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Profiting from Innovation

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Introduction

- Understanding returns to investment in innovative activities is of key importance
- But how does innovation really affect firm performance? How do firms appropriate returns from innovation?
- What affects appropriation?
  - Patents versus «Strategic Protection»
  - Firm Organization
    - Knowledge Make & Buy & Cooperate
    - Complementary Assets
    - M&A
      - Market Structure & Competition
      - Type of Knowledge
    - Ecosystem
- How do we measure appropriation?

Importance of Strategic Protection

		% firm that consider protection mechanism very effective				
Sector	**NACE**	**Legal Protection**	**Strategic Protection**	**Lead Time**	**Complexity**	**Secrecy**
Chemicals	20	16,67	33,7	17,02	19,15	20,83
Pharmaceuticals	21	33,33	40	6,25	13,33	31,25
Mechanical Engineering & Machinery	28	9,26	13,5	6,1	10,37	5,45
Textile & Clothing	13,14 & 15	8,25	15,31	7,07	8,16	5,05
Food & Beverages	10 & 11	4,9	9,72	6,85	5,98	3,6
Wood & Paper	16 & 17	1,49	10,45	8,82	7,35	4,41
Transport Equipment	29 & 30	8,7	13,91	6,49	10,3	4,72
Metal Products	25	5,93	9,87	4,24	5,51	2,13
Furniture	31	4,76	12,9	6,35	6,45	3,23
Research Service	72	60	60,61	15,15	41,18	52,78
Wholesale	46	6,56	8,11	3,93	6,26	3,25
Computer Services & Software	62	7,93	16,62	8,26	13,46	5,17
Transport Services	49, 50 & 51	0,45	2,23	1,78	1,78	0,45
Financial Services & Insurance	64, 65 & 66	4,26	7,45	5,32	3,19	1,06
Total		**12,32**	**18,17**	**7,40**	**10,89**	**10,24**

Source: CIS2012, ECOOM KU Leuven

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How do firms affect Appropriation through Strategic Protection?

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Can we measure this effect? (partially)

Joint with Stijn Vanormelingen KU Leuven and HUB

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Innovation & Markups

- Innovative activity may affect firm specific prices and markups
  - Product innovation may affect the markup through shifting out the residual demand curve and/or improve product quality
    - New design/new functions versus new components/new materials
  - Process innovation may affect the markup through incomplete pass-through of costs

Estimating Markups Using Production Data

- Hall (1988): imperfect competition drives a wedge between input revenue shares and the output elasticity for a cost minimizing producer
- De Loecker and Warzynski (2012): use this insight of Hall to estimate firm level markups and relate to exports

$$\mu_{it} = \varepsilon_{it}^{X} / \frac{w_{it} L_{it}}{p_{it} Q_{it}}$$

Data Set

- ESEE data set
- Unbalanced panel of over 4,600 Spanish manufacturing firms; 1990-2008
- Common income statement variables needed to estimate production functions
  - Double deflated value added
  - Number of employees
  - Real net capital stock (perpetual inventory method)
- Extra variables:
  - Innovation indicators such as product and process innovation dummies, R&D spending, patents…
  - Imports and exports
  - Market characteristics such as number of competitors, buyers, growth,…

Summary Statistics

Table 1: Summary Statistics

	All	Small	Large
Nr. of Firms	4,567	3,366	1,277
Nr. of Observations	33,570	22,574	10,996
Value Added (X1000 €)	20,810	2,649	58,091
Employment	256	46	687
Capital Stock (X1000 €)	12,222	1,542	34,992
Labor Productivity (X1000 €)	57.3	45.9	80.8
Labor Cost Share	.54	.56	.50
Product Innovation	.24	.18	.38
Process Innovation	.33	.25	.48
Exporter	.60	.45	.90
Importer	.61	.45	.92
Nr. of Competitors			
10 or less	57%	49%	73%
Between 11 and 25	15%	16%	14%
Over 25	10%	12%	6%
Atomistic Market	18%	23%	8%

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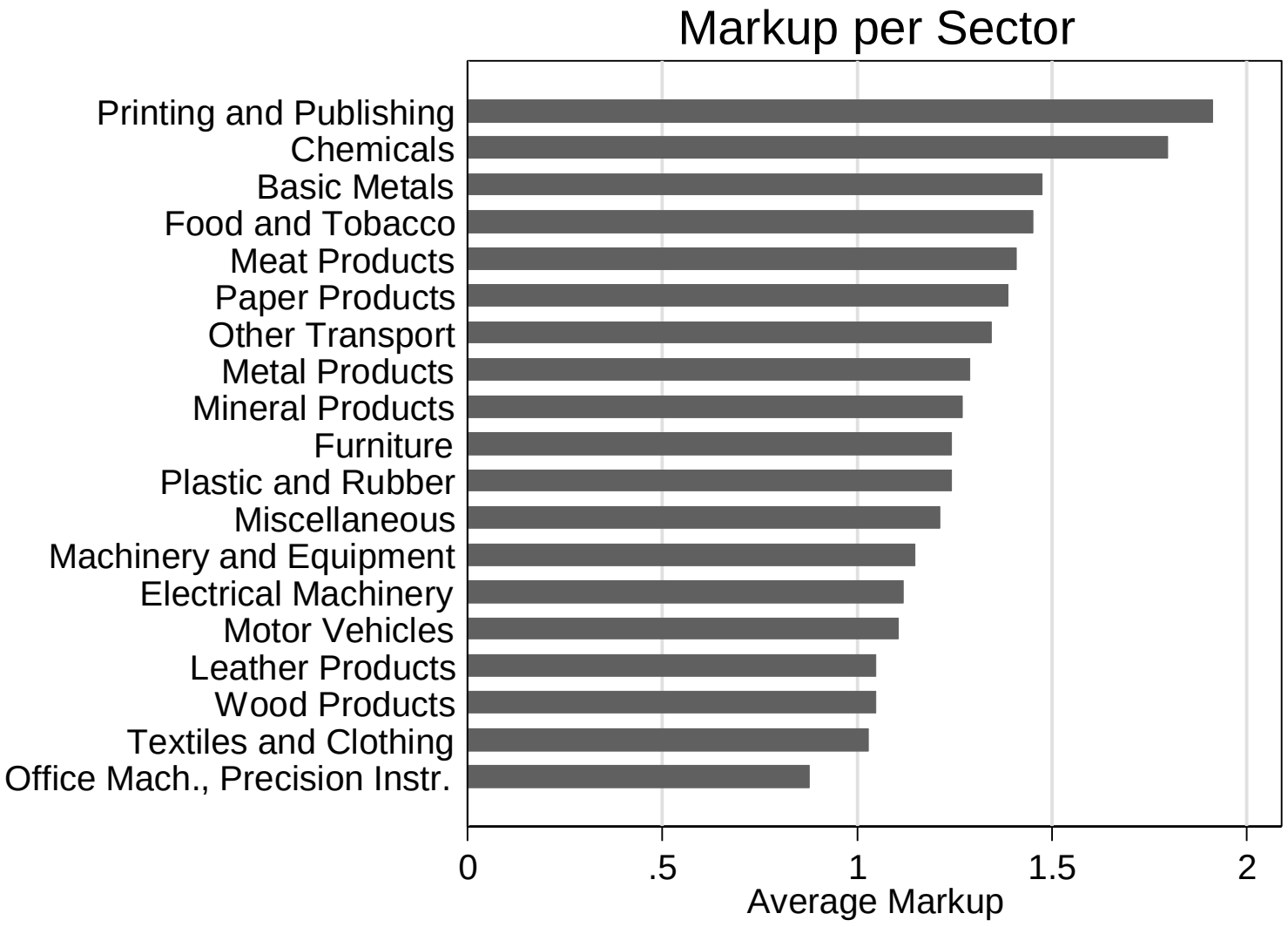
Product & Process Innovation

