Intellectual Capital and Knowledge Productivity:

The Taiwan Biotech Industry

Yi-Chun Huang, Associate Professor, Dept. of Business Administration
National Kaohsiung University of Applied Sciences
peterhun@cc.kuas.edu.tw

Yen-Chun Jim Wu, Professor, Dept. of Business Management
Director, International Business MBA Program, College of Management
National Sun Yat-Sen University
ycwu@faculty.nsysu.edu.tw

Abstract

Purpose – This purpose of this paper is to examine and test the effects of human capital, organization capital, and social capital on knowledge productivity and the interactive effects between intellectual capital and knowledge productivity.

Design/methodology/approach – This study adopts questionnaires to conduct a case investigation of the Taiwan Biotechnology Industry (TBI) and Taiwanese Pharmaceutical Manufacturers.

Findings – All dimensions of intellectual capital positively and significantly influence knowledge productivity. The study proves there are interactive effects between the components of intellectual capital and knowledge productivity.

Originality/value – The synthesis of two different literature streams, intellectual capital and knowledge productivity, in order to understand their linkage. This paper is the first to conduct a large sample survey to examine the relationship between intellectual capital and knowledge productivity.

Keywords: Knowledge Productivity, Human capital, Organization Capital, Social Capital, Peter Drucker.

Paper type: Research paper..

1. Introduction

The world is fast moving from a production-based economy to a knowledge-based one (Drucker, 1993; Powell and Snellman, 2004). Drucker (1999b) states that the most important contribution management needs to make in the 21st century is similarly to increase the productivity of knowledge work and the knowledge worker. The knowledge-based view of the firm identifies the primary rationale for the firm as the creation and application of knowledge (Demsetz, 1991; Nonaka, 1994; Grant, 1996; Spender, 1996). Therefore, the ability of firms to generate and exploit new forms of knowledge is vitally important (Anand *et al.*, 2007). The economic challenge of the post-capitalist society will therefore be the productivity of knowledge work and the knowledge worker(Drucker, 1993).

Knowledge productivity is a tricky construct. Some scholars adopt a macro-economic perspective to interpret knowledge productivity as a result (Machlup, 1972), while others apply a managerial perspective to interpret knowledge productivity as a human ability (Drucker, 1981; Drucker, 1993; Drucker, 1999b). This study integrates both perspectives to define knowledge productivity as the capability with which individuals, teams, and units across an organization achieve knowledge-based improvements, exploitation, and innovations (Drucker, 1993; Drucker, 1999b; Harrison and Kessels, 2004; Stam, 2007). Drucker (1999b) argued that knowledge-worker productivity will be the biggest managerial challenge of the 21st- century, and in developed countries, a first requirement for mere survival (p. 157). Knowledge productivity did not receive much attention until knowledge researchers began to explore a theory of knowledge productivity (Harrison and Kessels, 2004; Stam, 2007). Furthermore, in the existing academic literature, little is known as to how new knowledge is created, and empirical work is particularly lacking.

In order to help organizations improve their knowledge productivity, Drucker (1999a) highlighted six major factors: task, autonomy, continuing innovation, continuous learning, quality, and worker asset. Stam (2007) proposed the KP enhancer. Scholars have mainly suggested human resource and organizational structure approaches. Drucker (1993) argued that making knowledge productive is the responsibility of management and requires a systematic and organized application of knowledge to knowledge (p. 190). It is known that organizations adopt different approaches for accumulating and utilizing their knowledge, and that these approaches present themselves as different aspects of intellectual capital, i.e., human, organizational, and social capital (Davenport and Prusak, 1998; Nahapiet and Ghoshal, 1998). It is also widely accepted that an organization's capability to innovate is closely tied to its intellectual capital (Tsai and Ghoshal, 1998; Subramaniam and Venkatraman, 2001; Subramaniam and Youndt, 2005).

Previous studies have revealed that intellectual capital is positively and significantly related to organizational performance (Bontis, 1998; Bontis *et al.*, 2000). Recently, there has been increasing research focused on the relationships among intellectual capital, innovation, and competitiveness (Hermans and Kauranen, 2005; Subramaniam and Youndt, 2005; Tseng and Goo, 2005). On the other hand, the interaction between innovation and knowledge management or intellectual capital has also been studied (Darroch and McNaughton, 2002; McAdam, 2002; Gloet and Terziovski, 2004; Liu *et al.*, 2005). In this context, the dimensions of intellectual capital are interactive, transformable, and complementary activities, meaning that a resource's productivity may be improved through investments in other resources.

Numerous researchers have studied the relationships among intellectual capital, innovation, and competitiveness, but few studies have explored the relationship between intellectual capital and knowledge productivity, which is the primary aim of this study. The objectives of this study are: (1) to examine the relationship between intellectual capital components and knowledge productivity and (2) to study interactive effects between intellectual capital components and knowledge productivity.

2. Literature Review

Knowledge Productivity

In a review of the related literature, Stam (2007)found knowledge productivity to be an elusive construct, as there are two different interpretive perspectives. On the one hand, productivity refers to the amount of output per unit of input (labor, equipment, capital) (Machlup, 1972), while the concept of knowledge predominantly refers to a human ability (Drucker, 1981; Drucker, 1993; Drucker, 1999b).

Machlup's Perspective

Machlup (1972)in *The Production and Distribution of Knowledge in the United States* discovered the importance of knowledge as a product. In his recalculation of the gross national product (GNP) of the USA, he discovered that total knowledge production accounted for almost 29 percent of adjusted GNP in 1958. Moreover, the "knowledge industry" was not only the largest industry, but also grew faster than traditional industries. Machlup's (1972) perspective, based on economic theory, interpreted knowledge productivity as a result, aimed at explaining. These conclusions drew attention to the relationships between knowledge, value creation, and economic growth.

Drucker's Perspective

According to Drucker (1981), "we know that productivities are created and destroy, improved or damaged, in what we call the 'micro-economy': the individual enterprise, plant, shop, or office" (p. 20). As such, in *The post-capitalist society*, Drucker (1993) stressed the importance of the development of a new economic theory that puts knowledge at the centre of the wealth creation process. In *Management challenges for the 21st century* Drucker (1999b) elaborated on this new economic theory and described a set of management guidelines for knowledge-worker productivity. He argued that the productivity of knowledge and knowledge workers should be primarily seen as a managerial responsibility. Drucker (1999a) stressed that knowledge-worker productivity will be the biggest managerial challenge of the 21st century (p. 157). Drucker's perspective, based on managerial theories, interpreted knowledge productivity as an organizational ability and aimed at improving the knowledge-based production process. Based on this understanding, the competitive advantage of businesses will increasingly depend on the ability of organizations to make the knowledge worker more productive.

