# Patenting Motivations of Taiwanese Companies

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**Abstract**

Patenting motivations of firm have become important research issue because patent is generally regarded as ineffective appropriation mechanism but the number of patent applications has continuously surged all over the world, including developed and developing countries. However, most of the current literature is based on the empirical data of developed countries. Our paper is the first one of its kind in Taiwan, which has some typical context of newly industrializing countries (NICs). As latecomer in global economy, most manufacturing firms of Taiwan are OEM (Origin Equipment Manufacturer). They provide production service for foreign firms with international brand name. Although these OEM companies mainly depend on secret to protect their manufacturing technologies, they eagerly apply for patent in developed countries, like US.

By the Community Innovation Survey (CIS) data of Taiwan, we find that 81.5% of Taiwan companies with patenting experience have OEM businesses. Besides the traditional patenting motivations mentioned in the literature, we find 57.6% of these OEM companies will use patent to attract order from customers and 55.4% will deploy patent to preventing customers switch order. Furthermore, by employing multivariate Probit regression models to pin down the relationships between appropriability conditions and patenting motivations, we may explain why OEM firms apply for patents even though they do not depend on patent to protect their innovations.

***Keywords:*** Patenting Motivation, Appropriation, Innovation Survey
**JEL:** L29, O34

## Introduction

Stemming from the seminal work of Arrow (1962), theoretical economists usually emphasize the necessity of public intervention to improve the appropriability condition, so that the innovator may have enough incentive to invest in R&D. However, the actual effectiveness of patent protection is far from its official promise. From an empirical study of US firms, Mansfield (1981, 1985) found that U.S. patents are invented around ~~in~~ in four years~~(~~ (on average)~~)~~ after they were issued. As a result, Mansfield (1986) reported that ~~the~~ patent protection is found to be essential only in pharmaceutical and chemical industries. ~~In~~ At the same time, the Yale Survey was launched to explore the effectiveness of varied means of appropriation. ~~–~~Levin et al. (1987) show that "lead time" is the most effective means of appropriation for process~~es~~ innovation and "sales or service efforts" is the most effective one for product~~s~~ innovation. Once again, this empirical study shows that patents ~~is~~ are generally

not regarded as the most important and popular appropriation mechanism. Even after the Courts of Appeals for Federal Circuit (CAFC) was established in 1982 and the patent regime of the U.S. was effectively strengthened, the results of the Carnegie-Mellon Survey show that the importance of patents is still less than lead time and secrecy (Cohen, Nelson & Walsh, 2000).

Nonetheless, the number of patent applications has continuously surged over time in the U.S., and Hall & Ziedonis (2001) found that the propensity of patenting has risen dramatically since the mid-1980s. If firms do not rely primarily on patents to appropriate innovation, then why are they patenting so aggressively? This is a so-called "Patent Paradox". To resolve this paradox, Cohen, Nelson & Walsh (2000) proposed seven reasons why firms apply for patents. Their results show that the top three reasons are preventing imitation, blocking and preventing suits. In the successive study, Cohen et al (2002) compared the strategic uses of patents between Japan and the U.S. They found that Japanese firms are more inclined to use patents for negotiations than U.S. firms.

Following Cohen et al. (2000, 2002)'s works, we try to open the black box of the relationships between appropriability conditions and patenting motivations by the Community Innovation Survey (CIS) data of Taiwan. The current literature are based on the empirical data of developed countries, ~~like~~ such as the U.K. (Taylor & Silberston, 1973), the U.S. (Mansfield, 1986; Levin et al., 1987; Cohen et al., 2000), Japan (Cohen et al., 2002), and ~~Swiss~~Switzerland (Harabi, 1995). This paper is the first one of its kind in the context of newly industrializing countries (NICs), and is expected to explore the issue more globally. As latecomer in global economy, most manufacturing firms of Taiwan are OEM (Origin Equipment Manufacturer). They license in the patented technologies from the developed countries and provide production service for foreign firms with international brand name.

