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Impact of government and industrial agglomeration on industrial land prices: A Taiwanese case study

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A B S T R A C T

Government intervention in industrial development is important in promoting national economic development in numerous Asian countries. This study aims to examine the influence of government and industrial agglomeration on industrial land prices by constructing hedonic pricing functions. Based on model testing, this study indicates that variables related to general attributes, locational attributes, industrial agglomeration and government determine land prices. Moreover, industrial agglomeration is positively related to land prices; that is, industrial parks with a stronger agglomeration economy have higher land value. However, the role of government is negatively related to land prices, indicating that government intervention has no influence in increasing land prices and probably results from the inappropriate location of industrial parks and dissatisfaction of those parks' management services. To increase the development efficiency and industry competitiveness, this study proposes that government should identify and improve the weaknesses of industrial parks and promote the establishment of industrial clustering and information transfer among firms.

Introduction

After World War II, market intervention by the government was crucial to the recovery of the Taiwan economy. By assigning resources and implementing a series of economic policies, the government made different decisions regarding production and investment. Numerous Asian countries such as Korea and China adopted similar approaches to stimulating national industrial development (Wade, 1990). In Taiwan, the most obvious form of government was in providing industrial land. Industrial land in Taiwan may be from either the public or the private sector. During the 1960s, the public sector provided industrial land to solve the problem of insufficient industrial land for firms to establish factories and to absorb the foreign capital investment. The Taiwanese government thus was able to help develop industry by offering sufficient industrial land at low prices and by attracting firms to locate together, which thus achieved industrial agglomeration. The industrial parks established by the public sector provided essential software, hardware and management services while the private sector parks did not. Besides the roles of government of providing industrial parks were different (public or private), there was also a very great difference on the land price policy. To reduce the expenses incurred in purchasing land, the first sale prices between public developers and buyers were determined by the costs of constructing industrial parks. However, when the firms resold the land, the sale prices were determined by the market, and the government no longer intervened in pricing. The prices of industrial land offered by the private sector were also determined by the market.

Generally, government-developed industrial parks are characterized by a government intervention mode, which may involve comprehensive legislation, establishing organizations and institutes, offering a competitive production environment and management services, forming independent industrial parks, etc. The benefits associated with government-established industrial parks thus exceed those of private sector parks. This study analyzes whether the value of industrial land provided by the public sector still exceeds that by the private sector industrial land due to the superior production environment and better management services. Additionally, this study examines whether government influences significantly impact industrial land prices.

When selecting a factory location, firms consider factors such as distance to highways, stations, airports and other infrastructure, supply of labor and commercial services and land prices (Hodgkinson, Nyland, & Pomfret, 2001). The literature on industrial land prices has gradually received attention since the 1970s and currently emphasizes the influences of general attributes as well as

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location and social attributes on industrial land prices (Ambrose, 1990; Fehribach, Rutherford, & Eakin, 1993; Lockwood & Rutherford, 1996). However, the relationship between industrial agglomeration and industrial land prices is seldom discussed. Firms can achieve numerous advantages by locating together, including reduced communication and transportation costs (Yamamoto, 2003), helping form a localization economy, helping achieve economic rents (Coe, Hess, Yeung, Dicken, & Henderson, 2004) and improving competitiveness (Anderson, 1994; Tabuchi, 1998). Because industrial agglomeration offers so many advantages, industrial parks that provide economic benefits associated with agglomeration should attract more firms. Given the limited supply of land, prices of industrial park land with agglomeration effects should exceed those of parks without agglomeration effects. The relevant literature also indicates that industrial parks in Taiwan are already characterized by localization economies and agglomeration effects (Pai, 2000). This study analyzed how industrial agglomeration affects industrial land prices. The findings of this study can provide a reference to countries implementing policies designed to achieve industrial agglomeration and high industrial land prices.

