Discovering Important Factors of Intangible Firm Value by Association Rules

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Abstract. It is very important for investors to understand the critical factors affecting the value of firms before making investments. In knowledge-based economy, the method for creating firm value transfers from traditional physical assets to intangible knowledge. As intangible assets value is an important part of firm value, valuation of intangible assets becomes a widespread topic of interest in the future of economy. This paper applies association rules, one data mining technique, to discover critical factors affecting firm value in Taiwan and to provide a more flexible model than the traditional regression method. Based on collecting related factors found in literature, the results indicate that R&D intensity, family, participation in management, pyramids, profitability, and dividend are the six important factors, in which some are consistent with significant important variables in prior literature, but most of them are unique for Taiwan, one emerging economy.

Keywords: Firm value; intangible assets value; Tobin's Q; data mining; association rules.

1. INTRODUCTION

The market value of a firm's shares ultimately reflects the value of all its net assets. In the industrial era, physical assets, such as land, capital, and labor are critical factors to judge a firm's value. However, in modern economies, the development of communication

technology, electronic commerce, and the internet makes these resources circulate around the world quickly, letting the knowledge-based economy era evolve (Abu-Musa, 2009). In addition, the value of the knowledge industry increases rapidly. Organization for Economic Co-operation and Development (OECD) (2004) indicate that knowledge economy is possession, distribution, production, and use of knowledge as a critical resource in economics. Therefore, the important successful factors for companies are the capability and the efficiency in creation, expansion, and application of knowledge (Kessels, 2001; Greenstein-Prosch *et al.*, 2008; Flensburg, 2009).

The method for creating firm value transfers from traditional physical production factors to intangible knowledge. In this situation, a large part of a firm's value may reflect its intangible assets. Not only consider the tangible assets, but also respect the power of intangible assets (i.e. the difference between the market value and book value of a company) when we evaluate a firm's value. (Chan *et al*., 2001; Eckstein, 2004)

Intangible assets are firm's dynamic capability created by core competence and knowledge resource, including organization structure, employment expert skills, employment centripetal force, R&D innovation capability, customer size, famous brand, and market share. Many researchers (Edvinsson and Malone, 1997; Stewart, 1997; Bukh *et al*., 2001; Serrano-Cinca *et al*., 2003) indicate that intangible assets also can be represented by intellectual capital (IC) of a company. They divide IC into human capital, structure capital, customer capital, organization capital, innovation capital, and process capital and focus on the measurements and components of intellectual capital in some specific industry.

Other studies (Wiwattanakantang, 2001; Lang *et al*., 2003; Gleason and Klock, 2006; Fukui and Ushijima, 2007) investigate various types of impact factors in intangible assets value. Gleason and Klock (2006) and Black *et al.,* (2006) indicate that advertising and R&D expenditure are positively related to Tobin's Q a proxy for intangible firm value, but firm size has negative relation with it. Wiwattanakantang (2001) examines the effect of controlling shareholders including various type of controlling, participation in management, and pyramids on corporate value and find no significant evidences on Tobin's Q. Fukui and Ushijima (2007) investigate the industry diversification of the largest Japanese manufacturers. Regression results show that the average relationship between diversification and firm value is negative. However, research to date (Wiwattanakantang, 2001; Lins, 2003; Black *et al*., 2006) provides mixed evidence on the various factors affecting the firm value.

Different studies, focusing on different domain problems, discover different factors that affect a firms' intangible value. This paper reviews related literature from diverse domains including accounting, finance, management, and marketing to understand six categories impact factors of firm value and use Association Rule (AR) (Sánchez *et al*., 2008) one of the data mining techniques to discover related factors for evaluating the value of firms in Taiwan. This is mainly because knowledge economy is a prevailing concept to accomplish in the developed countries and most emerging markets, including Taiwan and mainland China. However, there is no clear, in-depth understanding about what factors really affect the value of Taiwanese companies. In related work, the regression models usually assume that the relationship between dependent variables and independent variables are linear. In order to get deeper insight of firm value, this paper employs association rules, one data mining technique, to explore the relationship between firm value and other critical factors with no linear assumption.

The findings of this paper support that association rules can be employed to extract some specific factors affecting the intangible values of firms in Taiwan including R&D intensity, family, participation in management, pyramid in ownership structure, profitability, and dividend. In addition, this work was compared and analyzed with prior literature. Because of rather limited regulations and disclosure in intangible capital, the financial reporting cannot always reflect intangible assets value. The problem with the traditional financial accounting framework is that the aforementioned reporting lacks the recognition of intangible capital value and hence, creates an information gap between insiders and outsiders (Vergauwen *et al*., 2007). As a result, we expect that the empirical results obtained from this study can provide useful information for investors or creditors to assess the investment opportunities or loans.

The remainder of the paper is organized as follow. Section 2 reviews the literature about firm value and related to various impact factors. Section 3 describes the research methodology, and Section 4 presents the experimental results and discussion. Finally, a conclusion is provided in Section 5.

2. LITERATURE REVIEW

2.1 Intangible firm value

With the arrival of knowledge-based economy era, the implementation and the application of knowledge and information technology have become the most crucial issues

and competitive advantages of every organization. The primary method for creating firm value is based on transferring from traditional physical production-factors to intangible knowledge (Eckstein, 2004).

Intangible assets are firm's dynamic capability created by core competencies and knowledge resources, including organization structure, employment expert skills, employment centripetal force, R&D innovation capability, customer size, brand recognition, and market share. It represents the future growth opportunities and profitability toward firm value (Ittner, 2008). Therefore, when we evaluate a firm's value, we not only consider the tangible assets, but also we must especially respect the power of intangible assets in recent years (Chan *et al.*, 2001; Eckstein, 2004).

2.2 The impact factors of intangible firm value

In order to understand the factors affecting intangible firm value, related relevant literature is considered. These factors can be further classified into six categories based on their specific features. To this end, we hope to identify which category or factor affect the firm's intangible values. In specific, these values are intangible capital, ownership structure, corporate governance, firm characteristic, industry characteristic, and reactions of analysts &-customers, respectively.

2.2.1 Intangible capital

Many empirical models (Rao *et al.*, 2004; Black *et al.*, 2006; Gleason and Klock, 2006; Fukui and Ushijima, 2007) use the firm value as a forward-looking performance measure. This value represents the market's valuation of the expected future stream of profits which are based on an assessment of the return that can be generated from a firm's tangible and intangible assets. Therefore, any intangible investment increases firm's value in the same fashion that tangible assets increase value. R&D and advertising expenses are viewed as investments which can increase a firm's intangible assets with predictably positive effects on future cash flow and firm value (Gleason and Klock, 2006). Each of them, over the past few decades, has had a strong impact on the relationship between firm performance and intangible capital stocks (Klock and Megna, 2000; Rao *et al.*, 2004; Gleason and Klock, 2006; Fukui and Ushijima, 2007) although the direction are not always consistent with the expected direction.

