Reputation and Persistence of Adverse Selection in Secondary Loan Markets

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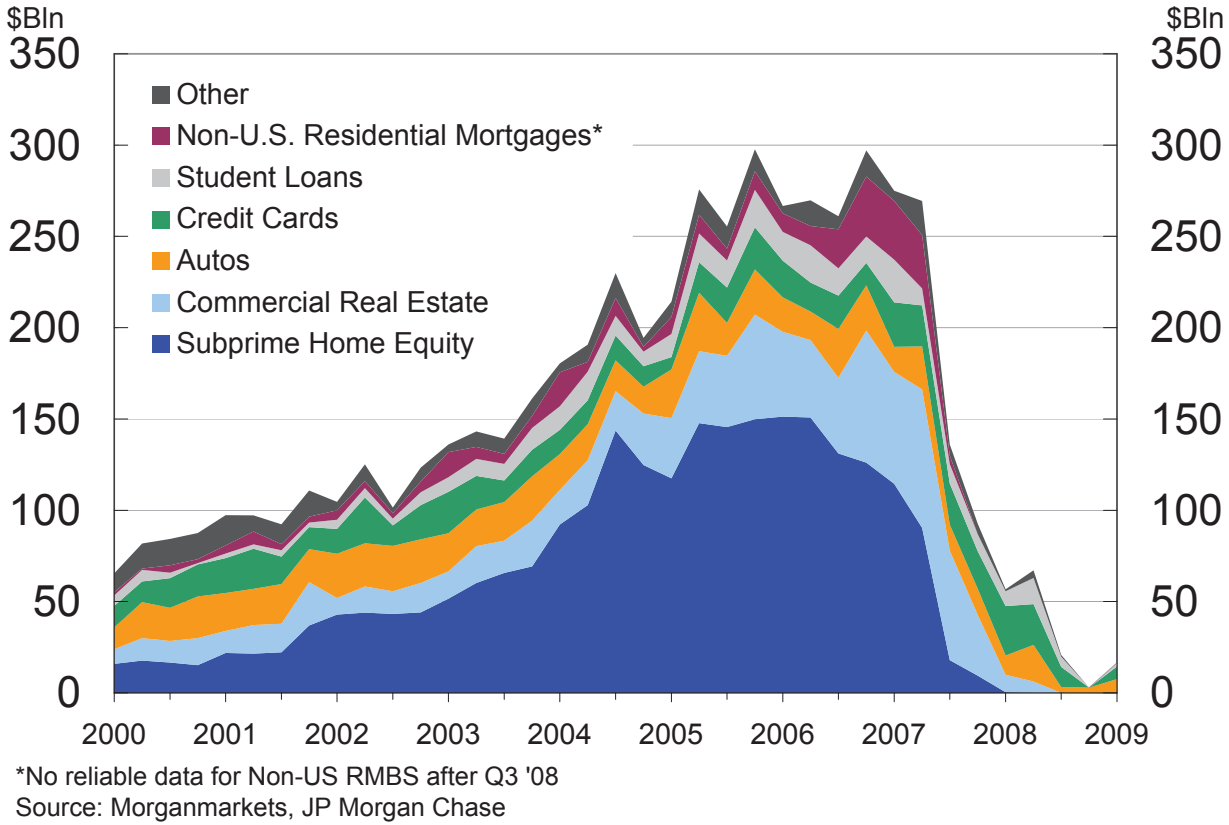
November 25, 2013

Introduction

- Volume of new issues in Secondary loan markets
    - Reallocate loans from originators to other institutions
- New issuances in such markets sometimes collapse
- Collapses associated with fall in underlying loan value

Illustration of Abrupt Collapses

New Issuances of ABSs in 2000s



- Market collapsed in Aug 2007, Land prices fell in 2007
- Similar pattern for syndicated loans; real estate bonds in the great depression

Economic Importance of Secondary Loan Markets

- From 1986 to 2012, average of $500 bn of new loans syndicated and sold in secondary loan markets
- In 2007, $1.3 trillion dollars of new loans syndicated
- Volume of new loans to corporations, almost all syndicated, declined by 37% from Aug. 2007 to Aug. 2008 (Ivashina and Scharfstein (2010))

What We Do

- Develop model of volume of new issues in secondary loan markets
- Show model generates fluctuations in volume when asset values fall
- Use model to evaluate policies intended to restore volume

Ingredients of Our Model

- Adverse Selection
  - Standard story of trade volume
  - Generates fluctuations in trade volume
- Reputation
  - Show necessary and sufficient:
    - Necessity: Absent reputational concerns, adverse selection does not persist
    - Sufficiency: With reputational concerns, adverse selection does persist

Characteristics of Equilibrium

- Absent reputational concerns, equilibrium always separating

- With reputational concerns, equilibrium must have pooling
  - Complete Pooling: no information revelation (high values of reputation)

  - Partial Pooling: partial information revelation (low values of reputation)

Policy Implications

- Adverse selection typically implies inefficiency (Prescott and Townsend (1984))

- With reputational concerns
  - Equilibrium is efficient unless...
    - Asset values are low and reputation is low

- Efficiency dictates low degree of separation across types

- Buyers have incentives to cream-skim when allocation has low separation; in dynamic model, these incentives are strongest when asset values are low and reputation is low

- Role for policy targeted at low reputation banks when asset values are low

Other Policy Implications

- Our reputational model has multiple equilibria
- In some models, policy can implement unique equilibrium without external resources
- Conventional asset purchase policies cannot do this in our model
- Unconventional policies which limit private trade are needed

Related Literature

- Adverse Selection in asset markets: Garleanu and Pedersen (2004), Duffie and DeMarzo (1999)

- Reputation literature: Milgrom and Roberts (1982), Kreps and Wilson (1982), Mailath and Samuelson (2001), Ordonez (2013)

- Policy Analysis: Phillipon and Skreta (2009); Tirole (2011)

- Evidence of Adverse Selection: Downing, Jaffee, and Wallace (2009), Drucker and Mayer (2008), Elul (2009), Ivashina (2009), Benmelech, et. al (2010), Sufi and Mian (2009)

- Dynamic adverse selection models: Eisfeldt(2004), Kurlat(2012), Guerrieri and Shimer(2013), Camargo and Lester(2013), Daley and Green (2012), Atkeson, Hellwig, and Ordonez (2012)

Outline

- Static Model of Adverse Selection in Secondary Loan Markets
- Dynamic Model of Adverse Selection in Secondary Loan Markets - Illustrative Two Period Model
  - Without Reputational Concerns
  - With Reputational Concerns
- Infinite Horizon Model with Stochastic Asset Values
- Implications for Policy

Static Model of Adverse Selection in Secondary Loan Markets

Model Environment

- Large number of loan originators, or *banks*
- Banks endowed with a portfolio of *risky* loans, size 1
  - Loan pays v with prob. π, 0 with prob $1-\pi$

    $\Rightarrow v = \bar{v} - \underline{v}$ is *spread*, $\underline{v}$ is *collateral value*
  - Probability of no default same for all loans in a bank's portfolio
  - Two types of banks, $\pi \in \{\underline{\pi}, \bar{\pi}\}, \underline{\pi} < \bar{\pi}$
  - Two buyers (Bertrand-style price competition)

Model Environment (cont.)

- Each bank chooses how much of its loan portfolio to sell, x
- Let t denote payment bank receives for selling x loans, p is price per loan
- Buyers have comparative advantage in holding loans $c > 0$
- Bank payoff from selling x loans for payment t:

$$t + (1 - x)(\pi v - c)$$

- Buyer profits from (x, t)

$$x\pi v - t$$

Model Environment (cont.)

- Adverse selection: bank knows type of loans, potential buyers do not
- Buyers believe given bank is high-quality with probability μ
- Distribution of Banks $H_2(\mu)$
- Call μ the *reputation* of the bank

Timing in Static Model

- Buyers simultaneously propose contracts consisting of offers to a given bank:

$$z = (x_h, t_h, x_l, t_l) \in Z$$

- Bank chooses whether to accept a contract or reject both
- If bank accepts a contract, then chooses which offer to accept
- Restrict to pure strategies for banks, possibly mixed strategies for buyers, $F(z)$ for $z \in Z$
- Equilibrium is standard

Equilibrium Conditions in Static Model

- Incentive Constraints

$$t_h + (1 - x_h)(\bar{\pi}v - c) \geq t_l + (1 - x_l)(\bar{\pi}v - c)$$

$$t_l + (1 - x_l)(\underline{\pi}v - c) \geq t_h + (1 - x_h)(\underline{\pi}v - c)$$

- Zero Profits for Buyers (at each point in support of F)

$$\mu(x_h\bar{\pi}v - t_h) + (1 - \mu)(x_l\underline{\pi}v - t_l) = 0$$

Equilibrium Characterization in Static Model

Proposition

The static model has a (unique) separating equilibrium.

- With low reputation, pure strategies by buyers, least-cost separating outcome (Rothschild and Stiglitz (1976))

- With high reputation, mixed strategies by buyers, cross-subsidization across types
  - Follow Dasgupta and Maskin (1986) and Rosenthal and Weiss (1984) to prove existence and characterize equilibrium in mixed strategies

Equilibrium Characterization in Static Model

- Three general properties (Dasgupta & Maskin (1986))
  - $x_l = 1$
  - Buyers make zero profits
  - Incentive constraint for low-quality bank holds with equality:

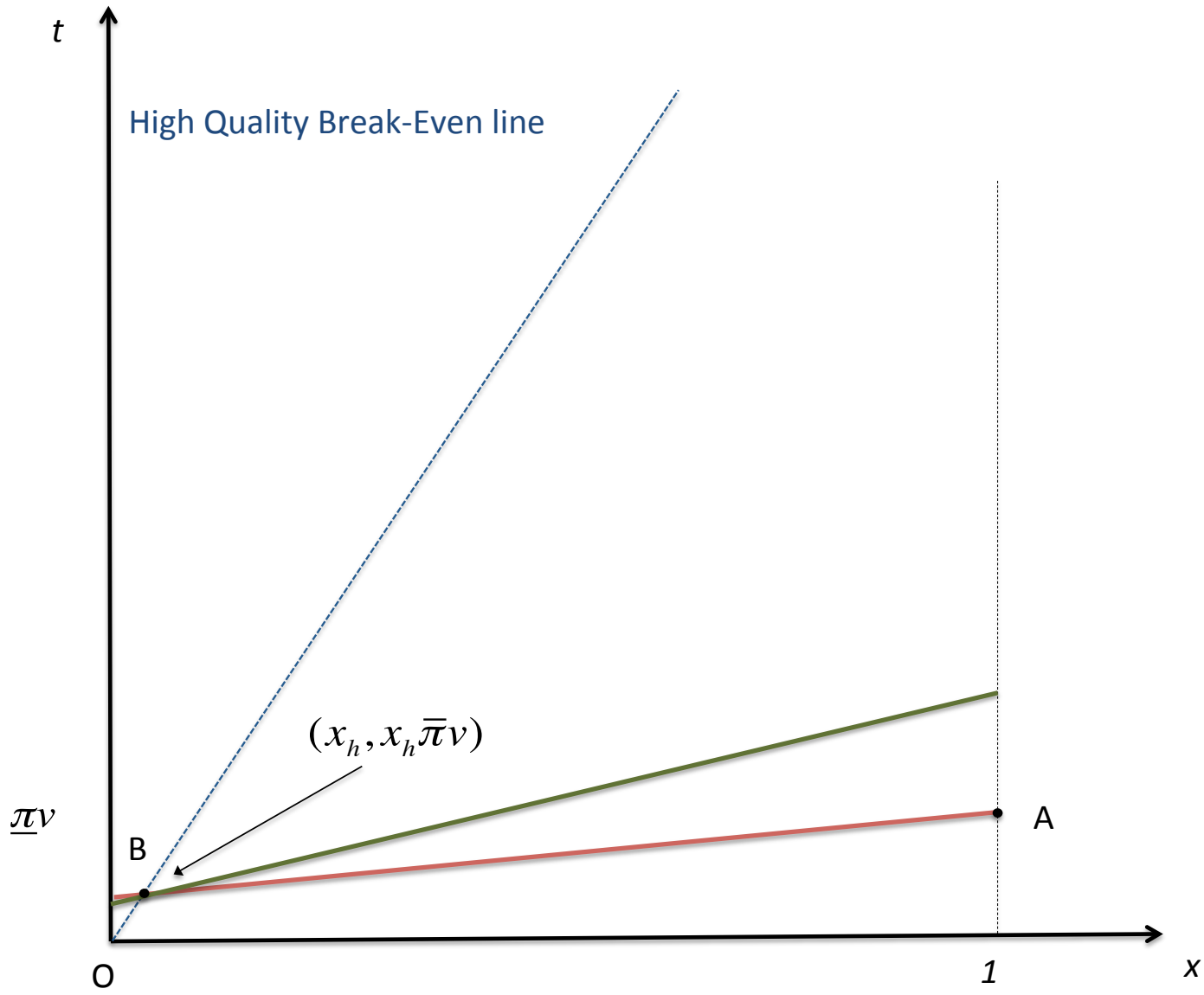
$$t_l = t_h + (1 - x_h)(\underline{\pi} v - c)$$

