Redeployability, Heterogeneity, Plus

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Capital Structure

- Classic capital-structure tradeoffs
  - say, Taxes vs. Distress.
- Add Asset Redeployability (Williamson 1988):
  - More redeployable assets $\Rightarrow$ more debt.
- Add Endogenous Asset Prices (Shleifer-Vishny):
  - Bankrupt when peers are? $\Rightarrow$ fire-sale prices.
- Add asset heterogeneity:
  - $\Rightarrow$ capital-structure heterogeneity.

Our Paper

A *very* stylized model to illustrate basic channel intuition.

- Firms can not only be bought, **but also buy**;
- ...although asset sold also incur some redeployment impairment costs;
- ...and asset prices will be determined by own and others' (fire-?) selling in the future, which is in turn determined by own and others' debt today.

...which means

- Firms prefer less debt if peers choose more debt
  - for own sale value *and* for buying bargains
- ... and perfectly identical firms can choose different capital structures
  - First fully endogenous heterogeneity

    Depends crucially on ________

    Diana shipping. (Local) real-estate developments, etc.
- ... and when assets are more redeployable
  - More debt $\Leftarrow$ easier to sell assets in distress
  - Less debt $\Leftarrow$ easier to buy bargains

...and then some

- The model has implications for many other basic comparative statics and welfare.
  - (transfer quantities, prices, recovery spreads, credit spreads, liquidation probabilities, etc.)
- Simple point: $(\partial D)/(\partial x)$ is empirically untestable.
  - Common object of interest in earlier work.

Model

- Risk Neutrality.
- No agency conflicts (value maximization).
- No private information.
- No aggregate uncertainty (except in appendix).

- ...just to show we don't need these, not to argue that they are not important.

Model

- A-Priori Identical Firms .
- Ex-Post Firms uniformly distributed $v \in [0, 1]$.
- Higher Type v_i = More Productivity.
  - productivity can extend to new assets,
    but with penalty $1-\eta$.
  - η will be our key parameter: redeployability.

Financing

- Debt or Equity.
- Debt gives extra value $\tau_i \cdot D$.
  - Tau is not just taxes, but "everything else net."
  - It does not matter whether debt subsidy accrues immediately or later, so let's just assume it is immediate.
- No financial slack.
  - If slack can be infinite, then our model goes away. Other models [e.g., Duffie, S-V] have this, too. It seems natural, but it is also a quantitatively-meaningful simplification.

Time 1: Redeployment

- Assets can be bought and sold.
- Firms sell when continuation value is less than selling price. They are never forced to sell.
  - They tend do so if their own type v_i is too low and redeployability is good.
- With too much debt, firms face distress impairment (linear in shortfall).
  - E.g., legal costs, damaged stakeholder relationships.

- If a firm i turns out great and has lots of money relative to its debt, then it can buy one selling peer,
- ...whose assets transfer only with $\eta (< 1)$ productivity.
- Firm i buys if redeployment is not too expensive given its own quality $v_i > P/\eta$ **and** when they have the money $v_i > P + D_i$.

Example

- Assets are redeployable at $\eta = 0.9$.
- Equilibrium price is P = \$0.3.
- Firms with $v_i <$ \$0.3 want to sell.
- All firms with $v_i >$ \$0.3/0.9 = 0.333 want to buy.
- Firms between 0.3 and 0.333 keep the asset —an ex-post unavoidable friction.

- If it is easy to wait out crisis or there are many good outside uses/buyers, then think of $\eta \to 1$.
  - Similar assumptions drive S-V, Duffie, etc.

Time 1: Financial Distress

Too much debt, and value becomes

$$v_i \quad \rightarrow \quad v_i - \phi \cdot (D - v_i)$$

If $v_i - \phi \cdot (D - v_i) < P$, then just sell.
If $v_i - \phi \cdot (D - v_i) > P$, suck it up and operate.

Sell iff

$$v_i < \left[\Lambda(D_i) \equiv \frac{P + \phi \cdot D_i}{1 + \phi} \right]$$

Example: $\phi = 10\%, P = 0.3, D = 0.4$. All firms i with value $v_i > (0.3 + 0.1 \cdot 0.4)/1.1 \approx 0.31$ are better off selling.
(Regions to keep track of! If helpful, game tree in paper.)