Taiwan's economy also has a paradoxical phenomenon. In the period between 2002 and 2006, Taiwan's net payments of technology balance were negative and continued to be worsened. Taiwan's payments ratios of technology balance are quite low. Both of the indexes reveal that the patents of Taiwanese companies cannot reduce their licensing payment and generate more licensing return. However, in the same period, the application number of U.S. patent by Taiwanese firms continued to surge and the granted patent number is in third place among all foreign countries (only behind Japan and Germany). If Taiwanese patents are too weak to alter the payments ratios of technology balance, why Taiwanese firms would apply for patent so aggressively? This is the Taiwanese version of patent paradox.

To solve the paradox and explain why Taiwanese firms will apply for patents even though their patents do not improve their payments ratios of technology balance, we first explore the conditions for firms to appropriate their innovation and various kinds of patenting motivations. Then, we will employ regression models to pin down the ~~the~~ relationships between appropriability conditions of innovation and patenting motivations. The remainder of this paper is structured as follows. In Section 2, we propose the analytical method by describing the data, defining the variables and setting up the regression models. In Section 3, we present and discuss the empirical results. Section 4 concludes the paper.

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## Method

### Data

Our data is from the Taiwan Innovation Survey (TIS-2007) which was administered in 2007 by National Science Council of Taiwan. The survey adopted a questionnaire and sampling procedures similar to the fourth edition of the Community Innovation Survey (CIS4),

and randomly sampled 10017 firms from the industries (including the manufacturing sector and the service sector) to investigate the innovation behaviors of firms in the period between 2004 and 2006. To compare our results with Carnegie Mellon Survey and related studies, we retrieve 1011 samples from manufacturing sector. These firms all have launched at least one technological innovation and have ever applied for patents.

**Variables**

***Dependent variables: patenting motivations***

Patenting motivations are the ways motivations for which firms apply their patents. Besides using their granted patents to prevent imitation, firms may apply patents to delay or block the innovation pace of their competitors, to prevent the risk of infringement suits, to strengthen their position in negotiations about mergers, cross-licensing or R&D co-operations contracts, to earn the licensing revenue, to evaluate the performance of R&D employees, to enhance firms' reputations, and to attract experts (Harabi, 1995; Cohen, Nelson &Walsh2000; Blind, Edler, Frietsch & Schmoch, 2006 ).There is a multi-choice question in the questionnaire of TIS-2007 that asks firms their patenting motivations. Because most of Taiwanese manufacturing companies have Original Equipment Manufacturer(OEM ) business. Besides the traditional patenting motivations mentioned in the literature, the TIS-2007 questionnaire has added two new patenting motivations from these OEM companies: Getting order from customers and preventing them switch order. Therefore, we may identify 10 patenting motivations and define 10 dependent variables as following: **NoCopy, Delay, NoSuit, Negots, License, Order, NoSwitch, Evaluate, Reputation, Expert**.

These 10 dependent variables are dummy variables. If firm has chosen one alternative, then the corresponding dependent variable equals to1 (otherwise 0). The sample distributions of the dependent variables are shown in Figure 1. NoCopy is the most popular (80.2%) patenting motivations and License is the least one (22%). 57.6% of the firms report that patent help them get order from customers and 55.4% of firms use patent to prevent customers switch order.

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Insert Figure 1 about here

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***Independent variable:***

Because appropriability conditions will affect how firms appropriate the innovation, we conjecture that in the process they also affect how firms use patents and then why firms apply for patents. According to Teece (1986, 2006), appropriability conditions include the vertical arrangements of complementary assets in the commercialization process (vertical scope of firm), the nature of technology and industry life cycle of innovation (nature of innovation), and the appropriability regimes. We will define 19 independent variables as approprability conditions from the questionnaire of TIS-2007.

**1. Appropriability conditions**

**1-1 Vertical scope of firm**

In innovation literature, the innovator is implicitly assumed to produce products with its own brand and go through the production process all by itself. However, as latecomer in global economy, most manufacturing firms of Taiwan are Origin Equipment Manufacturer (**OEM**) or Origin Design Manufacturer (**ODM**). They provide production service for foreign firms with international brand name. Some of the firms may strive to establish their own brand (**OB**) after mastering the production process. To identify this unique nature of Taiwanese firms, we differentiate the vertical scope of firm by three independent variables.

