Appropriating Value from Innovation

A Review of Readings

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Outline

Appropriating Value from Innovation

Firms, Markets, Industries, Institutions, Social Considerations

- Bandiera and Rasul (2006) - Empirical study of effect of social network on technology adoption
- Aghion et al. (2005) - Empirical study of relationship between competition and innovation
- Arora et al. (2001) - Markets for Technology and Strategy Implications
- Cohen and Levinthal (1990) - Absorptive Capacity

Effect of social network on technology adoption

Agenda

- Propensity to adopt varies inverted-U with number of adopters among family and friends
- Effect is stronger for farmers who have less information to begin with
- Effect stronger for individuals with stronger social ties
- Implications for incentivizing early adoption
- Caveats: asymmetric effects across pairs, identity of member in network may matter, boundaries of network definition are crucial

Effect of social network on technology adoption

Table 1

Main Reasons for Adoption or Non Adoption

(*a*) Why Adopters Adopted	
I want to consume the new crop	72%
I thought it would be remunerative	66%
The NGO convinced me it would be remunerative	35%
Number of respondents	102
(*b*) Why Non Adopters Did Not Adopt	
I did not know the production techniques	48%
I thought it would not be remunerative	18%
No land available	17%
Number of respondents	96

Notes: Each cell reports the percentage of farmers who reported each of the stated reasons for adoption/non adoption. The sample is respondents in villages where sunflower seeds have been distributed. This is the same sample used for the regression analysis. There are 102 adopters and 96 non-adopters in the sample. The responses of village leaders and contact farmers are not included. Respondents were asked to list two reasons why they chose to adopt, or not to adopt. Other reasons for non adoption were 'no market for this crop' (14%) and 'existing crops are remunerative', (3%).

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Table 2

Village Descriptives

	Sample Villages								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Households interviewed	20	19	34	18	32	20	27	27	14
Approximate number of households in the village	350	300	250	200	300	550	300	350	200
Male headed adopting households	105	179	80	46	112	242	106	200	54
Female headed adopting households	34	13	9	15	36	29	34	30	20
Village adoption rate	0.40	0.64	0.36	0.30	0.49	0.49	0.47	0.66	0.37
Travel time to nearest permanent market on foot (minutes)	40	5	120	60	30	10	60	180	90
Travel time to nearest paved road on foot (minutes)	50	2	60	30	30	10	60	180	60
Median oil consumption (days per month)	4	11	12	8	2	4	4	0	0
Other NGO operates in village	√	√	√		√	√		√	
Well		√							
School	√	√	√	√	√	√	√	√	
Health post	√	√		√					

Notes. The number of households in the village is an approximate figure based on Movimondo records. The village adoption rate is defined as the proportion of all households in the village that have adopted sunflower. At the time of the survey, one other NGO was operating in the region. They were involved in the rehabilitation of local infrastructure.

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Table 3

Social Networks by Adoption Status and Network Type

Mean network size (standard deviations in parentheses, 25th, 50th and 75th percentiles in brackets)	Total	Adopters	Non adopters
Number of adopters among family and friends	4.92	5.87	3.91
	(5.18)	(4.92)	(5.28)
	[0, 4, 7]	[3, 5, 8]	[0, 3, 5]
Number of adopters among family	2.46	2.69	2.22
	(3.36)	(3.01)	(3.70)
	[0, 1, 4]	[0, 2, 4]	[0, 0, 3]
Number of adopters among friends	2.46	3.19	1.69
	(2.86)	(3.02)	(2.46)
	[0, 2, 4]	[1, 3, 4]	[0, 0, 3]
Have no adopters among family and friends	0.278	0.167	0.396
	(0.449)	(0.374)	(0.491)

Notes. The sample is respondents in villages where sunflower has been distributed. This is the same sample used for the regression analysis. There are 102 adopters and 96 non adopters in the sample. The responses of village leaders and contact farmers are not included.

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Table 4

Descriptive Statistics by Adoption Status (Standard Deviations in Parentheses)

Basic Characteristics	Adopters	Non Adopters	Test of Equality (p-value)
Literate (yes = 1)	0.65	0.56	0.23
	(0.48)	(0.50)	
Numerate (yes = 1)	0.81	0.81	0.98
	(0.39)	(0.39)	
Number of Tools	4.21	4.25	0.90
	(2.79)	(2.30)	
Number of adults in the household	2.19	2.18	0.94
	(0.90)	(0.70)	
Months of food security	9.18	8.93	0.28
	(1.69)	(1.50)	
Number of crops cultivated (not including sunflower)	6.92	6.86	0.86
	(2.29)	(2.17)	
Cultivating cashew (yes = 1)	0.59	0.55	0.61
	(0.49)	(0.50)	
Participated in NGO projects in the past	0.22	0.11	0.06
	(0.41)	(0.32)	
Female headed households	0.22	0.09	0.01
	(0.41)	(0.29)	
Age of household Head	41.9	39.2	0.15
	(12.5)	(13.3)	
Migrated to village (yes = 1)	0.12	0.19	0.17
	(0.32)	(0.39)	
Oil consumption (days per month)	7.27	7.97	0.62
	(0.98)	(1.02)	
Asset Poverty (proportion in each group)			
Very Poor	23.5	20.8	
Poor	49.0	50.0	
Not poor	27.5	29.2	
Religion (proportion in each group)			
Catholic	43.1	54.2	
Protestant	38.2	30.2	
Other	3.9	5.2	
Not religious	14.7	10.4	

Notes. For all tests of means or proportions, the null hypothesis is that the proportion/means are equal, against a two-sided alternative. Village leaders and contact farmers are not included. The number of tools is the sum of hoes, machetes, axes, spades, forks, saws and scythes owned. Adults are defined to be those aged 14 or older. Months of food security measures the number of months per year the household has stocks of food available for consumption. There are 35 female headed households in the sample. Migrated to village refers to households which moved to the village during the civil war during 1982–92. Asset poverty is a relative poverty measure.