- Implies for each t_l, can uniquely determine x_h and t_h

- For reputation below a threshold, $\tilde{\mu}$, least cost separating outcome has

$$t_l = \underline{\pi} v, \quad t_h = x_h \bar{\pi} v$$

Equilibrium Characterization in Static Model

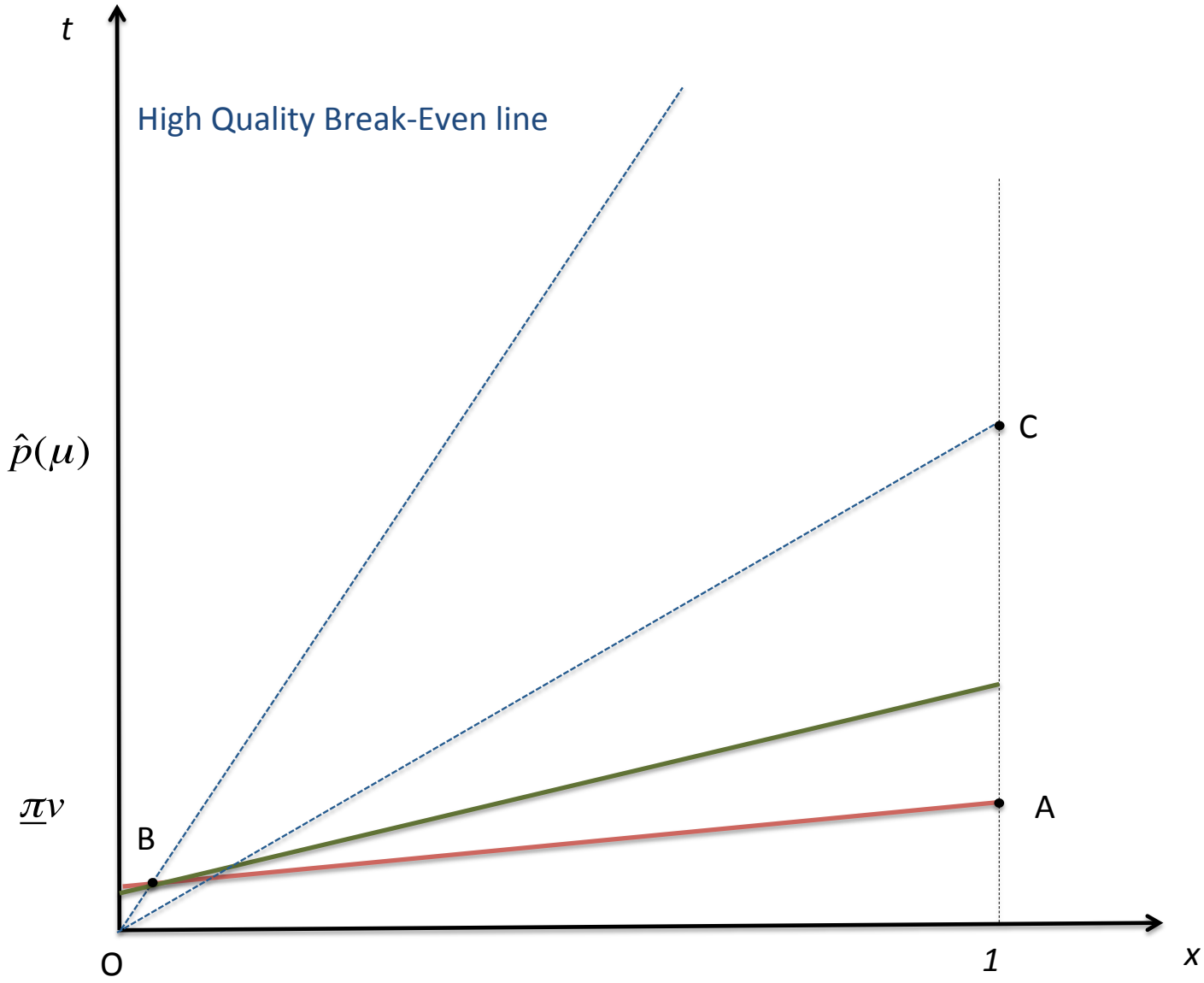


- Low prior(reputation): Least Cost Separating Equilbirium

Equilibrium Characterization in Static Model

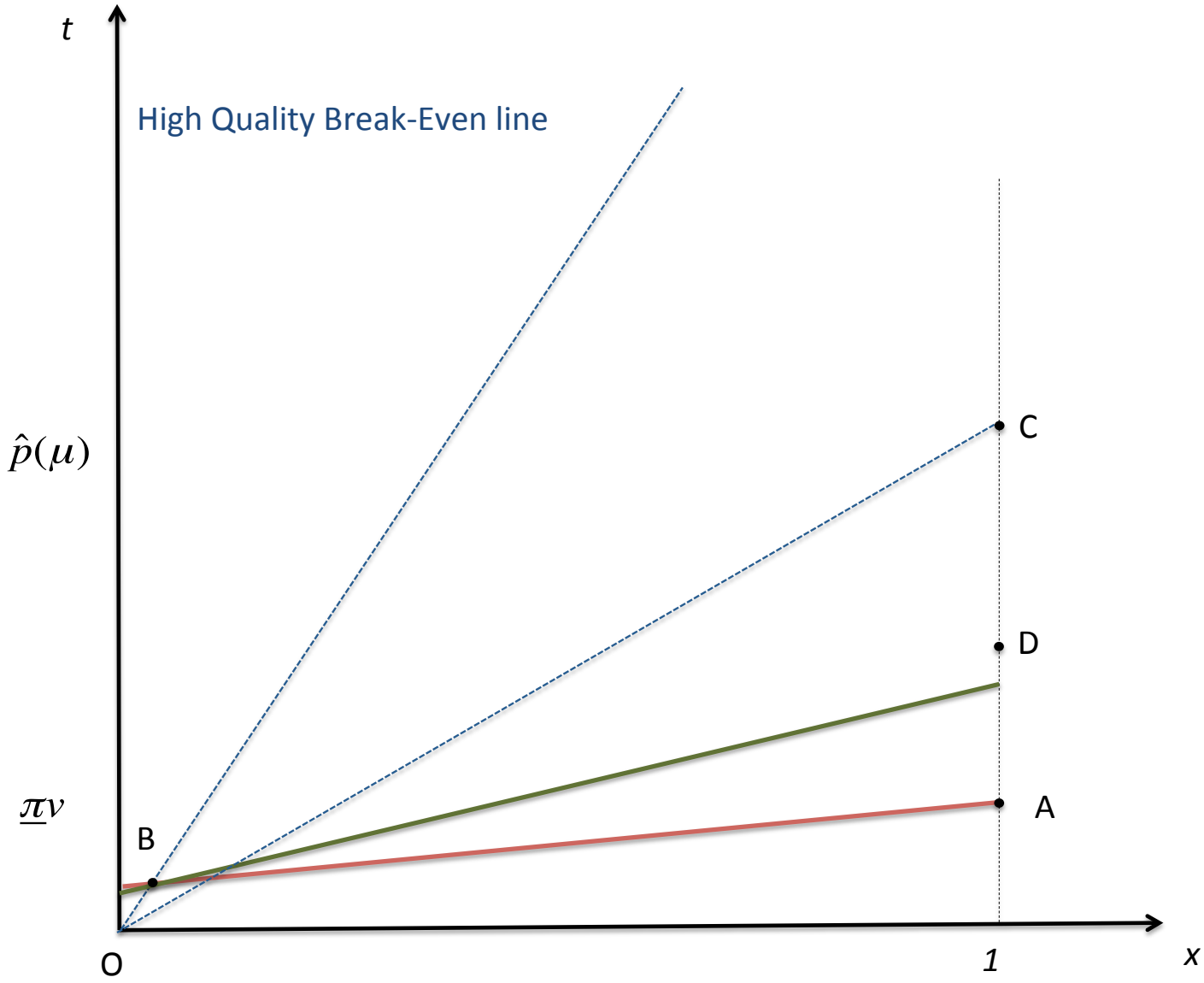
- At $\tilde{\mu}$, high-quality bank indifferent between pooling and Least Cost Separating outcome
- For reputation above threshold, $\tilde{\mu}$, no pure strategy equilibrium
- So focus on mixed strategy equilibrium
- Let F denote the distribution over t_l
- Idea: deviations attract low-quality banks with disproportionate probability

