Ignorance, Debt and Financial Crises

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Introduction

Money Markets (MM)

- High velocity trading ($billions traded quickly with no questions asked)

- MM instruments (=cash-liked securities)

  E.g. Treasuries, agency MBS, ABCP, MMF, repo

- For a long time these MM functioned smoothly (Quiet period of banking)

- The sudden breakdown of several of these markets during recent financial crisis came as a big surprise

Example

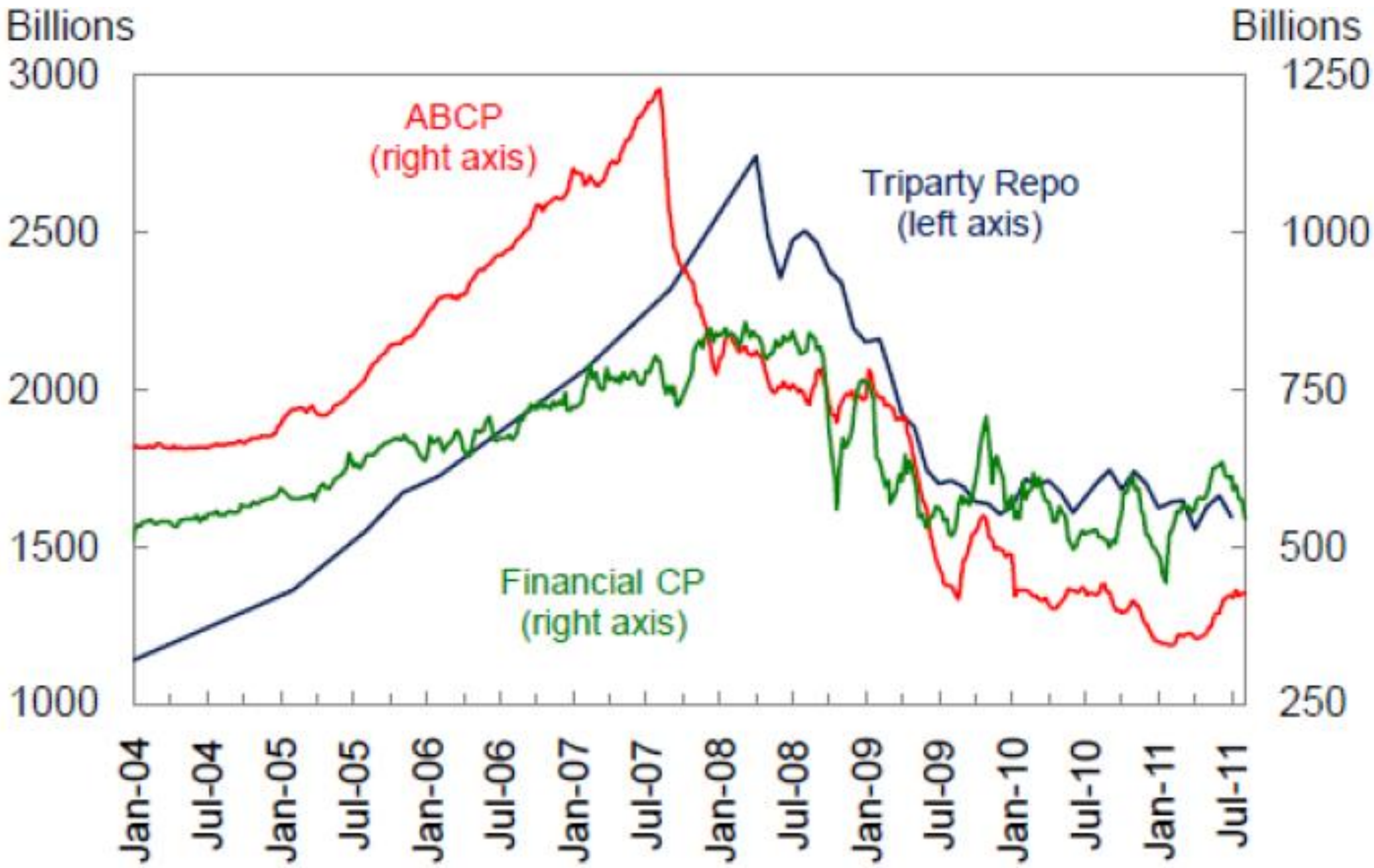
- Every morning more than $1 trillion rollover of tri-party repo in early 2008
- Daily trading volume of bilateral repo $5.81 trillion in 2007 (SIFMA (2008))
- Non-rollover of repos caused bankruptcy of Bear Stearns and Lehman

Bankruptcy Examiner's report (2010, p.3):

> "*Lehman funded itself through the short-term repo markets and had to borrow tens or hundreds of billions of dollars in those markets each day from counterparties to be able to open for business.*"

Note: Daily trading volume of all stocks at NYSE $87 billion in 2007

Outstanding Volume of Overnight Tri-Party Repo (in $bn)



Source: FRBNY and Federal Reserve Board

Money Markets versus Stock Markets

MM Markets	Stock Markets
- Cash and liability management	- Long term investment
- Delay can cause bankruptcy	- Can wait to trade shares
- No time for questions	- Much more money spent on analyses
- Shared understanding of ratings	- Price discovery through continuous trading
- “Trust”-based	- Thrives on heterogeneous beliefs
- Over-the-counter trading	- Centralized exchanges

The Nature of Liquidity Provision

- "No Questions Asked" = Liquidity (in money markets)

- Money markets very different from stock markets

- Academic work mainly focuses on stock trading

- A coherent theory of crisis should provide consistent answers to:

  What went "wrong" in the 2007/08 crisis <u>and</u> what went "right" in the last several decades?

- Understanding the nature of liquidity provision is central for the regulation of the banking system

Our Paper

Theory of money markets and private money

1) Formalize the notion of "No-Question-Asked"

→ New tail risk measure: Information Acquisition Sensitivity (IAS)

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   → Debt has minimal IAS (IA insensitive debt is private money)

   → Debt maximizes re-trade value if there is bad public news

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2) Two reasons for the optimality of debt as private money (=parking space)

   → Debt has minimal IAS (IA insensitive debt is private money)

   → Debt maximizes re-trade value if there is bad public news

3) A new mechanism of a financial crisis

   → Information insensitive debt becomes information acquisition sensitive

Plan

Related literature

Model

Equilibrium analysis:

Optimal security design with

- Arrival of public information
- Endogenous acquisition of private information

Discussion: Policy Implications

Conclusion

Related Literature

		Our paper
-	Gorton and Pennacchi (1990)	but with optimality of debt and tail risk
-	Townsend (1979)	no ex post verifiability problem, opposite implications regarding info cost
-	DeMarzo and Duffie (1999)	optimal design to avoid asymmetric info
-	Hirshleifer (1971)	ignorance may be good
-	Diamond and Dybvig (1984)	no coordination failure, bankruptcy remote collateralized lending
-	Kyotaki and Moore (1997)	different crisis mechanism, linked to optimality of debt

Model

Modeling Objective

A simple model that captures the key features of

- a sequence of trades in over-the-counter money markets
- where an investor (e.g. APPL) wants to buy a security to store his cash
- but is concerned about resale price fluctuations (public news)
- and endogenous adverse selection (private information acquisition)
- when he needs to resale and access his cash

Question: What is the optimal security (=parking space) and inefficiencies?

