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Relationship governance in the automotive supply chain

Alexander Schmitt
KU Leuven and FWO

Jo Van Biesebroeck
KU Leuven and CEPR

Different literatures

- Neoclassical theory:
  - Firm: decision made by “owner” (black-box)
  - Market: transactions governed by price mechanism
- Literature on the make-or-buy decision
  - Technology (*Smith, 1776*)
  - Market size (*Stigler, 1951*)
  - Transaction costs (*Coase, 1937; Williamson, 1975, 1985*)
  - Property rights theory (*Grossman-Hart-Moore, 1986, 1990)*

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FIRM

- Organizational economics: endogenous design & within-firm governance
  - Principal-agent (*Alchian-Demsetz, 1972; Holmstrom, 1982*)
  - Incentive system (*Holmstrom-Milgrom, 1994; Holmstrom-Roberts, 1998; Roberts, 2004*)
  - Sub-economy (*Simon, 1951; Holmstrom, 1999*)

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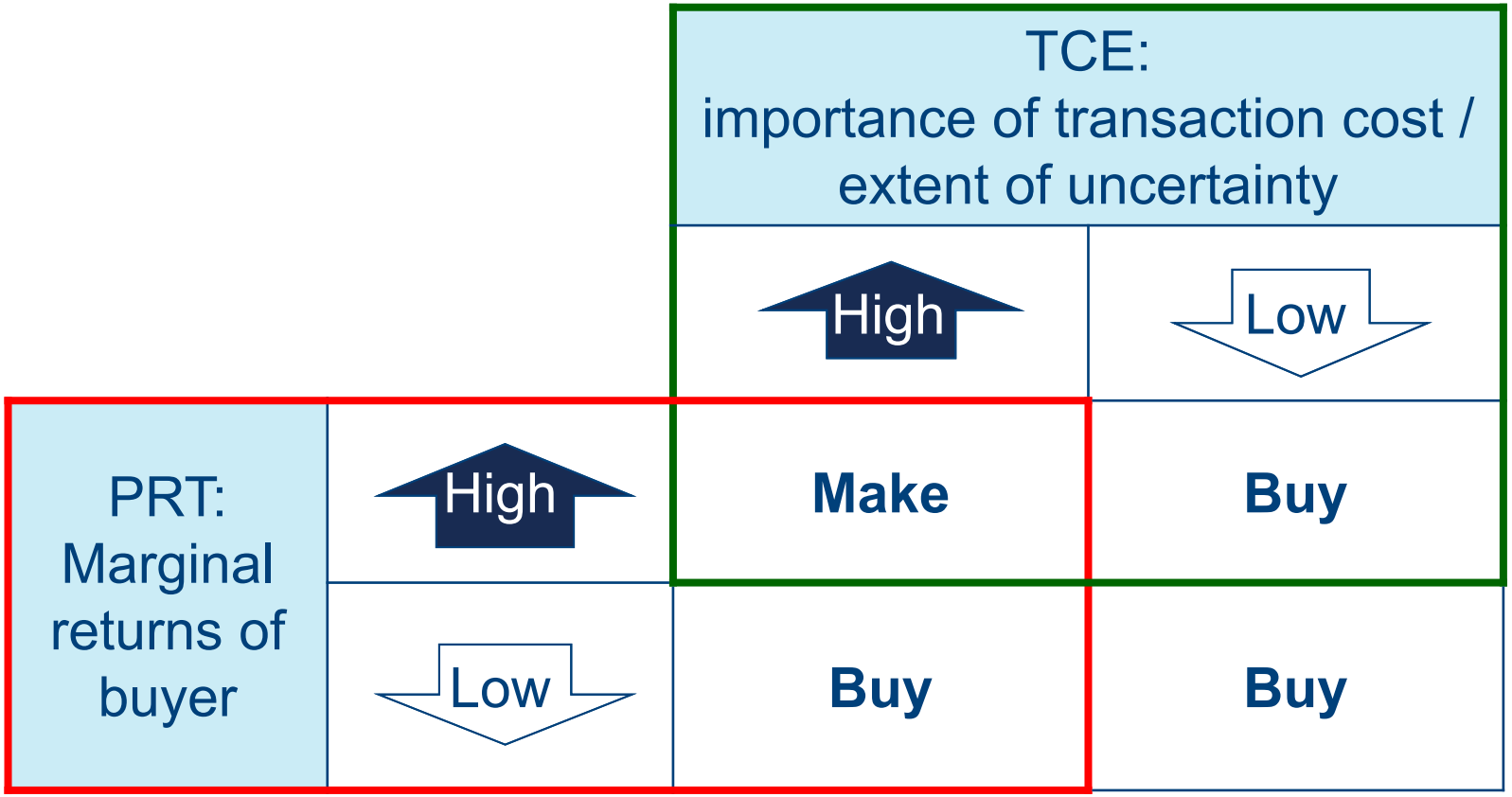
MARKET

