Exclusive Secrets: Trade Secret Protection in Supplier Relationships

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Roadmap

Introduction

Data

Empirical approach

Results

Introduction

- GVCs increasingly consist of transfer of intangible assets
  - → Sensitive info to keep market edge valuable when concealed
  - → Outsourcing components requires sharing trade secrets to assure adequate customization
  - → Supplier may misappropriate commercial information about business strategies or customer lists (knowledge leakage)
  - → Supplier may use OEM knowledge regarding manufacturing process or internal standards to improve parts sold also to others (positive externalty to rival firms)
  - → When international, dependent on foreign country legal regime

▸ Motivation

- Divergence in enforcement makes trade secret protection (TSP) a relevant problem for organization of GVCs

Some motivation

- Bai, Barwick, Cao & Li (2020) NBER WP
  - → find importance of suppliers for knowledge transfer between OEMs
  - → sharing suppliers with foreign JV partner accounts for 30% of quality improvement of Chinese OEMs

- Yan, Yang, Dooley & Chae (2020) J Op Mgt
  - → survey purchasing managers
  - → find that they rate "serving competitors" as most detrimental in terms of motive "information security"
  - → *"If a supplier works with our competitors, he needs to share with us some of their know-how. We do not like it because we may be infringing our competitors' IP. In addition, if that supplier is doing it to our competitors, they will do it to us."*

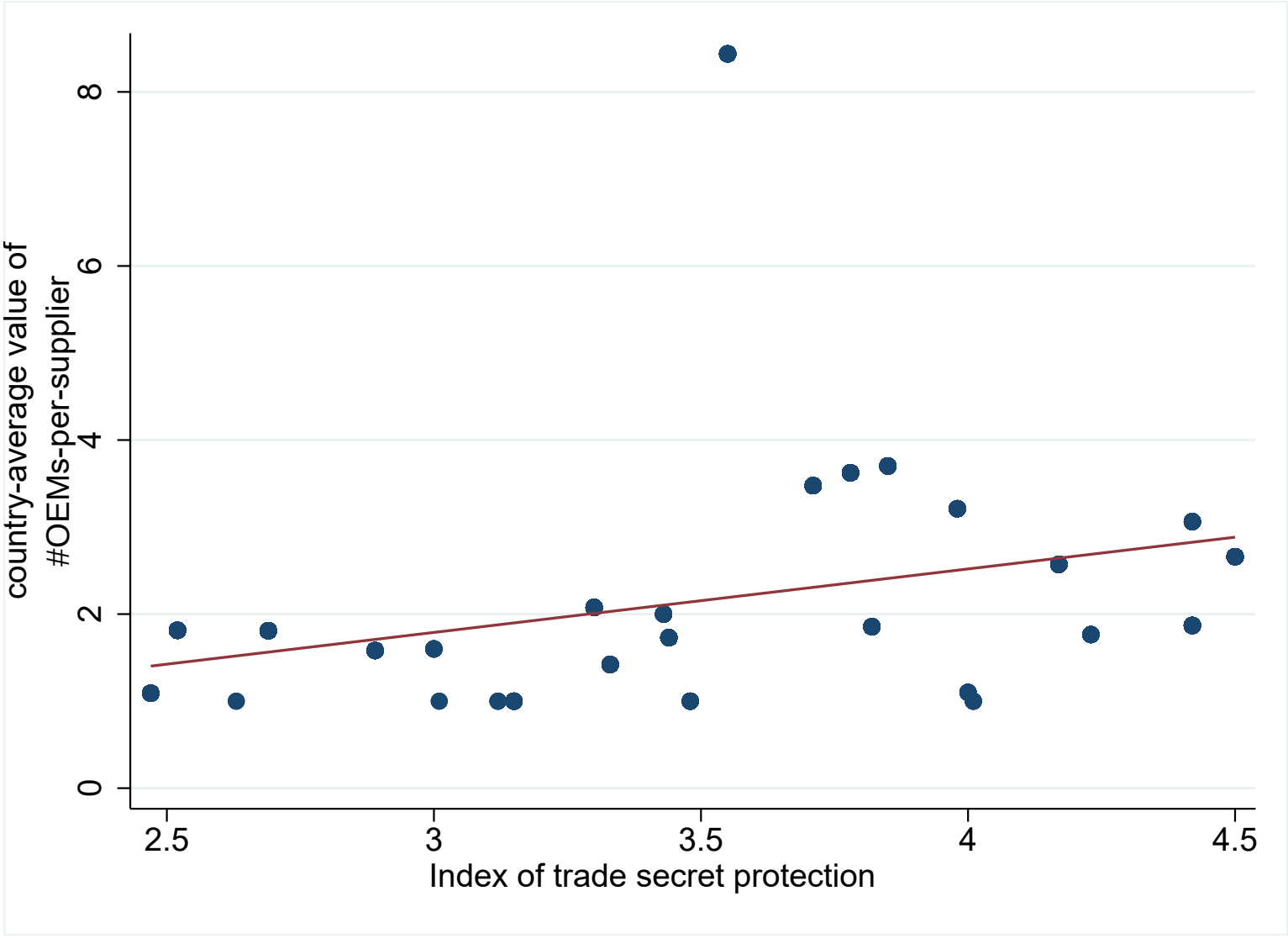
Idea

→ Solution: exclusivity when sourcing from poor TSP countries to mitigate dissipation to rivals through mutual supplier.

