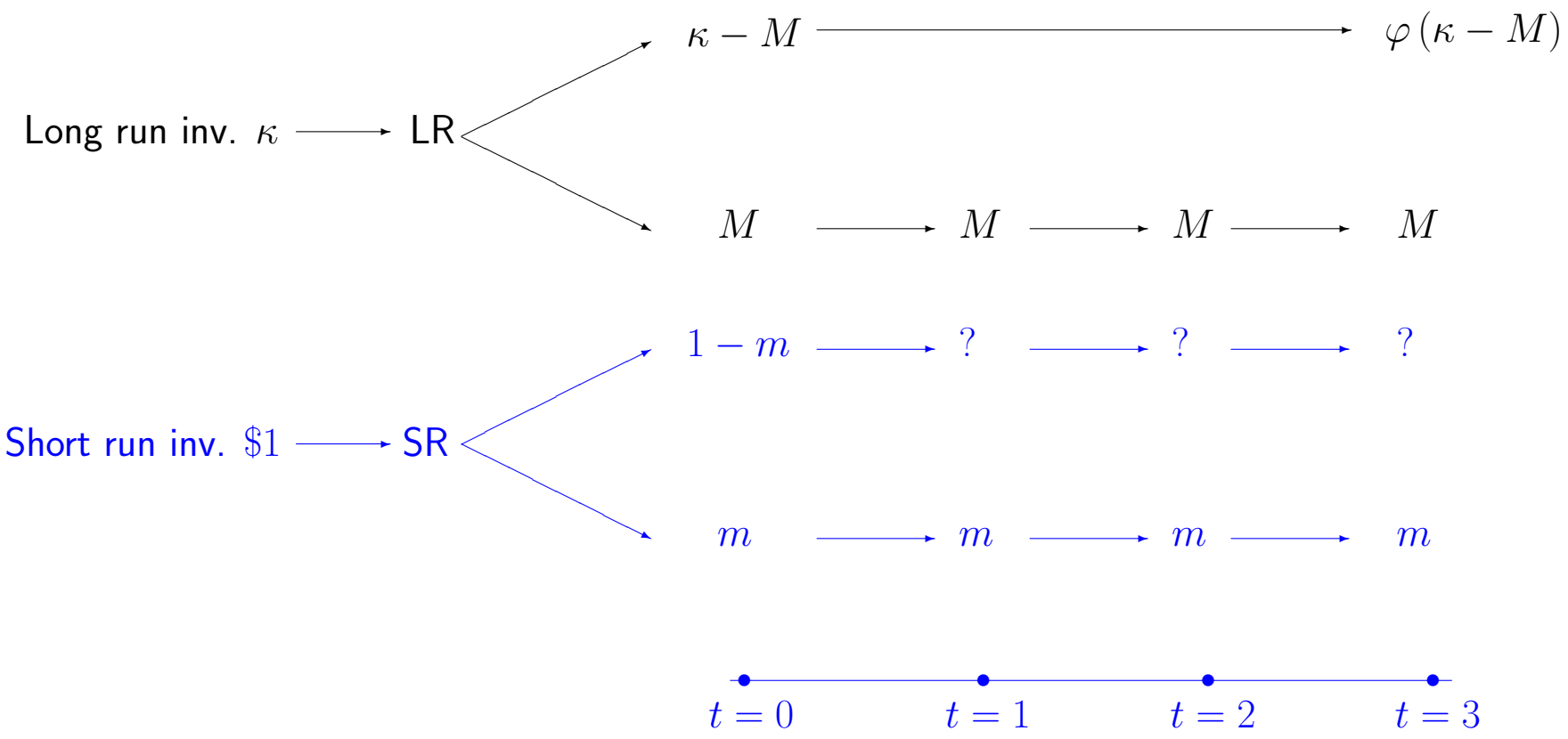
$$u(C_1, C_2, C_3) = C_1 + C_2 + C_3$$

- Assets: Cash, "long asset" and "risky asset."
  - The risky asset is the only source of risk.
  - SRs have 1 per-capita and can only invest at time 0 in cash and in the risky asset.
  - LRs have κ per-capita and only invest at time 0 in cash and the long asset. LRs may later buy risky projects from SRs.