Equilibrium Characterization in Static Model



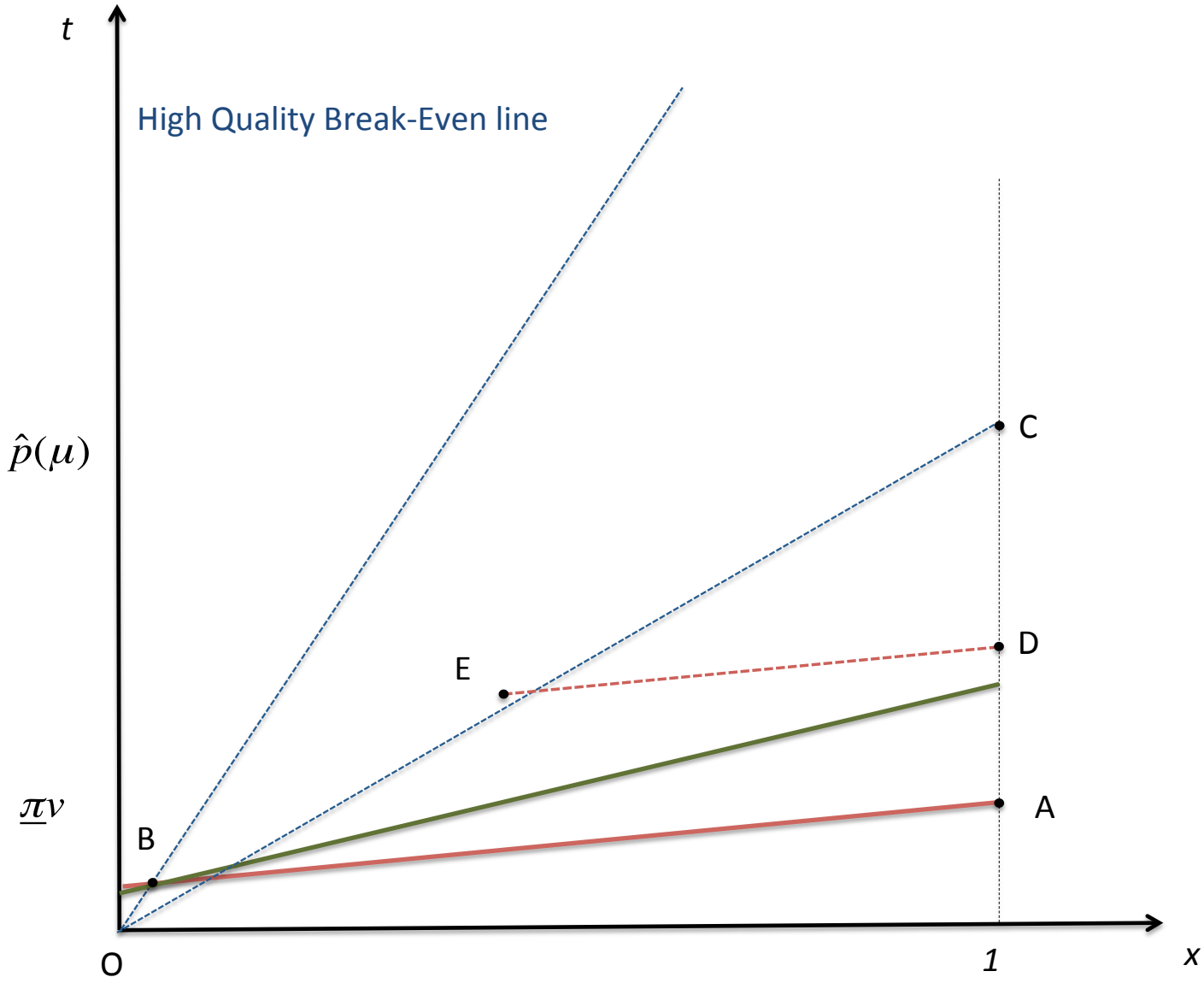
- High reputation: pooling (C) beats A and B

Equilibrium Characterization in Static Model



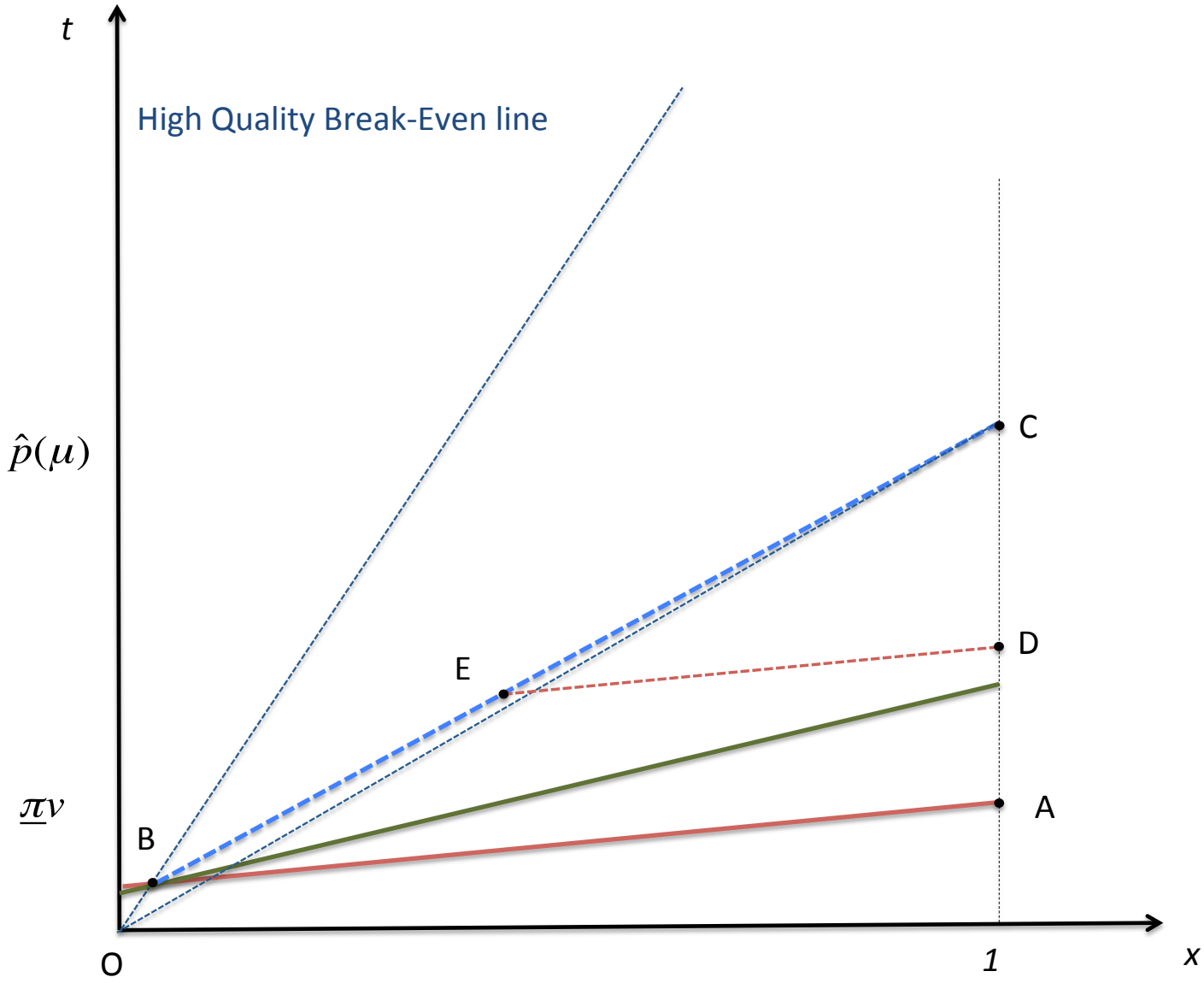
- Offer D to low-quality banks

Equilibrium Characterization in Static Model



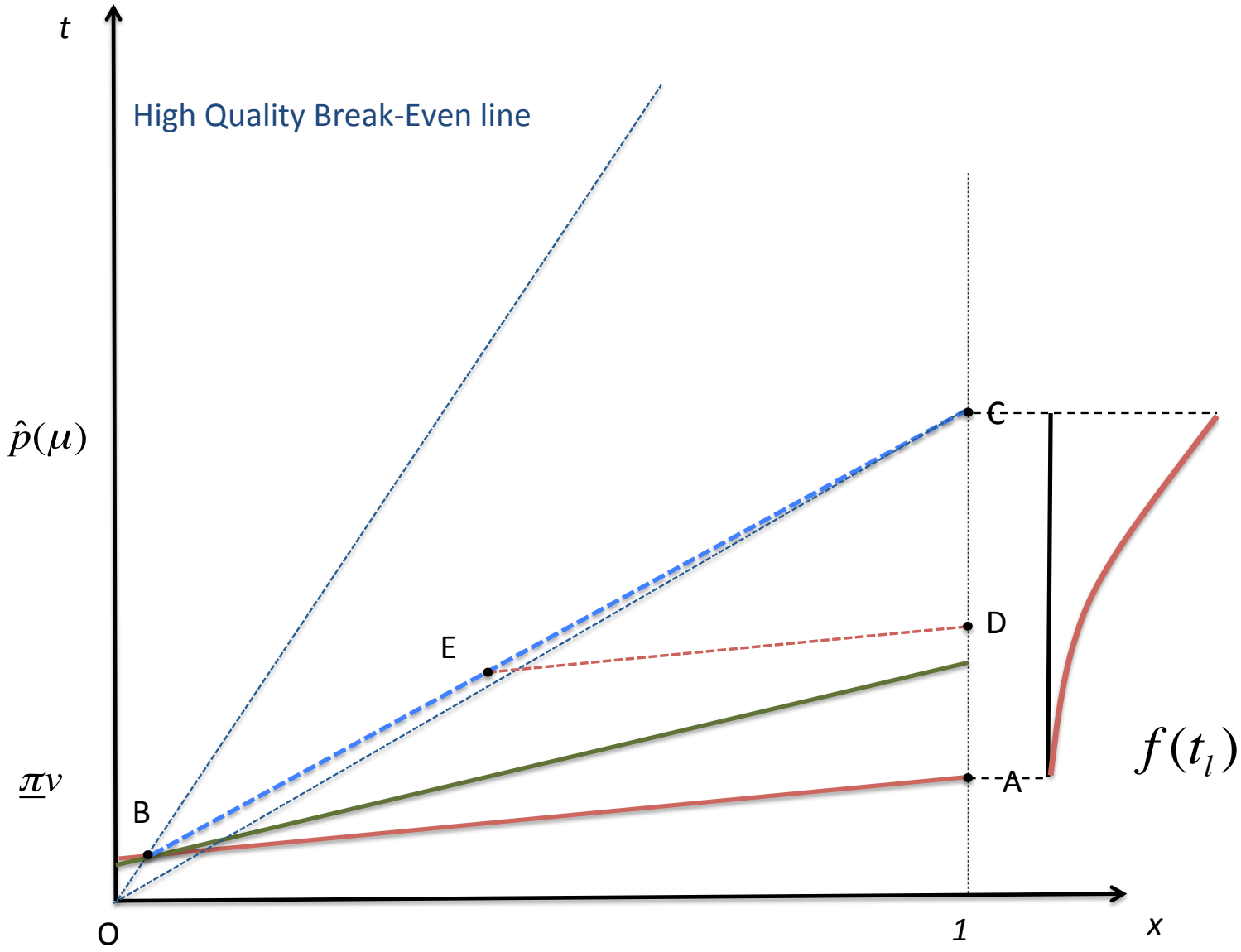
- Ride along low-quality bank's indifference curve to zero profits; Cross-subsidization