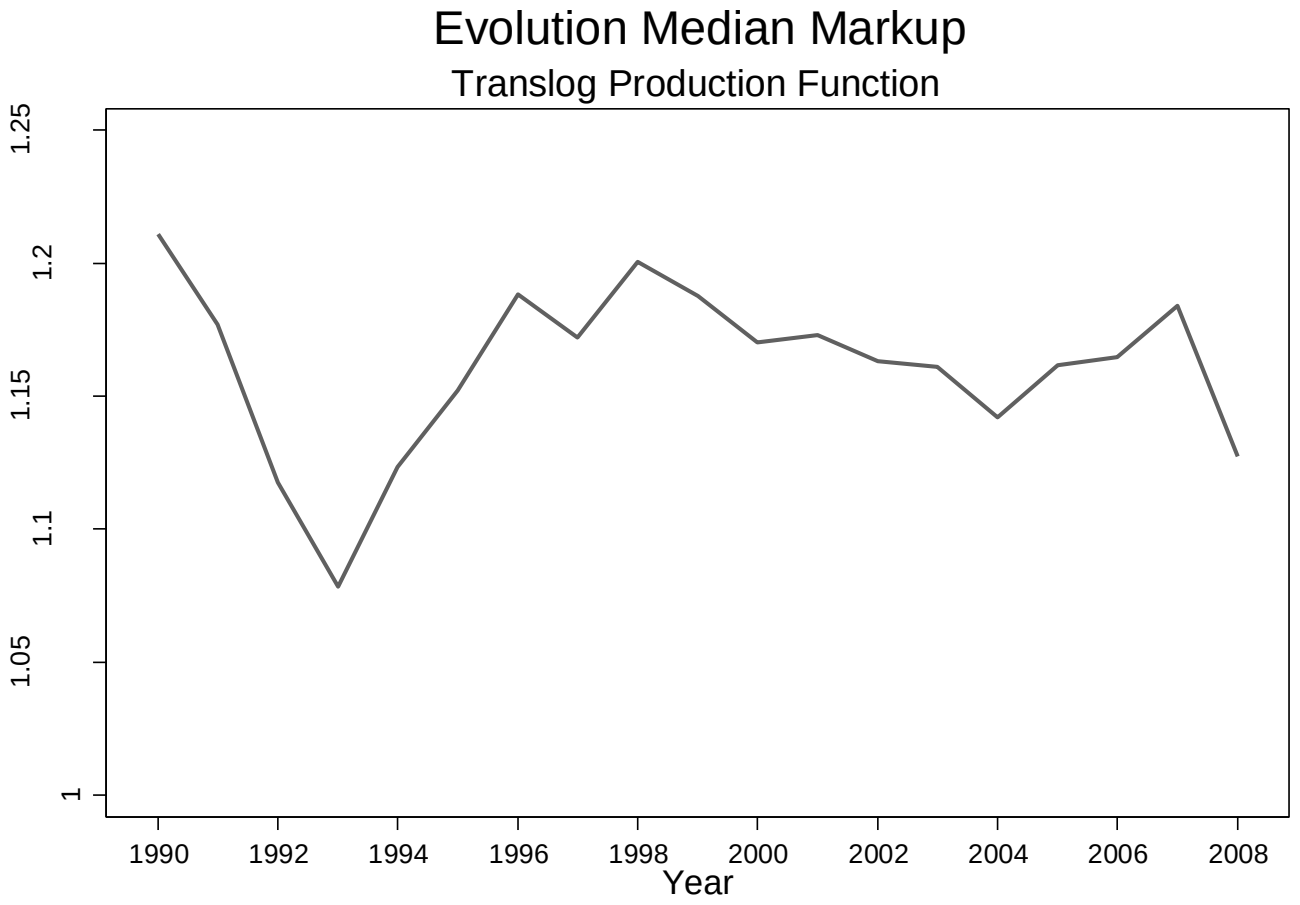
	All	Small	Large
Product Innovation	.243	.178	.375
New Materials	.125	.087	.202
New Components	.125	.083	.212
New Function	.117	.076	.202
New Design	.198	.145	.304
Process Innovation	.325	.251	.477
Machinery	.139	.129	.159
Methods	.047	.040	.062
Machinery and Methods	.146	.087	.266