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Table 5

Baseline Regressions

(a) *Social Networks and Adoption*
Dependent variable = 1 if household head adopts sunflower, 0 otherwise
Linear regression estimates
Robust standard errors reported in parentheses

	(1)	(2)	(3)	(4)
Number of adopters among family and friends	0.026***	0.024***		0.101***
	(0.007)	(0.007)		(0.018)
Number of adopters among family and friends, Squared				−0.005***
				(0.001)
1–5 Adopters among family and friends			0.271***	
			(0.075)	
6–10 Adopters among family and friends			0.577***	
			(0.092)	
10+ Adopters among family and friends			0.300**	
			(0.126)	
Marginal effect, evaluated at the mean				0.054***
				(0.009)
Implied maximum				10.57
Test 1: p-value on 1–5 = 6–10			0.001	
Test 2: p-value on 6–10 = 10+			0.031	
Test 3: p-value on 1–5 = 10+			0.815	
Individual Controls	No	Yes	Yes	Yes
Village fixed effects	Yes	Yes	Yes	Yes
Observations	198	198	198	198
R-squared	0.10	0.27	0.34	0.34

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(*b*) *Individual Determinants of Adoption*
Dependent Variable = 1 if household head adopts sunflower, 0 otherwise
Linear regression estimates
Robust standard errors reported in parentheses

	(2)	(3)	(4)
Literate (yes = 1)	0.264***	0.199**	0.207***
	(0.080)	(0.078)	(0.077)
Number of adults in the household	0.040	0.028	0.033
	(0.050)	(0.052)	(0.052)
Months of food security	0.071**	0.083***	0.077***
	(0.027)	(0.027)	(0.027)
Asset poverty (very poor)	−0.026	−0.052	−0.057
	(0.118)	(0.123)	(0.120)
Asset poverty (poor)	−0.011	−0.066	−0.047
	(0.089)	(0.084)	(0.085)
Cultivates cashew	0.014	0.014	0.004
	(0.083)	(0.080)	(0.079)
Participated in NGO projects in the past	0.283**	0.336***	0.333***
	(0.127)	(0.114)	(0.114)
Female headed household	0.357***	0.309***	0.324***
	(0.105)	(0.109)	(0.109)
Age	0.033**	0.034**	0.034**
	(0.017)	(0.016)	(0.015)
Age squared × 10^{-2}	−0.029	−0.032*	−0.032*
	(0.018)	(0.017)	(0.017)
Migrant (yes = 1)	−0.146	−0.178*	−0.164*
	(0.097)	(0.095)	(0.095)
Protestant	0.124	0.122	0.126*
	(0.076)	(0.074)	(0.071)
Other religion	−0.014	−0.109	−0.039
	(0.137)	(0.140)	(0.137)
Non Religious	0.217*	0.250**	0.266**
	(0.129)	(0.115)	(0.116)
Network controls	Linear	Spline	Linear, Quadratic
Village fixed effects	Yes	Yes	Yes
Observations	198	198	198
R-squared	0.27	0.34	0.34

Notes. *** denotes significance at 1%, ** at 5%, and * at 10%. Village elders and contact farmers are not included in the sample. Individual controls are literacy, the number of adults in the household, months of food security, relative asset poverty, whether cashew is cultivated, whether past NGO projects have been participated in, gender, age, age squared, migrant status and religion. Omitted categories are Catholic, and not poor.

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Table 6

Heterogeneity

Dependent Variable = 1 if household head adopts sunflower, 0 otherwise
Linear regression estimates
Robust standard errors reported in parentheses

	(1) Cashew Cultivation	(2) Past Participation in NGO Projects	(3) Migration status	(4) Poverty
Uninformed × Number of adopters among family and friends	0.114***	0.099***	0.218***	0.114***
	(0.028)	(0.020)	(0.047)	(0.021)
Uninformed × Number of adopters among family and friends, squared	−0.005**	−0.004***	−0.015***	−0.005***
	(0.002)	(0.001)	(0.003)	(0.001)
Informed × Number of adopters among family and friends	0.088***	0.120***	0.099***	0.092***
	(0.025)	(0.041)	(0.018)	(0.032)
Informed × Number of adopters among family and friends, squared	−0.004***	−0.007***	−0.004***	−0.006***
	(0.001)	(0.002)	(0.001)	(0.002)
Marginal Effect for UNINFORMED, evaluated at the mean	0.076***	0.057***	0.091***	0.072***
	(0.016)	(0.010)	(0.022)	(0.013)
Marginal Effect for INFORMED, evaluated at the mean	0.039***	0.052**	0.053***	0.025**
	(0.011)	(0.024)	(0.009)	(0.014)
Implied Maximum for UNINFORMED	11.21	11.67	7.14	120.4
Implied Maximum for INFORMED	10.36	8.23	11.01	7.98
Individual Controls	Yes	Yes	Yes	Yes
Village Fixed Effects	Yes	Yes	Yes	Yes
Observations	198	198	198	198
R-squared	0.35	0.36	0.37	0.38

Notes. *** denotes significance at 1%, ** at 5%, and * at 10%. Robust standard errors are calculated throughout. Village elders and contact farmers are not included in the sample. Individual controls are literacy, the number of adults in the household, months of food security, relative asset poverty, whether cashew is cultivated, whether past NGO projects have been participated in, gender, age, age squared, migrant status and religion. The omitted categories are Catholic and not poor. Along the first three dimensions, informed households cultivate cashew, have participated in NGO projects in the past, or are permanent residents of the village. In terms of poverty status, informed farmers are defined to be those that are not poor, uninformed farmers are either poor or very poor.

