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Deindustrialization and the Changing Spatial Structure of Hong Kong, China

Abstract | Deindustrialization and the rise of the service economy have altered the urban landscape in many countries, and are generally associated with redevelopment in central cities and gentrification. This paper examines the spatial dimension of the transformation of the economic geography of Hong Kong at the turn of the 21st century, asking specifically how the relative centralization of employment and steepening of the bid rent curve has affected the residential location of different income groups. The Hong Kong case is noteworthy due to the speed of deindustrialization, the centralization of employment during this time period, and extensive urban growth due in part to the construction of public housing projects in outlying new towns. The paper describes changes in the distribution of jobs over space and sectors from 1986 to 2006, and analyzes the changes by distance to city center and at the neighborhood level using census, geographic, and administrative data for 150 neighborhoods. Wealth is found to be centralized though this centralization has declined. This decline stems more from an increase in incomes in outlying areas, however, than from a change in incomes in central parts of the city. Public housing plays an important role in limiting income change, as residents of public housing move infrequently, and government investments do not have a significant impact on neighborhood change at the scale measured. The implications for Chinese cities are explored in the conclusion.

Keywords | deindustrialization – neighborhood change – urban spatial structure – Hong Kong – China

Introduction

HONG KONG is a paradoxical entity. It is generally understood as an extremely free-market state; for example, the World Bank's *Doing Business* study ranks it as second easiest place to do business in the world (2010). Yet in many areas, especially land and urban management, it is extremely highly regulated. The government owns all of the land except for one parcel, and while the practical workings of the leasehold system are not very different from a freehold one, new

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land development is constrained by decisions by the government on when and where to release land. Moreover, almost half of the city's population lives in public housing, much of which is located in new towns developed by the government.

Hong Kong at the turn of the 21st century is an important case for exploring urban spatial structure and neighborhood change for many reasons. Unlike other heavily regulated land markets, the urban spatial structure of Hong Kong fits the monocentric city model quite well. Employment is centralized and housing units are less heterogeneous than in most Western cities; the vast majority of the population lives in high-rise apartment buildings, a relatively homogenous housing stock with minimal variation in land area. With deindustrialization, the share of employment located in the center of the city has increased. Concurrently, the bid-rent curve for residential space, the rate at which price declines at greater distances from the city center, has been found to have steepened during this period (Monkkonen, Wong, and Begley 2011).

The city is also notorious for continuous redevelopment—in the mid-1990s it was estimated that half of new private housing came from redevelopment (PELB 1996). The government of Hong Kong has also supported urban redevelopment projects through several agencies that engage in public-private partnerships. Agencies like the Urban Renewal Authority continue to operate in spite of a recent rise in public protests over redevelopment projects, due to an increasing sensitivity to historic preservation.

Given the relative similarity of housing stock across the city, the high cost of residential space, and the dominance of mass transit, perhaps it is not surprising that high-income households outbid low-income households for more centrally located land. Median household incomes decline at about 2 percent for each kilometer of distance from the city center. Moreover, given that there is no variation in public services or tax rates as in some countries, most notably the United States (Tiebout 1954), because the territory is governed by only one body, these are not factors in decisions about residential location.

Recent changes in the economy of Hong Kong during the two decades allow for reflection on the urban spatial impacts of deindustrialization in a recently industrialized country. Hong Kong's manufacturing jobs recently shifted to the nearby Pearl River Delta region of China, and there was a concurrent growth in the financial and producer services sector. Yet the nature of deindustrialization was quite different from Western countries, as the city had only recently industrialized. Thus, employment in manufacturing was not well-paid and was located in the middle-ring of the city's new towns.

The stylized facts presented in this paper show that with deindustrialization, an increasingly monocentric employment structure of the city, and a vast

growth of the city into previously peri-urban areas, the centralization of wealth diminished. Yet, this change does not indicate a suburbanization of high-income households. Rather, as empirical analysis in this paper shows, the decline stems from changes among the low-income and middle-income groups, and major changes in areas located farther from the city center more than a decrease in incomes in inner-urban areas. The highest income neighborhoods in the city were located within five kilometers of the city center in 1986 and still are today. In fact, in spite of significant changes within the city, neighborhood income levels are quite sticky; the correlation between median incomes in 1986 and 2006 is 0.8.

This empirical analysis of the changes in the socio-spatial structure of Hong Kong and the city's economic geography also contributes to the international literature on gentrification and neighborhood change. One of the deficiencies of this international literature on redevelopment and gentrification is that comprehensive data and a broad understanding of urban spatial structure outside the United States is often lacking (Carpenter and Lees 1995; He 2007; Shin 2009). Additionally, explicit consideration is given to government redevelopment projects in the model of neighborhood change. They are not found to have limited and counterintuitive effects at the geographic scale analyzed. Public housing is also found to play an important role in limiting neighborhood change in Hong Kong. As residents of public housing do not pay market rents and move infrequently (Lui and Suen 2010; Hui and Lam 2005), they limit the impact of otherwise fairly frequent redevelopment.

The paper is organized as follows. After a short review of literature on deindustrialization, urban spatial structure, and neighborhood change, the recent history of Hong Kong in these areas is presented. Then, the neighborhood level data are described and analyzed using density gradients and a simple model of neighborhood change. The conclusion offers a summary and recommendations for further work in this area.

Spatial structure and neighborhood change in Hong Kong

Urban spatial structure is generally understood in terms of the relative centralization or decentralization of jobs and people at a large scale—job or population densities in different parts of the city—as well as how clustered or dispersed activity is at a smaller scale (Anas, Arnott, and Small 1998). The monocentric city model, developed in successive work by Alonso (1964), Muth (1967), and Mills (1969), provides the standard theoretical framework for explaining this structure, and the location of households of different incomes relative to the city center. The assumptions of the model—especially that all work

is carried out in the center of the city and all housing units consume an identical amount of land—have been rightly criticized as unrealistic in most cities. Yet Hong Kong is perhaps one of the places they still hold most strongly. In 2006, one quarter of the city's jobs were located in the two central districts, Central/Western and Wan Chai, which extend less than two miles from the central metro station. Additionally, the difference in the amount of land used by a residential tower built for low-income public rental housing or a high-income estate is minimal.