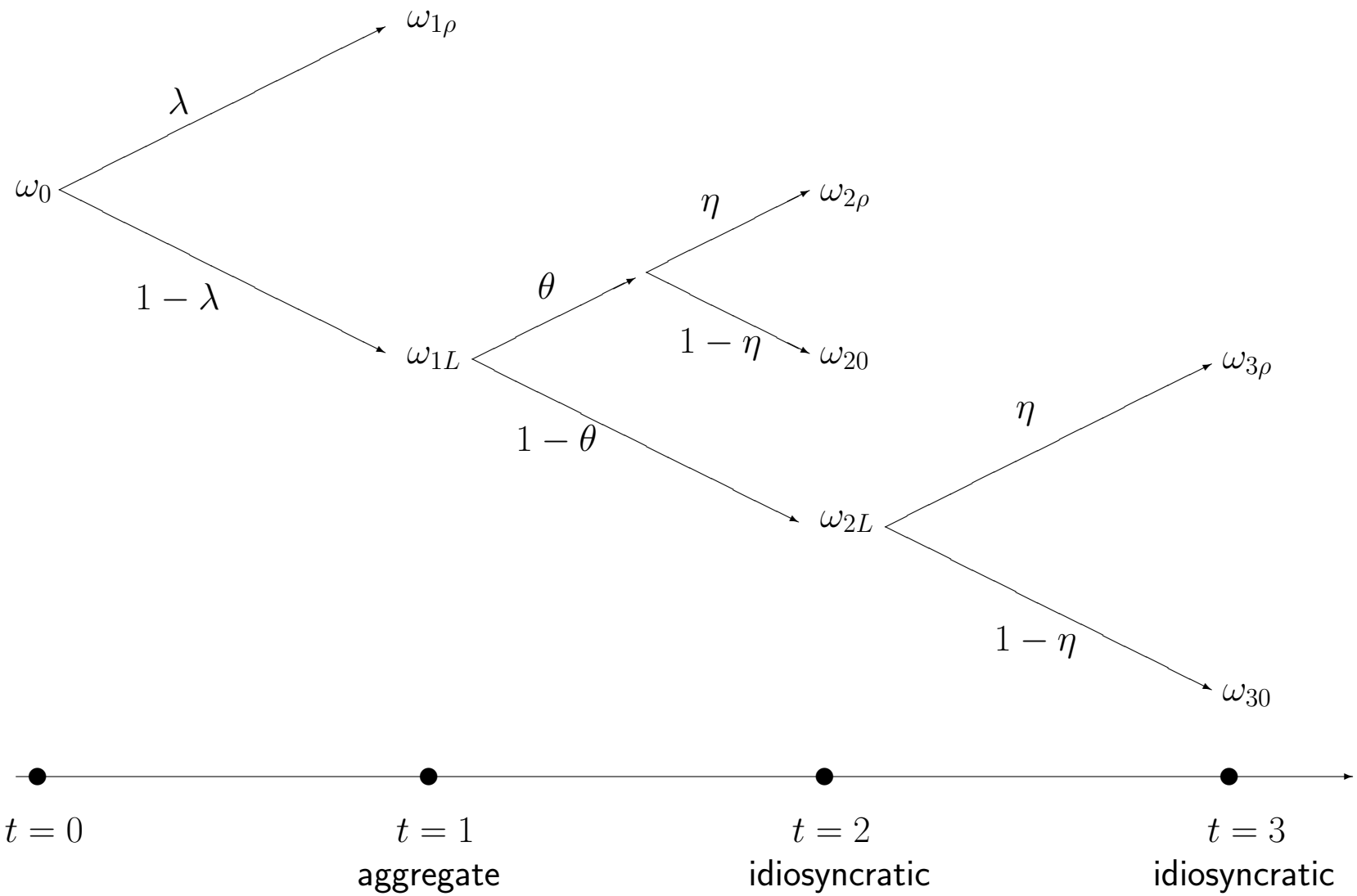
Agents and their investment opportunities - 1