Setting

Three agents {A, B, C} and three dates {0,1,2}

Preference and endowments

$U_A = C_{A0} + C_{A1} + C_{A2}$	$\varpi_A = (0,0,x)$	$F(x)$
$U_B = C_{B0} + \alpha C_{B1} + C_{B2}$	$\varpi_B = (w,0,0)$	
$U_C = C_{C0} + C_{C1} + C_{C2}$	$\varpi_C = (0,w_C,0)$	w, $w_C > 0$, $\alpha > 1$ constants

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$U_C = C_{C0} + C_{C1} + C_{C2}$	$\varpi_C = (0, w_C, 0)$	$w, w_C > 0$, $\alpha > 1$ constants

- At t=0: only x (project, pool of mortgages) is contractable;
  w_C (future income) is not (or agent C is not present at t=0)
- At t=2: realization of x is public information

Note: This presentation $w_C = w$ and $E[x] > w$.

Contracting

t=0: agent B proposes a price p_0 to buy a security s(x) backed by x from agent A

where {s(x): s(x)≤x, plus s(x) non-decreasing}

Examples (t=0 securities)

- Equity: s(x)=βx
- Debt: s(x)=min[x, D]   where D is face value
- s(x) can be a state contingent security or stochastic

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- Equity: s(x)=βx
- Debt: s(x)=min[x, D] where D is face value
- s(x) can be a state contingent security or stochastic

t=1: agent B proposes a price p_1 to sell a (new) security $\hat{s}(y)$ to agent C

where s(x)=y is collateral for new security and $\{\hat{s}(y):\ \hat{s}(y) \leq y\}$

Information

Symmetric information at t=0

All agents know F(x)

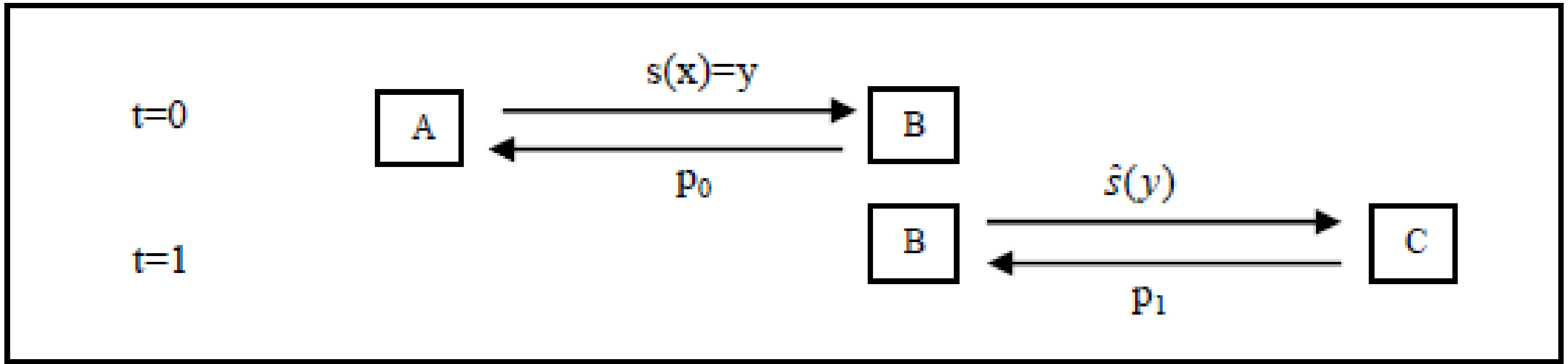
Public Information at t=1

Agents obtain public signal z about x: $\{F(x|z)\}$ (MLRP)

Possible Private Information Acquisition at t=1

Agent C can acquire *perfect* information about x at cost γ

Game



	A	B	C
t=0	p_0	$w-p_0$	0
t=1	0	αp_1	$w-p_1$
t=2	$x-s(x)$	$y-\hat{s}(y)$	$\hat{s}(y)$

Objective

- Optimal security design for Agent B (uninformed investors)

    - E.g. small financial institutions, cash-rich corporations

- Maximize agent B's expected utility subject to other agents getting their no trade options and agent C' information acquisition constraint.

    - E.g. investors with potential access to large data sets and sophisticated valuation models

Equilibrium Approach: Backward Induction

Decision of agent B:

At t=1: Optimal (p_1, $\hat{s}$(y)) to sell to agent C (taken y=s(x) as given)

At t=0: Optimal (p_0, s(x)) to buy from A

Equilibrium Analysis of the B-C Game at t=1

1) New measure and characteristic of security

→ Information Acquisition Sensitivity

2) Optimal contracting at t=1

Information Acquisition Sensitivity (IAS)

Agent C with $U_C=C_{C1}+C_{C2}$ can buy security s(y) for price p at t=1.

Value of Information = EU(Info) – EU(no info)

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Value of Information = EU(Info) – EU(no info)

Definition

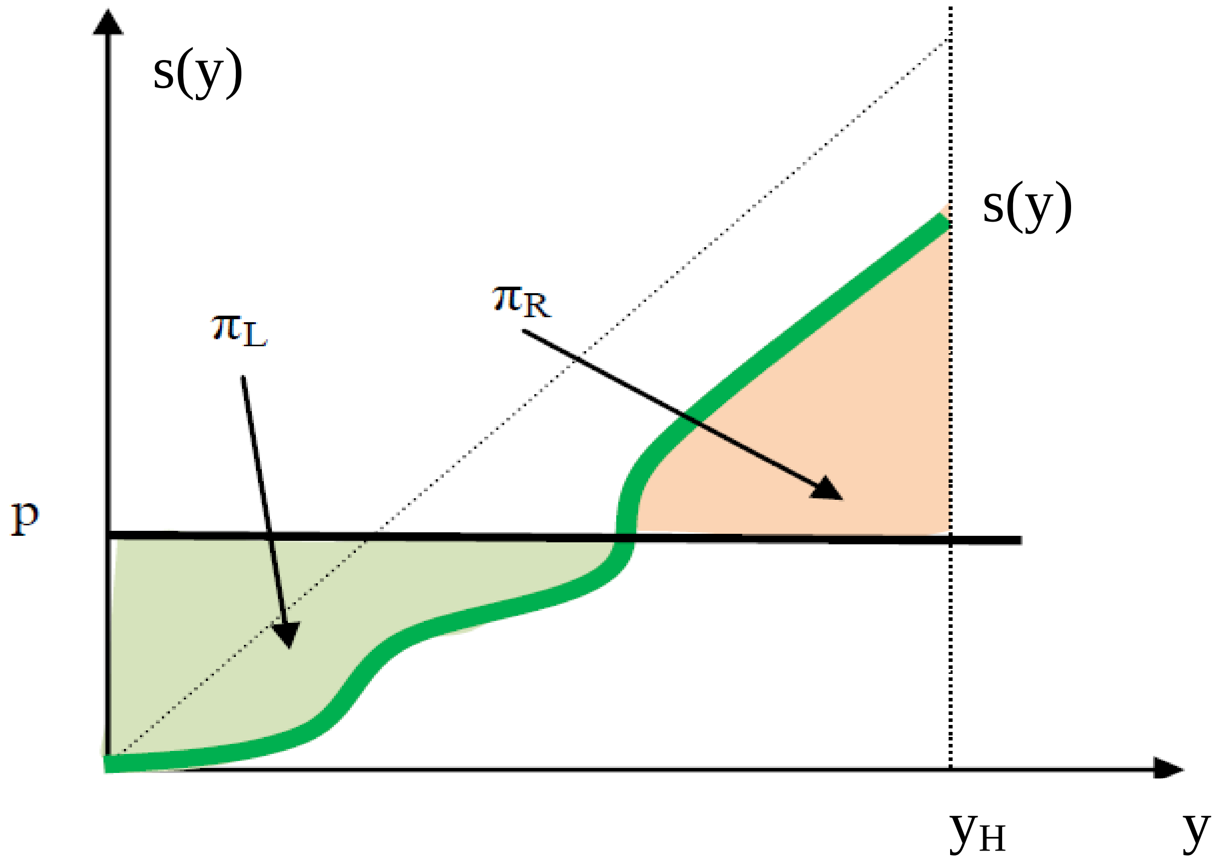
$$\pi_L(p) \equiv \int_{y_L}^{y_H} \max[p - s(y), 0] \cdot f(y)dy \qquad \pi_R(p) \equiv \int_{y_L}^{y_H} \max[s(y) - p, 0] \cdot f(y)dy.$$

Lemma 1 (IAS)

Consider an arbitrary contract (p,s(y)). The value of information to agent C or the IAS of (p, s(y)) is given as follows:

(i) If $p \leq E[s(y)]$, then $IAS = \pi_L$.

