E C O N O M I C S B U L L E T I N

SME Innovation in the Malaysian Manufacturing Sector

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Abstract

This paper examines the determinants of innovation amongst small and medium enterprises in the Malaysian manufacturing sector using firm-level data. For small-sized firms, younger firms are more likely to innovate compared to older firms. However, for medium-sized and large-sized firms, older firms are more likely to innovate. The extent of foreign ownership is not an important determinant of innovation. Small-sized firms with more employees are more likely to innovate. Medium-sized firms that produce for domestic market tend to be more innovative. In terms of ownership structure, medium-sized firms that are public limited companies are less likely to innovate. The relationship between technological characteristics of industry and firms' likelihood to innovate appear to be complex. Higher market concentration is associated with higher probability to innovate for medium-sized firms.

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1. Introduction

Small and Medium Enterprises (SMEs) have a significant presence in the Malaysian manufacturing sector. Around 90 percent of the total establishments in the manufacturing sector are SMEs[1]. These firms account for about 29 percent and 33 percent of the total output and employment in the manufacturing sector, respectively. Acknowledging the importance of SMEs to the manufacturing sector, the Malaysian government has made some effort to promote the development of SMEs in the sector. In the recent *Eighth Malaysia Pla*n (2001-2005) about 42 percent (or RM1.09 billion) of the development allocation for industrial development was allocated for SME development.

The government's emphasis has been on developing more resilient SMEs via the transformation from labor intensive operations to ones based on capital, knowledge and technology, including the ability to innovate, design and develop new products and processes[2]. Some of the government programs that have been implemented to bring about this transformation include the following:

- The Industrial Technical Assistance Fund (ITAF) to provide incentives for product and process improvement.
- The Technology Acquisition Fund.
- ICT Grants where a matching grant of up to RM500,000 per company was provided for purchase of hardware and the accompanying software.

Such emphasis on technology upgrading of SMEs is not unique to Malaysia. The role of SMEs in national innovation systems and the importance of technological change and innovation in creating opportunities for SMEs are explicitly recognized in the *Bologna Charter on SME Policies* (which was adopted on 15 June 2000). More specifically, the Bologna Charter calls for governments to consider implementing SME policies that will:

- improve SMEs' ability to manage innovation,
- reduce financial barriers to innovation in SMEs, and
- improve SMEs' access to national and global innovation networks.

Despite the importance of innovation in SMEs (or SME innovation, in short), there is relatively little empirical research on the subject, particularly in developing countries. The paper hopes to partially address this gap by analyzing the experience of Malaysia. This is made possible by the implementation of national innovation surveys in Malaysia the recent years.

This paper begins with a brief review of the existing literature on SME innovation in Section 2. This is followed by a general discussion of SME innovation in Malaysia in

[1] Figure based on 2001 census data and the official definition of SME. The official definition of SME is summarized and compared with selected definitions used by other countries and organizations in Appendix A.

[2] Quoted from the Eighth Malaysia Plan, p.262.

Section 3. In Section 4, we examine the determinants of SME innovation in a more rigorous fashion via firm-level econometric analysis. Section 5 concludes.

2. SME Innovation: A Brief Review of the Literature

This section briefly reviews some of the recent literature related to SME innovation. The literature on SME-related innovation is very diverse. Each paper tends to focus on different aspects of innovation, within the context of different sectors, and in specific countries. This is partly due to the significant variations in the nature of data that are used in the different studies.

Acs and Audretsch (1998) uses four-digit industry-level data to empirically examine innovation in small and large firms in the US. The innovation data in their study was constructed from innovations identified in technology, engineering and trade journals. The authors find that R&D is positively related to innovation and negatively related to market concentration. However, such innovation activities of small and large firms respond to different technological and economic environments.

Tether (1998) uses data on innovation from the United Kingdom that are based on information gathered from the Queen's Award applications. The author suggests that the value of innovation (impact of innovation on sales) should be an important measure of innovativeness. He finds that the value of innovation is higher for large firms compared to small firms.