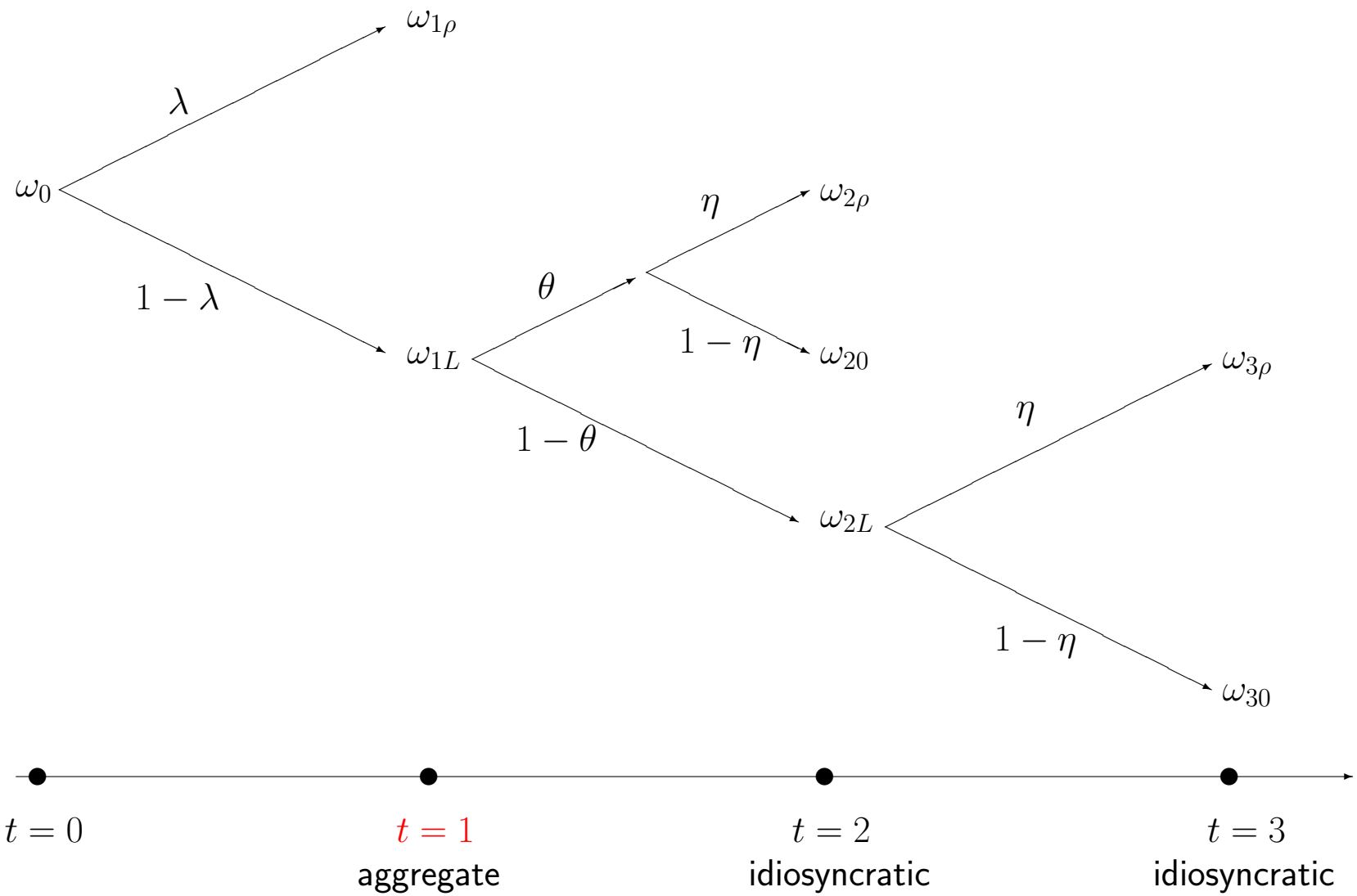
Agents and their investment opportunities - 2