Time 0: Firm Objective ($D_i < P$)

$$\int_0^P P\,dv$$ ←value < price, liquidate

$$+\int_P^1 v\,dv$$ ←normal ops

$$+\int_B^1 \max(0, \eta \cdot v - P)\,dv$$ ←buying

$$+\tau \cdot D$$ ←direct debt benefit

Note: Value v must be at least $P + D_i$ to buy! $B \equiv \min(P + D_i, 1)$ and $v_i > P/\eta$

Time 0: Firm Objective ($D_i > P$)

$$\int_0^{\Lambda(D_i)} P \, dv$$ ←value < price, liquidate

$$\int_{\Lambda(D_i)}^{D_i} v - \phi \cdot (D_i - v) \, dv$$ ←operate impaired

$$+ \int_P^1 v \, dv$$ ←normal ops

$$+ \int_B^1 \max(0, \eta \cdot v - P) \, dv$$ ←buying

$$+ \tau \cdot D$$ ←direct debt benefit

- Can't simply optimize with respect to D, given P(D), because firms are competitive price takers.
  - Can be tricky
- Supply = Demand
  - Sellers: Voluntary (some to avoid distress).
  - Buyers: Not in distress, enough $$s (given D_i), and enough productivity.

- Supply:

$$\int_0^P \int_0^P 1 \, dv \, dF(D) \quad \leftarrow \text{low-debt voluntary sellers}$$

$$+ \int_P^1 \int_0^{\Lambda(D)} 1 \, dv \, dF(D) \quad \leftarrow \text{quasi-forced sellers}$$

quasi-forced means due to distress costs that have lowered firm value

- Demand

$$\int_0^{1-P} \int_{\max(P+D, P/\eta)}^1 1 \, dv \, dF(D) \quad \leftarrow \text{\$\$ and productivity}$$

Double for type probability and for expected value over uniform.

More Sauce

- Only the three essential parameters:
  dbt bnft τ, reusablty η, dstrss impairmnt ϕ.
- What I am Sparing You:
  - Complete Equilibrium Definition
    - Firms optimize, price is endogenous
  - Infinite Financing Case (Section I)
  - Complete Parameter Space Solutions (Appendix)
  - Various extensions in the paper
- And no continuous time.

(Gentle) Solution

High reuse η, low impairment ϕ, low benefits τ.

$$P^* = (\eta - \tau)/(1 + \tau)$$

$$D^* = (1 - \eta + 2\tau)/(1 + \eta)$$

$\eta = 0.9$, $\phi = 0.1$, $\tau = 0.1$: $\Rightarrow P^* = \$0.42, D^* = \$0.158$:

In this region: firms have low leverage, never in distress.
Some sell, others buy.

	$D = \$0.1$	$D^* \approx \$0.158$	$D = \$0.2$
Sell	\$0.1773	\$0.1773	\$0.1773
Operate	\$0.4114	\$0.4114	\$0.4114
Buy	\$0.1262	\$0.1219	\$0.1169
Debt Benefits	\$0.01	\$0.0158	\$0.02
Total	\$0.7248	\$0.7263	\$0.7255

This tradeoff: tax benefits vs future buying opportunities.

Demand: $1-(P+D) \approx 0.4211u$. Supply: $P = 0.4211u$

Xfer: $Q \times \$0.42/u \approx \$0.2011$.

Less Gentle Solution: Little higher benefits τ.

