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市場結構與績效—以產業結構之網絡分析觀點

Market Structure and Performance: Perspective from Network Analysis of Industry Structure

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摘要

本研究提出一個量化模型來衡量影響產業獲利程度的四種競爭作用力，即運用競爭者侷限來衡量現有競爭者之間的競爭態勢、藉由供應商侷限來衡量供應商議價能力、利用客戶侷限來衡量客戶議價能力、最後採用結構同位侷限來衡量潛在競爭者與替代品的威脅。接著以台灣產業結構作為實證資料來源，加以驗證此量化模型之可行性。實證結果顯示這四種競爭作用力對於產業的獲利程度具有顯著影響，換言之，本研究所提出之量化模型，可以用來衡量競爭作用力並且比較他們之間的大小，以及評估各個競爭作用力對產業績效的影響程度。實證結果發現，影響台灣製造產業績效的競爭作用力強度大小依序為結構同位侷限、競爭者侷限、客戶侷限、供應商侷限。

關鍵詞：產業結構、競爭作用力模型、社會網絡分析、侷限、績效

Abstract

This study proposes a quantitative methodology for measuring the four competitive forces which affect industry profitability. More precisely, the proposed model uses the competitor constraint to measure rivalry among existing competitors, the supplier constraint to measure bargaining power of suppliers, the buyer constraint to measure bargaining power of buyers, and the structural equivalence constraint to measure threats of new entrants and substitutes. Then, this study empirically examines a sample of industry structures taken from Taiwan. The analytical results show that the four competitive forces indeed have statistically significant influences on industry profitability. Particularly, the model can quantitatively measure and compare the strength of the competitive forces that drive competition within industries, and estimate the impact of these forces on industry performance. The empirical results show that the sequence of the strength of the competitive forces that govern industry performance in Taiwanese manufacturing sectors is structural equivalence constraint, competitor constraint, buyer constraint, and supplier constraint.

Keywords: Industry structure, Competitive forces model, Social network analysis, Constraint, Performance

1. Introduction

The theory of industrial organization is built around the assumption that market structural variables are the primary determinant of industry performance. Industrial economics focus on the activities and strategies of organizations towards rivals, suppliers and customers in different market settings. The idea of industrial organization theory has attracted many economists to study how the market structure influences the conduct of organizations and then determines their performance. Among which, the competitive forces model proposed by Porter (1980) is undoubtedly the most widely known and used framework. The five competitive forces presented in his work have not only won considerable praise in academia, but have also proved highly popular among business leaders internationally (Aktouf et al., 2005). Both the teaching of strategy management in business schools and the practice of business strategy in business communities apply the competitive forces model as a tool for industry analysis. The model can be used to identify the key structural features of a certain industry that determine the strength of competitive forces and hence the ultimate profit potential of the industry (Porter, 1980). Although the industry analysis model of Porter is widely used, it is always exercised in a qualitative way and lacks quantitative methods, making it difficult for users to adopt related quantitative approaches to identify which competitive force governs industry competitive strength and determines industry profitability. It is unsurprising that recent years have seen numerous attempts to criticize the competitive forces model no way guarantees any scientific rigor (Aktouf et al., 2005). Therefore, there is a need to develop a quantitative method for measuring the strength of the competitive forces that drive industry competition, comparing the strength of the competitive forces which govern industry competition, and estimating the influence of these competitive forces on industry profitability. This quantitative method can help researchers to sum up all the dimensions of each competitive force in one measure and quantitatively compare which force or forces govern industry profitability.

The above research needs can be implemented by investigating the market structure of industries in a given economy by using social network analysis, which has a well developed set of methodologies for systematically studying social structures. Social network analysis, derived from graph theory, attempts to describe the structure of relations (displayed by edges) between given entities (displayed by nodes), and applies quantitative techniques to produce relevant measurements and models for studying the characteristics of a whole network and the position of actors in the network structure. The measurements and techniques of social network analysis, although primarily developed for studying sociology, are highly appropriate for application to examine the structural features of industries within an economy. This study aims to propose a quantitative methodology for measuring the competitive forces which affect industry profitability, and then tests these measurements and techniques by empirically studying the market structure of industries in Taiwan.

The remainder of this paper is organized as follows. Firstly, this paper reviews the literature on the structural analysis of industries. Secondly, it reviews the literature on the study of market structure from the perspective of social network analysis. Thirdly, it proposes network analysis measurements and techniques that are appropriate for application to investigate the structural features of industries. Fourthly, it empirically tests a sample of industry structure taken from Taiwan, measures and compares the strength of the competitive forces that drive industry competition in Taiwan, and estimates the influence of these competitive forces on industry profitability. Conclusions are finally drawn in the final section.

2. Structural analysis of industries

Since the pioneering inter-industry research of Bain (1951, 1956), industrial economics has been recognized as a specialized branch of economics concerned with the activities and policies of business firms towards rivals, suppliers and customers in different market settings resulting from inter-industry competition. Industrial economics clearly focuses on the industry as the key determinant of firm profitability, as expressed in a standard three-part paradigm comprising market structure, conduct, and performance, namely the SCP model. The SCP model assumes that the performance of a single industry is determined by how various kinds of firms in that industry can perform their activities in terms of structural characteristics of the economic environment (Lahti, 2006). Given their breadth of analysis across industries, SCP studies provide generalizable insights into the structural characteristics that make markets profitable and the conduct that is related to profitability (e.g., Kadiyali et al., 2001). The SCP model has been the dominant paradigm for studying industry analysis.

During the 1980s, the most influential contribution to industry analysis was undoubtedly Michael Porter's *Competitive Strategy* (Porter, 1980). Particularly, the competitive forces model of Porter rapidly came to be extensively used for industry analysis in teaching, consultation, and research projects. Porter began from the SCP model, and then extended it both by focusing on the concept of strategy and by introducing the concept of strategic group. Porter defines an industry as a group of firms producing products that are close substitutes for one another (Porter, 1980). Although the model of Porter can be interpreted as a simplification of the mainstream of industrial organization economics, Porter moves economic thinking closer to strategic management cognition (Lahti, 2006). Brandenburger (2002) suggested that Porter's thought provides a clear image of the core activities in business. It depicts the entire vertical chain of economic activity, running from suppliers through businesses and on to customers. It highlights the central role of business in creating value as well as emphasizing how businesses are interdependent with their related sectors in their competitive market settings.

Porter (1979) argued that competition in an industry is rooted in its underlying economics, and that competitive forces exist that go well beyond the established combatants in a particular industry. Firms need to realize industry structure that determines their profitability in the industry and hence shapes their competitive strategy (Porter, 1980). Porter defined the elements of industry structure, which is widely known as five competitive forces, as: (1) rivalry among existing firms; (2) bargaining power of suppliers; (3) bargaining power of buyers; (4) threat of new entrants; (5) threat of substitute products or services.