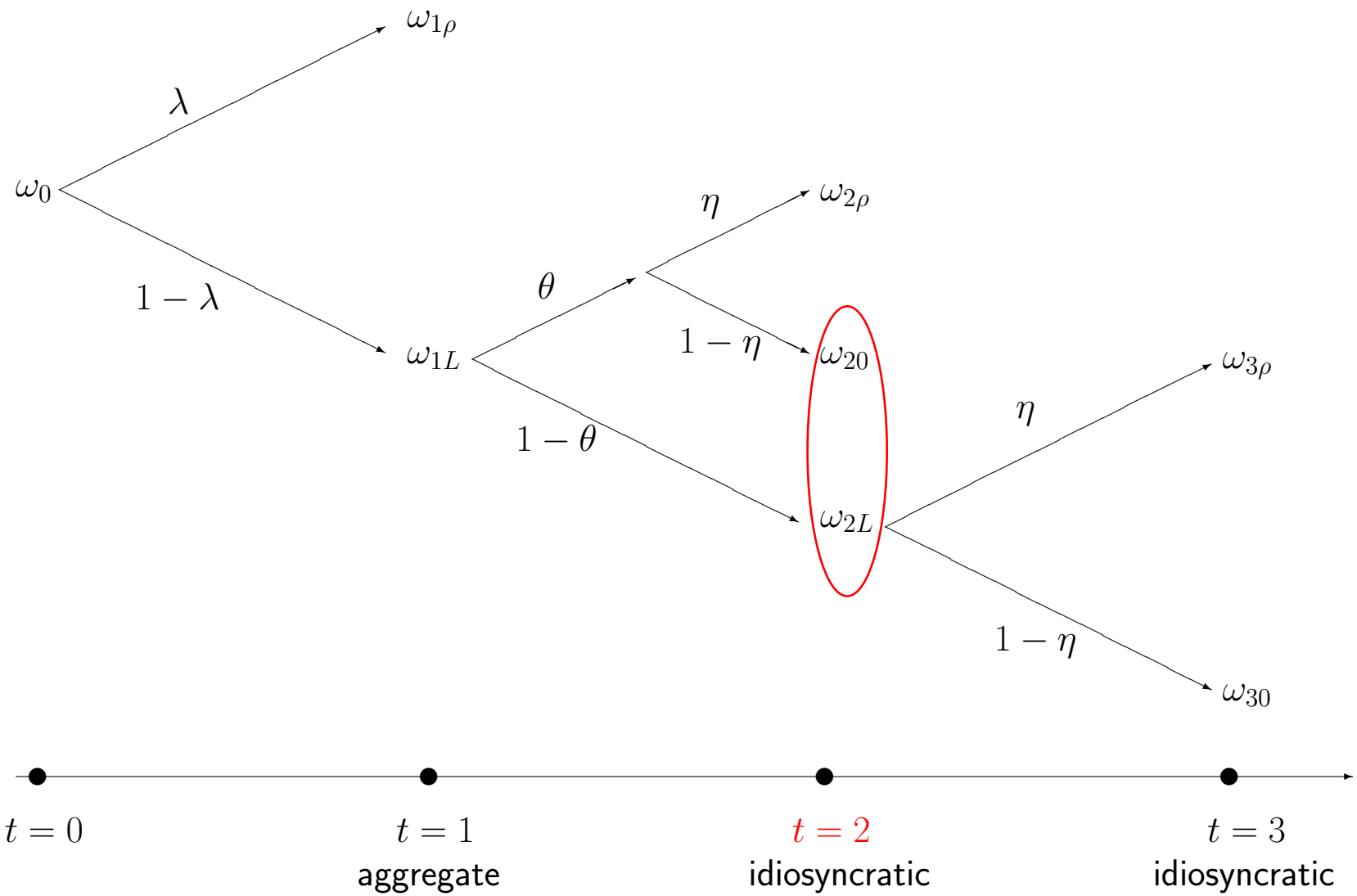
The risky asset - 1



The risky asset - 2



The risky asset - 3



Assumptions

- LRs carry cash only if they can deploy it to acquire the risky assets at advantageous prices. (cash-in-the-market pricing)
  - φ concave, $\varphi'(\kappa) > 1$. (also assume $\varphi'(0) = \infty$)
- SRs do not want to invest in the risky asset in autarchy: They only invest if they can liquidate at attractive prices.

