Economies of scope in governing global supply chains: Evidence from U.S. Customs records of the automotive industry

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The story of Kojima Press

- In the late 1930s, Hamakichi Kojima, owner of a small company, made repeated multi-hour trips by train to visit Toyota, hoping for work
  - Even though Kojima lacked processing technology needed to make auto parts
- Eventually, his tenacity was rewarded with order, for 'sand buckets' (a 'simple' part)
- Then, Toyota ordered other parts from Kojima,
  - e.g., washers and additional parts for a truck radiator grill (more 'complex')
  - as they guided and trained Kojima
- Today, Kojima supplies a wide variety of metal and plastic parts to Toyota, from subsidiaries around the world

- Wada 1991; Wada 2020

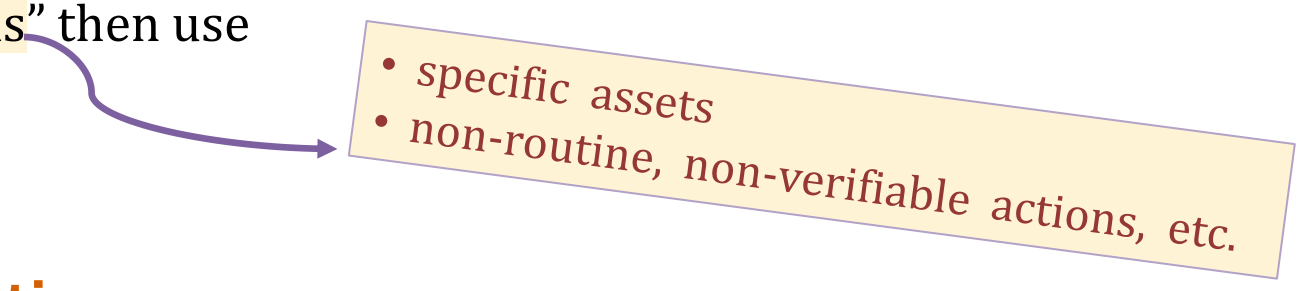
Puzzles from Kojima

- Toyota offered its suppliers a long-term relationship and technical assistance – even for commodity parts
- Toyota rewarded its suppliers with new products
- Not a strategy that Oliver Williamson would expect
  - Why give business to a firm that lacks technical capability, and pay to help them develop it?
  - Why establish a long-term relationship for commodity product, one with few "transaction hazards"?
  - Why give new parts to an existing supplier that does not specialize in making those parts?
- Answer: think about spillovers across transactions

Transaction-based theories (TB)

- **The nature of an individual transaction is the most important determinant of sourcing governance**

- **General predictions** [Williamson 1975, 1985; Grossman-Hart-Moore 1990; Gibbons-Henderson 2012]
  - If an input market is characterized by perfect competition then spot markets are optimal
  - If there are "transaction hazards" then use
    - Long-term relationships
    - Vertical integration



- **Implications of these predictions:** [Bensaou-Anderson 1999; Dyer, et al. 1998]
  - Every firm should govern transactions with different attributes in different ways
  - All firms should conduct transactions with similar attributes the same way

Hypotheses: Transaction based theories

- In product categories with higher levels of R&D or product differentiation,

  Vehicle manufacturers (VMs) will do less spot buying, that is, they will have

  - fewer suppliers per part
  - longer relationship with suppliers

- When the scale of purchases is greater, vehicle manufacturers will
  - employ more suppliers per part

Organization-based theories

- A management-based literature argues that firm strategy is key:
  - Successful firms buy all products the same way:
    - Toyota: always collaborative and long-term (Liker 2004)
    - Walmart: always hard-nosed bargaining (Mottner Smith 2009)
  - Implicitly, these theories assume there are spillovers across relationships, but they are not explicit about what these are
- An econ literature on "multi-market contact" shows that
  - such contacts increase ability to credibly enforce relational contracts (Bernheim and Whinston) and to
  - internalize externalities across markets (Argyres, Gil, Zanarone, 2021);
- **Firm organization is the most important determinant of sourcing governance**

Organization based theories: why might a firm govern all transactions in the same way?