Markup per Sector

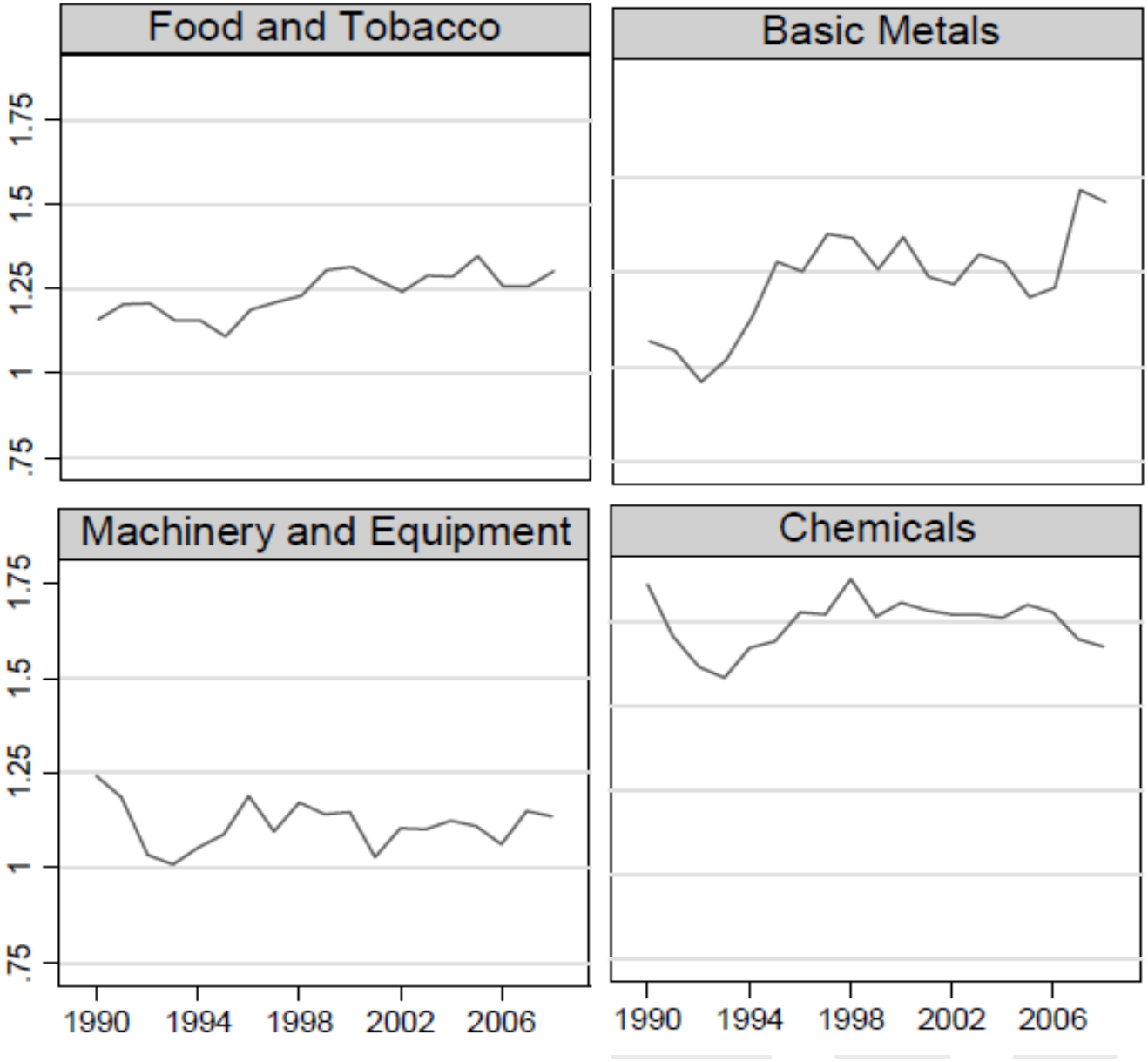


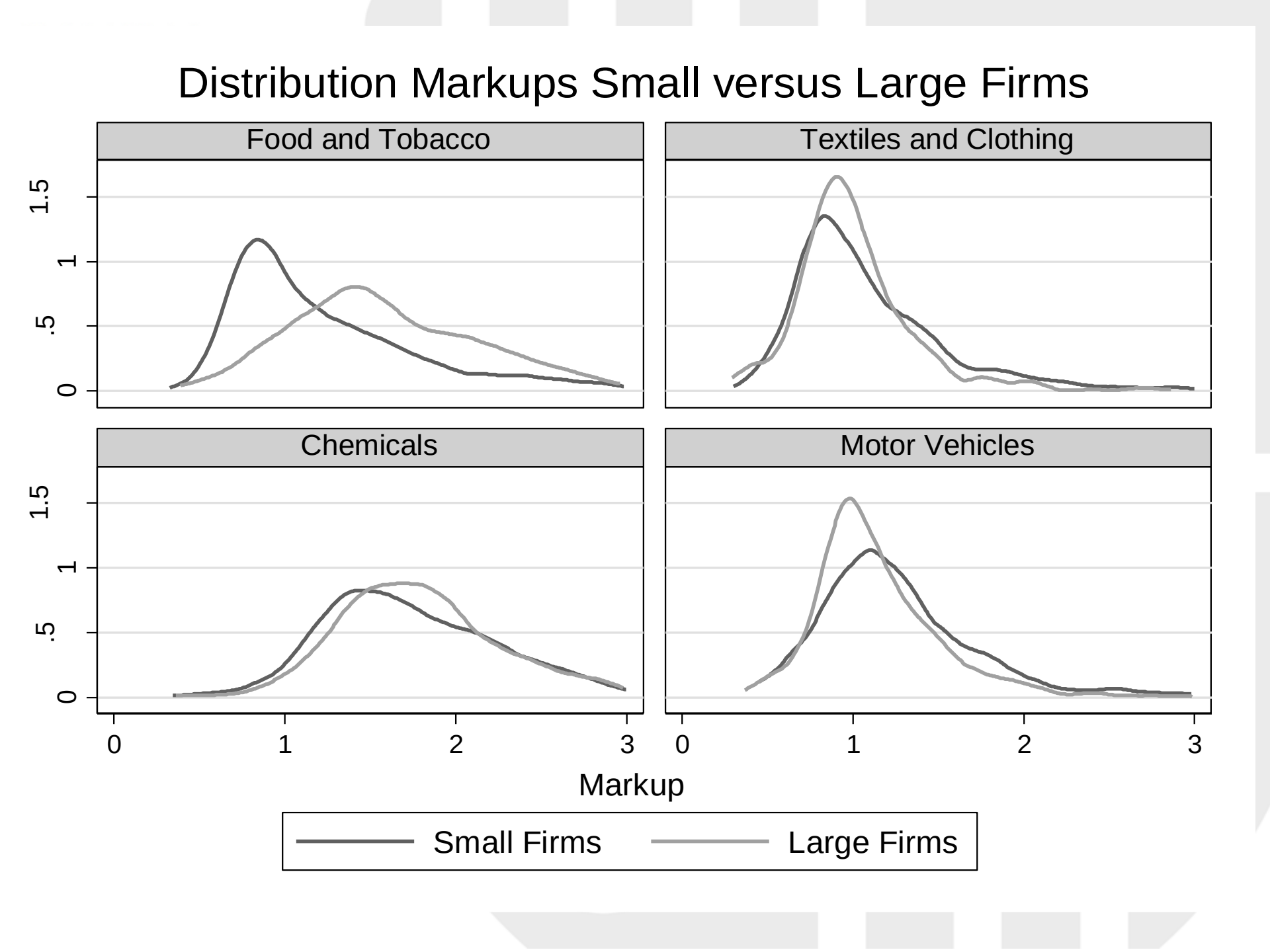
Evolution Markups

- Markups appear to be pro-cyclical (if anything), but still limited variation over time.