$$\lambda\rho + (1-\lambda)\left[\theta + (1-\theta)\,\delta\right]\eta\rho < 1$$

- But investing in the risky asset is socially beneficial - expected return on the asset exceeds that of cash.

$$\rho\left[\lambda + (1-\lambda)\eta\right] > 1$$

- Potential gains from trade

$$\frac{\varphi'(\kappa) - \lambda}{(1-\lambda)\,\eta\rho} < \frac{1-\lambda}{1-\lambda\rho}$$

The problem of the SRs and the LRs

- The SRs
  - Choose the scale of the risky project $1 - m$ and thus how much inside liquidity to carry (m).
  - A liquidation policy in the lower branch of the tree.
    - how much to liquidate at date $t = 1$, q_1, and $t = 2$, q_2, where the decisions depend on prices and public and private information.
- The LRs
  - How much outside liquidity to carry, M, and thus how much to invest in the long asset, $\kappa - M$
  - When to step in to acquire assets at firesale prices
    - how much to buy at date $t = 1$, Q_1, and $t = 2$, Q_2, where decisions depend on prices, public information, and expectations concerning SR's actions.

SRs optimization

- Objective function

$$\begin{aligned}\pi\left[m, q_1, q_2\right] &= m + \lambda\left(1-m\right)\rho + \left(1-\lambda\right)q_1 P_1 \\ &+ \left(1-\lambda\right)\theta\eta\left[\left(1-m\right) - q_1\right]\rho \qquad (1) \\ &+ \left(1-\lambda\right)\theta\left(1-\eta\right)\left[1-m-q_1\right]P_2 \\ &+ \left(1-\lambda\right)\left(1-\theta\right)q_2 P_2 \\ &+ \delta\left(1-\lambda\right)\left(1-\theta\right)\eta\left[\left(1-m\right) - q_1 - q_2\right]\rho\end{aligned}$$