If, $D^* < P^*$**.**

$$P^* = \frac{\phi\eta - (1+\phi)\cdot[\tau - \eta(1+\tau)]}{1+\phi(1+\eta)} - \frac{\sqrt{\eta(\phi+1)\cdot\{2\tau\cdot[\eta\phi + (\eta-\tau)\cdot(1+\phi)] + \eta\tau^2(\phi+1) - \phi\cdot(1+\tau-\eta)^2\}}}{1+\phi(1+\eta)},$$

in which fraction h^* of firms choose $D_H^* = 1$, and fraction $1-h^*$ choose D_L^*, where

$$D_L^* = \frac{\tau}{\eta} + \frac{(1-\eta)}{\eta}\cdot P^*,$$

$$h^* = \frac{(1+\phi)\cdot[\eta - \tau - (1+\eta)\cdot P^*]}{\eta\phi + (1+\phi)\cdot(\eta-\tau) - [1+\phi(1+\eta)]\cdot P^*}.$$

Or, $D^* > P^*$**.**

$$P^* = \frac{\phi\cdot[1+2\phi(1-\tau) - 3\tau] + \eta(1+\phi)\cdot[1+\tau+(2+\tau)\phi] - \tau}{1+(6-3\eta)\cdot(1+\phi)\cdot\phi} - \frac{\sqrt{(1+\phi)\cdot(\eta+\phi+\eta\phi)\cdot\left\{\begin{array}{c} 3\eta^2\phi(1+\phi) - 2[\phi(\tau-1)+\tau]^2 \\ +\eta[\phi(\tau-1)+\tau]\cdot[2+(\tau-1)\phi+\tau] \end{array}\right\}}}{1+(6-3\eta)\cdot(1+\phi)\phi},$$

in which h^* firms choose $D_H^* = 1$, and $1-h^*$ choose D_L^*, where

$$D_L^* = \frac{(1+\phi)\cdot\tau}{\eta+\phi+\eta\phi} + \frac{(1-\eta)\cdot(1+\phi)+\phi}{\eta+\phi+\eta\phi}\cdot P^*$$

$$h^* = \frac{(1+\phi)\cdot[\eta+\phi+\eta\phi - (1+2\phi)\tau - (1+\eta+5\phi-\eta\phi)\cdot P^*]}{(1+2\phi)\cdot[\eta+\phi+\eta\phi-(1+\phi)\tau] - (1+5\phi-\eta\phi+5\phi^2-\eta\phi^2)\cdot P^*}.$$

$\eta = 0.9$, $\phi = 0.1$, $\tau = 0.3$: $\Rightarrow P^* = \$0.2746, D^* = \$0.356$

In this region, firms have high leverage, and thus may operate in distress. Some sell, others buy.

	D=$0.3	$D_L^* \approx \$0.36$	D=$0.4	$D_H^* = 1$
Sell	$0.0761	$0.0775	$0.0786	0.0935
Reorg Op	$0.0066	$0.0232	$0.0384	0.4203
Operate	$0.4550	$0.4368	$0.4200	0
Buy	$0.1846	$0.1697	$0.1558	0
Debt Benefits	$0.0900	$0.1067	$0.1200	0.3000
Total	$0.8123	$0.8138	$0.8128	0.8138

Fraction operating at $D_H^* = 1$: $h \approx 0.2$. [Check border! At $\tau \approx 0.215$, some fraction h ↑ jump to $D^* = 1$]

Demand = Supply: 0.294 u.

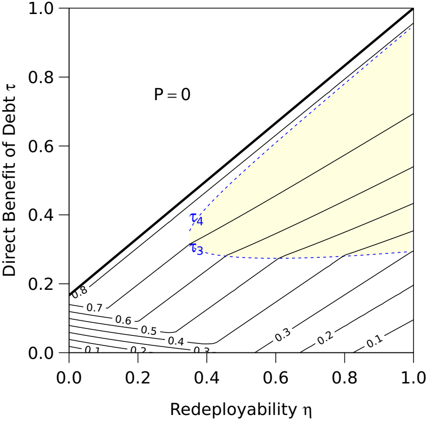
Supply: $0.2 \cdot (0.275 + 0.1 \cdot 1)/(1 + 0.1) + 0.8 \cdot (0.275 + 0.1 \cdot 0.356)/(1 + 0.1)$. Demand: $[1 - (0.275 + 0.356)] \cdot 0.8$

Xfer: $\times \$0.27/\text{u} \approx \$0.08$.