While Drucker (1999a) mentioned knowledge-worker productivity, he still emphasized the importance of the organization. Organization's function is to put knowledge to work, through tools, processes, and products. Knowledge itself must be organized for constant change and innovation. The ability to create "new" has to be built into the organization. Specifically, each organization has to build into its very fabric three systematic practices. First, the process of continuous improvement for both products and services. The Japanese have proven to be the best at implementing this concept, called *Kaizen,* a now widely coined term in the standard management theory. Secondly, there is the continuous exploitation of existing knowledge to develop new and different products, processes, and services. Finally, there is genuine innovation (p.185).These three ways of applying knowledge to produce change in the economy need to be implemented and integrated simultaneously (Drucker, 1993). In this light, this research aims to explore knowledge productivity at the organizational level.

Subsequently, Harrison and Kessels (2004)proposed that "knowledge productivity concerns the way in which individuals, teams and units across an organization achieve knowledge-based improvements and innovations" (p. 145). Stam (2007)argued that "knowledge productivity refers to the process of transforming knowledge into value".

Based on the above-mentioned research, this study defines knowledge productivity as the capability with which individuals, teams, and units across an organization achieve knowledge-based improvements, exploitation, and innovations.

Key Knowledge Productivity Factors

Economic theory as well as most business practices views manual workers as a cost. However, to be productive, knowledge workers must be considered a capital asset. Costs need to be controlled and reduced, while assets need to be made to grow

(Drucker, 1999a). In order to help organizations improve their knowledge productivity, Drucker (1993) suggested developing a theory that discloses the relationship between the productivity of knowledge workers and the business environment. He essentially stressed that to fail to see the forest for the trees is a serious failing. Nevertheless, it is an equally serious failing not to see the trees for the forest, as one can only plant and cut down individual trees. Yet the forest is the 'ecology', the environment without which individual trees would never grow. To make knowledge productive, we will have to learn to see both forest and tree. We will have to learn to connect (Drucker, 1993).

Moreover, Drucker (1999a)highlighted six major factors which determine knowledge-worker productivity. These were task, autonomy, continuous innovation, continuous learning and teaching, quality, and treating the knowledge worker as an asset rather than a cost (p. 142). Harrison and Kessels (2004) argued for the "Corporate Curriculum", which involves "transforming the daily workplace into an environment where learning and working can be effectively integrated. It facilitates the creation of a rich and diverse landscape that encourages and supports employees in the learning they need to do in order to continuously adapt and to innovate" (p. 155). Stam (2007) proposed the knowledge productivity (KP) enhancer, that includes acquiring subject matter expertise, learning to identify and solve problems, cultivating reflective skills, securing communication skills, acquiring skills for self regulation of motivation, promoting peace and stability, and causing creative turmoil in order to stimulate innovation.

Based on the above literature, scholars have mainly suggested human resource and organizational structure approaches. We know that above all, making knowledge productive is a managerial responsibility. It requires a systematic and organized application of knowledge to knowledge (Drucker, 1993). It is known that organizations adopt different approaches for accumulating and utilizing their knowledge, and that these approaches present themselves as different aspects of intellectual capital, i.e., human, organizational, and social capital (Davenport and Prusak, 1998; Nahapiet and Ghoshal, 1998). The concept of intellectual capital is based on the belief that the main resources for building competitive advantage are intangible in nature (Edvinsson and Malone, 1997; Stewart, 1997; Sveiby, 1997). It is widely accepted that an organizational capability to innovate is closely tied to its intellectual capital (Tsai and Ghoshal, 1998; Subramaniam and Venkatraman, 2001; Subramaniam and Youndt, 2005). Therefore, this research introduces a theory of intellectual capital, and explores its influence on knowledge productivity.

Intellectual Capital and Knowledge Productivity

Intellectual capital has received considerable attention from academics. The economist Galbraith (1969) was the first to propose the intellectual capital concept, and described intellectual capital as behavior that requires the exercise of the brain. Intellectual capital was not understood as static intellect, but rather as demanding dynamic intellect-creating activities. A review of previous studies finds that intellectual capital has been identified as a set of intangibles (resources, capabilities, and competences) that drive organizational performance and value creation (Roos and Roos, 1997; Bontis, 1998; Bontis *et al.*, 2000; Marr and Roos, 2005; Subramaniam and Youndt, 2005). It is assumed that competitive advantage depends on how efficiently the firm builds, shares, leverages, and uses its knowledge.

This study defines intellectual capital to be the sum of all knowledge firms utilize for competitive advantage (Nahapiet and Ghoshal, 1998; Seetharaman *et al.*, 2004; Subramaniam and Youndt, 2005). Specifically, a systematic interpretation of intellectual capital is adopted by identifying three main components: human capital, organizational capital, and social capital, all of which have been frequently cited in the literature (Nahapiet and Ghoshal, 1998; Youndt *et al.*, 2004; Subramaniam and Youndt, 2005).

Human Capital

Human capital has been defined as the knowledge, skills, and abilities residing within and utilized by individuals (Schultz, 1961). Human capital is the primary component of intellectual capital (Edvinsson and Malone, 1997; Stewart, 1997; Bontis, 1998; Choo and Bontis, 2002), since human interaction is the critical source of intangible value in the intellectual age (O'Donnell *et al.*, 2003). In the post-capitalist society, it is safe to assume that anyone with any knowledge will have to acquire new knowledge every four to five years, or else become obsolete (Drucker, 1993).

At the individual level, knowledge generation and transfer is a function of willingness. Making knowledge workers productive requires changes in basic attitudes, whereas making the manual worker more productive only requires telling the worker how to do the job (Drucker, 1999a). In addition, such attitudinal changes are not to be made only on the part of individual knowledge workers, but also of the total organization. At the organizational level, human capital is the source of innovation and strategic renewal (Bontis, 1998).

In terms of desired workforce properties, the characteristics of human capital are creative, bright, and skilled employees, with expertise in their roles and functions, and who constitute the predominant sources for new ideas and knowledge in an organization (Snell and Dean, 1992). The achieving of such a workforce is not without investment, however. Like the traditional workforce, knowledge employees need tools to succeed. Capital investments in such tools as education may be higher than ever required for manufacturing workers (Drucker, 1993). Individuals and their associated human capital are crucial for exposing an organization to technology boundaries that increase its capability to absorb and deploy knowledge domains (Hill and Rothaermel, 2003). Therefore, this study proposes the following hypothesis:

Hypothesis 1: The greater the human capital in organizations, the higher the knowledge productivity.