- $$\max_{m, q_1, q_2} \pi\left[m, q_1, q_2\right] \qquad (\mathcal{P}_{SR})$$

  subject to

  $$m \in [0, 1]$$

  and

  $$q_1 + q_2 \leq 1 - m \qquad \text{and} \qquad q_1, q_2 \in \{0, 1-m\}$$

LRs optimization

- Objective function

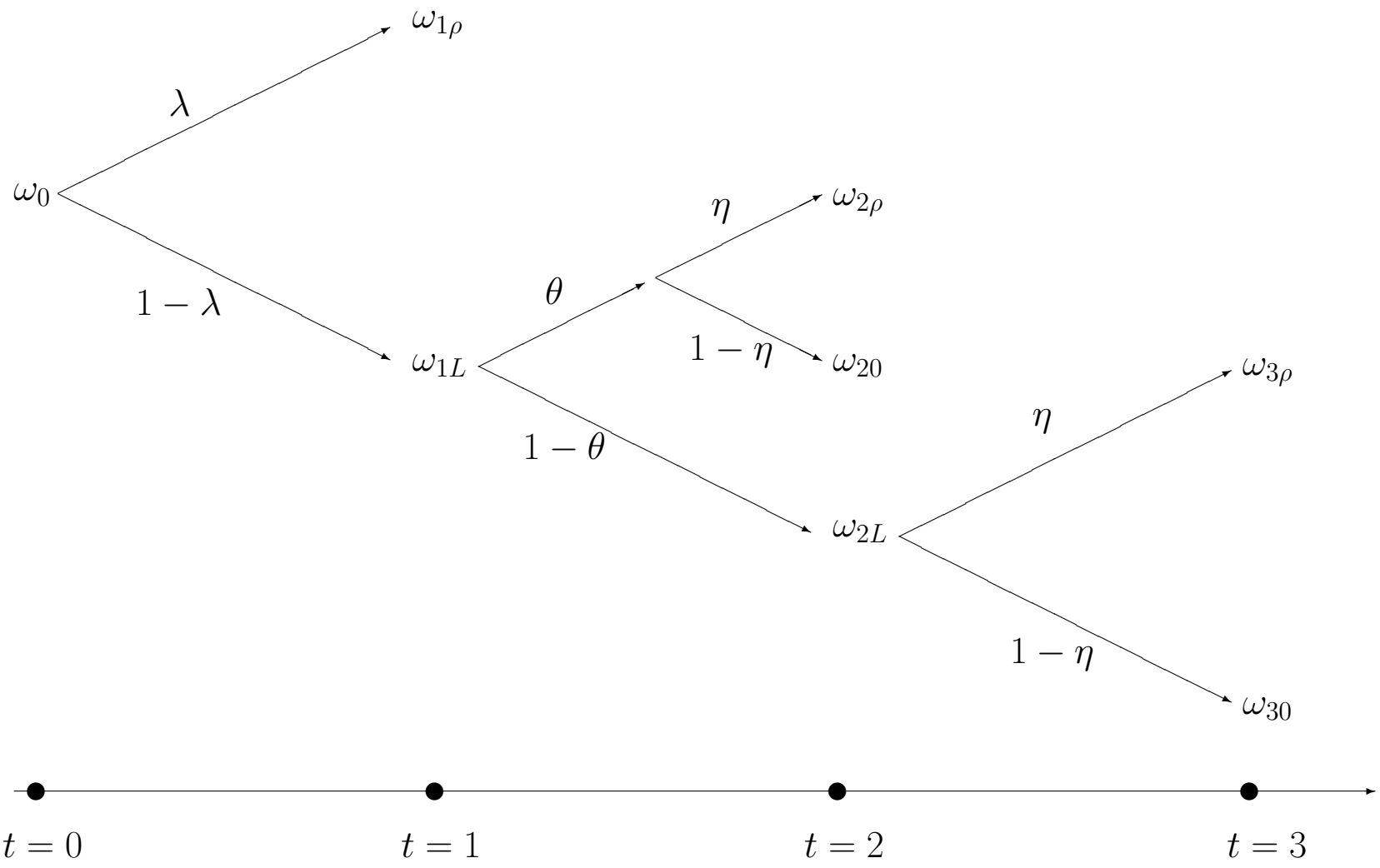
$$\begin{aligned} \Pi\left[M, Q_1, Q_2\right] &= M + \varphi\left(\kappa - M\right) \\ &+ (1-\lambda)\left[\eta\rho - P_1\right] Q_1 \\ &+ (1-\lambda) E\left[\tilde{\rho}_3 - P_2 \middle| \mathcal{F}\right] Q_2 \end{aligned} \tag{2}$$

- Return on assets bought in period 2 depends on which assets are being supplied.

Equilibrium

- Prices P_1^*, P_2^*.
- Portfolio policies m^*, M^*.
- Liquidation and acquisition policies such that agents maximize and markets clear.
- Two types of equilibria
  - Immediate trading equilibrium: Trading occurs at date $t = 1$
    - no adverse selection
  - Delayed trading equilibrium: Trading occurs at date $t = 2$
    - adverse selection