Clarysse and van Dierdonck (1998) looks at the Flemish experience in the textile and chemical industries. They are particularly interested in the impact of innovation strategies. Overall, the authors find that innovative SMEs do not necessarily create more employment. However, the picture is more complex if innovation strategies are further classified in different categories e.g. 'Porterian' (market focus), Schumpeterian (creative-destructors) and resource-based (core competencies). For example, only Schumpeterian is related to employment creation.

Motohashi (2001) uses plant-level data from Japan to evaluate SME innovation policy in Japan. His analysis suggests that government policies have impact on new firms as well as on existing firms. In particular, participation in SME promotion schemes has positive impact on SMEs' sales growth rates. Due to the volatility of small firms, he also suggests that government policy should be targeted towards these firms.

Harris et al. (2003) investigates firm-level innovation using panel probit estimation based on the data taken from the Confidentialised Unit Record File for the Business Longitudinal Survey of Australian firms. The authors find that larger firms are more likely to innovate. Past profitability, export activity and whether firm is a "start-up" have no effect on the likelihood of innovation. They also show that inter-firm network and the presence of business planning have a positive effect on the likelihood of innovation.

Mole et al. (2001) examines barriers to the adoption and deployment of technology within electronic and engineering SMEs in the UK manufacturing sector. The authors find that competition is an important factor in prompting firms to adopt new technology.

They also find evidence that larger firms are more likely to adopt new technologies. In terms of sources of information for innovation – trade journal is an important source.

Romijin and Albu (2001) attempts to explain the innovativeness of small high-technology firms in the United Kingdom. They emphasize on the role external factors such as scientific institutions that can foster and nurture technology firms. Government innovation policy should thus focus on promoting linkages between SMEs and scientific institutions.

Masurel et al. (2003) takes an entirely different research route in SME innovation by studying that the perception of SME entrepreneurs on innovation. Entrepreneurs tend to believe that they themselves are the most critical factor for innovation. Other important factors include product advantages, marketing activities and pre-development – all which are within the control of firms and entrepreneurs.

Rouvinen (2002) studies the characteristics of product and process innovators among the Finnish manufacturing firms. He uses probit method to estimate process innovation equation and product innovation equation with the data of the Community Innovation Survey conducted by Statistics Finland. He finds that the ability to benefit from inward spillover has a symmetric effect on these two types of innovations. Cooperation with non-academic is significant in both equations, but cooperation with universities and non-profit research organizations is only significant in product innovation equation.

Rolfo and Calabrese (2003) examines evidence on the impact of Italian aid programs that are aimed at fostering technological innovation in SMEs. The overall finding on the impact of industrial policy on SME innovation appears to be a negative one. This is attributed to policy clashes with the capacity of SMEs to absorb innovation due to lack of technical structures (technical office, design department, R&D laboratory) and staff capable of interacting with research bodies.

3. SME Innovation in Malaysia: Some Recent Evidence from Survey Data

Information on SME innovation at the firm level in Malaysia is only available recently. The most important source of information is the *National Survey of Innovation* (NSI) carried out by the Ministry of Science, Technology and Innovation, Malaysia (MOSTI). This section reviews the state of innovation across different classes of firm size as observed in NSI.

MOSTI has been carrying out innovation surveys at the national-level in Malaysia on a bi-annual or tri-annual basis since the mid-1990s. The methodology for these surveys is based primarily on the approach adopted in the *Community Innovation Survey* (CIS) that have been conducted in Europe since the early 1990s. The first NSI survey (NSI-1) was conducted in 1995 (covering the period 1990-1994), the second (NSI-2) in 2000 (covering 1997-1999) and the latest (NSI-3) in 2002/2003 (covering the period 2000-2001). The definition of 'innovation' that is used in these surveys comes from the OECD's *Oslo Manual* as well as their variations in the CIS surveys. In these surveys, two types of innovation are identified, namely, product innovation and process innovation.