- "Evidence-driven" models: attention to heterogeneity in the way transactions between firms are organized
  - Pairs of firms behave differently
  - How to govern different sourcing relationships?
    - Networks (*Powell, 1990; Dyer, 1996*)
    - Relational view (*Baker-Gibbons-Murphy, 2002*)
    - Customized governance forms (Williamson, 1985)
    - …Portfolios of governance (*Bensaou, 1999; many others*)
    - Global value chains (*Gereffi-Humphrey-Sturgeon, 2005*)

MARKET: nest two popular views



Contributions

1. Link the global value chains (GVC) model to the economics literature
   - Illustrate how it provides a way to integrate several prominent models in the make-or-buy literature
2. Test the GVC predictions using outsourcing data on the auto industry
   - Use findings to evaluate possibilities for supplier upgrading in the auto industry

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Outline

1. The GVC model (*Gereffi-Humphrey-Sturgeon 2005*)
   & Link with other literatures
2. Governance in the automotive industry
3. Empirical analysis
   3.1. Identify: Regress on characteristics
   3.2. Classify: Choice of governance
   3.3. Predict: Effects on suppliers
4. Conclusion and caveats

Types of supply chain governance

<table>
<tr><th></th><th>Make-or-buy literature</th><th>Networks / Relational sourcing</th><th>Global Value Chains</th></tr>
<tr><td rowspan="5">Governance choice

Firm boundary</td><td rowspan="3">Market</td><td>Market</td><td>Market</td></tr>
<tr><td rowspan="3">Hybrid/ Network/ Relational outsourcing</td><td>Modular</td></tr>
<tr><td>Relational</td></tr>
<tr><td>Captive</td></tr>
<tr><td>Hierarchy</td><td>Hierarchy</td><td>Hierarchy</td></tr>
</table>

Identifying GVC governance modes

- **Market**
  - Low switching costs for both buyer and supplier
  - No (little) transaction-specific investments, relatively easy to substitute to outside options
  - Standardized products
    - e.g. food industry
- **Modular**
  - Turn-key suppliers
  - Suppliers use generic machinery that limits transaction-specific investments
  - Rather customized products but with multi-use interface
    - e.g. electronics industry (*Foxconn*)

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Identifying GVC governance modes

- **Relational**
  - Strong inter-dependency between buyer and supplier
  - Both make relationship-specific investments
  - Highly customized products
    - e.g. auto industry (*Toyota vs. Denso*)
- **Captive**
  - Supplier does not work for other clients
  - Supplier has no outside options and makes investments to buyer's specifications
  - Products tailored to buyer's needs
    - e.g. apparel industry (*Nike*)
- **Hierarchy**
  - In-house production

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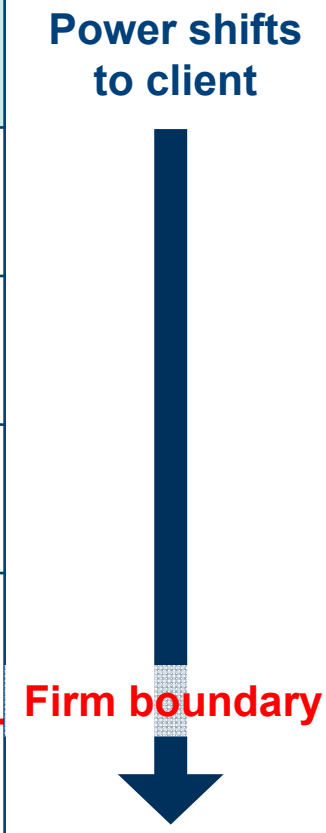
Determinants of GVC governance