Over the past two decades, the competitive forces model of Porter has become the dominant paradigm in industry analysis for teaching, consultation, and research projects. However, the model has also received considerable criticism (e.g., Klein, 2001; Bartlett & Sumantra, 2002; Aktouf et al., 2005). One critique of the model is its failure to guarantee scientific rigor (Aktouf et al., 2005). Although multiple dimensions for each of the five forces are mentioned in Porter's model, the model does not provide a simple formula for summarizing these multiple dimensions to assist model users (Sorensen, 1994). The lack of quantitative measurements for Porter's model increases the complexity of empirical studies and thus the difficulty in interpreting them. The quantitative measurements of the competitive forces and how they influence profits need to be developed and dealt with in a strong critique of sociometric testing in this area. The development of the quantitative measurements of the competitive forces can enhance the notion of Porter's model in two areas.

Firstly, all five competitive forces jointly determine the intensity of industry competition and profitability (Porter, 1980). To use the competitive forces model, a number of dimensions for each of the five forces are mentioned by Porter. The sum of all the dimensions is what defines the overall competitive situation and the intensity of competition. However, all the dimensions mentioned by Porter are via a qualitative means, so that it is unable to sum up all the dimensions of each competitive force in one measure, and it is difficult to quantitatively prove whether and how each force influences the intensity of industry competition and profitability. Therefore, the development of the quantitative measurements of the competitive forces can complement Porter's model in the quantitative method which offers measures to calculate the strength of the competitive forces that drive industry competition, and to estimate the influence of these competitive forces on industry profitability.

Secondly, another important application of Porter's model is to compare the strength of the five competitive forces which govern the industry competition and profitability. The strongest force or forces determine the profitability of an industry and are of greatest importance in strategy formulation (Porter, 1980). However, as mentioned above, the Porter's qualitative dimensions make this application implement hard. The competitive forces with quantitative measures thus can be used to compare the strength of the competitive forces which govern industry competition, and to identify which force or forces dominate industry profitability.

3. Market structure: constraints on performance from competitive market relations

Social network models of competition are a productive result of numerous cross-disciplinary researches between economics and sociology over the last two decades. For example, the sociological idea of autonomy generated by conflicting affiliations is derived from the traditional economic ideas of monopoly and oligopoly to produce network models of the extent to which producers in a market possess competitive advantages in negotiating price in their transactions with suppliers and customers (Yasuda, 2005). In contrast to the canonical economic models, which involve numerous assumptions regarding individual behavior, social network models are more realistic in that they focus on actual relationships among interacting actors within their social context. In addition, the social network perspective encompasses theories, models and applications that are expressed in terms of relational concepts or processes (Wasserman & Faust, 1994), so that social network analysis is an extremely appropriate method of examining the structural features of industries in relation to the wider economy. This study attempts to develop a quantitative methodology by using social network analysis to measure the competitive forces model of Porter. The following section reviews the literature on market structure from a social network perspective.

Competitive advantage is the central concept of social network analysis while addressing market structure. Differences in competitive advantages among producers can be traced to the opportunities and constraints arising from how they are embedded in the transaction relations among these producers. Social network theories measure opportunities to broker connections among others by having weak ties (Granovetter, 1973), by being between others (Freeman, 1979, 1980), or by having exclusive exchange relationships (Cook & Emerson, 1978). On the other hand, social network models illustrate that network structure forms a formal constraint in that the effect of an action should be restricted in terms of the intensity of connections between actors (Burt, 1983), in terms of relations with relatively influential actors (Cook et al., 1983), or in terms of embedded in a larger structure (Degenne & Forse, 1999).

These variations on the brokerage and constraint themes comprise the foundation of the structural hole theory of competition (Burt, 1992). Disconnections between transactions can create brokerage opportunities. When a product network is rich in structural holes, it is able for producers located at the position of structural holes to access diverse information and to broker transactions between disconnected parties. Producers in these disconnected positions are said to be structurally autonomous because they enjoy independent actions as a result of their position among other producers in the economic system. On the other hand, producers linked to densely interconnected alters are constrained in terms of their structural autonomy because they lack the benefits of access to diverse information and have few brokerage opportunities.

The structural hole theory is applied to industry analysis using the network concept of structural autonomy to measure competitive advantage. When applied to networks of buying and selling, structural autonomy embodies two properties: the extent to which producers are organized within an industrial market and the extent to which producers buy from and sell to many, disorganized industrial markets (Burt, 1992; Raider, 1998; Yasuda, 2005). Burt (2000) distinguished the two properties of structural autonomy into the two inverse concepts of internal constraint and external constraint, respectively. Structural autonomy decreases with network constraint within an industrial market, that is, internal constraint, and network constraint beyond the industrial market, namely, external constraint. The internal constraint is measured as the extent to which industry output is spread across many independent producers, while the external constraint is measured by the extent to which producers have few independent suppliers and customers (Burt, 2000). Producers in an industrial market are autonomous to the extent that they are able to compete in a negotiable industry and can negotiate advantageous prices in their transactions with suppliers and customers. Consequently, producers with structural autonomy are expected to achieve better margins on their profits.

Several empirical studies support the above argument. Burt (1983) described the positive relation between structural autonomy and performance for 1967 in American manufacturing markets and then extended the results into non-manufacturing markets through the 1960s and 1970s (Burt, 1988). Similar associations have been documented in other countries including Germany (Ziegler, 1982), Israel (Talmud, 1994), and Japan (Yasuda, 2005).

Internal constraint refers to the competition among firms in the same market seeking the same business. This is the traditional dimension of market competition, varying from the lack of competition in monopoly markets to the intense competition of commodity markets where opportunistic undercutting of one another's prices drives market price to the minimum possible and prevents any one firm in the market from rising above market price (Burt et al., 2002). This study attempts to devise a quantitative methodology by using social network analysis to measure the competitive forces. The internal constraint highlights the competition within a given industry, making it appropriate to examine the intensity of rivalry among existing firms in that industry. This study uses the internal constraint as the network model for measuring the competitive force derived from existing competitors, which is referred to the first competitive force, rivalry among existing firms, in the Porter's model.

External constraint refers to the competitive disadvantage related with being dependent on coordinated suppliers and buyers. Supplier and buyer constraints vary inversely with the extent to which a market's suppliers and buyers are spread across many unconnected markets that contain many competitors (Burt, 1988). The external constraint concentrates on the competition with suppliers and buyers, so it is proper to study the bargaining power of suppliers and buyers, respectively. This study adopts the external constraint as the network model for assessing the competitive forces resulting from the suppliers and buyers, which are the second and third ones in the Porter's model. However, the external constraint proposed by Burt (2000) is an aggregate constraint which is derived from supplier and buyer markets simultaneously. In order to measure the constraints created by the competitive forces of suppliers and buyers respectively, this study would separate the external constraint into supplier and buyer constraints, which will be discussed in the methodology section. The last two competitive forces in Porter's model are the threats of new entrants and substitutes. This study uses the network model of structural equivalence to measure the competitive forces derived from potential entrants and substitutes.

