The Portfolio of Intangible Investments and Their Performance: Evidence from Taiwanese Manufacturing Firms

Hui-Lin Lin* Mei-Lan Lo**

*Professor, Department of Economics, National Taiwan University.

** Ph.D.student, Graduate Institute of Business Administration, National Taiwan University.

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Abstract

Intangible investments are not only important elements of knowledge creation, but also the driving forces of economic growth. Traditional studies of intangible investments have mainly focused on the investment of research and development (R&D) rather than non-R&D activities, which include employee training, advertisement, structure and network capital, marketing promotion, software, purchases of databases, payment of patents, etc. This paper focuses on Taiwan's manufacturing industry and utilizes panel data of the 2001, 2006, and 2011 to explore the determinants and performance of intangible investment. Our results, based on Seemingly Unrelated Regression (SUR), show that capital intensity, amount of outward investment and exporting, the size of firms, and firm ages are the main determinants of intangible investment. As for firm performance, Taiwanese manufacturing industry's output elasticity of intangible investment is estimated to be 0.07, which is relatively lower than other advanced countries. Among the three intangible investments, the economic competency (EC) is the most productive factor and innovation property (IP) is the most innovative factor.

***JEL Classification*:**

Keywords: Intangible Investment, SUR Model, R&D, Taiwanese manufacturing firms

1 Introduction

The intangible assets represent an important input into the innovative process and further enhance economic growth (Hertog *et al*., 1997; Baldwin & Sabourin, 2001; Brynjolfsson *et al*., 2002; Eustace, 2003; Kaplan & Norton, 2004; Barnett, 2009; Kramer *et al*., 2011). Intangible assets mainly include organizational cultures, learning capacities, intellectual capital, brand awareness, technology, economies of scale, heterogeneous products, marketing skills, and financing abilities (Hymer, 1976; Roberts, 1999; Rao *et al*., 2004).Even though intangible investment greatly influences a firm's overall value, most firms do not have sufficient investments. The main causes for such deficiencies include the financing of financial markets and the accounting valuation system of intangible assets. As for financing capacity, since banks prefer tangible assets such as plants and equipment as collateral for financing, most of the firms focus on tangible fixed capital investments. Besides, since the value of intangible assets such as the relationship between a customer, a supplier, and patents is unstable and difficult to compare, it is getting harder for accounting valuation.

In addition, arguments abound about whether intangible investments such as R&D expenditure and advertising investment should be classified as expenses or capital. Hence, many countries want to increase the proportion of intangible asset investment to GDP through subsidies or other policy measures to improve industrial international competitiveness. Taiwan has faced the same situation; our industries prefer tangible investment. According to the Industrial Census conducted by the Ministry of Economic Affairs, total fixed capital investment in 2010 amounted to New Taiwan Dollar 1,213.6 billion, surpassing the total revenue New Taiwan Dollar 1,095.6 billion in the same year.

Intangible investment, including not only R&D investment, but also non-R&D investment, is more important to innovation. Due to professionalism and non-repetitiveness, intangible investment can increase added value. Regardless of the sector, whether it involves the manufacturing or service industry, these intangible investments gradually become the decisive factors of the innovation process. Most previous related literature explores the relationship between R&D and innovation output or productivity, while little research focuses on non-R&D intangible investment due to the difficulty of obtaining related statistics. However, non-R&D intangible investments such as personnel training, marketing, and acquisition of software can make the technological innovation caused by R&D investments create more value. Only measuring R&D may provide the bias information of intangibles towards industries.

Hansen & Birkinshaw (2007) propose the Innovation Value Chain to describe the process of a firm's innovation development. There are three stages for innovation development: Idea Generation, Idea Conversion, and Idea Diffusion. In other words, in addition to R&D activities, the innovation development also includes packaging, servicing, marketing, customer consulting, payment, delivery, and storage of the innovation outputs. Not only do R&D inputs affect the innovation output, but also personal and institutional innovation ability, intra- and inter-sectoral cooperation, financing, and cost control ability can greatly influence innovation outputs. Other Non-R&D inputs are geared towards understanding client needs better and interacting more closely with users. (den Hertog,1997).As of now, intangible investments are still a widely underestimated area of the knowledge-based economy. It need more comprehensive discussion on the intangibles concepts, the determinants, and relationships between intangible investment and firm performance. Thus, Our research will focus on those issues by using the manufacturing industry firm-level panel data of Industry, Commerce, and Service Census taken in 2001, 2006, and 2011 as conducted by the Directorate-General of Budget, Accounting and Statistics, Executive Yuan. In this paper, we aim to discuss the following : (1). What is the current status of Taiwanese manufacturing firms' intangible investment expenditures and growth from 2001 to 2011? (2). What are the shares and determinants of each type of intangible investment? (3). What are the effects of intangible investment on output? Is there any difference among different types of intangible investments? Finally, we will propose useful industrial innovation policies based on the empirical results to help enterprises improve innovation capacity and competitiveness.

2 The Importance of Intangible Investment

In previous literature regarding intangible asset investment, determinants mainly focus on the Research and Development(R&D). Most studies conclude that R&D has a significantly positive effect on innovation activity and productivity (Mansfield, 1965a, 1965b, 1977, 1980; Griliches, 1981; Jaffe, 1989; Acs *et al*., 1992; Mairesse & Mohnen, 2005; Hall & Oriani, 2006). Little research reflects a negative correlation (Bergman, 2011) and inverted-U shape relationships (Stock *et al*., 2001). The former finds that external R&D has a negative effect on productivity, and the latter finds that R&D will bring about a positive effect on innovation performance during the early stage, yet the influence turns out to be negative in the later stages. In addition to the direct effect on innovation performance, R&D investments are also considered to increase the speed for technology transferring. That is, R&D investments are beneficial for the accumulation of institutional knowledge capital (Griliches, 1998; Griffith *et al*., 2000; Hall *et al*., 2010). Haskel & Wallis (2013) explore the influence of R&D investment subsidies in the United Kingdom. They find that the outputs of research institutes have a significant spillover effect. Hence, the government should enforce the investment in research institutes in an effort to influence more external benefits.

By sector, R&D investment is more important to the innovation activities in the high-tech industry. Non high-tech industries can utilize other intangible investments, including design, use of advanced equipment, and personnel training to maintain innovation ability. However, R&D investment is the basic requirement for high-tech industries to maintain a competitive edge (Santamaría *et al*., 2009). Moreover, there are also many studies about human capital investment. Bartel (2000) finds that the real rate of return of employee training investment can reach 100 to 200 percent. The results from studies conducted in the United States, United Kingdom, Spain, Japan, Australia, France, and Sweden show that even though the effect of educational training on innovation performance is slightly less than that of R&D, employee training investment does contribute to innovation output (Hashimoto, 1991; Black & Lynch, 1996; Ballot *et al*., 2001; Rogers, 2004; Dearden *et al*., 2006; Santamaría *et al*., 2009; Gallié & Legros, 2012; González *et al*., 2012). Some research indicates that the ability to adopt new technology is related to workers' training. Employee training can increase the adaptability -- the ability to adapt to technological change. Trained employees or employees with higher education have higher adaptability capacities and can more readily implement new technology, which is helpful for intra-institutional technology diffusion (Nelson and Phelps, 1966; Bartel & Lichtenberg, 1987). Ballot *et al*. (2001) found that the influence is the most significant concerning managers and engineers. Furthermore, firms may obtain greater opportunities to cooperate with other institutions and absorb the regional information through external training (Kramer *et al*., 2011). The success of innovative products and services is correlated with the extent of users' acceptance of new products or services. Therefore, intangible investments such as marketing and advertising are also highly valued. Rogers (2003) mentioned that it is not easy for consumers to accept innovative products at the early stage of diffusion. The enterprises need marketing and advertising investment to increase consumers' acknowledgement and acceptance, which will further accelerate the diffusion process.