	Complexity of transactions	Ability to codify transactions	Capabilities in the supply base
Market	Low	High	High
Modular	High	High	High
Relational	High	Low	High
Captive	High	High	Low
Hierarchy	High	Low	Low



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Hierarchy	High	Low	Low

Firm boundary

Positioning in the literature

- **Complexity:** difficulty of writing complete contracts
  - Theory: *Bajari-Tadelis (1999), Tadelis (2002)* "Complexity, flexibility and the make-or-buy decision"
  - Empirics: *Monteverde-Teece (1982)* [engineering effort], *Walker-Weber (1984)* [uncertainty index]
- **Codifiability:** importance of tacit knowledge
  - Theory: *Arrow (1975)* "Vertical integration and communication"
  - Empirics: *Masten-Meehan-Snyder (1989)* [measure of know-how]
- **Capability:** learning and asset accumulation
  - Theory: *Penrose (1959)* "The theory of the growth of the firm", *Nooteboom (1999-2000)* [knowledge and governance]
  - Empirics: *Asanuma (1989)*

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TCE *vs.* PRT *within* GVC

Complexity		
	Low	**Market**
	High	**2 x 2 ↓**

Capability	Codifiability: High	Codifiability: Low
High	**Modular**	**Relational**
Low	**Captive**	**Hierarchy**

PRT: marginal returns

TCE: inverse of transaction costs

TCE *vs.* PRT *within* GVC

(Codifiability) TCE: Absence of transaction costs or lack of uncertainty	
High	Low
BUY: Modular / Captive	**MAKE: Relational / Hierarchy**

(Capability) PRT: Marginal Importance of supplier investment		
	High	**BUY: Modular / Relational**
	Low	**MAKE: Captive / Hierarchy**

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GVC applied to automotive supply chain

- Advantage:
  - Industry mobilizes many manufacturing sectors
  - Most downstream of industries (Antras et al., AER 2012)
  - Global, multi-stage value chain relationships
  - Highly disintegrated production chains
  - Firms differ in sourcing strategy
- Con:
  - Appropriate unit of analysis?
    - OEM design center vs. 1st tier supplier? Static?
  - Theory too technologically deterministic?
    - Useful from a measurement point of view. In practice, behavior might differ even when technology is the same.

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GVC applied to automotive industry

Sturgeon-Van Biesebroeck-Gereffi (2008):

- **Market**
  - Less prominent now that suppliers are responsible for increasing share of design and development
- **Captive**
  - Less prominent after wave of supplier consolidation and accumulation of expertise by suppliers
- **Modular**
  - Limited due to paucity of stable, industry-wide standards and codification schemes
- **Relational**
  - Prevalent as linkages between lead firms and suppliers require tight coordination and performance features are difficult to describe