(ii) If $p \geq E[s(y)]$, then $IAS = \pi_R$.



$$\pi_L(p) \equiv \int_{y_L}^{y_H} \max[p - s(y), 0] \cdot f(y)dy \qquad \pi_R(p) \equiv \int_{y_L}^{y_H} \max[s(y) - p, 0] \cdot f(y)dy$$

Which security has minimal IAS?

Set of securities

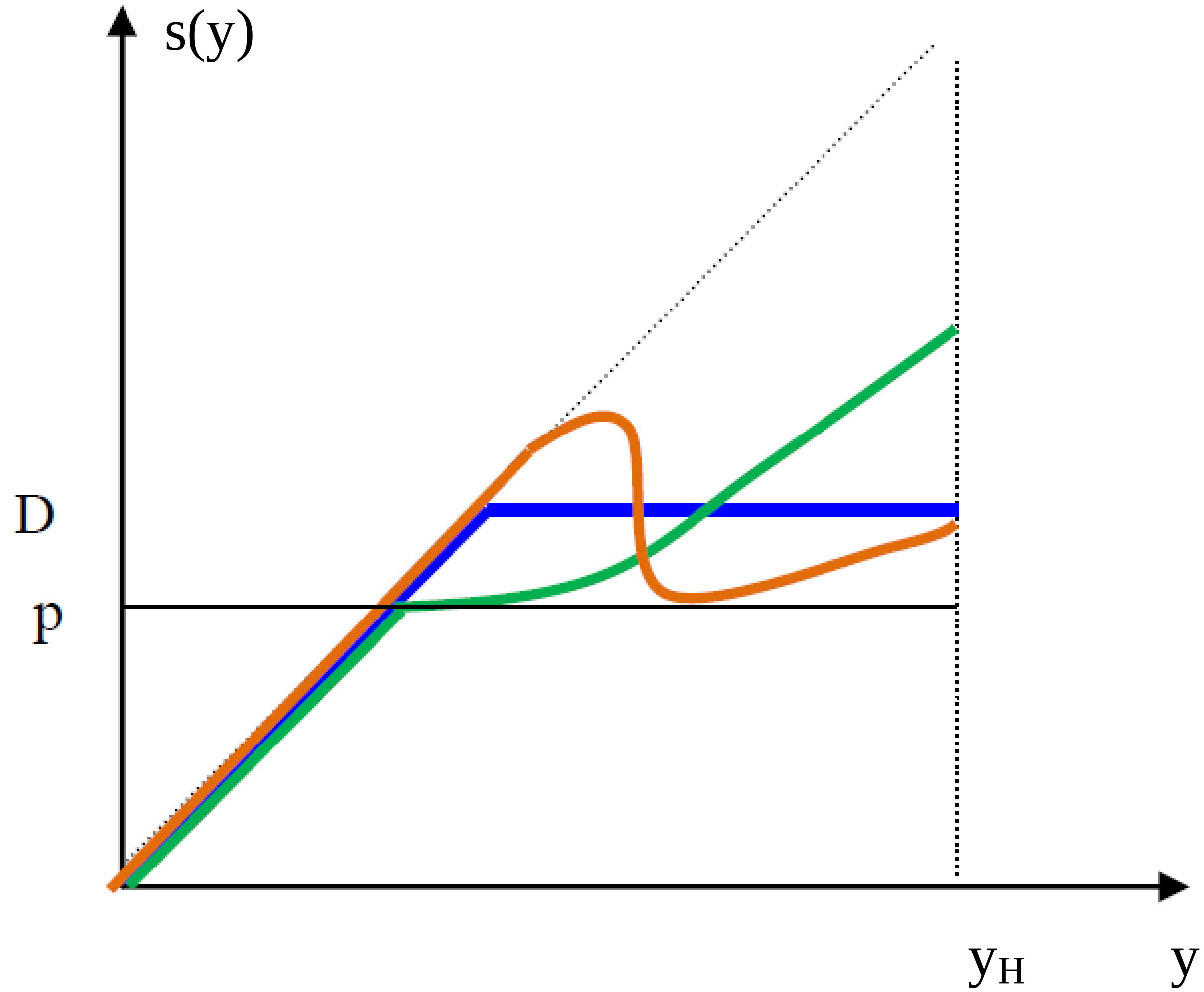
$S = \{(s(y) : s(y) \leq y \text{ and } E[s(y)] = V\}$.

Definition (Standard debt)

$s^D(y)=\min[y,D]$ where D is face value.

Remark: s(y) can be non-monotonic in y.

Examples of Feasible Securities



<u>Lemma 2</u>

Debt has minimal IAS for *all* prices and *any* f(y).

<u>In other words:</u>

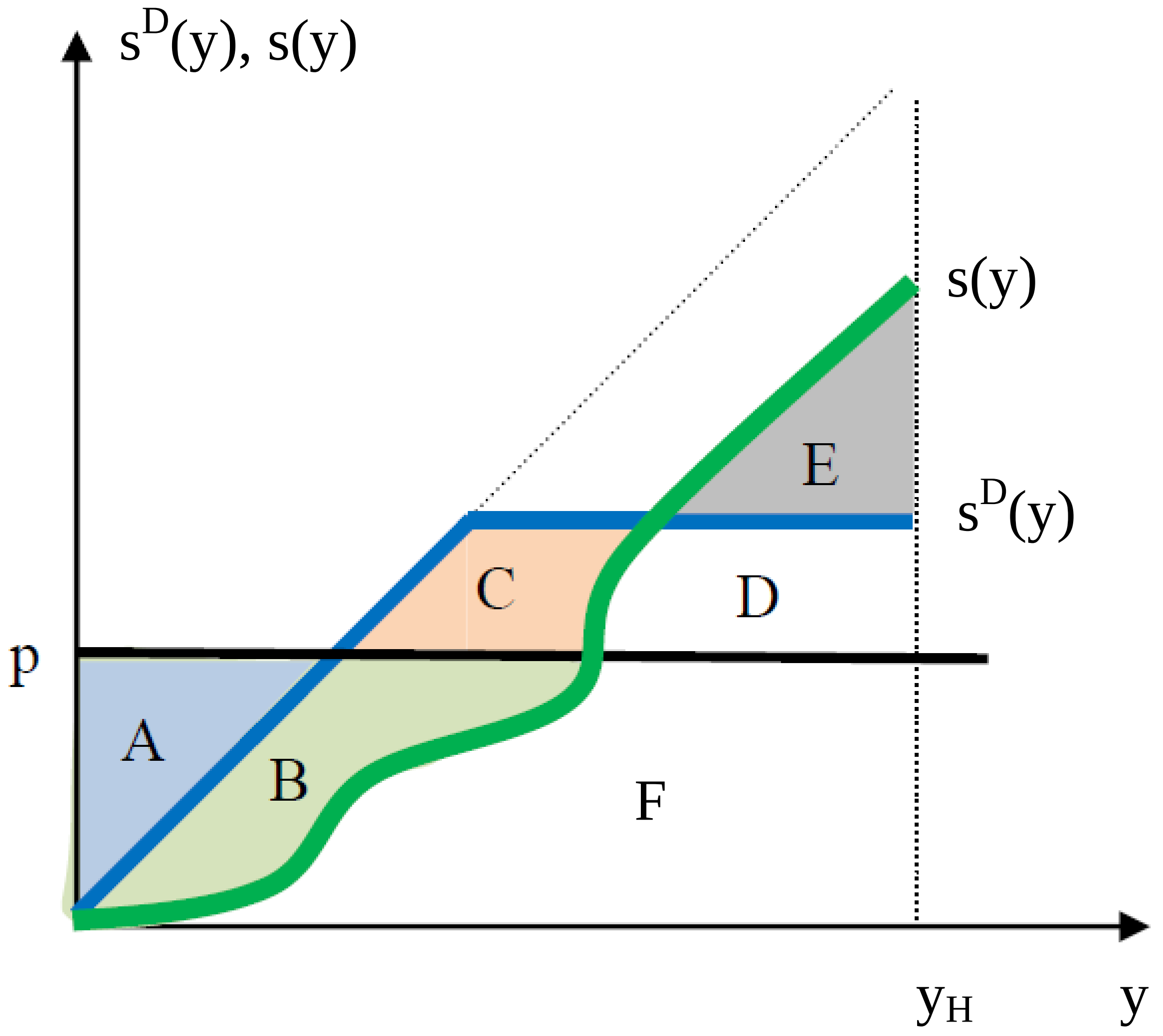
$s^D(y)=\min[y, D]$ is solution to both minimization problems in functional space:

$$\min_{s(y)} \pi_L(p) = \int_{y_L}^{y_H} \max[p - s(y), 0] \cdot f(y)dy$$

$$\min_{s(y)} \pi_R(p) \equiv \int_{y_L}^{y_H} \max[s(y) - p, 0] \cdot f(y)dy$$

$$S = \{(s(y) : s(y) \leq y \text{ and } E[s(y)] = V\}$$

Proof



For $p \leq E[s(y)]$: $IAS^D = \pi_L^D = A \quad < \quad A + B = \pi_L^S = IAS^S$

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For $p \geq E[s(y)]$:

$$IAS^D = \pi_R^D = C + D$$

$$IAS^S = \pi_R^S = E + D$$

For $p \leq E[s(y)]$: $IAS^D = \pi_L^D = A$ $<$ $A + B = \pi_L^S = IAS^S$

For $p \geq E[s(y)]$:

$$IAS^D = \pi_R^D = C + D$$

$$IAS^S = \pi_R^S = E + D$$

Note, C<E since

Debt: V=B+C+D+F s(x): V=E+D+F

→ C=E-B

Dang, Gorton and Holmstrom (2011): IAS paper

Characterize further properties of IAS and the full set of minimal IAS securities

Lemma 1 and 2 hold

- Unlimited liability: m(y)>y (seniority of repayment is key)
- Any utility function if signal is perfect
- Signal satisfies MLRP, partition, noisy signal type + monotone securities

Furthermore

IAS is sufficient statistics for EU maximization in portfolio theory if agent has linear reference point utility (no need for distributional assumptions)

Optimal Contracting at t=1

Agent B has bought s(x) from agent A at t=0.

Agent B makes a take-it-leave-it offer to agent C to sell: $(p_1, \hat{s}(y))$ where y=s(x)

Examples:

If $\hat{s}(y) = y$, then agent B wants to sell "whole" s(x) to agent C.

If $\hat{s}(y) = \frac{1}{2} y$, then agent B wants to sell 50% of s(x) to agent C ("strip").

If $\hat{s}(y) = \min[y, D]$, then agent B sells debt with face value D to agent C taking s(x) as the underlying ("tranche").

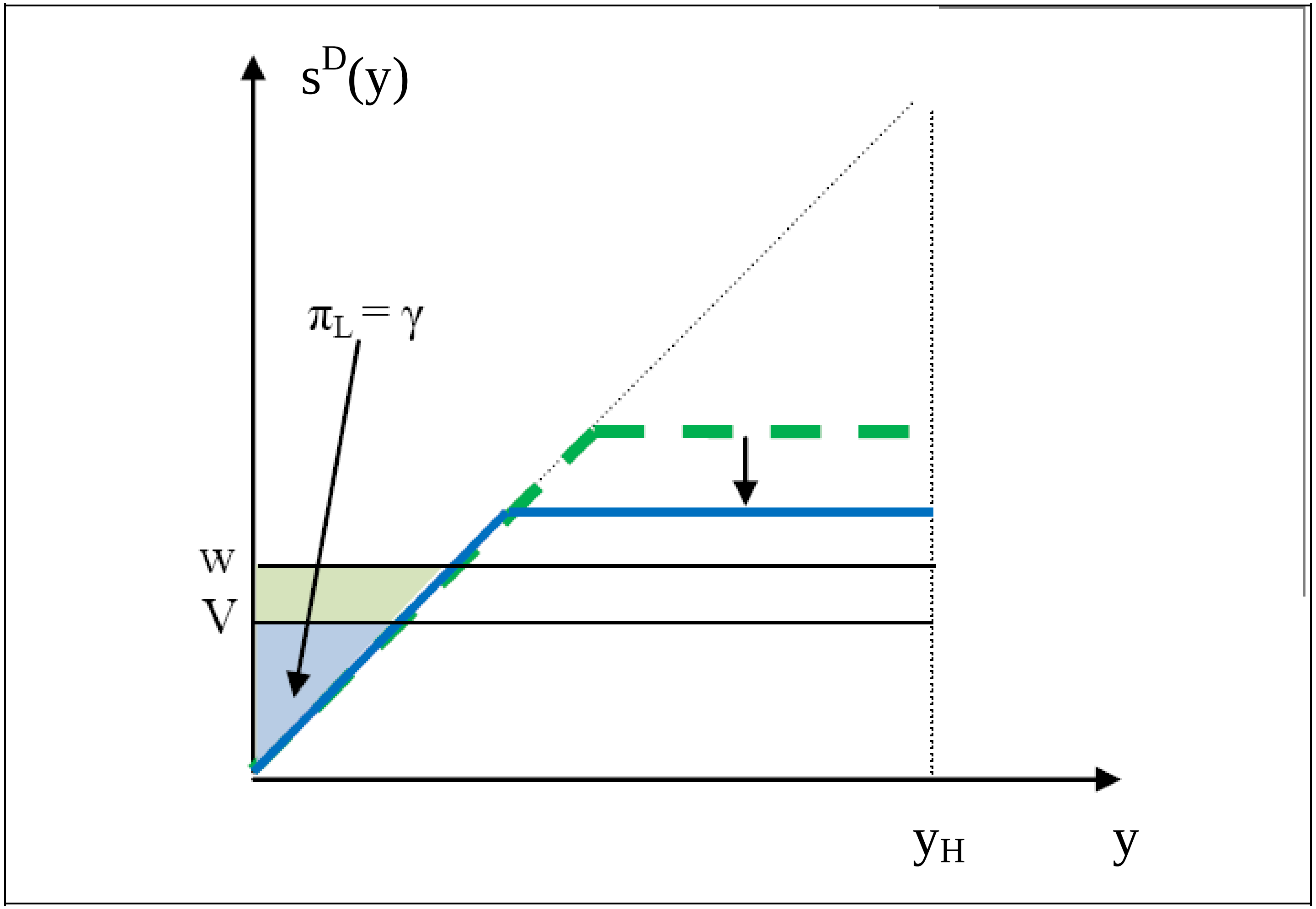
Proposition 1

At t=1, agent B sells debt to agent C (baked by whatever y he owns).