They all are dummy variables. If OEM = 1, the firm has manufacturing capacity, otherwise 0. If ODM = 1, the firm has designing capacity, otherwise 0. If OB = 1, the firm has branding capacity, otherwise 0. 81.5% of our sampled firms (824 out of 1011 cases)are OEM or ODM. Only 137 firms sell the products to final consumer with their own brand names.

**1-2 Nature of technology**

Technological innovations can be divided into product innovation and process innovation. By the CIS format, we can differentiate innovations further into narrowly defined innovation (new to the market) and imitation (new to the firm). Therefore, we can define four types of innovation as follows: **D_INNOV**: Product innovation (new to the market), **D_IMITA**: Product imitation (new to the firm only), **P_INNOV**: Process innovation (new to the market), **P_IMITA**: Process imitation (new to the firm only).

**1-3 Appropriation mechanisms**

We classify the appropriation mechanisms into 12 types. They are **Patent , Design, Trademark, Copyright, Secrecy, Franchise, Complexity, Lead time, Update, Essential Material, Complementary A&S,** and **Expertise**. These measures are revised from Yale survey and CMS (see Levin et al., 1987, Harabi, 1995, and Cohen et al., 2000). We use these variables as main explanatory variables in our model to scrutinize the determinants of different patenting motivations. In the questionaire of TIS-2007, firms are asked to pick the mechanisms they had adopted. We recode these variables into dummy variables.

The distribution of these 12 appropriation mechanisms are present in Figure 2. We find that utility patent is the most (62.8%) popular appropriation mechanism, secrecy is second (54.4%), and design patent is third (53.8%). Remember that our sampled firms all have applied for patents (either utility or design patent). Therefore, these portions do not represent the total picture of Taiwan manufacturing sector, within which some firms might adopt secrecy and lead time to appropriate their innovations and never apply for patents..

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Insert Figure 2 about here

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**2. Control variables: Characteristics of the firm**

To separate the impacts from other characteristics of the innovative firm, we set up 7 firm-specific variables as control variables.

**SIZE**: Firm size - The logarithm of the number of firm's employees in 2006.

**SIZE_R**: The squared term of SIZE.

**HO:** Focal firm is part of a business group or not.

**MULTIN**: Focal firm belongs to a multinational firm or not.

**INTL:** The degree of international market = The number of the firm's main markets outside of Taiwan (5 areas including Mainland China, North-Eastern Asia, America, Europe, and the other). The degree ranges from 0 to 5.

**ESTBL**: Firm is established after 2004 or not.

**RRDINENG**: Firm has in-house R&D activity or not.

Among these 7 controlled variables, HO, MULTIN, ESTBL, and RRDINENG are dummy variables.

**Model and Estimation Method**

Our regression model consist ten binary choice equations for the ten dependent variables (Y). Because the dependent variables are dummy and may be interrelated, we employ the

multivariate probit regression model, as in Cappellari & Jenkins (2003) and Belderbos et al. (2004), to capture the interdependence of various kinds of patenting motivations and their driving factors. First, we will explore all the determinants (X) for each of these ten patenting motivations separately. The coefficients (β) of the independent variables can be interpreted as their contribution to the propensity for firm to apply patent for that motivation. Although the coefficients OEM are our focus, we employ this comprehensive model to capture the influences of all factors and identify the idiosyncratic natures of OEM firms. Second, in order to identify the intrinsic linkages between these patenting motivations, we will compute and compare the correlations between the un-explained residuals of the ten dependent variables.

$$Y_{i,k} = \begin{cases} 1 & if \quad X_{i,k}\beta_k + \omega_{i,k} > 0 \\ 0 & otherwise, \end{cases} ; k = 1,2...,10; \quad i = 1,2,3....,N$$

$\omega_{i,k(1\times 2...\times 10)} \sim Normal(0,\Sigma)$ , where Σ is the covariance matrix of the error terms.