This study employs the hedonic pricing theory developed by Rosen (1974) to compare how different attributes of public and private sector industrial land affect industrial land prices in Taiwan. The rest of this paper is organized as follows. The next section reviews existing studies of how general attributes, location, government and industrial agglomeration affect industrial land prices and presents hypotheses which demonstrate the main points of this study. The third section then introduces the research design, the hedonic pricing model and the data for industrial land in Taiwan. Next, fourth section analyzes the empirical findings. Finally, conclusions are presented in the last section.

Factors influencing industrial land prices: literature review and hypotheses

Factors affecting industrial land prices

The numerous variables affecting industrial land prices include the general attributes of form, size and the width of abutting roads (Ambrose, 1990; Asabere & Huffman, 1991; Fehribach et al., 1993; Kowalski & Colwell, 1986; Lockwood & Rutherford, 1996). Generally, large square parcels provide sufficient space for flexibility in factory building sufficient flexibility for manufacturing facilities. An industrial area that is large and square enables firms to design the site of their factories and machines more easily. A large space is also convenient when firms expand the size of their facilities. Therefore, industrial land should be flexible and appropriately priced. Parcels of industrial land with wider abutting roads provide convenient access and sufficient space for trucks or other large vehicles to maneuver, which is positively related to industrial land prices. Further, the visibility of a parcel from a street assumedly confers locational prestige relative to non-street lot locations because of the potential advertising benefits. Land in a high-visibility location should have a higher value than less visible land. This study thus considers how the general attributes of industrial land impact prices. The following hypothesis is developed based on the above:

H1. General parcel attributes (form, size, width of abutting roads, a street lot) are positively related to industrial land prices.

Regarding locational characteristics, distances to highways, airports, CBD or other infrastructure, or urban hierarchies influence industrial land prices (Kowalski & Colwell, 1986; Kowalski & Paraskevopoulos, 1990). Transportation facilities are necessary for both products and raw materials. The reduced transportation costs achieved by short distances to highways, airports or ports can offset high land prices. This accords with the 'minimum cost of friction space' theory developed by Haig (1926).[1] Kowalski and Paraskevopoulos (1990) argued that convenient transportation can affect land price by as much as 50%, which highlights the importance of location. Further, a short distance to the seat of local government should provide convenient access to various financial and commercial services, meaning industrial parks located close to the seat of local government should be more valuable than those located further away. Additionally, higher urban hierarchy of a city means the city offers greater agglomeration economic effects, commercial and financial services, a large population and more economic activities and can therefore attract more firms, which should then increase land prices. Finally, a region (or a city) with a large supply of industrial land and sufficient space for firms to build their factories is conducive to industrial development. However, when the supply of industrial land exceeds demand, the rules of supply and demand dictate that the value of such land should be reduced. Thus, the quantity of industrial land available in a region (or a city) is also expected to affect industrial land prices. Locational characteristics thus also significantly influence industrial land prices; consequently, a second hypothesis is formulated as follows:

H2. Locational attributes of a parcel (distances to highways and local government administration, urban hierarchy and percentage of regional industrial land) are related to industrial land prices.

Government

Besides general and locational factors affecting industrial land prices, the role of government and the attributes of industrial agglomeration influence industrial land prices more than the housing market. For example, firms that locate together enjoy reduced transaction costs, positive external economic effects and increased land value. However, if too many firms locate together, the limited available space for industrial development may reduce the value of industrial land. Studies by Asabere and Huffman (1991) and by Kowalski and Paraskevopoulos (1990) stated that industrial policies, land use zoning regulation and reward measures are some of the government activities that impact industrial land prices. However, trends in industrial land prices in Taiwan reveal different findings. Besides the general government behavior mentioned above, the government in Taiwan is an important participant in the development of industrial parks and continuously supplies industrial land. The government, through its intervention in the industrial land market, plays a complex role of making decisions regarding location, land use zoning regulation and sale prices at first trade-off and also offers industrial park management services (Shen, Lin, & Ben, 2006). The government simultaneously plays the roles of developer, planner and administrator, which is rare in other developed countries. Based on the specific features of the Taiwan government, the relationships among government, industrial agglomeration and industrial land prices are described below.