Teece (1986) stated that marketing and distribution capabilities are necessary for innovations to earn profits. From 1988 to 1990, Chauvin & Hirschey (1993) used the data of 1,500 firms from COMPUSTAT and found that advertising and R&D expenditures positively and significantly contribute to a firm's market value. As for the effects stemming from a firm's size, regardless of sector, advertising and R&D expenditures are important to relatively larger firms, while advertising and R&D expenditures by smaller, specialized firms can be highly effective.

Information Technology (IT) investment is also considered a critical factor to drive intangible assets. IT is widely used in the stage of innovation and knowledge creation, and has positive correlations with innovation performances (Harris & Katz, 1991; Mahmood & Mann, 1993; Barua *et al*., 1995; Brynjolfsson & Hitt, 1996). Powell & Dent-Micallef (1997) proposed that IT information systems could accelerate a firm's internal communication and information transparency, serving as a platform for inter-departmental and external resource innovation communication. Besides, in the middle stage of production, IT information systems can improve innovation efficiency and further create more value. Usage or purchasing IT systems alone is not enough to yield a competitive advantage; however, IT information systems can generate significant benefits when combining with other factors such as business strategy and organizational structure (Bontis, 1998; Bontis & Girardi, 2000). Kleis *et al*. (2012) confirmed that a 10 percent increase in IT spending would increase innovation output by 1.7 percent. Brynjolfsson *et al*. (2002) found that firms with higher IT investment will have higher organizational capital and market value. The longer is a firm's IT investment, the more obvious the impact of IT investment on productivity will be. Research also finds that each dollar of computer capital may increase market value by 12 U.S. dollars.

Corrado *et al*. (2009) used the Bureau of Labor Statistics (BLS) survey data and concluded that the growth of intangible investment has a great impact on the growth of the non-farm business sector. Moreover, per-employee training expenditure increases with the size of the firm. It was noted that professional employees and managers received the most employee training. In addition, Delbecque & Bounfour (2011) used panel data of France, Germany, the United Kingdom, Sweden, Japan, and the United States over 15 years to estimate the contributions of labor, tangible, and intangible capital on growth. They found that various types of intangible capital, including software, R&D, architecture and design, advertising, training, and organization have positive contributions, especially software and organizational capital. However, the contribution of intangible capital is lower than that of labor and tangible capital. The researchers also conclude that product innovation has less impact on economic performance than process innovation. At times, process innovation has a greater contribution to growth than tangible assets. Due to the contribution to outputs, innovation should be encouraged and the innovation promotion policies should be planned in terms of individual industry. Furthermore, the government should not sacrifice labor and physical capital formation policies because both are still important factors that drive economic growth.

Domestic research such as Hsueh & Hsu (2009) used domestic-listed companies to analyze the relationship between intangible investment and a firm's return and risks. According to their findings, R&D intensity was correlated with a firm's return, and relation capital, innovation capital, and human capital would help to increase intangible asset output and a firm's performance. Chen & Wu (2008) used manufacturing data from the Industry, Commerce, and Service Census conducted in 1991 and 2001 to explore the relationship between skill upgrading and technological change, which was peroxided by R&D intensity; intensity of the purchased technology and computer ratio. The results showed that technological change had a significant impact on skill upgrading in Taiwan's manufacturing sector. There is also a significant correlation between firm size and skill upgrading. Industries with a lower SME ratio tend to have greater skill upgrading measures. Nevertheless, there is little research about the relationship between intangible investment and innovation in Taiwan. Only Wang & Liu (2011) used data of 130 listed companies in 2006. Findings showed that R&D manpower had a positive correlation with R&D performance, while the effect of R&D input was not significant. The researchers used cross-sectional data, and they do not take the deferred effect of intangible investment into consideration. Since the domestic research does not have a comprehensive assessment of various types of factors that affect intangible assets, and such research does not consider the long-term effects of intangible assets, we will use firm-level data in this study to explore the effect of each kind of intangible investment factor (Ballot *et al*., 2001; Stock *et al*., 2001).

3 Definition and Statistics of Intangible Investment

Taiwan has faced the rise of mainland China and competition with Korea, Singapore, Hong Kong, and Southeast Asian countries. Therefore, Taiwanese enterprises not only adopt overseas production strategies to reduce the cost, but they also actively carry out industrial restructuring and reallocation of resources, while further developing new strategic industries. In the 1990s, Taiwanese industrial policies focused on the development of knowledge economy, innovation, and higher education. However, innovation policies are multi-dimensional. Under the condition that the government has a limited budget, what is the optimal investment to enhance Taiwanese firms' competitiveness? How can Taiwan allocate different factors of production, and which type of innovation should be encouraged? To discuss the above issues, we will use the panel data from the 2001, 2006, and 2011 Industry, Commerce, and Service Census (ICSC) conducted by the Directorate-General of Budget, Accounting, and Statistics, Executive Yuan. First, we are going to observe the growth of the tangible and intangible investment. Figure 1 explicates the proportion of gross fixed capital formation (including inventory changes) to total GDP. According to Figure 1, the ratio of fixed capital decreased. It reached its highest record in 1994 (27 percent); the ratio dropped to 16 percent in 2009 due to the global financial crisis and it returned to 19.1 percent in 2013. Compared with Japan, the ratio of Japanese gross fixed capital formation to GDP was the highest in 1991 (20 percent), and it began to decrease until it was 14 percent when the financial crisis occurred in 2009. As a whole, the Taiwanese ratio of fixed investment to GDP is higher than that of Japan (Miyagawa, 2011).

