The Acquisition and Commercialization of Invention in the American Economy: Incidence and Impact

A. Arora, W. Cohen and
J. Walsh

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Contours of the "Division of Innovative Labor" (DoIL)

- *Rate of innovation in U.S. mfg sector*
- Extent to which innovating firms acquire inventions from external sources, what the sources are, and how inventions are acquired.
  - Note invention/innovation distinction
- *Impact of external sourcing on innovative performance*
- *Relationship with patenting*

Data

- Sample
  - > 22,000 firms from mfg and selected service sector inds.
  - 6685 responses (30.3% response rate)
- Focus
  - Manufacturing sector: 5,157 in sample.
  - New-to-the-market (**NTM**) innovators: companies that introduced a new or significantly improved product to their market before anyone else.
  - Companies respond wrt their "most important innovation"--That innovation intro'd since 2007 yielding plurality of 2009 business unit sales.
- Summary statistics
  - Correspond well with other data sources in U.S. and Europe
  - Adjusted for nonresponse and sampling strategy

Who innovates?

Table 2. Rates of innovation, imitation and patenting, and % sales for U.S. mfg. industries

INDUSTRY (Number of respondents)	% NTF **a**	% NTM **b**	Imitation **a-b**	% sales from NTF	% sales from focal innovation	% NTM patented
Food/Bev (362)	40%	15%	25%	26%	17%	25%
Textiles (210)	38%	18%	20%	20%	14%	54%
Wood (385)	33%	10%	23%	21%	20%	14%
Chemicals (365)	50%	27%	23%	23%	15%	46%
Pharma (128)	63%	36%	27%	33%	30%	59%
Plastics (340)	48%	22%	26%	24%	19%	48%
Minerals (323)	31%	11%	20%	23%	15%	34%
Metals (324)	38%	10%	28%	19%	9%	29%
Fab Metals (424)	39%	12%	26%	28%	15%	36%
Machinery (384)	46%	23%	23%	27%	19%	50%
Electronics (146)	76%	38%	39%	39%	25%	58%
Semicond (302)	61%	33%	28%	35%	25%	60%
Instruments (135)	60%	44%	16%	28%	24%	52%
Elec Equip (344)	54%	30%	25%	37%	28%	56%
Auto (339)	53%	30%	23%	35%	26%	33%
Med Equip (136)	56%	22%	34%	34%	27%	72%
Misc. (510)	48%	21%	26%	24%	19%	45%
All manuf. (5157)	**43%**	**18%**	**25%**	**27%**	**20%**	**42%**

Overall patterns

- (NTM) innovation rate for manufacturing: **18%**
- 25% imitate
  - While innovation rate varies across industries, imitation more stable
- **42% of NTM innovators patented their most significant product innovation**
  - **First estimate of product patent propensity (% of innovations patented) for U.S. mfg sector as a whole.**

Where do the inventions come from?

SOURCES of (NTM) INNOVATION

- ***Did any of the following originate this innovation, that is, create the overall design, develop the prototype or conceptualize the technology?*** **[Responses not mutually exclusive]**
  - **"SDR" would suggest a conservative bias.**

Manufacturing	
Supplier	13%
Customer	**26%**
Other Firm in industry	8%
Consultant/Comm. Lab/Service provider	8%
Independent inventor	8%
University/Govt Lab	5%
Any external source	**49%**

Technology specialists: **18%**

Sources of innovation (wtd. means)

	N	Any External	Supp.	Cust.	Other firm	Consult./ service provider	Ind. Inventor	Univ.	Special-ist
Food/Beverage	73	0.46	0.33	0.16	0.07	0.01	0.08	0.00	0.08
Textiles	38	0.45	0.30	0.23	0.03	0.03	0.05	0.00	0.08
Wood	60	0.55	0.18	0.34	0.09	0.11	0.01	0.01	0.13
Chemicals	115	0.49	0.15	0.14	0.04	0.13	0.06	0.04	0.20
Pharmaceuticals	39	0.45	0.05	0.07	0.14	0.04	0.04	0.17	0.26
Plastics	95	0.59	0.15	0.29	0.04	0.13	0.15	0.04	0.28
Minerals	44	0.38	0.05	0.18	0.03	0.06	0.09	0.08	0.21
Metals	52	0.48	0.26	0.29	0.11	0.09	0.04	0.07	0.12
Fab'd Metals	71	0.43	0.08	0.31	0.05	0.00	0.05	0.05	0.10
Machinery	111	0.46	0.08	0.34	0.09	0.11	0.07	0.06	0.19
Electronics	58	0.46	0.13	0.15	0.12	0.07	0.05	0.09	0.17
Semiconductors	108	0.58	0.14	0.43	0.10	0.13	0.11	0.10	0.26
Instruments	62	0.47	0.04	0.26	0.09	0.09	0.07	0.02	0.16
Electical Equip.	111	0.44	0.10	0.24	0.05	0.07	0.07	0.05	0.18
Automotive	110	0.52	0.11	0.29	0.12	0.05	0.16	0.14	0.24
Misc.	120	0.50	0.08	0.22	0.15	0.11	0.13	0.02	0.22
Medical Equip.	40	0.49	0.17	0.23	0.05	0.13	0.09	0.15	0.32
All MFG.	**1307**	**0.49**	**0.13**	**0.26**	**0.08**	**0.08**	**0.08**	**0.05**	**0.18**

