Risk-based Organizational Choices

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FDI funds do not plummet with uncertainty

Conditional Correlations of Liability Flows With the VIX, Quarterly, 1990:Q1 to 2012:Q4

Correlations inflows / VIX	North America	Latin America	Central, Eastern Europe	Western Europe	Emerging Asia	Asia	Africa
Equity	-0.06	-0.31	-0.32	-0.38	-0.08	-0.34	-0.25
FDI	0.10	0.35	0.07	0.06	0.08	0.16	0.07
Debt	-0.30	-0.15	-0.36	-0.23	-0.28	-0.06	-0.22
Credit	-0.29	-0.15	-0.16	-0.24	-0.26	0.09	-0.14

Figure: *Source: Rey (2015), Jackson Hole speech.*

US, supply chains are heterogeneous

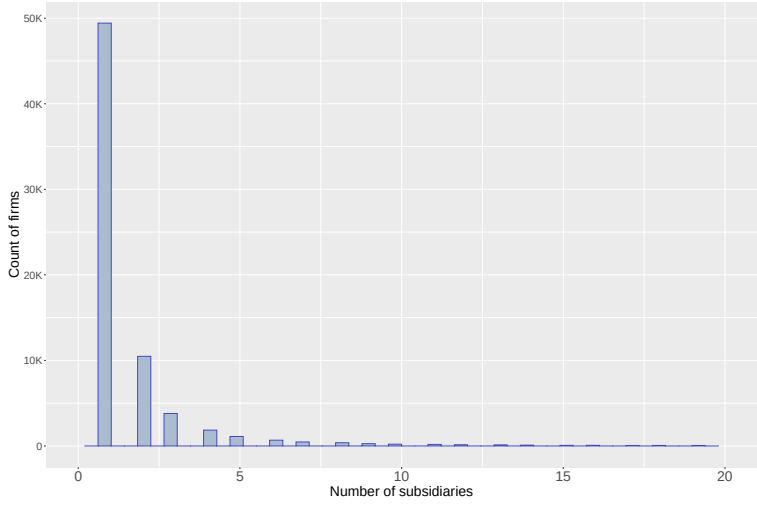


Figure: *Source: Dun&Bradstreet domestic establishment-level data, 2017. Firms=70,115, Subs=148,045.*

US, integration targets some sectors

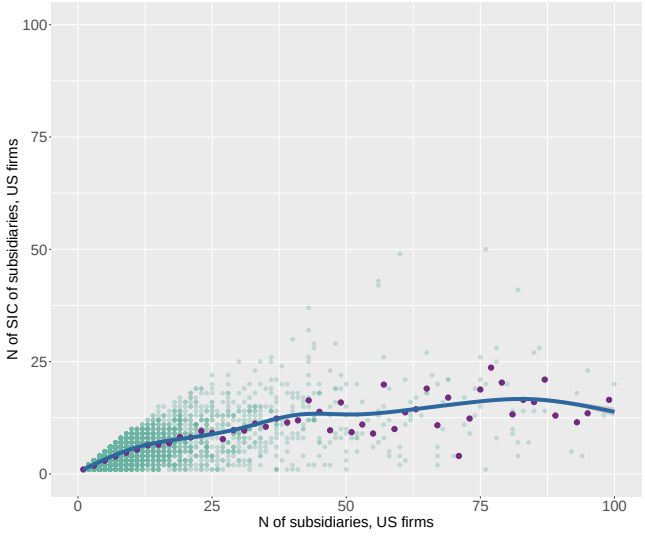
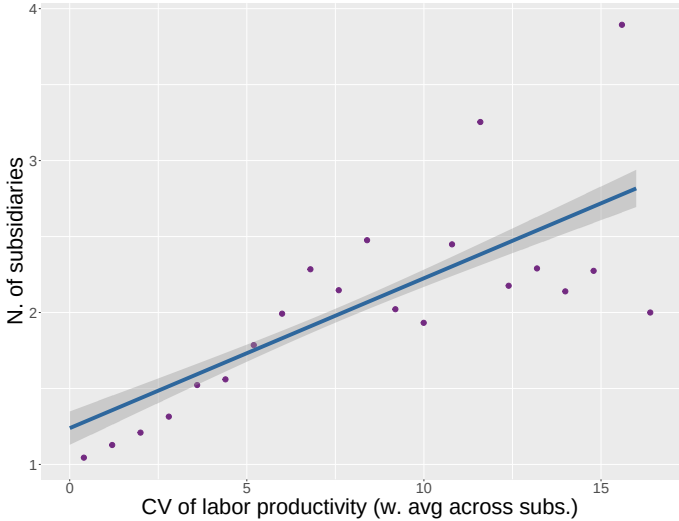