The scope of intangible investment is wide ranging. The general definition of intangible investment is the cost and expenditure incurred for intangible assets such as expenditure of education and R&D or purchasing of know-how. According to the definition by OECD (1992), intangible investments cover all long-term expenditures instead of the formation of fixed assets by firms aimed at the development of the enterprise. They classify 12 assets as intangible investments, including market share, patents, copyrights, customer lists, R&D spending, human resources training and investment, royalties, product certification, branding, art, software, and trade secrets. Table 1-1 shows the firms, which have intangible investments during 2001 and 2011 in Taiwan, and the overall and average investment. We can find that from a number of firms' amount of investment, each firm's intangible investment spending and per employee intangible investment increased rapidly over the 2001-2006 period. Although all the above increased between during 2006 and 2011, the growth rate has slowed down. Taiwanese intangible investment to the GDP ratio reached 12.42 percent in 2011. Compared with other advanced countries, the Japanese intangible investment to GDP ratio has been on the rise since 1980s, and the ratio approached 11.1 percent during 2000 and 2005; the ratio of United States was 11.7 percent during 1998 and 2000, and reached 13.8 percent over 2003 and 2006. The ratio of the United Kingdom in 2004 was 10 percent. Hence, we can observe that in 2000 the share of intangible investment to GDP in Japan, the United States, and the United Kingdom has attained 10 percent (Fukao *et al.*, 2009). Although the Taiwanese ratio of intangible investment to GDP has been rising in recent years, the share was only 3.36 percent in 2001, which is relatively lower to that of other advanced nations. Further,Table1-2 indicates firms in Taiwan spent expenditure on investing intangible is minority. The ratio in all industry is 1.62%,even though in manufacturing sector is only 6.68%.From the above discussion, we find that Taiwan has a higher share of fixed capital investment to GDP and a lower intangible investment ratio, which is not favorable to Taiwanese economic growth.

Corrado *et al*. (2005) grouped intangible investments into three categories: computerized information, innovative property, and economic competencies. The detailed definitions are as follows:

1. Computerized Information(CI)

   (a) Computerized information refers to knowledge embedded in computer programs and computerized databases. It covers computer software and computerized databases.

   (b) Computer software was recognized in the national income and product accounts (NIPAs) in 1999.

2. Innovative Property(IP)

   (a) In addition to the traditional R&D spending, this category encompasses 'non- scientific R&D' such as patents, licenses, general know-how (not patented) and artistic content in commercial copyrights, licenses, and designs.

   (b) According to the definition by the National Science Foundation (NSF), industrial R&D means the expenditures used on the design and development of new products and processes and on the enhancement of existing products and processes. These expenditures are restricted to activities carried out by professionals in certain fields including the physical sciences, the biological sciences, engineering and computer science (excluding geophysical, geological, artificial intelligence, and expert systems research), and mining R&D.

   (c) Non-scientific R&D spending is basically about the information industry, which includes book publishers, motion picture producers, sound recording producers, broadcasters, as well as financial and other service industries that consider R&D and the introduction of new products as a routine process.

(d) As for the financial services industries, Corrado *et al.* (2005) broadened the coverage of new product development costs to include security and commodity brokers and other financial investments and related activities.

3. Economic Competencies(EC)

(a) Economic competencies consist of three types of assets: brand names, firm-specific human capital, and organizational structure.

(b) Brand development spending includes expenditures on advertising, market research, introducing new products, developing customer lists, and maintaining brand value.

(c) Firm-specific human capital covers both direct expenses such as outlays on instructors and tuition reimbursements, and the indirect wage costs associated with employees' time expenditures in formal and informal training.

(d) The spending on organizational structure includes both own-account and purchased parts. The former is calculated by the time that managers spent on adjusting or improving business models and corporate cultures. The latter is represented by management consulting fees.

To compare Taiwanese intangible investments with other countries, we are going to adopt the definitions and framework by Corrado et al. (2005); we classify intangible investments into three categories: Computerized Information (hereinafter referred to as CI), which includes computer software and databases, Innovative Property (IP), which includes R&D and purchasing techniques, and Economic Competencies (EC), which includes employee training and marketing. According to the data of Industry, Commerce, and Service Census shown in Table 2, among three categories the share of IP is the highest (51.9 percent), followed by spending on EC (43.96 percent) and CI (4.14 percent). Compared to the data of Ontario, Canada in 2008, among the three categories of intangible investment, the share of EC was the highest (50.3 percent), followed by IP (33.4 percent) and CI (16.3 percent) (Muntean, 2014). Moreover, compared with Japan during 2000 and 2005, the share of IP is 54 percent, followed by EC (26.12 percent) and CI (19.81 percent). It is obvious that Taiwan has a relatively high share of IP, but a lower share of CI. As far as the manufacturing sector is concerned, it has the highest share of IP (63.34 percent) and the shares of EC and CI are 34.36 percent and 2.3 percent, respectively. In the Japanese manufacturing industry between 2000 and 2005, shares of IP, EC, and CI were 69.27 percent, 18.07 percent, and 12.65 percent. Among the four main industries in Taiwan, EC is regarded as the most important intangible investment in the consumer goods and chemical industries (50.88 percent), while the metal and information electronics industries consider IP to be of significant importance (72.22 percent).

Lev (2001) thought the main drivers of intangible assets were innovation, human resources, organizational processes, and the relationship between customers and suppliers; therefore, R&D, advertising or brand support, intangible asset expenditure, as well as acquisition of information systems and technology could be regarded as the main variables for intangible investment. Since 2006, the Directorate-General of Budget, Accounting, and Statistics has grouped intangible investment into five types: R&D, employee training, marketing, computer software and databases, and technology buyout. Figure 2 depicts the allocation of the five categories of intangible investments from 2006 through 2011. Figure 2, Table 3, and Table 4 show that the total intangible investments (and most of the intangible investments) increased from 2006 to 2011, while employee training expenditures decreased during this time. As for the growth rate, technological acquisition had the highest growth (107 percent), followed by R&D (64 percent), marketing (45.28 percent), and purchase of software and database (22.92 percent). The expenditure spent on marketing was the highest, followed by R&D, technological acquisition and employee training, implying that Taiwanese firms did not pay much attention to improving human resource quality. This result differs from that of Delbecque & Bounfour (2011) who found that both France and Germany had the highest share of R&D to intangible investments (20 percent in France and 25 percent in Germany), and the second highest was the share of employee training (15 percent in France and 20 percent in Germany). Figure 3 shows the shares of five intangible investments. Between 2006 and 2011, marketing and R&D comprised the largest proportion. The former took about 41 to 44 percent, followed by R&D (about 36 to 38 percent) and technological acquisition (10 to 13 percent), while shares of computer software decreased from 5.3 to 4.14 percent and employee training from 3.3 to 2.05 percent. These findings may be due to economic recession; the enterprises curtailed employee training expenditures.