The appropriate government role in markets, namely, whether or not it should interfere, has always attracted considerable controversy. Scholars of liberal economy emphasize the superiority

[1] Haig (1926) who extended the idea of the transportation costs of the land rents of Thunen, established the hypothesis of minimum Costs of Friction. Haig believed in the existence of a complementary relationship between land rents and transportation costs. Land rents are the surplus value of the transportation costs saved, and transportation is a means of reducing time and money costs when other factors remain unchanged, and reducing expenditure on transportation means simultaneously reducing rents, and thus the best location should be that with the least friction space costs.

of the market and believe that it cannot be replaced by the government; such scholars also view the need for government intervention in liberal markets as a government failure, which is worse than market failure (Krugman, 1991; Wilson, 1989). However, the view of liberal economists does not mean that government does not have to do something for the market, maintaining smooth market operations requires the government to offer needed infrastructure and instruction as required. Government intervention is supported by those who believe that a fully competitive market is impossible and that government intervention can overcome the problem of market failure (Parkin, 1993). One reason for the rapid development of industry in Asia is appropriate government intervention in markets (Wade, 1990). In Taiwan, for example, to improve the production environment, supply sufficient land for industrial development and encourage overseas Chinese to invest in Taiwanese industry, the government implemented an Investment Encouragement Policy in the 1960s. This enactment provided a legal basis for government intervention in industrial development in Taiwan. The government then began using its own resources to intervene in the industrial development and began to act as a planner, developer and supplier to industrial parks by establishing industrial development institutions.

In the case of Taiwan and other developing Asian nations, government intervention in industrial development has proven essential for attracting private investment and for concentrating resources on economic development following World War II (Wade, 1990). The related literature also confirms that government intervention has helped to improve the investment environment and to accelerate economic development in Asia (Wade, 1990). In Taiwan, the government developed many industrial parks during the 1960s and 1970s, which successfully reduced land purchase costs and the disparity between urban and rural areas and also stimulated national economic development. The most significant difference between public and private industrial land is that public sector industrial land offers superior public facilities, management services and information. The resulting independent industrial park is free from intervention from incompatible land use outside, etc. (Shen et al., 2006). Public sector industrial parks have already demonstrated economic agglomeration effects in Taiwan (Pai, 2000). Generally, public sector developed industrial parks have a preferable production environment and should thus be superior to private parks; however, Shiu (2004), who employed data envelopment analysis (DEA) to compare the productivity of public and private sector industrial parks, demonstrated that public sector industrial parks are less productive than private sector ones. Additionally, firms in public sector industrial parks were dissatisfied with the management services provided (Shen et al., 2006).[2] A significant gap between industrial goals is apparent in the present situation. The government role thus impacts industrial land prices, which is a key point of this study. Given the above arguments, the third hypothesis of this study is the following:

H3. The government role is related to industrial land prices.

Industrial agglomeration: effects on land prices

'Industrial agglomeration' is a concept related to agglomeration economy. It describes firms that choose to focus on certain spaces and establish external economies owing to different regional environmental characteristics (Hoover, 1948). In one geographical area, there could be pools of common production factors such as labor, capital, transportation, energy, etc. The larger the pools of common factors, the greater the tendency to decrease factor prices or raise productivity. These advantages indicate why firms choose to locate together in some spaces rather than others (Anderson, 1994). Besides the transportation and transaction costs saved by spatial proximity, firms that locate together can obtain surplus production value known as 'economic rents'[3] (Coe et al., 2004) compared to those which do not locate together. Economic rent formation lies in the localization economies made by firms locating together. Because spatial proximity can reduce distances between firms, firms can easily exchange technical knowledge and establish cooperative relationships. Spatial proximity also helps firms obtain technological rents which are the surplus value of improvements in production progress, and relational rents, which are the surplus value of cooperative relationships between firms. The related research demonstrates that Taiwan industrial parks have achieved agglomeration economies with economic rent effects (Pai, 2000).

