

Institutional Efficiency of Commonhold Industrial Parks Using a Polynomial Regression Model

Jeng-Wen Lin, Simon Chien-Yuan Chen

Abstract—Based on assumptions of neo-classical economics and rational choice / public choice theory, this paper investigates the regulation of industrial land use in Taiwan by homeowners associations (HOAs) as opposed to traditional government administration. The comparison, which applies the transaction cost theory and a polynomial regression analysis, manifested that HOAs are superior to conventional government administration in terms of transaction costs and overall efficiency. A case study that compares Taiwan's commonhold industrial park, NangKang Software Park, to traditional government counterparts using limited data on the costs and returns was analyzed. This empirical study on the relative efficiency of governmental and private institutions justified the important theoretical proposition. Numerical results prove the efficiency of the established model.

Keywords—Homeowners Associations, Institutional Efficiency, Polynomial Regression, Transaction Cost.

I. INTRODUCTION

MARKET relations have often been addressed in gated communities in order to efficiently provide public goods and services. The associated institutional cost and structure of gated communities plays an important role in determining overall efficiency. An efficiency analysis can be realized by means of approaches that are capable of providing accurate analytical models of the cost trend. For these concerns, this study compared the regulation of industrial land use in Taiwan by homeowners associations (HOAs) to traditional government administration, reducing everything to market relations, the institutional form, and the cost efficiency by using established models.

Organizations such as HOAs are a market response to the inefficiencies in land-use planning. Residential developments, wherein the residents possess freehold among their units, share public facilities and are governed by HOAs. HOAs are a kind of market-oriented neighborhood governance, which is advantageous in market competition because the residents voluntarily elect the governance by votes and use the collective

fund more efficiently [1]. Further, with regard to condominiums and gated communities, HOAs work in conjunction with Common Interest Development (CID) groups. Deng [2] used the transaction cost theory to support CID communities, suggesting that the traditional land-use pattern has created classic hold-up problems. In this situation, owners incur the high risk of being exploited after investment, and this fear of exploitation leads to under-investment or non-investment. Further, Deng [3] proposed that ownership integration resolves the problem of homeowners' special asset investment. If the homeowners control a share of ownership, they will not engage in rent seeking from any legal entity, and thus the hold-up problem with respect to rent capitalization can be controlled.

Another implication of CID communities is the regulation of other land-use types by HOAs such as industrial districts as well as business-improved districts pioneered in New York [4]. Ellickson [5], the pioneer of research in HOAs, signifies the advantage of HOAs to be that they provide opportunities for entrepreneurs to participate in neighborhood governance and bring about diversification in the institutional choices regarding neighborhood management in cities. The organization of HOAs, nonetheless, will inevitably vary from country to country and region so to suit the local context.

To observe why and how planning institutions are changing and evolving in developing industrial parks in Taiwan, this study aims to compare the institutional efficiency of industrial parks governed by HOAs with that of those administered by the government, by using established models. A short history of the development of Taiwan's government-led industrial parks (GLIP) and private-led commonhold industrial parks is first provided. Thereafter, the transaction (institutional) cost theory, distinguished from the production cost theory, is utilized for the analysis of the institutional efficiency of commonhold industrial parks and their governmental counterparts. A polynomial regression model is introduced to compare the institutional efficiency [6] between the two types of industrial parks in Taiwan.

II. DEVELOPMENT OF COMMONHOLD INDUSTRIAL PARKS IN TAIWAN

In Taiwan, the two major systems for the allocation of industrial districts are the traditional land-use planning system

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and the GLIP system. These two systems supply and manage over 90% of the industrial districts in Taiwan [7]. The traditional land-use planning system was unable to keep pace with the increasing market demand, thereby hampering economic development. A period between 1960 and 1970 when Taiwan's economy was experiencing rapid growth, the industrial land supply lagged behind demand. In order to overcome this problem by providing sufficient industrial land, the Industrial Development Bureau (IDB) was established in 1970. Along with the establishment of the IDB, an exclusive industrial land-use planning system, the GLIP system, was also formed. The GLIP system "dynamically" provided industrial land in Taiwan as opposed to the "static" provisions made by the urban planning system [8].

However, the institutional evolution of the GLIP system since 1970 has suffered from the same problems that troubled the traditional land-use planning system. This condition confirms the economists' claim that the government has an inherent tendency to move toward less efficiency and over sized. One aspect of the inflexibility of the GLIP system is its zoning ordinances that cannot be dynamically changed to fit the needs of the small-medium enterprises (SMEs). This problem can be found in urban suburbs that are witnessing a concentration of illegal SMEs. These SMEs can neither afford the cost of going through the traditional land-use planning system to legitimize their industrial land use nor are they interested in moving to a less efficient GLIP system.