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Table 7

Cohort-level Networks

Dependent Variable = 1 if household head adopts sunflower, 0 otherwise Linear regression estimates Robust standard errors reported in parentheses	(1)	(2)	(3)
Number of adopters among family and friends		0.097***	0.021***
		(0.019)	(0.007)
Number of adopters among family and friends, squared		−0.005***	
		(0.001)	
Number of adopters in the *same* religion	0.016***	0.014***	0.002**
	(0.005)	(0.005)	(0.001)
Number of Adopters in the *same* religion, squared × 10^{-2}	−0.010***	−0.009***	
	(0.003)	(0.003)	
Number of Adopters in *other* religion			0.001
			(0.001)
Marginal effect - Same religion network	0.015***	0.013***	
	(0.004)	(0.009)	
Marginal effect – family and friends network		0.052***	
		(0.010)	
Test 1: p-value on Same religion = Other religion			0.016
Individual controls	Yes	Yes	Yes
Village fixed effects	Yes	Yes	No
Observations	184	184	184
R-squared	0.24	0.35	0.21

Notes. *** denotes significance at 1%, ** at 5%, and * at 10%. Robust standard errors are calculated throughout. Both marginal effects are evaluated at the mean number of adopters among family and friends (4.91). Village elders and contact farmers are not included in the sample. Individual controls are literacy, the number of adults in the household, months of food security, relative asset poverty, whether cashew is cultivated, whether past NGO projects have been participated in, gender, age, age squared, migrant status and religion. The omitted categories are Catholic and not poor. The number of adopters in the same cohort is computed by multiplying the sample share in the village by the village population and it does not include the farmer if he has himself adopted. The number of observations is less than in the previous specifications because in some villages all farmers of the same religion make the same adoption choice.

Effect of social network on technology adoption

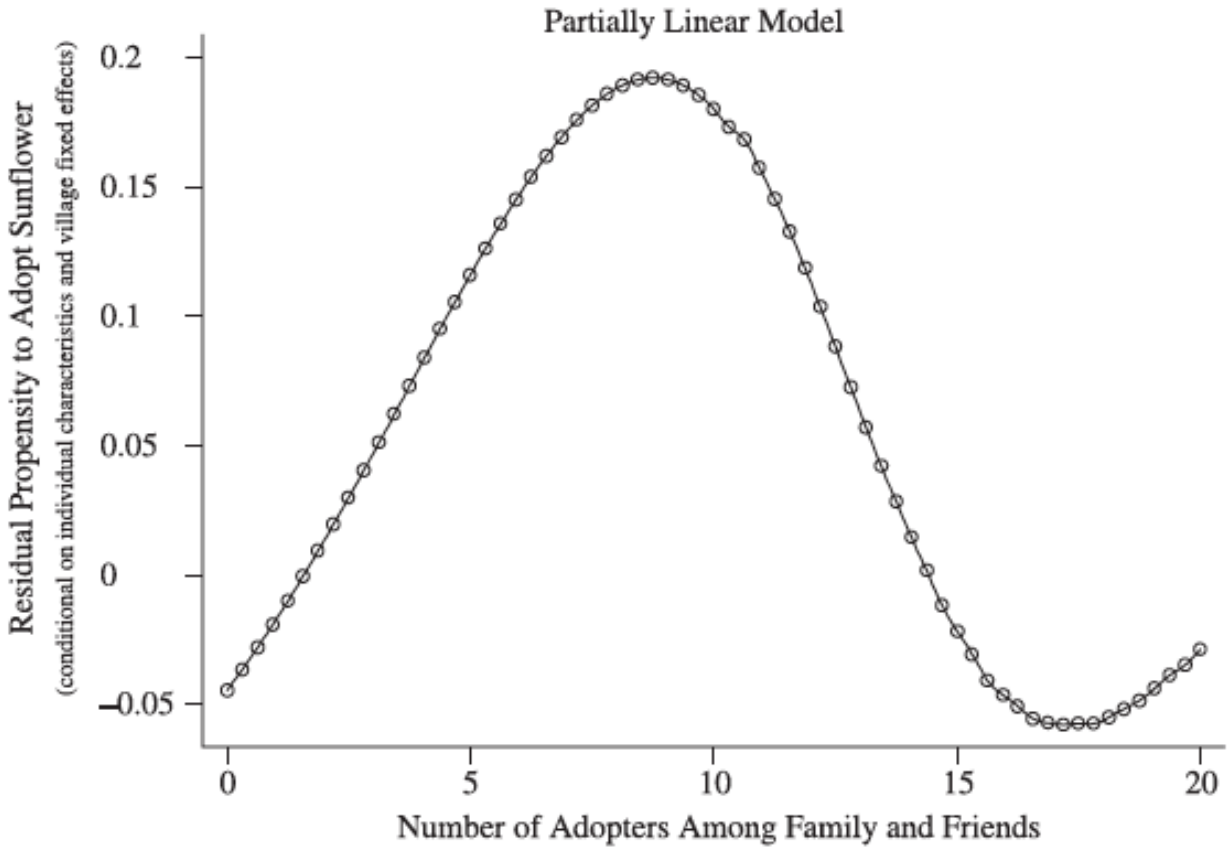


Fig. 1. *Non Parametric Estimate: Number of Adopters and the Propensity to Adopt*
Notes: A Gaussian kernel function is used a bandwidth of 3, and 65 grid points. Individual controls are literacy, the number of adults in the household, months of food security, relative asset poverty, whether cashew is cultivated, whether past NGO projects have been participated in, gender, age, age squared, migrant status and religion. Village elders and contact farmers are not included in the sample.

Effect of social network on technology adoption

Table A1

Robustness Checks

Dependent Variable = 1 if household head adopts sunflower, 0 otherwise
Linear regression estimates
Robust standard errors reported in parentheses

	(1) Reclassify Adopters	(2) Numerate Farmers Only	(3) Know At Least One Adopter Among Friends and Family	(4) Clustering at Village Level
Number of adopters among family and friends	0.098***	0.106***	0.091***	0.101***
	(0.019)	(0.033)	(0.020)	(0.012)
Number of Adopters among Family and Friends, Squared	−0.004***	−0.005***	−0.004***	−0.005***
	(0.001)	(0.002)	(0.001)	(0.001)
Marginal effect, evaluated at the mean	0.055***	0.049***	0.057**	0.054***
	(0.009)	(0.010)	(0.018)	(0.009)
Implied Maximum	11.14	11.55	10.76	10.57
Village Fixed Effects	Yes	Yes	Yes	Yes
Observations	198	161	143	198
R-squared	0.31	0.34	0.31	0.34

Notes: *** denotes significance at 1%, ** at 5%, and * at 10%. Village elders and contact farmers are not included in the sample. Individual controls are literacy, the number of adults in the household, months of food security, relative asset poverty, whether cashew is cultivated, whether past NGO projects have been participated in, gender, age, age squared, migrant status and religion. Omitted categories are Catholic, and not poor. In column 1 farmers that produced in the bottom 10% of the distribution of production of sunflower seeds at the end of the first year of the project are reclassified as non adopters. Column 2 drops innumerate farmers. Column 3 drops farmers that know no other adopters among family and friends. In column 4 standard errors are clustered at the village level.