Structural equivalence model highlights the competition between *ego* and *alter* (Burt, 1987). Two actors are structurally equivalent, defined by Lorrain & White (1971), if they have identical ties to and from all others in the social system. Structurally equivalent actors play the same role in the network or have similar linkages to the occupants of other positions, making them interchangeable with one another and giving them similar experiences or opportunities (Friedkin, 1984; Mizruchi, 1993). Burt (1988, 1989) applied the concept of structural equivalence to studies of market boundaries, and proposed that to the extent that the producers of one commodity and the producers of another have identical suppliers and customers, they are potential competitors in the same industrial market. Their identical patterns of transactions with suppliers and customers make them structurally equivalent and potentially compete with each other in the economy. In addition, Burt (1992) also made use of the idea of structural equivalence analogous to the concept of substitutable producers in input-output economics. Two producers are substitutable to each other in an economic network to the extent that they purchase similar volumes of the same kinds of suppliers to make the commodity that they sell to the same kinds of customers in similar volumes. Combining the two implications of structural equivalence by Burt's arguments, structurally equivalent industries perform transactions with similar suppliers and buyers, providing them with similar market relations and experiences and thus having the opportunity to enter as well as substitute for each other's industrial market. Hence, the identification of potential entrants and substitutes for a specific industry can be operationalized via network analysis using the concept of structural equivalence in terms of the extent to which industries share identical suppliers and customers. The threats of potential entrants and substitutes, i.e. the fourth and fifth competitive forces in the Porter's model, can then be measured based on the extent to which an industry has many structurally equivalent industries with an effective oligopoly.

4. Methodology

4.1 Analytical techniques

This study applies social network analysis to quantitatively measure the competitive forces. This section introduces the traditional network analysis measurements that are appropriate for application to examine the structural features of industries, and modifies these measurements as appropriate to develop a quantitative methodology for measuring the competitive forces.

4.1.1 Competitive force of existing competitors

The most widely understood market constraint on profits is the constraint created by competition among existing producers in an industry (Burt, 1983). The internal constraint, one property of structural autonomy, refers to the competition between producers in the same market seeking the same business. Competition is inversely associated with the extent to which producers in the industry can coordinate. This is the traditional concept of market competition, varying from the lack of competition in monopoly markets (maximum producers coordination) to the intense competition in perfectly competitive market (minimum producers coordination) (Burt et al., 2002). Following the standard practice of economics and network analysis (e.g., Burt, 1983, 1988, 1992; Talmud, 1994; Raider, 1998; Yasuda, 2005), the four-firm concentration ratio is extensively used as the measure of the constraint generated by the competitive force of competitors. The lower the concentration ratio of the focal industry, the more intense rivalry among existing firms in the industry would take place. Hence, this study uses concentration ratio as the measure of the competitor constraint which is represented as the quantitative measure of the first competitive force. This measure is expected to have a positive influence on the performance of an industry. The concentration ratio (*O*) of a certain industry *i* is formally defined as:

$$O_i = \textit{(sales of top four firms in industry i) / (sales of industry i)} \qquad (1)$$

4.1.2 Competitive forces of suppliers and buyers

The second property of structural autonomy, external constraint, refers to the constraints derived from the organization beyond the classification of industry. Industries are structurally autonomous to the extent to which their suppliers and buyers are spread across many, disconnected, disorganized markets that contain numerous competitors (Burt, 1988; Raider, 1998). Burt (1983, 1988) measured the external constraint (C) as the sum of transaction-specific constraints on the market using the following index defined for industry *i*:

$$C_i = \sum_j c_{ij}\ ,\ \ i \neq j\ , \qquad (2)$$

$$\text{where}\ \ c_{ij} = \left(p_{ij} + \sum_q p_{iq} \cdot p_{qj} \right)^2 \cdot O_j\ ,\ \ i \neq q \neq j\ ,$$

$$\text{where}\ \ p_{iq} = \frac{z_{iq} + z_{qi}}{\sum_j \left(z_{ij} + z_{ji} \right)}\ ,\ \ i \neq j\ .$$

Here, C_i denotes the extent to which industry *i* conducts a large volume of its business with interdependent, organized market *j*. The transaction-specific constraint c_{ij}, varying from zero to one, measures the degree to which industry i lacks competitive advantages in transactions with market j. The c_{ij} is measured as the product of the square term and the concentration ratio O_j, where the square term is the direct and indirect dependence of industry i on supplier/buyer market j, while O_j is the extent to which supplier/buyer market j is oligopolistic. Moreover, the square term is the degree of direct and indirect dependence of industry i on market j, and is measured by the p_{ij} which is the proportion of industry i buying/selling with supplier/buyer that occurs directly via market j, where z_{ij} is the number of dollars worth of commodities sold to industry j from industry i, shown in the form of an input-output table. The external constraint C_i ranges from zero to one and has been demonstrated to negatively impact on economic performance (e.g., Burt, 1983, 1988; Talmud, 1994; Yasuda, 2005). The number of competitive advantages available to firms operating in an industry increase with the weakness of the connections among the supplier/buyer markets of that industry (Burt, 1988).

Burt (1983, 1988) measured the external constraint on the market on the basis of the relationships of business transaction with suppliers and buyers. Social scholars traditionally employ the concept of centrality to measure the extent to which a certain actor is extensively involved in relationships with other actors in a system. Freeman (1979) had advocated the use of centrality measures in a seminal paper that systematically identifies three forms of centrality – degree, closeness, and betweenness. Degree centrality measures the centrality of an individual in terms of the number of actors to which a particular actor connects; closeness measures the extent to which an actor is close to all the other actors; betweenness measures the extent to which a particular actor lies between the various other actors in a system. Wasserman & Faust (1994) further included the information centrality developed by Stephenson & Zelen (1989) as the fourth index of centrality, which defines the information of an actor as the harmonic average of information for the combined paths from the actor to all other actors. In addition, Everett & Borgatti (2005) broadened the original centrality concept to three extensions. First, group centrality measures the number of actors outside the group that are connected to members of the group. Second, they applied the measures of centrality to two-mode data in order to compare the centrality of members of different modes using a comparable metric. Third, they employed core-periphery structures to extend the concept of centralization to the case of multiple actors and to propose the coreness centrality to bring a modeling perspective to the measurement of centrality. These different definitions of centrality produce actor indices which quantify the prominence of an individual actor embedded in a system. In general, the different measures of centrality can be categorized into two perspectives – direct and indirect relationships. Precisely, degree centrality is yielded based on direct connection, while closeness, betweenness, information, and coreness are produced on the basis of both direct and indirect connection. However, these centrality measures are mainly proper to deal with dichotomous networks. In this study, the transaction market is a valued network so the external constraint is measured better by methods derived from valued relations rather than methods for dichotomous relations, such as centrality. The measure of external constraint proposed by Burt (1983, 1988), i.e. Eq. (2), is a valued measure and it employs p_{ij} to measure the proportion of industry i buying and selling with suppliers and buyers that directly involves market j and uses $\sum p_{iq} \cdot p_{qj}$ to measure the proportion of industry i buying and selling with suppliers and buyers that indirectly involves market j via other markets in a system. Burt's external constraint model simultaneously considers the valued influence derived from direct transactions with suppliers and buyers as well as indirect ones. Hence, this study employs Burt's model to measure the transaction-specific constraints.