In this context, the market innovation of factory-office buildings (FOBs) emerged to match the SMEs' demand. FOBs are high-rise buildings similar to residential condominiums, but tailored to suit SMEs that require less space and are in close proximity to the city as opposed to traditional manufacturers. This is representative of the market's ability to do what government planners have long sought to do, such as facilitate beneficial industrial clustering and produce localized agglomeration economies and economies of scale. FOBs, similar to developer-led CID communities, are required to establish their own HOAs according to the stipulations of the Condominium Management Law (CML) enacted in Taiwan in 1995. Yet Taiwan's GLIP system resulted in an interesting case, that of NangKang Software Park (NKSP), which is built up of FOBs. Based on the CML, the NKSP is also required to establish its own HOA to manage the common affairs of the property owners in contrast to the other GLIPs which employ a service centre. This provides a good platform to observe how private governance works and to determine whether NKSP's governance is more efficient than GLIPs' service centre.

III. COMPARISON OF COST EFFICIENCY AND EVOLVING TRENDS BETWEEN NKSP AND GLIP

A. Comparison of Cost Efficiency

To compare the cost efficiency of NKSP with that of GLIP, financial data were collected for the period of 2002 to 2005 from NKSP's HOA and from the Committee of the Industrial Park Development and Management Fund.

Table I presents NKSP's revenue; a gradual decline over the years can be observed. However, the increase in the additional income of NKSP is a direct reward from its HOA's successful delineation of property rights from the public domain. It is necessary for NKSP's HOA to reach its objectives because government subsidies are unavailable. This market-oriented governance must seek ways to generate additional income and reduce unnecessary costs.

TABLE I
 NKSP'S REVENUE AND EXPENDITURE DATA FOR THE PERIOD OF 2002 TO 2005
 unit: English Pounds

Revenue	Service Charge	Others	Total
2002	1,401,207	93,825	1,495,032
2003	1,347,240	108,640	1,455,880
2004	1,209,039	111,828	1,320,867
2005	1,181,398	170,526	1,351,924

Expenditure	Production Cost of maintenance	Institutional Costs	Total
2002	1,073,643	51,046	1,124,689
2003	1,138,960	72,552	1,211,512
2004	1,142,562	94,736	1,237,298
2005	1,048,532	69,648	1,118,180

Source: NKSP's HOA

Table I also lists NKSP's expenditure data, which are classified into two groups. The first group includes direct spending, or production cost, covering the maintenance of public facilities and the provision of public services, such as building repairs and materials for public use. The other group includes the transaction (institutional) cost, involving the cost of establishing and employing the institution to provide public services and maintenance, such as labor cost and the cost of purchasing office assets. This classification was proposed in Buitelaar [9], in which Alexander's [10]-[11] transaction cost theory in institutional planning was further specified, suggesting that real production costs include the neo-classic's definition of production and transaction costs. The expenditure data shows that the production cost accounts for the majority of NKSP's spending and the institutional cost for about 5%.

Similar to the case of NKSP, GLIP's expenditure data are also classified into two groups and listed in Table II; however, the revenue information is unavailable. There is a decrease in the production cost of maintenance from 11 million pounds in 2002 to 10 million pounds in 2004. On the other hand, the institutional cost increases from 34 million pounds in 2002 to 37 million pounds in 2005. The institutional cost accounts for about 75% of GLIP's total spending each year. Most of the institutional cost arises from labor costs.

TABLE II
 GLIP'S EXPENDITURE DATA FOR THE PERIOD OF 2002 TO 2005
 unit: English Pounds

Expenditure	Production Cost of maintenance	Institutional Costs	Total
2002	11,467,735	34,713,128	46,180,863
2003	10,722,072	35,520,597	46,242,669
2004	10,289,230	36,332,388	46,621,618
2005	11,284,337	37,148,594	48,432,931

Source: Committee of the Industrial Park Development and Management Fund

A comparison between the expenditures of NKSP and GLIP manifests that NKSP's HOA has lower institutional costs with respect to the management and provision of public goods and services than its governmental counterpart. Further, NKSP's HOA displays features of market-driven governance, which continually evolves toward less institutional costs and generates extra income from public facility management. On the contrary, the characteristic problem of all government organizations is also evident in GLIP, that is, the tendency of evolving toward higher institutional costs and the rigidity of labor costs. These evolving trends will be explored in the following subsection.

B. Comparison of Evolving Trends

Recently, in social science, great attention has been given to the development of approaches that are capable of providing accurate analytical models of economic trends. To predict economic performance, it is required to include all the factors that affect the economy into the framework of system identification, which involves modeling and parameter estimation of the system for both qualitative and quantitative analyses. The key problem in system identification is to search, within a set of suitable models of the system, for the one that "best" represent the current status of the system [12].