One of the important insights of the monocentric model is an understanding of the two competing factors that influence where high- and low-income households locate relative to the city center. These two factors are commuting costs (t) and the consumption of land for housing (q). The ratio of the two t/q is theorized to determine the slope of the bid-rent curve, the rate at which demand for land falls at greater distances from the city center. The model was initially used to explain the seemingly counterintuitive spatial structure of US cities, where high-income households lived in the urban periphery in spite of the fact that the value of their time, and thus commuting cost, was high.

Yet, the model later was argued to be inadequate to explain the large differences in location of high- and low-income households found in cities around the world (Brueckner, Thisse, and Zenou 1999; Wheaton 1977) In most European and Latin American cities, for example, high-income households live closer to the city center than low-income households (Hohenberg and Lees 1986; Ingram and Carroll 1981). Other theoretical modifications have been put forward to explain this discrepancy, such as a model that incorporates a consideration of amenities in the bid-rent curve and assumes high-income households have a higher preference for them. Yet in Hong Kong, the model is sufficient if we consider that the amount of land used to provide housing in high-rise buildings does not differ much between low- and high-income housing. In that case, the ratio t/q is dominated by the numerator, commuting costs, and the higher value of time explains the residential location of high-income households.

Hong Kong is an ideal case study of urban spatial structure because it fits the monocentric model well, and because in a short period of time it experienced rapid economic restructuring and expansion of its urban area. Moreover, the government is generally understood as following *laissez-faire* principles, but has and continues to play a large role in the spatial development of the city. As a so-called property state, the government of Hong Kong draws a non-trivial share of revenue from selling leases on land, of which it is the sole owner (Haila 2000). In addition, the government shapes urban development through public housing led new town development, investment in transportation infrastructure, and support of urban redevelopment projects.

It is perhaps ironic that a city whose Territorial Development Strategy outlined a plan for the creation of new towns that would have a balance of jobs and housing (Dimitriou and Cook 1998), never achieved the policycentric form of US metropolitan areas, where “edge cities” with suburban office parks (Garreau 1991) have drawn a large share of employment out of the central urban area for the last half decade. Yet it is the relatively monocentric form of Hong Kong might actually be more efficient, especially given the reliance of the city’s population on public transit. The potential problem of the development of new towns without employment is that they diminish the employment opportunities of their residents, especially those in public housing (Lau 2010).

In spite of challenges to redevelopment due to the prevalence of multi-owner properties, which have inherit anti-commons problems (Hastings, Wong, and Walters 2005), Hong Kong is notorious for continuous piecemeal redevelopment of its central urban area. The government is pro-growth and despite its *laissez-faire* ideology, has been directly involved with urban redevelopment projects for many years (Ng 2002). Nonetheless, and while the government did play a fundamental role in directing urban growth through the history of the territory, its participation in urban redevelopment from the 1960s until the 1990s was characterized as minimal or ad-hoc (Ng 1998). In 1988, the Land Development Corporation (LDC) was created with the directive of facilitating redevelopment through partnerships with private sector developers (Ng 1998). It was intended that the LDC become a self-funding entity, although it did not actually possess powers of land resumption. Thus, an ambitious program was limited to redevelopment of less than a dozen sites. By the mid-1990s, significant public criticism of the LDC and the paucity of successful projects led to a proposal for its reform in 1997, and in 2000 the corporation became the Urban Renewal Authority (URA) (Adams and Hastings 2001). The core function of the organization did not change, but its purview was expanded into areas of rehabilitation and revitalization.

The recent period of government involvement in redevelopment has been grouped together with entrepreneurial strategies of other Asian megacities like Tokyo and Singapore that place an emphasis on urban revitalization to attract high-skilled international service sector workers (Murakami 2010). Projects such as the new airport express train, the central mid-levels escalator, and numerous smaller redevelopment projects have been argued to represent efforts to make central areas of the city more user-friendly for the creative class. Additionally, there have been several public-private partnership projects with the Metropolitan Transportation and Railways Corporation (MTRC) in a ‘Rail + Property’ model of urban development and redevelopment, which combines expansion of metro systems with retail, commercial and residential property development on the sites of new stations (Tiry 2003; Cervero and Murakami, 2009).

Not only is Hong Kong unlike Western cities in that redevelopment has been common for decades, it is also distinct in terms of the length of its urban development history (Yeh 1997). Unlike cities with inner urban areas dating back to the beginning of the 19th or even then end of the 18th century, where redevelopment was delayed for many decades (Hackworth and Smith 2001), the majority of Hong Kong's economic and urban growth has been relatively recent. Recent data from the Home Affairs Department show that 25 percent of the city's buildings were built in the last 20 years, and almost half in the last 3 (Home Affairs Department 2010). This fact, combined with the city's small land area, high population density, and lack of a strong tradition of historic preservation regulation¹ has led to a place where redevelopment has been almost continuous.

Major changes in the economic geography of Hong Kong between 1986 and 2006

Before a detailed analysis of neighborhood change, two broad and concurrent shifts in Hong Kong's economic geography merit empirical attention; rapid deindustrialization and the decentralization of the city's population into the New Territories. In order to understand the geography of the city, a map of Hong Kong is presented as Figure 1, indicating the main urban areas of Hong Kong Island and Kowloon, and the more recently developed area of the New Territories. The figure also highlights the fact that a small share of the total land area of Hong Kong is actually urbanized (roughly 200 kilometers of the territory's 1,000).