The external constraint model proposed by Burt (1983, 1988) simultaneously considers the constraints derived from the supplier and buyer markets. If the aggregate constraint is separated into supplier and buyer constraints, these two types of constraints can be used to measure the constraints created by the competitive forces of suppliers and buyers respectively. Therefore, the following Eq. (3) is proposed as a measure of the supplier constraint, which is an index of the extent to which the focal industry conducts a large volume of its business via interdependent, organized supplier markets. The supplier constraint can indicate the competitive force derived from suppliers.

$$C_{i,S} = \sum_{j} c_{ij,S}\ ,\ \ i \neq j\ , \tag{3}$$

$$\text{where } c_{ij,S} = \left(p_{ij,S} + \sum_q p_{iq,S} \cdot p_{qj,S} \right)^2 \cdot O_j ,\ i \neq q \neq j ,$$

$$\text{where } p_{iq,S} = \frac{z_{qi}}{\sum_j z_{ji}} ,\ i \neq j .$$

Eq. (3) is formulated from the Eq. (2) after eliminating the constraint derived from the influence of buyer markets, and then products the supplier constraint, $C_{i,S}$, where $p_{ij,S}$ denotes the proportion of buying in industry i that occurs via market j. Similarly, the buyer constraint, $C_{i,B}$, can be obtained, which indicates the competitive force of buyers:

$$C_{i,B} = \sum_j c_{ij,B} ,\ i \neq j , \tag{4}$$

$$\text{where } c_{ij,B} = \left(p_{ij,B} + \sum_q p_{iq,B} \cdot p_{qj,B} \right)^2 \cdot O_j ,\ i \neq q \neq j ,$$

$$\text{where } p_{iq,B} = \frac{z_{iq}}{\sum_j z_{ij}} ,\ i \neq j ,$$

where $p_{ij,B}$ denotes the proportion of industry i selling to buyers that take place directly with market j. Both $C_{i,S}$ and $C_{i,B}$ vary between zero and one owing to being maximum constraints from suppliers and buyers respectively. Both supplier and buyer constraints are expected to negatively impact economic performance in the same manner as the external constraint (e.g., Burt, 1983, 1988; Talmud, 1994; Yasuda, 2005).

4.1.3 Competitive forces of potential entrants and substitutes

Burt (1988, 1989) applied the structural equivalence model to research market boundaries and suggested that two commodities are products of different markets to the extent that the suppliers and buyers associated with producing and selling one commodity are different from the suppliers and buyers for the other commodity.

Following the structural equivalence model, two sectors are identified as being structurally equivalent within an economy to the extent that they have identical market transaction patterns with other markets as suppliers and buyers. Sociologists generally use Euclidean distance to measure the degree of structural equivalence, which equal zero between perfectly equivalent network actors and increase with the extent to which two actors are involved in different patterns of relations and therefore are far apart in terms of the social topology of network (Burt, 1988). Industries *i* and *j* are structurally equivalent in a market structure if the Euclidean distance d_{ij} between their respective industrial network position is zero. The Euclidean distance between industries *i* and *j* is formally defined as:

$$d_{ij} = \left[\sum_k \left(\frac{z_{ik}}{R_i} - \frac{z_{jk}}{R_j} \right)^2 + \sum_k \left(\frac{z_{ki}}{C_i} - \frac{z_{kj}}{C_j} \right)^2 \right]^{1/2}, \quad i \neq k \neq j, \tag{5}$$

where R_i denotes the sum of sales across industries in row *i* of the input-output table, and C_i represents total purchases by industry *i* in column *i*. That is, the degree of structural equivalence between two industries increases with the degree to which they purchase identical proportions of input from every other industry as suppliers, and they sell identical proportions of output to every other industry as customers (Burt, 1988).

Industries are more structurally equivalent to the extent to which they are involved in identical transactions with other industries as supplier and customer markets. Sharing identical patterns of transactions with suppliers and customers lead to industries having similar market relations and thus having opportunities to enter into or substitute for the industrial markets of one another. The structural equivalence model is extremely appropriate for application to examine the constraints associated with the competitive forces of potential entrants and substitutes. Based on the model used in network analysis, this study proposes Eq. (6) to measure the structural equivalence constraint, which is an index of the degree to which the focal industry has many potential entrants and substitutes that enjoy an effective oligopoly. The structural equivalence constraint can indicate the competitive forces of potential entrants and substitutes.

$$SE_i = \sum_j SE_{ij}\ ,\ \ i \neq j\ , \tag{6}$$

where $SE_{ij} = \overline{d_{ij}} \cdot O_j\ ,\ \ i \neq j\ ,$

where $\overline{d_{ij}} = \dfrac{\left(d\max_i - d_{ij}\right)}{\sum_k \left(d\max_i - d_{ik}\right)}\ ,\ \ i \neq k \neq j\ .$

The structural equivalence constraint of industry *i*, SE_i, is the sum of the structural equivalence constraints on industry *i* derived from all other industries in an economy. The structural equivalence constraint on industry *i* deriving from industry *j*, SE_{ij}, is measured as the product of the structurally equivalent proximity of the two industries, $\overline{d_{ij}}$, and the concentration ratio of industry *j*. The Euclidean distance between industries *i* and *j*, d_{ij}, is inversely associated with the proximity of structural equivalence, so $\overline{d_{ij}}$ is treated as shown in the above equation, where $d\max_i$ denotes the largest Euclidean distance between industry *i* and any other selected industry. Based on the assumption of Porter's competitive forces model, the structural equivalence constraint should be assumed to negatively impact on industry performance.

The concept of structural equivalence is associated with the notion of network position. Network positions are occupied by agents who are substitutable one for another, with respect to their relational ties (Burt, 1982). Two agents with identical network positions make them structurally equivalent and potentially compete with as well as substitute for each other. Structural equivalence is the most widely used definition of equivalence for analysis of network position. However, the fact that structurally equivalent actors must have identical connections to and from identical other actors is a limitation. Many researchers have proposed that structural equivalence is too restrictive for studying network positions, and have proposed equivalences on the basis of more abstract properties of relational patterns (Wasserman & Faust, 1994). For instance, Wasserman & Faust (1994) discussed four general approaches, including automorphic equivalence, regular equivalence, local role equivalence, and ego algebras. Automorphic equivalence is on the basis of the abstract concept that equivalent actors occupy indistinguishable structural locations in a network. Regular equivalence is based on the idea that actors are equivalent if they link in equivalent ways to other actors that are also equivalent (Doreian et al., 2005). Local role equivalence and ego algebras are focused on the types of ties in which each actor is involved. Two actors are local role equivalent if they have identical role sets (Winship, 1988), which is defined as the collection of the ways in which an occupant of a particular position relates to others in other positions. The idea of ego algebras is that an actor's view of the network is based, in part, on which sets of relations go together by always occurring together for that actor (Wasserman & Faust, 1994). These alternative equivalences for the description of network structural properties are proposed due to the limitation of structural equivalence, mentioned earlier. However, this study employs the idea of structural equivalence to measure the extent to which two sectors are structurally equivalent rather than to identify which sectors are fully structurally equivalent, so the limitation of structural equivalence does not need to be considered here. Hence, this study uses the idea of structural equivalence to measure the equivalence constraint, instead of these alternative equivalences which are more theoretically and formally abstract approaches and often require more sophisticated mathematics than structural equivalence (Wasserman & Faust, 1994).

