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The determinants of industrial property prices during period of economic restructuring – the case of Hong Kong

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Abstract

This study investigates the major determinants of industrial property prices in Hong Kong during the period of rapid economic restructuring resulting from China's open door economic policy since the late 70's. The empirical results suggest that besides the usual demand and supply side factors in the manufacturing sector, industrial property prices are also affected by the volumes of re-exports. This is a result of relocation of Hong Kong's industrial base to the Mainland. During the period of relocation of production base, the use of industrial buildings in Hong Kong gradually changed from production to other supporting uses, such as administration, research and development, storage, and marketing.

However, there were regulatory restrictions on the industrial space for non-production purposes despite the declining demand for space for production uses. The government's industrial land policy has also been adjusted many times during the process of economic structuring in Hong Kong. Our study suggests that the of all the policy changes, the changes in 1997 and 2001 that provided more flexibility for use of industrial space had the strongest positive impact on industrial property prices. These policies injected a valuable real option into the industrial buildings and removed much uncertainty in investing in industrial buildings.

Keywords:
Economic structuring, industrial property, land use policy.

Introduction

The development of Hong Kong's economy has witnessed a significant structural transformation from a labour-intensive manufacturing economy to a service-sector led tertiary economy. As summarized by Wong (1994) in her study, there has been extensive and massive restructuring in the manufacturing sector from the textile boom in the 1950s and 1960s to the flourishment of garments and plastics in the 1970s and to the development of electronics and toy industries into some multi-billion dollar business today. The manufacturing industries have moved from production of labour-intensive to more technology and human capital-intensive manufactures. Apart from the change in local factor endowment, there has been change in the physical location of labour-intensive manufacturing industries. From mid 1980s, there was massive relocation of manufacturing activities to other lower cost countries particularly Pearl River Delta region in China due to its proximity with Hong Kong.

Until 1989, manufacturing sector was the key power engine driving the economic development of Hong Kong. However since 1990, the importance of the sector as a GDP contributor has been gradually declining, overtaken by such rapidly growing service sectors as financing, insurance, real estate and business services; and community, social and personal

The massive restructuring means that the manufacturing sector in Hong Kong is manufacturing-related but non-manufacturing in nature, moving towards non-production and head-office supporting activities such as administration, documentation, trade financing, materials sourcing, sales, marketing, technology acquisition and the like. This coupled with the relocation to other lower cost countries have rendered many old factory buildings vacant. To tackle the problem of obsolete industrial properties brought about by industrial restructuring, the government revised its industrial land use planning policy by introducing a new land use – the composite industrial-office (I/O) in the late 1980s.

Despite the significant role of manufacturing or industrial sector in the economic development of Hong Kong, there has been very little research on the local industrial property sector. Majority of the empirical studies on local property market have been devoted to residential, office and retail property sectors. Even in the US and UK, the industrial property sector remains a relatively under-researched area. The lack of interest and published empirical work in this sector, as pointed out by Thompson and Tsolacos (1999), can partially be attributed to the importance of the owner-occupied sector in the industrial market and the lower weight that industrial property has in institutional portfolios. Another reason is that there is a lack of data on industrial properties in many markets due to low liquidity of industrial properties.

The scope and focus of this study is confined to the private flatted factories (multi-storey factories) in Hong Kong. The rational is threefold. First, private flatted factories have been the dominate type of industrial buildings in Hong

Kong. Second, compared with other types of industrial properties, this group has undergone much more massive changes in terms of spatial requirements, end users and institutional land use regulations over the past decades. Finally, flatted factories are relatively active with a lot of market data available. There is a relative comprehensive official archive for this type of traditional property which has grown and developed closely with Hong Kong, making an extensive and meaningful econometric study possible.

This paper is organized as follows: the next section presents a some background information including characteristics of the industrial property market; the development of the manufacturing industry and major changes in policy governing use of industrial properties. We then present an analysis of how economic restructuring affect in Hong Kong affect industrial property prices and derive a model for empirical tests. Finally we present data, method and results of empirical tests.

The Characteristics of Industrial Property Market

In Hong Kong, though private industrial properties comprise flatted factories, industrial/office premises, specialized factories and storage premises; the rapid industrialization from the 1950s to the 1980s coupled with institutional encouragement mean that flatted factories has been the focal point of the industrial property market. While factory building embraces both single-storey factories and flatted factories, as explicitly reflected in the Rating and Valuation Department's classification, it is dominated by flatted factories or multi-storey flatted factory buildings in Hong Kong. This is largely due to the limited territory and dense population in Hong Kong which make land an extremely scarce resource.

Development of the manufacturing industry in Hong Kong

In the past three decades, the industrial sector in Hong Kong has gone through massive restructuring in response to economic fluctuations and historical turmoil, growing from an entrepot to a highly industrialized city in the 1960s and 1970s to a world commercial and financial city at present times. To identify significant factors shaping the movement of industrial price, an understanding of the historical development of manufacturing industries in Hong Kong is essential.

The 1980s was a period of transition embarking Hong Kong on a massive economic restructuring marked by a drastic decline of manufacturing industry with rapid growth of service industries. The main driving forces of economic restructuring in the 1980s were threefold – local, sub-regional and regional. Firstly, the rising production cost locally was a key triggering factor. This was attributed to rising nominal and real wages which was further aggravated by labour shortage. The cancellation of the "touch-base" policy in 1980 meant that the problem could no longer be alleviated by the inflows of legal and illegal migrants from China as had repeatedly been in the past. The rising costs for factory premises due to soaring property market further increased the factor cost of production. From 1981 to 1990, rentals for private flatted

factories more than doubled and prices also increased by a remarkable 66.6% (Chiu et al, 1997, p.56).

Secondly, at the sub-regional level, there was an important political change – the fall of the Gang of Four in 1976 which led to the resumption of open-door policy in China in the late 1970s. This made possible the revival of entrepot trade in Hong Kong and brought about the massive relocation of manufacturing industries in Hong Kong to Southern China.