Organizational Capital

Organizational capital has been defined as the institutionalized knowledge and codified experience residing within firms utilized through databases, patents, manuals, structures, systems, and processes (Youndt *et al.*, 2004). Organizational capital represents the organization’s capabilities to meet its internal and external challenges. The components of organizational capital include infrastructure, information systems, routines, procedures, and organizational culture for retaining, packaging, and moving knowledge (Cabrita and Vaz, 2006). The productivity of the knowledge worker will almost always require that the work itself be restructured and made part of a system (Drucker, 1999a).

Nonaka and Takeuchi (1995)argued that knowledge management requires a commitment to “create new, task-related knowledge, disseminate it throughout the organization and embody it in products, services and systems”. At the organizational level, knowledge is generated from internal operations or from outside sources communicating with the corporate structure. Hibbard and Carrillo (1998) claimed that the information technologies adopted by organizations support management of intellectual assets to improve employee value creation.

Nonaka, Toyama, and Konno (2000) discussed how managers should create the circumstances necessary for the relationship building needed for knowledge creation by providing time, space, attention, and opportunities. Management can provide physical space such as meeting rooms, cyberspace such as a computer network, or mental space such as common goals to foster interactions. Moreover, it was found that when organizations used their preserved knowledge through structured periodic activities, they intensified their knowledge (Katila and Ahuja, 2002), and produced a path dependent rule of reinforced knowledge (Cohen and Levinthal, 1990). Subramaniam and Youndt (2005) found that organizational capital reinforces prevailing knowledge and influences an organization’s incremental innovative capabilities. Based on the above-discussed literature, this study proposes the following hypothesis:

Hypothesis 2: The greater the organizational capital in organizations, the higher the knowledge productivity.

Social Capital

Social capital is defined as the knowledge embedded within, available through, and utilized by interactions among individual and their networks of interrelationships (Nahapiet and Ghoshal, 1998). The concept of social capital was originally used in community studies to describe relational resources embedded in personal ties in the community (Jacobs, 1965). The concept has since been applied to a wide range of intra- and inter-organizational studies (Burt, 1992; Nahapiet and Ghoshal, 1998; Yli-Renko *et al.*, 2001).

Researchers have positioned social capital as a key factor in understanding value creation(Nahapiet and Ghoshal, 1998). An organization's social capital enhances the quality of group work and richness of information exchange among team members (Subramaniam and Youndt, 2005). Social capital and knowledge creation have been shown to have a positive relationship given that social capital directly affects the combine-and-exchange process and provides relatively easy access to network resources (Nahapiet and Ghoshal, 1998). Therefore, this study proposes the following hypothesis:

Hypothesis 3: The greater the social capital in organizations, the higher the knowledge productivity.

Social Capital Interaction

These three dimensions of intellectual capital are not independent. Rather, the effect of intellectual capital can be optimized only when these three constituent aspects interact and complement one another. Lynn (1999)described how if human capital resembles a root, absorbing all nutrition, then organizational capital is like a trunk, providing nutrient transit, and social capital is like the leaves, conveying environmental elements. These elements interact to create more than the sum of their parts (Subramaniam and Youndt, 2005). Accordingly, this study explores the interactive effects between intellectual capital and knowledge productivity.

Dosi (1982) pointed out that knowledge creation is a path-dependent process. Individuals and their associated human capital may encourage the questioning of established norms and originate new ways of thinking, but their unique ideas often need to connect with one another for radical breakthroughs to occur. Knowledge creation requires that network members jointly experience problem-solving processes and spend time together discussing, reflecting, observing, and interacting (Seufert *et al.*, 1999). While human capital provides organizations with a platform for diverse ideas and thoughts, social capital encourages collaboration both within and across organizations (Subramaniam and Youndt, 2005). Thus, social capital is expected to augment the human capital role in reinforcing knowledge productivity. This study proposes the following hypothesis:

Hypothesis 4: The greater social capital in organizations, the stronger the influence of human capital on knowledge productivity.

Preserved knowledge tends to be used in structured, recurrent activities, and is generally perceived to be more reliable and robust than other knowledge. Consequently, organizational capital not only improves how an organization's codified knowledge in patents, databases, and licenses is leveraged, but also improves how these knowledge sources are updated and reinforced. Groups and teams play a substantial role in deploying knowledge within organizations (Nonaka, 1994). An organization's social capital enhances the quality of group work and richness of information exchange among team members. Thus, social capital augments the role of organizational capital in reinforcing knowledge productivity. This study proposes the following hypothesis:

Hypothesis 5: The greater social capital in organizations, the stronger the influence of organizational capital on knowledge productivity.

3. Research Method

Research Framework

Based on the above discussion, this study proposes a conceptual model, illustrated as the research framework in Fig. 1. The three components of intellectual capital influence knowledge productivity directly. However, these influences are not always isolated, given that human capital, organizational capital, and social capital are often intertwined in organizations. Therefore, their interrelationships also play an important role in shaping these influences.

Place Figure 1 Here

Variables and Measurement

Dependent variable

This research defines knowledge productivity as the capability with which individuals, teams, and units across an organization achieve knowledge-based improvements, exploitation, and innovations (Drucker, 1993; Drucker, 1999a; Harrison and Kessels, 2004).

The improvement factor is further defined as the ability to improve each product or service to the point of transformation to a truly different product of service in two or three years time (Drucker, 1993). The exploitation of existing knowledge component is defined as the ability to develop new and different products, processes, and services (Drucker, 1993). Finally, innovation is concerned with identifying and using opportunities to create new products/service or work practices (Van de Ven, 1986).

This study measures continuous firm improvement with three statements regarding process, technology, and product/service capabilities. The three items assess the capability to exploit existing knowledge to develop processes, technologies, and products/services. The measurements of continuing improvements in knowledge exploitation are based on the concepts of Drucker (1993) and the interviewing of 6 field R&D managers in the Taiwan Biotechnology Industry (TBI) and Taiwanese Pharmaceutical Manufacturers. A five-point scale is adopted to measure capability on each questionnaire item, with one indicating "strongly low" and five indicating "strongly high".

The measures for the capability to innovate are based on the research of Subramaniam and Youndt (2005). Three items assess the capability to reinforce and create new products/services or work practices. Similarly, a five-point scale is adopted to measure capability on each questionnaire item, with one indicating "strongly low" and five indicating "strongly high".