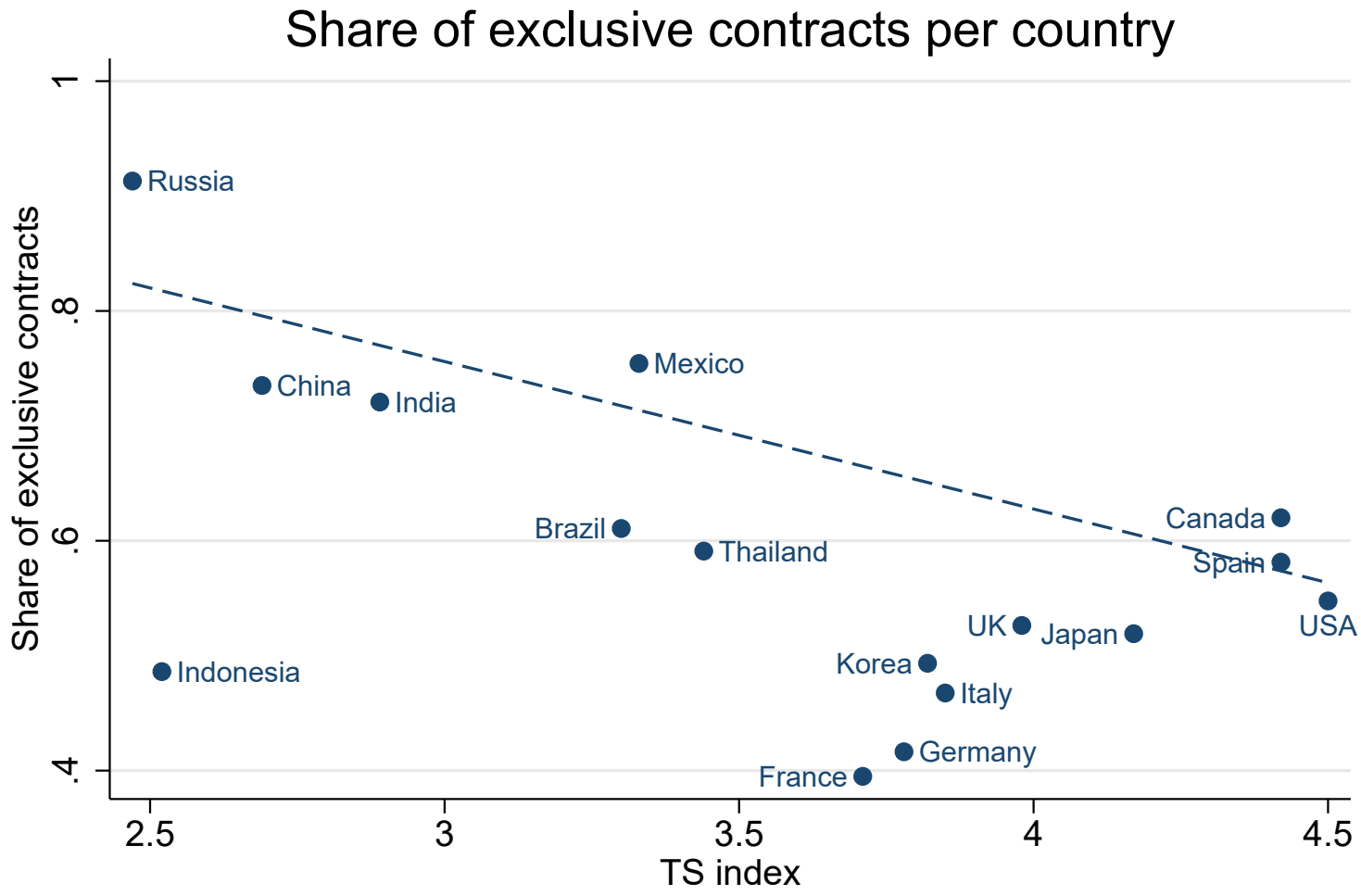
- GVCs distorted by incomplete contracts
- Allowing supplier to sell to many (competing) firms could be desirable to mitigate hold-up and avoid underinvestment
  - → strong TSP: not a problem to serve other OEMs due to enforceable non-disclosure agreements
  - → weak TSP: require some degree of exclusivity from supplier

⇒ Prediction 1: positive association between TSP and number of OEMs served by a supplier

Auto industry: TSP and number of OEMs per supplier



Auto industry: TSP and share of exclusive contracts



Conceptual framework

- Other country-specific confounding factors could also influence contractual agreement, number of buyers, etc.

→ Product-specific characteristics: relation-specificity (RS)

- Property rights theory: severity of hold-up increases in RS
  - → RS lowers an input's value outside a relation
  - → suppliers must be provided incentives to invest
  - → serving more OEMs increases supplier outside option

- TS necessarily transmitted for adequate customization
  - → with weak TSP, info may spillover to rivals through supplier
  - → loss of market power and market share in case of monopoly
  - → less product diff and mark-up under monopolistic competition

Mechanism

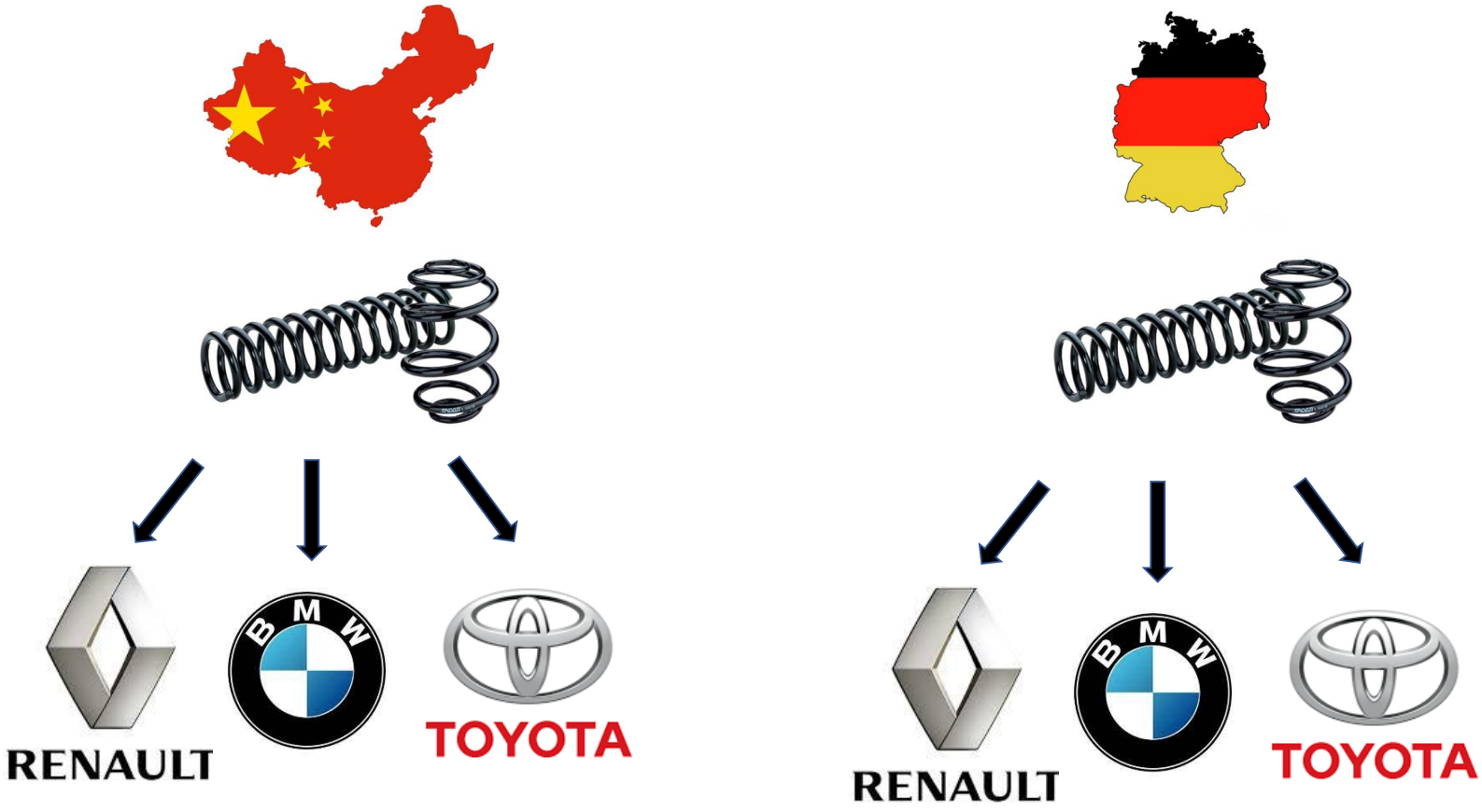
- Interaction of RS and TS:
  - → high RS: low value outside relation; cannot produce for many OEMs; cannot reduce hold-up even if allowed to serve others
  - → low RS: does not require customization; standard input sold in market; no OEM-specific knowledge
  - → med RS: susceptible to both hold-up and threat of exposure; can reduce hold-up by consenting supplier to serve more OEMs

→ trade-off between the lower compensation required to create investment incentives and risk of losing proprietary information

- → risk lower with strong TSP

⇒ Prediction 2: equilibrium number of OEMs served by a supplier increasing with TSP for medium relation-specificity