## Results

### International Comparisons

In order to analyze the difference between Taiwan and other developed countries (Japan and US), we compare our result with Cohen et al.'s (2002) study. The questions about patenting motivations in TIS-2007 are different from CMS, thus our comparison include only the overlap parts between these two surveys. The same patenting motivations in these two questionaires are NoCopy, NoSuit, Negots, License, NoSwitch, Evaluate, and Reputation. The comparisons are shown in Figure 3 and Figure 4.

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Insert Figure 3 about here

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Taiwan is a newly industrializing country with technology trade deficit -Taiwan's net payments of technology balance are negative and keep worsen after 2002. Most firms in Taiwan need to import essential technologies from developed countries, especially Japan. Therefore, 85.8% of Japanese product patents can be used for negotiations, but only 37.5% of Taiwanese product patents can have the same function. 66.7% of Japanese product patents are for licensing, but only 23.2% of Taiwanese product patents can be licensed out. These evidences indicate that the nature of innovation will confine the space for patents to use.

The remarkable difference between Taiwanese firms and the U.S. firms resides in Evaluate. Only 7.8% of the U.S. firms will use product patent to evaluate the performance of employee, but 47.3% of Taiwanese firms and 60.1% of Japanese firms will do that. Comparing to the Western culture, the Eastern culture is more implicative and treasures the human relationships within the firms. Therefore, the Taiwanese and Japanese firms need to use the patents, which are evaluated by an authorized third party, as the objective measure of performance. This evidence clearly shows that country or culture-specific factors would affect the ways firms use their patents.

### Determinants of Patenting Motivations

All ten probit equations are significant but the significant determinants are different.

These results imply that firms may have different patenting motivations induced by the same determinants. Owing to the limitation of space, we only present 4 equations (Negots, License, Order, NoSwitch) in Table 1.

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Because most of Taiwanese firms are OEM's, they appropriate their innovation by the sales of their manufacturing capacities. From Table 1, we notice that they will not license out (insignificant 0.08) their manufacturing technologies, but use their patents to get the outsourcing orders (0.195**), avoid their customers switching orders (0.243***), and then fully exploit their manufacturing capacities and technologies. It is reasonable for OEM firms to apply patent and keep it from licensing. Our research provides insights to solve the Taiwanese version of patent paradox. In fact, there is no paradox. The seemly paradox comes from the narrow-minded perspective of research which takes the top innovators, like IBM, HP or Phipps, as representative innovator and regards licensing revenue as the main profit of patent. This reminds us the importance to consider the vertical scope of firm and industrial specialization of global economy when we dealing with the related issues.

If we focus on the determinants of using patent to attract OEM order, we may find that firms with process innovation are most unlikely (- 0.297***, from Table 1) to use patent in this way. Because patenting requires disclosing the best practice of technology, firm will not apply for patent unless there is an immediate threat of imitation. If firm has process technology which is new to the market, her best choice is keeping it in secret.

From Table 1, we also find that firms who using patent to attract OEM order will not depend on patent (0.017, insignificant) to appropriate their innovation. Rather, they appropriate their innovation by the franchise method (0.453***), or complexity of technology (0.355***), or updating technology quickly (0.203*). They just employ the public nature and codified information of patent to advertise their production capability.

## Conclusion

This paper is aimed to explore the patenting motivations of Taiwanese companies. By the Community Innovation Survey (CIS) data of Taiwan, we find that 80% of Taiwan companies with patenting experience have OEM business. Besides the traditional patenting motivations mentioned in the literature, we find 57.6% of these OEM companies will use patent to attract order from customers and 55.4% will deploy patent to preventing customers switch order. These OEM companies usually protect their core competency by secret recipe of manufacturing process or know- how of expertise, rather than the publicly announced patent. However, they aggressively apply for patent in developed countries, like US. Before 2006, the number of US patents granted to Taiwan companies is ranked 3rd among all foreign countries, just after Japan and Germany. This is the Taiwanese version of patent paradox.

Our research provides insights to solve this paradox. Because most of Taiwanese firms are OEM's, they appropriate their innovation by the sales of their manufacturing capacities. Therefore, they will not license out their manufacturing technologies, but use their patents to get the outsourcing orders, avoid their customers switching orders, and then fully exploit their manufacturing capacities and technologies.