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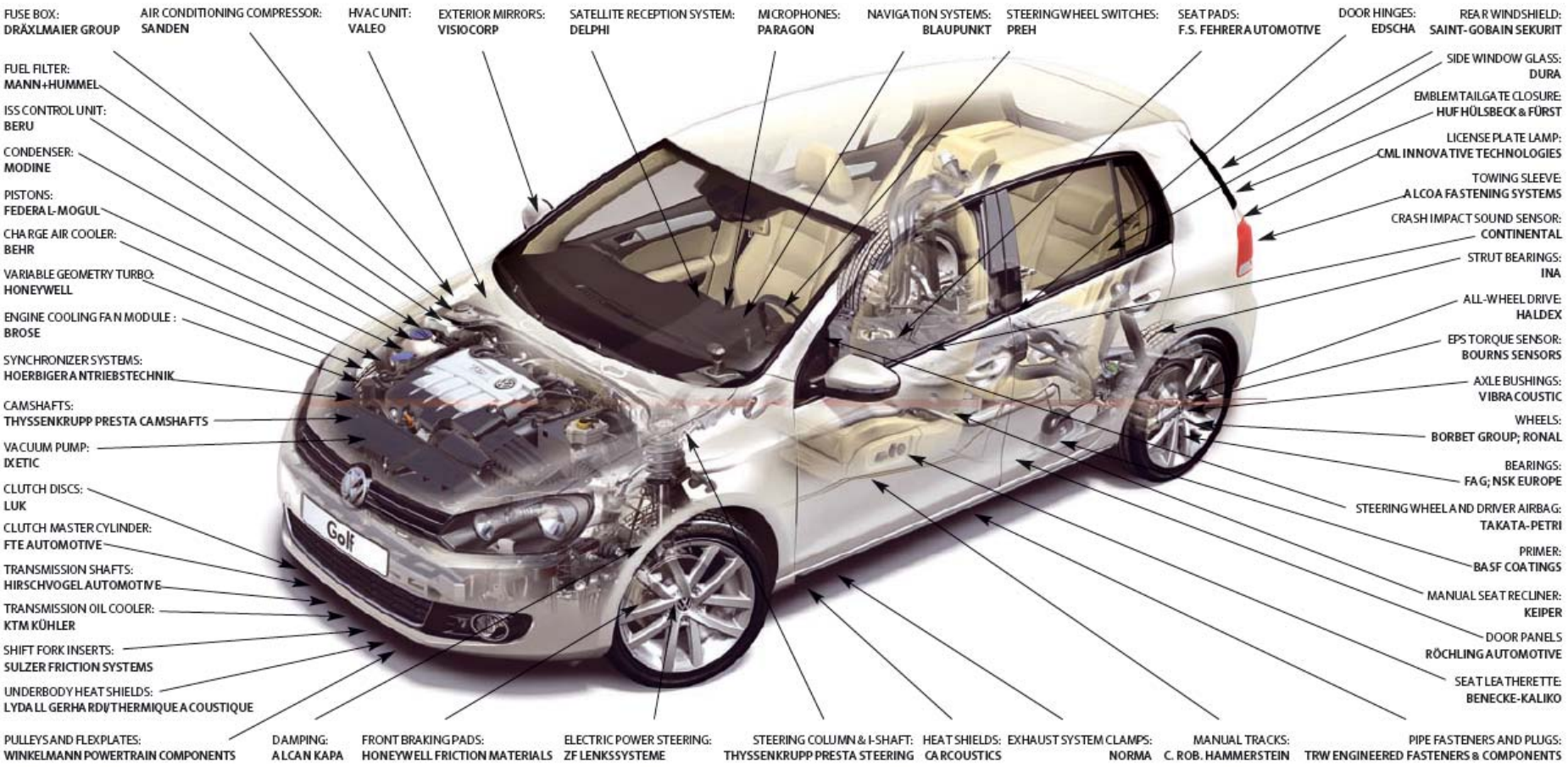
Outsourcing data



Combined dataset

- More than 57,000 outsourcing transactions
  - Basic data (*SupplierBusiness*)
    - 350 car models
    - 213 components
    - 1,157 suppliers

    } Transaction = Model-component-supplier triplet
  - Additional info on (*Amadeus, AutomotiveNews*)
    - Carmakers, OEMs, model assembly
    - Suppliers, branches, manufacturing plants
      - Financials, company size, business activity, locations