Independent Variables

Several studies have argued that intellectual capital be defined as a set of intangible resources, capabilities, and competences that drive organizational knowledge and value creation (Roos and Roos, 1997; Sveiby, 1997; Bontis, 1998; Bontis *et al.*, 2000; Marr and Roos, 2005). This study defines intellectual capital to be the sum of all knowledge firms utilize for competitive advantage and consists of the three main components discussed previously: human capital, organizational capital, and social capital (Nahapiet and Ghoshal, 1998; Seetharaman *et al.*, 2004; Subramaniam and Youndt, 2005).

The measurement of human capital is based on the research of Subramaniam and Youndt (2005), where human capital reflects the overall skill, expertise, and knowledge level of an organization’s employees. Five items are used to assess human capital. The measurement of organizational capital is based on the research of Davenport and Prusak (1998) and Walsh and Ungson (1991). Four items are used to assess an organization’s ability to appropriate and store knowledge at the physical organization level (such as databases, manuals, and patents) (Davenport and Prusak, 1998), as well as the structures, processes, culture, and ways of doing business (Walsh and Ungson, 1991). Lastly, the definition of the social capital component draws from core ideas of the social structure literature (Burt, 1992) as well as the more specific knowledge management literature (Gupta and Govindarajan, 2000). Five items are used to assess an organization’s overall ability to share and leverage knowledge among and between networks of employees, government, customers, alliance partners, suppliers, and technical collaborators. A five-point scale is adopted to measure the extent of the questionnaire items, with one indicating "strongly disagree" and five indicating "strongly agree".

Control Variables

This study uses the age and size of firms as control variables. As an organization grows older, organizational efforts to adopt new innovations may be hindered by organizational inertia (Egri and Herman, 2000; Yli-Renko *et al.*, 2001). Age is calculated as the difference between 2005 and the founding year of the organization. As well, we control for the size of firms since large organizations are more likely to have the resources needed to adopt new innovations (Subramaniam and Youndt, 2005; De Luca and Atuahene-Gima, 2007) and to exploit existing knowledge (Yli-Renko *et al.*, 2001). Following Child (1972), the size of firm is defined as the log value of the number of employees.

Data

To test our hypotheses, we required a comprehensive sample of knowledge productivity and a context with adequate variation in resources across firms, which nevertheless allowed for comparability of radical innovations across firms. Data were collected from samples of the TBI and Taiwanese Pharmaceutical Manufacturers. The pharmaceutical industry is a context that meets the above requirements well (Sorescu *et al.*, 2003; Stam, 2007). Further, biotechnology is an industry that is knowledge based and predominantly comprised of small firms involved in R&D (Audretsch and Stephan, 1996; Drucker, 1999a; Salman and Saives, 2005). Using only small and medium-sized companies in the study increased reliability, as many large companies tend to be multifunctional, with only minor components of their sales coming from biotechnology products (Hermans and Kauranen, 2005).

Moreover, Taiwan is an excellent case study of an emerging knowledge economy for several major reasons. First, the Taiwanese business environment has undergone significant adjustments creating considerable uncertainty. Many Taiwanese companies are thus under growing pressure to develop appropriate practices for meeting the challenges of this uncertain business environment (Tseng and Goo, 2005). Second, the Taiwanese government has highly prioritized intellectual capital over physical assets if the national infrastructure is to develop beyond its status as an emerging economy. Third, the TBI includes the pharmaceutical industry, pharmaceutical manufacturers of Chinese medicine, and biotechnology. The

Taiwanese pharmaceutical industry has long been considered technologically intensive (Bai, 1998), and has accepted considerable government guidance and assistance (Xie, 1997), with the majority of domestic pharmaceutical firms maintaining their small or medium size status. The government supported Development Center for Biotechnology was founded in 1984 with ten new industries in specialized chemicals and pharmaceuticals being listed. Further, the government invested 30 million U.S. dollars in 2001, which accounted for 20% of the technology budget. As development of biotechnology is rapidly increasing, most traditional pharmaceutical companies have begun engaging in bio-pharmaceutical R&D (Sun, 2001; Sun, 2003). Based on these factors, it was determined that the TBI was robust enough to allow for sufficient sampling to conduct this research.

Intellectual capital and knowledge productivity both reside at the organizational level and require “strategic awareness” from informants to respond to questionnaires such as that used in this study. Drucker (1993) emphasized that “a manager is one who is responsible for the application and performance of knowledge” (p. 44). Drucker (1993) argued that the function of organizations is to make knowledge productive (p. 49). Knowledge workers can work only because there are organizations for them to work in (p. 64). Based on this organizational focus, this study selected managers of R&D departments as respondents.

The questionnaires were mailed to (1) members of the Taiwan Pharmaceutical Manufacturers Association (TPMA) and the Pharmaceutical Manufacturers Association of Chinese Medicine (PMACM) and (2), biotechnology firms listed in a 2005 survey conducted by the Taiwan Institute of Economic Research. A total of 110 questionnaires were mailed to pharmaceutical companies, 220 to Chinese medicine pharmaceuticals, and 380 to biotechnology companies. To increase response rates, two follow-ups (personal visits and telephone calls) were carried out. Twenty-one, thirty, and sixty-two valid responses were obtained from the TPMA, PMACM, and biotechnology firms respectively. A total of 113 valid responses were obtained after 6 weeks, representing a valid response rate of 15.92%. An analysis of respondents and non-respondents revealed no differences in industry membership, number of employees, or revenues.

Validity and Reliability Test

This study assessed construct reliability by calculating Cronbach's alpha coefficients for each of the intellectual capital and knowledge creation constructs. The human capital α had a coefficient of 0.83, organizational capital of 0.89, social capital of 0.84, and knowledge creation of 0.91. All of the scales were above the suggested value of 0.70 (Nunnally, 1978). Thus, we concluded the measures utilized in the study were valid and internally consistent.

Using AMOS 5.0, we conducted confirmatory factor analysis (CFA) of the three aspects of intellectual capital and knowledge creation. Overall, the CFA results suggested that the intellectual capital model provided a moderate fit to the data and that the knowledge creation model provided a good fit to the data. Table 1 summarizes the results of the CFA of the measurement model. As the factor loadings indicate, the measurement model performed very well. The standardized factor loading were all above 0.53, with the recommended minimum in the social sciences usually being 0.40 (Ford *et al.*, 1986). The average variances extracted ranged from 0.72 to 0.86, while the recommended minimum is 0.50 (Fornell and Larcker, 1981).

Place Table 1 Here

A CFA can be used to evaluate discriminate validity. Constructs demonstrate discriminate validity if the variance extracted for each is higher than the squared correlation between the constructs (Fornell and Larcker, 1981). We examined each pair of constructs in our measurement model and found that all demonstrate discriminate validity. Convergent validity was also evident as positive correlations existed among the three intellectual capital components, as would be expected for components representing different dimensions of the same underlying latent theme. Table 2 reports means and correlations for the study variables.