Figure: *Source: Dun&Bradstreet domestic establishment-level data, 2017. Firms=70,115,*

US, integration of plants and upstream risk

Ranking	SIC 4	Subsidiaries	Description
Top, all sectors			
1	**6411**	3096	Insurance Agents, Broker Services
2	**7389**	2632	Business Services
3	**8742**	2444	Management Consulting
4	**8011**	2440	Offices and Clinics of Doctors of Medicine
5	**6531**	2381	Real Estate Agents and Managers
Bottom, all sectors			
1	**2517**	1	Wood Television, Radio Phonograph
2	**7241**	1	Barber Shops
3	**2257**	1	Weft Knit Fabric Mills
4	**3142**	1	House Slippers
5	**2397**	1	Schiffli Machine Embroideries
Top, manufacturing			
1	**2711**	823	Newspapers: Publishing or Printing
2	**2834**	767	Pharmaceuticals Preparations
3	**3089**	727	Plastic Products
4	**3714**	641	Motor Vehicle Parts and Accessories
5	**3841**	494	Surgical and Medical Instruments and Apparatus
6	**3674**	435	Semiconductors
7	**2869**	347	Industrial Organic Chemicals
8	**2752**	316	Commercial Printing, Lithographic
9	**3679**	291	Electronic Components
10	**3842**	287	Orthopedic, Prosthetic and Surgical Appliances
Bottom, manufacturing			
1	**2517**	1	Wood Television, Phonograph
2	**2257**	1	Welft Knit Fabric Mills
3	**3142**	1	House Slippers
4	**2397**	1	Schiffli Machine Embroideries
5	**2259**	1	Knitting Mills

US, integration of plants and upstream risk



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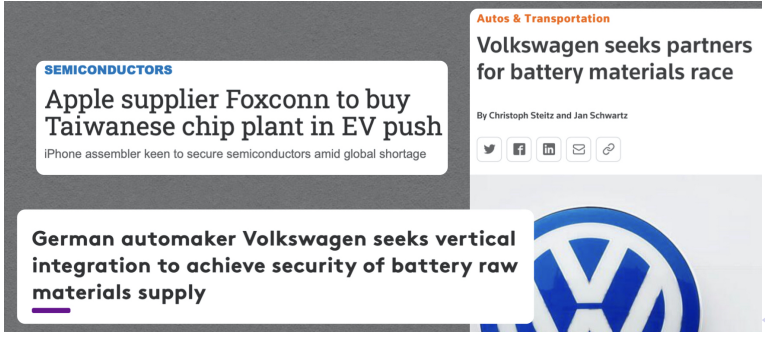
Research Question

How does **upstream risk** influence incentives to acquire **ownership** along the supply chain?



Off-the-shelf model of firm boundaries, Antràs (2003)

- Trading in **specific inputs** is subject to contract incompleteness
- First, irreversible specific investments. Then, ex-post bargaining over surplus
- Bargaining power distorts specific investments: high weight, invest more
- Organizational form = allocation of bargaining power

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- Exogenous shocks to supplier have same effect on joint surplus regardless of organizational form
- Vertical integration not helpful to deal with disruptions to upstream supply

→ **Organizational choice does not depend on level of risk**

Model setup

- A buyer, B and a supplier, S (of a specific input)
- Contract incompleteness

→ Disruptions hit upstream and hinder efficiency of S

→ B could take costly actions to address this (h)

- Signal from U to D about damage to S
- Precision depends on investments in transparency a ex-ante, q ex-post

→ Vertical integration: B acquires trade secrets of S priced at f, wins chance to visit U if shock hits and set appropriate q

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Preview: **Ownership** = trade-off b/w **ex-ante** and **ex-post leverage on disruptions**
→ outcome will depend on characteristics of the **shock** process: frequency, dispersion...