4 Methodology

4.1 Seemingly Unrelated Regression Model

The first stage of this study is to investigate the determinants of intangible investment, which includes computerized information (CI), innovative property (IP), and economic competencies (EC). During this stage, we find out whether there are complementary or substitute effects among the inputs. These investments are not independent due to firms' financial limitations, so it is not appropriate to assume the three types of intangible investments are independent. Therefore, we will adopt the Seemingly Unrelated Regressions Model to set up three intangible investment equations. Since we would like to collect two periods (including 2006 and 2011) of panel data, the main equations are as follows:

$$Y_{1it} = \acute{a}_1 + X_{1it}^{I}\hat{a}_1 + \mathring{a}_{1it} \tag{1}$$

$$Y_{2it} = \acute{a}_2 + X_{2it}^{I}\hat{a}_2 + \mathring{a}_{2it} \tag{2}$$

$$Y_{3it} = \acute{a}_3 + X_{3it}^{I}\hat{a}_3 + \mathring{a}_{3it} \tag{3}$$

where Y_{kit} ($k = 1, 2, 3$) is the dependent variable representing three types of intangible investments; $i = 1, \cdots, n$ meaning there are n firms; and $t = 1, 2$ implying two periods. The $\hat{a}_k$ ($k = 1, 2, 3$) and $\acute{a}_k$ ($k = 1, 2, 3$) are the parameters in which we are interested. The X^{I}_{kit}s ($k = 1, 2, 3$; $i = 1, \cdots, n$; $t = 1, 2$) are vectors of independent variables, and the $\mathring{a}_{kit}$s are random error terms. In each equation, we have the following assumptions: $E(\mathring{a}_{kit}\mathring{a}_{kjt}) = \acute{o}_{ij}$, $E(\mathring{a}_{kit}\mathring{a}_{kjs}) = 0$ for all i, j and $t \neq s$. In other words, there exists covariance among different firms in the same period, but not in different periods, and also there is no serial cross correlation.

If we use OLS to estimate the above three equations, we will obtain consistent but not efficient $\acute{a}_i$ and $\hat{a}_k$ because $\mathring{a}_{kit}$ ($k = 1, 2, 3$) are correlated and might be correlated with X^{I}_{kit}. To solve the problems that the estimators are not efficient and are not considered the best linear unbiased estimator (BLUE), we first plan to use generalized least squares (GLS) to obtain the efficient estimators. However, considering an individual firm's heterogeneity, the estimators from GLS might be inconsistent. Hence, to get consistent and efficient estimators, we are going to use the Fixed Effect model described as follows:

$$Y_{kit} = \acute{a}_{ki} + X_{kit}^{I}\hat{a}_k + \mathring{a}_{kit} \tag{4}$$

where $k = 1, 2, 3$; $i = 1, \cdots, n$; $t = 1, 2$.

According to the Frisch-Waugh Theorem (1933), the main estimation method is to derive: $Y_{kit} - \overline{Y}_{ki}$ and $X_{kit} - \overline{X}_{ki}$, and regress $Y_{kit} - \overline{Y}_{ki}$ on $X_{kit} - \overline{X}_{ki}$ to obtain the estimator:

$$\hat{\hat{a}}_{OLS} = (X^{I} M_D X)^{-1} X^{I} M_D Y$$

where Y is a $3 * 1$-dependent variable vector, and let X be a $3 * 3$ matrix of independent variables. M_D is a type of residual-making matrix, where $M_D = I - D(D^{I}D)^{-1}D^{I}$. When M_D is multiplied into any vector or matrix, the product is the residual from regressing the vector or matrix on X.

4.2 Intangible Investment Production Function

After we investigate the determinants of intangible investment, we then use the Cobb-Douglas production function to estimate the impact of traditional factors of production and intangible investment on productivity. The following is the production function equation:

$$(VA)_{it} = e^{\ddot{e}t}(TC)^{\acute{a}}_{it}(LI)^{\hat{a}}_{it}(IC)^{\tilde{a}}_{it}e^{\mathring{a}_{it}} \tag{5}$$

where VA represents the output measured by *value added*; TC indicates *tangible capitals* measured by net amount of actually used fixed assets in the end of that year including net amount of self-owned fixed assets and borrowed fixed assets; LI means *labor input* and IC is the variable for intangible investment. The subscript it for each variable refers to the observation of firm i in period t. $\ddot{e}$ represents the exogenous technology improvement. After taking the natural logarithm of Equation (5), we get the following regression model:

$$\ln(VA)_{it} = \ddot{e}t + \acute{a}\ln(TC)_{it} + \hat{a}\ln(LI)_{it} + \tilde{a}\ln(IC)_{it} + \mathring{a}_{it}$$

where $\mathring{a}$ is the random error term and $\acute{a}$, $\hat{a}$, and $\tilde{a}$ are coefficients. To analyze the relationship between intangible investment and output, we assume that there is an individual firm's effect. That is, an individual firm's effect is associated with other options, so we assume that:

$$\mathring{a}_{it} = \acute{i}_{it} + u_i$$

where u indicates individual effect, and $\acute{i}_{it}$ is a random term implying that the influence of the same firm is random in different periods. We utilize panel data of 2001, 2006, and 2011, and adopt the Fixed Effect (FE) model or the Random Effect (RE) model to eliminate individual effects. Then we are going to use the Hausman test to tell which model is more suitable. Moreover, we classify the intangible investment (IC) into three types (CI, IP, and EC) based on the definitions by Corrado *et* *al*. (2005). KT indicates tangible capitals measured by net amount of actually used fixed assets in the end of that year including net amount of self-owned fixed assets and borrowed fixed assets so the complete model will be as follows. Summary statistics are described in Table 5.

$$\ln(VA)_{it} = \text{ë}t + \text{á}\ln(\mathrm{KT})_{it} + \text{â}\ln(LI)_{it} + \text{ö}_1 \ln(CI)_{it} + \text{ö}_2 \ln(IP)_{it} + \text{ö}_3 \ln(EC)_{it} + \text{í}_{it} + u_i \tag{6}$$

4.3 Intangible Investment Innovation Function

Our study investigates also how intangible asset investments relate to innovation performance. Replacing the logarithm of value-added by the sale ratio of innovation product to total products (NEWP), equation (7) is rewritten as follows.

$$P_{it} = \alpha + \beta X + \sum \gamma_v \, ln \, I_{vit} + \varepsilon_{it} \tag{7}$$

We use Tobit model to estimate the relationship between innovation intensity (product innovation output/total output) and intangible investments. This measure has been adopted as a proxy of innovation in previous studies, such as Jefferson et al. (2005) and Yam et al. (2004). Term X is a vector of firm characteristics, including the firm characteristics, including firm age ,firm scale ,profit rate, capital intensity.Term I_{vit} is a vector of intangibles consisting of three assets as discussed previously.

5 Empirical Results

Table 6 states the empirical results for the determinants of three categories of intangible investments (CI, IP, and EC). At first, we assume that three categories of intangible investments are independent of one another. Under this assumption, we can find that it is better to adopt the Fixed Effect model for three categories of intangible investments. The X_k vector of regressors include five variables: scale, firm age, capital intensity, foreign investment, and export sale. The variable scale is a dummy variable, which equals to 1 for the firm with more than 200 employees, and 0 otherwise. In addition, we also control the time effect and 25 two-digit industry dummy variables. Since we suspect that there might be a correlation among three categories of intangible investments, assuming their independence may lead to biased results (Greene, 2007). Therefore, instead we consider the Seemingly Unrelated Regressions (SUR) model and the estimation results are shown in Table 7. Comparing Table 6 and Table 7 show differences exist. Based on the results from Table 7, three categories of intangible investments are truly correlated, which means that assuming three types of intangible investments' independence will produce incorrect results. According to Table 7's SUR model results, we conclude the following:

1. As for CI, scale has the greatest impact, implying that large firms are more likely to purchase computer software and databases than small firms. Furthermore, younger firms are more prone to invest in CI than older firms. The other three variables, capital intensity, foreign investment, and export sale have significantly positive impacts on CI.