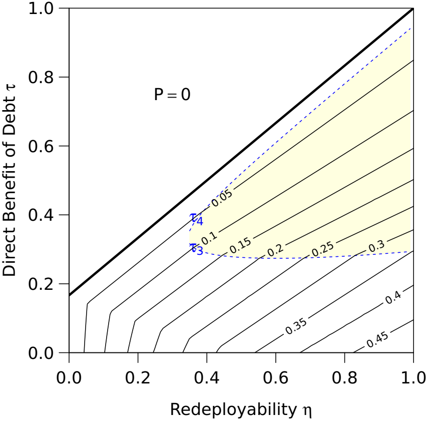
Fun

- Rest is (mostly) pictures
- ...with medium impairment $\phi = 0.25$.
- ...graphing outcomes against redeployability η and direct debt benefits τ in contour plots.
  - ...though it still will take us a moment to catch our orientation.

Debt D^*



Price P^*



Direct benefits τ: $D^* \uparrow$ $P^* \downarrow$.

Redeployability η: $D^* \uparrow\downarrow$ $P^* \uparrow$

"$\cap$" or "$\cup$" shapes indicate ambiguous comparative statics in redeployability η. (See $\partial D^*/\partial \eta$)
"$\subset$" or "$\supset$" shapes indicate ambiguous comparative statics in direct debt benefits τ.

Test

- Leverage always increase with direct debt benefits τ.
- Leverage can increase or decrease with redeployability η.
  - More debt $\Leftarrow$ easier to sell in distress.
  - **Less debt $\Leftarrow$ easier to buy (bargains).**
- Is this testable?

Test

NO!

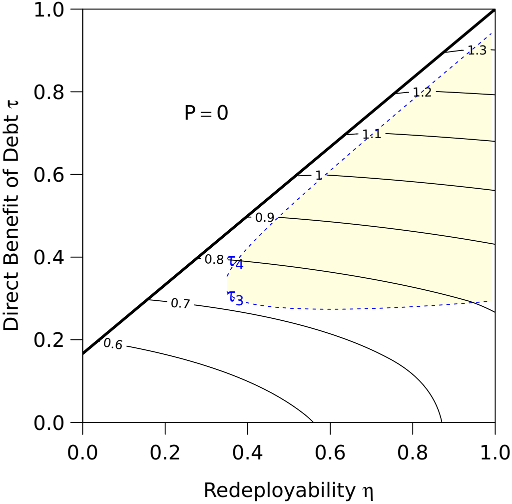
Test

NO!

Leverage $\neq$ D.

- (Market) Value changes with parameters, too.
- No empiricist has ever tested D^*.
  Only $D^*/V(D^*)$ is testable.
- $D^*/V(D^*)$ is about how quickly D^* changes vs. how quickly $V^* \equiv V(D^*)$ changes.

Firm Value V^*

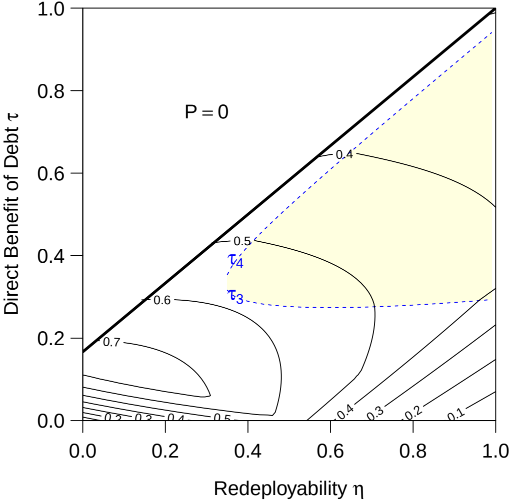


V^* increases in

- direct benefits τ
- redeployability η.

"∩" or "∪" shapes indicate ambiguous comparative statics in redeployability η. (See $\partial D^*/\partial\eta$)
"⊂" or "⊃" shapes indicate ambiguous comparative statics in direct debt benefits τ.

Industry Debt-Value Ratio D^*/V^*



- Both comp statics depend on parameters!
- Low τ (modest debt):
  - Small η: $\Delta\eta \rightarrow$ D/V $\uparrow$.
    = literature effect
    take more debt (rsllbl).
  - High η: $\Delta\eta \rightarrow$ D/V $\downarrow$.
    = **novel effect**
    take less debt (buyabl).
- D^*/V^* is also **not** monotonically increasing in direct debt benefits τ!!
- (Also graph E(D), not just [FV] D in paper.)