4. Findings

Table 2 provides the means, standard deviations, and correlations for the variables used in this research. Firm age was positively related to firm size (*r* = 0.348, $p < 0.01$). Firm age exhibited a significant negative relation with organizational capital (*r* = -0.207, $p < 0.05$). As anticipated, all dimensions of intellectual capital were positively related to knowledge productivity. Knowledge productivity exhibited a significantly positive relation with human capital (*r* = 0.537, $p < 0.01$), organizational capital (*r* = 0.424, $p < 0.01$), and social capital (*r* = 0.538, $p < 0.01$).

Place Table 2 Here

Relationship between Intellectual Capital and Knowledge Productivity

This research adopted industry as a control variable. As depicted in Table 3, Model 1 shows that industry had a positive and significant influence on firm knowledge productivity. The results imply that the knowledge productivity of the TBI and Taiwan Pharmaceutical Manufacturers are higher than the Pharmaceutical Manufacturers Association of Chinese Medicine. With regards to the other control variables, Model 1 shows that firm age and size had no significant influence on firm knowledge productivity.

Place Table 3Here

Using model 1, all dimensions of intellectual capital positively and significantly influenced knowledge productivity, and together explained 52.6% of total variance. These results support hypotheses 1, 2, and 3. This research also examined the extent of multicollinearity. Hair, Anderson, Tatham and Black (1998) suggest that the tolerance and VIF threshold values be 0.1 and 10, respectively. From model 1 in Table 3, the VIF values of all predictive variables were far beyond these threshold values. In other words, there was little multicollinearity among the predictive variables.

Moderation effects

To test hypotheses H4 and H5, this research utilized moderated regression analysis. Following Aiken and West (1991) and Jaccard and Turrisi (2003), this study centered (x = 0) the variables of intellectual capital when performing moderated regression analysis to minimize the effects of any multicollinearity among variables comprising interaction terms. The R_a^2 for model 2 increased from 0.526 to 0.555 over Model 1 ($\triangle R_a^2$ = 0.029, $p < 0.05$), which is significant to the moderating effects. As expected, social capital significantly and positively moderated the relationship between human capital and knowledge productivity (β= 0.173, $p < 0.01$), thereby providing support for hypothesis 4. However, the interaction between social capital and organizational capital was negatively but not significantly related to knowledge productivity (β= -0.098, p=0.140), and thus did not support hypothesis 5.

5. Discussion

The purpose of this study was to theoretically and empirically examine the link between intellectual capital and knowledge productivity. This study provided evidence that all dimensions of intellectual capital positively and significantly influenced knowledge productivity. This finding proves that social capital is a key factor in understanding knowledge creation (Nahapiet and Ghoshal, 1998; McFadyen and Canella, 2004). Furthermore, the argument that knowledge creation is a human process (human capital) is supported (Nonaka *et al.*, 2000). As well, as organizations harness their preserved knowledge through structured recurrent activities (organizational capital), they deepen their knowledge and legitimize its perceived value (Katila and Ahuja, 2002).

Additionally, this research found that social capital augments the ability of human capital and organizational capital to reinforce knowledge productivity. The social and human capital interaction was significantly and positively related to knowledge productivity. This finding complements Dosi (1982) who pointed out that knowledge creation is a path-dependent process. In addition, the findings support Subramaniam and Youndt (2005) who argued that human capital provides organizations with a platform for diverse ideas and thoughts, while social capital encourages collaboration both within and across organizations. However, the study found that the social and organizational capital interaction was significantly negatively related to knowledge productivity.

Implications

The findings of this study have several implications. Firstly, previous intellectual capital studies recommend generalization of their results to other countries. This study proves that intellectual capital is substantively and significantly related to knowledge productivity in Taiwan's biotechnology industry. Second, while past studies have examined the relationships between social capital (McFadyen and Canella, 2004) as well as external venturing (Wadhwa and Kotha, 2006) and knowledge productivity, this research is one of the few empirical efforts to examine the relationship between intellectual capital and knowledge productivity. Third, while previous work on the relationship between intellectual capital and innovation (Darroch and McNaughton, 2002; McAdam, 2002; Gloet and Terziovski, 2004; Liu *et al.*, 2005; Subramaniam and Youndt, 2005) as well as organizational performance and value creation(Roos and Roos, 1997; Bontis, 1998; Bontis *et al.*, 2000; Marr and Roos, 2005; Cabrita and Vaz, 2006) have been studied, few have explored the relationship between intellectual capital and knowledge productivity. The findings of this study provide evidence of the critical role that intellectual capital plays in explaining knowledge productivity.

Finally, this study partially empirically proves that intellectual capital is a phenomenon of interactions. For example, the social and organizational capital interaction was significantly negatively related to knowledge productivity. A possible explanation for the lack of interaction is that, in some cases, organizational capital may actually hinder knowledge productivity. Highly formalized processes, systems, structures, etc. have a tendency to reinforce existing norms and obviate against the variation and change that promote knowledge productivity. Therefore, this study suggests that managers build contingent circumstances for dynamic knowledge productivity. This is similar to Drucker (1993) who suggested developing a theory that discloses the relationship between the productivity of knowledge workers and the environment. Drucker stressed that to not see the forest for the trees is a serious failing. However, it is an equally serious failing not to see the trees for the forest. One can only plant and cut down individual trees. Yet the forest in the ‘ecology’, the environment without which individual trees would never grow. To make knowledge productive, we will have to learn to see both forest and tree. We will have to learn to connect (Drucker, 1993).

Limitations and Future Research

This study is not without limitations. It is recognized that the link between intellectual capital and knowledge productivity is complex and contingent on several multidimensional organizational actions, for example, organizational learning as well as specific strategic activities. Nonetheless, by synthesizing two different literature streams, intellectual capital and knowledge productivity, this study has initialized efforts to understand the multidimensional intellectual capital / knowledge productivity linkage. However, the valid sample size was relatively small given the number of variables in the models. Another limitation was the dependence on subjective perceptual measures since it was difficult to obtain relevant objective measures capturing the variations in intellectual capital and knowledge productivity.

The results of this study suggest several avenues for future research on knowledge productivity, with a particularly fertile area being moderating effects. For example, the development and testing of a framework for how technological learning (Lei *et al.*, 1996; Teece *et al.*, 1997; Zahra *et al.*, 2000) moderates the relationship between intellectual capital and knowledge productivity. Also, there is need for research into the moderating effects of knowledge integration (Nonaka and Takeuchi, 1995; Zahra *et al.*, 2000) on the relationship between intellectual capital and knowledge productivity. Moreover, with regard to the phenomenon of the negative correlation between the social / organizational interaction and the cognitive productivity, it would be interesting to compare those interactive impacts on knowledge productivity using as sample clusters of "traditional firms" (tangible, old, big, family controlled) and "cognitive" ones (intangible, young, small and non-family controlled).