- **Facilitates relational contracts**
  - ***Promotes Clarity*** [MacDuffie-Helper 1999; Gibbons-Henderson 2012; Helper-Henderson 2014]
    - **Understanding** the elements of the relational contracts: tacit knowledge
      - For example, clarifying "tenacity" requires a per-supplier investment by Toyota, and also benefits from learning from other suppliers
      - Toyota economizes by having few suppliers per part, for a long time, that learn from each other about the relational contracts
        - Large quantities of information, difficult to communicate content, nebulous concepts
    - It would be difficult to establish what is fair across several types of relational contracts
  - ***Promotes Credibility*** [Helper 1991, Sako 1996, Levin 2002, Gibbons-Henderson 2012]
    - **Assurance** that the terms of relational contracts will be upheld
      - Supplier associations monitor vehicle manufacturers (Sako)

Why might a firm govern all transactions in the same way? ... continued

- **Complementarities across functions in the buyer's organization**

  [Sako 2004; Takeishi 2002; Womack-Jones-Roos 1990; Helper 1991; Smitka 1991]

- Compartmentalization of information flow
  - Which functions should suppliers have access to?
    - Collaborative: many, so can share ideas
    - Arm's-length: only purchasing, so engineers don't design specs to limit the number of potential suppliers
- Who designs the product?
  - In-house design facilitates apples: apples comparison that arm's-length relies upon
- What is the career path for purchasing agents?
  - Collaborative: rotate through a variety of functions
  - Arm's-length: rotate among commodities within purchasing to avoid capture by suppliers; don't need engineering background

- **Disparate views about nature of a given transaction**

  [Stevens-MacDuffie-Helper 2018, Helper-Henderson 2014]

  - Some may see attributes of two products as similar, even when others in same industry do not
    - Toyota wants all suppliers to do both exploration and exploitation (Aoki/Wilhelm)
    - GM (in the past): most components were commodities

Hypotheses: Organization based theories

- **Firm organization determines supplier governance**
  - **Collaborative and non-collaborative VMs treat transactions with the same attributes differently,** i.e., transaction attributes are less important determinant of governance choices for collaborative VMs
    - Tested by interacting organization measure with product characteristics
  - **Collaborative VMs are less likely to engage in spot buying**
    - Collaborative VMs have fewer suppliers per part, regardless of transaction attributes
    - Collaborative VMs have longer relationships with their suppliers
  - **Collaborative VMs place more weight on the identity (e.g., supplier's familiarity with "Honda way") than the technical capabilities of the suppliers**
    - Collaborative VMs source more types of parts per supplier
  - **Collaborative VMs are more loyal to their suppliers**
    - They are less likely to exit a relationship when the exchange rate rises in the supplier country

Data

- **Longitudinal Firm Trade Transactions Database (LFTTD)**
  - By firm, transaction-level data collected by the U.S. Customs and Border Protection, ~1992-2021
  - For all Vehicle Manufacturers assembling cars and trucks in the U.S.,
  - Detailed 10-digit HTS categories (e.g., 'Vulcanized gaskets', 'washers and other seals', 'Mountings, fittings and similar articles, of base metal', etc.)
  - Identifies related party transactions