Our main limitation stems from the simultaneity bias. Since we employ cross-section survey data in one period (2004-2006), the econometric model only reveals the correlation, rather than the causality of relationships between independent variables and dependent

variables. Employing the panel data may relieve this correlation limitation. We leave these research programs to future studies.

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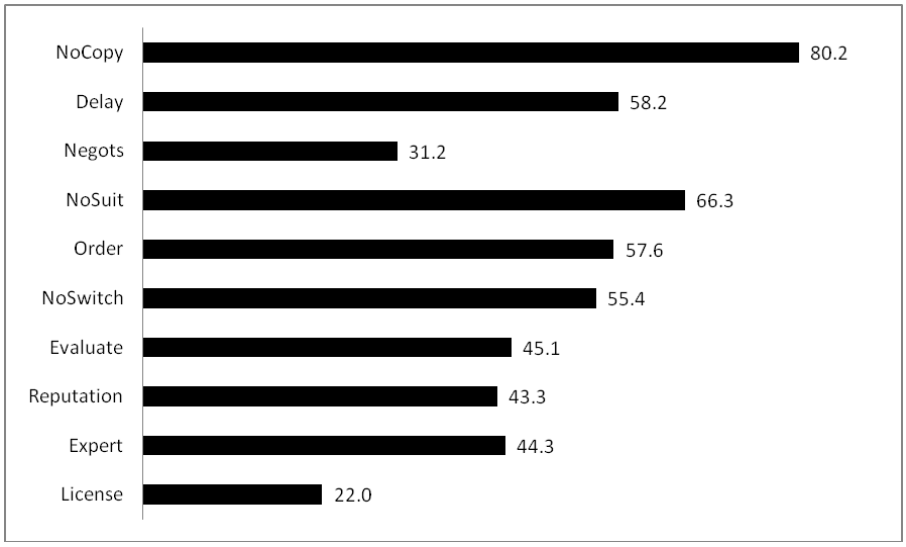
Table 1 MVprobit model of patenting motivations