Equilibrium Characterization in Static Model



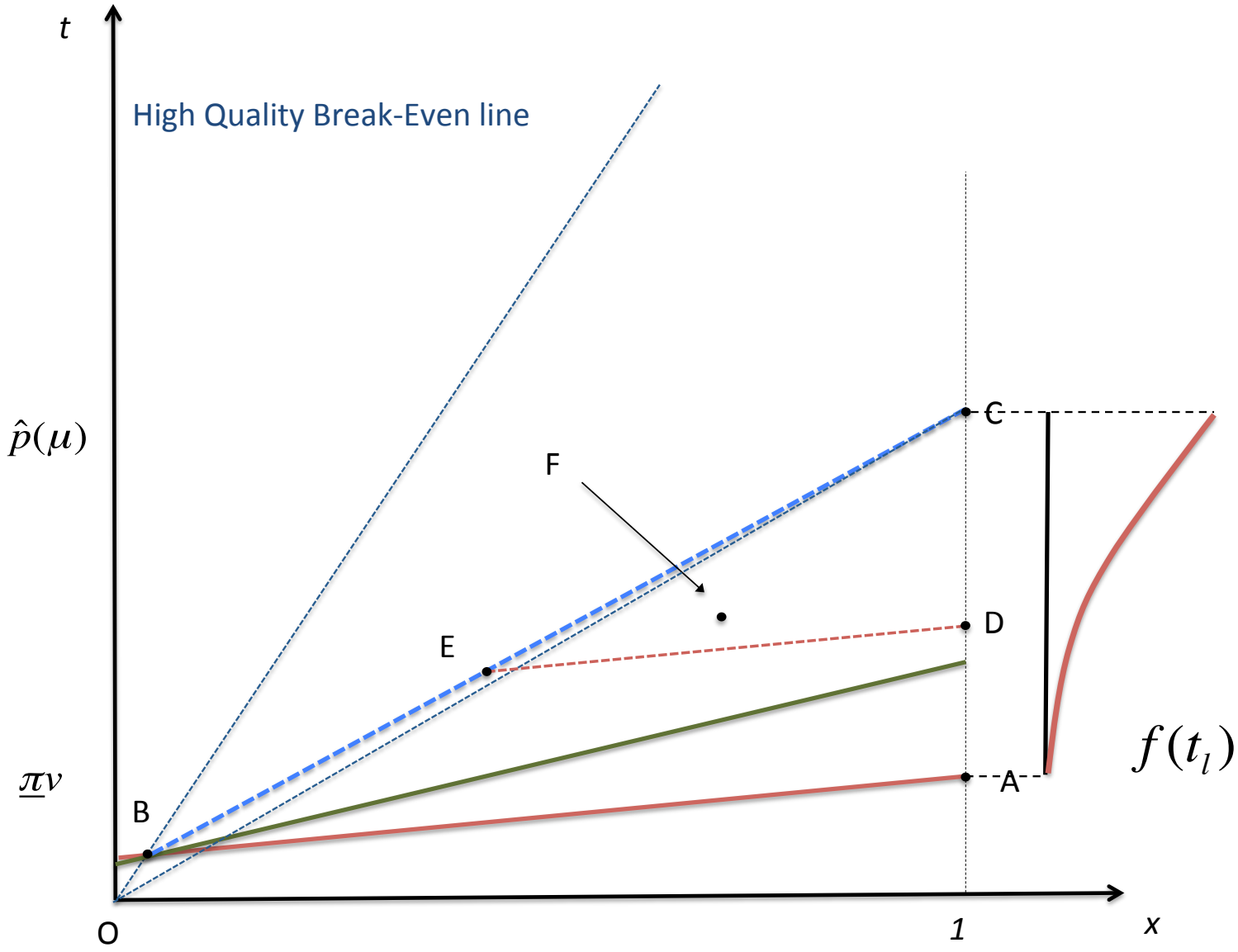
- Mixed Strategy Equilibrium

Equilibrium Characterization in Static Model



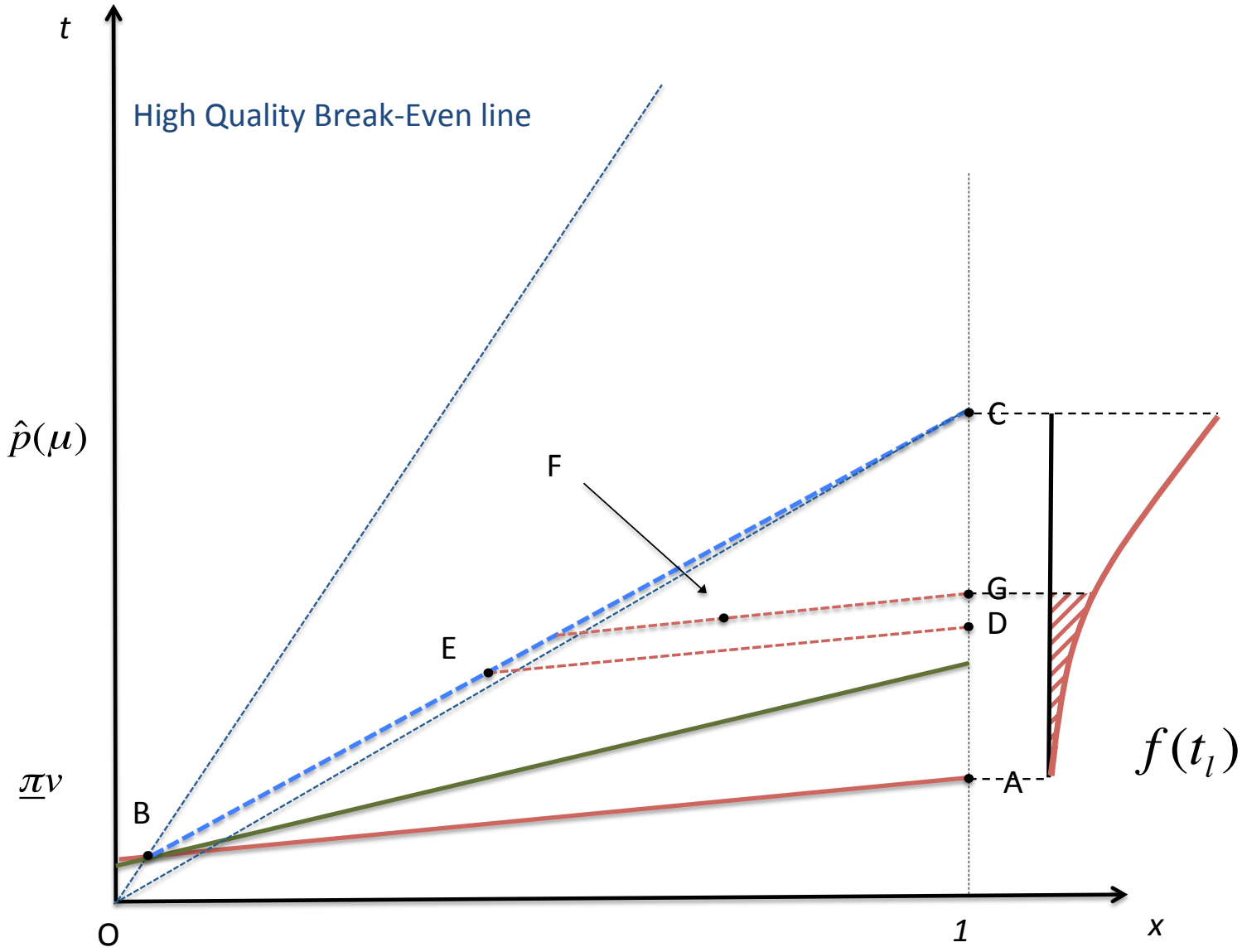
- Mixed Strategy Equilibrium

Equilibrium Characterization in Static Model



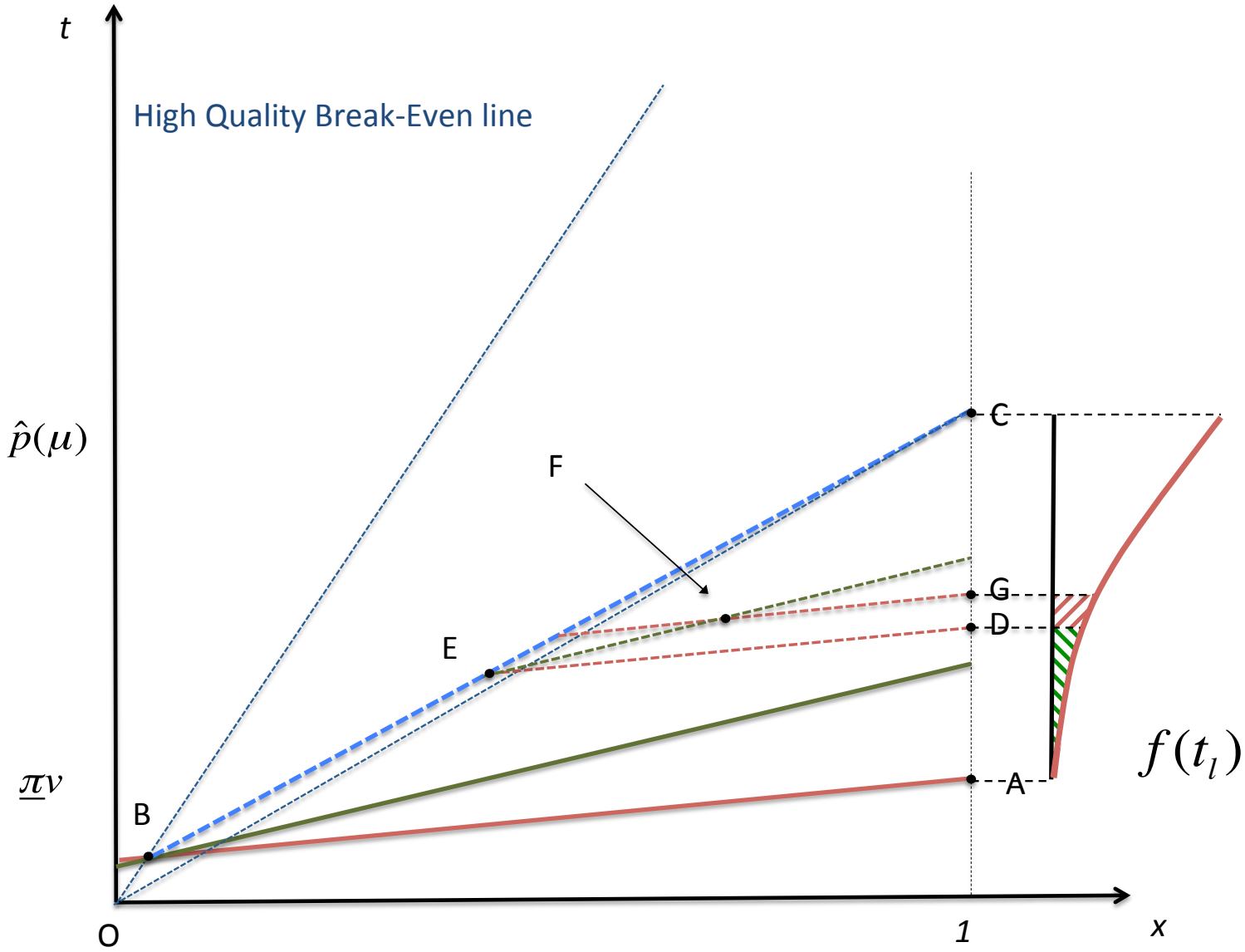
- Why deviation involving F is not profitable

Equilibrium Characterization in Static Model



- Why deviation F-G is not profitable

Equilibrium Characterization in Static Model



- Why deviation F-G is not profitable

Comparative Statics: Collateral Value Shocks and Volume

- How does an increase in v affect volume?