APPENDEX

"To what extent do you agree with the following items describing your company's intellectual capital? (1 = strongly disagree; 5 = strongly disagree)."

Human capital

HC1: Your employees are highly skilled.
HC2: Your employees are widely considered the best in our industry.
HC3: Your employees are creative and bright.
HC4: Your employees are experts in their particular jobs and functions.
HC5: Your employees develop new ideas and knowledge.

Organizational capital

OC1: Your organization uses patents and licenses as a way to store knowledge.
OC2: Much of Your organization's knowledge is contained in manuals, databases, etc….
OC3: Your organization's culture (stores, rituals) contains valuable ideas, ways of doing business, etc….
OC4: Your organization embeds much of its knowledge and information in structures, systems and processes.

Social capital

SC1: Your employees are skilled at collaborating with each other to diagnose and solve problems.
SC2: Your employees share information and learn from one another.
SC3: Your employees interact and exchange ideas with people from different areas of the company.
SC4: Your employees partner with customer suppliers, alliance partners, etc...to develop solutions.
SC5: Your employees apply knowledge from one areas of the company to problems and opportunities that arise in another.

Knowledge productivity

"To what extent do you agree with how would your company's capability to improve, exploit and innovate the process, technology and product/service? (1 = strongly disagree; 5 = strongly disagree)."

KC1: Your company continues improvement of process
KC2: Your company continues improvement of technology.
KC3: Your company continues improvement of product/ service
KC4: Your company often exploits existing knowledge to develop process.
KC5: Your company often exploits existing knowledge to develop technology.
KC6: Your company often exploits existing knowledge to develop products/service.
KC7: Innovations that reinforce your company prevailing product/service lines.
KC8: Innovations that reinforce how you currently compete.
KC8: Innovations that fundamentally change your prevailing products/service.

References

Aiken, L. S. and West, S. G. (1991). *Multiple Regression: Testing and Interpreting Interactions*: Newbury Park CA: Sage.

Anand, N., Gardner, H. K. and Morris, T. (2007), "Knowledge-based innovation: Emergence and embedding new practice areas in management consulting firms", *Academy of Management Journal*, Vol. 50 No. 2, pp. 406-426.

Audretsch, D. B. and Stephan, P. E. (1996), "Company-scientist locational links: The case of biotechnology", *American Economic Review*, Vol. 86 No. 3, pp. 641-652.

Bai, S. X. (1998). *Biotechnology Medicine*. Taipei: Jeouzhou Publisher.

Bontis, N. (1998), "Intellectual capital: An exploratory study that develops measures and models", *Management Decision*, Vol. 36 No. 2, pp. 63-76.

Bontis, N., Keow, W. C. C. and Richardson, S. (2000), "Intellectual capital and business performance in Malaysian industries", *Journal of Intellectual Capital*, Vol. 1 No. 1, pp. 85-100.

Burt, R. S. (1992). *Structural Holes: The Social Structure of Competition*. Cambridge: MA: Harvard University Press.

Cabrita, M. and Vaz, J. (2006), "Intellectual capital and value creation: Evidence from the portuguese banking industry", *The Electronic Journal of Knowledge Management*, Vol. 4 No. 1, pp. 11-20.

Child, J. (1972), "Organization structure, environment and performance: The role of strategic choice", *Sociology*, Vol. 6, pp. 1-22.

Choo, C. W. and Bontis, N. (2002). The Strategic Management of Intellectual Capital and Organizational Knowledge. New York: Oxford University Press, Inc.

Cohen, W. and Levinthal, D. (1990), "Absorptive capacity: A new perspective on learning and innovation", *Administrative Science Quarterly*, Vol. 35, pp.128-152

Darroch, J. and Mcnaughton, R. (2002), "Examining the link between knowledge management practices and types of innovation", *Journal of Intellectual Capital*, Vol. 3 No. 3, pp. 210-222.

Davenport, T. H. and Prusak, L. (1998). Working Knowledge. Cambridge: HBS Press.

De Luca, L. M. and Atuahene-Gima, K. (2007), "Market knowledge dimensions and cross-functional collaboration: Examining the different routes to product innovation performance", *Journal of Marketing*, Vol. 71 No. 1, pp. 95-112.

Demsetz, H. (1991). *The theory of the firm revisited* (In Williamson O. and Winter S. ed.). New York: The Nature of the Firm, Oxford University Press,.

Dosi, G. (1982), "Technological paradigms and technological trajectories", *Research Policy*, Vol. 11, pp. 147-162.

Drucker, P. F. (1981). *Managing in Turbulent Times*. London: Pan Business Management.

Drucker, P. F. (1993). *Postcapitalist Society*. New York: HerperCollins Publishers.

Drucker, P. F. (1999a), "Knowledge-worker productivity: the biggest challenge", *California Management Review*, Vol. 41 No. 2, pp. 79-94.

Drucker, P. F. (1999b). *Management Challenges for the 21st Century*: Elsevier Butterworth Heinemenn.

Edvinsson, L. and Malone, M. S. (1997). *Intellectual Capital: Realizing Your Company's True Value, by Finding its Hidden Roots*. New York: Harper Collins Publishers.

Egri, C. P. and Herman, S. (2000), "Leadership in the North American environmental sector: Values, leadership styles, and contexts of environmental leaders and their organizations", *Academy of Management Journal*, Vol. 43 No. 4, pp. 571-604.

Ford, J. C., Mccallum, R. C. and Tait, M. (1986), "The application of exploratory factor analysis in applied psychology: A critical review and analysis", *Personnel Psychology*, Vol. 39, pp. 291-314.

Fornell, C. and Larcker, D. F. (1981), "Evaluating structural equation models with unobservable variables and measurement error", *Journal Marketing Research*, Vol. 18 No. 1, pp. 39-50.

Galbraith, J. K. (1969). *The New Industrial State*: Harmondsworth: Penguin.

Gloet, M. and Terziovski, M. (2004), "Exploring the relationship between knowledge management practices and innovation performance", *Journal of Manufacturing Technology Management*, Vol. 15 No. 5, pp. 402-409.

Grant, R. M. (1996), "Prospering in dynamically-competitive environments: organizational capacity as knowledge integration", *Organization Science*, Vol. 7, pp. 375-387.