Thirdly, in the Asian Pacific region, there was rapid development of economic liberalization in terms of trade liberalizations, financial liberalizations, privatization and deregulation of capital movements so as to attract inflow of foreign direct investment (FDI). All these contributed significantly to the Asian Pacific restructuring and integration and the internationalization of industrial activities in Hong Kong (Wong, 1994).

As suggested by Wong (1994, p.546-552), this period of industrial restructuring was characterised by a period of internationalization, internalization and automation with production of more technology and human capital-intensive products. These three significant periods/phases of development reinforce one another, enabling and empowering Hong Kong to weather through the waves of economic restructuring and enter a higher rank in the economic development hierarchy. The key issues facing the sector changed from diversification in the 1970s to quality improvement in the late 1980s and early 1990s (Chen and Li, 1996, p.87).

The impetus of economic liberalization in the region encouraged the internationalization of industrial activities in Hong Kong. This could be gauged by the increase in both inward and outward FDI. The total value of FDI in Hong Kong manufacturing sector increased from HK$2,548 million in 1980 to HK$48,287 million in 1995 (Lethbridge and Ng, 2000, p.192). As can be seen from Table 2.3 below, the average annual growth per annum of the total FDI investment was the greatest between 1980 and 1985. Foreign investment, coming as a package with such critical factor supplies as technology, management skill, entrepreneurship and marketing network, was instrumental in upgrading the overall level of technology, product and labour quality of manufacturing industries in Hong Kong (Chen and Li, 1991; Wong, 1994).

Likewise, there was significant outward investment by Hong Kong in China and other South-east Asian countries like Malaysia, Indonesia, Thailand and Philippines. On the approval basis between 1980 and 1989, China was the main recipient as it took the lion's share of 72% of Hong Kong's outward FDI (Chen and Li, 1996, p.95). In fact, from 1979 to 1987, Hong Kong ranked as the top foreign country in both the number and amount of foreign investments in China, accounting for 86.7% and 74.99% of the total FDI respectively . This was largely the result of relocation of labour-intensive manufacturing activities to South China which will be discussed in the next section.

During this internationalization phase, there was also increase in the establishment of regional headquarters (RHQ) in Hong Kong. RHQs assumed

significance in the 1980s. Not just did they facilitate the transfer of technology to Hong Kong but also create extensive linkages for the service sector owing to the requirement to provide services to subsidiaries over the region. Since a significant proportion of RHQs engaged in manufacturing sector, they helped upgrade the industry's technology and productivity (Wong, 1994, p. 549).

The regional economic liberalization and the opening up of China enabled the manufacturers to internalize the locational advantage (such as cheap labour, land, raw materials) by relocating labour-intensive and low-value-added production to these countries (Wong, 1994). This greatly eased the tremendous pressure of rising production costs in Hong Kong. More importantly, it resulted in the fundamental change of manufacturing industries. During the 1980s, there were massive relocation of manufacturing activities to China and the ASEAN countries. Owing to linguistic and cultural bonds, China (particularly Guangdong Province) remained the major destination for investment by Hong Kong manufacturers (Industry Department, 1995). This was reflected in the growing significance of trade with China involving outward processing. Imports from China involving outward processing rose from HK$113,581 million (58.1% of total imports from China) in 1989 to HK$354,912 million (75.9%) in 1994 at an average annual rate of 25.6%. Total export to China involving outward processing also rose from HK76,868 million in 1989 to HK$181,179 million in 1994 at an average annual rate of 18.7% (Industry Department, 1995, p. 30).

The relocation of production activities offshore meant that Hong Kong entered a stage of "deindustrialization" with drastic decline of manufacturing sector in the 1980s. Between 1980 and 1990, the number of persons engaged in manufacturing industry decreased from 907,463 to 715,597 (a drop of 26%) and its contribution to GDP from 22.8% to 16.7% . By 2000, manufacturing sector employed 226,205 (accounting for 9.86% of the total) and contributed 5.4% to GDP. Since non-operative Hong Kong premises were engaged in more sophisticated process and supporting services such as sourcing of raw material, design, production management and engineering, marketing and the like, Hong Kong became more of a commercially oriented business networking centre than a manufacturing base (Chiu et al, 1997).

Prompted by the economic restructuring, there has also been a shift towards more capital-intensive and higher value-added production activities in Hong Kong. In response to the rising labour cost, apart from relocation of production base to China and other Asian countries, many manufacturers responded by increasing the degree of automation and capital investment. Hence, additional fixed asset investment increased at an average annual rate of 8.1% between 1983 and 1993 (Industry Department, 1995, p.9). This structural shift supported an improvement of labour productivity and value-added in the local manufacturing industries. According to the Census and Statistics Department (2005 website), value added increased significantly from HK$36,049 in 1981 to HK$92,241 in 1990 and peaked at HK$97445 in 1992 and started to level off then. This automation trend was also facilitated by the growth of overseas investment in Hong Kong's manufacturing sector, which was one of the features of the period of internationalization discussed above.

As succinctly summarized by Chiu et al (1997), there was a “double-restructuring process” in the 1980s. On the one hand, there was the general sectoral shift towards finance, trading and services sector in the economic structure. On the other hand, within the manufacturing sector, there was a shift away from production towards a more commercially and trade oriented centre.

In a nutshell, there have been significant changes in the nature of manufacturing activities. First, with the massive relocation, an “office-factory” relationship developed between Hong Kong and China (Chen and Li, 1996, p.106). The sector becomes more of non-production and supporting services oriented. Second, the production has moved from labour-intensive to hi-tech and high valued .

Industrial Land Use Policy

The new wave of industrial restructuring since 1980s had prompted the government to review its industrial land use policy. This section discusses the major changes in the land use planning policy which affect industrial buildings.