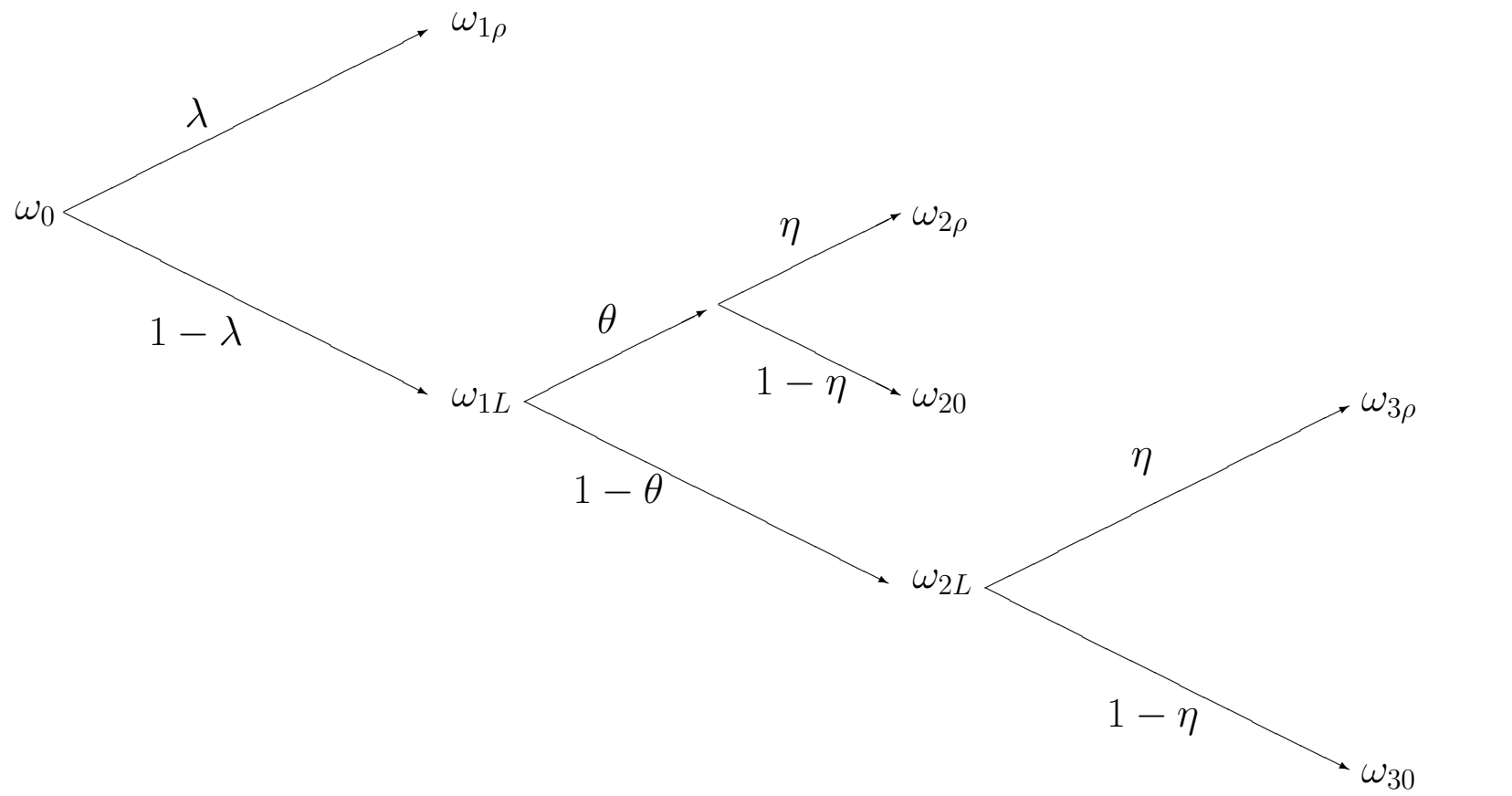
The immediate trading equilibrium



$Q^*_{1,i} = q^*_{1,i} = 1 - m^*_i$ $\qquad$ $Q^*_{2,i} = q^*_{2,i} = 0$

$P^*_{1,i} = \frac{M^*_i}{1-m^*_i}$ $\qquad$ $P^*_{2,i} < \delta\eta\rho$

The delayed trading equilibrium



$Q^*_{1,d} = q^*_{1,d} = 0$ $\qquad$ $Q^*_{2,d} = q^*_{2,d} = (1 - m^*_d)(1 - \theta\eta)$