The decentralization of Hong Kong's population into the New Territories occurred rapidly during the 1980s and 1990s. Over half of the city's population lived in the Kowloon region in 1981 and less than a quarter lived in the New Territories. By 2001, these proportions had almost flipped with half of the population living in the New Territories and 30 percent living in Kowloon. The share of the population living on Hong Kong Island decreased only slightly during this time period.

This decentralization of the population and residential expansion into the New Territories occurred as Hong Kong rapidly lost manufacturing jobs. In 1986, 42 percent of all employment was in manufacturing in 1986, while by 2006 this had dropped to only seven percent. Figure 2 shows the changes in the relative importance of different employment sectors in the city. As manufacturing jobs decreased in importance, transport, storage and import/export sectors

1 The Commissioner for Heritage's Office was established in 2008.

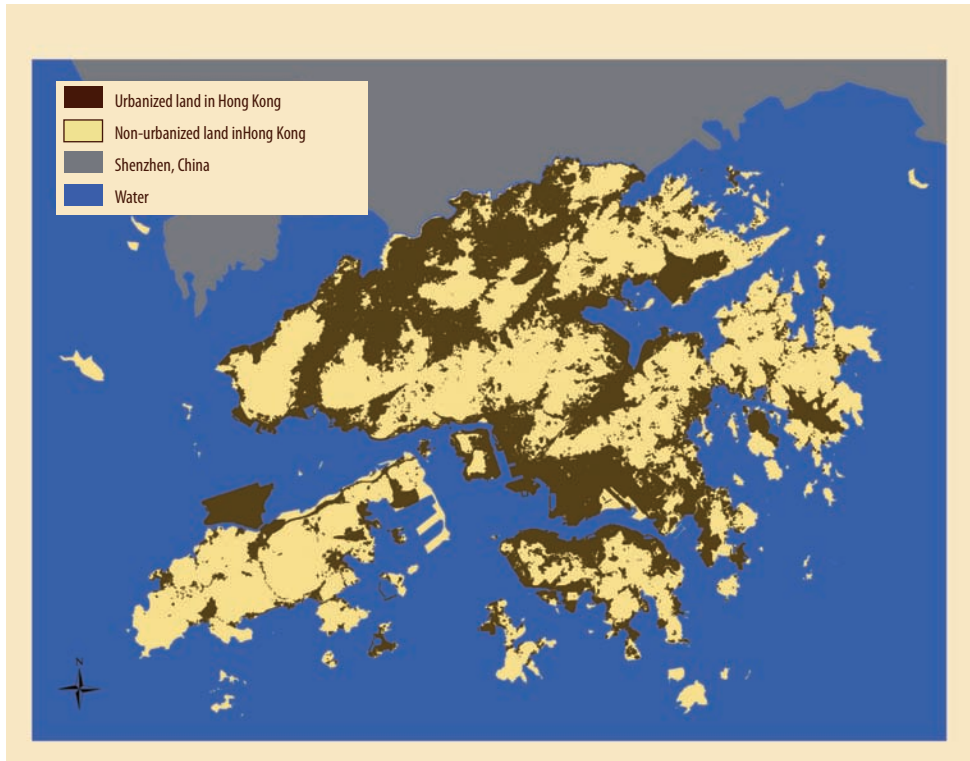


Figure 1. Map of Hong Kong with Three Major Regions and Urbanized Land in 2007.

Source: Planning Department 2007.

saw large increases in the number and share of jobs. Additionally, there was an expansion and consolidation of the financial services industry in the city, jobs in business services went from nine to 20 percent of total employment between 1986 and 2006.

Although it is not evident from these rough data, the deindustrialization process in Hong Kong was quite different from that of cities in Western countries or even in more established Asian economies like Japan. On account of the proximity of Hong Kong to the Pearl River Delta region of China, now the largest manufacturing area of the world, a large number of jobs in producer services were created to support industrialization nearby (Tao and Wong 2002). Some aspects of the labor market impacts of this change have been analyzed by sociologists, who confirm that the economic changes are associated with increasing inequality and those jobs related to China have been more successful (Chiu and Lui 2004; Lui 2009). Yet the spatial dimension of these changes has not received much attention.

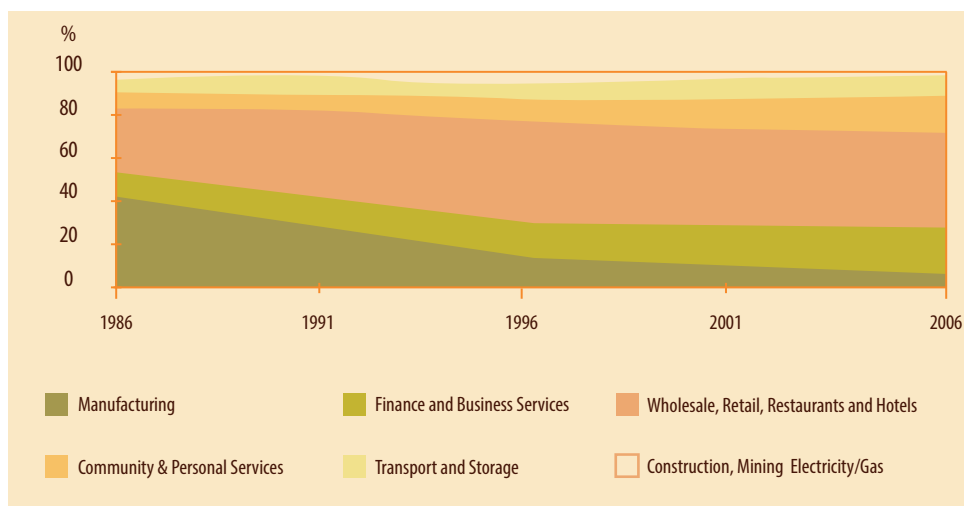


Figure 2. Share of Jobs by Sector, 1986-2006.

Source: HKSAR 2007b.