2. In terms of IP, the main input that contributed to IP is R&D. Our results show that large firms are more likely to engage in R&D and this verifies the Schumpeter Hypothesis (1942) that innovations are stimulated and promoted by large firms. However, compared with old firms, younger firms will be less likely to invest in R&D, probably because R&D investments cost more for younger firms or it is not easy for them to purchase technologies. Moreover, our findings indicate that capital intensity is significantly negatively correlated with R&D inputs, mainly because firms with large capital intensity pay more attention to economies of scale and cost reduction instead of technological upgrades. As for the other two operating variables, foreign investment and export sale, both have a significant and positive effect on IP. This may be because firms with higher foreign investment or exporting share face more global pressure to compete and further need more R&D inputs.

3. The main components of EC are expenditures on employee training and marketing. Similarly, large companies have relatively more investments in EC than smaller firms. They are more willing to invest in nurturing talent, and more capable of dedicating capital for marketing or

advertising. Older firms are also more willing to spend on EC. Finally, capital intensity, foreign investment, and export sales have a significantly positive influence on EC.

4. In general, most of the explanatory variables have similar effects on three categories of intangible investment. The differences between coefficients in scale and firm age are larger. Among three other operating variables, foreign investment has a greater effect on IP (R&D), implying that when a firm has more foreign investments in the long run, it will be more involved in R&D.

Table 8 states the results by using the production function to explore the influence of intangible investment expenditures on firms' output. The empirical results show that the Fixed Effect model is more appropriate in this study. From the results, we observe that the coefficient of intangible investments is 0.0769, which means when intangible investments increase by 10 percent, the output will have a 0.769 percent increase, lower than the increased output of tangible investment (0.955 percent). Compared to the results of European countries and the United States (0.18), we have a much smaller coefficient for intangible investment (Delbecque & Bounfour, 2011). However, they use the overall production function to estimate. Hence, there is still a need for further research to determine why Taiwanese firms have lower productivity of intangible investments.

To realize the tread of the productivity contribution of the intangibles, we estimate the elasticity of tangible and intangible capital using the datasets of individual year. Table 9 shows ,after adding the intangible capital variable(KI) , labor input(LI) and tangible capital(KT) effect have declined slightly. The effect of KI was much smaller than LI and KT. However, It increased year by year (from 0.0434 to 0.119),nearly triple within a decade ,that indicates the intangibles to value-added are more important in Taiwan economy.

We divide intangible assets into three categories, and Table 10 shows the estimation results of how each type of intangible investment influences output. From Table 10, the Fixed Effect model is a better model for explication. The coefficients for three types of intangible investments are 0.00749 (CI), 0.0105 (IP) and 0.0704 (EC), respectively. EC has the largest coefficient, thus enhancing intangible investment in EC will bring the most positive effects.

According to the definitions of EC, EC includes three types of assets such as brand names, firm-specific human capital, and organizational structure. Thus, enterprises should engage in intangible investments within these areas to create greater benefits. Delbecque & Bounfour (2011) concluded that among these three categories, the coefficient of CI is the largest in European countries and the United States (0.24). Nevertheless, the effect of CI is the lowest in the Taiwanese manufacturing industry, which is only 0.0074.

To figure out whether there is a complementary or substitute effect among these three types of intangible investments, we add the intersection terms in our model and the results are shown in the last column of Table 10. We conclude that IP and CI share complementary effects, while the relationship between EC and the other two types both are substituted in nature. In other words, when a firm engages in R&D activities and purchases computer software or databases at the same time, it can yield more outputs.

Fellowed the deflators of intangibles by Carrado et al.(2009) and Baldwin et al.(2012), we compared the stock measure with flow measure. Table 11 reports the estimation results. Columns (1)(3)(5) present the coefficients on intangibles by using the stock measure of intangibles, whereas columns (2)(4)(6) report the coefficients of flow measure on intangibles. the results of Stock Measure is similar with the Flow Measure. When the flow data of firm is not available , the stock measure could be an appropriate substitute method.

We now compare the investment portfolio between SMEs and large firms in Taiwan. As displayed in Table 12, we use more detail data by dividing IP into R&D and the Technology buyout, EC into Employee training and Marketing. Accounting ICSC survey, R&D includes operating expenses, personnel costs, maintenance costs, materials, outsourcing R&D, related intangible assets such as patent. Employee training includes instructor fees, site fees for conducting training, registration fee of assigned training , personnel and businesses ,etc. of training department. Marketing includes advertisement, market research ,packing design ,communication and public relations, and personnel and businesses of marketing department. SMEs have only less resource to invest in intangibles, However, it seem to deploy the portfolio more efficiently. Columns (1)- (3) present the most investment elasticities of SMEs are larger than Large firm. Marketing is specifically relevant to SMEs. Relatively speaking, Technology buyout are more favorable to Large firms. SMEs seem to focus on internal development reduced innovation complexities and speeded up the innovation process (Rosenbusch et al.,2011).In the other perspective, the absorptive capacity(Cohen and Levinthal ,1989) of SMEs on External technology sourcing is inferior to large firm.

Finally, we conduct estimations to assess the impacts of various intangibles on innovations by Tobit regression method. Table 13 lists the main estimation results. Columns (1) shows the intangible investment enhance firm innovation performance. Dividing into CHS groups, IP enters with a larger significantly positive coefficient (0.0311) than EC(0.0176). It suggests IP is the main driver facilitating firms to develop product innovations. CI has significant negative effect (-0.00294) on innovation performance. To develop the new product, some firms use information technology for workgroups, workflows, documentation management and customer forecasting. Despite IT improve efficiency and inventory turns, it also allow for increased variety. That is why some firms in Taiwan have used IT to great advantage, but most only limited utility. CI investment should be implemented wisely and thoughtfully on innovation process. In particular, incapable of using more data and sophisticated model may lead to the inefficiency of CI intangibles.

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6 Conclusion

In this paper, we use data from the Industry, Commerce, and Service Census (ICSC) conducted by the Directorate-General of Budget, Accounting, and Statistics, Executive Yuan, from 2001 through 2011 to analyze the status of manufacturing intangible investments. We find that the amount of intangible investment expenditure in 2001 was more than New Taiwan dollars 200 billion and it was over 1,300 billion New Taiwan dollars in 2011, a growth of 130.52 percent. The share of intangible investment to GDP increased from 3.36 percent in 2001 to 12.42 percent in 2011. Compared to other European countries, the United States, and Japan, Taiwanese intangible investment spending is relatively low, but fixed capital investment is higher. In 2011, although the share of intangible investment increased substantially, the ratio of intangible investment to fixed assets is still low compared to advanced countries such as the United States and Japan.

