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# Innovation and Profitability: Firm-Level Evidence from Taiwan

**Chia-Hui Huang**  
**Aletheia University**  
**Taipei, Taiwan**

E-mail: [au5631@au.edu.tw](mailto:au5631@au.edu.tw)

**Tony Chieh-Tse Hou**  
**National Dong Hwa University**  
**Hualien, Taiwan**

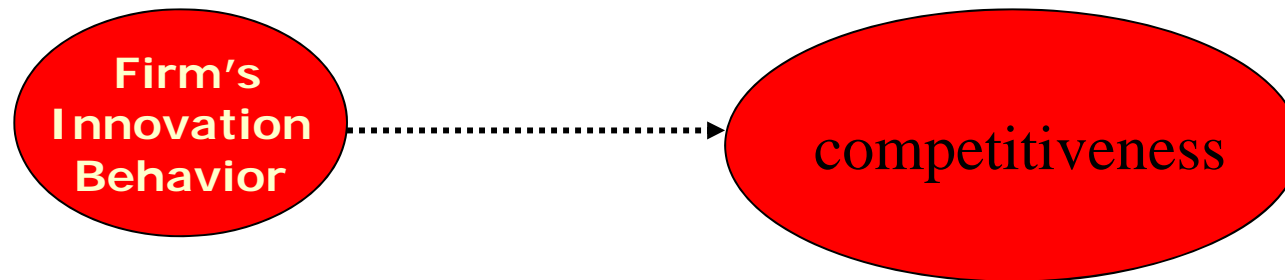
E-mail: [houc@mail.ndhu.edu.tw](mailto:houc@mail.ndhu.edu.tw)

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## Innovation and Profitability

The topic of innovation has attracted wide interest of economists since the seminal work by Schumpeter (1942), because innovation is widely recognized as a main driving force of economic growth as well as industrial evolution.



Recently, firms have been investing in innovative behaviour input to enhance competitiveness.



## Innovation and Profitability

Firms possessing successful R&D strategies and patent rights can exclusively profit from the patented product within specific periods based on governmental regulations.

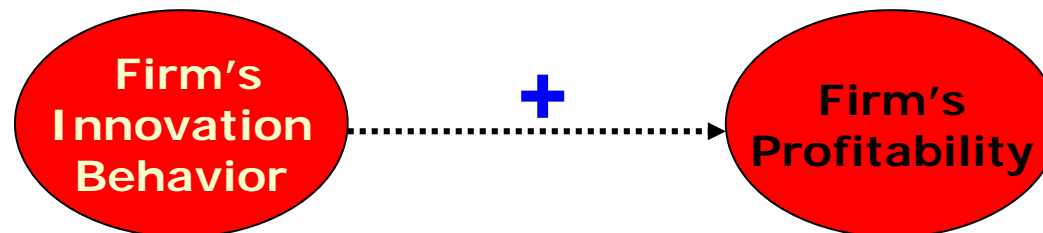
In addition, product improvements or technical advancements in novel production procedures enable firms to obtain a relative advantage in the market, thereby facilitating firm operations and **increasing profit** (Nas & Leppälähti, 1997).



## Innovation and Profitability

Innovative firms are highly capable of protecting products that involved innovation investment and avoiding profit losses from intra-industry competition.

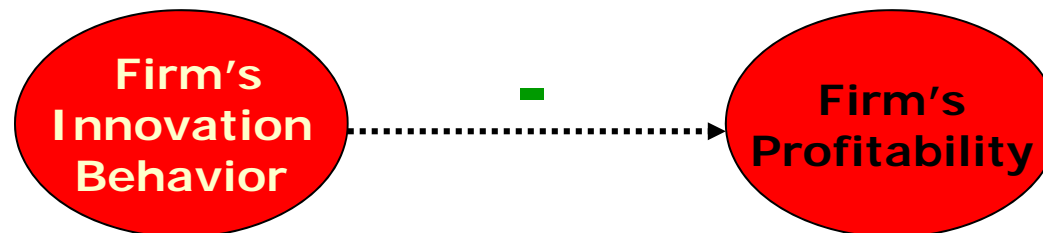
In addition, because innovative firms can introduce diverse innovations on a long-term scale, they maintain a high profit standard (Love et al., 2009).