2.2.2 Ownership structure

Unlike the companies in some developed countries (e.g. US, UK, and Japan), the firms in emerging countries including Taiwan are under single common administrative and financial control of few wealthy old families and their ownership is concentrated on family members (i.e. controlling shareholders) (La Porta *et al*., 1999; Claessens *et al*., 2000). Recently, Claessens *et al.,* (2002) and La Porta *et al.,* (2002) indicate that the voting rights of controlling shareholders are high or higher than their cash flow rights; hence, controlling shareholders could extract wealth from the firm, but only bear a little cost with holding low cash flow rights. In this situation, they could make decisions for entrenchment of minority shareholders' interest and let firm value decrease.

One alternative to mitigate the problem of controlling shareholder entrenchment is to increase the controlling shareholder's cash flow capability (Fan and Wong, 2005). Higher cash flow in the firm means that it will cost more to reduce the value of the corporation and thus, entrench the minority shareholders' benefit. In addition, it accrues a complementary effect, which lets the agency's conflict occurred between controlling shareholder and minority shareholders minimize, and consequently, the firm value increases (Claessens *et al*., 2002; La Porta *et al*., 2002).

In business groups, the situation of entrenchment is more serious (Morck and Yeung, 2003; Silva *et al*., 2006) because of pyramid ownership structure, different kinds of stocks, and cross-shareholdings. By such structures, they make the gap between voting rights and cash flow rights larger and the incentive of entrenchment stronger, and then the value of firm decreases (Wiwattanakantang, 2001).

2.2.3 Corporate governance

When the agency problem arises in companies, which can affects firm value; corporate governance may play an important role (Lins, 2003). These monitoring mechanisms are usually based on the board of directors (Xie *et al*., 2003; Larcker *et al*., 2007). Because boards are charged with monitoring management to protect shareholders' interests, they avoid firm value being entrenched. Especially, the empirical evidence on the efficacy of the monitoring that outsiders provide (proxy for board independence) appears in many studies (Bhagat and Black, 2002; Oxelheim and Randoy, 2003).

Otherwise, large shareholders or institutional shareholders are other general monitoring mechanisms. Jung and Kwon (2002) and Lins (2003) show that institutions, external, or large non-management shareholder are incentivized to monitor their management and protect their assets. Wiwattanakantang (2001) indicates that firms with more than one

controlling shareholder have higher return on assets by monitoring each other to reduce agency cost, related to firms with no controlling shareholder.

Oxelheim and Randoy (2003) suggest that foreign exchange listing signals a firm's commitment to the higher disclosure standards prevailing in the market in which it lists. Board representatives for large foreign shareholders are presumably ''outsiders'' who will not use their influence as board members to obtain benefits that do not accrue to other shareholders (Stulz, 1999). No matter ranking on the list in foreign exchange or foreign shareholders entry as owners, both of them will be expected to increase the value of the firm.

2.2.4 Firm characteristics

A firm's value may be affected directly or indirectly by factors related to the nature of the firm. Sales growth is a proxy for growth opportunities which increase firm value, but the firm size is likely to be inversely related to expected growth opportunities (Fukui and Ushijima, 2007). Rao *et al*., (2004) find that firms with higher growth opportunities have lower leverage. However, previous research (e.g. McConnell and Servaes, 1990) shows that firms with higher leverage can enjoy a tax benefit because they can deduct the interest costs, which results in greater cash flow and thus a positive relationship with firm value. Capital intensity also affects firm value, because it is a proxy for investment opportunities. Although research expects that the positive relation between capital intensity and firm value, most of them provide insignificant or negative results. Allayannis and Weston (2001) indicate that if management forgoes investment projects as they are not able to obtain the necessary financing, the firm's Tobin's Q ratio may remain high since they undertake only positive net present value (NPV) projects. If a firm pays a dividend, it is less likely to be capital constrained and may thus have a lower Q.

In general, a profitable firm triggers expectations among investors of higher cash flow potential and drives intangible value. Furthermore, there are evidences that higher intangible values are significantly associated with higher profitability (Rao *et al*., 2004). Older firms have better disclosure, more liquid trading, more attention from analysts, and more diversified activities leading to lower risk of financial distress and then higher firm value. However, younger firms may have more growth opportunities and likely be faster growing and perhaps more intangible asset intensive (Black *et al*., 2006). Diversification leads to lower risk of financial crisis and higher firm value. Allayannis and Weston (2001) indicate that industrial diversification is an outgrowth of agency problem between managers and shareholders, thus reducing value. Internationalization theory notes that

foreign direct investment occurs when a firm can increase its value by internationalizing markets from some of its intangible assets, such as production skills or consumer goodwill. On the other hand, Allayannis and Weston (2001) find that multi-nationality is positively related to firm value.

2.2.5 Industry characteristic

The degree of industry concentration should affect the firm's relative bargaining power. When an industry is fragmented and concentration is low, the degree of competition in the industry is likely to be more intense and the firm's bargaining power is decreased. Therefore, prior research indicates that higher concentration can provide more market power which can lead to a higher firm value (Anderson *et al*., 2004). On the other hand, many literatures argue that a higher firm value reflects better market efficiency rather than market power. The effect of the concentration index on firm value is negative (Rao *et al*., 2004).

For the traditional manufacturing industry, land, capital, and labor are critical factors to judge a firm's value. However, in the knowledge-intensive industry (e.g. high-technology industry) knowledge and innovation are the dominating resources and are far more important than physical assets (Tseng and Goo, 2005). Therefore, intangible assets determine a large part of a firm's value. Klock and Megna (2000) show that in communications industry, the industry average Tobin's Q is in excess of ten. This means that the market value is about ten times higher than book value. But in traditional industries, most firms' Tobin's Q is nearly equal to one or less than one. Firm value varies by industry.

2.2.6 Reactions of analysts and customers

Lang *et al*., (2003) indicate that more analysts follow means that more information is available, the firm's information environment is better, and the cost of capital is reduced. Analysts are one of outside users of financial statements and own professional domain knowledge; therefore, improving firm value by increasing the cash flows that accrues to shareholders (Lang *et al*., 2003). However, the link for analyst to follow and the value is not necessarily positive. For example, if analysts primarily gather private information, their activities could actually increase cost of capital by raising transactions costs and discouraging uninformed investors from purchasing shares (Diamond and Verrecchia, 1991). Although such an effect on valuation might be offset by an increase in investor

interest, reduced uncertainty, and reduced agency conflicts within firms, the relation between analyst following and valuation is not clear.