Depending on $\{\alpha, \gamma, F(y)\}$ agent B proposes either

- Strategy I (reduced trade)
- Strategy II (inducing information acquisition).

Strategy I: Reduced trade (with $p=E[s^D(y)]$)



Under Strategy I: Agent B offers (p, $s^D(y)$) where

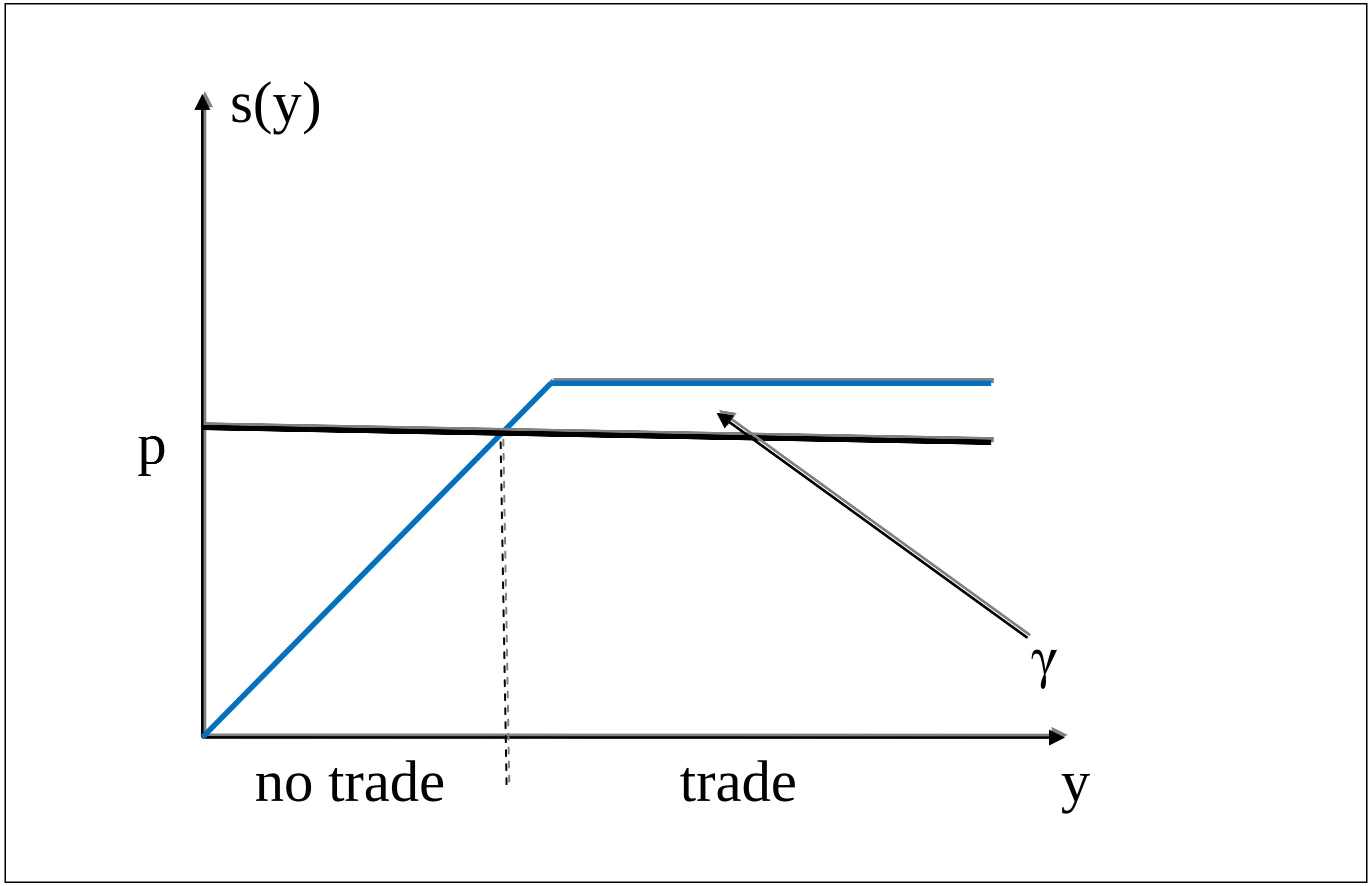
$$\int_{y_L}^{y_H} \max[p - s^D(y), 0] \cdot f(y)dy = \gamma$$

and D solves

$$\int_{y_L}^{y_H} \min[y, D] \cdot f(y)dy = p$$

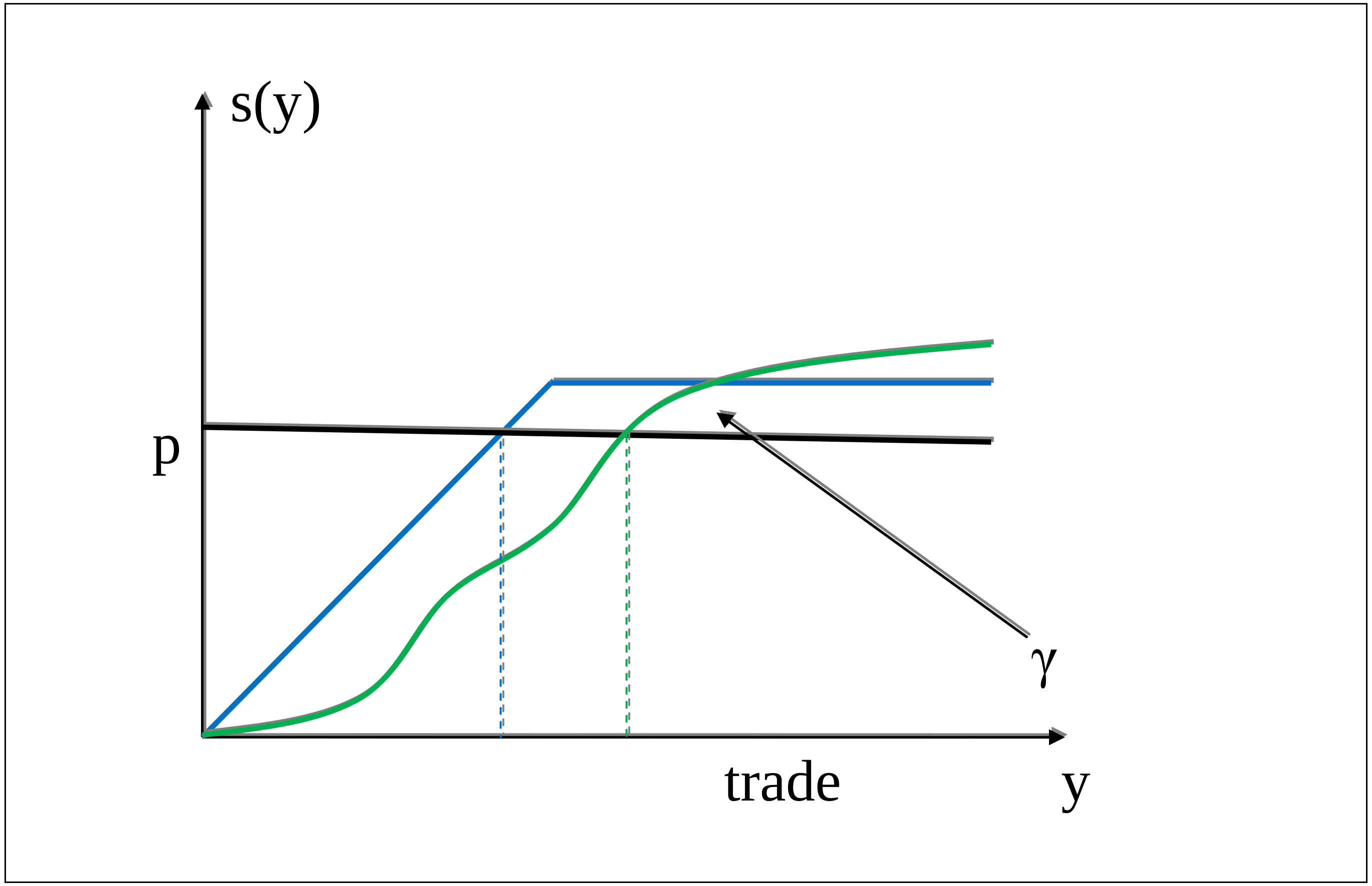
Remark: If γ is small the amount of trade (i.e. p) is small.

