

Technological and Non-technological Innovation and Productivity in Services vis a vis Manufacturing

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Motivation

- The service sector accounts for more than 60 percent of GDP in Latin America and 75 in developed countries.
- The share of the service sector has been increasing but its rate of productivity growth has remained stubbornly low in relative terms to other sectors in LA.
- Innovation seems key to improving the performance of this sector
- There are only a few studies assessing empirically the relationship between innovation and productivity in the service sector using firm level data,
- And even fewer comparing services and manufacturing.
- As far as we know, so far, all of the available evidence is for European or OECD countries.
- A recent research effort coordinated by IDB and CINVE with the support of IDRC is generating evidence for LA.

Hypothesis

- In a recent review of this literature Hall (2011) finds that the evidence of a positive impact of product innovation on revenue productivity is strong but the impact of process innovation is somewhat ambiguous.
- The literature on the impact of non-tech (marketing, organizational) innovation on productivity is scarce.
- We know that services innovate differently: higher (lower) propensity to non-technological (technological) innovation (and using more ICTs and training to produce them) than manufacturing.
- Therefore, we expect non-tech innovations to be more important for productivity growth in services than in manufacturing. ▶ inn & prod

Data

- Innovation surveys from Uruguay:
 - ▶ Service sector: 2 waves, 2004-2006 and 2007-2009
 - ▶ Manufacturing sector: 4 waves, 1998-2000, 2001-2003, 2004-2006 and 2007-2009
- Matched with EAS. (Loss of observations due to sampling problems)

	Number observations	When adding K/L
All services	1,868	1,093
Tradicional	1,240	750
KIBS	628	343
Small	1133	562
Manufacturing	3,202	1,037
Low Tech	2,478	250
High Tech	724	787
Small	1,930	494

Tech and Non-tech innovation

Technological (product and process) and Non-technological (organizational and marketing) innovation

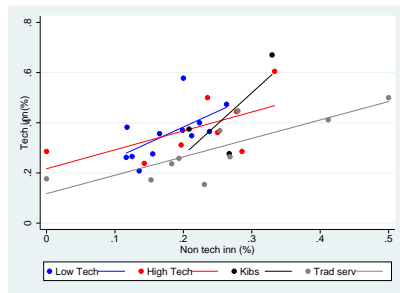
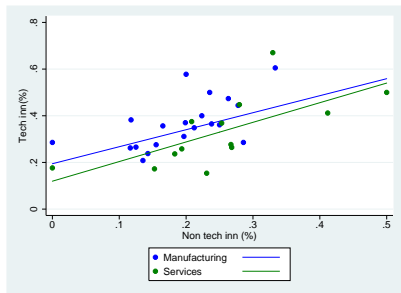
		Technological Innovation					Non-Technological Innovation				
	N	Prod	Proc	Tech	In-house RD	New to Market	Organiz	Mark	Non-Tech	Any Inn	Tech Non-T
Service	1,868	0.18	0.24	0.31	0.01	0.13	0.20	0.09	0.24	0.40	0.1
KIBS	628	0.22	0.25	0.34	0.01	0.16	0.25	0.09	0.27	0.44	0.1
Traditional	1,240	0.16	0.24	0.29	0.00	0.11	0.18	0.10	0.23	0.38	0.1
Small	1,133	0.14	0.19	0.24	0.01	0.11	0.14	0.07	0.18	0.31	0.1
National	1,675	0.17	0.24	0.30	0.01	0.12	0.19	0.08	0.22	0.38	0.1
Foreign	193	0.29	0.26	0.38	0.00	0.20	0.34	0.18	0.42	0.56	0.2
Manuf	1,727	0.23	0.32	0.38	0.01	0.15	0.17	0.08	0.20	0.43	0.1
Low Tech	1,328	0.20	0.30	0.35	0.01	0.14	0.15	0.07	0.18	0.40	0.1
High Tech	399	0.33	0.39	0.48	0.02	0.21	0.22	0.13	0.27	0.54	0.2
Small	1,037	0.16	0.22	0.26	0.01	0.10	0.10	0.05	0.13	0.30	0.0
National	1,529	0.22	0.30	0.36	0.01	0.15	0.15	0.08	0.19	0.41	0.1
Foreign	198	0.33	0.51	0.56	0.01	0.20	0.26	0.15	0.29	0.62	0.2

Heterogeneities between services and manufacturing

	Int markets	Coop with clients, providers	Coop in R&D	Coop with Univ. or Gov.	Public Support	Applied for patents
Service	0.07	0.91	0.14	0.03	0.02	0.01
KIBS	0.08	0.93	0.17	0.04	0.02	0.01
Traditional	0.06	0.90	0.12	0.03	0.02	0.01
Small	0.07	0.91	0.10	0.02	0.02	0.01
National	0.05	0.90	0.12	0.02	0.02	0.01
Foreign	0.17	0.87	0.16	0.09	0.01	0.02
Manuf	0.17	0.93	0.14	0.07	0.04	0.02
Low Tech	0.18	0.93	0.10	0.05	0.04	0.02
High Tech	0.15	0.92	0.25	0.12	0.06	0.04
Small	0.09	0.93	0.07	0.04	0.02	0.01
National	0.14	0.93	0.12	0.05	0.04	0.02
Foreign	0.46	0.91	0.24	0.19	0.04	0.05