According to the marketing theory (e.g. Heisenberg Uncertainty Principle of marketing), it is believed that the more a marketer of a firm understands about why and the way how a consumer behaves, the decision making process in general and the purchase decision or indecision in particular, the more likely the firm will be able to sell the intended products or services to the consumer. Consequently, increasing firm's market share will in turn, bring profitability, and thus affect the firm value. Black *et al.,* (2006) and Morgan and Rego (2009) show that market share is positively related to Tobin's Q proxy for firm value.

2.3 Summary

As per prior literature and/or studies from different business disciplines including accounting, finance, management, and marketing, the above six categories as the influencing factors to firm value are classified and discussed. Different disciplines only put focus on some of these aforementioned impact factors. Therefore, this paper is the first attempt to aim at including all related factors affecting intangible firm values by using Taiwan data.

In addition, the regression models adopted by many relevenat studies usually assume that the relationship between dependent variables and independent variables is linear. However, this assumption can be easily challenged. Consequently, the results are insignificant or mixed frequently in the prior studies. To overcome/remedy these problems, this paper employs association rules to explore the relationship between intangible firm value and critical factors with no linear assumptions.

3. METHODOLOGY

3.1 Association rule

The association rule (AR) was proposed by Agrawal *et al.,* (1993), which is a well-known data mining technique. It is also known as knowledge extraction in databases. More specifically, it was first used to discover regularities between products in transaction data. The aim of data mining is to discover useful information or patterns in large databases containing thousands to millions of records, where conventional statistical analysis is not feasible (Berry and Linoff, 1997; Roiger and Geatz, 2003). AR is usually adopted to discover variables relationships in a given database, and each relationship (also known as

an association rule) may contain two or more variables. These relationships are found by analyzing the co-occurrences of variables in the database. Therefore, an association rule may be interpreted that when the variable A (i.e. antecedent) occurs in a database, the variable B (i.e. consequent) also occurs and is defined as an implication of the form $A => B$. By employing AR, there are two popular algorithms which can be used to analyze the data, such as the Apriori and GRI algorithms. The former is used to analyze nominal or dummy variables; however the latter can be used for dummy and continuous variables which are used massively in this paper.

In addition, two measures are generally used to decide the usefulness of an association rule: *support* and *confidence*. The support of an association rule $A => B$ is the percentage of $A \cup B$. The confidence of an association rule $A => B$ is the ratio of the number of $A \cup B$ to the number of A. Support measures how frequently an association rule occurs in the entire set, and confidence measures the reliability of a rule. In AR, rules are selected only if they satisfy both a minimum support and a minimum confidence threshold. In specific, the AR algorithm is iterative by nature. In each iteration i, it generates the candidate itemsets C_i of size i from the database of transactions and then counts these to see whether or not they are frequent (i.e. satisfy the minimum support threshold). Only those candidates that are frequent (denoted as L_i) are used to generate candidate itemsets C_{i+1} for the next iteration. To generate the next set of C_{i+1} candidates of size $i+1$, joins are made of frequent itemsets, L_i, which is found in the previous iteration. A join may take place if two itemsets have i-1 items in common. Duplicate candidates are discarded after the join process is completed. This process stops when all C_{i+1} candidates in the next iteration are not frequent. Following this, association rules are generated for every frequent itemset l for all the itemsets, L_i. For every l, all nonempty subsets of l are generated. Next, for each nonempty subset s belonging to l, a rule of the form $s \Rightarrow (l - s)$ is generated only if it satisfies the minimum confidence threshold. All the rules are guaranteed to satisfy the minimum support threshold since they are derived from itemsets that already satisfy this requirement (Goh and Ang, 2007).

Although AR has been applied to empirical researches in many fields, application of association rules to analyze intangible firm value is very limited. In the firm value literature, the regression model as the conventional method is generally used for empirical investigations (Lang *et al*., 2003; Anderson *et al*., 2004; Black *et al*., 2006; Fukui and Ushijima, 2007). Unlike the regression model, AR is a non-parametric model without linear relationship assumption and pre-defined relationships between dependent variables

and independent variables. It is more flexible in model specification. Otherwise, AR discovers the relationships among a large set of variables. In other words, given a database of records, each containing two or more variables and their respective values, AR determines variable-value combinations that frequently occur. Similar to correlation analysis in which relationships between two variables are uncovered, AR is also used to extract variable relationships (Tsai and Chen, 2010). From the discussion above, this paper considers using AR to find out the affecting factors of intangible firm value for Taiwanese firms in particular as an emerging market.

However, the extracted rules in AR should not be taken as a definitive model to describe the solution to the problem at hand, since the association rules are generated on the basis of frequency counts of variables in the data sets. The situation- "no knowledge about the domain being investigated", is incorporated into the rule generation process. Consequently, a rule may or may not make sense, even if it has high support and confidence values (Goh and Ang, 2007). The AR process is thus, required to have a further discussion with a domain expert. To accomplish this, after using AR to find out the affecting factors, this paper will explore and discuss these affecting factors.

3.2 Variables measurement

3.2.1 Intangible Firm value -Tobin's Q

According to prior literature (La Porta *et al*., 2002; Lins, 2003; Fukui and Ushijima, 2007), Tobin's Q is always used as a proxy for firm value. However, Tobin's Q actually means the differences between the market value of a firm and the replacement cost of the tangible assets which is associated with the value of intangible assets. For this reason, the intangible firm value is considered as a proxy in this paper.

The construction of the Tobin's Q involves more complicated issues and choices. The standard definition Q is the market value of all financial claims on the firm divided by the replacement cost of assets (Tobin, 1969). There are practical problems associated with implementing this definition because neither of these variables is observable. A standard approach to construct the numerator is to use the sum of the market value of equity and the book value of debt. Otherwise, the denominator is used by the book value of assets to replace the replacement cost which is not readily available. Many prior researches (e.g. Chung and Pruitt, 1994; Dadalt *et al*., 2003; Gleason and Klock, 2006) indicate that this is a good approximation because the correlation between such a series and an alternative

detailed adjustment to the book value of debt is around 98%. The modified function is shown as following:

$$Q = \text{(Market value of common stock + Book value of preferred stock)}$$
$$/ \text{ Book value of total assets} \qquad (1)$$

When the Q ratio of firm is more than one, it represents that market firm value is greater than the book value of its assets. Hall (2001) and Anderson *et al.,* (2004) indicate that this excess value is due to intangible assets value. In this paper, the Q is a dummy variable, taking the value of 1 if the Q ratio is more than 1 which means a firm owns higher intangible firm value, otherwise it is 0.