## Innovation and Profitability

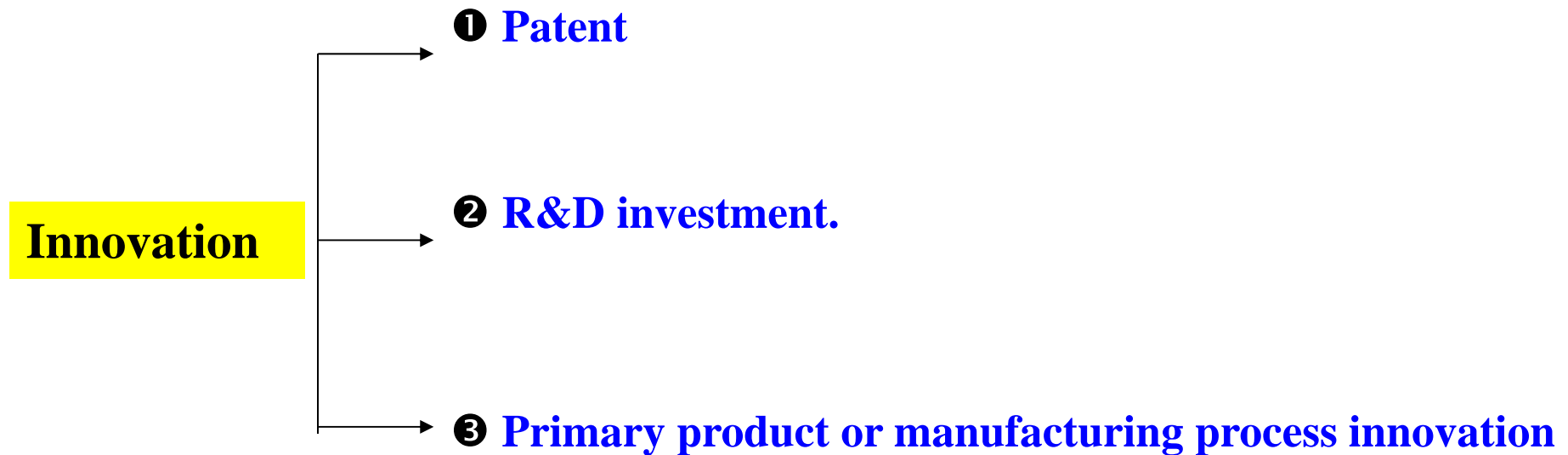
Although a spillover effect occurs in the process of successful R&D, the entitled profits of firms may be reduced because of competitive limitations.

Furthermore, R&D investment involves focusing on unknown research targets. In addition to the inherent high risk, an innovative firm must bear the immense cost of R&D failures, which reduces the expected profits of the firm (Czarnitzki & Kraft, 2010).





Firm-level studies on the relationship between innovative behavior and firm profitability have indicated that the profitability of innovative firms surpasses that of non-innovative firms.





## **Firm-level studies** on the relationship between innovative behavior and firm profitability

### **Innovation**

#### ① **Patent**

Finland (Leiponen, 2000)

Canada (Cozzarin, 2004)

United States (Cefis & Ciccarelli, 2005)

Germany (Kruger & Rhein, 2009; Czarnitzki & Kraft, 2010)

#### ② **R&D investment.**

United States (Hanel and St-Pierre, 2002 ;  
Rosenbusch et al., 2011)

Germany Czarnitzki and Kraft (2012)

#### ③ **Primary product or manufacturing process innovation**

United Kingdom (Geroski et al., 1993)

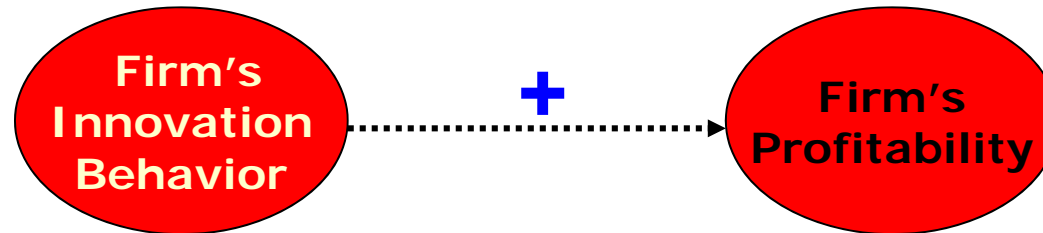
United States (Roberts, 1999)

Ireland (Love et al., 2009)

Italy (Cozza et al., 2012)

## Innovation and Profitability

★ Most of these studies adopted samples from developed Western countries and supported the argument that innovative behavior benefits firm profitability.