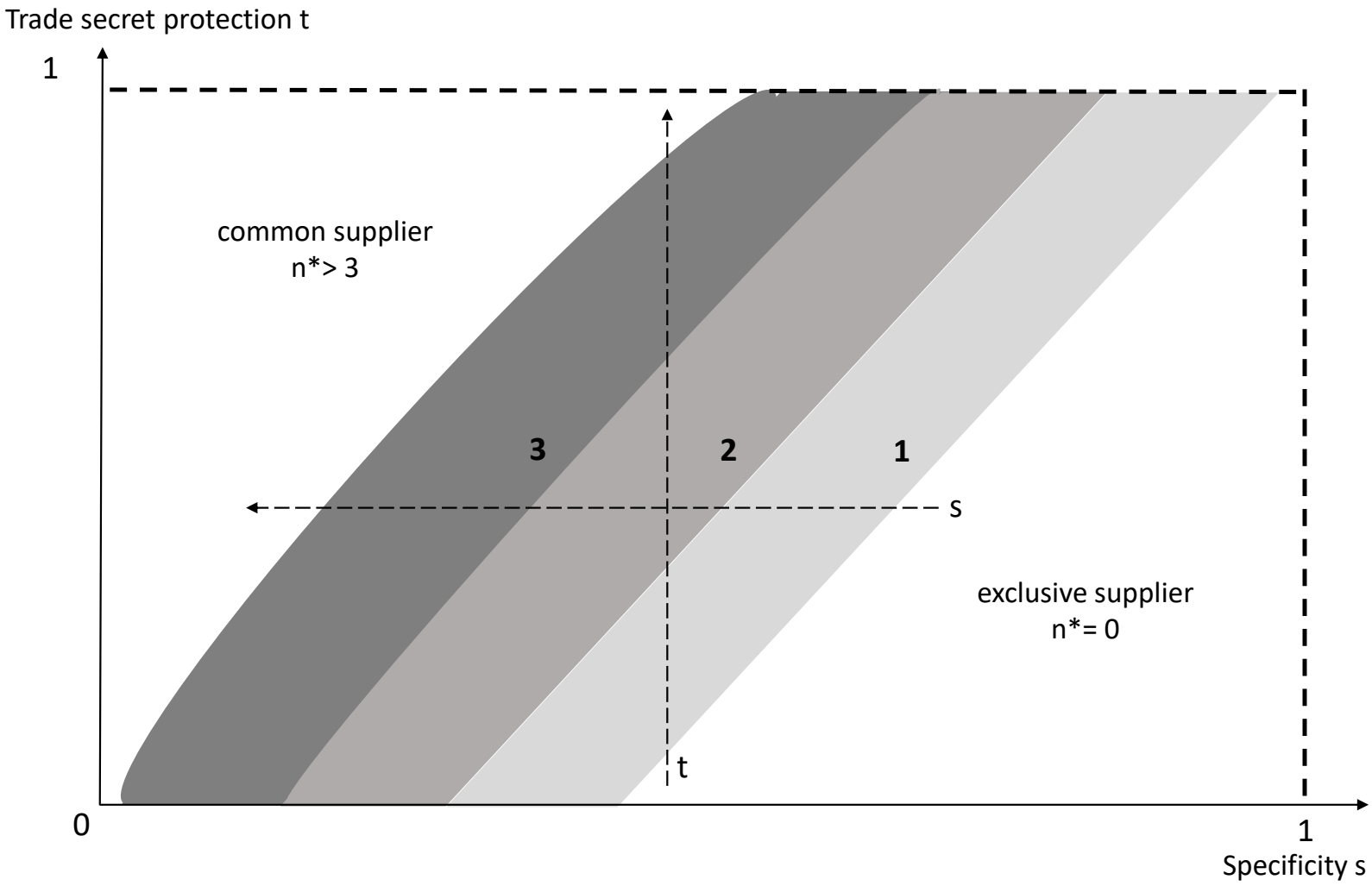
Example: Low relation-specificity



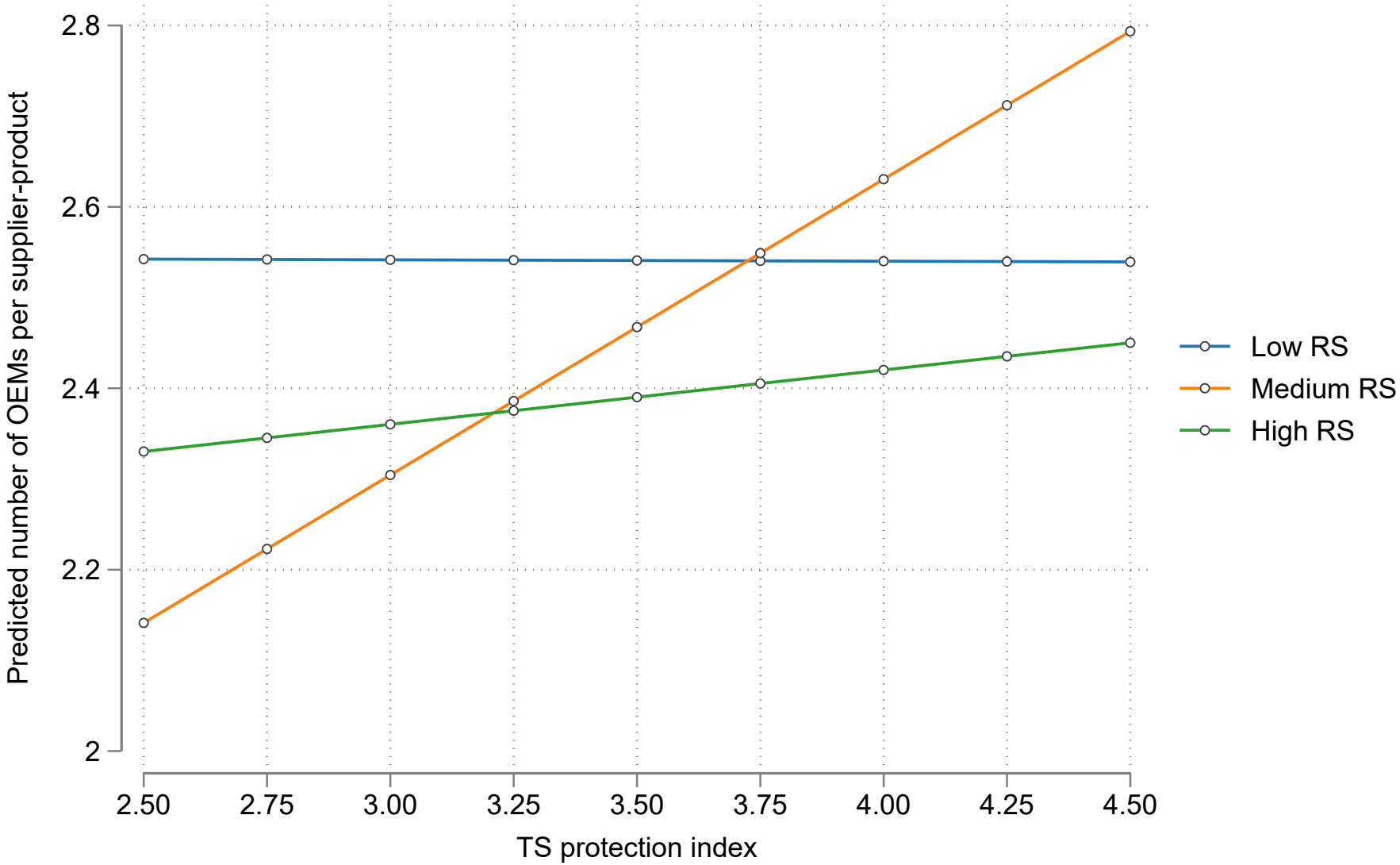
Example: High relation-specificity

Example: Medium relation-specificity

Summary


Trade secret protection t
1
common supplier
n*> 3
3
2
1
s
t
exclusive supplier
n*= 0
0
1
Specificity s