Industrial agglomeration is seldom discussed with respect to industrial land prices. As noted above, located firms achieve considerable profits from industrial agglomeration economies. Examples are savings in transportation and transaction costs, easy exchange of technical information and the realization of economic rents. The limited availability of industrial land should increase land prices when agglomeration effects exist. The number of firms or the number of employees are often used to measure the agglomeration effects of a region (Anderson, 1994). This study employed two variables, 'percentage of regional manufacturing firms' and 'Location Quotient of the manufacturing employees', to represent agglomeration economic effects of a region. A high percentage of regional manufacturing firms indicates that many firms are located together in certain place, which helps firm profit from the industrial agglomeration economy by reducing costs or exchanging technical information. The prices of such land should also be higher. An L.Q. exceeding 1 indicates the existence of specialization and concentration in manufacturing while the reverse is implied when L.Q. is lower than 1. In accordance with the above, firms located together obtain many advantages from agglomeration economic effects. Therefore, industrial land prices should be higher in regions with L.Q. higher than 1. Thus, the following hypothesis four is formulated:

H4. Industrial agglomeration of a parcel (the percentage of regional manufacturing firms, the Location Quotient of the manufacturing employees) is positively related to industrial land prices.

Research design

The model

Rosen (1974) combined a consumer theory, utility theory and competitive price theory and advanced hedonic pricing theory to estimate the implicit prices of different characteristics that compound a heterogeneous good. This hedonic pricing technique assumes that attributes compound a composite good that affects their markets. Because of a lack of theoretical guidelines on which functional form is preferable to the hedonic pricing model, as well

[2] Shen et al. (2006), who investigated the content of management services provided to firms in industrial parks provided by the public developers, found that 38.3% of firms were dissatisfied with the management services.

[3] Based on classical economy theory, economic rents denote the surplus value of producers. Kaplinsky (1998) stated that differences in the localization economy of different regions resulted in diverse varieties of economic rents. For example, the locating together of electronics firms in Silicon Valley helped firms to easily transfer technology and information, and helped in forming technological rents.

Table 1
Descriptive statistics of 693 observations of industrial land sales.

Variable	Mean			Maximum			Minimum		
	All data	Public provision	Private provision	All data	Public provision	Private provision	All data	Public provision	Private provision
Sale price per m^2 (Taiwan dollars)	15,700	12,800	17,600	77,900	62,600	77,900	1400	1400	2100
Width of the abutting road (m)	18.20	18.12	18.31	50.00	45.00	50.00	1.00	6.00	1.00
Size (m^2)	3303	6371.14	1273.81	64,385	64,385	35,806	3.92	16.80	3.92
Distance to a highway (km)	3.88	2.80	4.50	30.10	13.30	30.1	0.10	0.10	0.60
Distance to the administration of local government (km)	13.71	13.46	13.88	70.30	45.80	70.30	1.00	2.70	1.00
Management services provided		Yes	No						

as the bias of the estimated results lying in establishing the improper functions, Rosen (1974),[4] proposed that numerous functions should be compared to identify those that are preferable to avoid biased empirical results. A Box and Cox (1964) transformation was applied to the dependent variable to test functional forms. This method was used to identify the preferable functional form for the study data. The Box and Cox transformation model is presented below:

$$y^{(\theta)} = \sum_{i=1}^{n} \beta_i x_i^{(\lambda)} + \sum_{k=1}^{m} \alpha_k Z_k + \varepsilon \quad (1)$$

$$Y^{\theta} = \begin{cases} \left(Y^{\theta} - 1\right)/\theta & \theta \neq 0 \\ \ln Y & \theta = 0 \end{cases} \qquad X_i^{\lambda} = \begin{cases} \left(X_i^{\lambda} - 1\right)/\lambda & \lambda \neq 0 \\ \ln X_i & \lambda = 0 \end{cases}$$

where Y denotes a dependent variable which represents the price of an industrial land parcel; X_i is an independent variable that is transformed by the Box and Cox transformation (such as the numerical data); Z_k is an independent variable that is not transformed by Box and Cox transformation (such as dummy variables); ε is an error term, and β_i, α, θ and λ are the estimated coefficients.