4.2 Data

This study uses the industrial structure of Taiwan as an example to measure and compare the strength of the competitive forces that drive competition within and beyond each industry in Taiwan, and to estimate the constraints of the competitive forces on industry profitability. Regarding industry performance, Burt (1988) tested three profit indicators as indices of the extent to which industry performance is influenced by market structure, and found that price-cost margin (PCM), computed directly from data in the input-output table, is the best of these indicators. PCM is a measure of economic performance adopted from Collins & Preston (1969), and is defined as the difference between value added and payroll, divided by the value of products sold. PCM is a dependent variable widely used by economists in market-structure research as an indicator of profitability. This study thus adopts PCM estimated from the input-output table, as in the definition of I-O PCM proposed by Burt (1988), as the measure of industry performance.

In terms of data, PCM, supplier constraint, buyer constraint, and structural equivalence constraint can be measured from data in the input-output table. This study uses the structure of industry in Taiwan as a sample for empirically testing the usefulness of the proposed methodologies by using network analysis to quantitatively measure the competitive forces, and thus this study adopts the input-output table of Taiwan (Directorate-General of Budget, 2004) as the primary data source. In addition, the concentration ratio is measured and sourced from the Industry, and Commerce and Service Census of Taiwan (Directorate-General of Budget, 2003). After eliminating agriculture, forestry, fishery, mining, and industries composed of few firms and labeled as not classified elsewhere to approximate the theoretical definition of an industry, 134 industries were selected as subjects for empirical analysis.

Su (1997) studied the relations between market autonomy and performance in Taiwan and showed that the nature of industry profitability is different in terms of manufacturing/non-manufacturing and private/public sectors. In general, the level of profitability of non-manufacturing sectors is higher than that of manufacturing sectors (Burt, 1992). Due to government protection, the public sectors are mostly oligopoly or monopoly so that their performance is easy to be affected by non-economic factors. Therefore, one should divide the whole sectors into manufacturing/non-manufacturing and private/public sectors to get rid of the bias from other market-structure effects while studying the relations between market constrains and performance (Burt, 1988; Su, 1997). This study follows this idea and empirically discusses the relations between market constrains and performance in whole, manufacturing, non-manufacturing, private, and public sectors of Taiwan, respectively.

5. Empirical analyses

Table 1 lists the mean, standard deviation, minimum, and maximum values of the characteristics of market structure in Taiwan. The number of buyer markets contacted by industries range considerably from 1 to 133, resulting in average variability between industries of 48.11 (standard deviation of buyer markets), over three times the standard deviation of supplier markets (13.84). Consequently, the variance in the number of industry transactions with supplier markets appears more stable than that with buyer markets in Taiwan. In addition, the structural autonomy of an industry comprises two parts: organization within the industry and organization beyond the industry. Organization within the industry is the extent to which the market is an oligopoly, and is measured by the concentration ratio. The mean concentration ratio in 134 industries in Taiwan is 0.353, which closely resembles that of the American market, 0.352, as calculated by Burt (1983) from 77 industries in the American market averaged across 1963, 1967, 1972, and 1977. Organization beyond the industry indicates the extent to which there is a lack of interconnection among the industry's suppliers, buyers, and structural equivalence industries. That is, the more constraints of suppliers, buyers, and structural equivalence in an industry, the fewer competitive advantages are available to firms operating in the industry and thus the lower the profitability of the industry. Additionally, the mean of PCM of the 134 industries is 0.132, with a range of -0.222 to 0.798.

Several sets of regression analyses are conducted to test whether the impact of the four market constraints on the economic performance of industries conforms to expectations. First of all, the external constraint proposed by Burt (1983, 1988) is split into supplier constraint and buyer constraint in this study so the improved operationalization should be validated. Table 2 shows the results of regressions on the aggregated as well as the split measures and indicates that the performance variance is explained better by the split external constraints than the aggregated one in terms of the adjusted R-square values (aggregated: 0.081; split: 0.151). The improvement of the split operationalization for external constraint is confirmed. Next, the results obtained from the regression which related the PCM to competitor constraint (concentration ratio), supplier constraint, buyer constraint, and structural equivalence constraint, are shown in the second column of Table 2. Evidently, all of the coefficients of the constraint variables bear the expected signs, and all of them except for the structural equivalence constraint are significantly different from zero. Firstly, the concentration ratio positively impacts on industry profitability, which demonstrates the same results as shown in most of the literature. The fact that the concentration ratio of a specific industry significantly and powerfully impacts on its profitability, demonstrates that industry profitability increases with reducing intensity of the rivalry among existing firms in the industry. This quantitative result fully corresponds to the model of Porter (1980), arguing that industry profitability should reach the degree that allows industry firms to cooperate in an oligopoly market. Conversely, competition in an industry continually drives down the return on invested capital towards the competitive floor rate for a perfectly competitive market.

Table 1　Market structure of Taiwan

N=134	Mean	Standard deviation	Min.	Max.
Supplier markets	69	13.84	35	101
Buyer markets	69	48.11	1	133
Total contact markets	102	25.11	50	133
Concentration ratio	0.353	0.271	0.022	1.000
Supplier constraint	0.149	0.151	0.020	0.918
Buyer constraint	0.116	0.128	0.015	0.780
Structural equivalence constraint	0.317	0.105	0.071	0.703
Price-cost margin	0.132	0.125	-0.222	0.798

Table 2 Regression analyses for whole sectors of Taiwan

Independent variable	Dependent variable	
	Price-cost margin (PCM)	
	The whole sectors	The whole sectors
Competitor constraint (Concentration ratio)	0.23 (2.59)*	0.28 (3.27)***
Transaction-specific constraint (Supplier + buyer constraints)	-0.24 (-2.61)**	
Supplier constraint		-0.25 (-2.92)**
Buyer constraint		-0.27 (-3.22)**
Structural equivalence constraint (Potential entrant and substitute constraints)	-0.11 (-1.34)	-0.12 (-1.40)
N	134	134
R^2	0.094	0.176
$Adj\ R^2$	0.081	0.151
F	4.480	6.896

Note. (1) Standardized effects.
(2) Figures in parentheses are *t* values.
(3) In the *t*-test, * is significant at 5%, ** at 1%, and *** at 0.1% (the same significance levels apply correspondingly to the following).