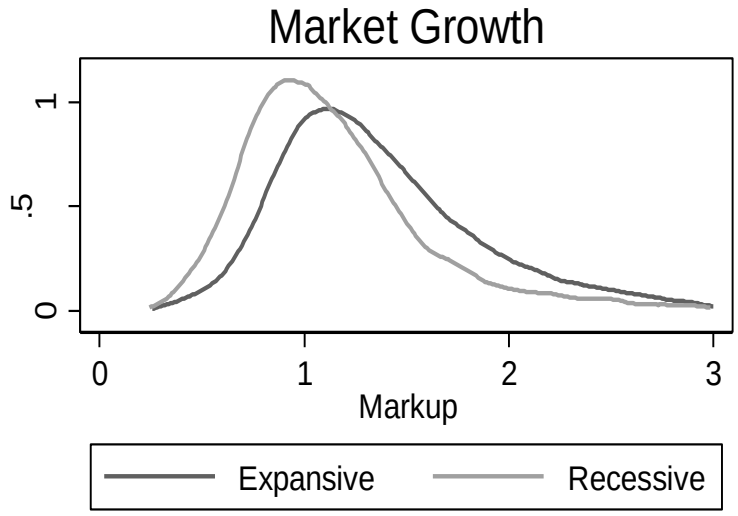


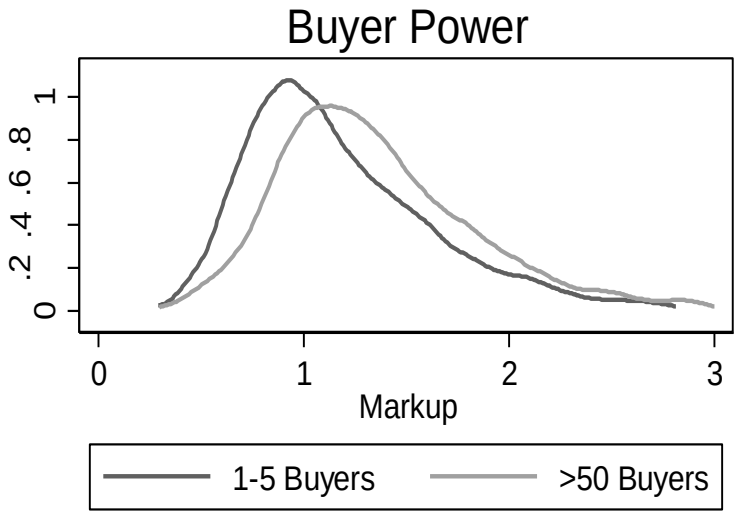
Evolution Median Markup Selected Industries

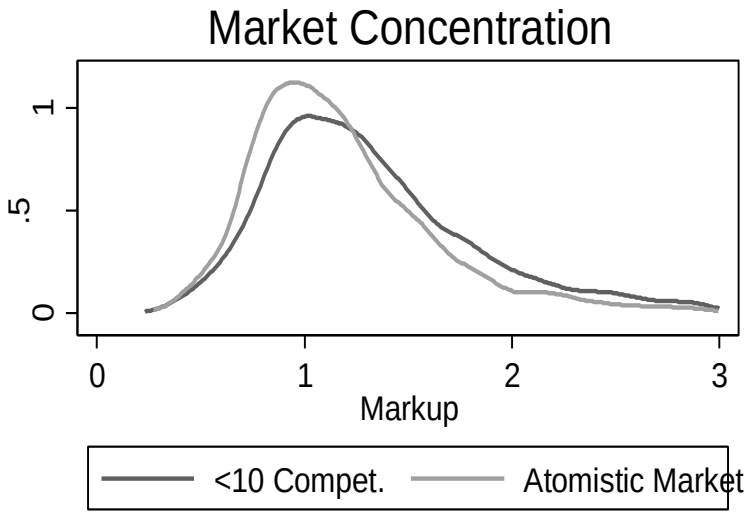


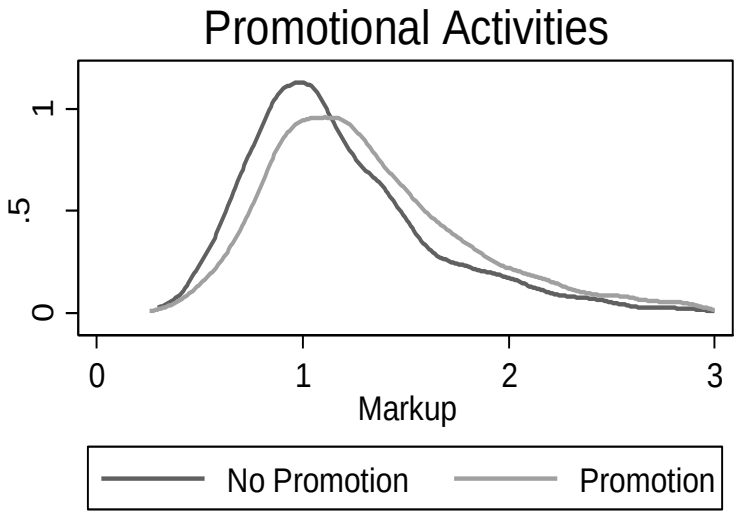

Distribution Markups Small versus Large Firms
Food and Tobacco
Textiles and Clothing
Chemicals
Motor Vehicles
0
.5
1
1.5
0
1
2
3
Markup
Small Firms
Large Firms