The price of an industrial land parcel can be considered a composite good. The price depends on various characteristics in the four main categories. First, this study considers general characteristics, including form, size, width of abutting roads, and whether or not the parcel is a street lot. Second, industrial land prices are influenced by locational characteristics such as distance to highways or distance to the seat of local government, urban hierarchy, percentage of regional industrial land,[5] etc. Third, the power of government to influence prices is an important consideration. Finally, other characteristics related to industrial agglomeration also significantly influence industrial land prices, including number of regional firms, number of manufacturing employees, etc.

Data

The analyzed data were 693 sales of industrial land parcels from two different sources. Of these, 39.8% were provided by the public sector, and the remaining 60.2% were by private developers.[6] Sales data were analyzed for the period 2002–2006 in order to avoid the impact of inflation (Kowalski & Paraskevopoulos, 1990); all nominal prices were adjusted to 31 December 2006. The data were obtained for 21 counties with industrial parks. Table 1 gives the descriptive statistics for the data set. Table 1 lists an initial impression of the industrial land market. Notably, the parcel size offered by the public sector was almost five times that of parcels provided by private developers. The greater land resources of the government apparently enabled it to offer firms larger parcels of land than private developers could. This table also indicates that the average price paid for public developer industrial land parcels was lower than that for private developer parcels. The preferable production environment and management services offered by public developers apparently did not contribute to the rise of industrial land prices. The impact of this factor is described further below.

Additionally, to test the hypotheses formulated above, this study also discussed other industrial land attributes, including general attributes, locational attributes and agglomeration attributes. In terms of general attributes, 37.7% of observations were street lots offered by the public sector compared to 25.8% offered by the private sector. The industrial lands provided by public developers were apparently in locations superior to those provided by private developers. Table 1 indicates that the average width of roads abutting public sector industrial land was 18.12 m compared to 18.31 m for the private sector, indicating the minimal difference between the two developer types. In terms of parcel shape, public and private parcels differed significantly: 78.6% of public sector parcels were square whereas 31.4% of private sector parcels were not square. This difference may have resulted from different development styles for parks offered by the two sectors. The government objective in developing industrial parks is not to obtain profits, but to provide an attractive production environment to stimulate economic development. Thus, every industrial park parcel offered by public developers had a square shape that helps firms easily establish factories. However, private developers seek maximum profits when developing industrial parks; therefore, they try to maximize land use and give relatively little consideration to convenient parcel shapes.

Regarding locational attributes, the average distance to a highway was 2.8 km for parcels provided by public developers and 4.6 km for parcels provided by private developers. Important differences also existed in terms of the distance to the center of local government. Public sector land was closer to local government than private developer land was. Further, this study divided urban areas of Taiwan into four hierarchies: municipalities, cities, counties and towns. Municipalities have a larger population and more economic activity than cities, and so forth. Whereas, 85.3% of observations related to private developers were located in towns, the percentage of those provided by the public developers was 86.6%. Most data were apparently for towns in remote locations, which are characterized by less economic activity and economic agglomeration than locations in urban hierarchies. Additionally, if a certain region contains a large quantity of industrial land, firms may have sufficient space to set up factories, which benefits

[4] Rosen (1974) proposed that the linear model, semi-log model, log–log model or log–linear model could be employed to identify the preferable form of the hedonic pricing model.

[5] The percentage of regional industrial land = the quantity of industrial land in a region (county, city or municipality) which an observation located in/the number of national industrial land.

[6] The sale data is provided by Department of Land Administration.

industrial development; however, when the supply of industrial land exceeds demand, the value of industrial land is reduced. This study developed an equation[7] to calculate the percentage of regional industrial land. The smallest percentage of regional industrial land was in Taitung County (0.6%) while the largest percentage was in Yunlin County (41.9%).