One exception is an analysis by Forrest, La Grange, and Yip (2004) who argue that relatively little of the broad patterns of the city's socio-spatial structure have changed since the mid-20th century and that while the city is very unequal, there is limited socioeconomic segregation. Although this is true when analyzed at a large geographic scale, a recent analysis using geographic units that correspond in population size to census tracts in the United States finds that socioeconomic spatial segregation in Hong Kong is found to be of a similar level to that of US cities. Surprisingly, however, in spite of increasing income inequality in Hong Kong between 1991 and 2006, the level of socioeconomic spatial segregation did not increase (Monkkonen and Zhang 2011).

Although manufacturing jobs were spatially concentrated in the different areas of Kowloon, especially the districts of Kwai Tsing and Kwun Tong, the change in the location of jobs was slightly less dramatic than the change in sector. Many of the producer services jobs mentioned above are located in the same areas. Nevertheless, given the significant growth of employment in the financial services sector, there was an increase in the share of employment in the central area of Hong Kong. In fact, the number in the Central/Western district almost doubled between 1991 and 2006 and it became the district with the most employment in the city, with roughly 13 percent of all jobs.

Given the trends of population expansion into the formerly peri-urban areas of Hong Kong and the growth of jobs in the central part of the city, it is no surprise that the average jobs-housing ratio across the districts of Hong Kong has

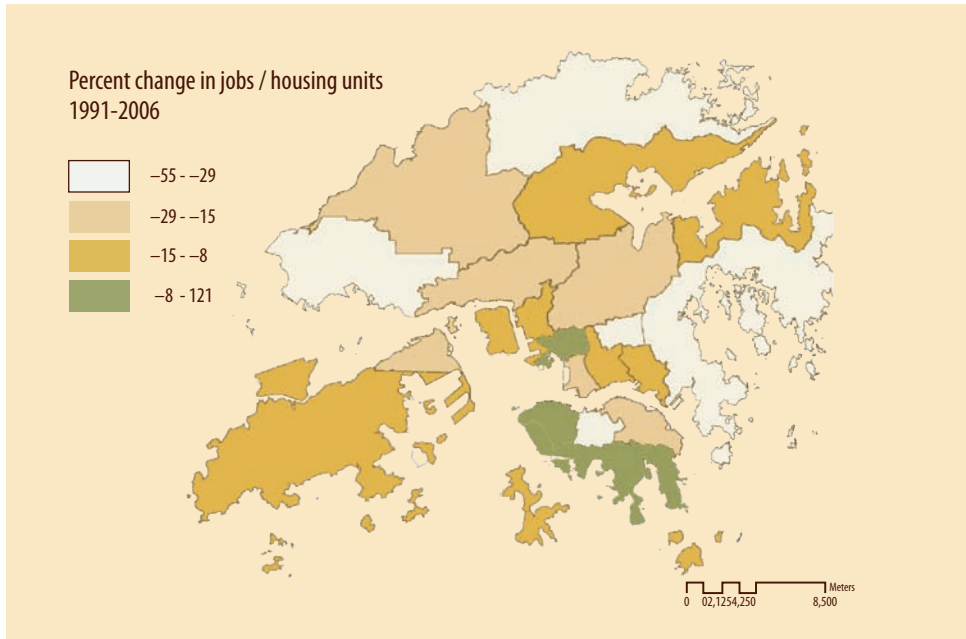


Figure 3. Change in Jobs / Housing Units Balance by District, 1991-2006.

Source: HKSAR 1992a, 2007a and 2007b.

decreased. A jobs-housing ratio is metric to measure the balance between employment and housing in a region (Cervero 1989). It is especially relevant in the Hong Kong context as the city's expansion occurred in new towns that were intended to be relatively self-contained (Dimitriou and Cook 1998). The average jobs-housing measure across the city's 18 districts decreased between 1991 and 2006, with only 6 having a ratio of greater than 1.3. In order to visualize the change in the jobs-housing ratio across the city, Figure 3 depicts the percent change between 1991 and 2006.

The significant drop in the jobs-housing ratio in the New Territories districts is mostly attributable to a change in the denominator. Nevertheless, this presents an important challenge for Hong Kong and there have been arguments of spatial mismatch in the peri-urban residential areas developed during the 1990s in the New Territories (Sui 1995; Lau, 2010). Given the trend of employment centralization, it is perhaps not surprising that housing prices increased by a greater degree in more centrally located areas during the period of price appreciation between 2003 and 2008 (Monkkonen, Wong, and Begley 2011).

At the district level, there is a high negative correlation (-0.6) between share of employment in manufacturing in 1991 (the oldest date for which consistent

data are available) and the percent change in the number of jobs between 1991 and 2006. The total number of jobs generally decreased slightly in districts in which manufacturing was concentrated.

Lastly, Hong Kong's political re-unification with the People's Republic of China should not be overlooked, as integration the city of Shenzhen, which is located immediately across Hong Kong's northern border, and the greater Pearl River Delta Region is one of Hong Kong's pressing spatial policy areas (Sit 2009). There has been a steady increase in the number of cross border trips, from 22 million in 1986 to 115 million in 2003 (Lin and Tse 2005). Detailed data on these cross border trips show that the vast majority are people who make trips infrequently—only three percent crossed more than once a week in 2002. Of the trips made by these more frequent travelers, slightly less than half are work related trips. Although there were more than 200,000 Hong Kong residents working in mainland China in 2003, almost 7 percent of the working population, most of these people did not make more than 50 trips per year (Lin and Tse 2005).

Neighborhood data and description

While it is clear from the rough numbers above that the city's economic geography changed, in order to understand the connection to neighborhood change more geographically detailed analysis is necessary. In this section, changes in the distribution of household incomes in 150 neighborhoods of Hong Kong are described.

Data

In order to analyze the question of neighborhood change, neighborhoods must be matched over time using a consistent indicator. With the cooperation of the Hong Kong Census and Statistics Department, data was obtained on the number of households in five income categories for the five year periods between 1986 and 2006, adjusted according to the consumer price index. Table 2 presents the nominal income categories for which data were obtained in the different years; clearly inflation was much higher during the 1980s and early 1990s.