For the purpose of comparison with other countries, we adopt the EU definition of SMEs, namely:

- Small-sized firm is defined as a firm having less than 50 employees.
- Medium-sized firm is defined as a firm having at least 50 employees but less than 250 employees.
- Large-sized firm is defined as a firm having at least 250 employees.

Table 1 summarizes the number of innovating and non-innovating firms in the NSI-2 and NSI-3. **Horizontal Percentage** provides the percentages of innovating and non-innovating firms for each class of firms and total. **Vertical Percentage** describes, among the innovating firms, how many percentage of them belongs to each class of firms. We also supply similar information for non-innovating firms. Generally, we find the following patterns:

- The proportion of innovating small-sized firms is smaller than medium-sized firms.
- The proportion of innovating medium-sized firms is smaller than large-sized firms.

The above results hold despite differences in samples in both surveys; the NSI-3 has more small-sized firms in the sample compared to NSI-2.

[Insert Table 1 here]

Table 2 summarizes the number of innovating and non-innovating firms by industry. Clearly, the distribution of firms across different firm size and industries are fairly uneven. This is a function of both the survey response rates in each categories as well as firm size distribution across different industries.

[Insert Table 2 here]

There are significant differences in the pattern of innovation rates between firms in each class of firm size across different industries. This is shown in Figure I.

[Insert Figure I here]

4. Econometric Analysis of the Determinants of Innovation

4.1 *Data and Methodology*

In this section, we carry out empirical analysis using the NSI-3 data to find out whether there are differences between small, medium and large-sized firms. However, due to unavailability of some observations, only a subset of the NSI-3 data is used. Market concentration data are computed from data collected by the Ministry of Domestic Trade and Consumer Affairs, Malaysia[3].

[3] Fore more details, see Lee (2004).

As discussed earlier in this study we are interested in explaining why a firm innovates. The dependent variable used in this study is binary. Let us defined our dependent variable as

$$Y_t = \begin{cases} 1 & \text{if} \quad \text{firm } t \text{ innovates} \\ 0 & \quad \text{otherwise} \end{cases} \qquad (1)$$

The model essentially describes the probability that $Y_t = 1$. In this study, we consider a class of binary response models of the form

$$P(Y_t = 1 \mid \boldsymbol{X_t}) = F(\boldsymbol{X_t}'\boldsymbol{\beta}) = F(Z_t) \qquad (2)$$

where F is a strictly increasing function taking on values strictly between zero and one, $\boldsymbol{X_t}$ is the column vector of full set of explanatory variables associated with firm t, in which one of them takes a value equals to one and $\boldsymbol{\beta}$ is the column vector of all parameters. The variables to be included as explanatory variables will be discussed in details later. We use both the cumulative distribution function of the standard normal and logistic distribution function as the function F. The cumulative distribution function of the standard normal leads to the probit model. The logistic distribution function results in the logit model. Additional discussion of these models can be found in monograph by Maddala (1983) and two surveys by Amemiya (1981, 1984).

The significance of each explanatory variable would be tested by the usual t-test. But, the sample size should be sufficient large as it relies on the asymptotic expressions for the variances. Therefore, the t-test follows approximately the standard normal distribution. Two goodness of fit measures: McFadden R^2 (1974) and perfectly correctly predicted are used to assess the accuracy with which the model approximates the data set. Detailed discussion of these two measures can be found in Verbeek (2004) and Wooldridge (2003).

We postulate that the probability of innovating is influenced by the following factors:

a) Firm characteristics such as age of firm (AGE), extent of local ownership (OWN) measured by the percentage share of local equity ownership, firm size measured by total employees (SIZE), and the percentage of sales derived from exports (EXPORT).
b) Type of ownership structure – measured by dummies to represent partnership (PARTNER), private limited (PRIVATE) and public limited (PUBLIC). Sole-proprietorship is used as the reference category.
c) Industry characteristics such as market concentration and technological levels of industry.[6] Market concentration is measured by Herfindahl-Hirschman Index (HHI). Technological levels of industry are measured by dummies to represent medium-low technology (MEDLOW), medium-high technology (MEDHIGH) and high technology (HIGH) where low technology level acts as the reference category.