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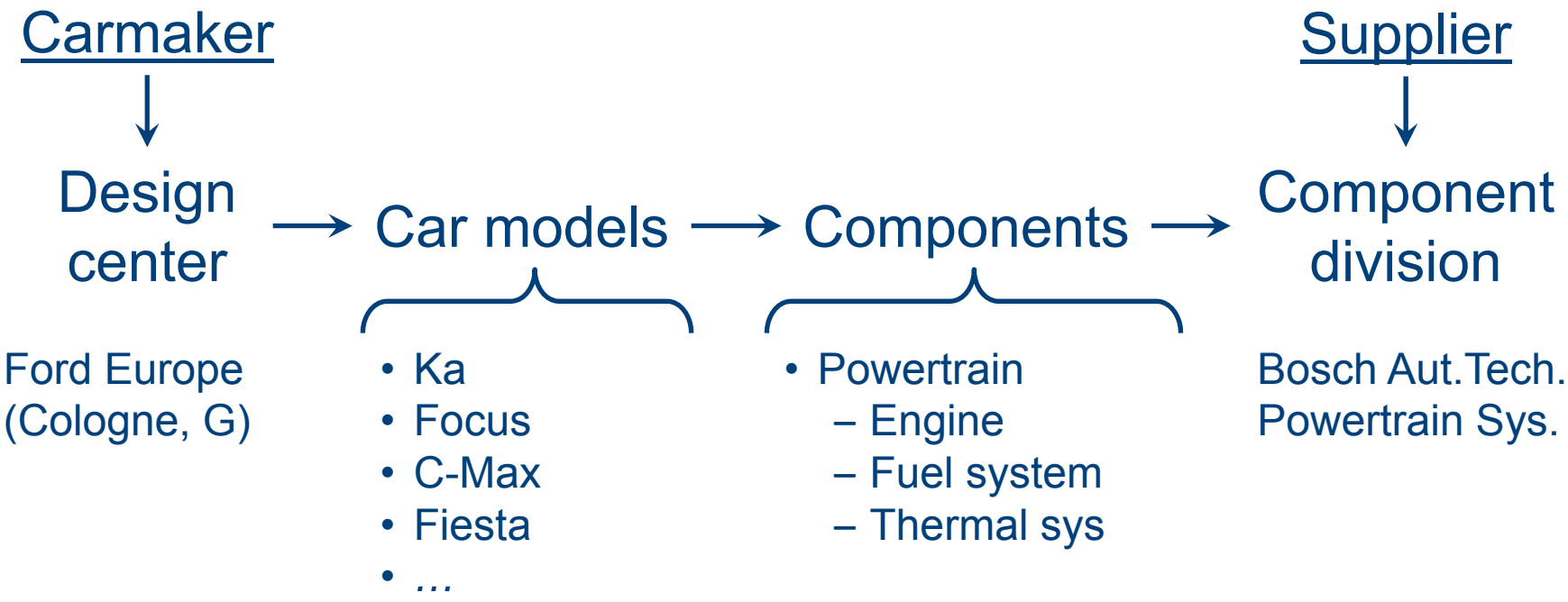
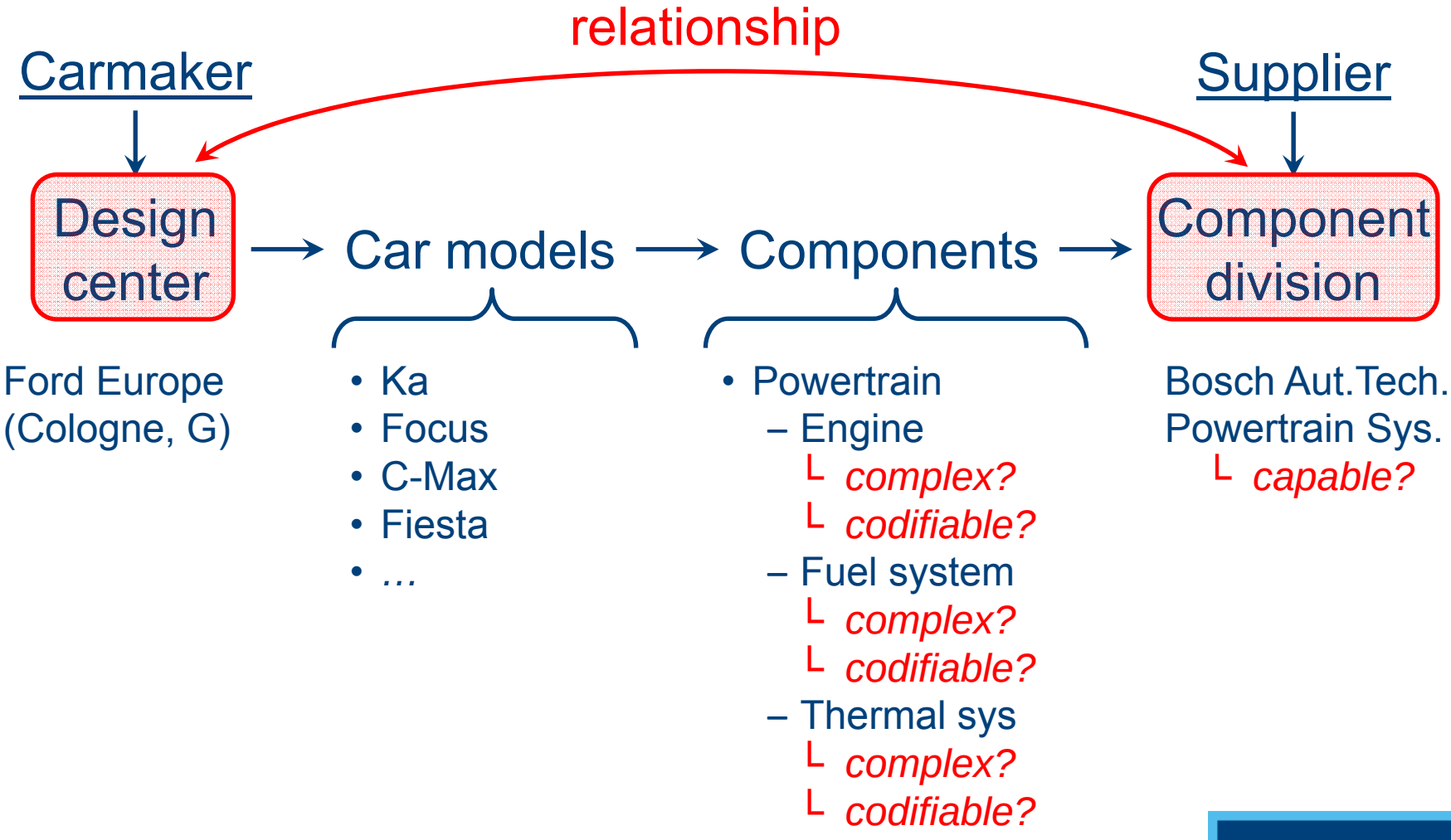
Data structure