Competition and Innovation

Summary

- Inverted-U relationship between competition and innovation
- Model: Escape-competition effect - increasing profit from innovation
- Model: Schumpeterian effect - reduction in innovation incentives for laggards
- Degree of technological neck-and-neckness should decrease with higher product market competition
- Higher degree of heck-and-neckness should imply a steeper inverted-U relationship

Competition and Innovation

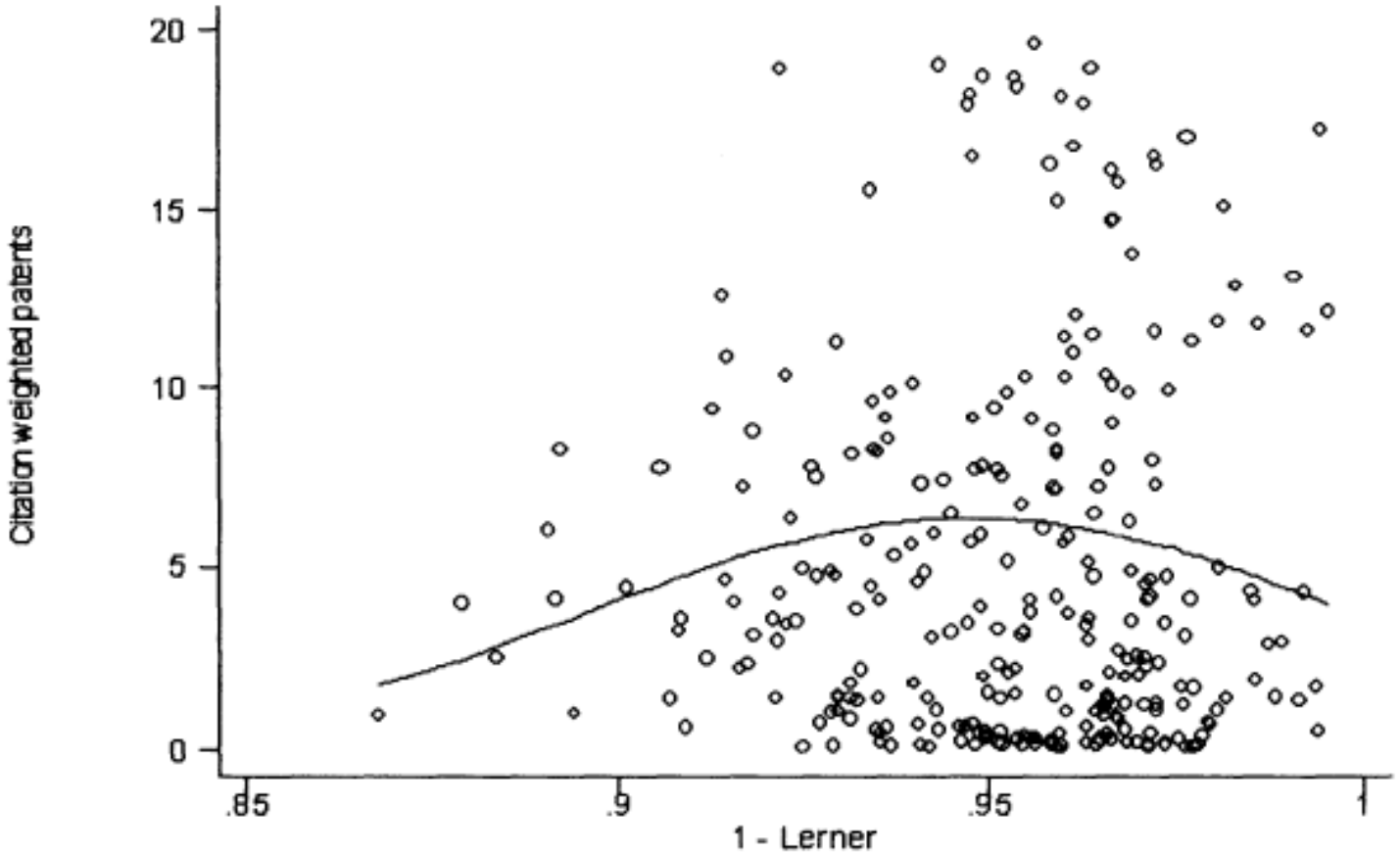


FIGURE I

Scatter Plot of Innovation on Competition

The figure plots a measure of competition on the x-axis against citation-weighted patents on the y-axis. Each point represents an industry-year. The scatter shows all data points that lie in between the tenth and ninetieth deciles in the citation-weighted patents distribution. The exponential quadratic curve that is overlaid is reported in column (2) of Table I.