The following specification of model is estimated by probit and logit models:

$$Z_t = \boldsymbol{X_t}'\boldsymbol{\beta}$$
$$= \beta_0 + \beta_1 AGE_t + \beta_2 OWN_t + \beta_3 SIZE_t + \beta_4 EXPORT_t + \beta_5 PARTNER_t + \beta_6 PRIVATE_t + \beta_7 PUBLIC_t + \beta_8 MEDLOW_t + \beta_9 MEDHIGH_t + \beta_{10} HIGH_t + \beta_{11} HHI_t + \varepsilon_t \quad (4)$$

4.2 *Results*

The maximum likelihood results are summarized in Table 3. The interpretations are provided below:

[Insert Table 3 here]

Age of Firms

For small-sized firms, younger firms are more likely to innovate compared to older firms. However, for medium-sized and large-sized firms, older firms are more likely to innovate. This implies market entry related innovation may be important only for small firms.

Extent of Local Ownership

The extent of local vs. foreign ownership is not an important determinant of innovation. This applies for SMEs of all categories.

Firm Size

The firm size is statistically significant at the 5 % level only for small-sized firms. The positive sign for the coefficient of this variable indicates that small-sized firms with more employees are more likely to innovate compared to small-sized firms with less employees.

Share of Export in Sales

Interestingly, the variable representing percentage share of export in sales is only statistically significant at the 5 % level for medium-sized firms. The negative sign of the coefficient indicates that medium-sized firms that produce for domestic market tend to be more innovative than medium-sized firms producing for export markets.

Types of Ownership

Overall, the results indicate that ownership structure matters in innovation only in the case of medium-sized firms. Medium-sized firms that are public limited companies are less likely to innovate compared to sole-proprietorship medium-sized firms. The dummy variable representing partnership for the case of large-sized firms has been excluded because in our sample none of the large-sized firms has the ownership structure which is partnership.

Types of Industry by Technological Characteristics

The results on the relationship between technological characteristics of industry and firms' likelihood to innovate appear to be complex. Small and medium-sized firms in low-technology industry are more likely to innovate compared to their counterparts in medium-high technology industry. Interestingly, large-sized firms in medium-low

technology industry are more likely to innovate compared to their counterparts in low technology industry but small-sized firms in the same technology industry are less likely. Small-sized firms in high technology industry are more likely to innovate.

Market Concentration
The market concentration variable is only statistically significant at the 5 % level for medium-sized firms. The positive sign for the coefficient indicates that higher market concentration is associated with higher probability to innovate for medium-sized firms.

5. Conclusion

In recent years, governments have become interested to implement SME policies that are aimed at improving SMEs' ability to innovation. Despite such initiatives, there is a lack of rigorous empirical work on the determinants of innovations amongst SMEs, particularly in the developing countries. This study attempts to address the lack of empirical work on SME innovation in developing countries by undertaking an econometric analysis of the Malaysian experience using firm-level data.

This study indicates that the innovation amongst SMEs in the Malaysian manufacturing sector is very complex subject matter. In terms of firm size, younger small-sized firms are more likely to innovate compared to older small-sized firms. In contrast, for medium-sized and large-sized firms, older firms are more likely to innovate. As determinants of innovation, some variables are only statistically significant for firms in specific class size, for example, firm size (positively, for small-sized firms), export market orientation (negatively, for medium-sized firms), ownership structure (medium-sized firms) and market concentration (positively, for medium-sized firms).

The relationship between technological characteristics of an industry and the likelihood of firms belonging to that industry to innovate also appears to be very complex. SMEs in low-technology industry are more likely to innovate compared to their counterparts in medium-high technology industry. Interestingly, large-sized firms in medium-low technology industry are more likely to innovate compared to their counterparts in low technology industry.