Main Result


Predicted number of OEMs per supplier-product
2.8
2.6
2.4
2.2
2
2.50
2.75
3.00
3.25
3.50
3.75
4.00
4.25
4.50
TS protection index
Low RS
Medium RS
High RS

Contribution

Key message:
suppliers in weak-TSP countries restricted to supplying (exclusively) fewer OEMs
particularly for components with medium-level RS

- (Global) Sourcing literature:
  - → *e.g., Williamson 1983; Grossman & Hart 1986; Hart & Moore 1988; Antràs 2003; Antràs & Helpman 2004; Grossman & Helpman 2005*
  - ⇒ add: nature of the "buy" contract, depending on location
- IO / competition literature:
  - → *e.g., Marvel 1982; Ide et al. 2016*
  - ⇒ add: exclusive contracts could be beneficial, tool to protect IP
- IP / strategy / "opportunistic behavior" literature:
  - → *e.g., Arora & Fosfuri 2003; Kim & Vonortas, 2006; Somaya et al. 2011; Kukharskyy 2020; Chen et al. 2021).*
  - ⇒ add: *spillover* of sensitive TS, not a story of supplier imitation;
    TS protection may be beneficial for competition in upstream markets

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1. “Transaction”-level data on automotive supply relationships (Marklines)

2. To measure legal institutions: Index of Trade Secret Protection (TSP) (Schultz & Lippoldt, 2014)

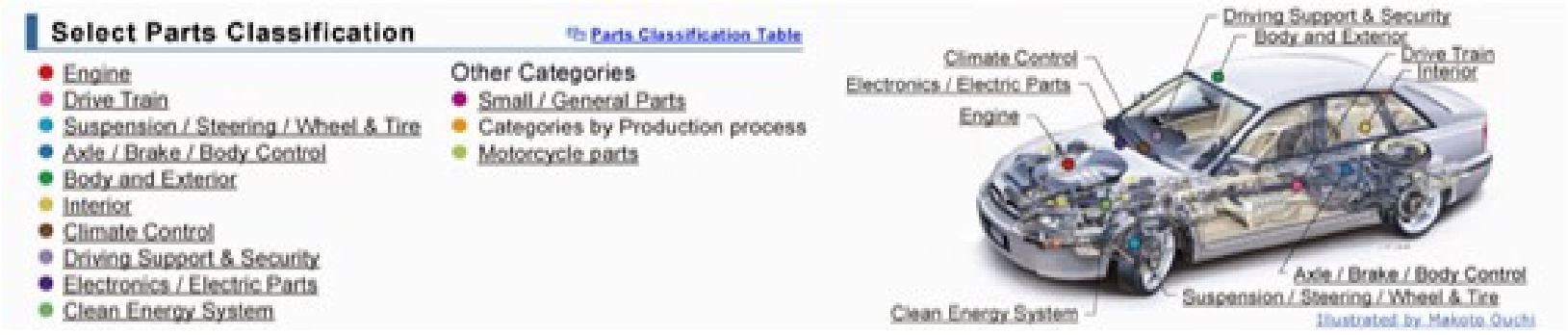
3. To measure product characteristics: Index of degree of relationship-specificity (RS) (Head et al., 2004)

Data 1. Transactions between automotive OEMs and (tier-1) suppliers

- Marklines “Who Supplies Whom”
- >150k observations, 2006-2016
- Level: OEM-country-model-part-year-supplier level
  - → Example: BMW – Germany – 3 Series – 2011 – Brake Hose – TI Automotive – UK
- Data obtained by a mix of firm surveys and Markline’s own search efforts
- Main dataset: pool 2011-2015
- Largest OEMs by production volume: 29 parents, 88 “brands”
- Dependent variable: nr. OEMs per supplier-country-product (#OEMs-per-supplier) and exclusivity dummy

Marklines

BMW	Germany	i8	2014	Engine Mount	Main Engine Parts	Engine	FEMALK Zrt.	Hungary
BMW	Germany	i8	2015	Engine Mount	Main Engine Parts	Engine	Continental AG	Germany
BMW	Germany	i8	2014	Exhaust Manifold Gasket	Exhaust System	Engine	ElringKlinger AG	Germany
BMW	Germany	i8	2014	Exterior Mirror	Body Components	Body Components	Magna International Inc.	Canada
BMW	Germany	i8	2014	Fuel Pump Control ECU	Powertrain Related	ECU/Sensor	Omron Corp.	Japan
BMW	Germany	i8	2014	Fuel Tank	Body/Structure/Module/O	Body/Structure/Module/O	Magna International Inc.	Canada
BMW	Germany	i8	2016	HV/PHV/EV Battery	HV/PHV/EV Parts	HV/PHV/EV Parts	Samsung SDI Chemicals & Electronic	Korea
BMW	Germany	i8	2014	Head Lamp	Lamp & Related Products	Lamp & Related Products	OSRAM Licht AG	Germany
BMW	Germany	i8	2014	Head Lamp	Lamp & Related Products	Lamp & Related Products	Zizala Lichtsysteme GmbH (ZKW)	Austria
BMW	Germany	i8	2016	Head Lamp	Lamp & Related Products	Lamp & Related Products	Valeo Group	France
BMW	Germany	i8	2014	Heater Hose	Climate Control	Climate Control	ContiTech AG	Germany
BMW	Germany	i8	2014	In-Vehicle Infotainment Unit	Driving Support & Security	Driving Support & Security	Harman International Industries, Inc	USA
BMW	Germany	i8	2014	Interior Lighting	Interior	Interior	Toyota Boshoku Corporation	Japan