Empirical Strategy: Crepon, Duget and Mairesse model

- System of four non-linear equations
- Multiple stage estimation procedure
- CDM model in the version proposed by Crespi and Zuniga (2012) with one change: distinguishing between tech and non-tech innovation (estimation using a bivariate probit)



CDM Model

- Innovation decision (firm i):

$$ID_i = 1 \text{ if } w_i\alpha + \epsilon_j > 0$$

$$ID_i = 0 \text{ if } w_i\alpha + \epsilon_j \leq 0$$

- innovation effort (or expenditure):

$$IE_i = z_i\beta + \eta_i \text{ if } ID_i = 1$$

$$IE_i = 0 \text{ if } ID_i = 0$$

- Innovation output (Tech, IT, and Non-tech, INT, innovation):

$$I_i = IEp_i\gamma + x_i\delta + \mu_i$$

- Productivity equation:

$$y_i = c + \pi_1 k_i + \pi_2 I_i + \pi_3 ITp_i + \pi_4 INTp_i + \pi_5 IBothp_i + \nu_i$$

Propensity to innovate and innovation expenditure

Variable	Services	Manuf	Services	Manuf
Dep var	Probability of investing in innovation IE>0		Log IE	
Exporter	0.375*** (0.0861)	0.0709 (0.0642)	0.518 (0.323)	0.159 (0.106)
Foreign owned	0.141 (0.126)	0.0922 (0.131)	0.570** (0.224)	0.0297 (0.139)
Patent protection	1.491*** (0.329)	1.884*** (0.525)	0.503** (0.245)	-0.383 (0.349)
Public support	1.984*** (0.413)	2.182*** (0.506)	0.994 (0.660)	0.649*** (0.247)
Cooperation in R&D	1.282*** (0.175)	1.525*** (0.207)	1.001*** (0.337)	0.525*** (0.165)
Market information sources (Info1)	0.520*** (0.0944)	0.377*** (0.108)	0.367 (0.299)	0.291 (0.203)
Scientific sources (Info2)	-0.140 (0.121)	-0.259*** (0.0980)	0.0410 (0.173)	-0.0193 (0.207)
Public sources (info3)	0.00993 (0.0902)	0.118 (0.105)	0.356*** (0.0650)	0.0846 (0.112)
Size	0.248*** (0.0216)	0.372*** (0.0247)		
Constant	-1.789*** (0.0626)	-2.109*** (0.129)	-0.0637 (0.565)	2.219*** (0.336)
Industry dummies	yes	yes	yes	yes
Number of obs.	1,868	1,727	1,868	1,727
Log likelihood			1,433	-2273

- Determinants of innovation propensity are very similar in the manufacturing and services sector

Tech and non-tech innovations

	Services	Manufacturing	Services	Manufacturing
Variable\Dep var	Technological innovation		Non technological innovation	
Exporter	-0.363 (0.230)	-0.253** (0.0989)	0.111 (0.0928)	-0.236*** (0.0822)
Foreign owned	-0.878*** (0.216)	-0.116 (0.131)	0.105 (0.113)	-0.0591 (0.117)
Patent protection	0.517** (0.215)	2.060*** (0.327)	0.413 (0.400)	1.001*** (0.155)
Cooperation in R&D	-0.142 (0.302)	0.183 (0.230)	0.368** (0.182)	0.165 (0.161)
Market information sources (Info1)	0.00295 (0.101)	-0.261* (0.152)	0.508*** (0.105)	0.0413 (0.150)
Scientific sources (Info2)	-0.194** (0.0890)	-0.235** (0.113)	-0.0397 (0.0675)	-0.0579 (0.0616)
Public sources (info3)	-0.456*** (0.163)	0.0214 (0.0948)	-0.114 (0.122)	0.244*** (0.122)
Size	0.196*** (0.0260)	0.346*** (0.0318)	0.227*** (0.0194)	0.309*** (0.0300)
Log IE_p	1.387*** (0.293)	2.332*** (0.333)	0.399** (0.197)	0.649*** (0.240)
Constant	-1.682*** (0.145)	-7.578*** (0.753)	-2.391*** (0.0566)	-3.898*** (0.569)
Industry dummies	yes	yes	yes	yes
Number of obs.	1,868	1,727	1,868	1,727
Log likelihood			-1809	-1587
Independece (rho)			0.563*** (0.0310)	0.533*** (0.0399)

- Stronger effect of innovation expenditure on tech innovation and manufacturing
- Size is a very important determinant of the probability of undertake technological