Appendix A: Definitions of SME for Manufacturing Sector

Country	**Small**	**Medium**
Malaysia	Employees: ≥ 5 & ≤ 50 Revenues: ≥ RM250,000 & < RM10 milllion	Employees: ≥ 51 & ≤ 150 Revenues: ≥ RM10 million & ≤ RM25 milllion
Thailand	Employees: ≤ 50 Fixed Assets: ≤ Baht 50 million	Employees: 51 - 200 Fixed Assets: > Baht 50 million & ≤ Baht 200 million
EU	Employees: < 50	Employees: ≥ 50 & < 250
World Bank	Employees: ≤ 50 Total Assets / Sales: ≤ USD 3 million	Employees: 51 - 300 Total Assets / Sales: > USD 3 million & ≤ USD 15 million

Table 1. Innovation in the Manufacturing Sector, 1997-2001

	NSI-2 (1997-1999)			NSI-3 (2000-2001)		
	Innovating	**Non-Innovating**	**Total**	**Innovating**	**Non-Innovating**	**Total**
Number						
Small	26	207	233	125	357	482
Medium	99	427	526	72	69	141
Large	64	134	198	66	61	127
Total	**189**	**768**	**957**	**263**	**487**	**750**
Horizontal Percentage						
Small	11.2%	88.8%	100.0%	25.9%	74.1%	100.0%
Medium	18.8%	81.2%	100.0%	51.1%	48.9%	100.0%
Large	32.3%	67.7%	100.0%	52.0%	48.0%	100.0%
Total	**19.7%**	**80.3%**	**100.0%**	**35.1%**	**64.9%**	**100.0%**
Vertical Percentage						
Small	13.8%	27.0%	24.3%	47.5%	73.3%	64.3%
Medium	52.3%	55.6%	55.0%	27.4%	14.2%	18.8%
Large	33.9%	17.4%	20.7%	25.1%	12.5%	16.9%
Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

Source: NSI-2 and NSI-3

Note: We exclude firms with no information on firm size.

Table 2. Innovation in the Manufacturing Sector by Industry, 2001

		Small			Medium			Large			Total		
Code	**Industry**	**0**	**1**	**T**	**0**	**1**	**T**	**0**	**1**	**T**	**0**	**1**	**T**
15	Food Products and Beverages	65	16	81	12	14	26	3	5	8	80	35	115
16	Tobacco Products	1	0	1	0	0	0	1	2	3	2	2	4
17	Textiles	2	5	7	1	2	3	0	1	1	3	8	11
18	Wearing Apparel	54	26	80	6	2	8	14	1	15	74	29	103
19	Leather Products	5	1	6	1	1	2			0	6	2	8
20	Wood Products Except Furnitures	25	2	27	6	1	7	6	4	10	37	7	44
21	Paper and Paper Products	6	3	9	3	1	4	1	2	3	10	6	16
22	Publishing, Printing and Recorded Media	27	21	48	0	5	5	1	4	5	28	30	58
23	Coke, Refined Petroleum Products	0	1	1	0	0	0	0	0	0	0	1	1
24	Chemicals and Chemical Products	8	3	11	9	7	16	2	4	6	19	14	33
25	Rubber and Plastic Products	12	6	18	11	8	19	4	6	10	27	20	47
26	Other Non-Metallic Mineral Products	17	7	24	3	3	6	2	4	6	22	14	36
27	Basic Metals	10	2	12	2	4	6	4	0	4	16	6	22
28	Fabricated Metal Products	55	9	64	7	14	21	3	5	8	65	28	93
29	Machinery and Equipment N.E.C.	30	3	33	4	0	4	4	1	5	38	4	42
30	Office, Accounting and Computing Machinery	1	3	4	3	1	4	3	3	6	7	7	14
31	Electrical Machinery and Apparatus N.E.C	2	5	7	0	3	3	4	4	8	6	12	18
32	Radio, TV and Communication Equipment	0	0	0	0	0	0	2	9	11	2	9	11
33	Medical, Precision Instruments	0	1	1	0	0	0	1	2	3	1	3	4
34	Motor Vehicles, Trailers and Semi Trailers	1	3	4	0	1	1	1	5	6	2	9	11
35	Other Transport Equipment	6	0	6	0	0	0	1	3	4	7	3	10
36	Furniture; Manufacturing N.E.C.	29	7	36	1	5	6	4	1	5	34	13	47
37	Recycling	1	1	2	0	0	0	0	0	0	1	1	2
	Total	357	125	482	69	72	141	61	66	127	487	263	750