Adoption of Composite Industrial-Office (I/O) Building in November 1989
As clearly spelled out by the Town Planning Board (TPB) in its 1990 annual report (Town Planning Board, 1990a, p. 42):

"In recent years, there has been a trend in industry in Hong Kong towards high technology and high value products. This change has resulted in an increased demand among some industrial firms for floor space to be used for management purposes, design and quality control, and other non-manufacturing activities which cannot be accommodated in a normal commercial building or located away from the industrial operations. To cater for this new demand, the Board approved in November 1989 the introduction of a new type of development called the 'Composite Industrial-Office Building'."

In January 1990, this new property concept was formally recognized by the government through the promulgation of Town Planning Board Guidelines (TPBGs) for such redevelopment in industrial zone, which was revised in December of the same year. According to the relevant TPBGs (Town Planning Board, 1990b), a composite I/O building was defined as “a dual-purpose building in which every unit of the building can be used flexibly for both industrial and office purposes.” In addition, there was no limit on the size of offices to be accommodated within I/O buildings provided that the “offices are ancillary to an industrial operation within the building.” However, the general intention was to “discourage the infiltration of general commercial uses as restaurants and supermarkets” into this property type. In terms of design and construction, I/O building had to comply with the standards and regulations applicable to both industrial and office buildings, whichever was more stringent. In short, upon application to and with approval from the TPB,

redevelopment of the whole site and in-situ conversion of existing industrial building to I/O use would be allowed.

Policy Revisions in 1992, 1993 and 1994

In order to cater for "the demands of an industrial sector which is undergoing structural change" (Town Planning Board, 1992, p.1), the TPB revised TPBGs for composite I/O buildings in July 1992, allowing accommodation of office ancillary to an industrial operation located "within the same industrial area" rather than "within the building". In addition, 75% of the I/O building would be assumed to be used for office use for the purpose of premium calculation (Town Planning Board, 1992, p.3). The October 1993 revision even relaxed the permitted office use to 100% of the floor area and used it as the basis for premium calculation (Tang and Tang, 1999).

Realizing the problems in defining the term "the same industrial area" and the fact that Hong Kong operations became non-manufacturing and headquarter-oriented after the relocation of production lines overseas, in January 1994, the TPB revised the guidelines to the effect that the requirement of office ancillary to an industrial operation "within the same industrial area" be deleted (Town Planning Board, 1994a, p.56 and 1994b, p.3).

Policy Revision in 1997

To assist the formulation of appropriate industrial planning strategy to meet the changing industrial sector, the Planning Department commissioned a consultancy study which recommended 1) the revision of the definition of "industrial use" so as to better reflect the modern characteristics of Hong Kong's industries; and 2) the recognition of the trend that industries require a greater proportion of space for ancillary office use rather than for ancillary showroom and that a greater range of commercial uses are necessary to support the increasingly diverse and business-oriented industrial sector (Town Planning Board, 1997a, p.80-81).

In response to this study, the TPB made several major changes to TPBGs related to applications within industrial zones in September 1997.

First, "training" was now regarded as a kind of industrial use and accordingly the definition of "industrial use" had been amended to include "training" (Town Planning Board, 1997a and 1997b).

Second, within industrial buildings, under the previous TPBGs (TPB PG-No.1 and No.6), the maximum proportion of usable floor space of an industrial firm for ancillary office permitted as of right was 30% and for ancillary showroom use was 20% upon application. Under the new TPBGs (TPB PG-No1A) , the Board combined the proportion of floor space permissible for ancillary office and/or showroom uses to a maximum of 50%. Within this 50% limit, the proportion for ancillary showroom was restricted to a maximum of 20% (Town Planning Board, 1997a, p. 83).

Third, within I/O buildings, in the previous TPBGs (Town Planning Board, 1994b, p.2) only "industrial operations, quasi-industrial operations and ancillary office activities related to these industrial/quasi-industrial operations"

were permitted. Besides, general commercial uses were discouraged though "a limited provision of floor space for such necessary and complementary local services to the industrial area as banks, showrooms and local provision stores might be allowed by the TPB upon application". In the revised guidelines (Town Planning Board, 1997c, p.2):

"Trading firm, being a type of office use requiring large storage space of no less than 30% of the total usable floor area of the firm and frequent loading/unloading which cannot be accommodated in conventional commercial/office buildings, will be permitted in an I/O building."

In addition, "Commercial uses included in Column 2 of the Notes of 'industrial' zone in the relevant Outline Zoning Plan will be permitted on the lowest three floors of an I/O building and subject to a maximum plot ratio of 1 or 10% of the total gross floor area of the building, whichever is the less."

In other words, trading firms and such commercial activities as banks, fast food shops, restaurants and retail shops were now permitted. These greatly broadened the range of activities that could be accommodated within I/O buildings.

Policy Revision in 2001

To streamline the use and development within industrial zone and in recognition of the growth of information-based industries, the TPB promulgated a new set of TPBGs for Use/Development within "Industrial" Zone in September 2001 (TPB PG-No.25A), replacing three previous sets of TPBGs concerning commercial uses in industrial buildings and office building development within industrial zone.

Under TPB PG-No.25A, the major change was that composite I/O building development within industrial zone would now be permitted as of right i.e. redevelopment or in-site conversion of industrial buildings in industrial zone into I/O buildings needed no planning permission. As a result, the guidelines on "Application for Composite Industrial-Office Buildings in Industrial Zone under Section 16 of Town Planning Ordinance" (TPB PG-No.4A) were deleted. (Town Planning Board, 2001b, p.2)

In addition, TPB allowed greater flexibility in industrial buildings by permitting as of right information technology and telecommunications industries, offices related to industrial uses and trading firms which required frequent loading/unloading and large storage space of not less than 30% of the total usable floor area (Town Planning Board, 2001a, p.45). In other words, uses permitted as of right in industrial buildings were now more or less at par with those in I/O buildings except that commercial uses (even located at the lowest three floors) within industrial buildings required planning permission.