Timing

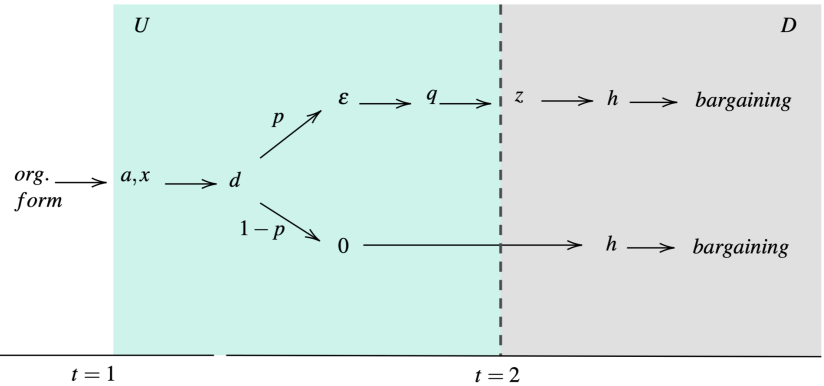

Figure: Timing. Signal from U to D: $z \sim \Sigma(z; a, q)$

A concrete example

- **B**= Harley Davidson← **S**=Tier 1, pistons←Tier 2 raw materials
- Disruption: raw materials from 2 inadequate, parts break
- B can adapt process, need to analyze batch of minerals

Model: characterization, Buyer

By backward induction, More modelling

Time 2, locations U and D - vertical integration

$$q^*(\varepsilon, a, x) \in arg\max_q E_z[V_v^B] = \int_z [\phi_v R(x, h_v^*(z), \varepsilon) - c_h^B h_v^*(z)] d\Sigma(z; a, q) - p c_q^B q$$

$$h_v^*(z, a, x, q) \in arg\max_h E_{\varepsilon|z}[V_v^B] = \int_\varepsilon \phi_v R(x, h, \varepsilon) dF(\varepsilon|z; a, q) - p c_q^B q - c_h^B h$$

Time 2, locations U and D - outsourcing

$$q^* = 0$$

$$h_o^*(z, a, x, 0) \in arg\max_h E_{\varepsilon|z}[V_o^B] = \phi \int_\varepsilon R(x, h, \varepsilon) dF(\varepsilon|z; a, 0) - c_h^B h$$

where

$$\phi_v = [\delta^\alpha + \phi(1 - \delta^\alpha)] \geq \phi$$

Model: characterization, Supplier and organization

By backward induction,

Time 1, location U - vertical integration

$$(a_v^*, x_v^*) \in arg\max E_z[E_{\varepsilon|z}[V_v^S|z]]$$

Time 1, location U - outsourcing

$$(a_o^*, x_o^*) \in arg\max E_z[E_{\varepsilon|z}[V_o^S|z]]$$

Time 0, organizational choice

$$\text{B integrates S iff} \quad E[V_v^B - V_o^B] = E_z[E_{\varepsilon|z}[V_v^B - V_o^B|z]] \geq f$$

Discussion: transparency and residual rights

- B and S have absolute advantage in different types of investments in transparency ($c_q^S = \infty, c_a^B = \infty$)
- Under **vertical integration**, S anticipates lower share of revenues $\rightarrow$ potential under investment in a
- Under **outsourcing**, B will have to keep out from trade secrets of S $\rightarrow$ ex-post investment q is zero

Simulations - an elementary increase in risk

- Suppose support of shock has dimension 3:

$$\varepsilon \in [low, medium, high] \quad p(\varepsilon) = [p_l, p_m, p_h]$$

- Consider a MPS to $p(\varepsilon)$: some mass of the probability distribution moves to the tails

  $\rightarrow \sigma_\varepsilon$ increases by 13.5% but the mean does not change

  How does the relative value of vertical integration change?