Strategy II: Inducing information acquisition but trade more if trade occurs: p>E[s(y)] and $\pi_R = \gamma$ where p max $EU_B = (1 - F(p))(\alpha p - p) - \gamma + E[y]$



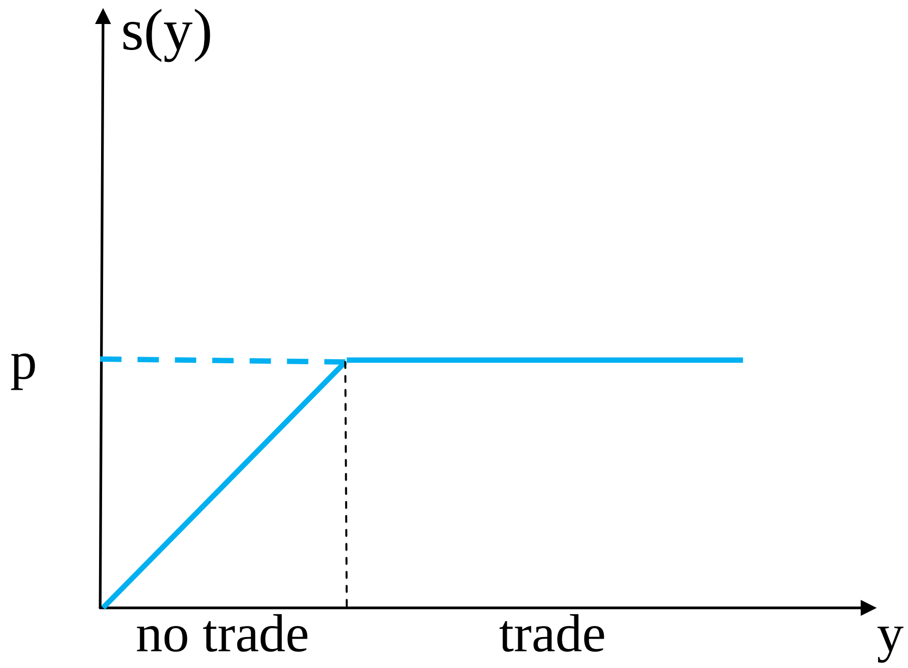
Intuition

For any given p, debt is optimal since it maximizes probability of trade.



Corollary

Suppose agent C is privately informed (γ =0). Agent B sells debt with face value D=p where p maximizes $(1-F(p))p$.



Equilibrium Analysis of the A-B-C-Game

→ Endogenizing y (=optimal choice of collateral at t=0)

Reminder

$U_A = C_{A0} + C_{A1} + C_{A2}$ $\varpi_A = (0,0, x)$

$U_B = C_{B0} + \alpha C_{B1} + C_{B2}$ $\varpi_B = (w,0,0)$

$U_C = C_{C0} + C_{C1} + C_{C2}$ $\varpi_C = (0,w,0)$

Question

What is the optimal s(x) for agent B to buy at t=0?

Impact of Public Information at t=1

Two effects

Fundamental value of s(x) changes: V(z)=E[s(x)|z]

$$V(z) = E[s(x) \mid z] = \int_{x_L}^{x_H} s(x) \cdot f(x|z)dx$$

IAS of s(x) changes

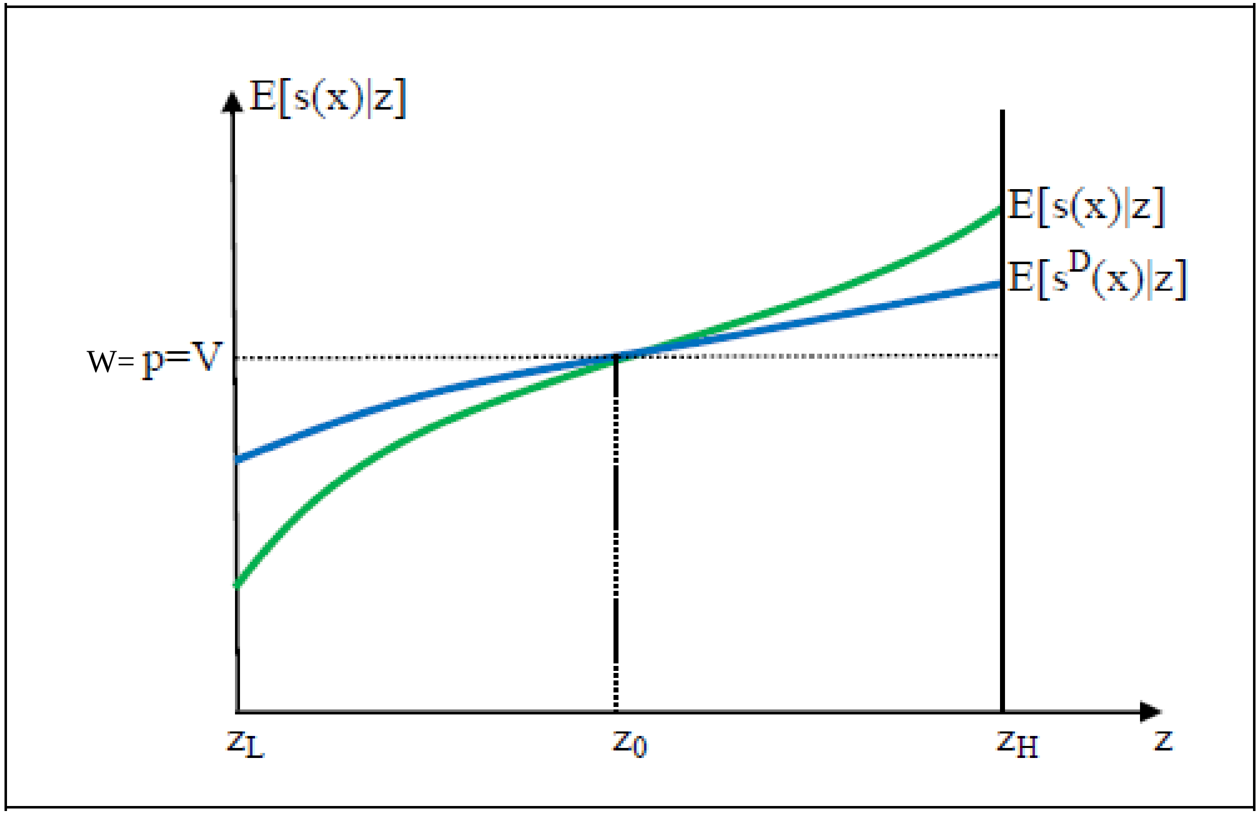
$$\pi(z) = \int_{x_L}^{x_H} \max[p_z - s(x), 0] \cdot f(x \mid z)dx$$

where $p_z = \int_{x_L}^{x_H} s(x) \cdot f(x \mid z)dx$

<u>Fundamental value is monotonic in z</u>

$$V(z) = E[s(x) \mid z] = \int_{x_L}^{x_H} s(x) \cdot f(x|z)dx$$

s(x) non-decreasing and MLRP imply V(z) monotonic (See DKS (2005))



Proposition 2

Suppose there is public information and no agent can produce private information. The equilibrium has the following properties:

At t=0, agent B buys debt from agent A with $E[s^D(x)]=w$ and $p=E[s^D(x)]$.