The major changes to the permitted uses in industrial and/or industrial-office buildings within industrial zone as discussed above are summarized in the following table:

Major Regulatory Changes of use of Industrial Buildings

Time	Major Changes
November 1989	TPB endorsed the composite I/O buildings concept.
January & December 1990	- Composite I/O development within industrial zone might be allowed upon application. - Within I/O buildings: no limit on the size of offices as long as they are ancillary to an industrial operation "within the building". - Within industrial buildings: ancillary office use no more than 30% of total usable floor area of an industrial firm.
July 1992	Within I/O buildings: - allow ancillary office use related to an industrial operation "within the same industrial area" rather than "within the building"; - calculate land premium on assumption that 75% of I/O building was for office use.
October 1993	Within I/O building: relax the permitted office use to 100% of the floor area and used it as the basis for premium calculation.
January 1994	Within I/O buildings: allow ancillary office use related to an industrial operation irrespective of geographical location.
September 1997	- Within I/O building: trading firm and commercial uses, such as banks, fast food shops, restaurants and retail shops, were permitted as of right on the lowest 3 floors. - Within industrial building: 50% of the total usable floor area (UFA) of an industrial firm in same premises or building permitted as of right for solely ancillary office use or for a combination of office and showroom uses. Ancillary showroom use no more than 20% of UFA within the 50% limit.
September 2001	- Composite I/O development within industrial zone was permitted as of right. - IT & telecommunication uses were permitted as of right in both industrial and I/O buildings. - Within industrial building: trading firms and office related to industrial use were now permitted as of right.

Sources: Town Planning Board Guidelines and Annual Report, various issues and Tang and Tang, 1999

Literature Review

There have been very few empirical studies on factors affecting the trends of industrial property prices. Most empirical studies on industrial properties have been on how the physical/property-specific characteristics of the industrial space such as ceiling height, floor loading, dock doors, accessibility, location and the like affect industrial property prices. Examples include Ambrose (1990), Hartman (1991), Rauch (1993), Sivitanidou and Sivitanides (1995) in the U.S.; Salway (1986), Hillier Parker (1987, cited by Thompson and Tsolacos, 1999) in the U.K.

The importance of regional over national variables in industrial price or rent determination may be due to the fact that the former is much more representative (and so more significant) of the general economic/market conditions at the local aggregate level. Rational for focusing on the demand side variables can also be inferred from the study by Wheaton and Torto (1990). In their study of the national industrial property market in the U.S., they found that 75% and 50% of total space is occupied by single user and owners respectively. Only a small portion is composed of multi-tenant,

independently built, rental space. As a result, they concluded that the construction of industrial space may be based on the "investment" decision of firms rather than speculative real estate development i.e. supply may be based on demand. In other words, occupation demand is much more influential than investment demand. Result of their model confirms the dominant role of demand variables. Industrial completions (i.e. supply) are determined by changes in output (or employment) and by movements in the after-tax cost of capital. As these two factors are the bases of the demand (precisely the derived demand) for industrial space, supply is affected by demand.

Hillier Parker (1985, 1986 cited by Thompson and Tsolacos, 1999) suggested that industrial rent can be determined and forecasted by demand-side proxies which include the volume of manufacturing output, level of manufacturing employment and volume of industrial production.

Several studies employ a demand-supply framework to examine pricing and rental changes of industrial space. In the empirical study of the Dallas/Fort Worth industrial property market, Atteberry and Rutherford (1993) shows that monetary base (a proxy for demand for industrial real estate through its effect on firms' cost of capital), industrial building construction (a proxy for supply, capturing investors' perception of future industrial capacity) and past industrial real estate prices each Granger-cause changes in current industrial real estate prices. The result also indicates that the industrial property market may not be efficient in that current prices do not fully reflect past publicly available information. In their building of a commercial rental value prediction model, McGough and Tsolacos (1995) also suggested that current and future changes in industrial rents are influenced by past changes in their rental values. These findings were further supported by the RICS study of the determinants of industrial rental values (RICS, 1994). At the national level, all lagged demand-side variables proxies: rental level 1 year ago, manufacturing output 1 year ago and contemporaneous GDP growth rate exert positive influence on the current level of industrial rents; except rental level 2 years ago which was a negative influence. As concluded by the study, this may be taken as representing the importance of non-industrial occupiers (such as distribution and low-grade services) in the industrial market. On the other hand, change in construction starts 2 years ago (a supply-side proxy) has negative impact (RICS, 1994, p.46). At the regional level, rental level (1 year ago), manufacturing employment and regional GDP (1 year ago) are strong positive demand side variables. On the supply side, both the total stock (2 years ago) and construction starts (2 years ago) appear as negative influence on rental levels though the magnitude of impact is not strong. The results suggest that regional industrial markets are demand-driven with substantial variations in the supply-side response to demand (RICS, 1994, p. 50).

Recognizing the dual role of real estate as a factor of production and an asset, Dobson and Goddard (1992) developed a model in which prices and rents adjust to equate demand (buyers and tenants) and supply (sellers and landlords). Result shows that changes in employment and house price have strong positive effect on the price and rent for industrial properties while real

interest rate exerts negative impact. The negative relationship between industrial property price and the interest rate (represented by industrial capitalization rate and prime rate) was also confirmed by Fehribach et al (1993).

Thompson and Tsolacos (1999) carries out an empirical study of industrial rent determination at the aggregate level in Britain. Two macroeconomic time series - GDP and manufacturing employment quarterly data are used to proxy demand influence, while the absorption rate of industrial floorspace is used to capture supply influence. Lagged industrial rents are also included as an explanatory variable. The real industrial rent model is given by the below equation:

$$\Delta 1RENT_t = \alpha_0 + \sum\alpha_{1i}\,\Delta 1GDPt\text{-}i + \sum\alpha_{2i}\,\Delta 1EMP_{t-i} - \sum\alpha_{3i}\,\Delta 1VAC_{t-i} + \sum\alpha_{4j}\,\Delta 1RENT_{t-j} + \varepsilon_t$$

for i = 0, 1 … I and j = 0, 1, … J.

where Δ1 signifies the first difference operator; RENT is an index of national industrial rents adjusted for inflation using the GDP implicit price deflator series and $RENT_{t-j}$ represents past changes in actual industrial rents; GDP is the volume of the gross domestic product; EMP is manufacturing employment; VAC is the level of industrial floorspace vacancy and Δ1VAC represents the absorption rate. t – i and t – j denote lags and I and J maximum lag lengths.