Competition and Innovation

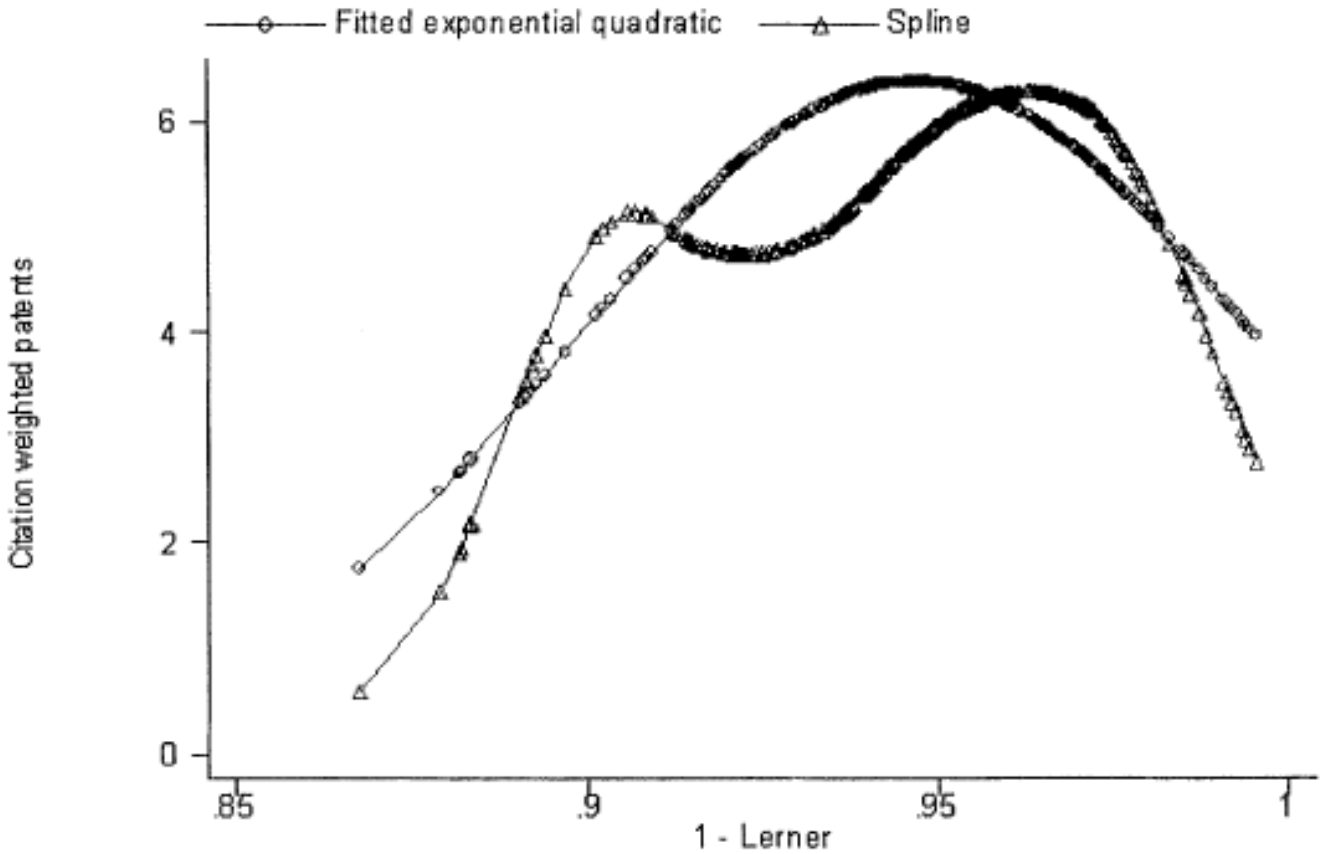


FIGURE II

Innovation and Competition: Exponential Quadratic and the Semiparametric Specifications with Year and Industry Effects

The figure plots a measure of competition on the x-axis against citation-weighted patents on the y-axis. Each point represents an industry-year. The circles show the exponential quadratic curve that is reported in column (2) of Table I. The triangles show a nonparametric spline.

Competition and Innovation

TABLE I
EXPONENTIAL QUADRATIC: BASIC SPECIFICATION

Dependent variable: citation-weighted patents	(1)	(2)	(3)	(4)
Data frequency	Annual	Annual	5-year averages	Annual
Competition_{jt}	152.80	387.46	819.44	385.13
	(55.74)	(67.74)	(265.63)	(67.56)
$\text{Competition squared}_{jt}$	−80.99	−204.55	−434.43	−204.83
	(29.61)	(36.17)	(141.43)	(36.06)
Significance of: Competition_{jt},	7.60	38.34	9.97	32.59
$\text{Competition squared}_{jt}$	(0.02)	(0.00)	(0.01)	(0.00)
Significance of policy instruments in reduced form				10.11
				(0.002)
Significance of other instruments in reduced form				5.00
				(0.000)
Control functions in regression				4.38
				(4.04)
R^2 of reduced form				0.801
Year effects	Yes	Yes	Yes	Yes
Industry effects		Yes	Yes	Yes
Observations	354	354	67	354

Competition_{jt} is measured by (1-Lerner index) in the industry-year. All columns are estimated using an unbalanced panel of seventeen industries over the period 1973 to 1994. Estimates are from a Poisson regression. Numbers in brackets are standard errors. The standard errors in column (4) have not been corrected for the inclusion of the control function. Significance tests show likelihood ratio test-statistics and P-value from the F-test of joint significance. The fourth column includes a control function. The excluded variables are policy instruments specified in Table II, imports over value-added in the same industry-year, TFP in the same industry-year, output minus variable costs over output in the same industry-year and estimates of markups from industry-country regression [Martins et al. 1996] interacted with time trend, all for the United States and France.

Competition and Innovation

TABLE II
POLICY INSTRUMENTS

Industry	Year(s)	Policy
All, but differential impacts	1988	Single Market Program
Brewing	1986	MMC action
Cars	1984, 1987, 1988	MMC action, Privatization
Car parts	1982, 1987	MMC action, Privatization
Periodicals	1987	MMC action
Razors and blades	1990	MMC action
Ordnance	1987	Privatization
Steel	1987	Privatization
Telecoms	1981, 1984, 1989	MMC action, Privatization
Textiles	1989	MMC action

Competition and Innovation

TABLE III

TECHNOLOGY GAP AND EXPONENTIAL QUADRATIC WITH NECK-AND-NECK SPLIT

Dependent variable:	(1) Technology gap	(2) Technology gap	(3) Citation-weighted patents	(4) Citation-weighted patents
Estimation procedure	Linear regression	Linear regression	Poisson	Poisson
Competition_{jt}	2.858	0.942	183.81	424.46
	(0.400)	(0.419)	(58.99)	(69.5)
$\text{Competition squared}_{jt}$			−96.35	−222.9
			(31.01)	(36.9)
$\text{Competition}_{jt} * \text{Technology gap}_{jt}$			1.43	3.82
			(2.48)	(2.66)
$\text{Competition squared}_{jt} * \text{Technology gap}_{jt}$			−1.30	−3.84
			(2.59)	(2.78)
Significance of:				
Competition_{jt},			16.59	39.21
$\text{Competition squared}_{jt}$			(0.00)	(0.00)
Significance of:				
$\text{Competition}_{jt} * \text{Technology gap}_{jt}$,			9.74	7.93
$\text{Competition squared}_{jt} * \text{Technology gap}_{jt}$			(0.01)	(0.02)
Year effects	Yes	Yes	Yes	Yes
Industry effects		Yes		Yes