Secondly, supplier constraint significantly and negatively impacts on industry profitability. Firms within a market drive more structural autonomy and competitive advantages from the market's suppliers to the extent to which the market's suppliers are spread across many, disconnected, disorganized markets. Hence, industry profitability increases with reducing supplier constraint. Porter (1980) suggested that powerful suppliers can exert bargaining power over industry participants by threatening to raise prices or reduce the quality of purchased goods, and thereby squeeze profitability as the industry becomes unable to recover cost increases through increased prices. The statistical result of the negative relation between supplier constraint and industry profitability examined herein provides support for the argument of Porter (1980). In the case of buyer constraints, the results show that buyer constraint is negatively and significantly related to profitability. Porter (1980) argued that a concentrated buyer market can compete with an industry by forcing down prices, bargaining for higher quality or more services, and playing competitors against each other, which all are the expense of the industry profitability. This argument has also been statistically demonstrated in this study.

The 134 surveyed industries included 94 manufacturing sectors and 40 non-manufacturing sectors, as well as 119 private sectors and 15 public sectors. Hence, this study used two variables to divide the surveyed industries into two analytic sets for estimation: one set for the manufacturing/non-manufacturing factor is applied to the second and third columns of Table 3, while another set for the private/public factor is listed in Table 4. The coefficient estimate for the structural equivalence constraint of the whole sectors is negative but not statistically significant. However, for manufacturing sectors the result shows that the structural equivalence constraint is negatively associated with industry profitability, and moreover this association is very significant. Firms in a market drive fewer structural autonomy and competitive advantages from the threats of potential entrants and substitutes to the extent to which the market's structural equivalence industries are oligopolistic. The greater the market power of potential entrants and substitutes, the lower the profit margins available to firms in a given market, since the firms have to set higher entry barriers to prevent potential entrants from entering their market and to offer more attractive price-performance alternatives against substitutes. Potential entrants and substitutes limit the potential returns of an industry by placing a ceiling on the prices that firms in the industry can profitably charge (Porter, 1980). However, the argument proposed by Porter has just been statistically proven in the case of manufacturing sectors, but no statistical significance exists in the relationship between structural equivalence constraint and PCM for non-manufacturing, private, and public sectors. Particularly, the result that the coefficient estimate of the structural equivalence constraint for non-manufacturing sectors is positive offsets the significantly negative coefficient estimate for manufacturing sectors, and thus generates the negative but insignificant relation in the case of whole sectors.

The results listed in Table 3 and 4 reveal that the model proposed in this study provides the best fit to the manufacturing sectors of Taiwan. The model used for manufacturing sectors demonstrates that, as shown in the second column of Table 3, the proportion of variance of industry profitability explained by the constraints of competitors, suppliers, buyers, and structural equivalence reaches 0.495 (R^2), and the signs of the coefficients are consistent with the expected way and all of their estimates reach a significant level. Conversely, the model is not quite appropriate for the cases of non-manufacturing, private, and public sectors in Taiwan. This result can imply that in the case of manufacturing sectors in Taiwan, firms facing relatively intense rivalry within their market, more constraint from the transactions with their suppliers and buyers, and relatively constrained structural position from structurally equivalent sectors, have fewer structural autonomy and competitive advantages and thus have less profitability to enjoy. These quantitative results are completely consistent with the arguments of Porter in his competitive forces model.

The results of the third column of Table 3 reveal that the proposed model is not appropriate for non-manufacturing sectors in Taiwan. There are four explanations for this result. Firstly, some non-manufacturing sectors in Taiwan, such as electricity, gas, city water, railway transportation, postal services, are the public sectors which operate in a monopoly or an oligopoly market controlled by government resulting in their high concentration ratio. However, these non-manufacturing as well as public sectors can not enjoy huge excess profits due to their mission on public benefits. Secondly, the dominant operating cost for non-manufacturing sectors is personnel expenditure, instead of raw materials, so that the impact from their suppliers is limited. Thirdly, the sectors selected in this study are intermediate buyers, instead of final demand sectors, and therefore the data from the input-output table can not reveal the "real" bargaining power of final consumers. Fourthly, the fact that entry barriers of some non-manufacturing sectors in Taiwan, such as food and beverage services, travel agency services, hotel services, consulting services, household services, are generally not very high leads to the stronger the threat of potential entrants and substitutes to them, the better the performance of these sectors due to their distinguished capabilities.

Table 3 Regression analyses for whole, manufacturing, and non-manufacturing sectors of Taiwan

Independent variable	Dependent variable		
	Price-cost margin (PCM)		
	The whole sectors	Manufacturing sectors	Non-manufacturing sectors
Competitor constraint (Concentration ratio)	0.28 (3.27)***	0.53 (6.31)***	0.15 (0.87)
Supplier constraint	-0.25 (-2.92)**	-0.22 (-2.85)**	-0.26 (-1.47)
Buyer constraint	-0.27 (-3.22)**	-0.30 (-3.47)***	-0.08 (-0.51)
Structural equivalence constraint (Potential entrant and substitute constraints)	-0.12 (-1.40)	-0.43 (-5.29)***	0.14 (0.87)
N	134	94	40
R^2	0.176	0.495	0.099
F	6.896	21.802	0.965

Table 4 Regression analyses for whole, private, and public sectors of Taiwan

Independent variable	Dependent variable		
	Price-cost margin (PCM)		
	The whole sectors	Private sectors	Public sectors
Competitor constraint (Concentration ratio)	0.28 (3.27)***	-0.01 (-0.16)	0.19 (0.67)
Supplier constraint	-0.25 (-2.92)**	-0.28 (-3.17)**	-0.28 (-0.97)
Buyer constraint	-0.27 (-3.22)**	-0.22 (-2.34)*	-0.29 (-0.99)
Structural equivalence constraint (Potential entrant and substitute constraints)	-0.12 (-1.40)	-0.13 (-1.51)	-0.09 (-0.30)
N	134	119	15
R^2	0.18	0.186	0.196
F	6.90	6.492	0.611

The relations between the four market constraints and PCM might be different in the most and least profitable quartiles of sectors. Table 5 shows the results of regression analyses in terms of the profitable quartiles in Taiwanese industries. The extent to which the variance of performance can be explained by the market constraints is most significant in the lowest quartile of Taiwanese sectors (R^2 = 0.498). The highest quartile is shown as the second one (R^2 = 0.301). Further, in terms of the profitable quartiles in Taiwanese manufacturing sectors, the results of regression analyses are shown in Table 6. In the highest quartile, the proportion of variance of industry performance explained by the four constraints is highest (R^2 = 0.642). The lowest quartile is exhibited as the second one (R^2 = 0.613). Regarding the two middle quartiles, their variances of performance can be explained by the independent variables are limited. The empirical results indicate an interesting finding that the proposed model provides the best explanation power of variances of industry performance in the most and the least profitable quartiles of the Taiwanese manufacturing sectors. However, the most significant market constraint affecting the industry performance in the two quartiles is different. In the highest quartile, the crucial market constraint is derived from competitor constraint. The reason explained the phenomenon is that the highest profitable quartile sectors in Taiwan enjoy certain oligopoly advantage so that the variance of performance is explained more significantly by the internal market constraint derived from competitors than transaction-specific constraints or structural equivalence constraint. In the lowest quartile sectors of Taiwan, the buyer constraint appears the most significant variable in terms of explaining the variance of industry performance. The fact that the sectors in the lowest profitable quartile face so perfectly competitive market that their performance is weak leads to their market without attraction for potential entrant and substitute as well as their performance without significant impact from internal competitors. Hence, the critical competitive force which leads to low and even negative industry profitability in the least profitable quartile of Taiwanese manufacturing sectors is mainly derived from external constrain, in which the buyer constraint in particular.