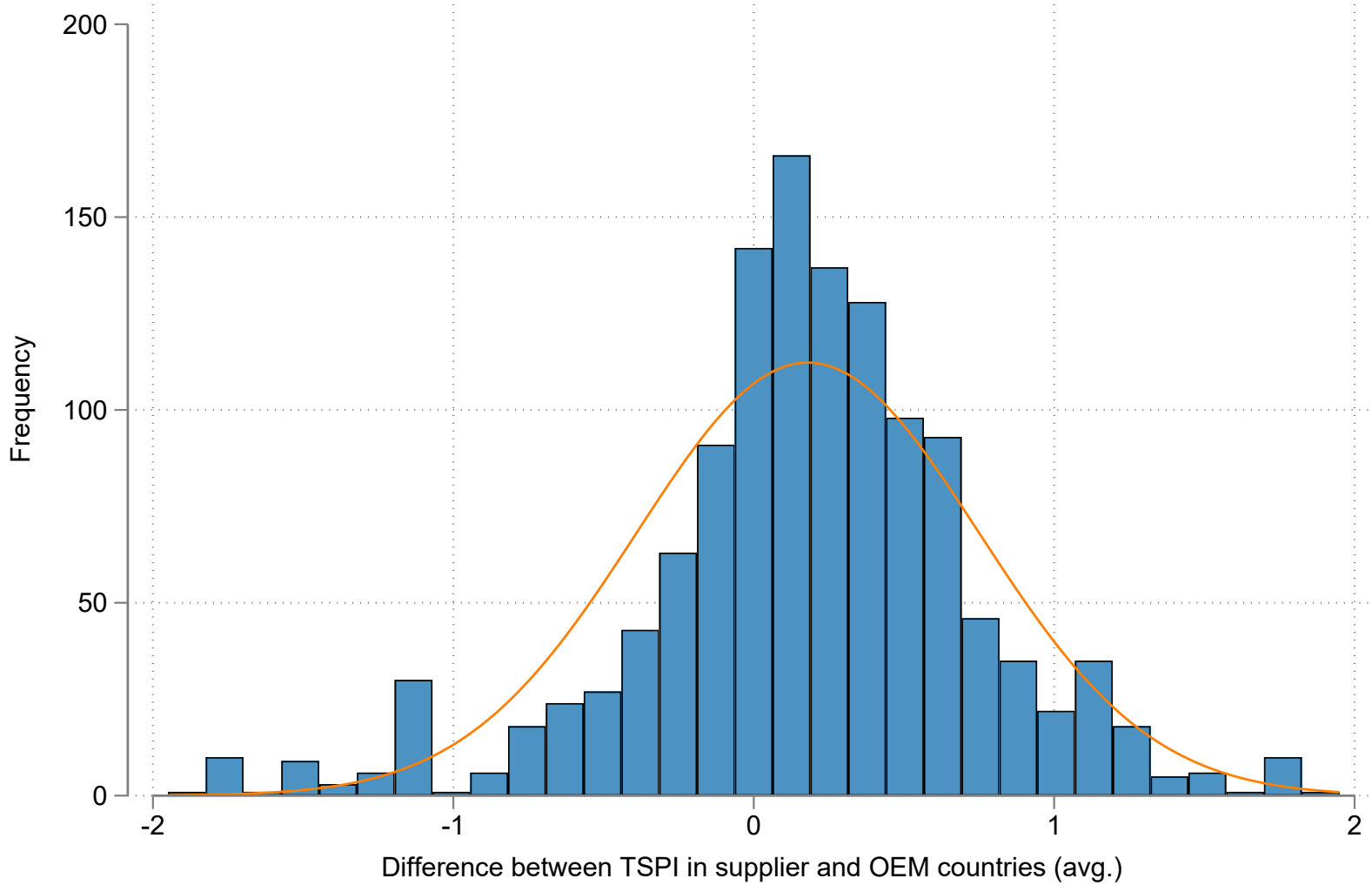


Data 2. Trade Secrets Protection (TSP)

Add the three-part figure.

- Patent Protection Index (PPI)?
  - → measures a different issue (correlation $\tilde{0}.5$)
- Novel index of the “stringency of trade secrets protection”
  - → OECD Trade Policy Papers in 2014: Schultz & Lippoldt ▸ Some quotes
- Proxy for: . . .
  - → Opportunity to protect TS
  - → Ability to enforce contracts
  - → Reliability & efficiency of legal system
- index defined in [0,5]
- 37 countries (27 with suppliers in our data)
- correlation with patent index: 0.54
- Supply relations across regimes

Supply relations across TS regimes



Two thirds of supply relations are between equally strong TS regimes (excluded from the graph).

Data 3. Relation-Specificity of Technology (Investment)

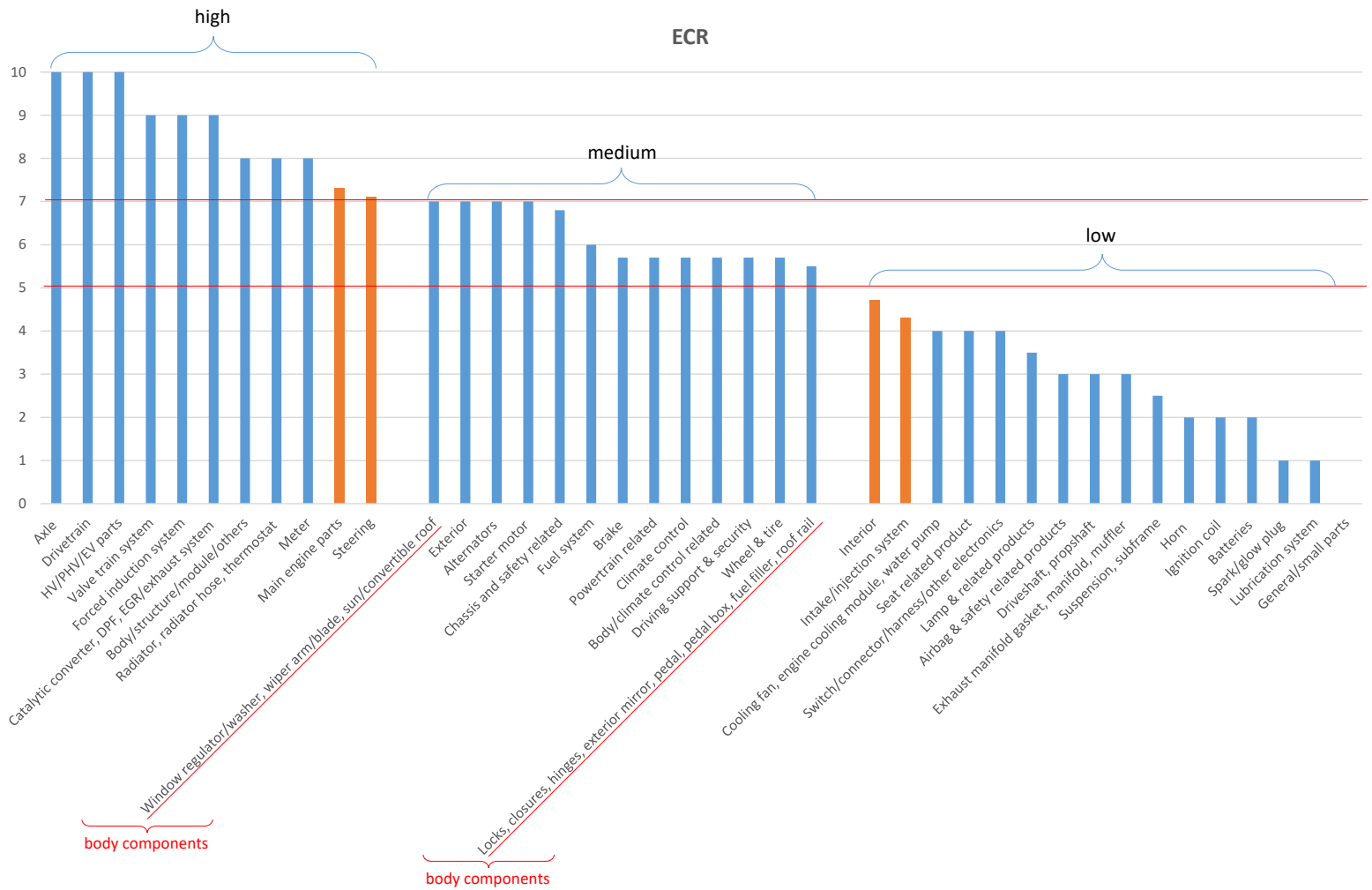
- Monteverde & Teece (1982, Bell J)
  - → rank automotive parts by engineering costs,
  - → interested in determining the cost of switching suppliers,
  - → ranking supplied by two US car design engineers