- Suppose μ is low:
  Incentive compatibility:

$$\underline{\pi} v = \bar{\pi} v x_h + (1 - x_h)(\underline{\pi} v - c)$$

- An increase in v, increases RHS more than LHS
  Low quality bank more tempted to lie; lower fraction sold by high quality bank

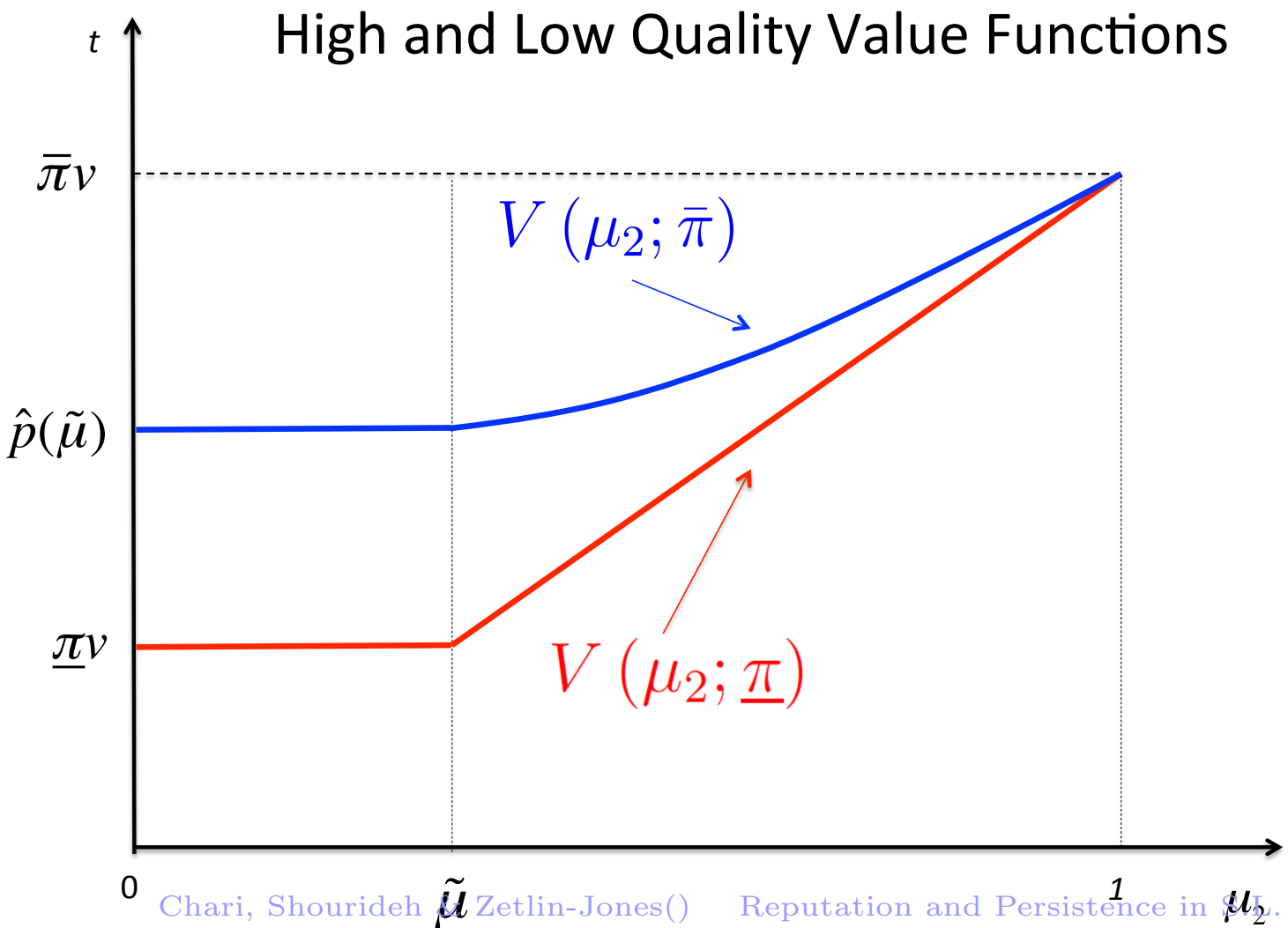
- Similar argument for high μ

Proposition

An decrease in collateral value leads to a decline in total volume of trade.

Main take-away

- Static separating equilibrium; Volume decreasing in spread
- Value function implied by static model - strictly sub-modular.



Dynamic Model of Adverse Selection in Secondary Loan Markets

Dynamic Environment

- In each $t = 1, 2$, banks originate loan portfolio
- Buyers offer 1 period contracts z
- Banks discount future payoffs at rate β
- Buyers observe contracts chosen by bank in previous periods
- Simplifications (abstract from other sources of learning):
  - Bank type is fully persistent
  - Buyers do not observe returns on loans in previous periods

Without Reputational Concerns

Proposition

Suppose $\beta = 0$ (or small). The equilibrium features full separation and complete learning in the first period. Trade volume in second period is independent of collateral values.

- Persistence issue: trade volume not linked to collateral values in second period
- Correlation issue: volume across bank types not correlated
- Same with more periods
- Why reputation is necessary

Findings With Reputational Concerns

- When β is large enough, no equilibrium features full separation
  - Implies Adverse Selection *persists*
  - Why reputation is sufficient
- Equilibrium has complete pooling for high reputations
- Equilibrium has partial pooling for low reputations
- Volume of trade in both periods declines when collateral values fall

No Fully Separating Equilibrium Exists

Proposition

Suppose $\beta \geq \beta_1$. Then no equilibrium has complete separation of high- and low-quality banks in the first period.

- In a separating equilibrium, static loss from mimicking the high type, but dynamic gain. For β sufficiently large, dynamic gain dominates
- Implies any equilibrium features at best partial revelation of information over time
- Implies adverse selection must persist so changes in collateral value induce changes in volume in the long-run

No Fully Separating Equilibrium Exists

Proof:

- In a separating equilibrium, incentive compatibility:

$$t_h + (1 - x_h)(\bar{\pi} v - c) + \beta V(1; \bar{\pi}) \geq t_l + (1 - x_l)(\bar{\pi} v - c) + \beta V(0; \bar{\pi})$$

$$t_l + (1 - x_l)(\underline{\pi} v - c) + \beta V(0; \underline{\pi}) \geq t_h + (1 - x_h)(\underline{\pi} v - c) + \beta V(1; \underline{\pi})$$

- Add them up:

$$(x_l - x_h)(\bar{\pi} - \underline{\pi}) v \geq \beta[(V(1; \underline{\pi}) - V(0; \underline{\pi})) - (V(1; \bar{\pi}) - V(0; \bar{\pi}))]$$

- When β is large enough, impossible to satisfy

Equilibrium Characterization in Dynamic Model

- Proposition above implies outcomes must have some pooling
- Signaling model with lots of equilibria: focus on the maximal-trade equilibrium
  - Maximal trade equilibrium pareto dominates other equilibria – more on this later

Proposition

If β is larger than β_1, the maximal trade equilibrium in the first period has the form:

- *When reputation is high, equilibrium has complete pooling: both types sell all their loans*
- *When reputation is low, equilibrium has partial pooling: low types randomize*

Characterization for High Reputation

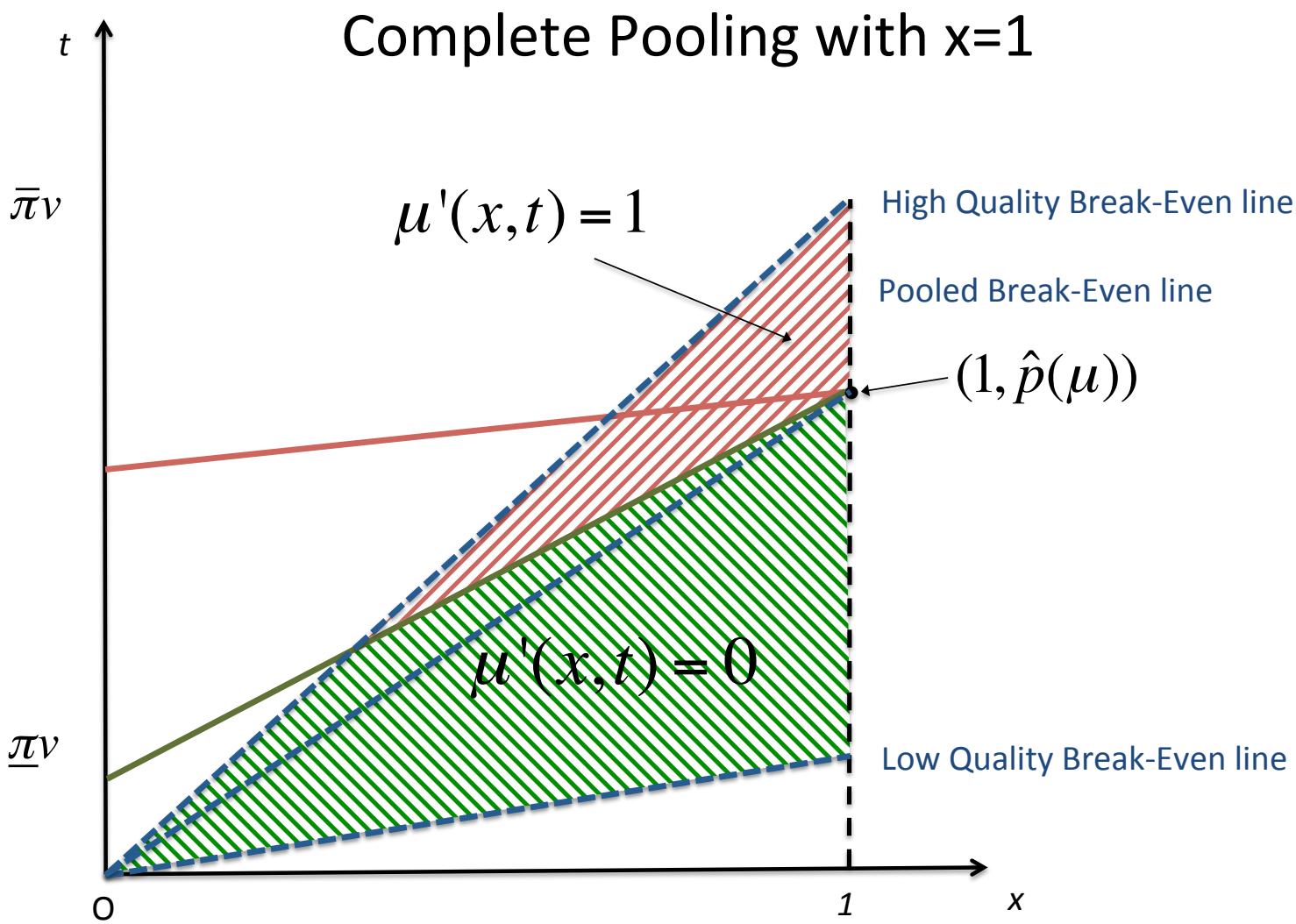
- Look for equilibrium with full trade
- At threshold μ^*, high-quality bank indifferent between pooling outcome and holding its loan
- When $\mu \geq \mu^*$, equilibrium has *complete pooling* with full trade
  - High- and low-quality banks sell all their loans
- Equilibrium features:
  - Both banks sell all loans at pooling price
  - Reputation levels do not change
  - Off-path beliefs:

$$\mu'(\hat{x}, \hat{t}) = \begin{cases} 1 & \text{if } \hat{t} + (1 - \hat{x})(\bar{\pi}v - c) \geq \hat{p}(\mu) \\ 0 & \text{otherwise} \end{cases}$$

Logic of Proof for High Reputation

- Consider cream-skimming contracts with lower number of loans sold and payment attractive only to high-quality banks
  - Such cream-skimming profitable deviation in static model
  - In dynamic model, reputational gains imply low-quality can earn future profits by accepting cream-skimming contracts
  - So such deviation not profitable
- We show logic of argument extends to deviations where buyer proposes contracts with different offers

Off-Path Beliefs Prevent Cream-Skimming



Characterization for Low Reputation

- When $\mu < \mu^*$, full trade not an equilibrium; instead we have *partial pooling*

- Any symmetric equilibrium is of the following form:
  - Buyers offer $z = (x_h, t_h, x_l, t_l)$
  - High quality bank: choose (x_h, t_h)
  - Low quality bank: randomize

Characterization for Low Reputation

- Properties induced by equilibrium:
  - IC:

$$t_h+(1-x_h)(\bar{\pi}v-c)+\beta V(\mu_h';\bar{\pi}) \geq t_l+(1-x_l)(\bar{\pi}v-c)+\beta V(0;\bar{\pi})$$

$$t_l+(1-x_l)(\underline{\pi}v-c)+\beta V(0;\underline{\pi}) = t_h+(1-x_h)(\underline{\pi}v-c)+\beta V(\mu_h';\underline{\pi})$$

  - zero profits
  - Participation for high quality bank

$$t_h + (1-x_h)(\bar{\pi}v-c) + \beta V(\mu_h';\bar{\pi}) \geq \bar{\pi}v - c + \beta V(0;\bar{\pi})$$