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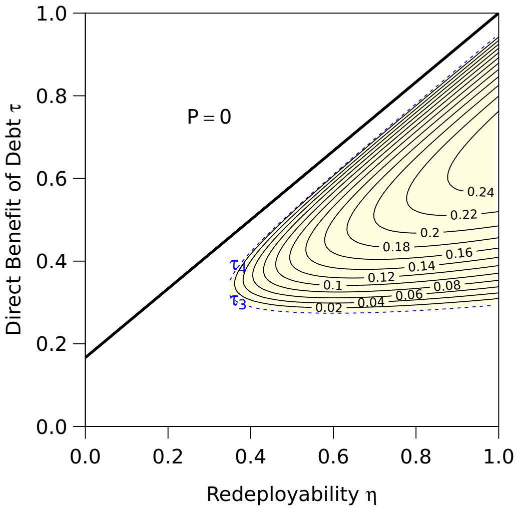
Frequency of Max-Debt Types, h^*



- Low eta and/or tau: no mixed equilibrium.
- Debt benefits can be so large, would all want 100% debt?
- But firesale price then become so low, marginal one can buy.
- Price equilibrates strategies.

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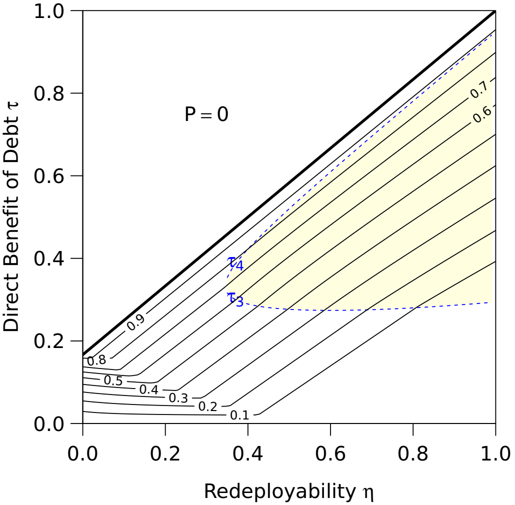
Credit Spread (r)



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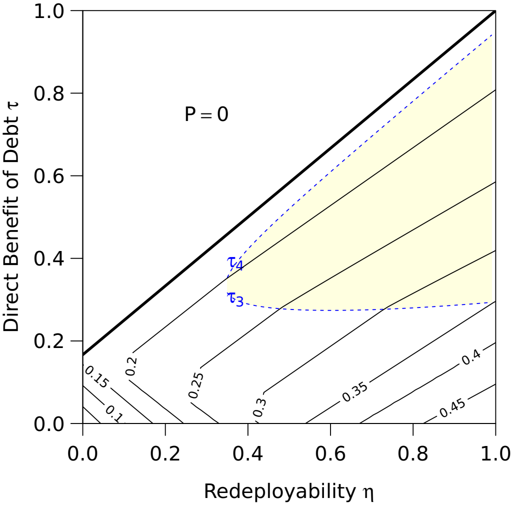
Asset Turnover (Q)



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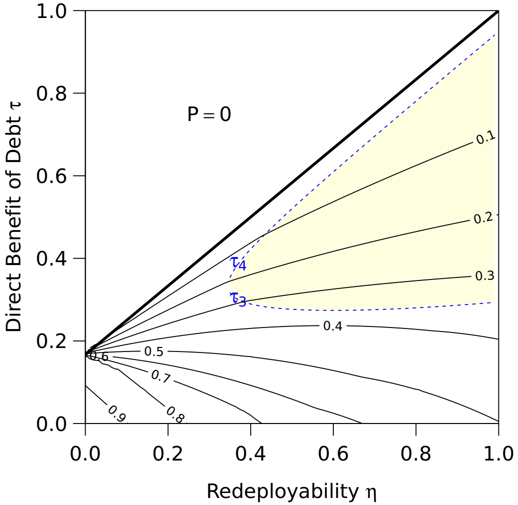
Demand-Reduced Liq Price P^*/η