The result shows that all these variables except manufacturing employment, particularly their lagged rather than contemporaneous changes, are significant in explaining rental changes. Depending on the type of rental index (two indexes has been used: Jones Lang Wootton Index and CB Hillier Parker Index) used, GDP changes lagged 2 to 6 quarters; absorption rate lagged 5 to 7 quarters and past actual rent changes lagged 1 to 2 quarters are found to be influential. In addition, changes in real rents are positively related to changes in real GDP and past real rents but negatively to absorption rate. As the information contained by the EMP variable about changes in demand for industrial space is captured by the GDP series, EMP's explanatory power is greatly undermined and becomes insignificant.

White et al (2000) developed a time series econometric model of both demand and supply-side variables for property rental determination in Scotland, Great Britain, London and the South East of U.K.. In case of industrial properties, proxies for demand variables include manufacturing employment, lagged rent (one year ago) and GDP while lagged new construction orders (one year ago) are proxies for supply variables. The OLS model indicated that lagged rent and GDP are significant in all regions. Manufacturing employment has a significant impact in all areas except Great Britain while lagged new construction orders only affect (and negatively) rents in Scotland. Difference in the local economic/market conditions across these regions may be the reason for the different role played by the demand-supply variables in determining the rents.

Empirical Model

At any point in time the demand function is

Qd = fd (Demand-side factors, IPP)

where Qd is quantity of industrial property demanded and IPP is industrial property price and the supply function is

Qs = fs (Supply-side factors, IPP)

where Qs is quantity of industrial property supplied and IPP is industrial property price.

Equilibrium implies that

Qd = Qs = Qe

Substituting this into the supply and demand function yields the following reduced form equation which express equilibrium industrial property price (IPPe) as a function of supply-side and demand-side factors

IPPe = *f*(Demand-side factors, Demand-side factors)

To operationalize the above model for empirical estimation, the functional form needs to be specified. For simplicity, We have assumed a linear model, which can be estimated using time-series data.

Variables in the model

The observed industrial price index for private flatted factories (DP) is taken as a measure of the equilibrium price level and is therefore included as the dependent variable. Since previous studies show that it is probable for property price or rent to have frictional response to the changes in the explanatory variables, time lag effect will be incorporated. For each explanatory variable, both contemporaneous and lagged changes will be considered. However, since the maximum lag length and the most significant lag for each explanatory variable cannot be determined *a priori*, it will be estimated by referring to previous studies (particularly those in Hong Kong) and by trial and error. Following RICS study (RICS, 1994) and Thompson and Tsolacos (1999), it is assumed that a period of two years in the past provides a sufficiently long time horizon for price movements to reflect the effects of different explanatory variables. The use quarterly data in this study means that the maximum lag length is up to eight periods.

The review of previous industrial pricing and rental determination models overseas identifies several common variables used to proxy the demand for industrial space. With specific consideration of the manufacturing restructuring and government industrial land use policy changes and with reference to previous research in other property sectors, twelve demand-side variables which are hypothesized to affect the industrial price will be incorporated into the model specification. They include Re-export (REV), Manufacturing Sector Employment (PS), Service Sector Employment (SS), Industrial Production (IP), Interest Rate (RI), six major industrial land use policy changes (F1, F2, F3, F4, F5 and F6 as dummy variables) and Lagged Price Changes Effect (AR(1) [1]). These demand-side variables reflect the broad trends and

[1] This abbreviation AR(1) derives from the fact that the autoregressive of order one model or AR(1) model in the EViews can be used to reflect the impact of the recent past industrial prices (i.e. lagged price changes) on the current industrial prices changes.

development of the economy and the characteristics of the industrial property market, thereby capturing the overall demand for industrial space. As for the supply-side variable, Supply of Private Flatted Factories (YS) will be incorporated. Definitions of the demand-side and supply-side variables are summarized in the following Table.

Definition of variables

Variable	Definition	Data
DP	**Industrial Price**	Industrial Price Index for Private Flatted Factories
REV	**Re-export Volume**	Re-export Quantum Index
PS	**Manufacturing Sector Employment**	Number of Persons Engaged in Manufacturing Sector
IP	**Industrial Production**	Industrial Production Index
SS	**Service Sector Employment**	Number of Persons Engaged in Manufacturing Related Service Sectors
RI	**Interest Rate**	3-month Hong Kong Dollar Interbank Offered Rates (Hibor)
F1	**Industrial Land Use Policy Revision in December 1990**	Dummy Variable (Q1 1991 & onwards = 1, 0 otherwise)
F2	**Industrial Land Use Policy Revision in July 1992**	Dummy Variable (Q3 1992 & onwards = 1, 0 otherwise)
F3	**Industrial Land Use Policy Revision in October 1993**	Dummy Variable (Q4 1993 & onwards, 0 otherwise)
F4	**Industrial Land Use Policy Revision in January 1994**	Dummy Variable (Q1 1994 & onwards, 0 otherwise)
F5	**Industrial Land Use Policy Revision in September 1997**	Dummy Variable (Q4 1997 & onwards, 0 otherwise)
F6	**Industrial Land Use Policy Revision in September 2001**	Dummy Variable (Q4 2001 & onwards, 0 otherwise)
AR(1)	**Lagged Price Changes Effect**	Autorgressive of Order One or AR(1)
YS	**Supply of Private Flatted Factories**	Total stock of industrial properties at year end

Expected Signs of Coefficients of Independent Variables

Re-export Volume (REV)

Given the export-oriented nature of the industrial sector, an increase in re-export not just indicates an increase in demand for manufactured goods and services but also a favourable economic condition for the manufacturing sector. As industrial space is a factor of production in the industrial sector, a higher demand for manufactured goods and services will directly lead to a higher demand for industrial pace. This will, in turn, drive up the industrial price level, particularly in the short-run when supply is largely inelastic. As such, the independent variable of re-export quantum index is expected to have a positive sign of coefficient.