3.2.2 Antecedent variables

According to prior related literature, this paper uses R&D intensity and advertising intensity to proxy intangible capital. R&D intensity is measured by research and development expenditures to total assets, and advertising intensity is measured by advertising expenditures to total assets.

In ownership structure variables, this study is similar to Wiwattanakantang (2001) by using three types of controlling shareholders: family, government, and foreign investor which are dummy variables, indicating if the firm has a controlling shareholder who is an individual, government, and a foreign investor, respectively. On the other hand, ownership structure variables include cash flow right measured by the cash flow right of controlling shareholders and divergence measured by using voting rights of controlling shareholders minus cash flow rights. In addition, the participation in management is a dummy variable, indicating if the controlling shareholder and his family are present among the management level. Nonparticipation in the management level is set equal to 1 if controlling shareholders are not in the management level. Management owners measured by cash flow rights of controlling shareholders who are also management, which is the pyramids dummy variable, indicating if there exists pyramids ownership structure and/or cross-shareholdings, and business group dummy variable, taking the value of 1 if the firm belongs to one of the 100 largest business groups in Taiwan (Wiwattanakantang, 2001; Claessens *et al*., 2002; La Porta *et al*., 2002; Lins, 2003; Black *et al*., 2006).

In corporate governance variables, this paper uses board size measured by the number of directors on the board; board independence measured by the percentage of independent outsider directors; blockholder, a dummy variable is defined that if the percentage of shares of the second largest shareholder is more than 5% adapted by Jung and Kwon (2002) that the variable is 1, otherwise is 0; the multi control dummy variable, if the firm has more than one controlling shareholder as proxy for corporate governance mechanisms. This paper uses more than 10% voting right hold by shareholder to determine if company exist controlling shareholder including one or more than one (La Porta *et al*., 1999). Foreign listing is a dummy (value 1 for foreign listing, 0, otherwise) used to identify firms that are listed or traded on one or more foreign exchanges, such as NYSE, NASDAQ, USA OTC(ADRs).

About firm characteristics variables, sale growth measured by growth rate in sales size measured by log total assets. We use the ratio of total debt to total assets of the firm as a measure of leverage. In this paper, fixed capital (i.e. property plant and equipment) to total sales ratio is the measure of capital intensity. According to Allayannis and Weston (2001), we use a dividend dummy, which equals 1 if the firm paid a dividend in the current year to proxy for the ability to access markets. We calculate profitability as the ratio of net income to total assets. We use the years since establishment as a measurement of age. Diversification is measured by the number of subsidiary companies. We use the ratio of export sales to total sales as a continuous measure of multi-nationality in the paper, and export to name it.

In industry characteristics variables, we measured concentration using the herfindahl–hirschman index (hhi), which is the sum of the squared market shares of the firms in the industry (Schmalensee, 1977; Anderson *et al*., 2004; Rao *et al*., 2004). Industry is a dummy variable for four-digit industries or two-digit industries traded on Taiwan stock exchange or gretai securities market.

On the other hand, in reactions of analysts and customers variables, we use a number of analysts that report estimates for each firm to measure. Market share is measured by firm's share of total sales by all firms in the same four-digit industries or two-digit industries traded on the Taiwan stock exchange or gretai securities market. All the 30 variables are summarized in Table 1.

Category	Variables	Measurement	Reference
Intangible capital			
	R&D INTENSITY	Research and development expenditures to total assets.	Klock and Megna (2000), Allayannis and Weston (2001), Rao *et al.,* (2004), Black *et al.,* (2006), Gleason and Klock (2006), Fukui and Ushijima (2007).
	ADVERTISING INTENSITY	Advertising expenditures to total assets.	Klock and Megna (2000), Allayannis and Weston (2001), Rao *et al.,* (2004), Anderson *et al.,* (2004) Black *et al.,* (2006), Gleason and Klock (2006), Fukui and Ushijima (2007).
Ownership structure			
	FAMILY	Dummy variables; indicating if the firm has a controlling shareholder who is an individual or a family.	Wiwattanakantang (2001), La Porta *et al.,* (2002).
	GOVERNMENT	Dummy variables; indicating if the firm has a controlling shareholder who is government.	Wiwattanakantang (2001), La Porta *et al.,* (2002).
	FOREIGN INVESTOR	Dummy variables, indicating if the firm has a controlling shareholder who is a foreign investor or a company.	Wiwattanakantang (2001), Oxelheim and Randoy (2003), Black *et al.,* (2006).
	CASH FLOW RIGHT	Cash flow right of controlling shareholders.	Wiwattanakantang (2001), Claessens *et al.,* (2002), La Porta *et al.,* (2002), Black *et al.,* (2006).
	DIVERGENCE	Voting rights of controlling shareholders minus cash flow rights.	Claessens *et al.,* (2002), La Porta *et al.,* (2002).
	PARTICIPATION IN MANAGEMENT	Dummy variable; indicating if the controlling shareholder and his family are present among management.	Wiwattanakantang (2001), Lins (2003).
	NONPARTICIPATION IN MANAGEMENT	If controlling shareholders are not management the variable is 1; otherwise is 0.	Lins (2003).
	MANAGEMENT OWNERS	Cash flow rights of controlling shareholders who are also management.	Wiwattanakantang (2001), Lins (2003).
	PYRAMIDS	Dummy variable; indicating if there exists pyramids ownership structure and/or cross-shareholdings.	Wiwattanakantang (2001), Lins (2003).

Table 1. The factors affecting firm value

Category	Variables	Measurement	Reference
	BUSINESS GROUP	Dummy variable; taking the value of 1 if the firm belongs to one of the 100 largest business groups in Taiwan.	Wiwattanakantang (2001), Black *et al.,* (2006).
Corporate governance			
	BOARD SIZE	The number of directors on the board.	Oxelheim and Randoy (2003), Xie *et al.,* (2003).
	BOARD INDEPENDENCE	The percentage of independent outsider directors.	Oxelheim and Randoy (2003), Xie *et al.,* (2003).
	BLOCKHOLDER	Dummy variable defined that if the percentage of shares of the second largest shareholder is more than 5%.	Oxelheim and Randoy (2003), Lins (2003).
	MULTI CONTROL	Dummy variable, if the firm has more than one controlling shareholder.	Wiwattanakantang (2001), Lins (2003).
	FOREIGN LISTING	Dummy variables; identify firms that are listed or traded on one or more foreign exchanges.	Oxelheim and Randoy (2003), Lang *et al.,* (2003), Black *et al.,* (2006).
Firm characteristics			
	SALE GROWTH	Growth rate in sales.	Wiwattanakantang (2001), Claessens *et al.,* (2002), La Porta *et al.,* (2002), Lang *et al.,* (2003), Klapper and Love (2004), Rao *et al.,* (2004), Black *et al.,* (2006), Fukui and Ushijima (2007).
	SIZE	The log of total assets.	Wiwattanakantang (2001), Allayannis and Weston (2001), Claessens *et al.,* (2002), Oxelheim and Randoy (2003), Lang *et al.,* (2003), Lins (2003), Klapper and Love (2004), Gleason and Klock (2006), Black et al., (2006), Fukui and Ushijima (2007).
	LEVERAGE	The ratio of total debt to total assets.	Wiwattanakantang (2001), Allayannis and Weston (2001), Lins (2003), Rao *et al.,* (2004), Black *et al.,* (2006), Fukui and Ushijima (2007).
	CAPITAL INTENSITY	The ratio of fixed capital (i.e. property plant and equipment) to total sales.	Allayannis and Weston (2001), Claessens *et al.,* (2002), Lins (2003), Klapper and Love (2004), Black *et al.,* (2006).
	DIVIDEND	Dummy variable; which equals 1 if the firm paid a dividend in the current year.	Allayannis and Weston (2001).