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  How does the relative value of vertical integration change?

$$\rightarrow \quad 6x \quad \text{increase in} \quad E[V_v^B - V_o^B]$$

Posterior distribution given signal z_m: $a = 0$

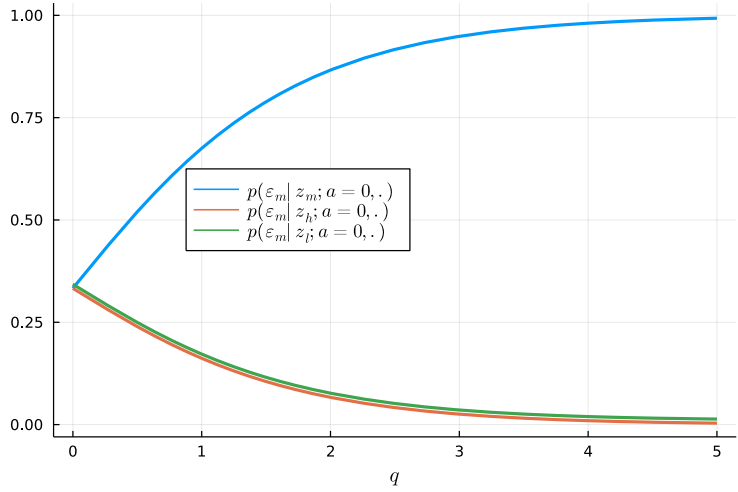

Figure: Effect of B's investment on posterior.

Posterior distribution given signal z_m: $a = 1$

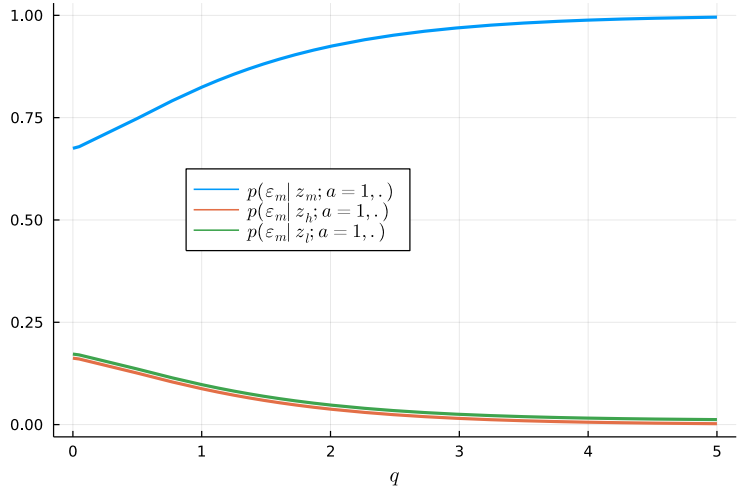

Figure: Effect of B's investment on posterior.

B policy: choice of h - outsourcing

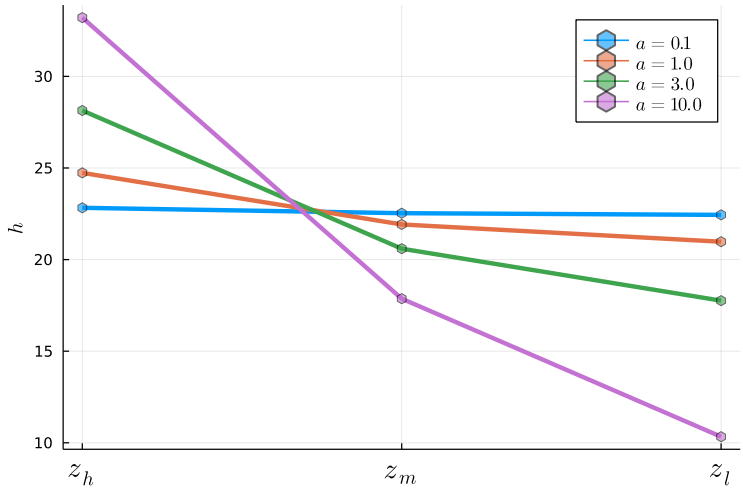

Figure: Policy function, x fixed.