Manufacturing Sector Employment (PS)

The number of persons engaged in the manufacturing industries is a measure of economic activities in the manufacturing sector. The larger the number of person employed, the larger the industrial space required *ceterus paribus*. The study by Lockwood and Rutherford (1996), Buttimer et al (1997), Dobson and Goddard (1992), Thompson and Tsolacos (1999) and White et al (2000) all indicated a significant and positive relationship between industrial rent or

price and the manufacturing employment. Therefore manufacturing employment should have a positive impact on industrial prices and so it is expected to have a positive sign.

Industrial Production (IP)

Industrial production index together with re-export and manufacturing employment constitute the key components of the derived demand for the industrial space. Therefore, similar to the above two explanatory variables, IP is expected to have a positive relationship with industrial price. The positive role of manufacturing output or industrial production is also confirmed in the study of the industrial rents by Hillier Parker (1985, 1986 cited by Thompson and Tsolacos, 1999) and RICS (1994).

Service Sector Employment (SS)

The influence of the service sector employment on industrial price should be similar to that of the manufacturing employment except that the former exerts an indirect rather than direct impact on the demand for industrial space. This is particularly the case as the industrial space demand derived from the related service sectors is affected by such factors as changes in the office rentals/prices and the pace of relaxation of the permitted commercial uses in the industrial buildings. Despite this indirect relationship, *ceterus paribus*, an increase in related service sector employment will increase the demand for industrial space, driving up the industrial price level. The sign of SS is, therefore, expected to be positive.

Interest Rate (RI)

The relationship between interest rate and industrial property price is expected to be a negative one. This negative relationship has been widely studies and shown in the previous research. In the residential property market, Harris (1989) showed that effect of real interest rate on housing prices is strong and negative in the U.S.. This is echoed in the findings of Chau and Lam (2001) and Peng (2002) which show that housing prices are negatively affected by rising real interest rates in Hong Kong. Similarly, in the industrial property market, both Dobson and Goddard (1992) Fehribach et al (1993) found significant negative relationship between industrial property price and interest rate.

Industrial Land Use Policy Revisions (F1 – F6)

Since the inception of the industrial-office concept in the late 1989, the Government had gradually changed and relax the regulations about the use of industrial buildings. Each policy revision introduced an added flexibility in the use of industrial properties. As such, with incremental flexibility, each policy change is expected to have a positive impact on industrial property price thus a positive coefficient for all dummy variables.

Lagged Price Changes (AR(1))

While Atteberry and Rutheford (1993) found negative relationship between lagged industrial prices and current prices, both Thompson and Tsolacos (1999) and White et al (2000) confirmed a positive relationship. As such, the influence of lagged price changes on current price changes may not be

straight forward and fixed. However, due to high transaction costs in property transactions and the relative sluggish of industrial property price to shocks, we expect that a relationship between lagged price changes and current price is likely to be positive.

Supply of Private Flatted Factories (YS)
An increase in the supply of industrial properties should have a negative effect on prices, *ceterus paribus*. A shortage of industrial space usually causes prices to rise because of competition among buyers, while an oversupply may lead to a decline in prices due to higher vacancy rate and reduced competition. It is, therefore, expected that supply has a negative relationship with industrial property prices and will be negatively signed in the result.

The expected signs of all independent variables are summarized below

Summary of Expected Signs of Coefficients of Independent Variables

Variable	Expected Sign
REV	+
PS	+
IP	+
SS	+
RI	-
F1	+
F2	+
F3	+
F4	+
F5	+
F6	+
YS	-

Period of Observation
The data used in this study is restricted to the period between 1982 and 2004, totalling 23 years. It is the longest time period within which full data sets are available for all selected variables. Quarterly data from 1982 Q1 to 2004 Q4 are used as majority of the data are in quarterly figures. More importantly, this enables large enough sample size for efficient OLS process. In order to obtain the complete data set, monthly and yearly figures of some variables will be adjusted to quarterly basis.

Description and source of data

All the data employed in the empirical analysis are publicly available and collected from various authoritative sources - government websites and official publications.

Industrial Price (DP)
The quarterly Industrial Price Index for Private Flatted Factories (1989 = 100), the proxy for Industrial Price, is compiled by the Rating and Valuation Department (RVD). This index is designed to measure price changes with

quality kept at a constant by making reference to the factor of price divided by rateable value of the property rather than to the price per square meter of floor area. The index is derived from the average prices on an analysis of transactions scrutinised by the RVD for stamp duty purposes (RVD, 2006). Over the period of the study, since the indices spread over two data series with different base year (1989 = 100 and 1999 = 100), adjustment has been made to standardize the data to the same base year of 1989. The data are sourced from "Hong Kong Property Review", both annual reports and monthly supplement from various years, published by the RVD.

Re-export Volume (REV)

The Re-export Quantum Index (2000 = 100) is used to measure the re-export trade in Hong Kong. It is compiled by the Census and Statistics Department (CSD) based on information contained in import/export declarations. This quantum index also includes Hong Kong's merchandise trade with the mainland of China and measures the changes in volume of external merchandise trade (CSD, 2006 website). Since the indices are in monthly figures, quarterly indices are then obtained by averaging the corresponding monthly data. The data are obtained from the official website of the CSD.

