



# Metro-induced gentrification: A 17-year experience in Taipei



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## ABSTRACT

The present study explores the relationship between metro systems and gentrification. Three hypotheses are proposed as follows: access to metro stations induces gentrification, metro-induced gentrification occurs in both inner and outer city areas, and metro-induced gentrification differs between the inner and outer city areas. The present study tested these hypotheses by using population migration, college graduates, increased floor area, and house price as gentrification outcomes. Panel data and traditional linear regression analyses were conducted between 1996 and 2013 in Taipei City, Taiwan. Empirical evidence generally supports the hypotheses. Particularly, metro-induced gentrification revealed by highly educated residents and real-estate development was significantly stronger in the outer city areas, whereas metro-induced gentrification revealed by house prices was significantly stronger in the inner city areas. The current results broaden the understanding on the manner in which infrastructure investments were related to gentrification in an emerging city and imply that the local government should adopt sufficient means to deal with metro-induced gentrification when upgrading public transport systems.

## 1. Introduction

After World War II, many emerging cities have started developing their metro systems to enable efficient and environment-friendly urban progress. For instance, the metro systems in Eastern Asia have started their services sequentially in Beijing (1969), Pyongyang (1973), Seoul (1974), Hong Kong (1979), Singapore (1987), Shanghai (1993), Kuala Lumpur (1996), Taipei (1996), Guangzhou (1997), and Bangkok (2004). Empirical evidence and the literature generally agree that metro systems are associated with improved transportation efficiency (e.g., [Cervero, 1994](#)), reduced air pollution and energy consumption (e.g., [Poudenx, 2008](#)), elevated accessibility (e.g., [Lewis-Workman & Brod, 1997](#)) and land value (e.g., [Lin & Hwang, 2004](#)), and relocated populations and industries (e.g., [Cervero & Landies, 1997](#)) along metro corridors. However, the above changes also increase living expenses because they usually increase the livability and commercialization of a metro corridor. These changes can attract people and businesses who can afford land costs to move in the corridor and displace pre-existing low-income families and small businesses. This class-upward process along metro corridors can be considered metro-induced gentrification. Developing a metro system welcomes capital investment, and it is regarded as one of the major causes of gentrification ([Zheng & Kahn, 2013](#)); however, its effects on gentrification have not convincingly been recorded in the literature.

Previous research on the effects of capital investment on gentrifica-

tion have mostly focused on urban redevelopment (e.g., the Shanghai study of [Wang and Lau \(2009s\)](#)) and housing renewal (e.g., the Seoul study of [Ha \(2004\)](#)); however, studies that have explored the relationships between metro system and gentrification are rare. The research by [LeRoy and Sonstelie \(1983\)](#) is the first in the literature to study the influence of transportation innovation on gentrification. The Alonso–Muth model ([Alonso, 1964](#); [Muth, 1969](#)) was extended and used to explain how declining car costs influenced the residential locations of the rich and the poor. Their major argument is that the affluent resided at the city center before the era when cars were used as commuting modes, moved to suburbs when cars became affordable for only the rich, and returned to city center as cars were affordable to both the rich and the poor. They used socioeconomic descriptive statistics and commuting mode attributes between 1850 and 1977 in the US to support the above argument. [Lin \(2002\)](#) used the model developed by [LeRoy and Sonstelie \(1983\)](#) and hypothesized that metro station access spurs gentrification and empirically confirmed the hypothesis using the changes in residential property values between 1975 and 1991 in Chicago. Both of the above studies used a single indicator of gentrification (house price) while ignoring many of its other features ([Hamnett, 1991](#); [Lees, 1994](#); [Zukin, 1987](#)). The study by [Kahn \(2007\)](#) on 14 major cities in the US in 1970–2000 is a start of using multiple indicators to represent gentrification in transit and gentrification literature. He found that gentrification (denoted by house price and college graduates) is greater in communities with easy access to “Walk and Ride” stations

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compared to communities close to “Park and Ride” stations. From then, further research on transit and gentrification mostly used multiple indicators to represent gentrification and distance to station to represent transit access. These studies included those of Young (2007), Plevak (2010), Pollack, Bluestone, and Billingham (2011), Feinstein and Allen (2011), and Saldana and Wykowski (2012) in the USA, Pagliara and Papa (2011) in Italy, and Zheng and Kahn (2013) in China. However, none of the above studies determined whether their samples were from gentrifiable areas. A gentrifiable area reveals a below-average social status that could be measured through income, education, or percentage of residents in professional occupations. For an area to be susceptible to gentrification, it must be considered gentrifiable at the beginning of the analysis period according to the arguments by Freeman (2005), Hammel and Wyly (1996), and Walks and Maaranen (2008). Considering the above requirement, Grube-Cavers and Patterson (2015) analyzed a sample of gentrifiable census tracts in three major Canadian cities and reported that proximity to metro stations has a statistically significant effect on gentrification in Toronto and Montreal.