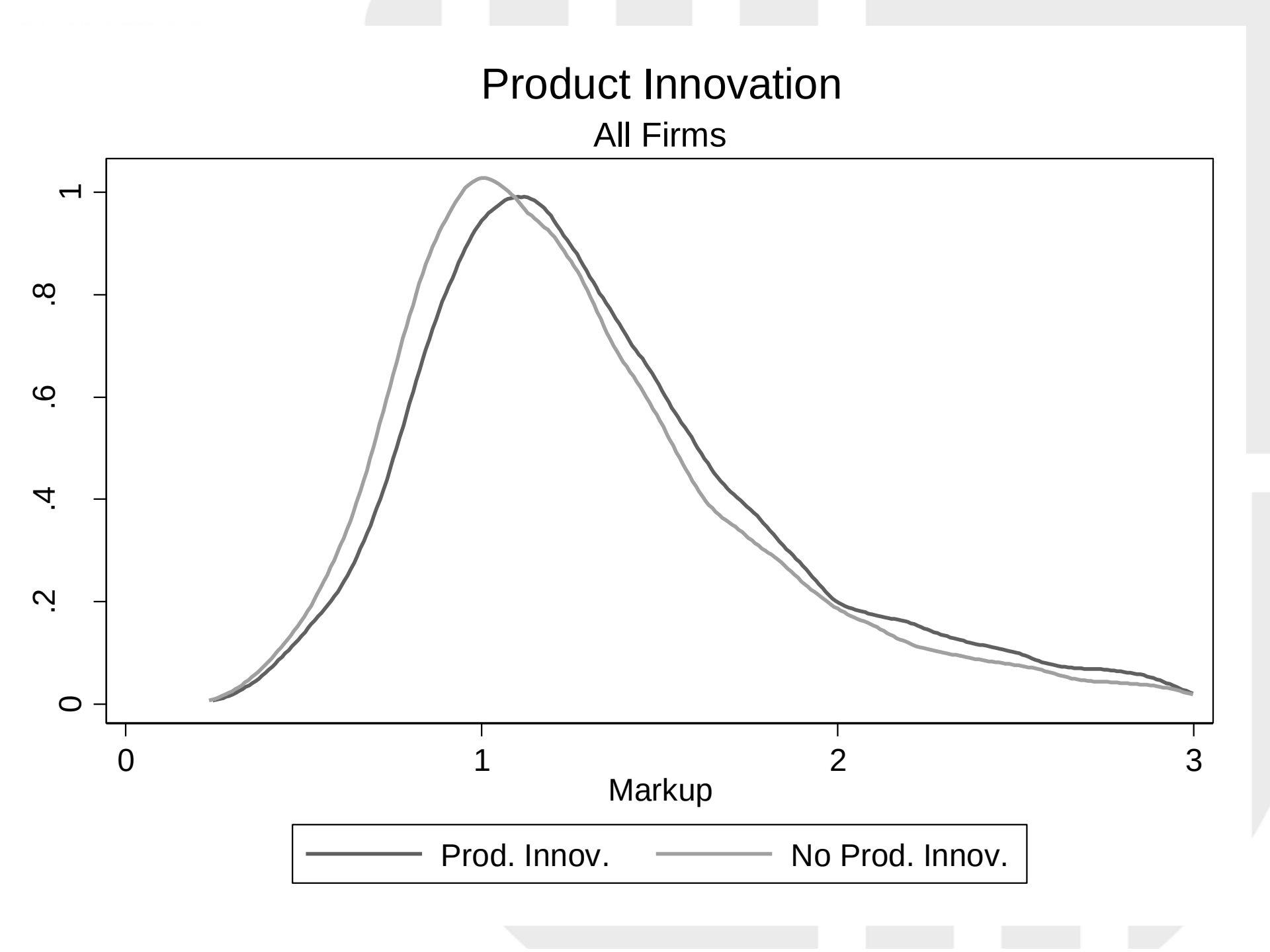
Drivers of Markup Differences

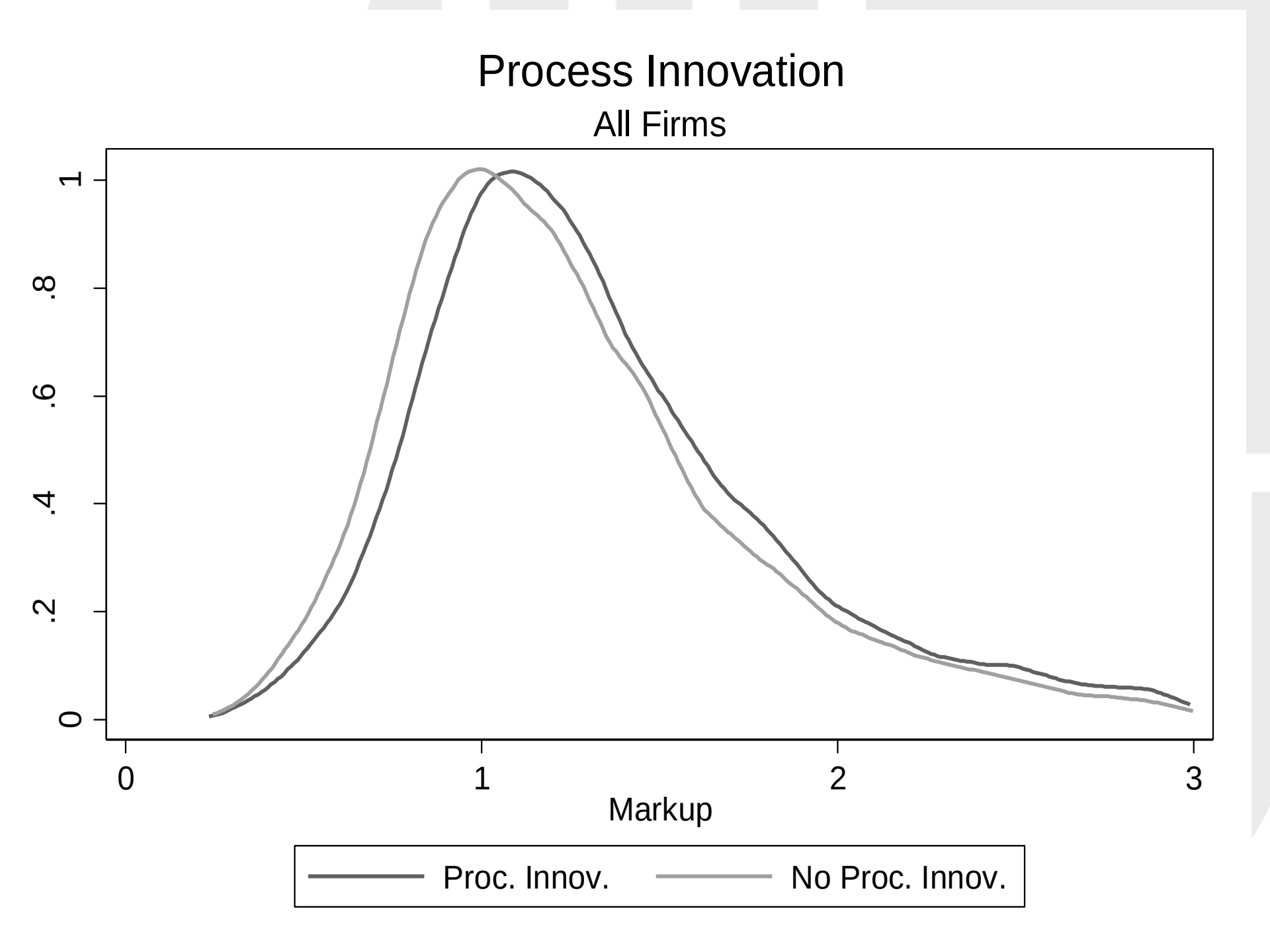









Product Innovation
All Firms
0
.2
.4
.6
.8
1
0
1
2
3
Markup
Prod. Innov.
No Prod. Innov.


Process Innovation
All Firms
0
.2
.4
.6
.8
1
0
1
2
3
Markup
Proc. Innov.
No Proc. Innov.