B policy: choice of h - vertical integration

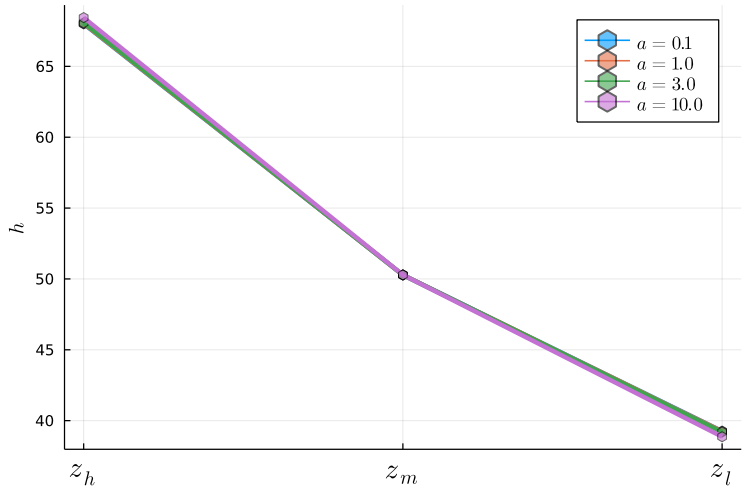

Figure: Policy function, x fixed.

B policy: choice of q - vertical integration

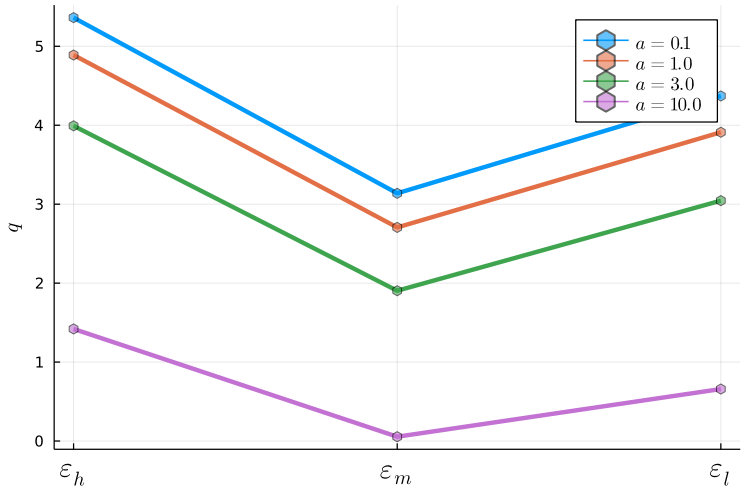

Figure: Policy function, x fixed.

S policy: choice of a, x - vertical integration

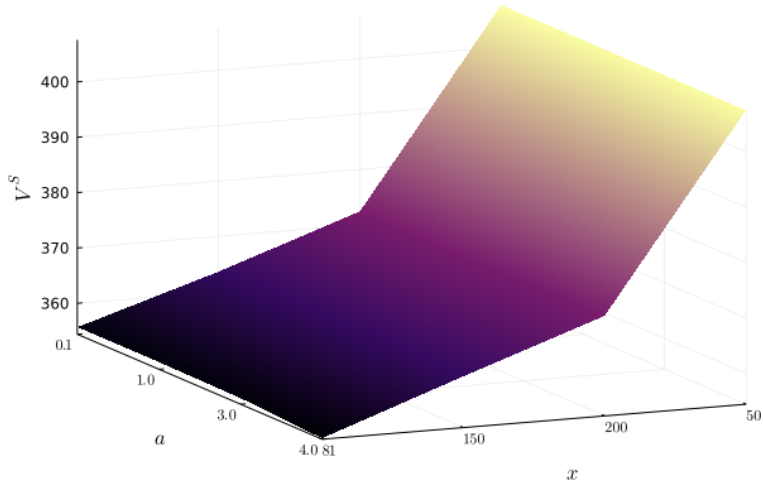

Figure: Value function of S.