- Head et al. (2004, JEMS) make ranking available
  - → use it to proxy for the *efficacy of relationship-specific investment* to study formation of vertical networks ▸ Some quotes

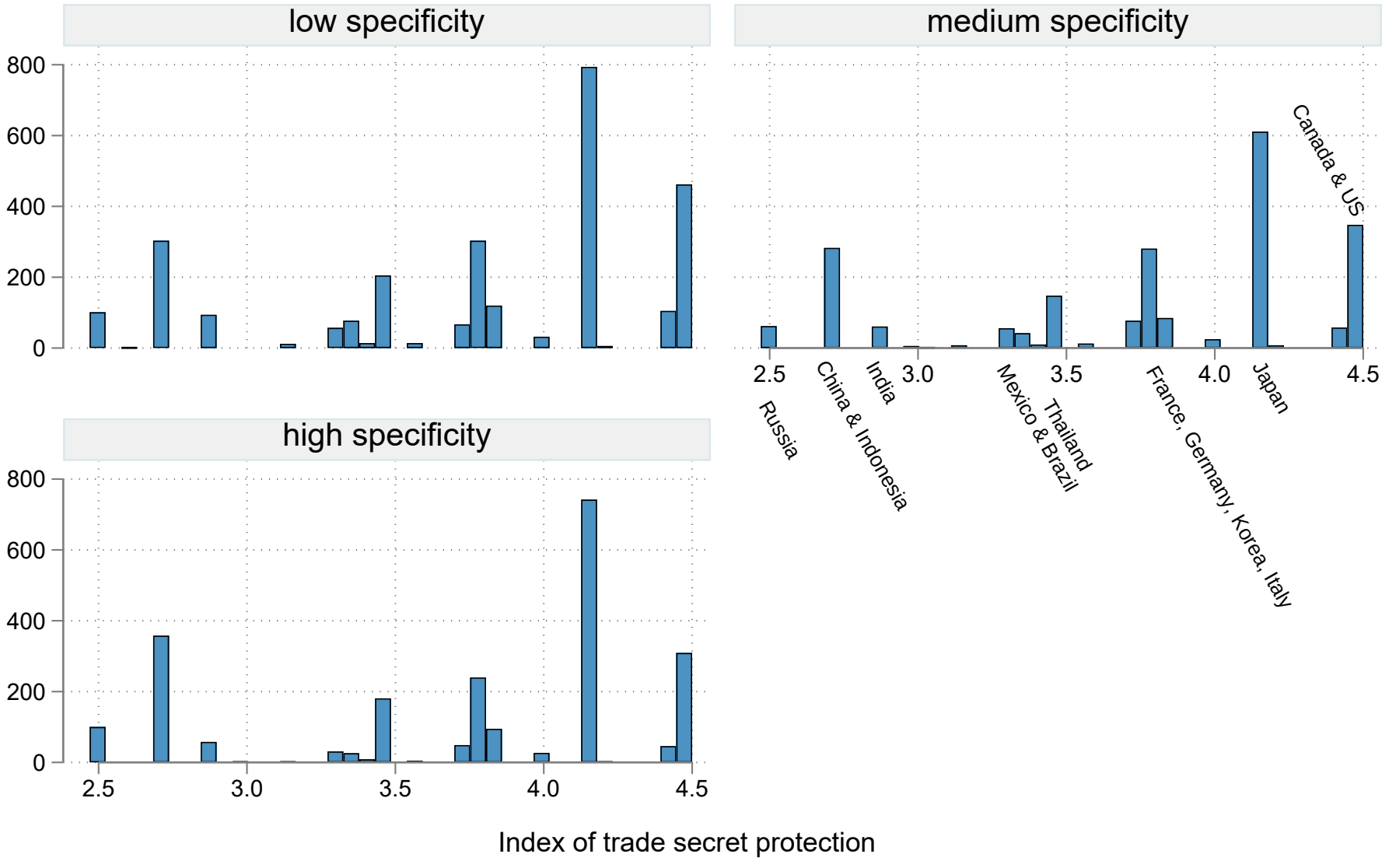
- defined in [0,10]

- form three groups “low” / “medium” / “high”, interact with TSP ▸ TSP distribution
  - → dummy variables: “medium RS”, “high RS”

The relation-specificity measure



The relation-specificity measure



Description of the dataset

Descriptive statistics:	min	med	max	mean	s.d.
#OEMs-per-supplier-industry	1	1	33	2.50	2.94
TSP	2.47	3.85	4.5	3.76	0.63
Dummy: medium RS	0	0	1	0.29	0.45
Dummy: high RS	0	0	1	0.32	0.47

Number of observations:	
Suppliers	2,534
Supplier countries	27
Industries	290
Supplier-country-industry triplets	7,006

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Empirical approach

$$\#OEM_{sci} = \beta_0 + \beta_1 TSP_c + \beta_2 RS_i^{med} + \beta_3 RS_i^{high}$$
$$+ \beta_4 TSP_c \times RS_i^{med} + \beta_5 TSP_c \times RS_i^{high} + B \cdot X + \varepsilon$$

where

- s supplier firm (name);
- c supplier country;
- i component (product).

▸ Control variables

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Main result – OLS

	(1)	(2)	(3)	(4)	(5)
TSP	0.544***	0.544***	0.440***	0.424***	-0.002
	(0.044)	(0.044)	(0.069)	(0.068)	(0.145)
medium RS		0.398***	-0.846**	-1.078***	-1.220***
		(0.089)	(0.406)	(0.404)	(0.410)
medium RS × TSP			0.329***	0.289***	0.328***
			(0.111)	(0.110)	(0.111)
high RS		-0.015	-0.080	-0.240	-0.366
		(0.080)	(0.364)	(0.362)	(0.370)
high RS × TSP			0.016	0.027	0.061
			(0.101)	(0.099)	(0.101)
Marklines controls	no	no	no	yes	yes
Country controls	no	no	no	no	yes
Obs.	7,006	7,006	7,006	7,006	7,006
R^2	0.013	0.017	0.018	0.105	0.122

Main result – country and product fixed effects

	(OLS-fixed)	(OLS-clust)	(Poisson)	(Dum-Exclusive)
medium RS × TSP	0.366***	0.366**	0.103*	-0.209**
	(0.118)	(0.163)	(0.057)	(0.086)
high RS × TSP	-0.113	-0.113	-0.047	0.196
	(0.105)	(0.167)	(0.080)	(0.168)
Country fixed effect	yes	yes	yes	yes
Product fixed effect	yes	yes	yes	yes
Obs.	7,006	7,006	7,003	6,927
(Pseudo-)R^2	0.203	0.203	0.131	0.095

SEs clustered by country and product.

All regressions include the same set of control variables.

ORBIS Match – Firm-size Control

Firm size measure:	sales revenue			employment
	(1)	(2)	(3)	(4)
TSP	-0.010			
	(0.390)			
medium RS	-1.588*	-1.522*		
	(0.848)	(0.802)		
medium RS × TSP	0.427*	0.412*	0.743***	0.660**
	(0.220)	(0.211)	(0.250)	(0.315)
high RS	0.320	0.533		
	(0.893)	(0.759)		
high RS × TSP	-0.122	-0.171	-0.241	-0.322
	(0.216)	(0.188)	(0.225)	(0.241)
Avg annual firm size (log.)	0.167***	0.186***	0.218***	0.244***
	(0.053)	(0.037)	(0.040)	(0.051)
Country fixed effect	no	yes	yes	yes
Product fixed effect	no	no	yes	yes
Obs.	3,817	3,817	3,817	2,756
R^2	0.153	0.183	0.273	0.291

Clustered country & product. Same set of controls. Results similar with Poisson & exclusivity dummy.