Competition_{jt} is measured by (1-Lerner index) in the industry-year. $\text{Technology gap}_{jt}$ is measured by the average distance to the TFP frontier firm across all firms in the industry-year, so it is an inverse measure of neck-and-neckness. All columns estimated using an unbalanced panel of 354 yearly observations on seventeen industries over the period 1973 to 1994. Significance tests show likelihood ratio test-statistics and P-value from the F-test of joint significance. Numbers in brackets are standard errors. The standard errors in columns 3 and 4 have not been corrected for the inclusion of the control function.

Competition and Innovation

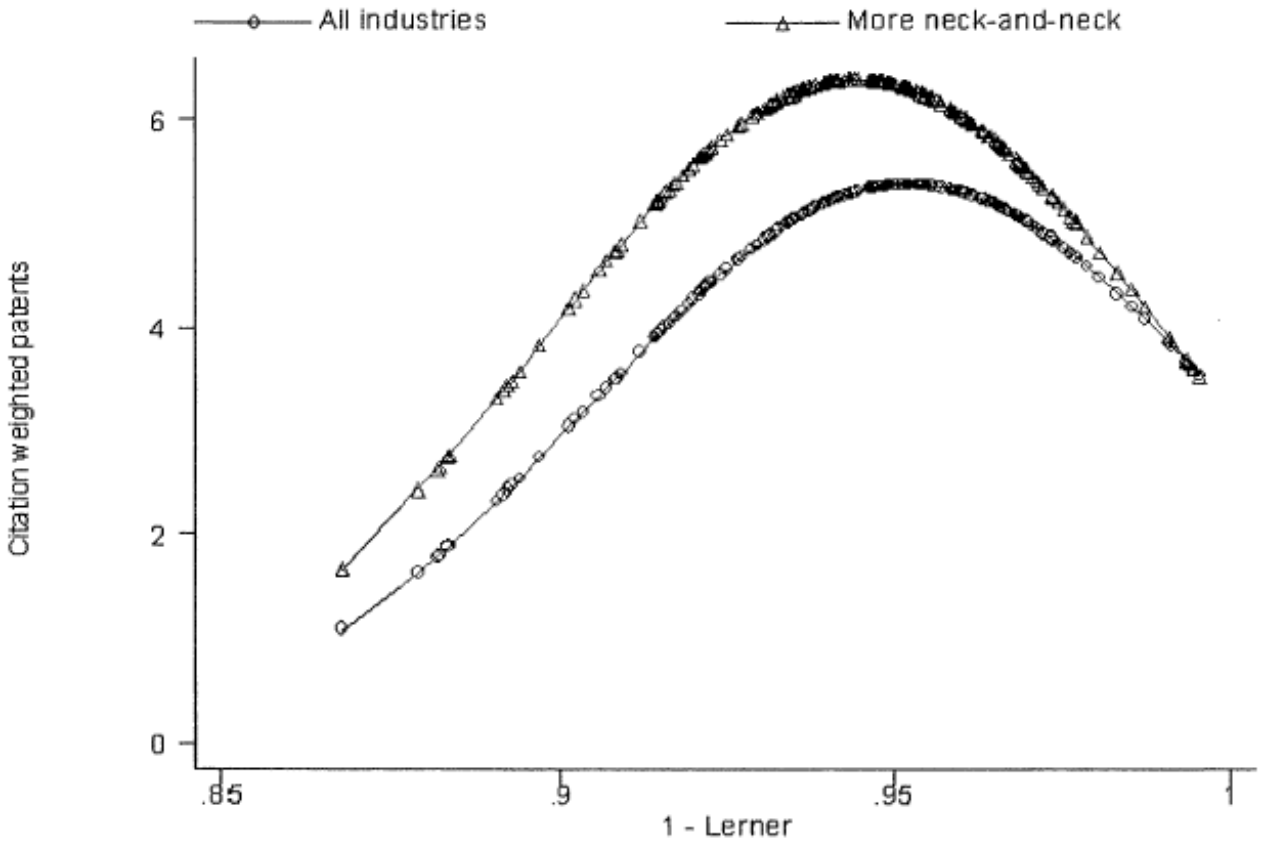


FIGURE III

Innovation and Competition: The Neck-and-Neck Split

The figure plots a measure of competition on the x-axis against citation-weighted patents on the y-axis. Each point represents an industry-year. The circles show the exponential quadratic curve that is reported in column (2) of Table I. The triangles show the exponential quadratic curve estimated only on neck-and-neck industries that is reported in column (4) of Table III.

Competition and Innovation

TABLE IV
DESCRIPTIVE STATISTICS

	Mean (s.d.)	Median	Min	Max
Patents	6.59 (8.52)	3.5	0	54
Cite weighted patents	6.65 (8.43)	3.35	0	45
1-Lerner	0.95 (0.023)	0.95	0.87	0.99
Technology gap (m)	0.49 (0.155)	0.51	0.080	0.81

The sample is an unbalanced panel of 354 yearly observations on seventeen industries over the period 1973 to 1994.