Table 1 The factors affecting firm value (continuation)

Category	Variables	Measurement	Reference
	PROFITABILITY	The ratio of net income to total assets.	Allayannis and Weston (2001), Lang et al., (2003), Rao et al., (2004), Black et al., (2006).
	AGE	The years since establishment.	Wiwattanakantang (2001), Claessens et al., (2002), Oxelheim and Randoy (2003), Gompers et al., (2003), Rao et al., (2004), Black et al., (2006).
	DIVERSIFICATION	The number of subsidiary companies.	Allayannis and Weston (2001), Fukui and Ushijima (2007).
	EXPORT	The ratio of export sales to total sales.	Allayannis and Weston (2001), Black et al., (2006).
Industry characteristics			
	CONCENTRATION	The sum of the squared market shares of the firms in the industry.	Anderson et al., (2004), Rao et al., (2004).
	INDUSTRY	Dummy variable for four-digit or two-digit industries traded on Taiwan stock exchange or Gretai securities market. Contain thirty two industries.	Oxelheim and Randoy (2003), Lang et al., (2003), Lins (2003).
Reactions of analysts and customers			
	ANALYST FOLLOWING	The number of analysts that report estimates for each company.	Lang et al., (2003), Gompers et al., (2003).
	MARKET SHARE	Firm's share of total sales by all firms in the same four-digit industries or two-digit industries.	Anderson et al., (2004), Black et al., (2006), Morgan and Rego (2009).

Table 1. The factors affecting firm value (continuation)

3.3 Sample selection

Nowadays, knowledge economy is prevailing in developed countries and emerging markets, including Taiwan and mainland China. Taiwan and China share the same culture and celebrate the same holidays, and many private enterprises in China are invested by Taiwan enterprises. For example, Taiwan Semiconductor Manufacturing Co., Ltd. directly invests USD$ 371,000 thousand dollars in TSMC Shanghai in Shanghai. End in 2008, the accumulated investment of Formosa Plastics Corporation in China is USD$ 398,770 thousand dollars.

In this paper, we use sample firms from manifold industries in Taiwan except regulated utilities and financial institutions due to the unique aspects of their regulatory environments. We hope to take the Taiwan economy as a lesson and learn some lessons about the business practice for applying to Chinese cases.

In order to increase the accessibility of the sample data and avoid the influence of different fiscal year-ends, this study considers only listed companies with December 31 fiscal year-ends and collects from the Taiwan Economic Journal (TEJ) database. The controlling shareholder's ownership structure data is accessed from corporate governance database and the financial data it received from financial database in TEJ. The period of the data is from 1996 to 2007. After excluding missing data, in total, 9,027 observations are used for the final analysis.

4. RESULTS AND DISCUSSION

4.1 Descriptive Statistics

Table 2 provides the descriptive statistics of variables for the overall samples. The consequent variable, Tobin's Q, indicates that about two-third sample companies own intangible firm value. In antecedent variables, the average of R&D intensity is 1.974%, higher than the advertising intensity which is 0.403%. For the ownership structure variables, most of the sample companies are controlled by family members, exist pyramids construct, and most controlling shareholders participate in management since their Q1 value is 1. These results are consistent with the findings from prior literature (Claessens *et al*., 2002; La Porta *et al.,* 2002; Morck and Yeung, 2003; Silva *et al*., 2006).

In terms of corporate governance variables, most companies do not own these monitoring mechanisms, since the medians of board independence, blockholder, multi control, and foreign listings are 0. About 70% companies pay dividend in accordance with dividend variables. The average and median age of samples are about twenty-three and twenty-one years, respectively. The diversification variable indicates that one company has 3.5 subsidiary companies in average. Most of the sample companies do not have any analyst to report and analyze their information.   Further, the industry variable (not detailed in Table 2) includes 32 industries in Taiwan.

Variables	Average	St.	Min	Q1	Median	Q3	Max
Tobin's Q	0.669	0.470	0	0	1	1	1
R&D INTENSITY	1.974	3.200	0	0	0.818	2.533	39.868
ADVERTISING INTENSITY	0.403	1.215	0	0	0.023	0.265	25.002
FAMILY	0.859	0.348	0	1	1	1	1
GOVERNMENT	0.020	0.141	0	0	0	0	1
FOREIGN INVESTOR	0.004	0.065	0	0	0	0	1
CASH FLOW RIGHT	23.769	16.897	0	10.290	20.335	34.165	97.750
DIVERGENCE	5.529	9.987	0	0	1.280	5.930	81.360
PARTICIPATION IN MANAGEMENT	0.738	0.439	0	1	1	1	1
NONPARTICIPATION IN MANAGEMENT	0.262	0.439	0	0	0	1	1
MANAGEMENT OWNERS	3.563	5.354	0	0	1.240	5.210	46.350
PYRAMIDS	0.963	0.189	0	1	1	1	1
BUSINESS GROUP	0.703	0.457	0	0	1	1	1
BOARD SIZE	7.047	2.863	2	5	7	8	27
BOARD INDEPENDENCE	9.367	14.756	0	0	0	22.222	66.667
BLOCKHOLDER	0.277	0.447	0	0	0	1	1
MULTI CONTROL	0.047	0.212	0	0	0	1	1
FOREIGN LISTING	0.044	0.205	0	0	0	0	1
SALE GROWTH	15.270	76.790	-197.400	-5.403	7.345	23.845	3897.660
SIZE	6.583	0.568	5.018	6.178	6.519	6.903	8.793
LEVERAGE	40.035	17.245	1.550	27.600	39.620	50.710	307.380
CAPITAL INTENSITY	11.203	317.175	-15.377	0.673	2.349	7.329	30022.682
DIVIDEND	0.690	0.462	0	0	1	1	1
PROFITABILITY	3.771	11.462	-249.945	0.570	4.452	9.007	58.359
AGE	22.967	11.758	1	14	21	31	62
DIVERSIFICATION	3.535	3.553	0	1	3	5	41
EXPORT	59.251	1026.070	0.000	3.952	41.623	78.362	72128.073
CONCENTRATION	1248.915	1190.441	310.481	514.859	787.726	1571.453	9884.513
ANALYST FOLLOWING	0.649	0.899	0	0	0	1	5
MARKET SHARE	3.241	7.022	0	0.277	0.925	2.955	99.419