Nevertheless, factors that are associated with economic performance are very difficult to foresee unless they are included in the algorithm of system identification. Further, their true values are influenced by the presence of other factors. For an accurate identification, it is necessary to use considerable insight when candidate factors are being included [12]. Such schemes can be classified into the group defined as "parametric methods," indicating that they search the solution directly in the (physical) parameter space. The other group is defined as "non-parametric methods," representing algorithms that search in the (nonphysical) function space [12]. In fact, every methodology is only an approximation [13], and its result may differ from case to case.

A least-squares curve-fitting method such as polynomial regression [14] has been applied to the analysis of the evolving institutional trends of both NKSP and GLIP. The polynomial regression method, utilizing the computer program Matlab that has a built-in function "polyfit" (Version 7.1.0 (R14)), is described as follows: " $p = \text{polyfit}(x, y, n)$ finds the coefficients of a polynomial $p(x)$ of degree n that fits the data, $p(x(i))$ to $y(i)$ for the i -th data point, in a least squares sense. The resulting p is a row vector of length equal to $n+1$, containing the polynomial coefficients in descending powers."

$$p(x) = p_1x^n + p_2x^{n-1} + \dots + p_nx + p_{n+1} \quad (1)$$

A set of data points is approximately fitted using a polynomial with the degree n that is user-specified in (1). The linear model, with $n=1$, demonstrates the linear basis function and often yields an initial rough estimation. A third degree of order, with

$n=3$, is usually selected in the polynomial regression model, and a higher-order model would probably show marginal improvement [15]. Hence, the cubic polynomial model, a function of time, is adopted in this study. However, caution should be exercised while using high-degree polynomials because they can have large variations between the data points; this can result in erroneous estimates for values in these intervals [14]. It is noteworthy that the only economic factor, in this case, is the time factor in the established cubic polynomial model, after having introduced the effects of transaction (institutional) and production costs for both NKSP and GLIP.

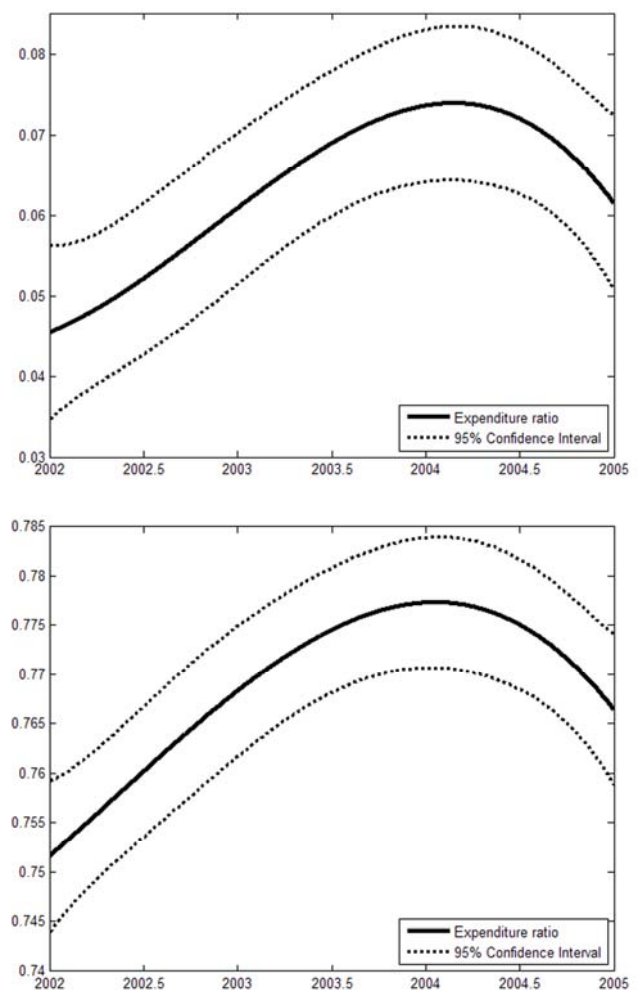


Fig. 1 Comparison of the ratio of the institutional cost to the total cost between NKSP (upper) and GLIP (lower) during 2002–2005

Using data set rearrangement, regression analyses were conducted to observe the changes in the evolving trends of both NKSP and GLIP. In order to rule out the factor of scale, the ratio of the institutional cost to the total cost between the two classes of industrial parks was compared. As shown in Fig. 1 (solid line), the ratio moves in a downward trend; thus, the analysis confirms the institutional efficiency of NKSP. An interesting aspect is that the same downward trend is also evident in the case of GLIP, albeit with a higher institutional

cost ratio in magnitude (about ten-fold). This implies that GLIP is going through a learning process and is transforming so to become more like NKSP in terms of efficiency.