GVC characterization



Empirical method 1

1. Use 1 key characteristics to identify governance mode
2. Construct proxies for GVC variables (and controls)
3. Regress continuous measure for #1 directly on #2, #3
   - rather than transform the dependent variable into 0-1
   - One regressions for each governance mode
4. Level of analysis:
   - Observations are transactions: supplier-parts x model
   - Cluster at division x buyer

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Empirical method 1

1. Identifying GVC governance modes empirically from impact on observable market outcomes

- **Market**
  - Low switching & entry costs: Product has many potential suppliers
- **Captive**
  - Supplier has few clients overall
- **Modular**
  - Turnkey producer: makes diversified product for handful of clients
  - Modular design: Bundle of complementary parts
- **Relational**
  - Specialized suppliers & buyers form unique outsourcing relationship: Model-specificity of component

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Empirical method 1

- Proxies for GVC variables
  - Complexity: mainly electronics, powertrain components
  - Codifiability: mainly exterior components, e.g. glass, mirrors; switches
  - Supplier capability: age of firm (division)
- Control variables
  - Contract length, K/L ratio, geographic distance, cultural distance, NA & Asia dummies, VA proxy

Test market governance

- More suppliers per component makes the governance mode more market-like

	Complexity	Codifiability	Capability
Market	Low	High	High
Modular	High	High	High
Relational	High	Low	High
Captive	High	High	Low

Test market governance

	(1)	(2)
Complexity	-0.075***	-0.104***
Codifiability		-0.030**
Supplier capability		-0.016
Contract length		0.061
K/L ratio		2.19
VA proxy		-1.48**
Geographic distance		9.43
Cultural distance		-2.57
Supplier is Asian		-0.0413**
Supplier is American		0.0115
Constant	-0.742***	-0.715***
Observations	2,723	1,117
Adj. R-squared	0.063	0.103

*** p<0.01, ** p<0.05, * p<0.1

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Test captive governance

- Fewer clients per supplier makes the governance mode more captive-like

	Complexity	Codifiability	Capability
Market	Low	High	High
Modular	High	High	High
Relational	High	Low	High
Captive	High	High	Low