Finally, Location Quotient[8] (L.Q.) of manufacturing employees and the percentage of regional manufacturing firms were used to represent industrial agglomeration attributes. Six of the sampled counties had L.Q. exceeding 1, including Taoyuan County, Hsinchu County, Hsinchu City, Taichung County, Tainan County and Kaohsiung County. In these regions, concentrations of industrial development and manufacturing employees may have contributed to high land values; the remaining regions did not display this tendency. Additionally, the formation of agglomeration economies increased with the number of regional manufacturing firms, and this phenomenon caused more firms to locate together, which resulted in increased industrial land prices. The smallest percentage of regional manufacturing firms (0.25% of regional manufacturing firms) was in Taitung County, and the largest percentage (25.6%) was in Taipei County.

Table 2 lists the variables used in the hedonic pricing model analysis.

Table 2
Description of the variables included in the hedonic pricing model.

Variable name	Description
Price (December 31, 2006, Taiwan dollars)	A dependent variable, the sale data covered the period between 2002 and 2006, and nominal prices were adjusted to 31 December 2006 ($N = 693$)
FS	Dummy—the form of a parcel is square
Size (m^2)	The size of a parcel
Width (m)	The width of the abutting road of a parcel
Street	Dummy—a parcel is a street lot
DTH (km)	The distance of a parcel in kilometers to a highway
DTLG (km)	The distance of a parcel in kilometers to the center of local government
UH-County	Dummy—a parcel is located in a county
UH-City	Dummy—a parcel is located in a city
UH-Municipality	Dummy—a parcel is located in a municipality
PRL (%)	The number of industrial land in a region (county, city or municipality) which an observation located in/the number of national industrial land
GOV	Dummy—a parcel is provided by the public sector
PRF (%)	The number of manufacturing firms in a region (county, city or municipality) which an observation located in/the number of national manufacturing firms
L.Q.	Dummy, if the Location Quotient of the manufacturing employees is larger than 1 = 1, if not = 0

Empirical results

The model developed in this study investigated the relationship between the sale price of a parcel of industrial land and its characteristics. Given the lack of theoretical guidelines for determining preferable functional forms, a Box and Cox (1964) transformation proved suitable for testing functional forms. However, the model estimation accepted log specification of the dependent variable and independent variables.[9] Therefore, the estimation equation was as follows:

$$\begin{aligned}\ln \text{Price}_i = {} & \alpha + \beta_1 \ln \text{FS}_i + \beta_2 \ln \text{Size}_i + \beta_3 \ln \text{Width}_i \\ & + \beta_4 \ln \text{Street}_i + \beta_5 \ln \text{DTH}_i + \beta_6 \ln \text{DTLG}_i \\ & + \beta_7 \ln \text{UH} - \text{County}_i + \beta_8 \ln \text{UH} - \text{City}_i \\ & + \beta_9 \ln \text{UH} - \text{Municipality}_i + \beta_{10} \ln \text{PRE}_i \\ & + \beta_{11} \ln \text{GOV}_i + \beta_{12} \ln \text{PRL}_i + \beta_{13} \ln \text{LQ}_i + e_i, \end{aligned} \quad (2)$$

Table 2 defines the variables analyzed in this study. Table 3 lists the results of the estimated hedonic equation, including the full and reduced models. All variables were significant to at least 0.01 in the reduced model. The adjusted R^2 ranged from 0.51 to 0.52, and the F statistics indicated the overall significance of the estimated model. A Park–Glejser test of fitted values of dependent variables confirmed the null hypothesis of heteroskedasticity.[10] Multicollinearity was also tested.[11]