At t=1, agent B sells (new) debt to agent C with expected payoff $E[s^D(y)]=\min[w, E[s(x)|z]]$ for the price $p_1=E[s^D(y)]$.

Intuition

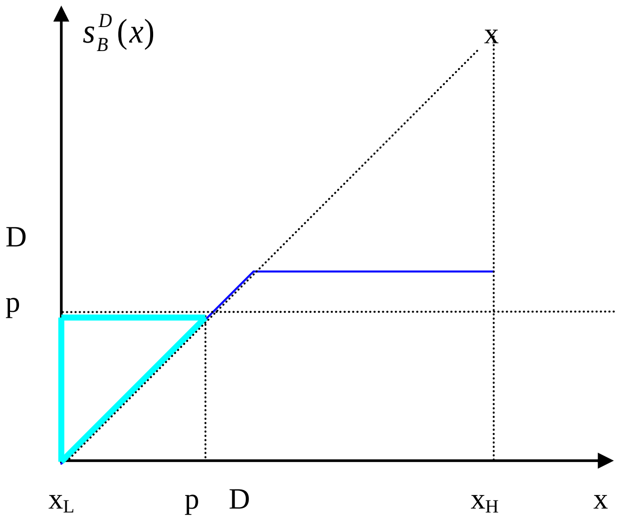
Debt fluctuates less and preserves the maximal value in low signal states.

Remark: $w_C=w$ is not crucial.

IAS and Public Interim News

$$\pi_Z = \int_{x_L}^{x_H} \max[p_Z - s(x), 0] \cdot f(x \mid z)\,dx \quad \text{where} \quad p_Z = \int_{x_L}^{x_H} s(x) \cdot f(x \mid z)\,dx$$

→ π(z) might be non-monotonic in z even z is ordered by FOSD.



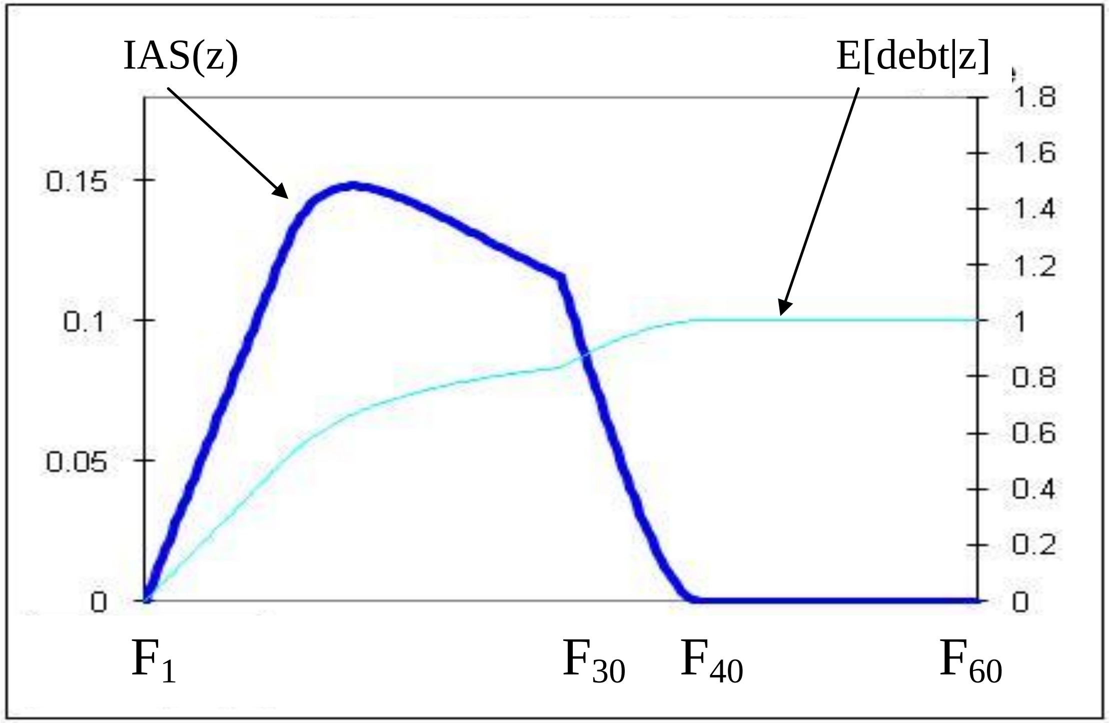
"Good news" increases price (triangle) but there is less probability mass on the left tail.

"Bad news" decreases price (triangle), but there is more probability mass on the left tail.

Example (A picture of a crisis)

F_1 ~u[0, 0.1], F_2 ~u[0, 0.2], F_3 ~u[0, 0.3],. ..F_{31}~u[0.1, 3], F_{31}~u[0.2, 3],...., F_{60}~u[2.9, 3]

All posterior equally likely →Prior=F_{30}~u[0, 3] ({F(x|z)} satisfies FOSD)
Debt with face value D=1.



<u>Proposition 3 (Equilibrium):</u>

Suppose $(\alpha - 1)w \leq \gamma$. Equilibrium has the following properties.

At t=0, agent B buys debt from agent A with price $p_0=E[s^D(x)]=w$.
At t=1, depending on {α, γ, F(x|z)} agent B potentially reduces the face value of debt and sells a (new) debt contract to agent C.

<u>Remark:</u>

- When there is bad news, fundamental value of debt drops but IAS can rise. In that case agent B writes-down debt.

- The best response at t=1 is Strategy I (no endogenous adverse selection) yet there is a collapse of trade.