These income data were obtained at a geographical scale referred to as the Tertiary Planning Unit (TPU), which are defined by the Hong Kong Planning Department and have been used as a neighborhood in previous analyses of Hong Kong (Forrest, La Grange, and Yip 2004). Although they contain too many people for detailed analysis of spatial segregation, they are adequate for a description of broad changes in the city's socio-spatial structure. For privacy considerations, TPUs with small numbers of residents are joined with others such that

Table 1. Nominal Household Income Categories HKD per Month, 1986-2006.

Year	Income Category (HKD per month)				
	1	2	3	4	5
1986	< 2,700	2,700 – 4,499	4,500 – 8,999	9,000 – 13,499	> 13,500
1991	< 4,200	4,200 – 6,899	6,900 – 13,899	13,900 – 20,799	> 20,800
1996	< 6,300	6,300 – 10,399	10,400 – 20,799	20,800 – 31,299	> 31,300
2001	< 6,200	6,200 – 10,299	10,300 – 20,599	20,600 – 30,999	> 31,000
2006	< 6,000	6,000 – 9,999	10,000 – 19,999	20,000 – 29,999	> 30,000

Source: HKSAR 1987, 1992, 1997, 2002 and 2007.

Table 2. Comparison of Geographic Boundaries for Census Data, 2001/2000.

Geographic Area	Households (thousands)			Area (km ²)		
	Mean	Median	SD	Mean	Median	SD
Tertiary Planning Unit (HK)	10.42	5.53	11.94	5.68	1.82	10.28
Census Tract (USA)	1.77	1.67	0.78	13.20	1.66	69.24

Source: HKSAR 2001; US Census 2000.

the roughly 300 TPUs into which Hong Kong is divided are grouped into about 200 by the census department for data tabulation purposes.

Although TPUs have been compared to census tracts, and the median size in land area of Hong Kong's TPUs is quite similar to that of a census tract in the United States, the extreme difference between population densities in Hong Kong and US cities means that TPUs contain a much larger number of people. Table 2 presents a comparison between TPUs and US census tracts. The median number of households is five times in Hong Kong as in the United States, and TPUs have much more variation in geographic and population size.

Before describing the spatial dimension of changes in income levels in Hong Kong, we first examine the changes in income categories over the years, and we impute a median household income for each TPU using the income category data given by the census in order to describe income levels across the city.² In order to create a consistent set of TPU boundaries over the 20 year period between 1986 and 2006, it was necessary to aggregate them in a consistent way, as the Census and Statistics Department releases tabulated data in different groupings for some areas. This procedure yielded 155 neighborhoods.

² Imputation is done by estimating the median income of a neighborhood using the coefficient from a regression of the cumulative percent of households according to each income category.

Table 3. Description of Neighborhood Data, 1986-2006.

Variable	1986	1991	1996	2001	2006
Households (thousands)	9.96 [14.34]	10.64 [15.47]	12.18 [17.33]	13.16 [19.09]	14.08 [20.60]
Median HH income (imputed)	17.57 [11.60]	21.36 [14.66]	23.47 [15.72]	26.10 [19.87]	25.63 [16.26]
% Low-income	0.21 [0.12]	0.16 [0.09]	0.14 [0.08]	0.15 [0.08]	0.15 [0.07]
% High-income	0.16 [0.19]	0.23 [0.21]	0.28 [0.21]	0.32 [0.21]	0.34 [0.20]
% Same address	NA	0.60 [0.19]	0.60 [0.17]	0.55 [0.16]	0.64 [0.14]
% Public housing	NA	0.36 [0.17]	NA	NA	0.31 [0.13]

Notes: Standard deviation in brackets. NA indicates not available.

Source: HKSAR 1987, 1992, 1997, 2002 and 2007a.

Table 3 reports descriptive statistics of these neighborhoods from 1986 to 2006, including median household incomes and the share of households that are low-income and high-income. Clearly, the major changes in incomes occurred during the 1986—1996 period, when the average neighborhood's median household income went up by about 35 percent and the percent of low-income residents dropped by the same degree.

Figure 4 presents a graphic of these income changes. This is not a complete picture of the changes in income dynamics of the population of Hong Kong, as there were significant increases in incomes at the upper end of the income distribution. Nevertheless, given that the data reported at the level of the TPU is only available in these categories, it is worthwhile to understand how their relative share has changed.

The notable shifts in the incomes presented in Figure 4 are the increase of the share of population in the highest income category and the decrease in the share of households in the middle income category. There was also a significant decline in the share of the population in the lowest income categories during the end of the 1980s and early 1990s though during the early 2000s the share of households earning less than 6,000 Hong Kong dollars³ (HKD) actually increased.

³ Exchange rates are 7.8 HKD for 1 USD dollar.