Discussion

The first hypothesis was that general parcel attributes such as form, size, width of abutting roads and street lot are positively related to industrial land prices. Table 3 shows that, as expected, the FS variable was positive, which demonstrates that a square parcel gives a firm more flexibility when establishing its factory, which thus increases the value of the industrial land. Notably, and unexpectedly, the price per square meter was negatively related to lot size. The obtained results demonstrated that, for each square meter increase in parcel size, the price per square meter of land was NTD 0.107 lower. Given the nonlinear relationship between land price and parcel size, sales prices assumedly include transaction costs, which results in a negative relationship between parcel size and land price (Colwell & Munneke, 1999). As expected, the width and street variables were both positively related to land prices. For every meter of increase in the width of abutting road, the price of the parcel increased by NT$ 0.177. Moreover, the prices of street lots were 0.248 higher than those for non-street lots. The empirical results for the analysis of width and street variables supported the hypotheses in the second section. However, given the negative relationship between size and land prices, the empirical data did not fully support H1.

H2 proposed a relationship between locational attributes and industrial land prices. Table 3 shows that the DTLG variable was negative, as expected, which reflects the trade-off between transportation costs and land prices. The coefficient of the DTLG variable implied that each additional kilometer of distance from the nearest center of local government reduces the price of a land parcel by 0.264 Taiwan dollars. The UH-County, UH-City and UH-Municipality variables were employed to test how urban hierarchy affects industrial land prices. The empirical results demonstrate that the UH-City and UH-Municipality variables impact land prices, but the UH-County variable does not. The coefficient of the UH-Municipality variable (0.624) exceeded that of the UH-City variable (0.235), which indicates that the value of industrial land increases with urban hierarchy. Because a municipality has more people and economic activities than a city or county does, firms have access to diverse commercial and financial services in a municipality. Industrial land prices should therefore be higher in a municipality. The PRL variable measures the percentage of regional land (see

[7] The percentage of regional industrial land = the quantity of industrial land in a region (county, city or municipality) which an observation located in/the number of national industrial land.

[8] L.Q. $= (E_{ij}/E_i)/(E_j/E_t)$, E_{ij}: employees of industry j in region i, E_i: total employees of region i, E_j: national employees of industry j, and E_t: national employees.

[9] The t-statistic of θ is -0.678, and Prob. = 0.4997; the t-statistic of λ is -0.785, Prob. = 0.4326. Both are insignificant, but we cannot reject the situation in which the value of θ is 0 and that of λ is 0.The fit function of the study data is log–log model (see Eq. (1)).

[10] H0: Heteroskedasticity exists between error terms, H1: No heteroskedasticity exists between error terms; this study employs a Park–Glejser test for heteroskedasticity, and all fitted.

[11] The Variance Inflation Factor of all variables is lower than 10.

Table 3
The results of the hedonic equation estimated.

Variable	Full model		Reduced model	
	Coefficient (β)	t-statistics	Coefficient (β)	t-statistics
FS	0.119	2.135*	0.109	2.369**
Size (for H1)	−0.112	−8.516**	−0.107	−8.270**
Width (for H1)	0.177	4.036**	0.177	4.046**
Street (for H1)	0.264	5.123**	0.248	4.956**
DTH (for H2)	−0.038	−1.520	–[a]	–
DTLG (for H2)	−0.245	−7.605**	−0.264	−9.168**
UH-County (for H2)	0.046	0.796	–	–
UH-City (for H2)	0.255	3.067**	0.235	2.935**
UH-Municipality (for H2)	0.634	6.577**	0.624	6.568**
PRL (for H2)	−0.252	−7.224**	−0.257	−7.451**
GOV (for H3)	−0.254	−4.445**	−0.236	−4.292**
PRF (for H4)	0.427	17.358**	0.431	18.366**
L.Q. (for H4)	−0.026	−0.467	–	–
Constant	0.971	20.634**	3.947	22.259**
F	50.198**		74.438**	
R^2	0.527		0.522	
Adjusted R^2	0.516		0.515	

a Variable removed in the model reduction process.
* Identifies significance at 5%.
** Identifies significance at 1%.