Test captive governance

	(1)	(2)
Complexity		-0.089***
Codifiability		-0.024
Supplier capability	-0.066***	-0.062***
Contract length		2.04***
K/L ratio		15.9***
VA proxy		-9.67***
Geographic distance		24.9
Cultural distance		-17.2**
Supplier is Asian		-0.103***
Supplier is American		-0.073***
Constant	0.347***	0.270***
Observations	2,723	1,117
Adj. R-squared	0.010	0.116

*** p<0.01, ** p<0.05, * p<0.1

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Test relational governance

- Fewer models using a particular component makes the governance mode more relational-like

	Complexity	Codifiability	Capability
Market	Low	High	High
Modular	High	High	High
Relational	High	Low	High
Captive	High	High	Low

Test relational governance

	(1)	(2)
Complexity		0.001
Codifiability	-0.057***	-0.063***
Supplier capability		-0.025*
Contract length		0.53**
K/L ratio		2.29
VA proxy		-2.81***
Geographic distance		-7.83
Cultural distance		-2.45
Supplier is Asian		-0.135***
Supplier is American		-0.047***
Constant	0.261***	0.260***
Observations	2,723	1,117
Adj. R-squared	0.022	0.073

*** p<0.01, ** p<0.05, * p<0.1

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Test modular governance

- More turnkey components supplied to a model makes the governance mode more modular-like

	Complexity	Codifiability	Capability
Market	Low	High	High
Modular	High	High	High
Relational	High	Low	High
Captive	High	High	Low

Test modular governance

	(1)	(2)
Complexity	0.042***	0.046***
Codifiability	0.016***	0.007
Supplier capability	0.017***	0.019***
Contract length		-0.57***
K/L ratio		-3.35***
VA proxy		2.38***
Geographic distance		-24.6***
Cultural distance		3.39
Supplier is Asian		0.023*
Supplier is American		0.005
Constant	0.076***	0.127***
Observations	2,723	1,117
Adj. R-squared	0.035	0.131

*** p<0.01, ** p<0.05, * p<0.1

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Test make-or-buy decision

- Classifying sourcing contracts is straightforward now:
  - Unobserved components that are outsourced in other car models = in-house production (Hierarchy)

	Complexity	Codifiability	Capability
Market	Low	High	High
Modular	High	High	High
Relational	High	Low	High
Captive	High	High	Low
Hierarchy	High	Low	Low

Test make-or-buy decision

	(1)	(2)	(3)	(4)
Complexity	0.041***			0.137***
Codifiability		-0.086***		-0.019
Supplier capability			-0.062*	-0.200***
Contract length				-8.60***
Labor on-site				0.391**
Capital/Labor on-site				11.3
Distance to plant				189.0***
Distance to office				51.3***
Shared culture dummy				-0.383***
Supplier is Asian				0.283***
Supplier is American				0.442***
Observations	68,179	68,179	68,179	67,976
Pseudo R2	0.038	0.042	0.038	0.330

*** p<0.01, ** p<0.05, * p<0.1

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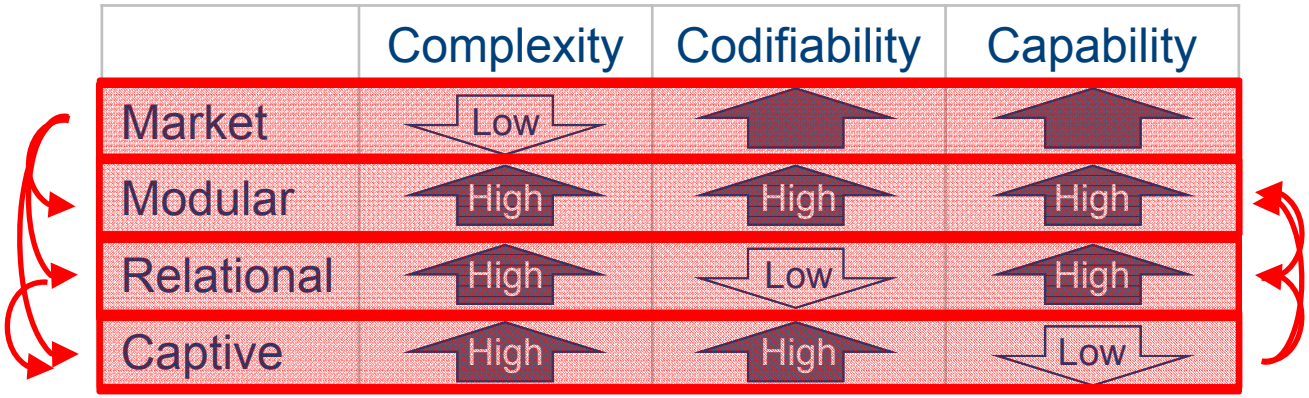
Empirical method 2