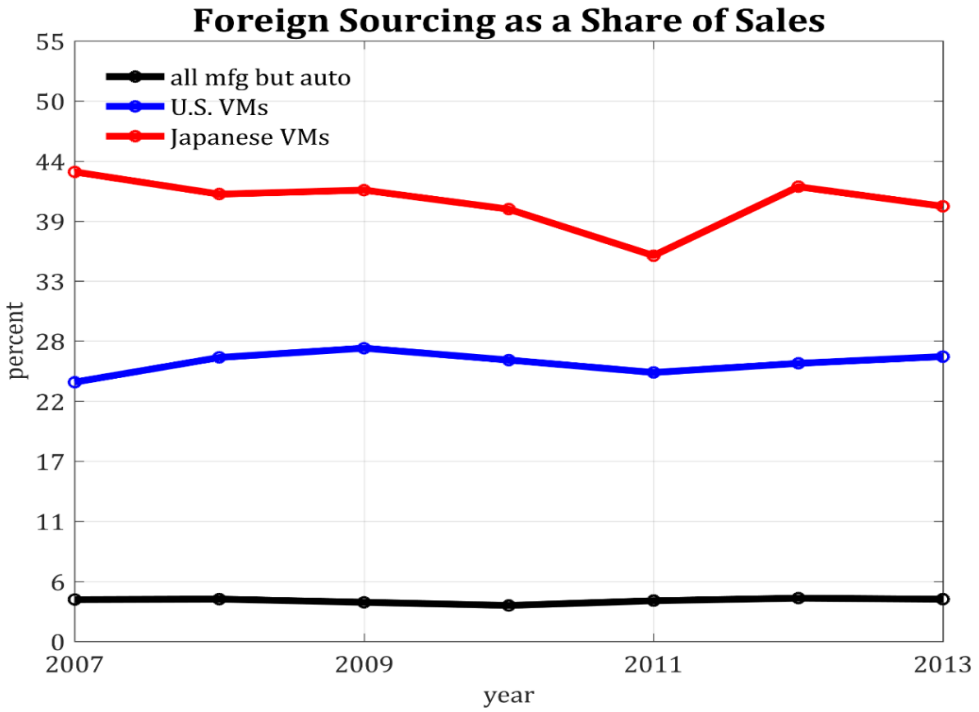
- **Foreign suppliers**
  - Information on suppliers coded in *Manufacturer ID*
  - We use the first eight characters and drop transactions without a valid ID
  - Since no data on domestic suppliers of U.S. VMs, we drop suppliers from other VM home countries in some cases (doesn't affect results)

- **The main sample**
  - VMs operating in the U.S., identified using external sources
  - Countries that VMs imported from for at least 5 years (~44)
  - Product categories that VMs imported for at least 5 years, excluding final auto products (~600)

Representativeness

Foreign sourcing

At least one-quarter of sales in the case of U.S.-headquartered vehicle manufacturers and over 40 percent of sales of foreign-headquartered vehicle manufacturers



Source: BEA. The data underlying this chart come from combining AMNE data with some additional information from *Compustat*

Governance of foreign vs domestic sourcing

Multiple surveys, e.g.,

- 2011 survey data [Helper-Krueger-Wial 2012]
  - Show automakers operating in the U.S. use similar supplier governance practices for domestics and foreign suppliers.
- Industry survey conducted every year since 2002 of North American suppliers to the 6 largest automakers in the North American market. [See Yenyurt et al 2014]
- Import share as a control.

Measures

- **Measures of "collaboration"**
  - "JAPAN" : VM is Japanese-owned (dummy variable)
  - "Historical Collaborativeness": a VM's average number of suppliers per part during a 10-year pre-period (1992-2001)
    - Continuous variable; larger values indicate a VM is less collaborative

- **Measures of supplier governance**
  - Number of suppliers that supplied in a product category, in a given year
  - Parts per supplier: Average number of parts sold to a given VM by each of its suppliers
  - Vertical integration is measured by the existence of related party trade with a supplier

- **Measures of product attributes**
  - *R&D intensity* [Nunn and Trefler's (2013) R&D intensity]
  - *US import trade elasticities – product differentiation* [Broda and Weinstein (2006)]
  - *Product upstreamness* [Antràs et al. (2012)]
    - Methodology applied on all BEA Benchmark Use tables over 1997-2017
  - *Import share*: Share of imports in total trade (exports plus imports) at the 6-digit HS level