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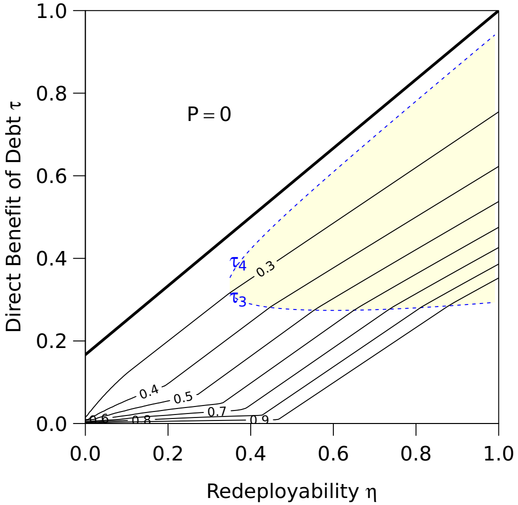
Conditional Liquidation Freq Λ^*/D^*



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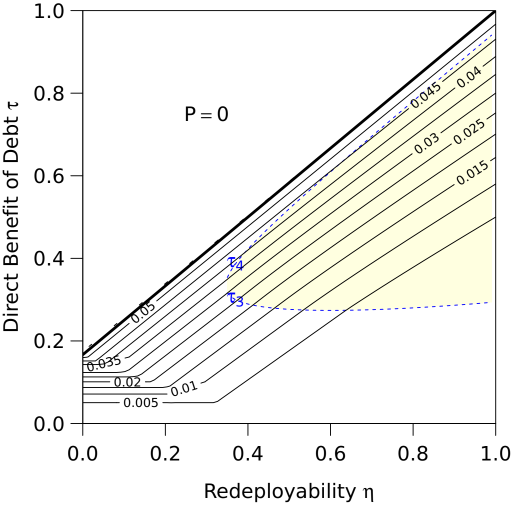
"⊂" or "⊃" shapes indicate ambiguous comparative statics in direct debt benefits τ.

Exp Reorg Cost $E[\phi \cdot (D^* - V^*)]$



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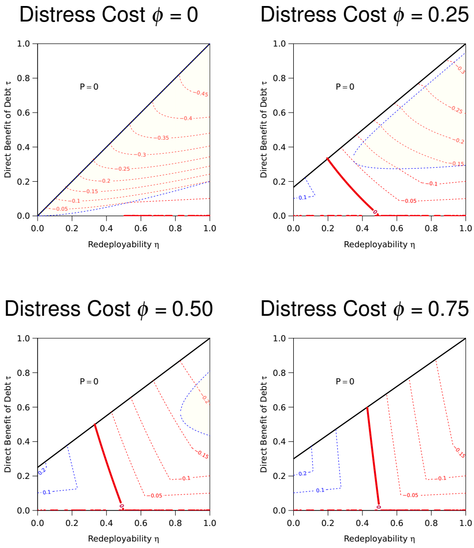
"⊂" or "⊃" shapes indicate ambiguous comparative statics in direct debt benefits τ.