Markets for Technology

Summary

- Technology Users: Markets for Technology allow for licensing in addition to internal exploitation
- Tradeoff: Profit dissipation effect vs. Revenue effect - distant market, lower licensor share, highly competitive downstream market
- Imporved internal management and organization of company intellectual property
- Small firms and Technology startups: Increase effectiveness based on specialization
- Lack of complementary assets does not require them to incur costly and risky downstream investments
- Technology Buyers: Increase in penalty of the not invented here syndrome, reduce relative importance of technology as source of distinct advantage
- Firms may increase in downstream differntiation

Markets for Technology

TABLE 1. A Simple Typology of Markets for Technology

	Existing technology	Future technology or component for future
Horizontal market/transactions with actual or potential rivals	Union Carbide licensing Unipol polyethylene technology to Huntsman Chemicals	Sun licensing Java to IBM; R&D joint ventures or other technological alliances between rivals
Vertical market/licensing to non-rivals	Licensing of IP core in semiconductors	R&D joint ventures or other technological alliances; Affymax licensing combinatorial drug discovery technology to pharmaceutical companies

Markets for Technology

TABLE 2. The Market for Technology: Number and Value (millions of 1995 dollars) of Technology Transactions 1985–1997 by Sector

	1985–1989	1990	1991	1992	1993	1994	1995	1996	1997	Total no. (total value)
SIC28	439	310	461	395	486	596	351	208	222	3496
	(5809)	(4102)	(6101)	(5227)	(6431)	(7887)	(4645)	(2753)	(2938)	(46 264)
SIC35	129	115	210	188	195	192	164	63	69	1360
	(6280)	(5599)	(10 224)	(9153)	(9493)	(9347)	(7984)	(3067)	(3359)	(66 211)
SIC36	234	190	310	316	366	415	326	135	151	2479
	(10 971)	(8908)	(14 534)	(14 816)	(17 160)	(19 457)	(15 284)	(6329)	(7080)	(116 227)
SIC73	143	207	360	334	363	610	770	405	424	3689
	(1740)	(2518)	(4380)	(4063)	(4416)	(7421)	(9368)	(4927)	(5158)	(44 881)
SIC87	11	9	45	253	156	73	34	22	17	707
	(171)	(140)	(701)	(3939)	(2429)	(1137)	(529)	(343)	(265)	(11 009)
All others	174	209	468	523	560	540	545	289	293	3858
	(2781)	(2901)	(5471)	(6373)	(6549)	(6354)	(6658)	(3342)	(3156)	(48 240)
Total	1130	1040	1854	2009	2126	2426	2190	1122	1176	15 073
	(27 753)	(24 169)	(41 410)	(43 571)	(46 479)	(51 604)	(44 469)	(20 761)	(21 956)	(332 831)

SIC28, chemicals; SIC35, industrial machinery and equipment; SIC36, electronic and other electric equipment; SIC73, business services; SIC87, engineering and management services. Value of transactions in millions of 1995 dollars.

Source: Computations based on SDC database. For more details see Arora *et al.* (2001a).

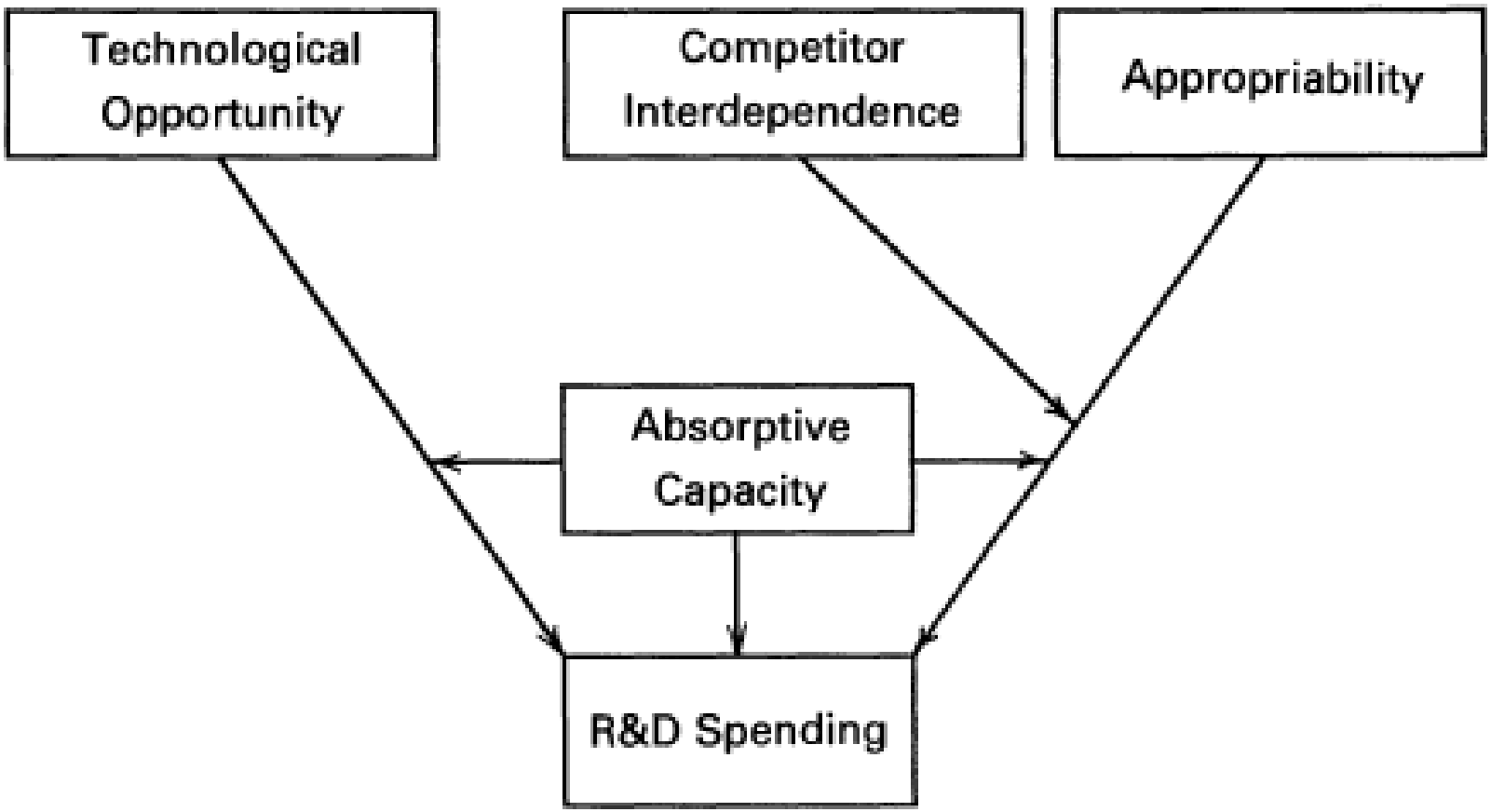
Absorptive Capacity

Summary

- R&D creates capacity to assimilate and exploit new knowledge
- Firms may conduct basic research less for particular results, but for building absorptive capacity
- Ease of learning affected by degree to which an innovation is related to pre-existing knowledge base
- Explanation for cooperative research ventures