Markups & Firm Decisions

- Relate our firm level markup estimates with firm decisions.
- The estimated specification is:

$$\ln \mu_{it} = \beta_0 + \beta_1 prodinn_{it} + \beta_2 procinn_{it} + X_{it}\gamma + \gamma_t + \gamma_i + \varepsilon_{it}$$

- Logarithm of the markup

	(1) Translog	(2) Translog
Innovation	0.0481**	
	(0.00768)	
Process Innov.		0.0281**
		(0.00755)
Product Innov.		0.0379**
		(0.00930)
10 < Compet.< 25	-0.0296**	-0.0299**
	(0.0105)	(0.0105)
Compet.>25	-0.0334**	-0.0340**
	(0.0124)	(0.0124)
Atom. Market	-0.0408**	-0.0408**
	(0.0106)	(0.0106)
Exporter	0.0490**	0.0487**
	(0.0120)	(0.0121)
Importer	0.104**	0.104**
	(0.0115)	(0.0115)
Nr. Obs.	26828	26828
R^2	0.206	0.206
Nr. Firms	3777	3777

Standard errors clustered at the firm level in parentheses. $+\ p < .10$, $*\ p < .05$, $**\ p < .01$

- Markups positively related to Product and Process Innovation
- Markups decrease in the number of Competitors

Types of Innovation & Markups

	(1) OLS	(2) FE
New Components	-0.00263	-0.00449
	(0.0134)	(0.00791)
New Materials	0.00467	-0.00585
	(0.0134)	(0.00768)
New Design	0.0501**	0.0159*
	(0.0114)	(0.00663)
New Function	0.00324	0.0168*
	(0.0124)	(0.00728)
New Machinery	0.0419**	0.0153**
	(0.00982)	(0.00562)
New Methods	0.00369	-0.00752
	(0.0148)	(0.00873)
New Mach & Method	0.0155	0.00312
	(0.0109)	(0.00618)
N	23359	23359

- Product innovation involving new design and new functions leads to higher markups
- Process innovation through the introduction of new machinery leads to higher markups

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Market Structure & Markups

	(1) OLS	(2) OLS Small
Product Innovation	-0.0196	-0.0268
	(0.0214)	(0.0235)
(Comp.<10) × Prod. Innov	0.0602*	0.0832**
	(0.0239)	(0.0284)
(10< Comp.) × Prod Innov	0.0822**	0.125**
	(0.0270)	(0.0322)
Process Innovation	0.0146	-0.00262
	(0.0165)	(0.0181)
(Comp.< 10) × Proc Innov	0.0199	0.0401+
	(0.0192)	(0.0222)
(10< Comp.) × Proc. Innov	-0.0160	0.0119
	(0.0210)	(0.0240)
N	23080	15532

Standard errors in parentheses

$+ p < .10$, $* p < .05$, $** p < .01$

- Intermediate Levels of Competition lead to higher markups from product innovation
- Low levels of Competition reduce pass-through of Process Innovation

	(1) OLS	(2) FE	(3) OLS	(4) FE	(5) OLS	(6) OLS	(7) FE	(8) FE
Product Innov.								
New Components	-0.00262	-0.00424	-0.00230	-0.00398	-0.00255		-0.00483	
	(0.0135)	(0.00793)	(0.0135)	(0.00798)	(0.0133)		(0.00791)	
New Materials	0.00591	-0.00581	0.00445	-0.00603	0.00356		-0.00684	
	(0.0134)	(0.00769)	(0.0135)	(0.00774)	(0.0134)		(0.00768)	
New Desi								
New Func								
Process In								
New Mach								
New Meth								
New Mach & Meth	0.0125	0.00138	0.0115	0.000140	0.0125		-0.000190	
	(0.0108)	(0.00620)	(0.0108)	(0.00623)	(0.0108)		(0.00620)	
Patent (Y/N)	0.0554**	0.0127						
	(0.0157)	(0.00872)						
Nr. Patents			0.0103**	0.000393				
			(0.00339)	(0.00203)				
Log(R&D)					0.00124	0.00283**	0.00212**	0.00254**
					(0.00104)	(0.000997)	(0.000562)	(0.000522)
N	22202	22202	22172	22172	22324	26828	22324	26828

Not (only) Patents or R&D
Strategic Protection?

Young Innovative Firms & Markups

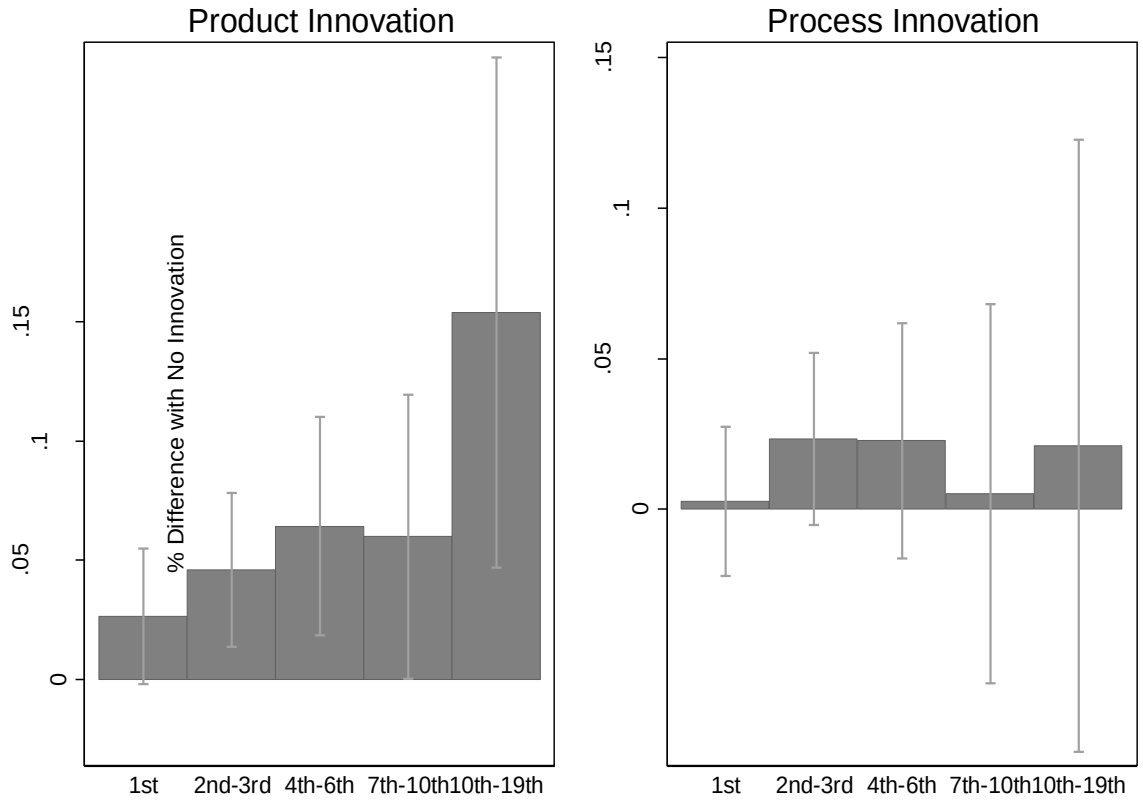
	(1) All OLS	(2) All FE	(3) Small OLS	(4) Small FE
Process Innov.	0.0292**	0.0126**	0.0297**	0.0124*
				00600)
YoungX				0133
				0164)
Product				00390
				00748)
YoungX				0491*
	(0.0278)	(0.0180)	(0.0315)	(0.0200)
Young Firms	0.0500**	0.0335**	0.0541**	0.0207+
	(0.0168)	(0.0101)	(0.0174)	(0.0109)
N	23994	23994	16410	16410