Supplier Bargaining Power 1: relative number of firms

Our mechanism should show more strongly the more bargaining power is with the OEM.

	(1)	(2)	(3)
# Suppliers $>$ # OEMs:			
Medium RS $\times$ TSP	0.207*	0.367***	0.328**
	(0.114)	(0.141)	(0.131)
Dummy: # Suppliers $<$ # OEMs	0.410***	-0.764	-0.617
	(0.133)	(1.058)	(1.035)
Dummy $\times$ medium RS $\times$ TSP		-0.568**	-0.529*
		(0.274)	(0.273)
Country fixed effect	no	no	yes
Obs.	7,006	7,006	7,006
R^2	0.079	0.082	0.107

Clustered country & product. Same set of controls except industry covariates & fixed effect.

Supplier Bargaining Power 2: Cartelization

	(1)	(2)	(3)
Non-cartelized industry:			
Medium RS × TSP	0.203*	0.365***	0.324**
	(0.109)	(0.134)	(0.135)
Dummy: Cartelized industry	0.296**	0.039	-0.125
	(0.130)	(0.922)	(0.821)
Dummy × medium RS × TSP		-0.508***	-0.473***
		(0.143)	(0.177)
Country fixed effect	no	no	yes
Obs.	7,006	7,006	7,006
R^2	0.078	0.082	0.107

Clustered country & product. Same set of controls except industry covariates & fixed effect.

Suppliers' Absorptive Capacity

- Another prediction: strength of our mechanism differs with a supplier's absorptive capacity (capacity to utilize the received information).
- Proxy absorptive capacity with patent stock.

1. Risk of transfering knowledge to suppliers increases with their absorptive capacity $\rightarrow$ our mechanism becomes stronger with supplier patenting
2. Relationships with suppliers with high patenting involve less knowledge transfer $\rightarrow$ our mechanism becomes weaker with supplier patenting

$\Rightarrow$ Inverse U-shaped relationship between the role of TS protection and supplier patenting

Suppliers' Absorptive Capacity

	(1)	(2)	(3)
Sample restriction: RS dummy group	low	medium	high
TSP × patent stock (log.)	-0.139	0.174***	-0.128
	(0.137)	(0.027)	(0.125)
TSP × patent stock (log.) squared	-0.002	-0.066***	0.020
	(0.016)	(0.003)	(0.036)
Country fixed effects	yes	yes	yes
Industry fixed effects	yes	yes	yes
Obs.	2,455	1,958	1,974
R^2	0.262	0.273	0.198

Clustered country & product. Patent stock measured by the number of DOCDB patent application families in 2001-2010. Yearly depreciation rate of 15%.

Instrumental Variables Approach

1. IV group 1: supplier country's legal origins (Nunn, 2007, QJE)
   - → Dummies for British/German/French/Soviet/Scandinavian legal origins
   - → F-stats $>$4,000
2. IV group 2: strength of 'unrelated' IP rights
   - → Plant Protection Index (2000)
   - → Level of Copyright Piracy (2009)
   - → F-stats between 25 and 15,000
3. IV group 3: country's approach to protection of and access to information
   - → Corporate Disclosure Requirement (2006)
   - → Government Censorship Effort (2000)
   - → Freedom of Media & Expression (2000)
   - → (Existence of) Privacy Protection Law (2000)
   - → F-stats between 200 and 4,000

Instrumental Variables Approach

IV group:	(1) legal origins	(2) other IPRs	(3) information attitude
Medium RS × TSP	0.414***	0.347**	0.458***
	(0.157)	(0.142)	(0.135)
High RS × TSP	-0.218*	-0.213*	-0.111
	(0.132)	(0.127)	(0.111)
Country and industry fixed effects	yes	yes	yes
Obs.	7,003	6,120	7,003
R^2	0.042	0.042	0.042
Diagnostic tests:			
Kleinbergen-Paap rk LM stat. (p-val.)	0.000	0.000	0.000
Kleinbergen-Paap rk F stat.	3,973	15,000	4,999
Anderson-Rubin Wald Chi-sq. test (p-val.)	0.000	0.003	0.001
Hansen J stat. (p-val.)	0.035	0.546	0.171

Robust standard errors.

US State-Level Analysis

- Restrict attention to a single country to improve comparability.
- No (sufficient) changes in US state-level TS law during our sample period.
- But: changes in state courts' adoption or not of the Inevitable Disclosure Doctrine (IDD)
- IDD: may restrict employee movement to a competitor if this "inevitably" involves the disclosure of confidential business information

US State-Level Analysis

	(1)	(2)	(3)	(4)
Panel dimension:	long	long	short	long
Dummy: IDD	-0.202	0.026	0.211	-0.079
	(0.169)	(0.215)	(0.269)	(0.137)
Medium RS × IDD	0.530	0.523	0.646	0.905
	(0.370)	(0.355)	(0.584)	(0.647)
High RS × IDD	0.057	0.057	-0.499	0.466
	(0.494)	(0.486)	(0.372)	(0.463)
State × RS-group fixed effects				yes
Obs.	2,943	2,943	1,787	3,041
R^2	0.165	0.170	0.155	0.241

Long panel: 2006-2016; short panel: 2011-2015. Errors clustered at the state level.

State × RS-group FEs restrict identification to within-state time-variation in the ID dummy.

US State-Level Analysis

- Clustered standard errors must be interpreted with caution (Cameron & Miller, 2015): industries heavily concentrating in a few states, combined with small sample size and limited state coverage
- Addressing the issues from few clusters: apply wild (cluster) bootstrap (Cameron et al., 2008) to the regression estimates
- Wild bootstrap tests (Roodman et al., 2019) of the estimated coefficients of column (4) on the previous slide:

Error weights:	Rademacher	Webb
IDD dummy:		
WCR	0.744	0.761
WR	0.768	0.796
Medium RS × IDD dummy:		
WCR	0.050	0.063
WR	0.045	0.026
High RS × IDD dummy:		
WCR	0.432	0.359
WR	0.539	0.561

Values are p-values .
"WCR" refers to the restricted wild cluster bootstrap, while "WR" is the wild bootstrap without clustering, performed after a regression using clustered standard errors.