  - Betrand Competition:

$$\frac{1}{2}\mu(x_h\bar{\pi}v - t_h) + (1-\mu)(\underline{\pi}v - t_l - (1-x_l)(\underline{\pi}v - c)) \leq 0$$

Characterization for Low Reputation

Proposition

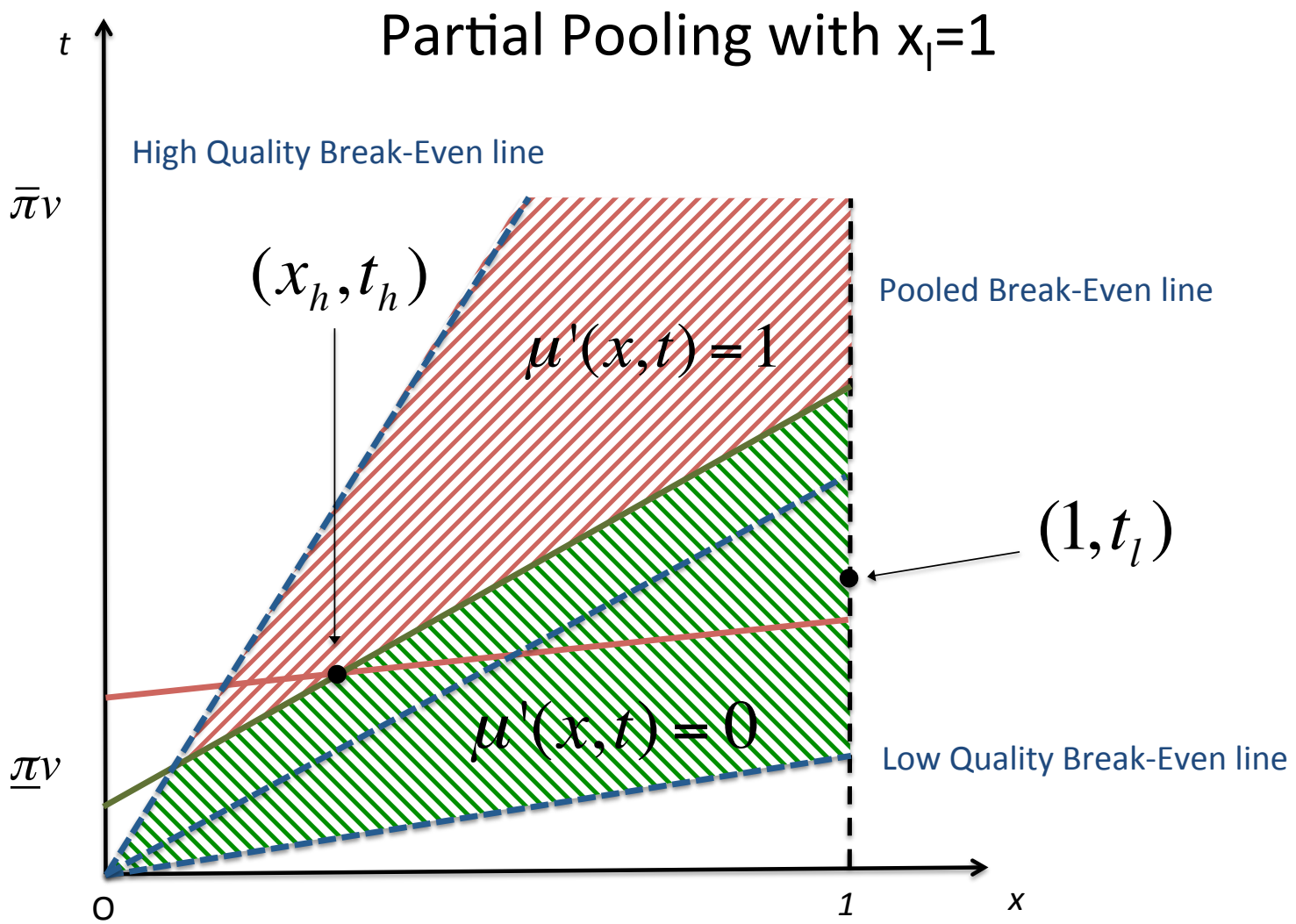
A contract $z = (x_h, t_h, x_l, t_l)$ is a partial pooling symmetric equilibrium if and only if it satisfies the above.

- Maximal Trade Equilibrium: Maximize trade volume subject to above

Logic of Proof for Low Reputation

- As when reputation high, reputational gains ensure buyers cannot profitably cream-skim
- Buyers also have incentive to induce better sorting by low-quality types by adjusting (x_l, t_l)
- Such a deviation
  - may increase profits per low-quality bank
  - attracts low-quality banks with greater probability
- Bertand Competition constraint ensures deviation attracts disproportionate number of low-quality banks so deviation is unprofitable

Off-Path Beliefs Prevent Cream-Skimming



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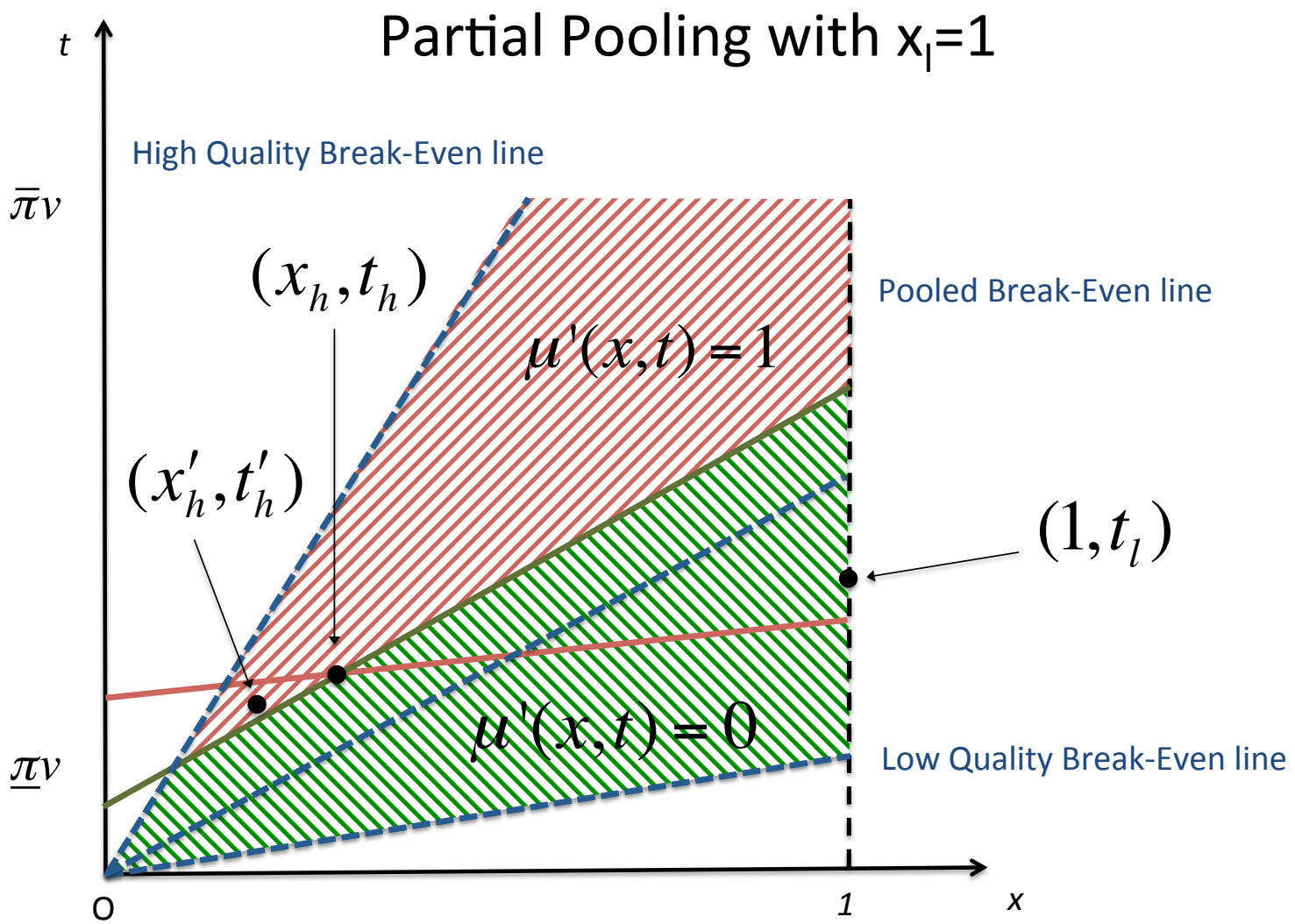

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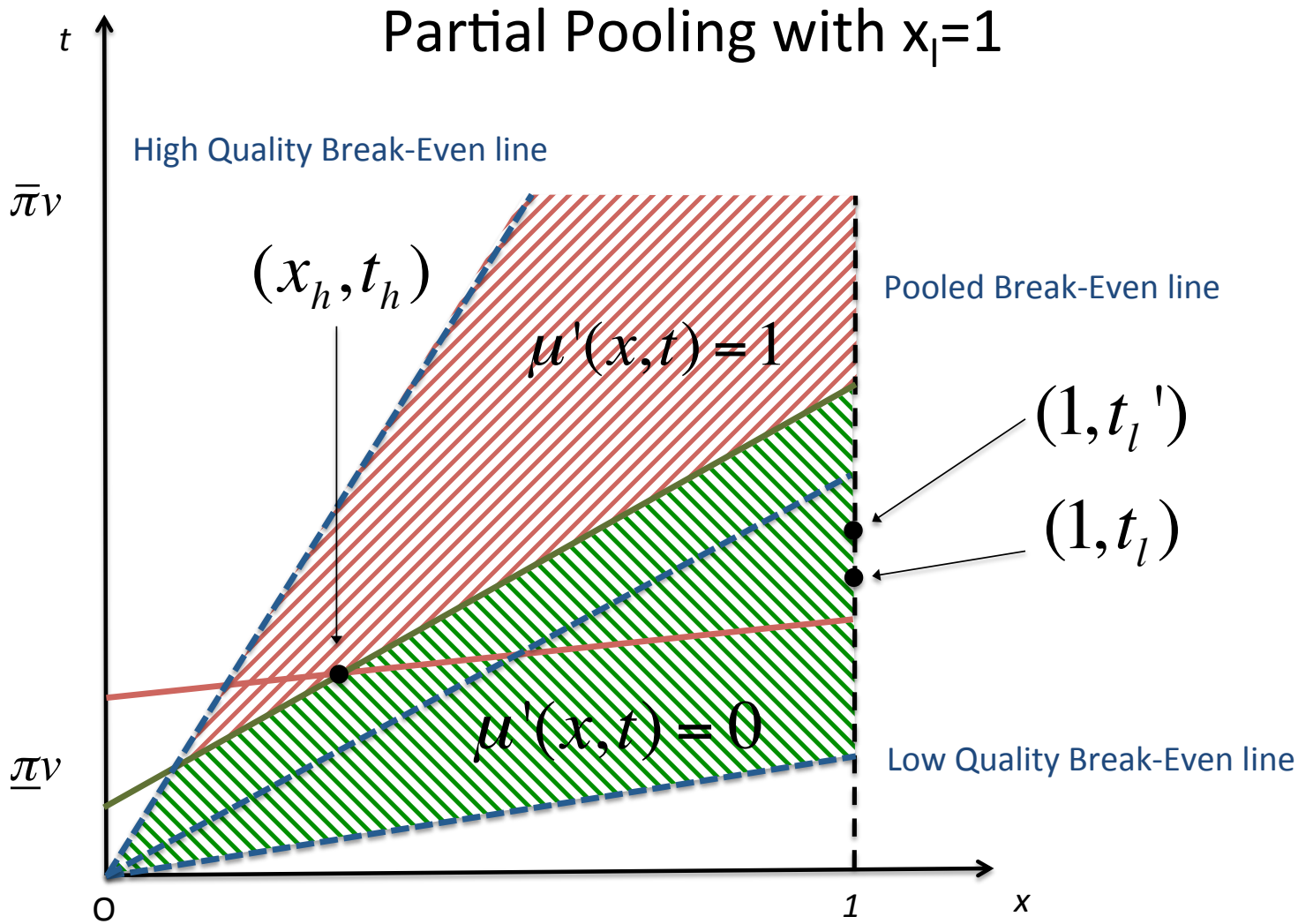