Clustered standard errors in parentheses + $p < .10$, * $p < .05$, ** $p < .01$

Young Firms benefit from product Innovation

More on Dynamics, Innovation & Markups

Small Firms



Small Firms, All Controls Included

Conclusions

- Large heterogeneity in firm level markups for Spanish companies
- Controlling for market structure: Product as well as process innovation associated with higher markups.
  - Product innovation due to new design and new functions
  - Process innovation due to new machinery
- Combining markup estimates with data on firm level price changes shows that:
  - Product innovation increases firm level prices, but not marginal costs leading to and increase in markups
  - Process innovation lowers marginal costs, but incomplete pass-through to prices leads markups to increase
- How do Spanish companies appropriate returns to innovation?
  - Smaller firms increase markup
  - Competition escaping product innovation
  - Market power for process innovation
  - Patents and promotions increase appropriation
  - Product innovations cumulate and increase markups over time, especially for young firms.

Innovation and Total Factor Productivity

Table 1: TFP and Firm Decisions

	Cobb Douglas OLS		Cobb Douglas Control		Translog Control	
	Small	Large	Small	Large	Small	Large
Product Innovation	0.0502**	0.0340*	0.0426***	0.0393*	0.0498+	-0.0017
	[0.0161]	[0.0165]	[0.0125]	[0.0182]	[.0296]	[0.041]
Process Innovation	-0.0237*	-0.0038	0.00703	0.00751	-0.0284	0.029
	[0.0113]	-0.0152	[0.0102]	[0.0170]	[.021]	[0.041]
Nr. Observations	21,171	9,956	21,171	9,956	21,171	9,956

Standard errors in parentheses + p ¡ .10, * p ¡ .05, ** p ¡ .01

Dependent variable is log TFP, computed after estimating Cobb Douglas production function with OLS and Control Function Approach and Translog production function estimated with control function approach. Results reported for small and large firms separately

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Low Markup & Exit

Table C.1: Transition Matrix Markups

	Quint. 5	Quint. 4	Quint. 3	Quint. 2	Quint. 1	Disappear	Total
Quint. 5	45.5%	17.5%	9.8%	4.5%	5.0%	17.68%	100.0%
Quint. 4	25.0%	28.1%	18.6%	11.0%	5.8%	11.48%	100.0%
Quint. 3	13.8%	24.8%	26.4%	17.6%	9.9%	7.39%	100.0%
Quint. 2	7.1%	14.8%	21.5%	30.9%	19.4%	6.35%	100.0%
Quint. 1	5.2%	7.1%	11.7%	22.1%	45.6%	8.44%	100.0%

Estimated 5 year transition matrix. Firm specific deviations from the sector/year average. Quintile 5 represents the lowest markups relative to the sector/year average. Quintile 1 represents the highest markups relative to the industry/year average

Prices, Marginal Costs and Innovation

- Percentage changes in output prices can be used to disentangle markup changes in price and marginal costs changes: $\Delta \ln c_{it} = \Delta \ln p_{it} - \Delta \ln \mu_{it}$
- Product innovation leads to higher prices; no impact on marginal costs
- Process innovation puts downward pressure on both prices and marginal costs, but impact on prices is smaller, leading to an increase in markups.

$$\Delta \ln p_{it} = \underset{(.0007)}{.0014} * prodinnov_{it} - \underset{(.0005)}{.0025} * procinnovdum_{it} + year_t$$

$$\Delta \ln c_{it} = \underset{(.0027)}{.0014} * prodinnov_{it} - \underset{(.0025)}{.0048} * procinnovdum_{it} + year_t$$

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Internal Organization of Innovation

How do Firms Profit?

- Innovation and Performance
  - Firm Organization
    - Make & Buy & Collaborate
    - Complementary assets (Teece, 1986)
  - Market Structure/Firm Size (Schumpeter and following, see Cohen and Levin (1989) and Cohen (2010) for a 50 year review)
  - First Mover Advantages and Lead Time