By the CHS classification, we divide intangible investments into three main categories: Computerized Information (CI), Innovative Property (IP) and Economic Competencies (EC), which accounted for 4.14 percent, 51.90 percent, and 43.95 percent, respectively in 2011, implying that Taiwanese major intangible investments focused on Innovative Property. In addition, the share of IP is higher in the manufacturing industry (63.34 percent), especially in the Information & electronic industry (72.22 percent).

In this study, we point out five factors that affect three intangible investments: scale, firm age, capital intensity, foreign investment, and export sale. The empirical results show that larger firms are more likely to engage in IP and EC investment. The capital intensity has a positive impact on CI and EC, but has a negative influence on IP. Both operating variables -- foreign investment and export sale -- have positive and significant effects on three categories of intangible investments. We also prove the existence of Schumpeter's hypothesis that large firms are more willing to engage in innovation-related intangible investments. However, a substitute effect exists between tangible and intangible capital. Large companies with a great amount of tangible investment will be less likely to invest in intangible assets. This may be due to investment in tangible assets target expanding the scale and lowering costs, instead of focusing on intangible investments.

Finally, we observe that the output elasticity of intangible investment is 0.0769, almost the same as that of fixed assets (0.0955). In other words, intangible investment has a very important productivity effect. Among three categories of intangible investments, EC is the most productive. On the other hand, IP is the most innovative factor. However, CI investment is unfavorable on innovation performance.

According to our empirical result, intangibles can promote productivities and innovation, Taiwan policy-maker and the firm manager should develop the strategy to increase the portfolio of intangibles for better performance. We need to conduct further research to discuss the determinants and output elasticity of three types of intangible investments in the Taiwanese service industry. In addition, how intangible investments affect Taiwanese industrial development, economic growth or productivity is also a possible future research direction.

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Table 1-1: Overview of the Overall Industrial Intangible Investment

Data period	No. of firms	Total amount of intangible investment[1]	Average intangible investment	Per-employee intangible investment	Intangible investment intensity[2]
2001[3]	935,316	234,935,222	251.2	35.3	3.36%
2006	1,105,102	920,693,245	833.1	121.9	9.80%
2011	1,184,811	1,325,683,036	1,118.9	165.4	12.42%

[1] We use the current period number of total amount of intangible investments, average intangible investments, and per-employee intangible investment, and the unit is 1,000 New Taiwan dollars.[2] The definition of intangible investment intensity is the ratio of total intangible investment expenditure to whole year GDP.[3] 2001 only collected R&D and Technology Buyout Data.

Table 1-2: Overview of the Overall Industrial Intangible Investment

(%)	ratio of enterprise units investing intangibles in all industries	ratio of enterprise units investing intangibles in manufacturing	ratio of manufacturing enterprise units investing intangibles to all enterprise units investing intangibles	ratio of manufacturing intangible investment to all industries intangible investment
2001	0.92	3.69	60.56	81.40
2006	1.09	4.61	56.41	67.27
2011	1.62	6.68	54.93	71.37

Table 2: Overview of Three Types of Intangible Investments

Industry	Computerized Information (CI)		Innovative Property(IP)		Economic Competencies(EC)	
	2006 Amount	*2011 Amount*	*2006 Amount*	*2011 Amount*	*2006 Amount*	*2011 Amount*
Total	48,787,702 (5.30%)	54,905,334 (4.14%)	427,801,300 (46.47%)	688,071,830 (51.90%)	444,104,243 (48.24%)	582,705,872 (43.96%)
Manufacturing	18,716,217 (3.02%)	21,714,738 (2.30%)	361,824,637 (58.42%)	599,271,832 (63.34%)	238,850,860 (38.56%)	325,119,809 (34.36%)
Food, Textile and Other	1,308,387 (3.73%)	1,245,441 (1.56%)	9,317,265 (26.55%)	33,802,631 (42.29%)	24,470,101 (69.72%)	44,884,561 (56.15%)
Chemical	2,388,111 (2.84%)	2,489,729 (2.36%)	27,121,764 (32.30%)	37,456,222 (35.47%)	54,461,491 (64.86%)	65,660,575 (62.17%)
Metal & Machinery	4,473,639 (5.00%)	2,768,906 (2.77%)	44,059,802 (49.19%)	50,800,876 (50.88%)	41,028,294 (45.81%)	46,266,363 (46.34%)
Information & electronic	10,498,214 (2.60%)	15,210,662 (2.30%)	280,878,524 (69.59%)	477,212,103 (72.22%)	112,247,475 (27.81%)	168,308,310 (25.47%)

[1] The unit for three types of expenditure is 1,000 New Taiwan dollars.[2] The figures in parentheses represent the shares.

Table 3: The Growth Rate of Overall Intangible Investment Spending

Type of Industry	2001-2006 Growth Rate[1]	2006-2011 Growth Rate[2]	2001-2011 Growth Rate[3]
Overall Industry	306.63%	55.56%	130.52%
Manufacturing	236.06%	65.03%	135.95%

[1] The growth rate is calculated by subtracting data of one census from that of another census, rather than using data of each year.
[2] The calculation is the same as above.
[3] The growth rate is the geometric mean of the 2001-2006 growth rates and 2006-2011 growth rates.

Table 4: Growth Rate of Three Types of Intangible Investment from 2006 to 2011

Type of Industry	**Overall Growth Rate**	**Computerized Information**	**Innovative Property**	**Economic Competencies**
Overall Industry	55.56%	21.59%	73.77%	41.76%
Manufacturing	65.03%	25.35%	78.94%	47.06%
Consumer Goods	146.06%	2.84%	291.96%	98.17%
Chemical	35.87%	12.64%	49.20%	30.25%
Metal and Mechanical	20.43%	-33.13%	24.57%	21.83%
Information Technology	76.86%	56.53%	83.56%	62.00%

Table 5: Summary Statistics

Variable	Measurement[1]	Observations	Mean (Std. Dev.)	Max (Min)
VA	Value- added input	90,156	41,511	291,000,000
			(1,411,072)	(5)
Employee	No. of employees	90,156	23	30,081
			(196)	(1)
KI	Net amount of actually used fixed assets in the end of that year	90,156	75,078	481,000,000
			(2,702,682)	(1)
IC	Total expenditure on R&D, employee training, marketing, purchasing software and databases, and acquisition of technology	90,156	5,969	54,000,000
			(259,917)	(0)
CI	Expenditure on purchasing software and databases	60,104	213.5	1,706,470
			(10,371.3)	(0)
IP	Expenditure on R&D and acquisition of technology	60,104	5,201.6	49,900,000
			(269,264.6)	(0)
EC	Expenditure on employee training and marketing	60,104	2,576.3	10,900,000
Scale	Equals to 1 when employees are greater than 200	90,156[2]	(0.4024)	(0)
Firm Age	The observation year minus the registered start year	90,156	18.7	99
			(10.4)	(0)
Capital Intensity	Net amount of actually used fixed assets in the end of that year divided by employee	90,156	1,614	142,645.8
			(2,674.3)	(0.11)
Foreign Investment[3]	Long- term investment-overseas	60,104	28,522	105,000,000
			(866,530)	(0)
Export Sale	Propensity to export	60,104	172,528.5	1,000,000,000
			(6,875,588)	(0)

[1] The unit for amount is 1,000 New Taiwan dollars. Data source: 2001, 2006, and 2011 Industry, Commerce, and Service Census (ICSC) conducted by the Directorate-General of Budget, Accounting and Statics, Executive Yuan.