Table 2) and is negatively related to industrial land prices. Each additional percentage increase in regional land price was associated with 0.257 Taiwan dollar decrease in industrial land. The supply of regional industrial land thus seemed to exceed demand. One explanation for the empirical results of the PRL variable in the present analysis is that over 13,000 ha of industrial land were unsalable in Taiwan during 2004 (Shiu, 2004). Thus, the oversupply of industrial land may explain the decreased land value. The above data clearly demonstrate that location significantly influences sales prices, but the empirical results do not support H2 regarding the insignificance of the DTH and UH-County variables.

H3 argued that the role of government has an important impact on sale price. The GOV variable was significantly and negatively related to land price (see Table 3). Thus, the empirical results supported H3. A negative relationship between government and the industrial land prices was observed. The prices paid charged by public developers were 0.236 Taiwan dollars less than those changed by private developers. Table 1 displays the empirical results, which demonstrate that the average price paid for a parcel offered by a public developer was lower than that for parcels offered by private developers. Moreover, Table 3 also demonstrates this difference. This study proposed that the industrial parks provided by the public sector have lower land prices for many complex reasons, including inappropriate location (most data were for remote towns with low population, small labor forces and low levels of economic activity), dissatisfaction with management services and negative expectations regarding future industrial development (Shen et al., 2006; Shiu, 2004). In the case of Taiwan, government allocation of large quantities of material resources and manpower provide a favorable industrial production environment for improving industry development but did not increase land prices. The Taiwan experience provides an excellent reference for governments elsewhere when choosing whether to intervene in industrial development.

Finally, H4 was that industrial agglomeration was positively related to industrial land price. The PRF variable that measures the percentage of manufacturing firms in a region was positively related to sales price, but the L.Q. variable was insignificant (see Table 3). The empirical data thus do not support H4 regarding the insignificance of the L.Q. variable. The empirical results indicate that the impact of industrial land prices is firm agglomeration rather than employee agglomeration. Although employee agglomeration can provide sufficient labor, technology transfer and reduced transaction costs cannot be achieved without firm agglomeration. Due to spatial proximity, firms can gain advantageous cost savings and economic rents, and this effect corresponds with increased industrial land values. Industrial land values increase with the number of agglomerated firms.

Conclusion

The market value of industrial land is clearly influenced by numerous factors. Although numerous studies have examined the price of industrial land in comparison with its past characteristics, this study tested four hypothesized impacts on industrial land price: general attributes, locational characteristics, the role of government, and attributes of industrial agglomeration. The main contribution of this study is its confirmation of how government and industrial agglomeration impact industrial land prices. The empirical results indicate that the variables related to general attributes, locational attributes, industrial agglomeration and government are determinants of industrial land prices. Variables related to general attributes include abutting road width, size, form and street lot; those related to location include distance to the center of local government and urban hierarchy. The variable related to industrial agglomeration is the percentage of regional manufacturing firms.

The significant influence of the industrial agglomeration variable demonstrated that the effects of agglomeration economy could respond to industrial land value. Industrial agglomeration not only positively impacts industrial development, it also helps increase industrial land value. This study thus suggests that the government should help firms to establish industrial clusters, improve information and technology transfer and boost industrial competitiveness.

Governments that intervene in industrial park development can provide considerable resources and manpower to achieve a superior production environment that can then contribute to overall economic development. During the initial stages of industrial development in Taiwan, the economic miracle resulting from government intervention was admired and studied by other Asian countries. Presently, the empirical results show that government efforts fail to increase land values. Inappropriate location of industrial parks and dissatisfaction with management services (Shen et al., 2006) may impact industrial land prices. To improve industrial environment quality, we recommend that the market provide management services without government interference. Further, location should be the primary consideration for governments establishing industrial parks. In order to avoid government intervention impact the land market operating and fitting the needs of the government to implement industrial polices. Collaboration between public and private sectors may help stimulate national industrial development. The private sector must ensure that the market operates flexibly and that the public sector has the resources to support industrial development. Combining both energies could bring advantages and avoid disadvantages of the two. Because government intervention in industrial development varies, this study is a useful reference for countries wishing to adjust their policies of industrial land prices related to industrial agglomeration (or other impact factors) by government intervention.

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