| | Negots | | License | | Order | | NoSwitch | |
|---|---|---|---|---|---|---|---|---|
| **Appropriability conditions** | Co-eff. | S.D. | Co-eff. | S.D. | Co-eff. | S.D. | Co-eff. | S.D. |
| ***Vertical scope of firm*** | | | | | | | | |
| OEM | 0.263*** | (0.094) | 0.080 | (0.097) | 0.195** | (0.087) | 0.243*** | (0.090) |
| ODM | 0.018 | (0.090) | -0.062 | (0.092) | 0.068 | (0.084) | 0.251*** | (0.085) |
| OB | 0.029 | (0.095) | -0.104 | (0.096) | -0.020 | (0.089) | 0.105 | (0.092) |
| ***Nature of innovation*** | | | | | | | | |
| D_INNOV | 0.248** | (0.120) | -0.018 | (0.124) | 0.016 | (0.109) | 0.104 | (0.112) |
| D_IMITA | 0.053 | (0.141) | 0.077 | (0.142) | -0.085 | (0.128) | 0.000 | (0.132) |
| P_INNOV | -0.026 | (0.117) | 0.024 | (0.122) | -0.297*** | (0.111) | 0.020 | (0.113) |
| P_IMITA | -0.209 | (0.128) | -0.073 | (0.132) | -0.192 | (0.120) | -0.087 | (0.122) |
| | | | | | | | | |
| ***Appropriation mechanism*** | | | | | | | | |
| *Legal Mechanisms* | | | | | | | | |
| Patent | 0.031 | (0.109) | -0.068 | (0.114) | 0.017 | (0.096) | -0.142 | (0.098) |
| Design | 0.145 | (0.104) | 0.024 | (0.110) | 0.120 | (0.095) | -0.070 | (0.097) |
| Trademark | -0.129 | (0.107) | 0.128 | (0.110) | -0.031 | (0.099) | 0.025 | (0.100) |
| Copyright | 0.197 | (0.124) | 0.283** | (0.122) | -0.039 | (0.121) | 0.248** | (0.123) |
| Secret | 0.303*** | (0.109) | 0.159 | (0.113) | 0.153 | (0.097) | 0.122 | (0.098) |
| Franchise | 0.700*** | (0.131) | 0.435*** | (0.127) | 0.453*** | (0.141) | 0.118 | (0.139) |
| *Superior Mechanisms* | | | | | | | | |
| Complexity | 0.212* | (0.109) | -0.019 | (0.113) | 0.355*** | (0.104) | 0.363*** | (0.105) |
| Lead time | 0.070 | (0.120) | 0.093 | (0.127) | 0.080 | (0.106) | 0.006 | (0.110) |
| Update | 0.227* | (0.130) | 0.166 | (0.135) | 0.203* | (0.116) | 0.145 | (0.118) |
| *Preemtive Mechanisms* | | | | | | | | |
| Essential Material | 0.007 | (0.132) | 0.065 | (0.134) | 0.105 | (0.122) | 0.173 | (0.121) |
| Complementary A&S | 0.043 | (0.128) | 0.130 | (0.129) | 0.155 | (0.115) | 0.116 | (0.116) |
| Expertise | -0.187 | (0.128) | 0.053 | (0.131) | -0.067 | (0.116) | 0.294** | (0.116) |
| **Controlled Var.** | | | | | | | | |
| size | 0.158 | (0.146) | 0.201 | (0.149) | 0.202 | (0.133) | 0.306** | (0.136) |
| size_R | -0.010 | (0.013) | -0.014 | (0.013) | -0.009 | (0.012) | -0.022* | (0.013) |
| HO | -0.081 | (0.153) | 0.130 | (0.156) | 0.081 | (0.144) | 0.252 | (0.154) |
| MULTIN | -0.258 | (0.260) | -0.074 | (0.249) | -0.143 | (0.235) | -0.273 | (0.242) |
| INTL | 0.065** | (0.032) | 0.021 | (0.033) | 0.012 | (0.030) | -0.005 | (0.031) |
| ESTABL | -0.046 | (0.184) | 0.089 | (0.183) | 0.069 | (0.163) | -0.236 | (0.165) |
| RRDINENG | -0.294*** | (0.111) | -0.101 | (0.119) | -0.002 | (0.102) | -0.025 | (0.106) |
| _cons | -1.639*** | (0.384) | -1.889*** | (0.394) | -1.027*** | (0.350) | -1.577*** | (0.360) |




n=1011.

Figure 1 Distribution of patenting motivations
(For all innovations)