Manufacturing Sector Employment (PS)

Persons engaged in the manufacturing sector (excluding those in Civil Services), compiled by the CSD, are used as a measure of the manufacturing sector employment. The quarterly figures are collected from the CSD official website (2006).

Industrial Production (IP)

The industrial production in the manufacturing sector is measured by the Indices of Industrial Production (2000 = 100) compiled by the CSD. The indices reflect changes in the volume of local manufacturing output after discounting the effect of price changes. The price changes are measured by the producer price indices for manufacturing industries compiled from data on producer prices of industrial goods/services collected from the same survey (CSD, 2006 website). In other words, the price component has been taken care of and the index is a real data series. The quarterly index is sourced from the official website of the CSD (2006).

Service Sector Employment

As discussed, persons engaged in manufacturing related service sectors: 1) Transport, Storage and Communications; 2) Wholesale, Retail and Import and Export trades, Restaurants and Hotels are used as a measure of the service sector employment. Like the manufacturing employment, the quarterly figures exclude those Civil Services and are obtained from the CSD official website (2006).

Interest Rate (RI)

The 3-month Hong Kong Dollar Interbank Offered Rates (Hibor) is used as a proxy of the interest rate. The rate is at end of period and refers to the middle rate which is the average of bid rate and offered rate (CSD, 2006 website). The quarterly data are sourced from the official website of the CSD (2006).

Industrial Land Use Policy Changes (F1 – F6)

Being the qualitative variables, these policy changes are neither numerical nor easy to quantify. It is possible to include them into econometric models by what are known as dummy or dichotomous variables. It is assumed that each policy change may affect the industrial price in the month when it was introduced. As such, for the policy revision in December 1990, F1 represents the time series in which the first quarter in 1991 and all subsequent quarters are equal to 1, the quarters prior to Q1 1991 are 0. By the same token, other policy changes can be represented and defined by the following dummy variables:

- Policy revision in July 1992 - F2: representing the series in which Q3 1992 and all subsequent quarters are equal to 1, and 0 otherwise
- Policy revision in October 1993 – F3: representing the series in which Q4 1993 and all subsequent quarters are equal to 1, and 0 otherwise
- Policy revision in January 1994 – F4: representing the series in which Q1 1994 and all subsequent quarters are equal to 1, and 0 otherwise
- Policy revision in September 1997 – F5: representing the series in which Q4 1997 and all subsequent quarters are equal to 1, and 0 otherwise
- Policy revision in September 2001 – F6: representing the series in which Q4 2001 and all subsequent quarters are equal to 1, and 0 otherwise

Supply of Private Flatted Factories (YS)

The stock of private flatted factories at year end, compiled by the RVD, is used to proxy the supply of private flatted factories. The figure in a given year is compiled by adding completion and demolition during the year to the stock figure at the previous year end. According to the RVD (2006), stock figures are based on rating record, completions comprise those premises deemed completed by virtue of the issue of an occupation permit and demolition show rated private accommodation deleted during the year under review due to demolition. All these figures exclude public sector ones. Year-end stock figures are available from the RVD on a yearly basis (year end) only. For the purpose of this study, quarterly figures are estimated by linear interpolation between the available year-end figures.

Tests for stationarity and Data Transformation

As pointed out by Asteriou (2006), since nominal series incorporate a price component, comparison of two nominal variables becomes problematic. This is because the dominant price component in each will produce close matches between the series, resulting in a spuriously high correlation coefficient. Converting nominal series to real terms by using an appropriate price deflator can resolve this problem. Therefore, in this study, all variables will be expressed in real or quantity terms. As can be seen from the above data definition, the variables which require conversion include the industrial price index and interest rate. All other variables are already in real or quantity/volume terms. Implicit Price Deflator of GDP, compiled by CSD and available from its website will be used as the price deflator. However, since

this GDP deflator exhibits strong seasonality, the series has to be deseasonalize before use.

Logarithmic Transformation

Except the dummy variables and the time series for interest rate which is already in percentage term, logarithmic transformation will be applied to the time series for all dependent and independent variables (denoted as ln(Variable)). The reasons are threefold (Asteriou, 2006, p. 18-19). Firstly, many economic time series exhibit a strong trend and when this is caused by some underlying growth process, a plot of the series will reveal an exponential curve. In such cases, this exponential/growth component dominates other features of the series and may obscure the more interesting relationship between this variable and another growing variable. Taking the natural logarithm of such a series will effectively linearize the exponential trend. Secondly, as there is no prior knowledge about the functional form of the price determination model, a linear from is assumed. Logs are useful in this case as it can be used to linearize a model which is non-linear in the parameters. Thirdly, the transformation allows the regression coefficients to be interpreted as elasticities, since for small changes in any variable x, change in log x = relative change in x itself.

Stationarity and Differencing

As pointed out above, many economic time series exhibit a strong trend (i.e. a consistent upward or downward movement in the values), they are not stationary. Since presence of non-stationary series in a regression model produces spurious result, the test statistics cannot be interpreted in the usual manner. However, most time series data become stationary after taking first-order differencing i.e. they are I(1) (Chau and Lam, 2001). Differencing is generally denoted by the sign Δ. Augmented Dickey-Fuller test, is be used to test for stationarity. The results are shown below.

Augmented Dickey-Fuller Test Staistics

Variable	Notation	Level	1st difference
Industrial Price	Ln(DP)	-1.142832	-3.13211**
Re-export Volume	Ln(REV)	-1.89148	-10.72221*
Manufacturing Sector Employment	Ln(PS)	2.084726	-5.440208*
Industrial Production Index	Ln(IP)	-3.061431**	-13.53373*
Service Sector Employment	Ln(SS)	-3.176326**	-5.419647*
Interest Rate	RI	-2.914298**	-9.190683*
Supply of Flatted Factories	Ln(YS)	-2.388215	-2.638802***

* Rejects presence of a unit root at the 1% level, ** Rejects presence of a unit root at the 5% level, *** Rejects presence of a unit root at the 10% level

The above result shows that, except IP, SS and RI, all other time series requires the application of differencing in order to be stationary. To be consistent and to improve the significance level, first order differencing will also be applied to IP and SS. As for RI, in theory level should be used for interest rate which tends to be a stationary time series. This can also be gleaned from the fact hat the significance level only improves a little bit from

5% (at level) to 1% (at first difference form). Therefore, in this study, level will be used for interest rate time series.