Gupta, A. K. and Govindarajan, V. (2000), "Knowledge management's social dimension: Lessons from Nucor Steel", *Sloan Management Review*, Vol. 42 No. 1, pp. 71-79.

Hair, J. F., Anderson, R. E., Tatham, R. L. and Black, W. C. (1998). *Multivariate Data Analysis* (5th ed.): Prentice-Hall International, Inc.

Harrison, R. and Kessels, J. W. M. (2004). *Human Resource Development in a Knowledge Economy: An Organisational View*. New York: Palgrave Macmillan.

Hermans, R. and Kauranen, I. (2005), "Value creation potential of intellectual capital in Biotechnology- Empirical evidence from Finland", *R&D Management*, Vol. 35 No. 2, pp. 171-185.

Hill, G. W. L. and Rothaermel, F. T. (2003), "The performance of incumbent firms in the face of radical technological innovation", *Academy of Management Review*, Vol. 28, pp. 257-274.

Jaccard, J. and Turrisi, R. (2003). *Interaction Effects in Multiple Regression* (2nd ed.): Thousand Oaks: Sage Publications.

Jacobs, D. (1965). *The Death and Life of Great American Cities*: Penguin: New York.

Katila, R. and Ahuja, G. (2002), "Something old, something new: A longitudinal study of research behavior and new product introduction", *Academy of Management Journal*, Vol. 45, pp. 1183-1194.

Lei, D., Hitt, M. A. and Bettis, R. (1996), "Dynamic core competences through meta-learning and strategic context", *Journal of Management*, Vol. 22, pp. 549-569.

Liu, P. L., Chen, W. C. and Tsai, C. H. (2005), "An empirical study on the correlation between the knowledge management method and new product development strategy on product performance in Taiwan industries", *Technovation*, Vol. 25, pp. 637-644.

Lynn, B. E. (1999), "Culture and intellectual capital management", *International Journal of Technology Management*, Vol. 18, pp. 590-603.

Machlup, F. (1972). *The Production and Distribution of Knowledge in the United States*, . Princeton, NJ: Princeton University Press.

Marr, B. and Roos, G. (2005). *A strategy perspective on intellectual capital in Perspectives on Intellectual Capital-Multidisciplinary Insights into Management: Measurement and Reporting* (Marr, B. ed.). Oxford: Butterworth- Heinemann.

Mcadam, R. (2002), "Knowledge management as a catalyst for innovation within organizations: A qualitative study", *Knowledge and Process Management*, Vol. 7 No. 4, pp. 233-214.

Mcfadyen, M. A. and Canella, J. A. A. (2004), "Social capital and knowledge creation: Diminishing returns of the number and strength of exchange relationships", *Academy of Management Journal*, Vol. 23, pp. 242-266.

Nahapiet, J. and Ghoshal, S. (1998), "Social capital, intellectual capital, and the organizational advantage", *Academy of Management Review*, Vol. 23, pp. 242-266.

Nonaka, I. (1994), "A dynamic theory of organizational knowledge creation", *Organization Science*, Vol. 5 No. 1, pp. 14-37.

Nonaka, I. and Takeuchi, H. (1995). *The Knowledge-Creating Company*. New York: Oxford University Press.

Nonaka, I., Toyama, R. and Konno, N. (2000), "SECI, Ba and leadership: A unified model of dynamic knowledge creation", *Long Range Planning*, Vol. 33 No. 1, pp. 5-34.

Nunnally, J. (1978). *Psychometric Theory* (2nd ed.). New York: McGraw-Hill.

O'donnell, D., O'regan, P., Coates, B., Kennedy, T., Keary, B. and Berkery, G. (2003), "Human interaction: The critical source of intangible value", *Journal of Intellectual Capital*, Vol. 4 No. 1, pp. 82-99.

Powell, W. W. and Snellman, K. (2004). *The knowledge economy* (Vol. 30). Greenwich: CT: JAI Press.

Roos, G. and Roos, J. (1997), "Measuring your company's intellectual performance", *Long Range Planning*, Vol. 30 No. 3, pp. 413-426.

Salman, N. and Saives, A. L. (2005), "Indirect networks: An intangible resource for biotechnology innovation", *R&D Management*, Vol. 35 No. 2, pp. 203-215.

Schultz, T. W. (1961), "Investment in human capital", *American Economic Review*, Vol. 51, pp. 1-17.

Seetharaman, A., Lock, T., Low, K. and Saravanan, A. S. (2004), "Comparative justification on intellectual capital", *Journal of Intellectual Capital*, Vol. 5 No. 4, pp. 522-539.

Seufert, A., Vonkrogh, G. and Bach, A. (1999), "Towards knowledge networking", *Journal of Knowledge Management*, Vol. 3 No. 3, pp. 180-190.

Snell, S. A. and Dean, J. W. (1992), "Integrated manufacturing and human resources management: A human capital perspective", *Academy of Management Journal*, Vol. 35, pp. 467-504.

Sorescu, A. B., Chandy, R. K. and Jaideep, J. C. (2003), "Sources and financial consequences of radical innovation: Insights from Pharmaceuticals", *Journal of Marketing*, Vol. 67, pp. 82-102.

Spender, J. C. (1996), "Making knowledge the basis of a dynamic theory of the firm", *Strategic Management Journal*, Vol. 17, pp. 45-62.

Stam, C. D. (2007), "Making sense of knowledge productivity: beta testing the KP-enhancer", *Journal of Intellectual Capital*, Vol. 8 No. 4, pp. 628-640.

Stewart, T. A. (1997). *Intellectual Capital: The New Wealth of Organizations*. New. York: Currency/Doubleday.

Subramaniam, M. and Venkatraman, N. (2001), "Determinants of transnational new product development capability: Testing the influence of transferring and deploying tacit overseas knowledge", *Strategic Management Journal*, Vol. 22, pp. 359-378.

Subramaniam, M. and Youndt, M. A. (2005), "The influence of intellectual capital on the types of innovative capabilities", *Academy of Management Journal*, Vol. 48 No. 3, pp. 450-463.

Sun, Z. L. (2001). Establishing Operation and Innovation System of Knowledge Economy: Current Development and Strategy of Taiwan Biotechnology Industry. Taipei: Taiwan Institute of Economic Research.

Sun, Z. L. (2003). 2003 Survey of Taiwan Biotechnology Industry. Taipei: Taiwan Institute of Economic Research. Document Number)

Sveiby, K. (1997). *The New Organizational Wealth*. San Francisco: Berrett Koehler.

Teece, D. J., Pisano, G. and Shuen, A. (1997), "Dynamic capabilities and strategic management", *Strategic Management Journal*, Vol. 18, pp. 509-533.