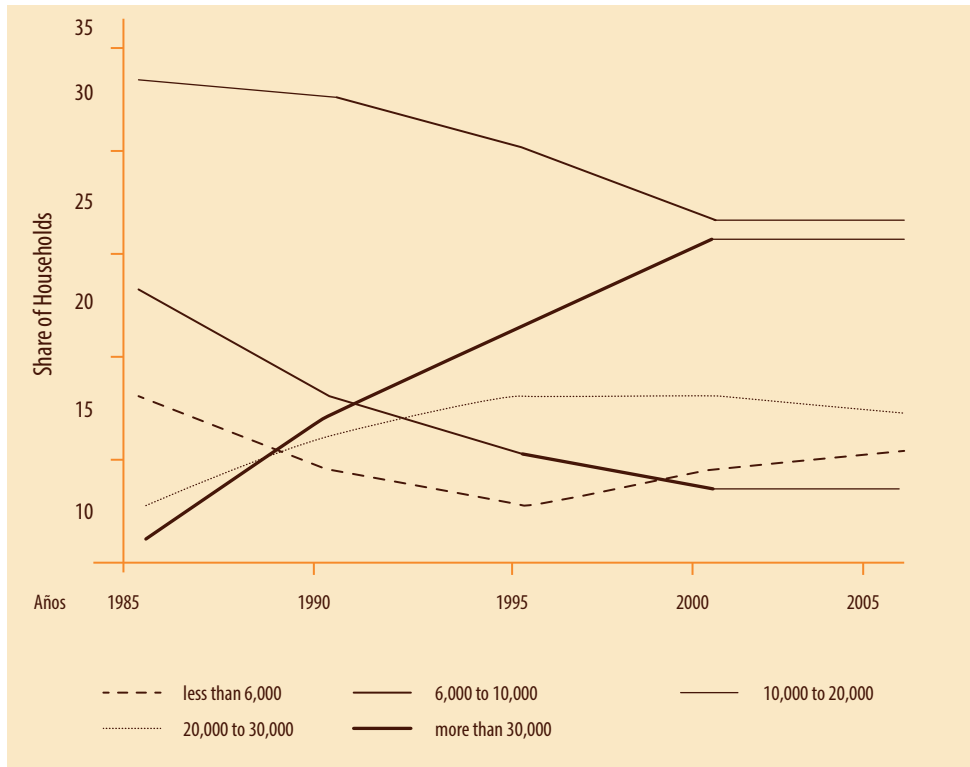


Figure 4. Share of Households According to Income Categories, 1986-2006.

Source: Authors with HKSAR 1987, 1992, 1996, 2002 and 2007a.

Description of neighborhoods

In this section, the spatial distribution of different income groups and other neighborhood characteristics are examined in relation to the city center. Figure 5 presents a set of scatterplots that show median household incomes, and the share of high- and low-income households in 150 neighborhoods by the kilometer distance of those neighborhoods to the city center in 1986 and 2006. The scatterplots also contain regression lines that demonstrate a significant increase in levels of income but only minor change in the relationship between income level and distance to city center.

Figure 5 also illustrates the importance of changes among low-income households among the overall changes in incomes, in addition to the positive distance gradient of the share of a neighborhood that are low-income. Moreover, the fact that changes in all three measures of income were much greater in the outlying parts of the city is also evident.

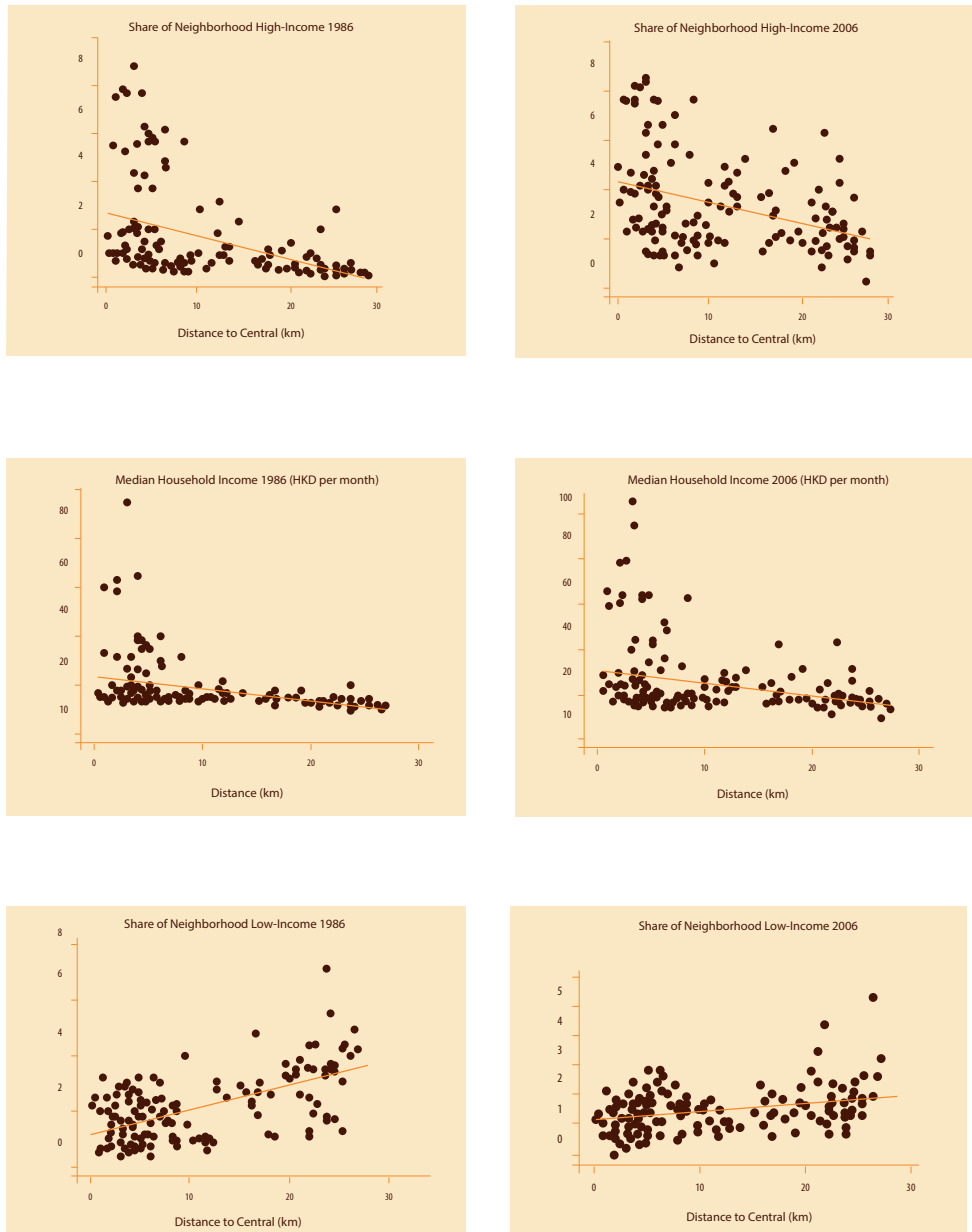


Figure 5. Median Income, Share of High- and Low-Income Households by Distance to City Center, 1986 and 2006.