However, **Sohn et al. (2010)** used **South Korean samples** and reached a contrasting conclusion, which stated that the **R&D** variable possessed a significantly **negative influence** on firm net return rates and the patents variable did not demonstrated a significant correlation to firm net return rates.





Aims

**Base on the above motivations,** this study employed the structure-behavior-performance analysis framework used in traditional industrial economics to verify the influence of innovative behavior in Taiwanese manufacturing firms on firm profitability.

❶ We use R&D intensity (RDS) and the number of patent counts (PAT) as the proxy variable.



Aims

**Base on the above motivations,** this study employed the structure-behavior-performance analysis framework used in traditional industrial economics to verify the influence of innovative behavior in Taiwanese manufacturing firms on firm profitability.

② Patents are further categorized as invention patents and new design patents. This study examined whether different types of patents exert a varying influence on firm profitability.



Aims

**Base on the above motivations,** this study employed the structure-behavior-performance analysis framework used in traditional industrial economics to verify the influence of innovative behavior in Taiwanese manufacturing firms on firm profitability.

③ Previous empirical studies have focused on developed countries. Our firm-level evidence from Taiwan can complement the existing literature that focuses only on advanced countries.



## Innovation and Profitability

A set of panel data from manufacturing firms listed on the Taiwan Stock Exchange (TSE), over the 2000 to 2010 period, are collected.

- ① R&D expenditure and other firm-specific variables

Taiwan Economic Journal (TEJ) company

- ② Patent data

Taiwan Intellectual Property Office (TIPO) database

■ By eliminating those few firms with incomplete data for all the relevant variables, we obtain an unbalanced panel data of 641 enterprises, yielding an overall sample of 6983 observations.

### Objective :

Estimate the **causal effect** of **innovation behavior** on the **firm profitability**.

- ❶ Does the R&D activity enhance firm's profitability?
- ❷ In view of innovative output, we use patents as a measure of innovation.

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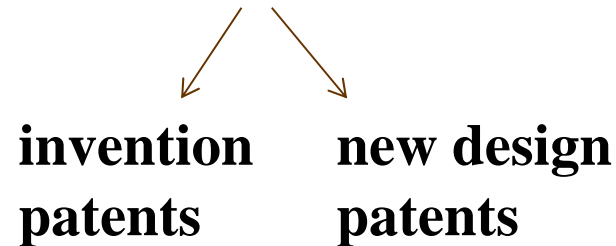
Because differences exist among the statutory protection provisions of various patents, which are mandated in accordance to the Taiwan Patent Act, the duration that patenting firms are permitted for consolidating profits also varies.

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Patents are further categorized as invention patents and new design patents.

## Innovation and Profitability

To estimate the effect of innovation on profitability of firms, this study refers to previous studies that discuss the determinants of profit and then specifies the following equation:

R&D intensity (RDS)

and the number of patent counts (PAT)

$$PROFIT_{it} = \alpha_0 + \beta INNO_{it} + \alpha_1 SIZE + \alpha_2 AGE + \alpha_3 CAP + \alpha_4 ADS_{it} + \alpha_5 HUM_{it} + \sum_t \delta_t D_t + \mu_i + \varepsilon_{it} \quad (1)$$



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 \end{aligned}
 \tag{1}$$

To further investigate the potential differentials for the profitability effects between different types of patent,

we separate patent into invention patent (PAT-I) and design patent (PAT-D).