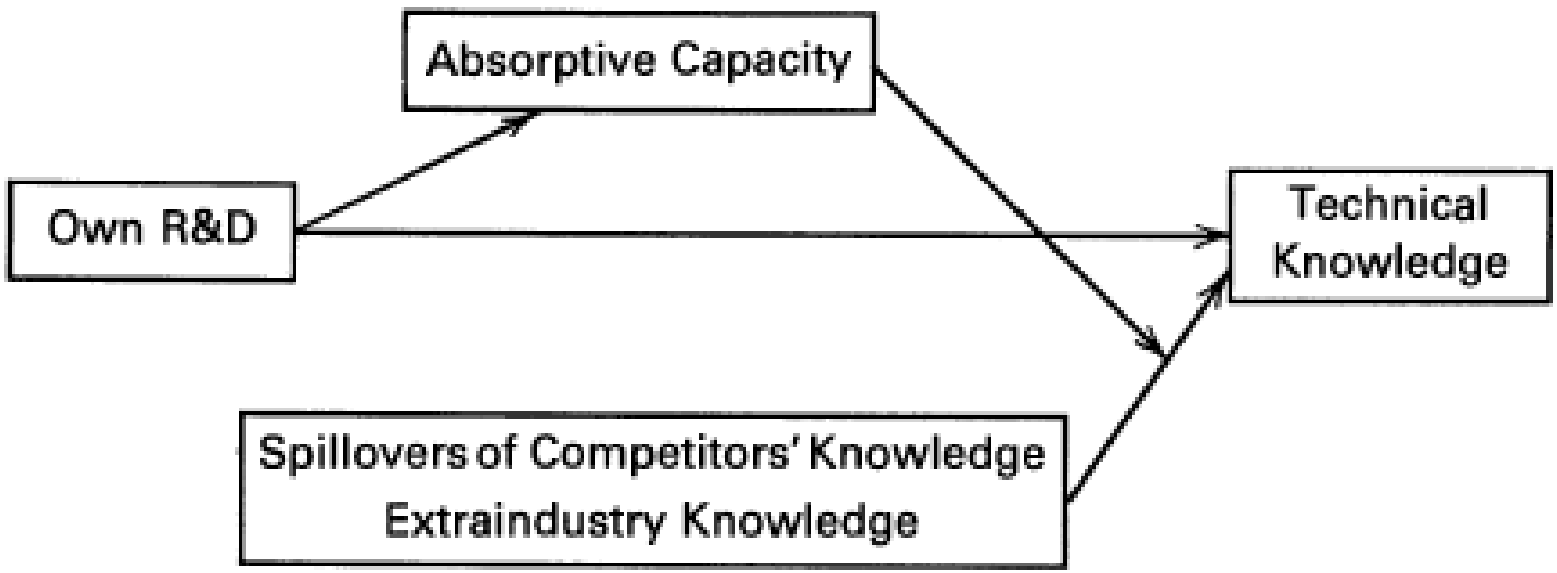
Absorptive Capacity

Figure 1. Model of absorptive capacity and R&D incentives.



Absorptive Capacity

Figure 2. Model of sources of a firm's technical knowledge.



Absorptive Capacity

Table 1

Analysis of R&D Intensity*

Variable	Regression Coefficient OLS (N = 1302)	GLS (N = 1302)	Tobit (N = 1719)
Intercept	−5.184••	−2.355•	−4.086••
	(1.522)	(1.037)	(1.461)
APPROPRIABILITY × C4	.213	.342••	.368••
	(.128)	(.103)	(.130)
APPROPRIABILITY × PELAS	−.192	−.200•	−.176
	(.106)	(.091)	(.103)
APPROPRIABILITY × DUMAPP	.448•	.248	.211
	(.202)	(.143)	(.194)
APPROPRIABILITY × DUMBAS	.302	.174	.094
	(.208)	(.144)	(.206)
USERTECH	.470••	.397••	.612••
	(.104)	(.069)	(.107)
UNIVTECH	.374••	.318••	.395••
	(.131)	(.091)	(.147)
GOVTECH	.221•	.069	.137
	(.106)	(.079)	(.107)
MATERIALTECH	−.258••	−.074	−.303••
	(.098)	(.070)	(.100)
EQUIPTECH	−.401••	−.484••	−.574••
	(.111)	(.077)	(.117)
Biology	.314••	.185••	.276•
	(.102)	(.071)	(.114)
Chemistry	.289••	.081	.191•
	(.084)	(.062)	(.088)
Math	.184	.151	.123
	(.131)	(.097)	(.143)
Physics	.373••	.323••	.310•
	(.117)	(.091)	(.128)
Agricultural Science	−.441••	−.273••	−.308••
	(.088)	(.064)	(.099)
Applied Math/Operations Research	−.237	−.117	−.366•
	(.148)	(.102)	(.152)
Computer Science	.294•	.116	.433••
	(.124)	(.090)	(.122)
Geology	−.363••	−.240••	−.365••
	(.084)	(.061)	(.097)
Materials Science	−.110	−.150	.116
	(.125)	(.095)	(.118)
Medical Science	−.179	−.133	−.133
	(.093)	(.070)	(.103)
Metallurgy	−.315••	−.195••	−.393••
	(.077)	(.053)	(.089)
NEWPLANT	.057••	.049••	.045••
	(.008)	(.006)	(.007)
PELAS	.936	1.082•	.892
	(.611)	(.527)	(.573)
INCELAS	1.077••	.587••	1.112••
	(.170)	(.131)	(.188)
DGROWTH	.068	−.074	.004
	(.090)	(.053)	(.105)
R^2	.287		

• $p < .05$; •• $p < .01$.
* Reproduced from Cohen and Levinthal (1989a: 590–591, 569–596). Standard errors are in parentheses.

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