Internal and External Activities performed by the same firm

	Frequency	*% Sales from New Products*
No		
M		
Bu		
M		
TOTAL	522 (100%)	9.4%

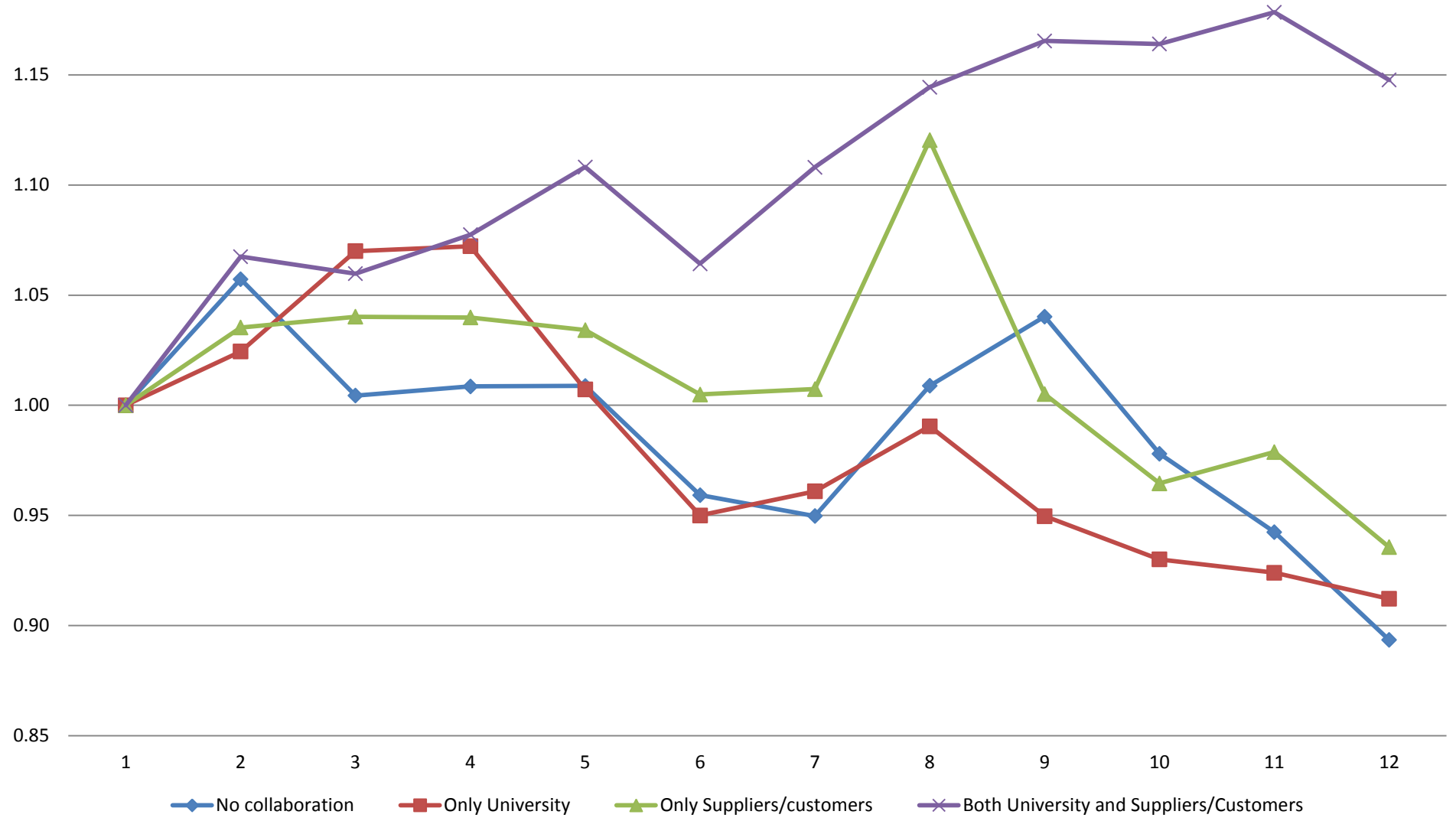
Complementarity in Innovation Process

…improve innovation performance!

Scientific Knowledge & Innovation

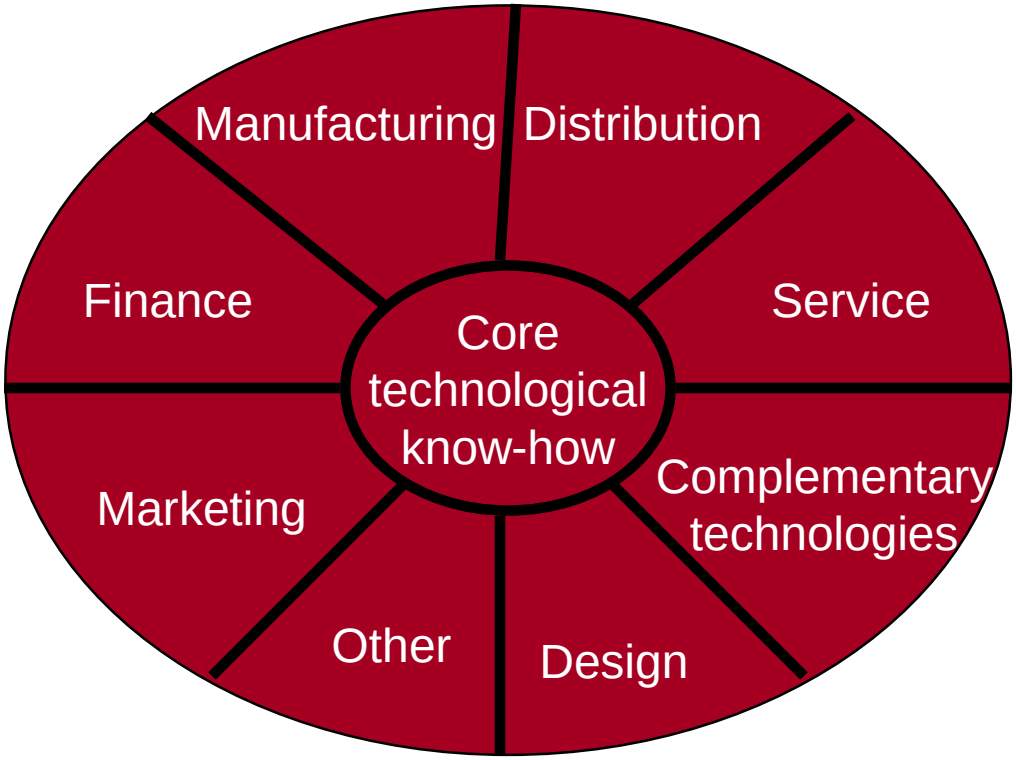
	Low Basicness		***High Basicness***	
	Frequency	% Sales from new Products	Frequency	% Sales from new Products
NoMake&NoBuy	7 (4%)	0.6%	5 (4%)	2.0%
MakeOnly	32 (18%)	5.1%	10 (8%)	4.7%
BuyOnly	18 (10%)	4.2%	9 (7%)	5.6%
Make&Buy	**124 (68%)**	**10.4%**	**106 (81%)**	**15.7%**
TOTAL	181 (100%)		130 (100%)	

Evolution of Productivity and Types of Collaboration



Source: ESEE, own elaboration (Cassiman, Ghemawat & Vanormelingen, 2013)

Complementary Assets



Bargaining power of owners of complementary resources depends upon whether complementary resources are *generic* or *specialized*.

Teece (1986)

Profiting from Innovation Think Complementarities

- Complementarity in Innovation Process
  - Internal and External Knowledge
  - Role of Science
- Complementarity in Value Chain
  - Control Complementary Resources and Capabilities
- Complementarity in Value System
  - Manage Co-Innovation and Adoption Risks

$\Rightarrow$ Hard to experiment with innovation, but the innovation process can be source of Sustainable Competitive Advantage.

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Predicted Effects M&A on R&D Process

	Impact (positive/negative/unknown)		Likelihood that predicted effect may occur when...		
Effects of merger	**R&D input**	**R&D efficiency**	**Firms are active in same product markets**	**Firms are active in same technological fields**	**Firms are active in complementary technological fields**
Indivisibilities/specialisation: spreading fixed cost of R&D over more R&D output (scale)	+	+	Medium	High	Low
Indivisibilities/specialisation: spreading fixed cost of R&D over more and different types of R&D output (scope)	+	+	Medium	Low	High
Elimination of common R&D inputs	–	+	High	High	Low
Synergies: combining different R&D knowledge inputs	+	+	Low	Low	High
Technology market power and appropriation	?	+	Medium	High	Low
Internal organisational changes	–	–	High	Medium	Low
			R&D input/R&D performance		
TOTAL EFFECT	?	?	– / +?	? / +	+ / +