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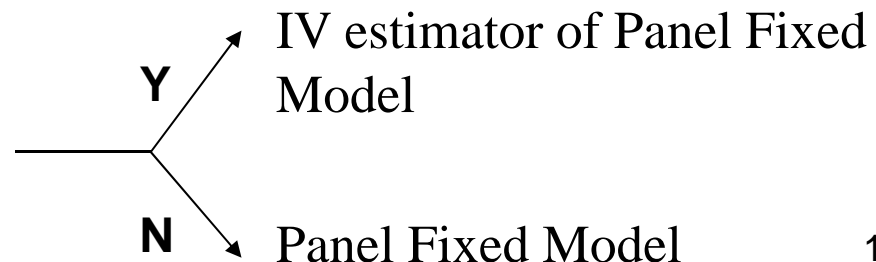
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 \end{aligned}
 \tag{1}$$

★ One econometric problem in equation (1) is that there is an **endogenous causality** between INNO and firm's profit.

Wu-Hausman Test

Endogenous  
problem



**Table 3** Profit Effects of Innovation-R&D Activities

<b>Variable</b>	<b>Fixed-Effect</b>	<b>Panel IV</b>
<b>INNO</b>	<b>0.0771*</b>	<b>0.4376*</b>
	<b>(0.0463)</b>	<b>(0.2320)</b>
<b>SIZE</b>	<b>-9.8394</b>	<b>-11.5818</b>
	<b>(2.6019)</b>	<b>(2.7040)</b>
<b>AGE</b>	<b>0.0485*</b>	<b>0.03345</b>
	<b>(0.03882)</b>	<b>(0.3914)</b>
<b>CAP</b>	<b>-7.0665***</b>	<b>-8.4641</b>
	<b>(1.7284)</b>	<b>(1.6857)</b>
<b>ADS</b>	<b>0.5860</b>	<b>3.9109***</b>
	<b>(0.9344)</b>	<b>(0.9774)</b>
<b>HUM</b>	<b>1.8154</b>	<b>2.0092</b>
	<b>(2.9169)</b>	<b>(2.8887)</b>
<b>R<sup>2</sup></b>	<b>0.0359</b>	<b>0.0420</b>
<b>Hausman Test</b>		<b>21.93*</b>
		<b>(p-value=0.08)</b>

Figures in parentheses are standard deviations.

\*\*\*, \*\* and \* denote coefficient significant at 1%, 5% and 10% statistical level,

**Table 3** Profit Effects of Innovation-R&D Activities

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Using the hausman test, the statistic value indicates an **endogenous causality** between innovation behavior and firm's profitability.

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**Q.** To what extent does the R&D activity enhance firm's profitability?

**① positive and statistically significant** innovation behavior is an important influence on firms' profitability, implying that there is potential profit-enhancing effect of firms' R&D activities.

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**Table 3** Profit Effects of Innovation-R&D Activities

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Figures in parentheses are standard deviations.

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② The coefficient for INNO in model (2) is 0.4376, which suggests that as the R&D intensity increases by 1%, a firm's profit increases by about 0.43%.

Compared with result shown in model (1), the coefficient on INNO variable is still significantly positive, but the estimated coefficient decreased sharply from 0.4376 to 0.0771.

Thus, if the endogenous problem is not taken into account, the estimate results would suffer estimation bias.

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The estimates for observed characteristics :

small firms generate higher income than large firm.

labor-intensive firms have better profitability. It shows firms should improve the efficiency of assets utilization in order to enhance their profitability.

positive and significantly relationship between advertising density and firm's profitability. It provides evidence that firm can raise awareness through advertising and media, and further improve their profitability.

Figures in parentheses are standard deviations.

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**Table 4** Profit Effects of Innovation-Patent-Panel IV Fixed Effect Model