$P^*_{1,d}$ $\qquad$ $P^*_{2,d} = \frac{M^*_d}{(1-m^*_d)(1-\theta\eta)}$

Existence

- Immediate equilibrium always exists and is unique.
- Delayed equilibrium depends on pooling SR's with projects that are not paying off with those that are still uncertain about the quality of their project.
- If δ is large (holding constant the other parameters in the model), SR's that still don't know how good their project is will prefer not to sell and the delayed equilibrium breaks down.
- Formally: Candidate delayed equilibrium is unique and independent of δ but must satisfy $P_{2d}^* \geq \delta\eta\rho$. It exists if δ small (holding constant the other parameters in the model)
- A larger θ requires a smaller δ.
- Fixing all other parameters delayed equilibrium exists for θ sufficiently small.

Argument (immediate equilibrium)

- FOC for LR (if $\kappa > M > 0$), $\lambda + (1-\lambda)\frac{\eta\rho}{P} = \varphi'(\kappa - M)$
- FOC for SR (if $m < 1$), $(1-\lambda)P - (1-\lambda\rho) \geq 0$
- Cash in the market pricing $P = \frac{M}{1-m} \geq \frac{1-\rho\lambda}{1-\lambda}$
- $\lambda + (1-\lambda)\frac{\eta\rho}{P} = \varphi'(\kappa - P)$. Positive solution always exists.
- If $P \leq \frac{1-\rho\lambda}{1-\lambda}$, set $P_{1i}^* = \frac{1-\rho\lambda}{1-\lambda}$ and m such that $P_{1i}^* = \frac{M}{1-m}$ where

$$\lambda + (1-\lambda)\frac{\eta\rho}{P_{1i}^*} = \varphi'(\kappa - M)$$

- Otherwise set $P_i^*(\omega_i) = P$, $M = P$ and $m = 0$.
- Take $P_{2i}^* = 0$. Non-lemon SRs prefer to wait. LRs assume that only lemons could be supplied.

Efficiency and the distribution of outside and inside liquidity

- In delayed equilibrium SR's keep upside of the risky asset ($\omega_{2\rho}$)
- If tried to implement same investment policy in immediate trading, LR's would have to bring in much more cash.
- In immediate trading equilibrium, LR's acquire less risky assets, hence SR's engage in less risky projects and provide more inside liquidity.
  - There is more aggregate liquidity in immediate equilibrium
  - Prices are closer to expected payoffs in immediate equilibrium (less liquidity problems)
- Delayed equilibria are more efficient.
- Formally for θ small delayed equilibrium Pareto superior to immediate equilibrium

Ex-ante contracts

- Not mechanism design
  - Simplify aspects of the model that are not crucial
- Ex-ante contracts: LRs aquire right to pursue the risky project in exchange for (contingent) payments to the SRs
- Owner of the risky project now observes payoffs, what introduces new information constraints
- In certain cases allocation induced by delayed equilibrium Pareto Superior to ex-ante contracts that involve transferring projects to LRs
  - Ex-ante contracts limit transfers to SRs in state $\omega_{2\rho}$

Public provision of liquidity

- If immediate trading equilibrium prevails
  - Public liquidity increases prices expected in the second period
  - Ameliorates quality of assets provided in the second period
  - Increases liquidity provided by LR's
  - Public and private liquidity are complements
  - Move to (better) delayed equilibrium
- If delayed trading equilibrium prevails
  - Public liquidity lowers returns for LR's
  - Public and private liquidity are substitutes
- How can authorities distinguish between which equilibrium prevails?

Other interventions

- Collateralized lending
  - Encourages hoarding and crowds out outside liquidity
  - Raising δ and thus encouraging SRs to inefficiently hold risky assets until they mature at date 3.
  - The delayed trading equilibrium may disappear.
  - Another unintended consequence: retire from market the best assets
    - Libor spreads?
- Mergers between problem large institutions and "good" institutions
  - Increases adverse selection problem for new entity

- Marking to market + capital requirements may help sustain delayed equilibrium
- Model indicates the value of knowledge by regulators of assets held by institutions
  - Separate SRs that have solvency problems from those with liquidity problem
- TARP? TALF?