Source: Authors with HKSAR 1987 and 2007a.

Table 4. Distance Gradients of Selected Neighborhood Characteristics, 1986 – 2006.

Dependent Variable	Gradients (Coefficient on Distance)		
	1986	1996	2006
Employment (log) ^a	-0.052 ^{*b}	-0.053 [*]	-0.047 [*]
Median HH income (log)	-0.024 [*]	-0.021 [*]	-0.019 [*]
Median HH income private hsg. (log)	-0.024 [*]	-0.022 [*]	-0.021 [*]
% HH high-income	-0.089 [*]	-0.086 [*]	-0.088 [*]
% HH low-income	0.058 [*]	0.039 [*]	0.030 [*]
Ordinal entropy (income diversity)	-0.091 [*]	-0.027 [*]	-0.006
Housing Unit Density (log)	-0.154 [*]	-0.145 [*]	-0.125 [*]

Notes: (a) Employment data are only available at the district level – there are 18 districts in Hong Kong.

(b) Employment data are not available in 1986 – this coefficient is from 1991.

* Denotes a statistically significant coefficient at the 0.01 level.

In order to compare changes more precisely, Table 4 presents distance gradients for several socioeconomic characteristics of the 150 neighborhoods in Hong Kong. The population and median income gradients are calculated according to the standard population density equation (Clark 1951; Bertaud and Malpezzi 2003), found below.

$$D(u) = D_0 e^{-\gamma u \varepsilon} \quad (1)$$

Where D is the population density, and in this case the median income, u is the distance from the city center, ε is the exponential function, and γ is the gradient, the rate at which density or median⁴ household income falls at greater distances from the city center. Thus, the coefficients for population density and median household income reported in Table 4 can be interpreted as the percent change in the dependent variable for each kilometer farther from the city center that a neighborhood lays.

The coefficients reported in Table 4 for the share of high- and low-income households were estimated using a log-linear regression model, where the percents were regressed on the log of distance to the city center. Thus, they can be interpreted as the decrease in the percent of high-income households, for example, for 10 percent one moves from the city center. Lastly, the ordinal entropy, which is a measure of income diversity in a neighborhood, is calculated using the methodology developed by Reardon and O'Sullivan (2004), and the following equation:

⁴ Editor's note: median represents the value of the central position variable (or median value) in a data set ordered from low to high.

$$v = -\frac{1}{M-1} \sum_{m=1}^{M-1} c_m \log_2 c_m + (1-c_m) \log_2 (1-c_m) \quad (2)$$

Where M indicates the number of income groups, and c_m is the cumulative proportion of the population in each income group. Using available data from five income groups, the average entropy increased across the city's neighborhoods between 1986, when it was 0.93, and 2006, when it was 1.14. The variation in entropy decreased concurrently, and the gradient of income diversity, which was significant and fairly steep in 1986, flattened completely between 1986 and 2006.

The changes in income and other gradients between 1986 and 2006 provide several important stylized facts. Although the gradient of median household income dropped by 25 percent overall, the median income gradient among households living in private housing only dropped by half that amount. This implies that in public housing, the gradient flattened by an even greater amount. This is not surprising; as mentioned previously, residents of public housing do not face housing market push factors to move when rents increase (Lui and Suen 2010; Hui and Lam 2005).

Moreover, the centrality of high-income households changed very little over the 20 year period, while the decentralization of low-income households was reduced by almost half. Thus, the decrease in the overall income gradient clearly came from changes in the centrality of low-income households. The density gradient also decreased by about 20 percent. This change, like those in the income gradient is also due more to an increase in the outlying areas of the city than in the center.

Models of neighborhood change

To analyze neighborhood change in greater detail, we model the change in neighborhood income over a 20 year period in several types of disaggregation—median income of all households, median income of households in private housing only, the share of high-income households, and the share of low-income households. These are regressed on a variety of other neighborhood characteristics, such as distance from the city center, the share of public housing, the share of rental private housing, and including dummy variables that indicate whether a neighborhood saw a redevelopment project or other major government investment.

Before the full model results are reported, Table 5 presents Spearman⁵

⁵ Editor's note: Spearman's correlation coefficient is a correlation measure between two continuous random variables. It allows to assess the relationship level between the two variables from a monotone function (or between ordered arrays).

Table 5. Correlations between Initial Characteristics in 1986 and Later Values.

Year	Correlation with 1986 value (Spearman coefficients)			
	Median-income	% low-income	% middle-income	% high-income
1991	0.93	0.87	0.60	0.93
1996	0.89	0.73	0.50	0.87
2001	0.83	0.62	0.39	0.81
2006	0.81	0.47	0.40	0.82

correlation coefficients between a neighborhoods initial income condition and the value in a later date. The numbers provide important evidence about the nature of neighborhood change. Not surprisingly, neighborhood incomes are highly path dependent; the high correlation between median household income in 1986 and 2006 is evidence that rich places tended to stay rich. This stickiness was much stronger at the higher income levels.

Table 6 reports the results of OLS regressions⁶ of the four models. Although the dependent variables are percents, the regressions are not censored as the percent change can be less than zero and greater than one. There are four independent variables in addition to the variables for which descriptive characteristics have been reported previously in Table 3. Three of these are dummy variables that indicate whether a TPU has received a particular type of investment between 1991 and 2006; a new MTR station (20 values of 1), a URA project (13 values of 1), or a significant transportation investment such as a road or bridge valued at more than 1 billion HKD (52 values of 1). The last independent variable is measured at the district level (there are 18 in Hong Kong), and indicates the share of employment in that district in manufacturing in 1991.