Regression: number of suppliers per part

	Number of suppliers	
Japan dummy	-6.54***	-5.99***
Covariates: value of purchase, length of purchase, related party trade	yes	yes
Japan interacted with covariates	yes	yes
Product characteristics: R&D intensity, elasticity, upstreamness, share of imports	no	yes
Japan interacted with product characteristics	no	yes
Observations	23,500	23,500
Year fixed effects	yes	yes
Product (HS-10) fixed effects	yes	no
Joint F statistic: year fixed effects	3.99***	3.56***
Joint F statistic: product fixed effects	4.52***	---

Regression at VM group-product (HS-10)-year level
44 countries, 600 products

‘Japan’ as a measure of collaborativeness

Support for transaction cost theory

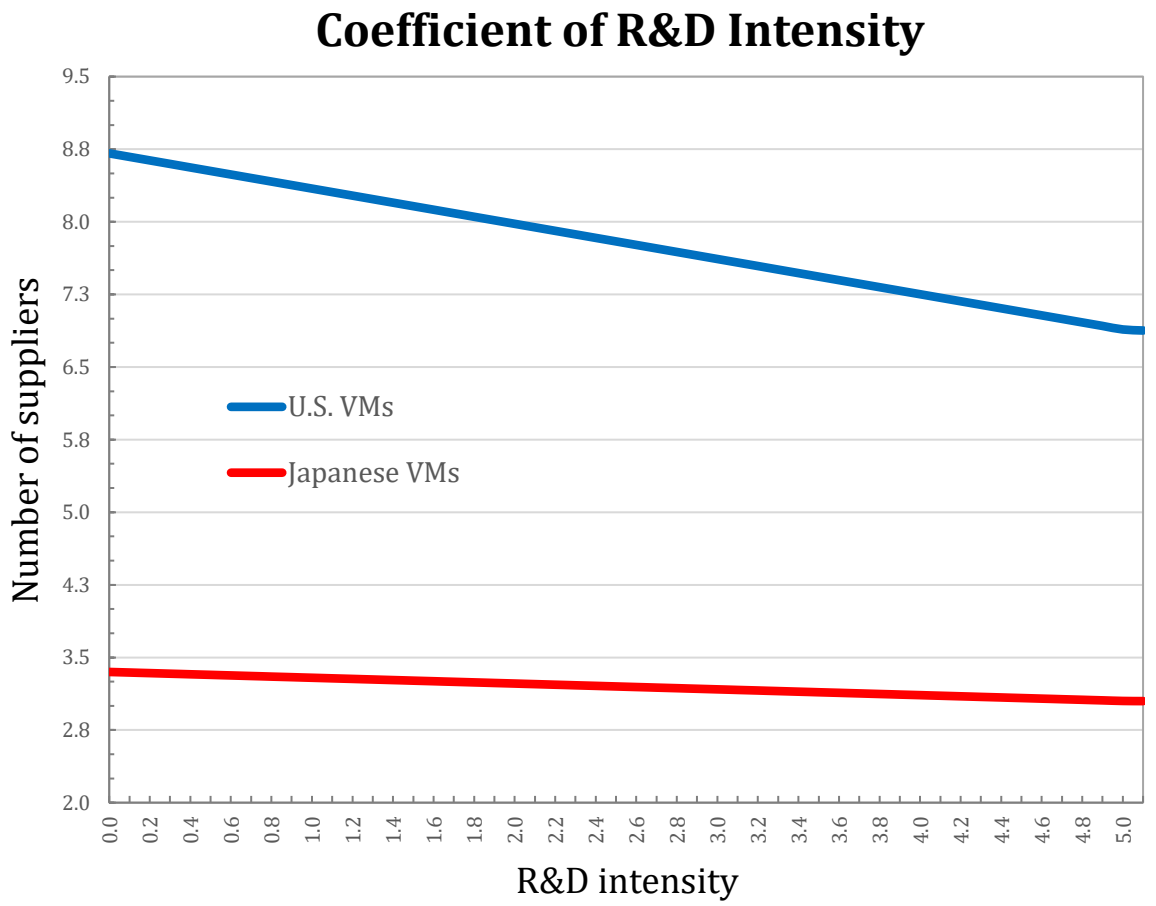
As R&D intensity increases from its mean to mean + 2 standard deviation