The above metro-induced gentrification research obtained interesting conclusions but left notable questions unanswered. The first question is whether metro-induced gentrification occurs in both inner and outer city areas. If so, then the next question is: what are the differences between metro-induced gentrification in the inner and outer city areas. Hackworth (2002) argued that gentrification extended from city centers to suburban areas and even rural areas by the 1990s; however, previous metro-induced gentrification research neglected this sprawling and provided very limited information about the outer areas of a city. The last question is whether metro-induced gentrification also occurs in regions other than North America in view of long-term experiences. The existing evidence of metro-induced gentrification outside North America are all short-term changes, which are three-year changes in China (Zheng & Kahn, 2013) and seven-year changes in Italy (Pagliara & Papa, 2011), and these changes were not confirmed that they were in gentrifiable areas. Gentrification is related to land development and household migration; thus, the changes that occurred over a period longer than a decade should be more convincing than those that occurred within a few years.

To answer these questions, the present study used data collected during a 17-year period in order to explore how access to metro stations is related to gentrification in Taipei, Taiwan. Sample data were from seven gentrifiable districts in both inner and outer areas in Taipei City between 1996 and 2013. Panel data and traditional linear regression analyses were used to examine the relationships between proximity to metro stations and gentrification. The present study contributes two novel arguments to the literature. First, in addition to the developed cities in North America, metro-induced gentrification could also occur in emerging cities worldwide. Second, metro-induced gentrification could happen in both inner and outer city areas, as well as reveal the different features between them. Analytical results imply that governments should adopt sufficient means to deal with metro-induced gentrification when upgrading public transport systems.

## 2. Method

This section specifies the gentrification outcomes and the factors that can potentially affect such outcomes. Furthermore, it describes the hypotheses and model specifications of the present study.

### 2.1. Gentrification outcomes

Most previous studies on gentrification have applied the perspectives of either neoclassical economics or Marxism. Researchers who have simultaneously applied these two perspectives since the 1980s include Clark (1992), Hamnett (1991, 1992), Knox (1991), Rose (1984), and Smith (1987, 1996). To prevent asking blind men to

describe the “elephant” (Hamnett, 1991), using “two eyes” to explore gentrification should be better than using a single perspective (Lees, 1994; Zukin, 1987). Therefore, the present study simultaneously analyzed four outcomes from two perspectives.

Most neoclassical economic research on gentrification has emphasized consumer preferences and attributes. Gentrifiers are generally defined by their income, employment, education, and race. For instance, Kahn (2007) and Zukin (1987) described gentrifiers as white workers who possess good economic conditions and prefer convenient, fast-paced, and fashionable urban lifestyles. However, economic inequity among races is not a serious problem in Taiwan. The four major races in Taiwan are Aborigines, Hokkiens, Hakkas (the above three races are also called native Taiwanese), and Mainlanders (the post-war influx of migrants from Mainland China). Recent studies have commonly revealed that the socio-economic gaps among the races shrunk for younger cohorts (e.g., Hsu & Chen, 2011; Su & Yu, 2007). Furthermore, income and employment statistics are unavailable for a Li. Li is the basic administrative unit in Taiwan, and it was used as an observation unit in the present study. According to the neoclassical perspective and the available data, the present study selected population migration and college graduates as two outcomes and defined these two variables to measure gentrification in an area as follows:

$$Migrate_{it} = (\text{number of residents moving in or out Li } i \text{ during year } t) / (\text{number of residents in Li } i \text{ at the end of year } t),$$

and

$$College_{it} = (\text{number of college graduates residing in Li } i \text{ at the end of year } t) / (\text{number of residents in Li } i \text{ at the end of year } t).$$

Both outcomes have been used in several gentrification studies, including Feinstein and Allen (2011), Hammel and Wyly (1996), Kahn (2007), Ley (1986), London, Lee, and Lipton (1986), and Zheng and Kahn (2013).

In contrast, Marxists argue that instead of people, capital moves (back) to gentrifiable areas. Rent-gap theory originally proposed by Smith (1979) and further extended by many studies such as Clark (1988) provides a basic explanation for gentrification from the Marxism perspective. Rent gap denotes the disparity between the potential ground rent level and the actual ground rent capitalized under the present land use. This theory states that investment in the property market only occurs if a sufficient rent gap exists. Rent gap increases rent and real estate supply, which then induces migration among different classes. Therefore, increased floor area and house price are two major outcomes according to the Marxist perspective of gentrification, and the following two variables are further defined to measure gentrification in this study:

$$NewFloor_{it} = (\text{increased floor area in Li } i \text{ during year } t) / (\text{urban development land area in Li } i \text{ at the end of year } t),$$

and

$$HousePrice_{it} = \text{transaction price per Ping of house } i \text{ adjusted by consumer price index, which was set as 100 in 2011 (unit: } 10^4 \text{NT\$/Ping)}.$$

In Taiwan, Ping is a commonly used area unit (3.3 m<sup>2</sup>). These two outcomes were also used in previous gentrification studies, including Badcock (1989), Yung and King (1998), Feinstein and Allen (2011), Grube-Cavers and Patterson (2015), Kahn (2007), and Zheng and Kahn (2013).

### 2.2. Access to Metro Station

Table 1 lists the explanatory variables and their hypothetical

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