It should be noted that the established models in Fig. 1 (solid line), by means of the polynomial regression method, result in an R-square value [16] of 100%. This indicates the best fit of data points, and hence, the perfect model establishment. The R-square value refers to the fraction (100% in this case) of the variation in the values of the target that is explained by the least-squares regression of the target on the explanatory factor. In this case, the 100% R-square value presents an interesting but theoretical result; this is because the 4 data points during 2002–2005 result in a unique solution to row vector p containing 4 polynomial coefficients, $n = 3$, in (1).

In general, the R-square value of the established model using a regression-based approach should be as close to 100% as possible. This can be accomplished by incorporating a large number of parameters, or factors [17]. However, the quality of the black-box modeling procedure is always a result of a compromise between the “expressive power” (order) of the model we try to identify (the larger the number of parameters used to describe the model, the more flexible is the approximation), and the measurement (stochastic) error (which is proportional to the number of parameters) [18]. Such a rapprochement leads to search for an initial flexible series model and then refine it to the degree that cannot be further simplified [17].

IV. DISCUSSIONS

The comparison of the institutional efficiency between the two entities, private and governmental institutions, has been shown through the established regression models. Some factual examples can further explain the connection between institutional form and type on the one hand and institutional performance on the other. This institutional efficiency issue concerns the correct level of analysis on industrial parks, apart from the value of technological evolution.

There are benefits at the firm and the region/nation levels that have been theorized through changes to the system’s institutional structure [19]. At the firm level, there must be some kind of strategic or economic benefit to participating in collaboration, such as the market-oriented HOA governance for firms in NKSP. Firms in NKSP evolved with economizing objectives by adopting more strategic objectives, after having learned of their value from government-led strategic networks. Regionally, it is expected that there will be spillover effects as a result of innovation networks along with improvements in national competitiveness [19], such as the traditional government administration for GLIP with respect to industrial neighborhoods in Taiwan.

Further, institutions (government, universities, research institutes and firms) are more consistent within sectors than they are within nations [20]. Thus, firms within the software sector, the NKSP, are more efficient than the governmental counterparts spreading within Taiwan. Moreover, since the

evolution of governance can be reflected on regulations created as time proceeds, these regulations might explain the comparison between NKSP and GLIP with respect to institutional efficiency.

It may be said that this study belongs to one of the two major research streams in the field, that is, the national innovation systems. The other research stream is the studies of collaborative innovation networks. Exploration of how to integrate the “institutional” and “relational” innovation systems into a comprehensive model is the recent research interests [19].

V. CONCLUSIONS

In this study, an effective polynomial regression model was applied to two kinds of industrial parks in Taiwan for a comparison of institutional efficiency, reducing everything to cost efficiency and market relations. From market relations to the commonhold institution to the transaction (institutional) cost analyses, the established models suggested that commonhold governance supersedes its governmental counterpart.

The failure of the government of Taiwan in supplying industrial land to SMEs has created significant unexplored opportunities and resulted in a market niche for entrepreneurs. As a result of market power, Taiwan’s entrepreneurs built commonhold industrial parks to meet the SMEs’ demand. These parks, such as NKSP, are governed by HOAs and have features of a principal-agent structure. By clearly defining each participant’s rights and responsibilities, the institutional design of NKSP has constrained rent-seeking behavior and has worked efficiently. The sectoral level of industrial parks works more efficiently than the national level of those in Taiwan. In addition, the regulations of governance might explain the institutional efficiency between NKSP and GLIP.

On the analyses of NKSP’s expenditures and evolving trends, the typical characteristics of a commonhold organization in which the transaction (institutional) cost occupies a small part of the total cost and evolves downward are shown. In comparison, the expenditures of GLIP reflect an ordinary evolving path, which is typical of any governmental organization, wherein the transaction (institutional) cost increases steadily and the labor cost is the highest. Such an evolving trend leads toward over-sized and inefficient agencies. With the aid of the established polynomial regression models, this comparison manifests that market-oriented HOA governance is more efficient than traditional government administration with respect to industrial neighborhoods in Taiwan.

Although this comparative study reduces everything to cost efficiency and market relations, the broader issues of social equity have not been ignored. For instance, higher labor costs in the government-run operations reflect employment and working conditions that are similar to the private sectors in hi-tech NKSP. In addition, the private collection operations attain the same level of casualization as those in GLIP.

However, continuing research is suggested to provide more factual examples concerning social equity between the two entities. It is also suggested to conduct research on the co-evolution of private and governmental institutions on the one hand, and the learning from new institutions on the other.

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