- # of suppliers to U.S. VMs falls from 8.3 to 7.3 (11%)
- # of suppliers to Japanese VMs also falls a bit: from 3.3 to 3.1 (5%)

But organization-based theories have more impact

At every level of R&D intensity …

the U.S. VM group has at least double the suppliers than the Japanese VM group



Product-level regressions

	Number of suppliers		Vertical integration		Relationship longevity	
Japan	-6.54***	-5.99***	10.62***	10.94***	1.39***	1.52***
R&D intensity (rdi)		**-0.36****		**0.54**		**-0.02**
Japan * rdi		**0.3****		**-1.04**		**0.06**
Upstreamness		**-0.22**		**-1.60***		**0.22*****
Japan * upstreamness		**0.04**		**-2.65****		**-0.17**
Import elasticity (elasticity)		**-0.1*****		**0.17****		**0.0**
Japan * elasticity		**0.09*****		**-0.03**		**0.01**
Import share (imshare)		**-0.02**		**-0.03**		**0.0**
Japan * imshare		**0.02**		**0.06**		**0.0**
Value of purchase (vp)	1.72***	1.95***	0.95***	0.64***	0.18***	0.09***
Japan * vp	-1.4***	-1.73***	1.0***	1.43***	-0.14***	-0.13***
Other controls	yes	yes	--	--	yes	yes
Observations	23,500	23,500	23,500	23,500	1,200	1,200
R-squared	0.58	0.25	0.33	0.16	0.73	0.3
Year fixed effects (FEs)	yes	yes	yes	yes	--	--
Product FEs	yes	no	yes	no	yes	no
RMSE	8.92	11.73	28.23	31.21	0.81	0.92
Adj-R2	0.56	0.25	0.32	0.16	0.45	0.29
Joint F: year FEs	3.99***	3.56***	3.59***	1.15***	--	--
Joint F: product FEs	4.52***		423.2***		173.5***	

Results: Transaction attributes vs Organization

- **Japan dummy as a % of 1 s.d. outcome**

  Number of suppliers (outcome)

  Japan effect is 44% of 1 s.d. of the variable "number of suppliers"

- **Continuous variable = (coefficient*1 s.d.) as a % of 1 s.d. outcome**

  Number of suppliers (outcome)

  As R&D intensity increases by 1 s.d., magnitude of effect is 3% of 1 s.d. of number of supplier

	Number of suppliers	Vertical integration	Relationship Longevity
Japan dummy (organization)	44	32	139
Transaction attributes			
Upstreamness	0	3	13
R&D intensity	3	0	0
Import elasticity	8	5	0
Import share	0	0	0

Only magnitudes, direction of impacts is ignored.

Product-level regressions

	Number of suppliers per part
Historical Collaborativeness	- (***)
Upstreamness	-
Upstreamness × Collaborativeness	- (***)
R&D Intensity	+
R&D Intensity × Collaborativeness	- (***)
Elasticity	+ (***)
Elasticity × Collaborativeness	- (***)
Import Share	+ (***)
Import Share × Collaborativeness	- (***)
LN Imports	- (***)
LN Imports × Collaborativeness	+ (***)
Constant	+ (***)
Year Fixed Effects	yes

VM-level regressions

	(1)	(2)	(3)
	Parts per Supplier		
Historical Collaborativeness	- (***)	- (**)	- (***)
Upstreamness			+
Upstreamness × Collaborativeness			-
R&D Intensity			-
R&D Intensity × Collaborativeness			+
Elasticity			- (*)
Elasticity × Collaborativeness			+ (*)
Import Share			-
Import Share × Collaborativeness			-
LN Imports	-	+ (***)	- (***)
LN Imports × Collaborativeness			+ (***)
Constant	+ (***)	+	+ (**)
Year Fixed Effects	yes	yes	yes
Manufacturer Fixed Effects		yes	

Returning to Kojima-Toyota

- Questions
  - Why give business to a firm that lacks technical capability, and pay to help them develop it?
  - Why establish long-term relationship for commodity product, one with few "transaction hazards"?