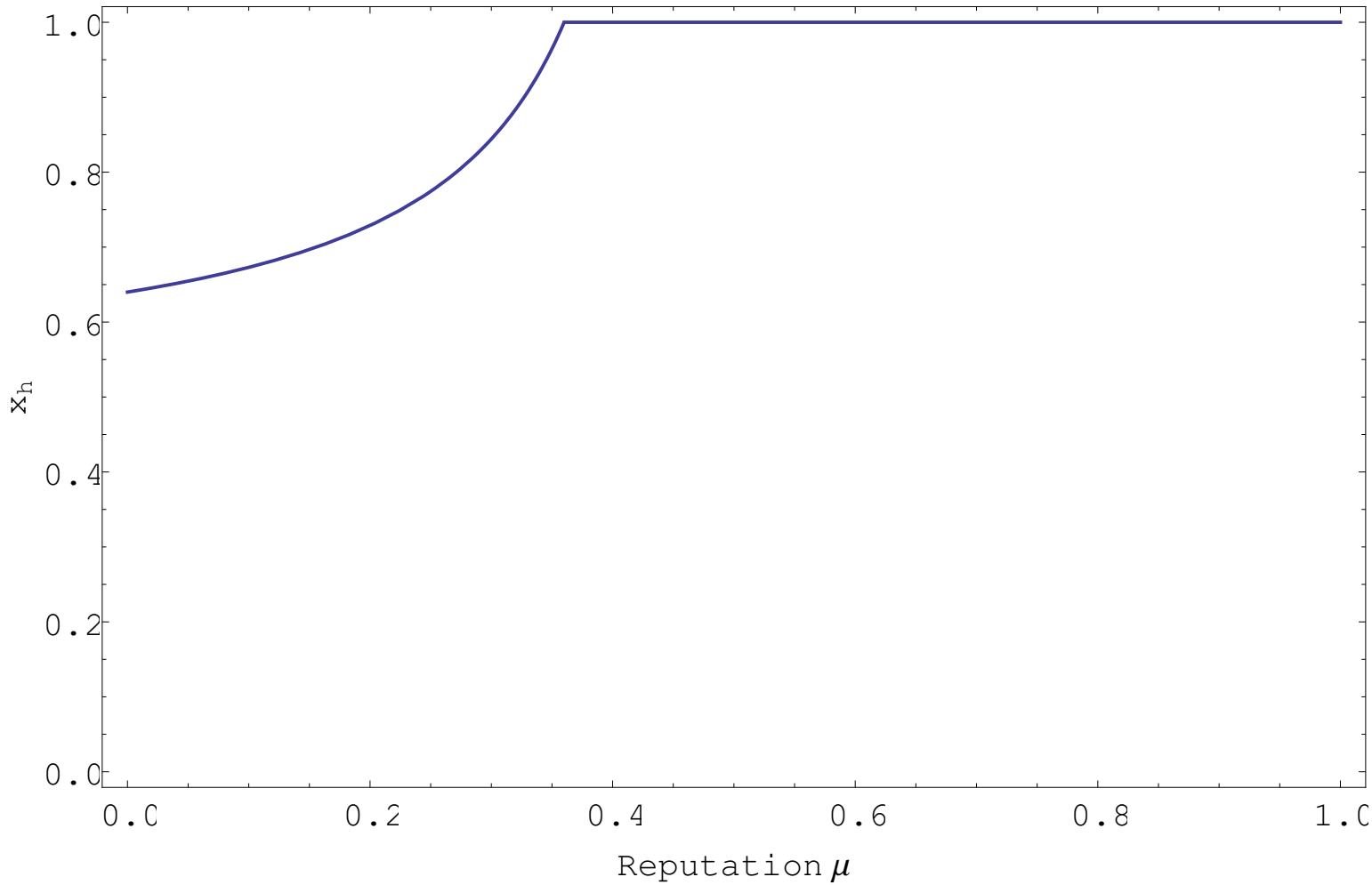
- Explaining Bertrand Constraint

Properties of Maximal Trade Equilibria

- High μ
  - Both bank types sell
  - No learning ($\mu' = \mu$)

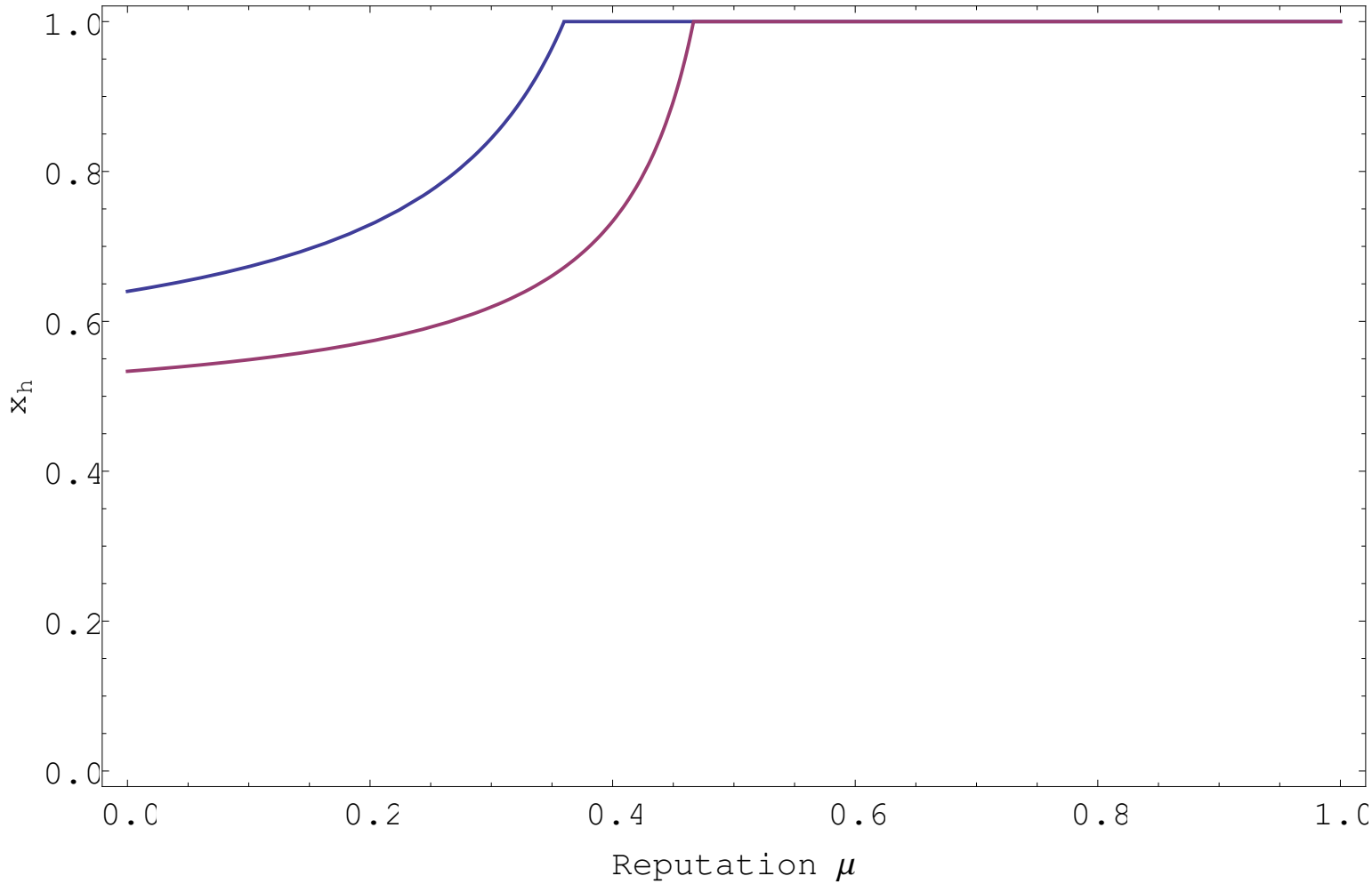
- Low μ:
  - Cross-subsidization
  - Some learning
  - Can show participation constraint for high-quality bank binds
  - Can show bertrand constraint binds only when v is high and μ is low

Comparative Statics on Collateral Value



- x_h in maximal trade equilibrium

Maximal Trade Equilibrium



- Increase in v lowers x_h and so volume in maximal trade equilibrium

Volume of Trade and Collateral Values

Proposition

Temporary reduction in collateral values in first period reduces expected trade volume for both types

- If $H_1(\mu)$ has mass at or below μ^*: trade volume falls
- Infinite horizon: endogenize distribution of reputation

Dynamic Model of Adverse Selection in Secondary Loan Markets:

Infinite Horizon With Reputational Concerns

Infinite Horizon with Stochastic Collateral Value

- Assume $v_t \sim G(v_t), v_t \in [v_{min}, v_{max}]$

- Quality of banks not fully persistent:
  - Each period, bank draws new quality with prob. λ (observable)
  - If new draw, becomes high-quality with prob. $\mu_0 \sim H(\mu_0)$
    - $H(\cdot)$: continuous distribution; support $=[0,1]$