1. Assign each observed relationships to one governance type
   - Using key characteristics used earlier – those in top 25%
   - Mutually exclusive classification into the four types
2. Run pairwise regressions of any two types to have more unambiguous predictions on effect of GVC characteristics

Pair-wise choice of governance

1 vs. 0	Modular vs. Market	Relational vs. Market	Captive vs. Market	Modular vs. Relational	Modular vs. Captive	Relational vs. Captive
Complexity	0.108***	0.238***	0.227***			
Codifiability				0.011		-0.118***
Supplier capability					0.093***	0.099**
Observations	1,930	1,233	858	1,973	2,396	773
Pseudo R2	0.062	0.035	0.033	0.000	0.012	0.013



Pair-wise choice of governance

1 vs. 0	Modular vs. Market	Relational vs. Market	Captive vs. Market	Modular vs. Relational	Modular vs. Captive	Relational vs. Captive
Complexity	0.078***	0.384***	0.370***	0.086***	0.134***	0.124
Codifiability	0.026**	0.067	0.244**	0.071***	0.061*	-0.114
Supplier capability	0.008	-0.058	-0.165**	0.070***	0.117***	0.065
Contract length	-0.39*	0.703	3.66**	-1.50***	-2.48***	-3.69**
K/L ratio	-3.56*	1.24	25.7**	-6.09**	-22.3**	-423.0***
VA proxy	4.14	11.2	-6.82	5.18*	9.38**	57.8**
Geographic dist.	-7.83	12.0	21.0	-26.6	-44.9**	-153.0*
Cultural distance	7.38*	-13.8	-44.1	20.8***	36.3***	64.1**
Supplier is Asian	0.033	-0.460***	-0.353***	0.096*	0.194***	
Supplier is Amer.	0.011	-0.272***	-0.363***	0.038*	0.074***	0.055
Observations	839	437	313	842	992	277
Pseudo R2	0.248	0.114	0.144	0.117	0.157	0.144

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Implications: Ordering of types

	Market	Modular	Relational	Captive
Profit margin %	0.51 (16.1)	6.85 (4.53)	1.90 (14.0)	0.72 (14.4)
VA proxy	0.93 (0.50)	1.64 (3.60)	1.07 (1.15)	0.82 (0.29)
R&D ('000€)	52.4 (54.7)	204 (289)	261 (509)	349 (595)

Note: Average across suppliers for 2007, st. dev. in parenthesis. Supplier GVC type based on majority (mode) of transactions. 20 suppliers with market governance, 16 modular, 27 relational, and 25 captive.

- Profit: Modular >> Relational >> Captive > Market
- VA: Modular >> Relational > Market > Captive
- R&D: Captive >> Relational >> Modular > Market
  - Intuitive?
  - Yes for profit (VA follows profit)
  - No for R&D (except Market)

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Implications: Possible transitions

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- Natural progression for supplier upgrading:
  - Hierarchy → Capability↑ → Relational → Codifiability↑ → Modular
  - Hierarchy → Codifiability↑ → Captive → Capability↑ → Modular
- Natural risk for suppliers
  - In both cases: Modular → Complexity↓ → Market

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Conclusion and caveats

- Analysis shows that GVC theory can predict governance types in automotive industry
  - Directly on variables that correlate with governance type
  - Indirectly by classifying relationships
- Usefulness of the model:
  - Study the exogenous effect of technology on governance
  - A way to integrate prominent models in make-or-buy literature
- To add:
  - Effect of historical ties & repeat relationships
  - Role for relationship-specific investments & complementarities
  - Distinguish better the role of technology & firm behavior

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