Source: NSI-3

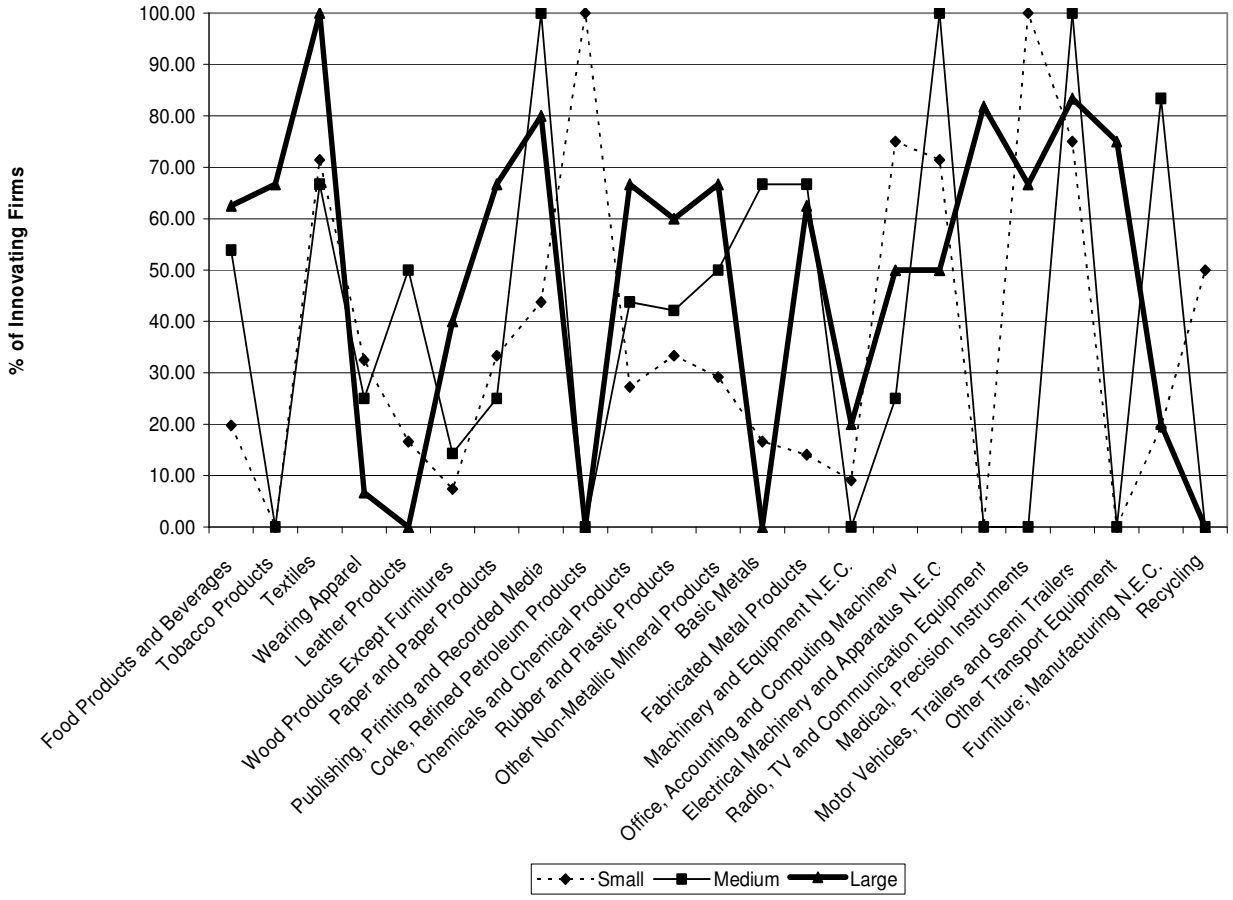
Note: 0 = Non-Innovation, 1 = Innovation, T = Total