The Model with Stochastic Loan Spreads

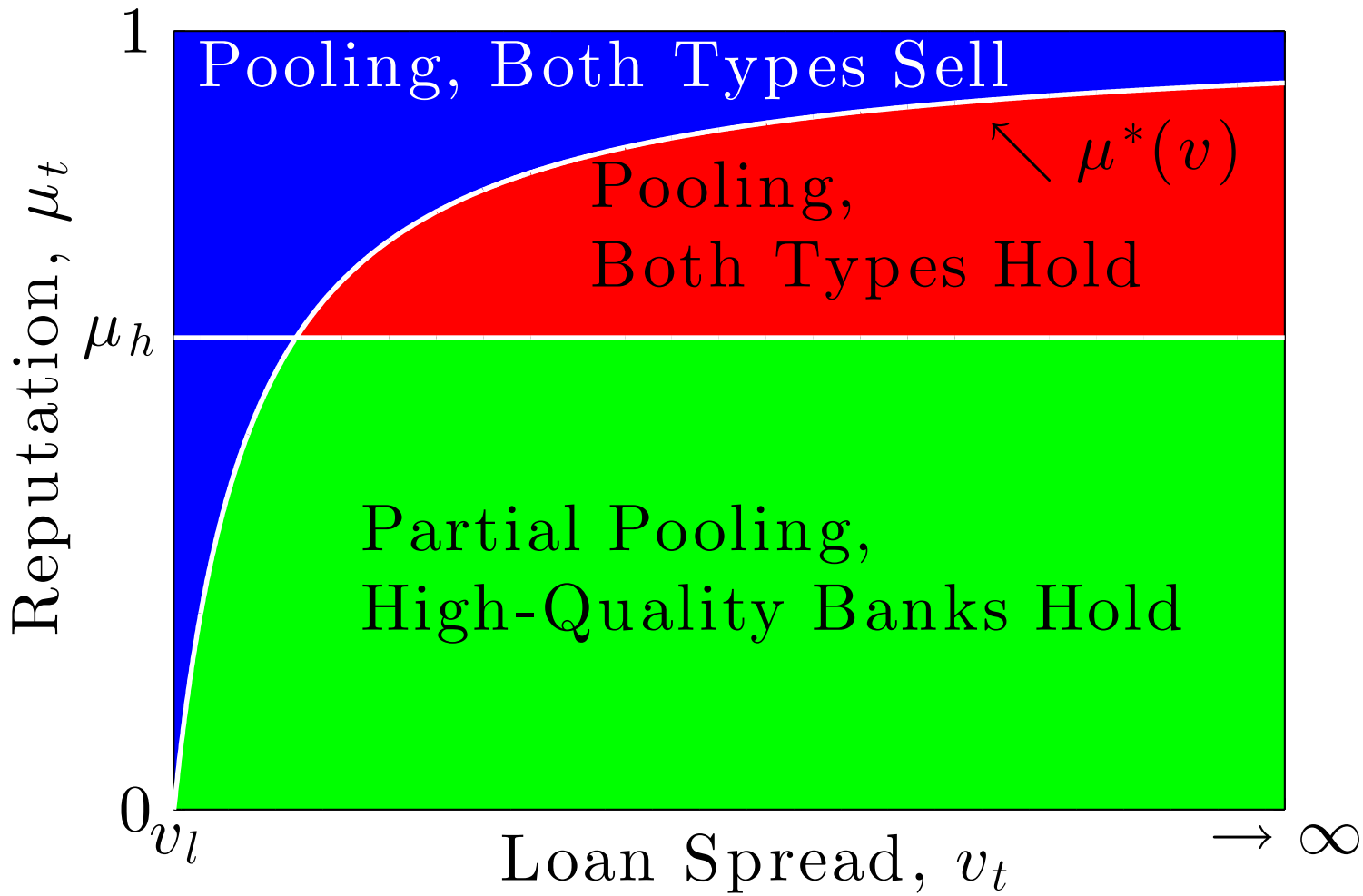
- If banks patient, then no separating equilibrium exists

- Equilibrium:
  - For each v_t, low reputation has partial-pooling, high reputation has complete pooling
  - For each μ_t, low spread has both types selling, high spread has at least high-quality bank holding

  - Partial Pooling
    - high-quality bank holds loans, low-quality bank mixes between holding and selling

  - Complete Pooling:
    - For low spreads, both types sell
    - For high spreads, both types hold

The Model with Stochastic Loan Spreads



The Model with Stochastic Loan Spreads

- Why Complete Pooling, Both Types Hold?
  - Low-quality banks hold to maintain reputation
  - Sell at favorable prices in future when spreads fall
  - Expected future aggregate shocks imply maintaining reputation has value

- Would not be consistent with equilibrium in deterministic model

- Implies anticipation of future shocks to v affects nature of equilibrium
  - Greater value to maintaining a reputation

Anticipated Shocks to Collateral Values

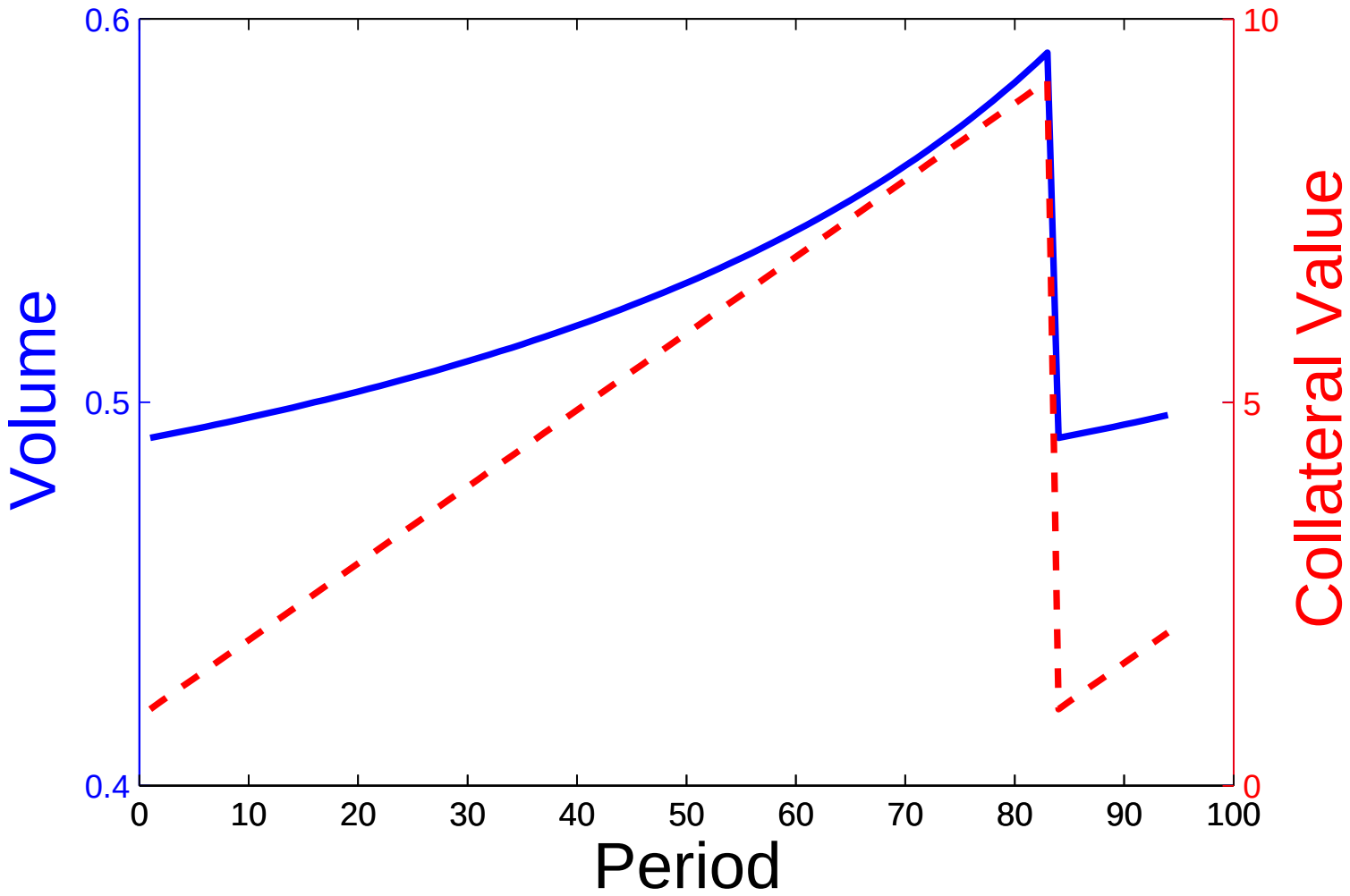
- Invariant distribution:
  - Mass at $0, \mu_h$
  - Continuous everywhere else

- Mass points at $0, \mu_h$: discontinuous change in volume

Proposition

If $\beta \geq \underline{\beta}$ and shocks to collateral values are independent over time, aggregate volume is declining in the spread, v, and declines are discontinuous.

A Simulation



Implications for Policy

Implications for Policy

- End of 2007, policymakers implemented programs intended to re-start volume of trade in secondary loan markets

- Optimal Policies in this environment? Two period model

- Our notion of constrained efficiency with commitment
  - Maximize ex-ante payoff of banks
  - Respect incentives
  - Do nothing in the second period
  - Bester and Strausz (2001): direct mechanisms with mixed strategies

Planning Problem

- First period bank payoffs equal to $\hat{p}(\mu) - c(1-T)$, so that

$$\max \hat{p}(\mu) - c\mathbb{E}_\mu \left[(1-x_i)\right] + \beta \mathbb{E}_\mu V(\mu_i'; \pi_i)$$

subject to

- Incentive compatibility
- Banks' participation constraints
- Buyers' participation constraints
- Note: equilibrium has Bertrand constraint in addition

Efficiency with High Reputation

Proposition

Pooling with full volume of trade is constrained efficient.

- Complete pooling maximizes first period payoffs
- Separation could increase second period continuation values
- Separation tightens IC, has lower trade trade in first period and so lower first period payoffs
- Show separation cannot increase welfare because value functions satisfy decreasing differences (sub-modularity)

Efficiency with Low Reputation

Proposition

Maximal Trade equilibrium is inefficient if and only if reputation is low and v is high. When inefficient, there is too much separation in equilibrium.

- Basic logic:
  - Planner's allocation: partial pooling allocation
  - Recall the maximal trade equilibrium
  - Extra Constraint: imposed by Bertrand competition
  - Works as an externality

Efficiency with Low Reputation

- Efficiency pushes outcomes towards minimal separation
- Also requires $\mu'_h = \tilde{\mu}$
- As v rises, more cross-subsidization at x_h, t_h (rather than at x_l, t_l)
- Implies subsidy to low-quality bank at x_l, t_l decreasing in v
- Bertrand constraint (in equilibrium) requires higher subsidies to low-quality bank at x_l, t_l

Implications for Policy to Weakly Implement Efficient Allocations

- Intervene when adverse selection is severe
- Target low reputation banks
- Optimal Policy: Tax low-price/high-quantity trades.

Asset Purchase Policies and Strict Implementation

- Possible motivation for asset purchase policies:
  - Strict implementation of high volume equilibrium

- Policies that work require outside revenues or limits to private trade

Asset Purchase Policies that Do Not Work

- Consider version of our model without strategic interaction of buyers
- Banks and buyers take price $p(\mu)$ as given
- Banks choose x_h, x_l loans to sell
- Buyers choose y loans to buy
  $\Rightarrow$ buyers payoffs:

$$y\left[\mu \mathbb{1}_{[x_h>0]}(\bar{\pi}v - p(\mu)) + (1-\mu)\mathbb{1}_{[x_l>0]}(\underline{\pi}v - p(\mu))\right]$$

- Model has a competitive equilibrium with externalities

Static Model with Price Taking Behavior

- When $\mu \geq \mu^*$, multiple equilibria
- High-trade: $p(\mu) = \hat{p}(\mu) = \mu\bar{\pi}v + (1-\mu)\underline{\pi}v$
  - Both banks sell their loans
- Low-trade: $p(\mu) = \underline{\pi}v$
  - Only low-quality banks sell their loans
- Good policy: Offer to buy at $\hat{p}(\mu)$
  - Eliminates low-trade equilibrium
  - Does not require resources by Gov't
  - Similar to deposit insurance in bank run models

Asset Purchase Policies in Dynamic Model

- Why we prefer our equilibrium concept
  - Buyers have strong incentives to cream-skim, use nonlinear contracts
  - Restricting to linear contracts, have strong incentives to offer pooling price near $\hat{p}(\mu)$

- Our model has multiple equilibria:
  - Suppose equilibrium switches from maximal volume to zero volume in our dynamic model

Asset Purchase Policies That Do Work

- Gov't offers to buy $(1, \hat{p}(\mu))$ in first period
- Policy at best ineffective
  - Either nobody sells to government or only low-quality bank sells to government
- Reason:
  - An individual buyer could have offered this contract
  - Did not do so because was not profitable
  - So policy does not work
- For price $p > \hat{p}(\mu)$ can attract high-quality banks but also attract low-quality banks
  - Implies policy requires outside resources

Conclusions

- Adverse selection is a promising candidate for fluctuations
- Lack of anonymity implies those who think adverse selection is promising should take reputation seriously
- We have developed a tractable model of adverse selection and reputation; useful for other applications as well