Comp Statics

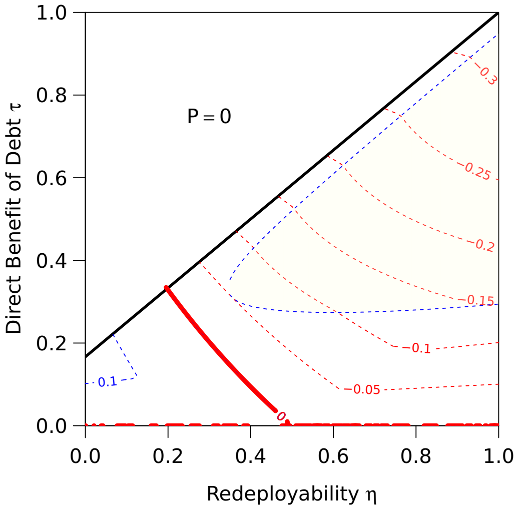
		Redeploy-ability η	Distress Cost ϕ	Direct Debt Benefits τ
Optimized Firm Value	V^*	0.9,0.2,0.9† 0.9,0.0,0.0	↓	↑
Debt Face Value, Industry Low-Debt Firm	D^*_{Ind} D^*_L	0.6,0.0,0.1 0.1,0.7,0.0	↓ 0.1,0.2,0.1 0.5,0.0,0.1†	↑
Debt Value, Industry Low-Debt Firm	$E(D^*_{Ind})$ $E(D^*_L)$	0.6,0.0,0.1 0.1,0.1,0.6	↓ 0.4,0.0,0.3 0.9,0.5,0.5†	0.3,0.8,0.5 0.1,0.3,0.1
Debt / Value, Industry Low-Debt Firm	$E(D^*_{Ind})/V^*$ $E(D^*_L)/V^*$	0.7,0.1,0.1 0.1,0.9,0.1	0.1,0.2,0.1 0.9,0.5,0.5	0.1,0.1,0.1 0.1,0.4,0.1

Credit Spread	r	0.3,0.1,0.3 0.1,0.2,0.1[†]	0.1,0.2,0.1 0.3,0.0,0.1	↑
Asset Price	P^*	↑	↑	↓
Asset Price/Max Value (NPV 0)	P^*/η	0.1,0.5,0.2 0.1,0.2,0.2	↑	↓
Asset Sales #	Q^*	↑	↑	0.6,0.0,0.1 0.1,0.6,0.1
Low Type Liquidation Freq.	Λ^*/D^*	↑	↑	↓
Reorganization Cost	$E[\phi \cdot (D^* - V^*)]$	↓	0.1,0.2,0.1 0.9,0.0,0.8	↑

Allocational Efficiency



Allocational Efficiency $\phi = 0.25$



Left = Too much xfer

Right = Too little xfer.

Not easy to understand: usually optimal medium level of realloc. But parameters also influence reallocation through a-priori debt, too, which influences distress operations vs. resale.

Conceptual! Not (easily) testable! (Influenced by unmodelled factors. Just some among many real-world forces.)

Model Welfare Analysis

Are you kidding?

Welfare analyses are almost always taking economic models much too seriously.

It only makes sense if we know we have everything in the model!

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Conclusion

- Endogenous Prices.
- **Endogenous Heterogeneity with crucial link to Asset Divisibility (!)**
- (Elegant closed-form model.)
- Sensible comparative statics and intuition:
  - Redeployability does not always favor more debt,
  - **...redeployability can also favor less debt!**
  - ...and many capital-structure theory implications are easily misinterpreted by empiricists, because not only D but also V is endogenous.

Comparative Comparative Statics

	$\frac{\partial \text{Leverage D/V}}{\partial \text{Debt Benefits}}$	$\frac{\partial \text{Level D}}{\partial \text{Debt Benefits}}$	$\frac{\partial \text{Indebtedness}}{\partial \text{Redeployability}}$
Williamson 1988	D/V not derived	Positive	Positive
Harris-Raviv 1990	D/V derived, but benefits unexplored	Benefits unexplored	Positive
Shleifer-Vishny 1992	D/V not derived	Negative within parameter region. Positive across.	Positive
Acharya-Vishwanathan 2011	D/V not derived	Negative for existing firms. Positive for new firms.	Redeployability online only. No comparative statics.
Our Model	Positive when debt benefits τ are small. **Negative** when large(!)	Deemphasized due to empirical identifiability.	**Negative** when acquisition channel dominates. Positive when liquidation channel dominates.

(**also:** rare implications on D/V and not just D, industry vs. individ, credit spreads, etc.)

Comparative Model Features

	Model Features	
	Endogenous Asset Price	Hetero-geneity
Williamson 1988	No	No
Harris-Raviv 1990	No	No
Shleifer-Vishny 1992	Mostly	Exogenous
Acharya-Vishwanathan 2011	Yes	Exogenous
Our Model	Yes	**Endogenous when indivisible**

also: rare endogenous fire-sale asset pricing, and closed forms.