- Answer : Spillovers across transactions
  - Japanese VMs: Build clear, credible relational contracts with suppliers
  - How would low-collaboration firms answer?
    - Higher discount rate, more concerns about hold-up, more faith in market generation of capabilities leads to:
      - Lower estimated value of relational contract (action sustained by shadow of the future)
      - Thus, establish relational contracts only with hi R&D suppliers and maintain some option to exit even from these firms

Conclusion

- We offer new insights into the development of relational contracts by considering several transactions at once
  - We analyze U.S. Customs microdata of all imports by vehicle manufacturers (VMs), 1992-2021
- We find that while transaction-based measures are statistically significant, organization-based measures generally have much greater explanatory power
  - In predicting number of suppliers, Japan effect is 10 times greater than that from 1 s.d. change in R&D
- Lead firms and suppliers experience economies of scope in developing clear and credible relational contracts
  - Because of these spillovers across relationships, firms have distinct and stable strategies for value chain governance, such as the number of suppliers per part, length of relationship with suppliers, and number of part types their suppliers provide

Extra Slides

Adding country dimension

Product-country-level regressions

	Number of suppliers		Vertical integration		Relationship longevity	
Japan	-0.096***	-0.126***	1.439***	1.253***	0.188***	0.37***
Control variables	yes	yes	yes	yes	yes	yes
Japan * control variable	yes	yes	yes	yes	yes	yes
Product characteristics	no	yes	no	yes	no	yes
Japan* product characteristics	no	yes	no	yes	no	yes
Per capita GDP (pcGDP)	0.064***	0.063***	0.01	0.019	--	--
Japan * pcGDP	-0.012***	-0.007**	-0.734***	-0.756***	--	--
Exchange rate change (xchage)	-0.016	-0.015	0.288***	0.287***	--	--
Japan * xchange	0.028**	0.028**	-0.185*	-0.185*	--	--
Observations	1,003,000	1,003,000	1,003,000	1,003,000	53,000	53,000
Year fixed effects	yes	yes	yes	yes	--	--
Product (HS-10) fixed effects	yes	no	yes	no	yes	no
Country fixed effects	yes	yes	yes	yes	yes	yes
Joint F: country fixed effects	7.35***	9.00***	61.93***	61.13***	17.49***	18.26***
Adj-R2	0.334	0.317	0.421	0.416	0.69	0.684

Corporate Culture and National Culture

	Number of suppliers	Vertical integration
U.S. OEM dummy variables	positive on average	negative on average
Japanese OEM dummy variables	negative on average	positive on average
Log value of purchase	yes	yes
Number of years purchased	yes	yes
RPT	yes	no
Constant	yes	yes
Year FE	yes	yes
HS10 FE	yes	yes
SE cluster	OEM-HS10	OEM-HS10
Goodness of fit	Good	Good
Year fixed effects	Jointly significant	Jointly significant
Product fixed effects	Jointly significant	Jointly significant
Group of U.S. OEM dummies	Jointly significant	Jointly significant
Group of Japanese OEM dummies	Jointly significant	Jointly significant
H0: U.S. OEM dummies are not different from each other	Reject	Reject
H0: Japanese OEM dummies are not different from each other	Reject	Reject

Omitted category: A Japanese OEM

Corporate Culture and National Culture

- Lots of evidence that supplier governance varies by firm, as well as by nation
- We can't disclose firm names, but do have suggestive evidence
  - Significant variance of automaker strategy within national groups

Number of suppliers
Within Group Variation (VM-product-year level sample)

	VM Group	
	Japan	USA
Average number of suppliers per product	1.7	6.2
Standard deviation of number of suppliers per product	0.5	3.4

H0: U.S. VM dummies are not different from each other
Reject
H0: Japanese VM dummies are not different from each other
Reject