$E[V_v^B - V_o^B]$

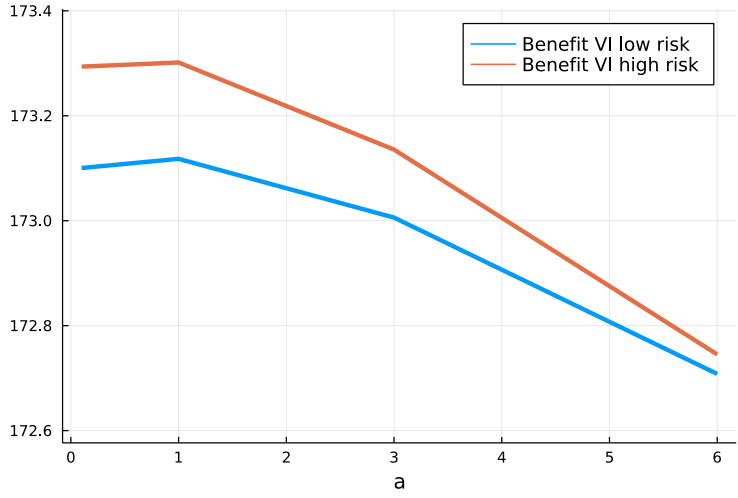

Figure: Incentives to vertically integrate the supplier.

Conclusion

- Propose a simple model to make the point that ownership can be a tool to manage upstream risk

→ The configuration of upstream risk (frequency and dispersion of disruptions) is a determinant of organizational choice

- Obtain several implications testable in the cross-section of industries (e.g. we should see more integration in industries subject to large and rare events)

Next step:

- How do organizational choices impact strength of propagation channels?

Literature Review: firm boundaries and uncertainty

- **Firm boundaries and contractual frictions:** Grossman and Hart (1986); Antràs (2003); Antràs and Helpman (2002); Antràs and Chor (2013); Chor and Ma (forthcoming); Oberfield and Boehm (2020)
- **Ex-post supply assurance:** Carlton (1979); Baker et al. (2002)
- **Supply chains and uncertainty:** Arrow (1975); Alfaro et al. (2018); Rigobon et al. (2021); Pankratz and Schiller (2019); Grossman et al. (2021); Ramondo et al. (2013)
- **Production networks (formation and propagation)** Oberfield (2018); Acemoglu and Azar (2020); Huneeus (2018); Acemoglu et al. (2016)
- **Intra-firm trade (or lack thereof):** Yi (2003); Johnson and Noguera (2012); Atalay et al. (2014); Ramondo et al. (2016)

Model

Back **Technology**

$$y = ((1-\eta) * (x-\varepsilon)^{\nu} + \eta * h^{\nu})^{\frac{1}{\nu}} \quad \nu < 1$$

Revenues

$$R(x, h, \varepsilon) = A^{1-\alpha} y^{\alpha} \quad \alpha < 1$$

Shocks

$$\xi = 1[d = 1]\varepsilon \quad \text{where} \quad P(d = 1) = p \quad \text{and} \quad \varepsilon \sim F(\varepsilon)$$

Signal from U to D

$$z \sim \Sigma(z; a, q)$$

Investments B and S can invest in transparency: S chooses a *ex-ante*, B chooses q *ex-post*

Model: payoffs

Under **outsourcing**:

$$V_o^B = \phi R(x, h(z), \varepsilon) - c_h^B h$$

$$V_o^S = (1-\phi) R(x, h(z), \varepsilon) - c_x^S x^2 - c_a^S a$$

Under **vertical integration**:

$$V_v^B = \phi_v R(x, h(z), \varepsilon)) - p c_q^B q - c_h^B h - f$$

$$V_v^S = (1-\phi_v) R(x, h(z), \varepsilon) - c_x^S x^2 - c_a^S a$$

where

$$\phi_v = [\delta^\alpha + \phi(1-\delta^\alpha)] \geq \phi$$

Notice: $\delta \to 1 \quad \phi_v \to 1$ and VI is always preferred, $\delta \to 0 \quad \phi_v \to \phi$ and outsourcing is always preferred. Focus on the case $\delta \in (0,1)$.

Model

Incomplete contracting
S and B cannot contract on a, q: former not verifiable, for latter it is not possible to enumerate all disruption scenarios

Nash bargaining
After production, B and S bargain over the division of revenues.
B will get a fraction ϕR

Organizational form
B can integrate S by paying f, i.e. buying the trade secrets and intellectual property of S

Outside option
Under VI, B can operate upstream machinery at lower productivity and produce low-quality final good

$$\delta y \to \delta^{\alpha} R$$