<b>Variable</b>	<b>All</b>	<b>Invention</b>	<b>Design</b>
	<b>(3)</b>	<b>(4)</b>	<b>(5)</b>
<b>INNO</b>	<b>68.1700*</b>	<b>45.9264*</b>	<b>-75.6160*</b>
	<b>(40.9588)</b>	<b>(27.5941)</b>	<b>(45.4326)</b>
<b>SIZE</b>	<b>-31.2346**</b>	<b>-25.4891***</b>	<b>19.3044</b>
	<b>(13.0595)</b>	<b>(9.7010)</b>	<b>(17.7592)</b>
<b>AGE</b>	<b>-1.2349</b>	<b>-0.8363</b>	<b>0.4925</b>
	<b>(0.8758)</b>	<b>(0.6696)</b>	<b>(0.4629)</b>
<b>CAP</b>	<b>-1.8902</b>	<b>-1.6950</b>	<b>-12.0235***</b>
	<b>(3.4853)</b>	<b>(3.5877)</b>	<b>(3.5141)</b>
<b>ADS</b>	<b>-1.0673</b>	<b>-.3021</b>	<b>4.9611*</b>
	<b>(1.3512)</b>	<b>(1.0675)</b>	<b>(2.8060)</b>
<b>HUM</b>	<b>-12.9212</b>	<b>-14.0677</b>	<b>16.6668*</b>
	<b>(9.1836)</b>	<b>(9.8392)</b>	<b>(9.5247)</b>

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**Table 4** Profit Effects of Innovation-Patent  
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<b>HUM</b>	<b>-12.9212</b>
	<b>(9.1836)</b>
<b>R<sup>2</sup></b>	<b>0.0359</b>

Model (3) shows significantly positive coefficient on the total number of patents (PAT).

It suggests firms investing in R&D and successful innovation obtained a patent, and the patent protection granted by the government which can actually improve firm's profit performance.

Moreover, model (3) shows the PAT coefficient is 68.17, it indicates each additional patent can increase the firm's profit by 68.17%.

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**Table 4** Profit Effects of Innovation-Patent  
Panel IV Fixed Effect Model

<b>Variable</b>	<b>Invention patents</b>	<b>Design patents</b>
	<b>(4)</b>	<b>(5)</b>
<b>INNO</b>	<b>45.9264*</b>	<b>-75.6160*</b>
	<b>(27.5941)</b>	<b>(45.4326)</b>
<b>SIZE</b>	<b>-25.4891***</b>	<b>19.3044</b>
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<b>ADS</b>	<b>-.3021</b>	<b>4.9611*</b>
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<b>HUM</b>	<b>-14.0677</b>	<b>16.6668*</b>
	<b>(9.8392)</b>	<b>(9.5247)</b>
<b>R<sup>2</sup></b>	<b>0.0359</b>	<b>0.0359</b>

Model (4) and model (5) further separated patent types and investigates the impact on firm's profitability.

The result shows that the number of invention patents is significantly positive related to firm's profitability, while the number of new design patents is significantly negative related to firm's profitability.

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Specifically, model (4) shows the increase for each additional invention patent will increase firm's profitability about 45.9264%;

however, model (5) shows the increase for each additional new design patent will reduce firm's profit by 75.6160%.

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**Table 4** Profit Effects of Innovation-Patent  
Panel IV Fixed Effect Model

<b>Variable</b>	<b>Invention patents</b>	<b>Design patents</b>
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The result in table 4 demonstrates different types of patents can have difference impacts to firms profit performance.

As we find the increase number of invention patents indeed can help enhance firm's financial performance, whereas the increase number of new design patent generate opposite results and erode firm profits.

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## Innovation and Profitability: Firm-Level Evidence from Taiwan

This paper aims to evaluate the impact of innovation behavior for firm profitability in Taiwan.

Using a panel dataset of 641 enterprises listed on the Taiwan Stock Exchange over the period 2000-2010, the empirical results based on panel instrument variable (Panel IV) are summarized as below:

① innovation behavior has a significantly positive impact on firm profitability in Taiwanese manufacturing industry.

implying that there is potential profit-enhancing effect of firms' R&D activities.

This paper aims to evaluate the impact of innovation behavior for firm profitability in Taiwan.

Using a panel dataset of 641 enterprises listed on the Taiwan Stock Exchange over the period 2000-2010, the empirical results based on panel instrument variable (Panel IV) are summarized as below:

② we separate patent modes into invention patents and design patents.

It finds that the increase number of invention patents have a significantly positive effect on firm's profitability, while the increase number of design patents illustrate opposite effect.

This result shows different patent modes have different impact on firm profitability for Taiwanese manufacturing firms.

## Innovation and Profitability: Firm-Level Evidence from Taiwan



*Thank you for your attention !*