Tsai, W. and Ghoshal, S. (1998), "Social capital and value creation: The role of intrafirm networks", *Academy of Management Journal*, Vol. 41, pp. 464-478.

Tseng, C. Y. and Goo, Y. J. J. (2005), "Intellectual capital and corporate value in an emerging economy: Empirical study of Taiwanese manufacturers", *R&D Management*, Vol. 35 No. 2, pp. 187-201.

Van De Ven, A. H. (1986), "Central problems In the management of innovation", *Management Science*, Vol. 32, pp. 590-607.

Wadhwa, A. and Kotha, S. (2006), "Knowledge creation through external venturing: Evidence from the telecommunications equipment manufacturing industry", *Academy of Management Journal*, Vol. 49 No. 4, pp. 819-835.

Walsh, J. P. and Ungson, G. R. (1991), "Organizational memory", *Academy of Management Review*, Vol. 16, pp. 57-91.

Xie, X. Y. (1997) Institutionalization of Drug Production- Interaction among Institution, Organizational Ecology and Consumption Inertia. *Sociology Institute.* Taipei, National Taiwan University.

Yli-Renko, H., Autio, E. and Spaienza, H. J. (2001), "Social capital, knowledge acquisition and knowledge exploitation in young technology-based firms", *Strategic Management Journal*, Vol. 22, pp. 587-613.

Youndt, M. A., Subramaniam, M. and Snell, S. A. (2004), "Intellectual capital profiles: An examination of investments and returns", *Journal of Management Studies*, Vol. 41, pp. 335-362.

Zahra, S. A., Ireland, R. D. and Hitt, M. A. (2000), "International expansion by new venture firms: International diversity, mode of market entry, technological learning, and performance", *Academy of Management Journal*, Vol. 43 No. 5, pp. 925-950.

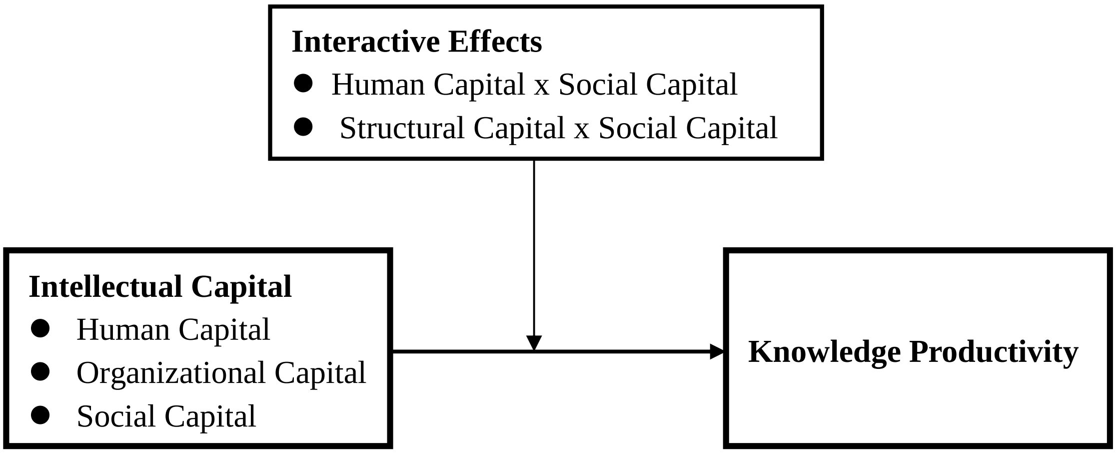

Figure 1 Conceptual Framework

Table 1 Confirmatory Factor Analysis

Constructs	measure items	Std. loading	St. error	t value	Cronbach's Alpha	Composite reliability	Average variance extracted
Human Capital	HC1	0.57	0.15	5.29	0.83	0.94	0.78
	HC2	0.75	0.13	7.17			
	HC3	0.68	0.12	6.39			
	HC4	0.76	0.13	7.24			
	HC5	0.76					
Organizational Capital	SC1	0.76	0.19	6.95	0.89	0.95	0.72
	SC2	0.85	0.18	7.71			
	SC3	0.87	0.21	7.88			
	SC4	0.70					
Social Capital	SC1	0.65	0.27	4.59	0.84	0.95	0.81
	SC2	0.73	0.25	4.90			
	SC3	0.93	0.32	5.39			
	SC4	0.72	0.26	4.83			
	SC5	0.53					
Knowledge Productivity	KC1	0.86			0.87	0.91	0.83
	KC2	0.88	0.16	9.60			
	KC3	0.90	0.12	9.88			
	KC4	0.86	0.15	9.48			
	KC5	0.82	0.18	8.90			
	KC6	0.85	0.14	9.26			
	KC7	0.87	0.20	9.59			
	KC8	0.84	0.13	9.18			
	KC9	0.73	0.26	8.68			

Table 2 Correlations and Descriptive Statistics (n=113)

Variable	1	2	3	4	5	6
1. Firm Age	1.000					
2. Firm Size	0.348**	1.000				
3. Knowledge Productivity	-0.089	0.138	1.000			
4. Human Capital	-0.147	0.157	0.537**	1.000		
5. Organizational Capital	-0.207*	-0.005	0.424**	0.165	1.000	
6. Social Capital	0.105	0.149	0.538**	0.432**	0.186*	1.000
Mean	21.549	689.248	3.690	3.564	3.748	3.599
S.D.	12.279	957.236	0.666	0.616	0.651	0.649

Note: **p＜0.01, *p＜0.05

Table 3 Regression Analysis for Intellectual Capital and Knowledge Productivity (n=113)

Dependent. Variable / Independent Variable	Knowledge Productivity						
	Model 1				Model 2		
	Beta	t	p.	VIF	Beta	t	p.
Taiwan Biotechnology Industry	0.330	3.658	0.000		0.303	3.428	0.001
Taiwan Pharmaceutical Manufacturers	0.243	2.998	0.003		0.226	2.813	0.006
Age	-0.005	-0.066	0.948		-0.029	-0.401	0.689
Size	0.006	0.079	0.937		0.000	-0.005	0.996
Human Capital	0.281	3.670	0.000	1.242	0.274	3.693	0.000
Organizational Capital	0.208	2.851	0.005	1.072	0.206	2.920	0.004
Social Capital	0.296	3.861	0.000	1.259	0.252	3.319	0.001
Human Capital x Social Capital					0.173	2.647	0.009
Organizational Capital x Social Capital					-0.098	-1.487	0.140
F	18.729				16.492		
Sig.	0.000				0.000		
R_a^2	0.526				0.555		
$\triangle R_a^2$					0.029		
Sig. F Change					0.000		