Table 2. The descriptive statistics of variables

4.2 The result of association rule

4.2.1 Main results

The GRI algorithm is implemented by Clementine, a commercial data mining software product, as some antecedent variables are continuous variables (SPSS, 2005). Sliding support and confidence values are used, starting initially at 80% and reducing 10% gradually until the final threshold value of 30% is reached or none of the rule arisen. The number of rules of the antecedent variables is limited to 5 to simplify the rule (Goh and Ang, 2007), and the number of association rule is determined in the maximum value 100.

In this paper, association rules are generated to determine the critical factors affecting intangible firm value. We decide two higher support and confidence threshold values (50% / 80% and 50% / 70%) as the representative result shown in Table 3. The Panel A of Table 3 shows the result of 50% / 80% (i.e. support / confidence) including 5 association rules. The result indicates that profitability, pyramids, family, and participation in management are critical factors affecting intangible firm value. Especially, profitability > 4.429 toward 1 of Tobin's Q, which means the firm has higher intangible firm value owns the highest confidence and this rule is found in 89% of sample firms. The result provides that when the company's ROA is higher than 4.429, it may own higher intangible firm value. In addition, profitability is also a critical factor from the second to the fifth rules. The second rule indicates that if a firm owns pyramids ownership structure and/or cross-shareholdings and profitability > 4.202 then the firm has or has higher intangible firm value. This result provides that besides profitability, pyramids ownership structure will further affect firm's intangible firm value. Furthermore, a controlling shareholder who is an individual, or the controlling shareholder and his/her family are present among management are another affecting factors in the third and the fifth association rule with higher confidence and support, respectively. As a result, we can find out four critical factors affecting intangible value of a firm.

On the other hand, the lower value of support and confidence, the lager the number of rules generated, holding other parameters constant (Goh and Ang, 2007). Therefore, in Panel B, the result contains 7 association rules. Among them, the first five rules are the same as Panel A and the sixth rule also owns similar affecting factors. However, in the seventh rule, R&D intensity is a new and unique appearance. It indicates that when firms invest in R&D intensity more than 0.811%, it will influence intangible firm value significantly. In this rule, R&D is the only one factor which affects intangible firm value

with higher confidence and support. Therefore, this result indicates that R&D intensity is also another critical affecting factor. Besides these five factors, in order to find out other critical factors affecting intangible firm value, this paper tries many models to verify the results, and shows them in Table 4.

No.	Association Rule	Support	Confidence
Panel A[*] (The number of association rules: 5)			
1	*PROFITABILITY > 4.429 => Q*	50.15%	89.00%
2	*PYRAMIDS ^ PROFITABILITY > 4.202 => Q*	50.04%	88.00%
3	*FAMILY ^ PROFITABILITY > 3.349 => Q*	50.02%	84.00%
4	*FAMILY ^ PYRAMIDS ^ PROFITABILITY > 3.097 => Q*	50.01%	84.00%
5	*PARTICIPATION IN MANAGEMENT ^ PROFITABILITY > 2.013 => Q*	50.01%	81.00%
Panel B[**] (The number of association rules: 7)			
1	*PROFITABILITY > 4.429 => Q*	50.15%	89.00%
2	*PYRAMIDS ^ PROFITABILITY > 4.202 => Q*	50.04%	88.00%
3	*FAMILY ^ PROFITABILITY > 3.349 => Q*	50.02%	84.00%
4	*FAMILY ^ PYRAMIDS ^ PROFITABILITY > 3.097 => Q*	50.01%	84.00%
5	*PARTICIPATION IN MANAGEMENT ^ PROFITABILITY > 2.013 => Q*	50.01%	81.00%
6	*PARTICIPATION IN MANAGEMENT ^ PYRAMIDS ^ PROFITABILITY > 1.573 => Q*	50.01%	80.00%
7	*R&D INTENSITY >0.811 => Q*	50.09%	78.00%
[*]Support threshold value is 50%; Confidence threshold value is 80%.			
[**]Support threshold value is 50%; Confidence threshold value is 70%.			

Table 3. Support and Confidence for association rules

Regarding Table 4, the results are consistent with prior literature, and the generated association rules are dependent on the minimum support and confidence threshold values. Therefore, when these values become larger, the number of rules generated decreases. The results of all test threshold values in this paper are similar to the above result that the appearance number of critical factors is either large or persistent. For instance, for 30% / 30% rules, there are 42 association rules and then profitability appears 40 times. This result shows that profitability presents in 40 association rules and the results are similar in other threshold values. Besides, other critical factors, such as pyramids, family, participation in management, and R&D intensity almost present in all threshold values. These results indicate that profitability pyramids, family, participation in management, and R&D intensity are also critical factors affecting intangible firm value indeed. On the other hand, dividend exists in each model with lower support, the reason may be because there are less sample companies pay dividend shown in Table 2. However, it not only appears persistent, but also exists in the first five association rules of the model with different confidence values (i.e. from low to high) shown partially in Table 5 . The result shows that dividend may be another important factor. Therefore, in summary, we can find out six critical factors affecting intangible firm value from our sample including R&D intensity, family, participation in management, pyramids, profitability, and dividend.

support/ confidence	30/30	30/40	30/50	30/60	30/70	30/80	40/20	40/30	40/40
Number*	42	42	42	23	16	16	30	30	30
R&D INTENSITY	3**	3	3	3	3	3	2	2	2
FAMILY	27	27	28	12	6	6	13	13	13
CF RIGHT	12	12	12	3			8	8	8
DIVERGENCE	2	2	2				2	2	2
PARTICIPATION IN MANAGEMENT	14	14	14	6	5	5	4	4	4
MANAGEMENT OWNERS	2	2	2				2	2	2
PYRAMIDS	21	21	21	10	6	6	15	15	15
BOARD INDEPENDENCE	21	21	21	4			15	15	15
SALE GROWTH	1	1	1	1	1	1			
PROFITABILITY	40	40	40	21	14	14	28	28	28
DIVIDEND	5	5	5	5	5	5			

support/ confidence	40/50	40/60	40/70	40/80	50/30	50/40	50/50	50/60	50/70	50/80
Number*	30	15	9	8	11	11	11	7	7	5
R&D INTENSITY	2	1	1		1	1	1	1	1	
FAMILY	13	8	4	4	2	2	2	2	2	2
CF RIGHT	8	6			1	1	1			
DIVERGENCE	2									
PARTICIPATION IN MANAGEMENT	4	4	4	4	2	2	2	2	2	1
MANAGEMENT OWNERS	2									
PYRAMIDS	15	7	4	4	5	5	5	3	3	2
BOARD INDEPENDENCE	15				3	3	3			
SALE GROWTH										
PROFITABILITY	28	14	8	8	10	10	10	6	6	5
DIVIDEND										

*The number of association rule.
**The number which appearance in all association rules.