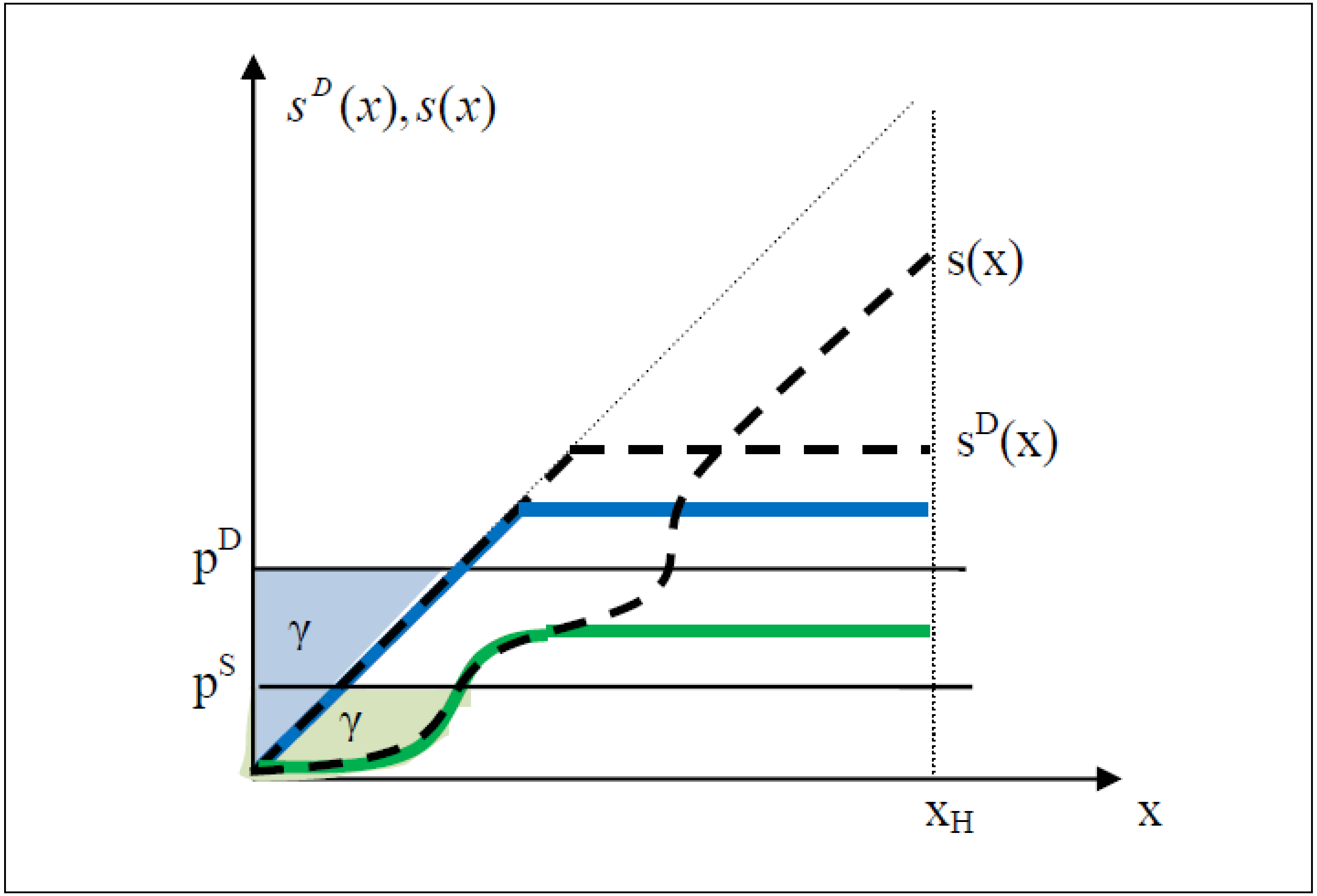
→ Restore "No Question Asked" by agent C.

Intuition (Why is t=0 debt optimal collateral for t=1 debt?)

Proposition 1 shows that agent B sells debt to agent C at t=1 backed by any s(x).

At t=1, if there is adverse selection concern, agent B reduces trade

→ t=0 debt enables maximal trade without triggering information acquisition.



$s^D(x), s(x)$
s(x)
$s^D(x)$
p^D
γ
p^S
γ
x_H
x

Numerical Example

$x \in [0,2]$

Public signal (Posterior)

F_1 ~u[0,0.8] with prob $\lambda_1 = \varepsilon$

F_2~u[0.8, 1.2] with prob $\lambda_2 = \varepsilon$

F_3~u[1.2, 2] with prob $\lambda_3 = 1 - 2\varepsilon$

Prior

ε=0.00001 → almost F_0 ~u[1.2,2]

w=1, $\gamma = 0.001$, $\alpha = 1.001$

Equilibrium (number exact up to 4 decimal)

At t=0, B buys debt with face value D_0=1and price p_0=1.

At t=1, Depending on public signal:

(i) F_3 is the true distribution (good news): $V^D(3)=1$, $\pi_1^D(3) = 0$.

Agent B sells (whole) debt to agent C for $p_1(3)=1$.

Equilibrium (number exact up to 4 decimal)

At t=0, B buys debt with face value D_0=1and price p_0=1.

At t=1, Depending on public signal:

(i) F_3 is the true distribution (good news): $V^D(3)=1$, $\pi_1^D(3) = 0$.

Agent B sells (whole) debt to agent C for $p_1(3)=1$.

(ii) F_2 is the true distribution (bad news): $V^D(2) = 0.95$, $\pi_1^D(2) = 0.0281$.

Agent B sells a (new) debt with D_1=0.9 and $p_1(2) = 0.82$

(i.e. 87%=0.82/0.95 of expected cash flow as a senior tranche)

Equilibrium (number exact up to 4 decimal)

At t=0, B buys debt with face value D_0=1and price p_0=1.

At t=1, Depending on public signal:

(i) F_3 is the true distribution (good news): $V^D(3)=1$, $\pi_1^D(3)=0$.

Agent B sells (whole) debt to agent C for $p_1(3)=1$.

(ii) F_2 is the true distribution (bad news): $V^D(2)=0.95$, $\pi_1^D(2)=0.0281$.

Agent B sells a (new) debt with D_1=0.9 and $p_1(2)=0.82$

(i.e. 87%=0.82/0.95 of expected cash flow as a senior tranche)

(iii) F_1 is the true distribution (crisis news): $V^D(1)=0.4$, $\pi_1^D(1)=0.1$.

Agent B sells debt with $D_1=0.0411$ and $p_1(1)=0.04$

(i.e. 10% percent of cash flow as a senior tranche)

Remark

Buying t=0 debt maximizes the expected utility of agent B

In example there can be a 90% write down of debt in equilibrium.

We explain why debt exists in a model of financial crisis.

A financial crisis arises if information acquisition insensitive debt becomes information sensitive.

Discussion

“No Questions Asked” = Liquidity (in money markets)

Examples of Purposeful Opacity

- De Beers and diamonds (Milgrom-Roberts 1992)
- 19th century clearinghouses (Gorton, 1988)
- Money market funds (NAV lag/frequency)
- Money (most opaque of all)

<u>Implications of NQA</u>

- Neglected risks by design (ignorance is bliss)

- Potential for panic (infrequent, shocking)

- Transparency matters, but not the way commonly thought

- Role for monitoring by regulator

A common, but false inference

Widely agreed:

Symmetric information (about payoffs) => liquidity

But:

Transparency $\not\Rightarrow$ Symmetric information

Because:

Provision of better yet imperfect information can make private information more relevant and profitable (triggering adverse selection concerns)

Symmetric information often easier to achieve through shared ignorance (plus certification and guarantees).

An Uneasy Trade-Off

- Relying on debt, securitization, coarse ratings makes sense in good times

  → shared understanding enhance liquidity

- But pushes risk into tail and hides systemic risk, can increase cost of crisis

- Transition from information irrelevant to information relevant state

  → discontinuity

- Information about systemic risk hidden, supporting external monitoring by regulator <u>but not</u> necessarily disclosure of more information to market

<u>Remark:</u> Don't regulate based on crisis state alone (two aggregate states)

What is special about current financial crisis?

"*The causes of crises are so subtle in nature that any attempt to foretell fluctuations in the financial world might well be considered hazardous.*

No one in the opening months of the year ____ *thought of doubting the continuance of the rising tide of prosperity which had begun to gather strength the year before.*

And yet the closing months of the year saw such a destruction of trade and credit, and the downfall of so many powerful houses, that the financial situation in New York and, indeed, throughout the United States generally, occasioned deep anxiety to the financiers of the world."

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"*The causes of crises are so subtle in nature that any attempt to foretell fluctuations in the financial world might well be considered hazardous.*

No one in the opening months of the year ***1860*** *thought of doubting the continuance of the rising tide of prosperity which had begun to gather strength the year before.*

And yet the closing months of the year saw such a destruction of trade and credit, and the downfall of so many powerful houses, that the financial situation in New York and, indeed, throughout the United States generally, occasioned deep anxiety to the financiers of the world."

Swanson (1908, p. 65)

Conclusion

- Banking (=maturity transformation) is inherently vulnerable to "runs"

  Past: Runs on commercial banks (question banks asset, demand deposit)

  Recently: Runs on shadow banks (SPV of ABCP, repo, MMF)

- "No Question Asked" is liquidity (in money markets)

- Information acquisition insensitive debt is private money

- A financial crisis arises if public information about fundamentals that back private money (debt)

  makes information insensitive private money information acquisition sensitive