Observations on sources

- **Dependence on external sources is high and stable across industries and firm-size classes**
  - **49% of innovators claim that an outside source created, developed or conceptualized the technology for their innovation**
- Customers (26%) most pervasive source and technology specialists second (18%).
- But a detailed comparison indicates the value of inventions sourced from technology specialists is highest, and those from customers lowest.
- **Startups** reported to be source of invention for **14%** of respondents, suggesting their disproportionate role in the DoIL.

Patent rates for externally acquired innovations, by innovating firms and by source

	Any external	Supplier	Cust.	Other firm in industry	Consult/ Contractor	Indep. Inventor	University	Technology specialist
Share patented by respondent	0.40	0.33	0.32	0.39	0.61	0.69	0.67	0.64
Share patented by source	0.26	0.35	0.16	0.27	0.33	0.52	0.40	0.40

- High-value innovations sourced from technology specialists are disproportionately patented by the innovating firm and/or the source
  - 25% patent overlap (driven by univs. and indeps.) suggests acquired patented inventions often further developed by the innovator.

CHANNELS:

Results for those who acquire their inventions from outside the firm

Channels for acquiring innovation (wtd.)

	N	M&A	JV/Coop	License	Service Contract	Informal	Market*	Market only*
Food/Beverage	29	0.10	0.76	0.15	0.18	0.14	0.28	0.15
Textiles	10	0.07	0.76	0.20	0.17	0.09	0.34	0.16
Wood	27	0.10	0.50	0.11	0.36	0.39	0.47	0.12
Chemicals	42	0.07	0.68	0.05	0.38	0.33	0.47	0.18
Pharmaceuticals	15	0.43	0.35	0.58	0.07	0.19	0.80	0.47
Plastics	44	0.16	0.68	0.10	0.20	0.30	0.35	0.13
Minerals	15	0.13	0.69	0.12	0.11	0.56	0.36	0.17
Metals	18	0.17	0.65	0.05	0.15	0.42	0.37	0.16
Fabricated Metals	24	0.01	0.60	0.09	0.05	0.68	0.14	0.01
Machinery	37	0.11	0.53	0.07	0.16	0.41	0.33	0.22
Electronics	22	0.13	0.76	0.12	0.16	0.11	0.28	0.12
Semiconductors	44	0.16	0.61	0.16	0.31	0.39	0.42	0.19
Instruments	21	0.06	0.48	0.37	0.12	0.12	0.54	0.40
Electical Equipment	32	0.28	0.59	0.18	0.32	0.37	0.60	0.26
Auto	39	0.11	0.66	0.34	0.18	0.21	0.53	0.29
Miscellaneous	50	0.06	0.64	0.14	0.20	0.36	0.33	0.12
Medical Equipment	15	0.15	0.47	0.16	0.29	0.30	0.56	0.23
All	**484**	**0.10**	**0.61**	**0.14**	**0.20**	**0.36**	**0.37**	**0.16**

Channels for acquiring inventions

	N	M&A	Lic.	Serv Cont	JV/ Coop	Infor-mal	Mkt.	Mkt. only
All	484	0.10	0.14	0.20	0.61	0.37	0.37	0.16

- Market-based channels comprise just over a third of inventions acquired from outside sources.
- About two-thirds of exchanges rely on non-market channels, especially cooperative efforts.

  =>DoIL spans more than market transactions
- But in market transactions, patents important
  - Market channels of licenses and M&A are disproportionately (~60%) patented by the innovating firm and/or the source (~40% by both)
- Of the market-based transactions, 24% are with startup sources, and two-thirds of these inventions are patented.

Contribution of external supply of inventions to mfg sector innovation rate

- Our model predicts the % reduction in rate of innovation if all outside sources were made unavailable
- Rate would drop 43%; i.e., the % of firms that innovate would drop from current 18% to 10%
  - Circumspection warranted given strong assumptions
- But can confidently say that external sources do not only substitute for internal invention; they also affect overall rate of innovation, perhaps substantially.

Conclusions

- Results demonstrate firms' high reliance on external sources for their inventions.
- Underscore the idea that the economy's innovative performance is the outcome of a system of relationships—between firms of different types, and between firms and other institutions.
- Thus, policymakers would be well advised to consider policies that strengthen those relationships.
- Patents in particular may play an enabling role.
  - For example, while we make no causal claims, patents are clearly tied to market transactions, and to the high-value inventions originating from technology specialists and startups.

Thank you