Productivity equation

Variable\Dep. Var.	Services		Manufacturing	
	log(sales/employee)			
Size	-0.0588*** (0.0211)	-0.163*** (0.0336)	0.188*** (0.0300)	0.261*** (0.0432)
K/L	0.0695** (0.0297)	0.0724** (0.0295)	0.210*** (0.0514)	0.208*** (0.0650)
Log IE_p	0.489*** (0.0756)		0.471*** (0.0965)	
I_Both_p		1.358*** (0.297)		-1.006*** (0.290)
I_tech_p		1.177* (0.669)		1.249*** (0.299)
I_nontech_p		4.315*** (0.889)		-5.412*** (1.292)
Constant	12.84*** (0.124)	12.95*** (0.172)	11.31*** (0.273)	12.51*** (0.176)
Ind dumm	yes	yes	yes	yes
Observations	1,093	1,093	1,209	1,209
R-squared	0.385	0.379	0.300	0.311

- Positive impact of tech and non-tech innovation on productivity in services.
- In services, non-technological innovations have a bigger impact than technological innovations
- In manufacturing, only technological innovations improve productivity.

Results

- Technological innovations are more important for productivity in manufacturing than in services
- High importance of non-tech innovations for productivity in services
- Size is an important determinant of the decision of innovation, tech and non-tech innovation, and productivity
- But size is more important for innovation in manufacturing than services (probably because services innovation require less formal RD, and therefore economies of scale are less relevant)
- Patent protection is relevant for the decision to invest. As expected, it is more important in manufacturing than in services and for technological innovations (services use other types of protection, copyrights, trademarks, etc.)

Some descriptive statistics

	Innovators	Tech inn	Product inn	Process inn	Non-tech	Organizational	Marketing
Services	39.8	30.7	18.3	24.2	24.4	20.3	9.4
Kibs	43.6	33.8	22.1	25.2	27.4	25.0	8.6
Traditional	37.9	29.1	16.3	23.7	22.8	17.9	9.8
Manufacturing	43.5	38.7	23.8	33.2	20.6	16.8	8.5
High tech	54.2	48.4	34.0	40.1	27.5	22.2	13.4
Low tech	40.3	35.6	20.7	30.9	18.3	15.0	7.0

Table: Share of firms (%)

	Public support	Coop_RD	Network	Patents	Exporter	Productivity	IE
Services	2.1	3.1	20.1	1.7	14.2	1,116	14.8
Kibs	1.9	4.3	18.9	2.1	17.2	582	11.6
Traditional	2.3	2.5	20.6	1.5	12.7	1,386	16.5
Manufacturing	4.3	6.8	8.3	3.2	38.1	1,503	30.5
High tech	5.8	12.1	10.6	5.0	40.6	1,985	31.3
Low tech	3.8	5.2	7.6	2.6	37.3	1,360	30.3

Table: Firm characteristics

(a) Surveys 2004-2006 and 2007-2009

Heterogeneities across sectors

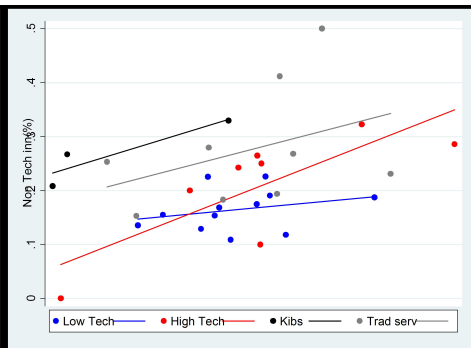
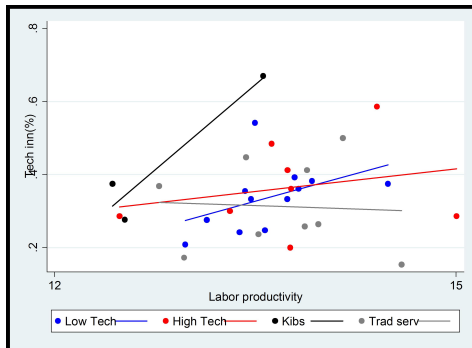
Results look very similar across services (Kibs and traditional) and Manufacturing (Low-High Tech)

- Patent protection seems to be especially important for KIBS and High-tech firms
- Size, cooperation on R&D and market sources of information are relevant for all to the decision to invest
- Size is more important for manufacturing subsectors than for services subsectors
- Only two important determinants for the amount invested across all manufacturing subsectors are cooperation in R&D and public support
- Cooperation in R&D seems the key variable to determine the amount to invest across all subsectors
- All the coefficients of innovation output are bigger for the services sector
- For High Tech industries non-technological has negative effect. For Low-Tech technological innovation is the driver of productivity

Financial constraints and lack of qualified workers

- Some effect of these constraints mainly in the level of expenditure
 - ▶ Lack of qualified workers and financial constraint negative effect on traditional services and low-tech firms
- Human capital is very important determinant of innovation and productivity

Tech and Non-tech innovations increase Productivity?



▶ back