[2] Total numbers of dummies that equal 1 are 88,890 firms.

[3] This variable has been compiled since 2006, so there are only two periods of observations.

Table 6: Estimation Results of the Determinants of Three Types of Intangible Investments

	Fixed Effect CI	Fixed Effect IP	Fixed Effect EC
Scale	-0.0632	0.0148	-0.0640
	(-1.19)	(0.47)	(-1.36)
Firm Age	-0.0606***	-0.000170	-0.0209***
	(-73.73)	(-0.35)	(-28.77)
Ln(Capital intensity)	-0.00117	-0.0184***	-0.0149***
	(-0.49)	(-12.98)	(-7.13)
Ln(Foreign investment)	0.0562***	0.0453***	0.0302***
	(27.47)	(37.00)	(16.75)
Ln(Export sale)	0.00766***	0.00817***	0.00863***
	(8.38)	(14.93)	(10.69)
_cons	1.848***	0.215***	1.366***
	(31.59)	(6.12)	(26.46)
Year	YES	YES	YES
Industry	YES	YES	YES
N	60104	60104	60104
Within R^2	0.200	0.058	0.051
Between R^2	0.010	0.283	0.011
Overall R^2	0.024	0.204	0.014
Hausman Test	5060.58	928.41	759.53

[1] **t** statistics in parentheses.
[2] $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$

Table 7: Estimation Results of the Determinants of Three Types of Intangible Investments — SUR Model

	Fixed Effect CI	Fixed Effect IP	Fixed Effect EC
Scale	0.454***	0.0307***	0.554***
	(42.59)	(4.11)	(62.09)
Firm age	-0.00450***	0.000897***	0.000384**
	(-23.77)	(6.58)	(2.43)
Ln(Capital intensity)	0.00732***	-0.00505***	0.00733***
	(5.48)	(-5.63)	(6.55)
Ln(Foreign investment)	0.0377***	0.0545***	0.0241***
	(35.45)	(75.47)	(27.05)
Ln(Export sale)	0.0219***	0.0202***	0.0173***
	(41.85)	(58.54)	(39.45)
Year	YES	YES	YES
Industry	YES	YES	YES
N	60104	60104	60104

[1] **t** statistics in parentheses.
[2] $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$

Table 8: Estimation Results of Cobb-Douglas Production Function

	Random Effect Ln(VA)	Fixed Effect Ln(VA)
Ln(LI)	0.813***	0.683***
	(335.23)	(143.51)
Ln(KT)	0.124***	0.0955***
	(82.50)	(44.84)
Ln(KI)	0.0926***	0.0769***
	(89.38)	(53.45)
_cons	5.571***	6.097***
	(512.21)	(316.68)
Year	YES	YES
Industry	YES	YES
N	60104	60104
Within R^2	0.5466	0.5489
Between R^2	0.9372	0.9371
Overall R^2	0.9046	0.9043
Hausman Test	1437.31***	

[1] t statistics in parentheses.

[2] $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$

Table 9: Aggregated Effect of Intangibles on Productivity (2001~2011)

	(1) 2001 ln_VA	(2) 2006 ln_VA	(3) 2011 ln_VA	(4) 2001 ln_VA	(5) 2006 ln_VA	(6) 2011 ln_VA
ln_LI	0.870***	0.924***	0.921***	0.857***	0.869***	0.755***
	(372.37)	(363.47)	(260.99)	(369.67)	(322.13)	(182.13)
ln_KT	0.177***	0.111***	0.172***	0.169***	0.100***	0.144***
	(88.08)	(58.03)	(71.29)	(84.79)	(54.23)	(62.95)
ln_KI				0.0434***	0.0617***	0.119***
				(34.62)	(49.22)	(65.93)
_cons	4.973***	5.771***	4.850***	5.053***	5.766***	5.138***
	(287.54)	(335.33)	(228.18)	(295.21)	(348.30)	(252.60)
Industry	YES	YES	YES	YES	YES	YES
N	30,052	30,052	30,052	30,052	30,052	30,052
R^2	0.946	0.921	0.879	0.948	0.927	0.894
adj. R^2	0.946	0.921	0.879	0.948	0.927	0.894

t statistics in parentheses
* p<.1, ** p<0.05, *** p<0.01

Table 10 Effect of CHS Intangibles on Productivity

ln_VA	(1)RE	(2)FE	(3)RE	(4)FE
ln_LI	0.812***	0.685***	0.812***	0.683***
	(332.79)	(143.59)	(332.38)	(142.98)
ln_KT	0.123***	0.0950***	0.123***	0.0956***
	(81.48)	(44.44)	(81.22)	(44.76)
ln_CI	0.0209***	0.00749***	0.0274***	0.0223***
	(13.09)	(3.53)	(9.14)	(5.67)
ln_IP	0.0278***	0.0105***	0.0186***	0.0278***
	(23.08)	(5.45)	(7.10)	(7.66)
ln_EC	0.0742***	0.0704***	0.0744***	0.0756***
	(63.42)	(46.67)	(58.67)	(45.77)
ln_IP_ln_EC			0.00124***	-0.00339***
			(3.31)	(-6.18)
ln_IP_ln_CI			0.000749*	0.00115*
			(1.71)	(1.96)
ln_EC_ln_CI			-0.00166***	-0.00319***
			(-2.97)	(-4.33)
_cons	5.622***	6.128***	5.623***	6.115***
	(507.69)	(318.19)	(501.29)	(317.07)
Year	Yes	Yes	Yes	Yes
N	60,104	60,104	60,104	60,104
R^2 within	0.5432	0.5467	0.5431	0.5480
R^2 Between	0.9371	0.9365	0.9372	0.9352
R^2 Overall	0.9044	0.9034	0.9044	0.9022
Hausman Test		1447.33***		1563.02***

t statistics in parentheses

* p<.1, ** p<0.05, *** p<0.01

Table 11 The Stock and Flow Measure of intangibles

	(1)Stock ln_VA	(2)Flow ln_VA	(3) Stock ln_VA	(4)Flow ln_VA	(5)Stock ln_VA	(6)Flow ln_VA
ln_LI	0.921***	0.921***	0.768***	0.755***	0.760***	0.752***
	(260.93)	(260.93)	(185.52)	(183.43)	(181.91)	(181.60)
ln_KT	0.172***	0.172***	0.142***	0.145***	0.140***	0.142***
	(71.33)	(71.33)	(61.24)	(63.60)	(60.00)	(62.07)
ln_KI			0.123***	0.119***		
			(61.86)	(66.93)		
ln_CI					0.0344***	0.0273***
					(13.74)	(9.87)
ln_IP					0.0209***	0.0248***
					(12.17)	(13.73)
ln_EC					0.100***	0.105***
					(42.80)	(50.75)
_cons	4.849***	4.849***	4.943***	5.123***	5.038***	5.168***
	(228.20)	(228.20)	(246.28)	(253.11)	(245.23)	(253.48)
Industry	YES	YES	YES	YES	YES	YES
N	30052	30052	30052	30052	30052	30052
R^2	0.879	0.879	0.893	0.895	0.893	0.895
adj. R^2	0.879	0.879	0.893	0.895	0.893	0.895

t statistics in parentheses

* p<.1, ** p<0.05, *** p<0.01

Table 12 The Productivity Model(SMEs vs. Large firms)