Table 5 Regression analyses for the profitable quartiles of Taiwanese sectors

Independent variable	Dependent variable			
	Price-cost margin (PCM)			
	Highest	Higher	Lower	Lowest
Competitor constraint (Concentration ratio)	0.43 (2.302)*	0.20 (1.126)	-0.20 (-0.977)	-0.75 (-5.085)***
Supplier constraint	-0.29 (-1.656)	-0.42 (-2.434)*	0.13 (0.729)	0.23 (1.561)
Buyer constraint	0.14 (0.823)	-0.14 (-0.754)	0.13 (0.636)	-0.06 (-0.400)
Structural equivalence constraint (Potential entrant and substitute constraints)	-0.26 (-1.562)	0.17 (1.018)	-0.09 (-0.455)	0.20 (1.404)
N	33	34	34	33
R^2	0.301	0.235	0.058	0.498
F	3.021	2.223	0.447	6.955

Table 6 Regression analyses for the profitable quartiles of Taiwanese manufacturing sectors

Independent variable	Dependent variable			
	Price-cost margin (PCM)			
	Highest	Higher	Lower	Lowest
Competitor constraint (Concentration ratio)	0.66 (4.083)***	-0.09 (-0.301)	-0.13 (-0.493)	-0.35 (-1.891)
Supplier constraint	-0.33 (-2.153)*	0.03 (0.128)	-0.22 (-0.938)	0.22 (1.377)
Buyer constraint	-0.08 (-0.500)	0.14 (0.425)	0.12 (0.443)	-0.54 (-3.227)**
Structural equivalence constraint (Potential entrant and substitute constraints)	-0.42 (-2.702)*	-0.09 (-0.350)	0.20 (0.848)	-0.05 (-0.315)
N	23	24	24	23
R^2	0.642	0.012	0.093	0.613
F	8.059	0.058	0.489	7.137

In addition, the competitive forces with quantitative measures can be used to identify and compare which force or forces dominate industry profitability. Based on the regression analyses, the proposed model is most appropriate for studying manufacturing sectors in Taiwan. Therefore, this study uses the case of manufacturing sectors in Taiwan to compare the impacts of competitive forces on industry profitability and adopts dominance analysis (Budescu, 1993; Azen & Budescu, 2003) to implement this comparison. Table 7 shows the results of dominance analysis for the manufacturing sectors in Taiwan. Azen & Budescu (2003) proposed three levels of dominance to compare the impacts of independent variables on dependent variable, that is, complete dominance, conditional dominance, and general dominance. Firstly, one predictor is said to completely dominate another if its additional contribution to each of the subset models that form the basis for comparison is greater than that of the other predictor (Azen & Budescu, 2003). Based on this argument, one can find that X_1 (competitor constraint) completely dominates X_2 (supplier constraint); X_1 completely dominates X_3 (buyer constraint); X_4 (structural equivalence constraint) completely dominates X_2; X_4 completely dominates X_3. The comparisons between pairs of X_1 and X_4 as well as of X_2 and X_3 can not be determined under this examination, and thus the other two weaker testing levels of dominance should be conducted. Secondly, if the average additional contribution within each model size is greater for one predictor than the other, then that predictor is said to conditionally dominate the other (Azen & Budescu, 2003). Because the average contribution of X_3 is greater than that of X_2 for each model size (i.e., 0.065 > 0.009 for k = 0, 0.083 > 0.019 for k = 1, 0.086 > 0.032 for k = 2, and 0.068 > 0.046 for k = 3), X_3 conditionally dominates X_2. Similarly, X_1 conditionally dominates X_2; X_1 conditionally dominates X_3; X_4 conditionally dominates X_2; X_4 conditionally dominates X_3. Thirdly, if the overall averaged additional contribution is greater for one predictor than the other, that predictor is said to generally dominate the other (Azen & Budescu, 2003). The corresponding values for this measure are shown in the last row of Table 7. Because the overall averaged additional contribution of X_4 is greater than that of X_1 (i.e., 0.208 > 0.184), X_4 generally dominates X_1. In this testing, X_4 generally dominates all predictors, X_1 generally dominates X_2 and X_3, and X_3 generally dominates X_2. Based on the results of these three levels of dominance analysis, the order of the impacts of the competitive forces on industry profitability is X_4(structural equivalence constraint), X_1(competitor constraint), X_3(buyer constraint), X_2(supplier constraint).

In the case of manufacturing sectors in Taiwan, the structural equivalence constraint, that is, constraints from potential entrant and substitute, appears the most important competitive force among the four constraints in terms of explaining inter-industry differences based on market-structure effects on industry performance. Additionally, the fact that the competitor constraint, represented by the concentration ratio, is situated at the second ranking by dominance analysis suggests that the rivalry among existing competitors is the second most important force in explaining industry performance. Compared to the above two competitive forces, the transaction-specific constraints, represented by supplier constraint and buyer constraint respectively, demonstrate the lower but still significant importance of explaining performance differences among industries in Taiwan. Comparatively, the effect of the transaction-specific constraints on industry performance is greater by buyer constraint than by supplier constraint.

There are two reasons interpreting the fact that the structural equivalence constraint, compared with competitor constraint and transaction-specific constraints, relatively dominates industry profitability in Taiwan Firstly, the manufacturing sectors in Taiwan are famous for their OEM (original equipment manufacturer) business model. Due to the nature of their low entry barriers, OEM firms can not obtain excess profit and are easy to be attacked by potential entrants or be replaced by substitutes. Secondly, the fact that guanxi is very crucial in Taiwanese business society leads to the phenomenon of co-operation, namely simultaneous cooperation and competition between firms, prevailing among competitions, and the phenomenon of collaboration between firms and supply-chain partners being popular. Hence, the influence of competitor and transaction-specific constraints on industry profitability would be affected by these non-economic factors. The above reasons explain why the factor of structural equivalence constraint dominates the industry performance in Taiwanese manufacturing sectors.