Table 4. The summary of results of all test threshold value in the paper

No.	Association Rule	Support	Confidence
Panel A[*] (The number of association rules: 16)			
1	*DIVIDENT ^PROFITABILITY > 6.792=> Q*	35.29%	95.00%
2	*PYRAMIDS ^DIVIDENT ^PROFITABILITY > 6.763 => Q*	34.29%	95.00%
3	*FAMILY ^ DIVIDENT ^PROFITABILITY > 6.794 => Q*	30.86%	95.00%
4	*FAMILY ^ PYRAMIDS ^* DIVIDENT *^PROFITABILITY > 6.763=> Q*	30.11%	95.00%
5	*PARTICIPATION IN MANAGEMENT ^ DIVIDENT ^ PROFITABILITY > 6.063 => Q*	30.89%	94.00%
Panel B[**] (The number of association rules: 16)			
1	*DIVIDENT ^PROFITABILITY > 6.792=> Q*	35.29%	95.00%
2	*PYRAMIDS ^DIVIDENT ^PROFITABILITY > 6.763 => Q*	34.29%	95.00%
3	*FAMILY ^ DIVIDENT ^PROFITABILITY > 6.794 => Q*	30.86%	95.00%
4	*FAMILY ^ PYRAMIDS ^* DIVIDENT *^PROFITABILITY > 6.763=> Q*	30.11%	95.00%
5	*PARTICIPATION IN MANAGEMENT ^ DIVIDENT ^ PROFITABILITY > 6.063 => Q*	30.89%	94.00%
[*]Support threshold value is 30%; Confidence threshold value is 80%. [**]Support threshold value is 30%; Confidence threshold value is 70%.			

Table 5. Support and Confidence for association rules (the first five rules)

4.2.2 Additional Test

After reviewing related literature, Allayannis and Weston (2001) provide that if the management is hedgers, they would use foreign currency or derivative financial products to avoid the risk, and then affect the intangible firm value. Therefore, we add the hedger dummy variable, indicating if the firm uses any financial techniques to avoid the risk as another antecedent variable in additional test. Otherwise, since the data of hedger is unavailable in the database of Taiwan before the year of 2005, the final samples are reduced to 1,789 observations, and hence, the period used is from 2005 to 2007. Even adding the hedger variable will decrease the sample size, we can still verify the result from different periods by additional test. Similar to the main results, we present the results extracted from AR with first two highest support and confidence threshold values (50% / 80% and 50% / 70%) shown in Table 6 and then, summarize the results of all threshold values in Table 7. The results indicate that the new variable hedger never exists in any association rule and is not an important factor affecting intangible firm value. Otherwise, although divergence exists in the 50% / 70% rule or other threshold values the appearance number is either less or not persistent. From the above discussion, it is not an important factor. Similar to the main results, profitability, pyramids, family, participation in

management, and R&D intensity almost present in all threshold values and dividend exists in the first several rules. Therefore, the critical factors are similar to prior main results including R&D intensity, family, participation in management, pyramids, profitability, and dividend.

No.	Association Rule	Support	Confidence
Panel A[*] (The number of association rules: 7)			
1	*PROFITABILITY > 5.292 => Q*	50.06%	91.00%
2	*PYRAMIDS ^ PROFITABILITY > 5.165 => Q*	50.11%	91.00%
3	*FAMILY ^ PROFITABILITY > 4.020 => Q*	50.00%	85.00%
4	*FAMILY ^ PYRAMIDS ^ PROFITABILITY > 3.945 => Q*	50.00%	85.00%
5	*PARTICIPATION IN MANAGEMENT ^ PROFITABILITY > 2.149 => Q*	50.00%	82.00%
6	*PARTICIPATION IN MANAGEMENT ^ PYRAMIDS ^ PROFITABILITY > 1.866 => Q*	50.00%	81.00%
7	*R&D INTENSITY >0.773 => Q*	50.62%	81.00%
Panel B[**] (The number of association rules: 8)			
1	*PROFITABILITY > 5.292 => Q*	50.06%	91.00%
2	*PYRAMIDS ^ PROFITABILITY > 5.165 => Q*	50.11%	91.00%
3	*FAMILY ^ PROFITABILITY > 4.020 => Q*	50.00%	85.00%
4	*FAMILY ^ PYRAMIDS ^ PROFITABILITY > 3.945 => Q*	50.00%	85.00%
5	*PARTICIPATION IN MANAGEMENT ^ PROFITABILITY > 2.149 => Q*	50.00%	82.00%
6	*PARTICIPATION IN MANAGEMENT ^ PYRAMIDS ^ PROFITABILITY > 1.866 => Q*	50.00%	81.00%
7	*R&D INTENSITY >0.773 => Q*	50.62%	81.00%
8	*DIVERGENCE >0.135 ^ PROFITABILITY > 2.287 => Q*	50.06%	81.00%
[*]Support threshold value is 50%; Confidence threshold value is 80%. [**]Support threshold value is 50%; Confidence threshold value is 70%.			

Table 6. Support and Confidence for association rules-Additional test

4.3 Discussion

4.3.1 The critical factors from Taiwan

From the sample firms in Taiwan, this paper discovers six critical factors with either persistent appearance in difference threshold value model or emergence in the first association rule of the model. The variables are R&D intensity, family, participation in management, pyramids, profitability, and dividend, respectively. After comparing the

results with prior related researches, we can see that some critical variables are also significantly important variables in prior literature, but the majority is not in our case.