Table 3. Results

	Small		Medium		Large	
	Logit	**Probit**	**Logit**	**Probit**	**Logit**	**Probit**
AGE	-0.1478***	-0.0799***	0.0416*	0.0265*	0.0737*	0.0414*
	(-6.2208)	(-6.6517)	(1.6535)	(1.7623)	(1.7318)	(1.7626)
OWN	0.0131	0.0074	-0.0027	-0.0017	0.0143	0.0083
	(1.2401)	(1.3218)	(-0.3708)	(-0.3814)	(1.5247)	(1.5594)
SIZE	0.0358**	0.0189**	0.0074	0.0045	0.0004	0.0002
	(2.4093)	(2.2735)	(1.5847)	(1.6002)	(0.7261)	(0.7864)
EXPORT	-0.0069	-0.0035	-0.0145**	-0.0089**	-0.0080	-0.0048
	(-0.8084)	(-0.7431)	(-2.1427)	(-2.2057)	(-0.8720)	(-0.8739)
PARTNER	-0.4172	-0.2062	-0.1439	-0.1162		
	(-0.6362)	(-0.5523)	(-0.0778)	(-0.1057)		
PRIVATE	0.5050	0.3504	-0.9276	-0.6061	0.0723	0.0080
	(1.3352)	(1.5794)	(-0.8029)	(0.9025)	(0.0529)	(0.0098)
PUBLIC	-0.1588	-0.0594	-2.9511*	-1.8145*	-0.8872	-0.5219
	(-0.054)	(-0.0385)	(-1.8774)	(-1.9400)	(-0.5598)	(-0.5448)
MEDLOW	-0.8549*	-0.5140**	0.3087	0.1794	1.4876*	0.8770*
	(-1.9410)	(-2.0566)	(0.5914)	(0.5710)	(1.6946)	(1.7583)
MEDHIGH	-1.1865**	-0.7086**	-2.6498**	-1.5551**	-0.0134	-0.0304
	(-2.2943)	(-2.4522)	(-2.1602)	(-2.2174)	(-0.0102)	(-0.0405)
HIGH	2.3412*	1.3696**	-1.1276	-0.6656	1.1539	0.6667
	(1.9163)	(2.0031)	(-1.0814)	(-1.0748)	(1.1646)	(1.1827)
HHI	2.5351	1.5457	18.4524**	10.8124**	8.8665	5.4049
	(1.0694)	(1.2208)	(2.2013)	(2.2729)	(1.3671)	(1.4445)
Intercept	-0.0681	-0.1129	-0.7899	-0.4304	-2.7510	-1.5522
	(-0.0613)	(-0.1910)	(-0.4409)	(-0.4070)	(-1.5760)	(-1.5180)
LR Test	99.3884***	97.1601***	25.5452***	26.0012***	28.6023***	29.0745***
McFadden R^2	0.2703	0.2643	0.1771	0.1803	0.2864	0.2911
Percent Correctly Predicted	78.26	78.62	69.09	68.18	76.74	72.74
Log Likelihood	-134.1262	-135.2403	-59.3304	-59.1024	-35.6389	-35.4028
Number of Observations	276		110		86	
Number of Innovating Firms	106		70		63	

Note: LR Test is the likelihood ratio test of the overall significance.
*** Significant at the 1% level, ** at the 5% level, * at the 10% level.
Values in parentheses are t-ratio.

Figure I: Proportion of Innovating Firms (%) Across Various Industries, 2001



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