Table 7 Dominance analysis for manufacturing sectors of Taiwan

Subset Model (X)	ρ^2	Additional contribution of: Competitor constraint (X_1)	Supplier constraint (X_2)	Buyer constraint (X_3)	Structural equivalence constraint (X_4)
k = 0 average	0	0.128	0.009	0.065	0.242
X_1	0.128		0.031	0.177	0.249
X_2	0.009	0.150		0.062	0.252
X_3	0.065	0.240	0.006		0.187
X_4	0.242	0.135	0.019	0.011	
k = 1 average		0.175	0.019	0.083	0.229
$X_1 X_2$	0.159			0.177	0.268
$X_1 X_3$	0.305		0.031		0.144
$X_1 X_4$	0.377		0.050	0.072	
$X_2 X_3$	0.071	0.265			0.198
$X_2 X_4$	0.261	0.166		0.008	
$X_3 X_4$	0.253	0.196	0.016		
k = 2 average		0.209	0.032	0.086	0.203
$X_1 X_2 X_3$	0.336				0.159
$X_1 X_2 X_4$	0.427			0.068	
$X_1 X_3 X_4$	0.449		0.046		
$X_2 X_3 X_4$	0.269	0.226			
k = 3 average		0.226	0.046	0.068	0.159
$X_1 X_2 X_3 X_4$	0.495				
Overall average		0.184	0.027	0.076	0.208

Note. (1) The column labeled ρ^2 indicates the variance in the *dependent variable* explained by the model appearing in the corresponding row.
(2) Columns labeled X_i contain the additional contributions to the explained variance gained by adding the column variable (X_i) to the row model.
(3) Blank cells represent that data are not applicable.

6. Conclusion

Since the appearance of the competitive forces model of Porter in 1980, this model has become the dominant paradigm of industry analysis for teaching strategy management in business schools and for practicing business strategy in business communities. The model argues that competition in an industry is rooted in the underlying economics of that industry and that competitive forces derived from those underlying economics jointly determine the intensity of industry competition and also profitability. However, the model must be exercised in a qualitative way and lacks available quantitative methods and thus has attracted much criticism for a perceived lack of scientific rigor. This study attempts to develop a quantitative method with the help of methodologies derived from social network analysis to measure the competitive forces which affect industry profitability. A key contribution of social network analysis is that it offers numerous measurements and techniques by measuring the linkages of actors in a certain network to illustrate the structural patterns of connected systems. The properties of each actor can be classified within a structural pattern of a larger connected system. Differences among actors can be traced to the opportunities or constraints arising from how they are embedded in their connected networks; on the other hand, the structure and characteristics of connected networks are grounded in and enacted by local interactions among actors. The approach of social network analysis is highly applicable to quantitatively study the structural characteristics of industries within an economy since differences in competitive advantages among industries can be traced to the opportunities or constraints resulting from different market settings. Hence, the effects of actions of firms in a specific industry would be motivated or restricted in terms of the coordination among existing firms, the bargaining power of their suppliers and buyers, and the threats of potential entrants and substitutes.

The development of the proposed model in this study is motivated by Burt's seminal works (Burt, 1983, 1988, 1989). However, the proposed model has extended the measurements and applications of Burt's works in three areas. Firstly, Burt (1988, 1989) employed the idea of structural equivalence to define the market boundaries in terms of supplier and consumer transactions. In this study, the concept of structural equivalence is used to measure the market constraint of potential entrants and substitutes and the measurement of structural equivalence constraint is first proposed and defined as Eq. (6). Secondly, the external constraint proposed by Burt (1983, 1988, 1989) considers the market constraint from supplier and buyer markets aggregately. The model splits the external constraint into supplier constraint and buyer constraint, which are defined as Eqs. (3) and (4). The split operationalization of external constraint has been proven able to explain the performance variance better than the aggregated one. Furthermore, this split operationalization makes one able to compare the strength of the external constraints from suppliers and buyers respectively. Thirdly, Burt (1983, 1988, 1989) used two independent variable, i.e. the internal and external constrains, to explain the performance variance. The proposed model employs competitor constraint, supplier constraint, buyer constraint, and structural equivalence constraint as the independent variables to explain the variance of industry performance.

In addition, the proposed quantitative measures of competitive forces can enhance the notion of industry analysis in two areas. Firstly, one can sum up all the dimensions of each of the competitive forces in one measure and quantitatively prove whether each force has a significant impact on the intensity of industry competition and profitability. Secondly, the strongest force or forces determine the profitability of an industry and become crucial from the point of view of strategy formulation (Porter, 1980). The competitive forces with quantitative measures can be used to identify and compare which force or forces govern industry profitability.

The analytical results shown herein demonstrate that the model proposed in this study is a successful quantitative methodology for measuring the strength of the competitive forces within an industry, for comparing the strength of the competitive forces which dominate the industry competition, and for estimating the impact of those competitive forces on industry performance. In addition, this study uses manufacturing/non-manufacturing, private/public, and profitability-quartile variables to separate the surveyed industries into different analytical sets to eliminate the bias from other market-structure effects. The proposed model appropriate to study certain types of industries will depend on the empirical data of the surveyed economy. Similarly, the model may produce different sequence of the relative importance of competitive forces for explaining the industry performance of the surveyed economy. Consequently, the results that this proposed model is appropriate for studying Taiwan’s manufacturing sectors and the sequence of the relative importance of competitive forces for explaining industry performance presents in this study are Taiwan-specific. Thus the quantitative model proposed in this study appears appropriate for application to other economy and can produce specific results for the studied economy.

It is important to acknowledge the limitations of this study since such acknowledgement can lead to identify future research directions. Firstly, most criticisms on the competitive forces model are derived from its structural position approach. That is, it treats businesses as a kind of black box in the model, inasmuch as it chooses to situate its analysis at the industry level and it ignores the diverse capabilities of firms in a certain industry. Future research can consider the resource-based approach (Prahalad & Hamel, 1990; Stalk et al., 1992) within the proposed model to enhance the perspectives on competitive analysis. Secondly, this study fails to distinguish the measures between the competitive forces of threats of potential entrants and substitutes, and thus uses an aggregate index, the structural equivalence constraint, to measure the two competitive forces together. Future works can find an appropriate method to separate the competitive forces of threats of potential entrants and substitutes from the index of the structural equivalence constraint. Thirdly, this study employs linear regression analyses to test the influence of the four market constraints on economic performance of sectors and finds that these explanatory variables significantly explain the performance variance in the manufacturing sectors but no statistical significance exists in the non-manufacturing sectors. The reasons explaining why the proposed model is not appropriate for non-manufacturing sectors in Taiwan have been discussed earlier. A potential direction of future research may use non-linear analyses to model the relations between these market constraints and sector performance in the non-manufacturing sectors, which exhibits mashed value networks rather than linear value chains. Finally, this study uses the domestic transaction data of input-output table to examine the impact of market structure on industry performance. However, the industry profitability can be affected not only from domestic competition but also from the competition of foreign competitors, suppliers, buyers, potential entrants and substitutes. The input-output table just includes the domestic inter-sector transaction and lacks the influence from foreign competitive forces. The nature of input-output table is one of the limitations of this study. Future studies can consider the impact of both domestic and foreign competition forces on industry profitability.

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