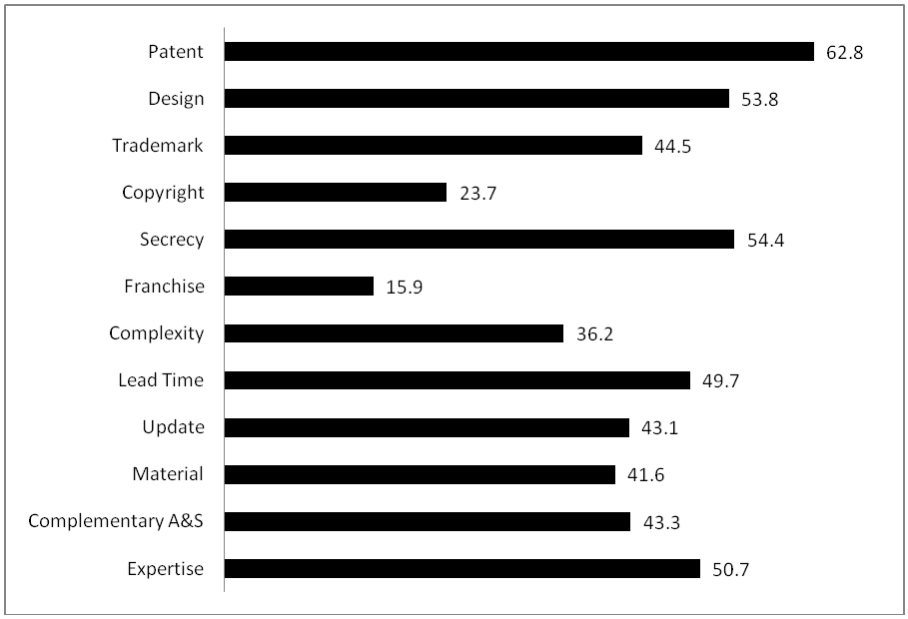
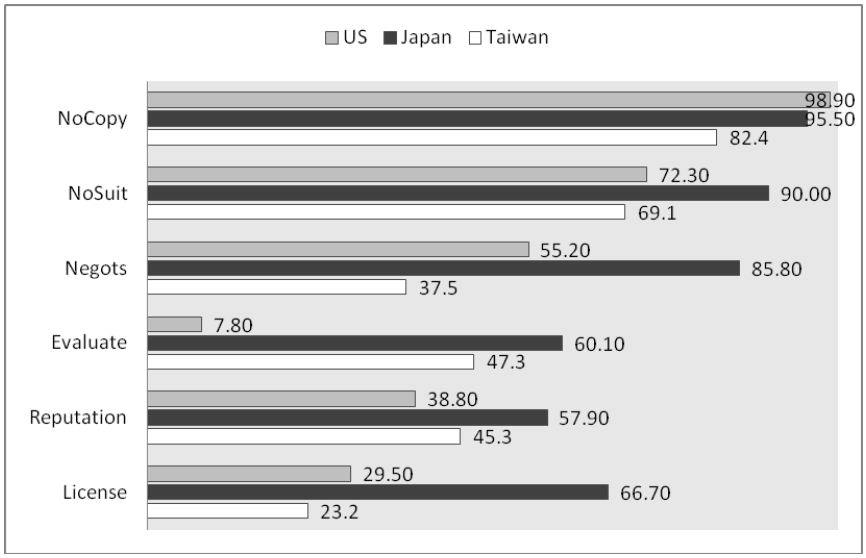
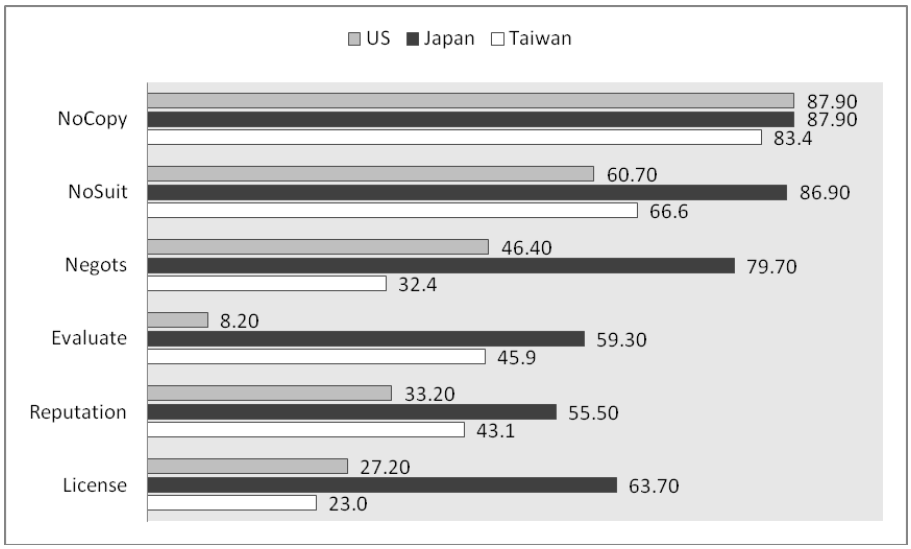



Figure 2 Popularity of Appropriation Mechanisms (n=1011).




(Taiwan n=512; Japan n=526; U.S. n=561)

Figure 3 International comparisons of patenting motivations
(For product innovations)
Source: Adopted from Cohen, Goto, Nagata, Nelson, & Walsh (2002)




(Taiwan n=392; Japan n=479; U.S. n=495)

Figure 4 International comparisons of patenting motivations
(For process innovations)
Source: Adopted from Cohen, Goto, Nagata, Nelson, & Walsh (2002)