Further robustness checks

- Panel: Exploit firm fixed effect and different clustering levels (also with ORBIS-matched data)
- Firm fixed effects in the pooled dataset: mechanism also applies to different divisions of the same supplier firm.
- Separately investigating all cases of in-house production and OEM-owned suppliers: our mechanism is not present for those cases
- Checking the impact of 43 variables capturing “alternative explanations”; TSPI remains statistically significant in 38 cases, and quantitatively comparable to our main result in the 5 remaining cases.
- Reweighing observations using entropy balancing to mirror the observed distribution of suppliers by country and industry: slightly increases the estimated effect of TSP in medium-RS industries
- Alternative mappings for RS, using all years 2006-2016, error clustering, alternative TS protection measures

Conclusions

- Robust and strong positive association between trade secrets protection and the number of customers per supplier firm for the relevant range of relation-specificity of auto component

- Evidence for:
  - → Exclusive contracts as a means to protect business information
  - → Trade secrets law as a means to allow competition in supplier industries

Exclusive Secrets:
Trade Secret Protection in Supplier Relationships

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Roadmap

Appendix

- Additional Results

Appendix contents

Some motivation

- Bai, Barwick, Cao & Li (2020) NBER WP
  - → find importance of suppliers for knowledge transfer between OEMs
  - → sharing suppliers with foreign JV partner accounts for 30% of quality improvement of Chinese OEMs

- Yan, Yang, Dooley & Chae (2020) J Op Mgt
  - → survey purchasing managers
  - → find that they rate "serving competitors" as most detrimental in terms of motive "information security"
  - → *"If a supplier works with our competitors, he needs to share with us some of their know-how. We do not like it because we may be infringing our competitors' IP. In addition, if that supplier is doing it to our competitors, they will do it to us."*

▸ back

Cost & availability of TSP

Quotes from Schultz & Lippoldt (2014):

- Subject to reasonable efforts on the part of such firms to maintain the required secrecy, **in many jurisdictions trade secrets protection is readily available** without burdensome administrative requirements and in some cases **may be maintained at comparatively low cost**.
- Depending on the circumstances, this might be accomplished for example via such means as **nondisclosure agreements with** employees and **commercial partners** or basic digital or physical security measures.
- While patents may be appropriate for protecting some types of intellectual property – as in cases where a new technology is readily discerned by competitors upon the release of a product into the market, they can also be more costly in terms of time and resources. For example, in addition to filing and maintenance fees and administrative requirements, patenting may expose firms to risks of litigation (Lanjouw and Schankerman, 2004).

▶ back

Engineering Cost Rating (RS)

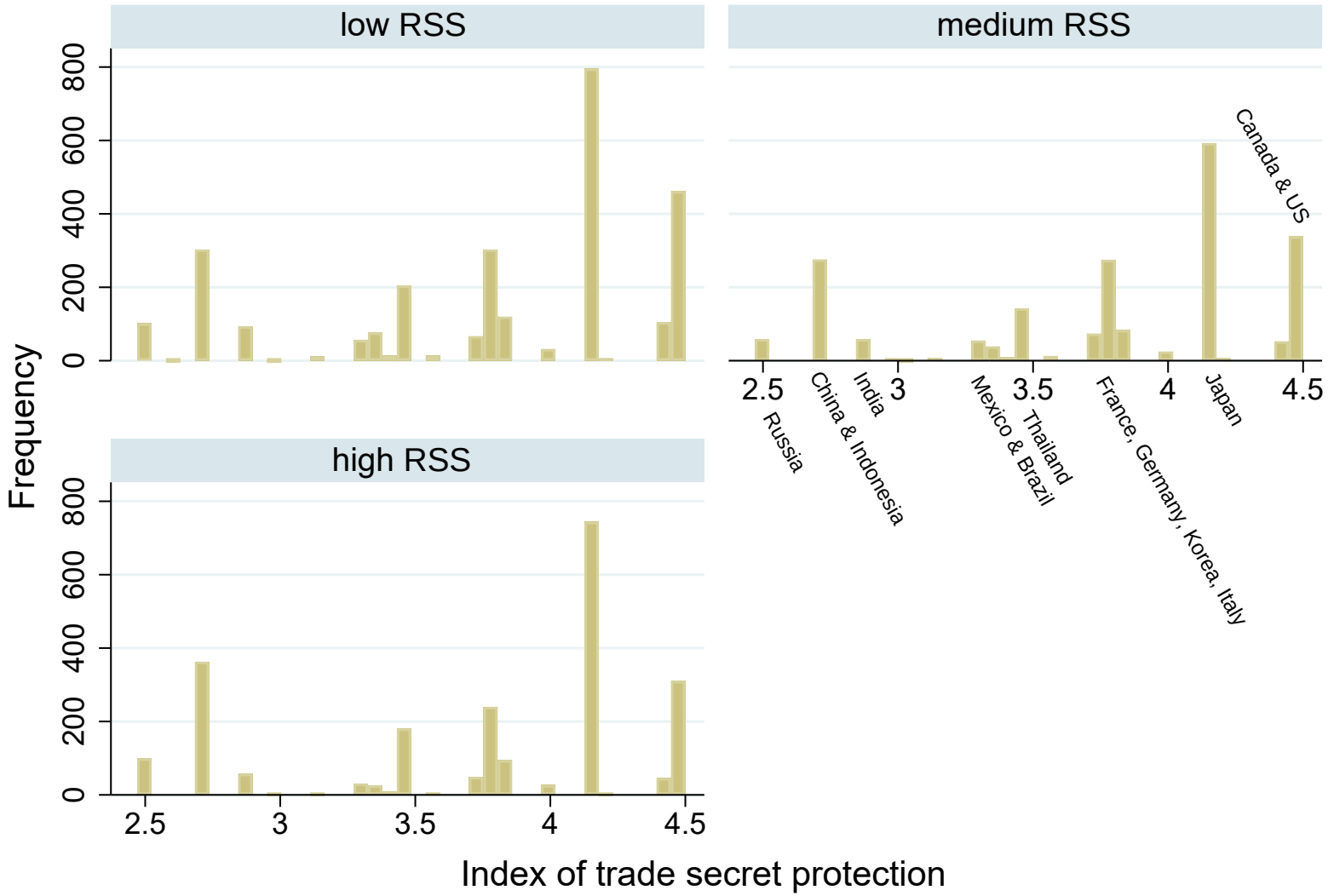
Quotes from Head et al. (2004):

- Supposing that these **engineering costs are specific mostly to a maker**, we use the engineering cost rating for part i [. . .] as a proxy for the efficacy of [relationship-specific investment].

- There are no doubt other technical characteristics that enhance the potential for RSI. For example, RSI could be important for achieving just-in-time delivery, with the nature of these investments varying over parts due to differing requirements for packaging and transport. We do not consider this possibility due to **lack of data**.

▸ back

Distribution of the TSP



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Control variables

- Product-level (Marklines)
  - → number of suppliers serving the component;
  - → number of OEMs procuring the component;
- Firm-level (Marklines)
  - → number of components the supplier is active in;
- Country level
  - → average distance to OEM countries;
  - → absence of trade barriers;
  - → GDP per capita.

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Main result – Panel

	(OLS)	(Cluster)	(FE)	(FE)	(FE)
TSP	0.174***	0.174	0.162***		
	(0.063)	(0.138)	(0.062)		
medium RS	-1.100***	-1.100**	-1.059***		
	(0.360)	(0.478)	(0.359)		
medium RS × TSP	0.283***	0.283**	0.274***	0.222***	0.230***
	(0.090)	(0.115)	(0.089)	(0.062)	(0.089)
high RS	-1.412***	-1.412**	-1.276***		
	(0.370)	(0.556)	(0.368)		
high RS × TSP	0.305***	0.305**	0.270***	0.067	0.117
	(0.095)	(0.125)	(0.095)	(0.055)	(0.076)
Year	no	no	yes	yes	yes
Product	no	no	no	yes	yes
Country	no	no	no	yes	yes
Firm	no	no	no	no	yes
Obs.	17,642	17,642	17,642	17,640	16,549
R^2	0.126	0.128	0.128	0.180	0.196

All regressions include the same set of control variables.