	(1) ALL firms	(2) SMEs	(3) Large firms
lnLI	0.836***	0.833***	0.698***
	(307.20)	(300.67)	(20.21)
lnKT	0.139***	0.138***	0.254***
	(83.15)	(81.88)	(11.56)
lnR&D (IP1)	0.019***	0.020***	0.017***
	(12.97)	(12.59)	(3.53)
lnTeBuy (IP2)	0.006***	0.003	0.013***
	(2.88)	(1.30)	(2.75)
lnHR (EC1)	0.049***	0.048***	0.033***
	(22.89)	(21.89)	(3.53)
lnMKT (EC2)	0.067***	0.072***	0.007
	(42.81)	(49.28)	(1.42)
lnIT (CI)	0.029***	0.031***	0.015***
	(15.81)	(15.38)	(3.11)
Constant	5.368***	5.375***	5.371***
	(340.72)	(339.56)	(22.63)
Ind. Dummy	Yes	Yes	Yes
LM Test	**1,585*****	**1,469*****	**97.4*****
R-square	**0.897**	**0.875**	**0.817**
N # obs.	**60,104**	**59,038**	**1,066**

Table 13 The Innovation Performance Model

	(1)	(2)
	ratio_innov_sale	ratio_innov_sale
ln_age	0.0680***	0.0600***
	(14.19)	(13.32)
ln_wage_pw	-0.0363***	-0.0379***
	(-6.62)	(-7.62)
Profit_Rate	0.0616***	-0.000244
	(2.66)	(-0.01)
ln_CapitalIntensity	-0.0109***	-0.0115***
	(-5.98)	(-6.75)
D_Size	0.0172*	0.0584***
	(1.90)	(6.27)
ln_KI	**0.0412*** **	
	(38.74)	
ln_CI		-0.00294**
		(-2.51)
ln_IP		0.0311***
		(32.01)
ln_EC		0.0178***
		(16.50)
_cons	-0.477***	-0.386***
	(-13.18)	(-11.58)
N	89752	89752

Figure 1: The Share of Capital Formation to GDP

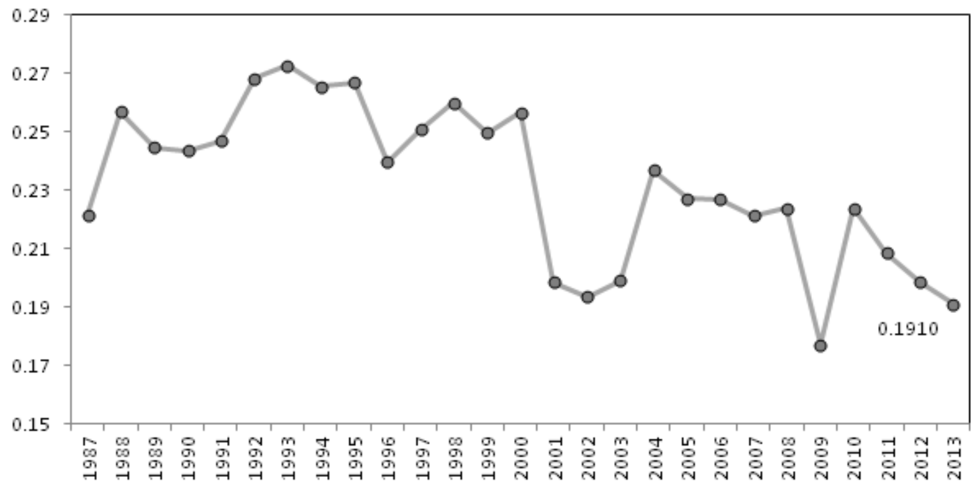

Figure 2: Five Intangible Investment Expenditures

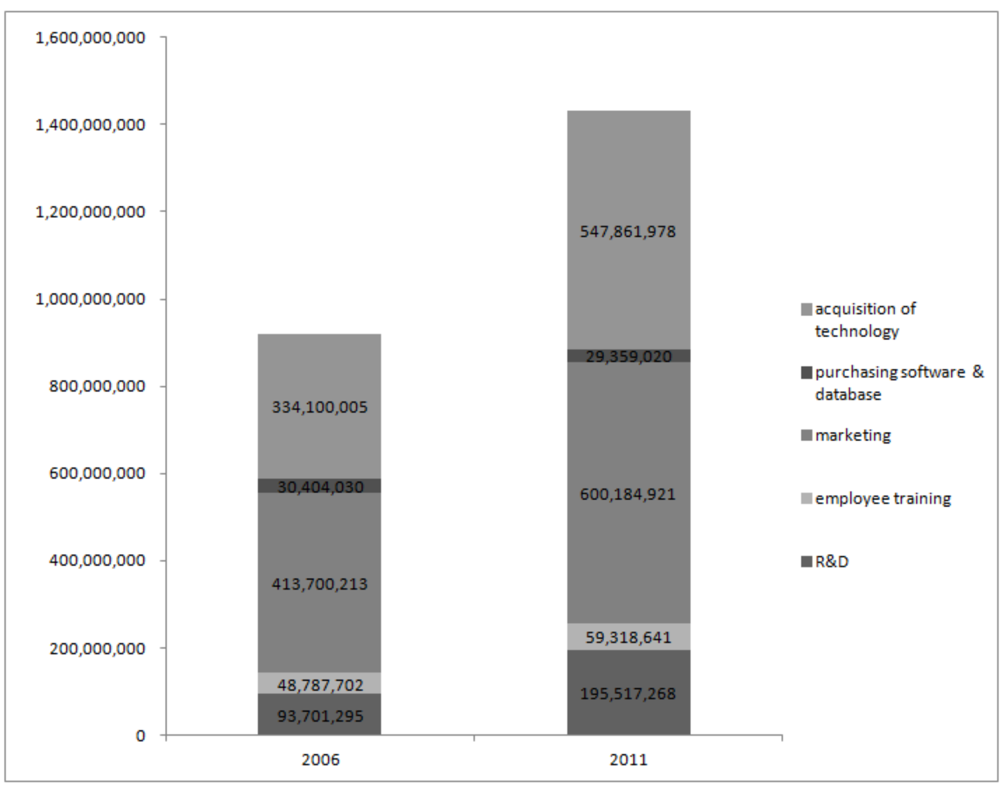

Figure 3: The Share of Five Intangible Investments in 2006 and 2011