After data transformations, the empirical model to be for estimation

$$\Delta_1 \ln(DP_t) = a_0 + a_1\Delta_1\ln(REV_{t-k1}) + a_2\Delta_1\ln(PS_{t-k2}) + a_3\Delta_1\ln(IP_{t-k3}) + a_4\Delta_1\ln(SS_{t-k4}) + a_5 RI_{t-k5} + a_6 F1_{t-k6} + a_7 F2_{t-k7} + a_8 F3_{t-k8} + a_9 F4_{t-k9} + a_{10} F5_{t-k10} + a_{11} F6_{t-k11} + a_{12}\Delta_1\ln(YS_{t-k12}) + a_{13} AR(1) + \varepsilon_t$$

where Δ_1 signifies the first difference operator; ln(Variable) signifies the natural log of the variable; and ki represent the number of lag for variable i

Results and Discussions

Some independent variables will have a lagged effect on industrial property prices. However, there is no theoretical basis to precisely determine the number of lagged periods. We have determined the lags empirically by maximizing the coefficient of determinations. The regression results are presented in below.

Result of Estimating the empirical model

Variable	Coefficient	t-Statistic	P-value
Constant	0.042817**	2.045587	0.0443
D(REV(-3))	0.118846**	2.22846	0.0288
D(PS(-1))	0.667166**	2.146466	0.0351
D(IP(-2))	0.095681**	2.008535	0.0482
RI	-0.006289**	-2.18156	0.0323
D(YS(-5))	-3.76489	-1.641824	0.1048
D(SS(-1))	0.623844***	1.93936	0.0562
F1	-0.016689	-0.923739	0.3586
F2	-0.009621	-0.419175	0.6763
F3	-0.004975	-0.175992	0.8608
F4	-0.028796	-1.111842	0.2698
F5	0.053192*	4.118905	0.0001
F6	0.045196**	2.324625	0.0228
AR(1)	-0.195014	-1.405086	0.1641
Dependent variable	$\Delta 1\ln(DP_t)$ (Real Industrial Price Index)		
No. of observations	89		
R-squared	0.579027		
Adjusted R-squared	0.506059		
F-statistic	7.93529		
P-value (F-statistic)	0.00000		

* Significant at the 1% level, ** Significant at the 5% level, *** Significant at the 10% level

All independent variable have the expected sign. However, only REV, PS, IP, SS and RI are significant. Though correctly signed, the YS is insignificant. This is likely to do with the inherent data problems. While the year-end stock is a good indicator of the net supply of completed private flatted factories in Hong Kong, it is not equivalent to a measure of the direct impact of new supply in the market since most new units are presold by developers. Further

more the duration between presale and completion vary significantly across developers and at different points in time. Therefore lagged year-end stock figures may not duly capture the actual timing of the supply.

Amongst the policy dummy variables, only F5 (1997) and F6 (2001) are significant. The coefficient of F5 is most significant amongst all policy variables. Its magnitude is also the largest. This suggests that the 1997 policy change has the largest impact on industrial property prices. The 1997 policy change includes relaxation of non-industrial use in industrial buildings and permit non-industrial use on the lowest 3 levels of I/O buildings. Non-industrial use in industrial buildings has been very common since the earlier 90's. Owners of industrial buildings faces the risks of financial penalty if such used are discovered by the Land Department. The 1997 policy change was in fact a "retrospective" approval of the some existing non-conforming uses in the industrial buildings and thus removed some of the risks and this lead to increase in industrial property prices. Such changes also relieved the workload of Lands Department. The permission as of right the commercial uses on the lowest 3 floors within I/O buildings also had an significant effect on industrial property prices. Unlike the non-conforming uses on the upper floors, commercial uses has a much higher value than industrial use, however in the lower floors can be easily being spotted and thus there are comparatively fewer non-forming uses on lower floors, particularly on the ground floor. As such, this revision greatly increasing the value of I/O buildings and in turn the industrial buildings which can be converted to I/O type upon successful application. The 1997 policy change has in essence injected a uncertain real option into the industrial properties, which can be exercised by paying a premium for conversion to I/O buildings.

The coefficient of F6 is the second most significant coefficient. The size of the coefficients of F5 and F6 do not different from each other significantly. The variable F6 represent policy revision in 2001 which allowed conversion, as of right, industrial use to industrial/office (I/O) use. While F5 brings about a drastic change by injecting an uncertain real option, F6 removes much the uncertainty completely.
Other policy variable are insignificant as they represent incremental relaxation of restriction of non-industrial use in industrial buildings.

Conclusion

This study provide some insights into the price dynamics of the industrial property market and the effect of economic restructuring on industrial property prices, filling a major gap in the industrial property market research.
The positive impact of re-export volume on industrial property price indicated that industrial property has been used as backup service for the production manufacturing good in China. These used are non-confirming uses that were not allowed. The economic reform in China led to a decline in demand of industrial buildings for production use. However, there has not been a forward looking adjustment in land use planning in Hong Kong. Most of the policy changes are incremental in nature until 1997. Policing the restriction

on use industrial building for non-industrial use is both costly and does not led to non-optimal land use.

The government's industrial land policy has also been adjusted many times during the process of economic structuring in Hong Kong. All the adjustments before 1997 are incremental in nature. Our study suggests the policy changes in 1997 and 2001 have the strongest positive on industrial property prices. The former provided more flexibility for use of industrial space which is equivalent to creating a real option value, though uncertain in nature, which can be exericed by property owners. The latter removes the uncertainty making the real option even more valuable.

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