The initial value of the dependent variable in all four models is significant and negative, meaning that a higher income or share of high-income or low-income households is associated with less change in that value. This is akin to the mean reversion phenomenon in price changes. Lower levels of household mobility, as measured by the percent of households living in the same address, on the other hand is consistently associated with less increase in income levels.

The presence of public housing has a significant effect on changes in median incomes, leading to roughly 50 percent less change for a 100 percent difference

6 It is a statistical method for estimating relationships between variables. It is useful in determining the impact of a variable (the independent variable) on another (the dependent variable), controlling a group of other variables. In this case we want to know what factors affect the neighborhood income rate.

Table 6. Results of OLS Regressions: Change in Neighborhood Characteristics.

Variable	Percent Change in Value, 1986-2006			
	Median income	Median income, private housing	Share high-income	Share low-income
Value of dependent variable, 1986	-0.008 [0.002]**	-0.019 [0.007]**	-5.400 [0.764]**	-2.638 [0.426]**
% same address (1991)	-0.391 [0.192]**	-1.469 [0.512]**	-1.179 [0.642]*	0.601 [0.163]**
% private housing rental (1991)	0.264 [0.183]	-0.042 [0.386]	1.507 [0.875]*	0.725 [0.221]**
% public housing (1986)	-0.541 [0.085]**	0.148 [0.161]	2.019 [1.140]*	-0.678 [0.238]**
Distance to central (log)	0.003 [0.040]	-0.041 [0.072]	0.736 [0.250]**	0.060 [0.040]
New MTR station, 1991-2006	-0.085 [0.060]	-0.264 [0.127]	-0.440 [0.394]	-0.147 [0.082]*
URA project, 1991-2006	-0.127 [0.071]*	-0.321 [0.132]**	-0.471 [0.408]	-0.024 [0.063]
Transport project, 1991-2006	0.049 [0.070]	-0.008 [0.104]	0.075 [0.386]	-0.003 [0.077]
% district employment manufacturing (1991)	0.310 [0.180]*	0.166 [0.299]	-0.036 [1.065]	-0.175 [0.228]
Constant	0.730 [0.358]	2.284 [1.092]	-4.501 [2.398]	-0.313 [0.326]
F-statistic	6.67	5.13	14.07	16.88
Number of Observations	144.00	144.00	142.0	144.00
R ²	0.26	0.21	0.43	0.56
Adjusted R ²	0.21	0.20	0.39	0.53

Notes: White robust standard errors in brackets. ** and * indicate significance at the 0.05 and 0 levels.

in the share of population in public housing. This factor was also associated with less increase in high-income households and less decrease in low-income households. On the other hand, a greater share of rental housing in the private sector was associated both with an increase in the share of high-income households and low-income households.

The share of employment in manufacturing was only significant in the regression of overall median incomes, and was associated with a greater increase in incomes. Finally, and surprisingly, government investments are loosely associated with a smaller increase in neighborhood incomes. Median household incomes in neighborhoods where the URA carried out a project increased by 13 percent less than in other neighborhoods.

Conclusion

This paper describes the spatial changes in employment, housing unit density and neighborhood incomes in Hong Kong during and after a period of major economic changes. Hong Kong is an exemplary case study for examining how changes in the urban economy affect the location of households of different incomes and socioeconomic characteristics of neighborhoods because of its unique high-rise living environment and consequent dominance of commuting costs in determining bid-rent curves.

The deindustrialization of the city and the rise of the service economy were associated with an increase in incomes across the city, but changes were far greater in the growing New Territories than in the central urban areas. A key finding is that neighborhood socioeconomic characteristics showed considerable path dependency, neighborhoods with a large share of high-income households in 1986 had a large share of high-income households in 2006. However, overall neighborhood incomes changed less as a percent in higher income neighborhoods. The centrality of income diminished slightly, but only from an increase in incomes in outlying areas.

Although the importance of economic restructuring for Hong Kong has been acknowledged for many years, this has mostly been in regards urban planning (Yeh 1997). In some ways, the government has responded strongly to the changed in economic forces in Hong Kong, with large transportation infrastructure projects, such as the new airport and train connecting to the city center, which respond to the need for internal and international mobility. However, projects associated with efforts to change neighborhoods have had less success, due to public resistance to government proposals, the challenges of large-scale redevelopment in a high-density urban setting and bureaucratic inertia. Thus, understanding the spatial structure of Hong Kong is not only academically interesting, it has important policy implications. The role of government in urban revitalization continues to be controversial.

The importance of Hong Kong's policy regarding urban spatial change extends beyond the borders of the Hong Kong Special Administrative Region. Hong Kong has served as a model for urban development in China since that country began its reform period, especially in the area of urban planning (Scobell 1988). The two major differences between the two systems is the existence of multiple levels of government in mainland China and the limited land areas of Hong Kong. Unlike Hong Kong, which has managed to sell its land assets slowly as the city expanded over the decades, cities in mainland China have a greater incentive to sell land leases and expand rapidly. China is currently expanding its public rental housing system (Deng, Shen, and Wang 2011), in part based on the success of the Hong Kong experience. Cities should consider the

location of this new public housing carefully, as even Hong Kong suffers from problems associated with the concentration of public housing in the urban periphery (Lau 2010).

Moreover, as Chinese cities grow and rapidly redevelop their inner urban areas, they should look to future changes in the economy and consider the continued success of Hong Kong's urban management. This has occurred without many large public-sector led urban redevelopment projects, which are prevalent in Chinese cities (He 2007). In this study, incomes in neighborhoods in which URA projects were carried out were not found to have increased to a greater extent than other neighborhoods. It is location that matters more in the growth of high-income households in a neighborhood. Allowing for piecemeal redevelopment that preserves some older building stock creates more heterogeneous neighborhoods, which have been argued to attract the "creative class" (Florida 2002), and create more social diversity. Local officials in China should consider how they might stimulate this piecemeal urban redevelopment.

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