support/ confidence	30/30	30/40	30/50	30/60	30/70	30/80	40/30	40/40	40/50
Number[*]	28	28	27	25	20	19	27	27	27
R&D INTENSITY	1[**]	1	1	1	1	1	2	2	2
FAMILY	11	11	11	9	7	7	15	15	15
CF RIGHT	2	2	2						
DIVERGENCE							2	2	2
PARTICIPATION IN MANAGEMENT	11	11	10	10	7	5	6	6	6
MANAGEMENT OWNERS	5	5	5	5	5		1	1	1
PYRAMIDS	15	15	14	13	13	10	13	13	13
BOARD INDEPENDENCE	4	4	3	3	3	3	9	9	9
SALE GROWTH	1	1	1	1	1		1	1	1
PROFITABILITY	23	23	22	20	20	15	25	25	25
DIVIDEND	12	12	12	12	10	10	5	5	5
support/ confidence	40/60	40/70	40/80	50/30	50/40	50/50	50/60	50/70	50/80
Number[*]	16	16	14	9	9	9	8	8	7
R&D INTENSITY	1	1	1	1	1	1	1	1	1
FAMILY	8	7	7	2	2	2	2	2	2
CF RIGHT									
DIVERGENCE	1	2		1	1	1	1	1	
PARTICIPATION IN MANAGEMENT	6	5	5	2	2	2	2	2	2
MANAGEMENT OWNERS	1	4							
PYRAMIDS	6	6	6	3	3	3	3	3	3
BOARD INDEPENDENCE				1	1	1			
SALE GROWTH									
PROFITABILITY	15	15	13	8	8	8	7	7	6
DIVIDEND	5	5	5						
*The number of association rule. **The number which appearance in all association rules.									

Table 7. The summary of results of all test threshold value-Additional test

Generally, a profitable firm is expected to have higher cash flow and can drive intangible value by investors, and then influence investors to assess the firm. However, in prior literature, most studies have no significant association between profitability and intangible firm value (e.g. Lang *et al*., 2003; Black *et al*., 2006). Through the data mining technique, we discover that profitability is an important factor because of its persistent occurrence in the model with different threshold values and also the appearance in the first association rule of the models. Further, although few literatures examine the relation between dividend and firm value, we find that if a firm pays dividends, it is an important reference for investors to evaluate the firm. This is simply because it appears in the first association rule of the models.

The mass of prior studies (Black *et al*., 2006; Fukui and Ushijima, 2007) provide that R&D investment has statistically significant positive effects on future cash flow and firm value. These results show that in a knowledge-based economy, enormous competitive pressure always push the firms to produce innovation products through investing more and more R&D expenditures, and then create larger market and meet more consumer's demands. Similar to majority related literature, the result of this paper indicate that R&D intensity is associated with Tobin's Q as a proxy for intangible firm value. It means that innovation is an important factor affecting intangible firm value in knowledge economy.

Unlike the companies in some developed countries which have widely dispersed ownership, developing countries are under single common administrative and financial control of few wealthy old families and their ownership is concentrated in family members. Therefore, the discussion of agency problem from family controlling shareholder always appears in emerging countries researches (e.g. Claessens *et al.,* 2000; La Porta *et al.,* 2002; Morck and Yeung, 2003), although some results of studies are not significant. Claessens *et al*., (2000) provide about half of the sample firms of Taiwan pyramids, and 79.8% firms indicate that the controlling shareholder and their respective family's are present among management. Otherwise, the firms have a controlling shareholder who is an individual or family member with about 65.6% of sample firm. These results show that the problems from controlling shareholder may exist in many firms and influence firm value. Therefore, among the ten ownership structure variables we find out family, participation in management, and pyramids are more important variables affecting intangible firm value.

Summary of the above discussion: the six variables are critical factors influencing intangible value of firms in Taiwan. Some are consistent with prior literature, but some are difference. Therefore, we expect that the empirical results can provide other information

for investors or creditors not only in Taiwan, but also in other emerging countries including China when they evaluate intangible value of firm.

4.3.2 Difference from prior literature

According to the results, we can find that the antecedent variables belong to corporate governance, industry characteristics, and reactions of analysts and customers are less or never occur in association rules. Fan and Wong (2005) indicate that the conventional corporate control systems (e.g. boards of directors and institutions) in developing countries do not have a strong governance function, since they have weaker legal environments. Therefore, in these countries, outside corporate control system (e. g. auditors) may play a more critical role for corporate governance, and then conventional corporate control systems may not be more important in emerging countries.

Otherwise, the industry characteristics and reactions of analysts and customers are not related to intangible firm value. Industry situation and reaction of customers could give management some advice. When they want to increase intangible firm value they may pay much attention to produce high value-added products or to care about industry trend, not focus on extending the market share only. The unimportance of the analyst variable may vary since the analysts focus on "big corporations" which may not be a firm with high intangible firm value when they forecast.

5. CONCLUSION

With the arrival of knowledge-based economy era, the implementation and the application of knowledge and information technology have become the most crucial issue and competitive advantage of every organization. Because of the method for creating firm value transfers from traditional physical assets to intangible knowledge, it is commonly found that the market values of knowledge based firms are much higher than the book values. Therefore, valuation of intangible assets value becomes a widespread topic of interest in the new economy.

This paper aims at understanding the determinants of intangible firm value in Taiwan. In particular, related literature is reviewed over various domains and six categories of impact factors of intangible firm value are found including Intangible capital, Ownership structure, Corporate governance, Firm characteristics, Industry characteristics, and Reactions of analysts and customers. Next, a data mining technique, association rules, is applied to discover critical factors affecting the intangible firm value in Taiwan. The results

indicate R&D intensity, and then family, participation in management, pyramid in ownership structure, otherwise, profitability, and dividend are important antecedent variables for Tobin's Q as a proxy for intangible firm value.

After comparing the results of prior researches, we find out that R&D intensity is consistent with prior literature (Rao *et al*., 2004; Gleason and Klock, 2006; Black *et al*., 2006; Fukui and Ushijima, 2007). However, family, participation in management and pyramid are unique factors for emerging countries. On the other hand, profitability and dividend are verified to be important factors affecting intangible firm value.

Data mining techniques have been applied in many business fields, but none was utilized in assessing the intangible firm value. In addition, for these aforementioned studies, AR is usually employed to discover the relationships between a large set of variables. This paper considers using AR to find out the affecting factors of intangible firm value especially for the firms in Taiwan as one example of the emerging markets. It is authors' belief that this proposed method can provide a more flexibility than traditional statistics method can. However, no knowledge about the investigated domain in general is incorporated into the association rule generation process. Consequently, a rule may or may not make sense, even if it has high support and confidence values. The AR process thus, requires further discussion with a domain expert. In sum, after using AR to find out the affecting factors, this paper discusses these affecting factors and hope these empirical results and discussion can provide newer insights for investors or creditors to help them asess the investment opportunities or loans.

Although we have tried to collect as many related important factors as possible in all kinds of business disciplines in recent years, some variables might be missing. For future work, more new and related literature or minor factors found in related studies could be incorporated to conduct the analysis. In addition, other feature selection methods, such as decision trees and genetic algorithms can also be applied to compare with the selected variables of AR in order to make a more reliable conclusion.

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