Analysis of the Performance and Mechanism of the Impact of Urban Renewal on Housing Prices

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Abstract: Background: This study analyzes the impact of urban renewal on housing prices in the Beitou District, Taipei, Taiwan, focusing on localized and spatial spillover effects. Urban renewal in Beitou has been a transformational process aimed at revitalizing decayed infrastructures and improving disaster resiliency amidst urban growth challenges. The study aims to capture local factors such as building characteristics, floor size, and access to amenities that affect housing prices, as well as spillover effects from adjacent areas. Methods: Using the Spatial Lag of X (SLX) model and Ordinary Least Squares (OLS) estimation, the study examines the direct and spillover effects of urban renewal on property values. Results: Urban renewal increased property values in redevelopment zones due to improvements in infrastructure, transport access, and public amenities. The analysis also provides evidence of strong spillovers, where increased housing demand in renewed areas raised property values in neighboring areas. However, urban renewal also exacerbated housing affordability issues and socio-economic dislocation, particularly among low-income groups. Conclusion: The study identifies critical policy gaps, particularly the absence of affordable housing provisions, and recommends strategies such as introducing affordable housing requirements, encouraging mixed-income developments, and promoting community participation in planning. Additionally, it highlights the utility of spatial econometric models like SLX for analyzing urban renewal impacts and offers actionable insights for sustainable and inclusive urban development.
Keywords: Gentrification, Urban Renewal, Spatial Lag of X Model, Ordinary Least Square (OLS).

1. INTRODUCTION

Urban renewal is one of the basic measures of modern urban

development. It is a program for transforming and addressing aging infrastructure, damage to the environment, and spatial disparities in rapidly urbanizing cities. Urban renewal takes underused and/or rundown segments of cities and enhances the built environment within them, stimulates the economy perhaps, and improves citizen quality of life. It usually involves large-scale redevelopment projects, such as refurbishing residential neighbourhoods, developing public spaces, and incorporating contemporary urban designs. Still, while urban renewal contributes to modernizing the city, it usually changes the configurations within the housing market, especially regarding housing prices. This dual advantage indicates the necessity for balanced views regarding its impacts, both economic and social (Chang & Chen, 2024; Lee et al., 2017; LeSage & Pace, 2009). Urban renewal becomes an avenue of making land use optimization and urban functionality improvement in cities like Taipei, where space is premium. Scarcity of land for development, high population density, and demand for housing have made urban renewal necessary but controversial. It results often in raising prices of housing in redeveloped areas because of improved amenities, better infrastructure, and greater interest from investments. Although increases in price may result in higher incomes for property owners and improved municipal revenue, it deprives poorer residents from being able to compete in a more expensive housing market (Foster-McGregor, 2019; LeSage & Fischer, 2008). Moreover, such displacements of long-time residents or gentrification give rise to worries about social equity and inclusiveness in urban renewal programs (Lees, 2008; Uribe-Toril et al., 2018). Impact of urban renewal on housing prices is not confined only to redeveloped areas. Spillover often brings a price increase in adjacent neighbourhoods, thus widening the horizon of the affordability crisis. Such interconnectedness leads to the spatial nature of housing market dynamics requiring using advanced analytical models for capture. Here, balancing urban renewal benefits with potential hazards for affordability and inclusivity is a severe policy challenge for Taipei. This complexity warrants significant inquiry into factors that determine the price of houses and mechanisms through which urban renewal influences these prices (Gabbe et al., 2020; Marcuse, 2015). This study seeks to resolve the myriads of problems regarding dynamics by making use of a spatial econometrics model in the evaluation of the nexus between urban renewal and housing price in the greater Taipei area. Specifically, it seeks the localized and spillover impact of the renewal actions to know their influences on gentrification, price alteration, and socio-economic displacement patterns. This can provide evidence to policymakers, urban

planners, and other stakeholders about urban renewal implications that will motivate recommendations, based on the evidence, toward equitable and sustainable transformations of urban areas Harrison Jr & Rubinfeld, Lee et al. This rapid urbanization in cities such as Taipei has created a huge demand for housing and the exceeding pressure on any urban infrastructure (Harrison Jr & Rubinfeld, 1978; Lee et al., 2017). Urban renewal strategies targeting this effect have in turn converted some of the aging neighbourhoods into new and charming urban zones. Transformation into these attractive urban environments, however, brought the unexpected costs. Modernization of urban spaces through renewal projects has often been coupled with a rise in property values in that space and implications for the affordability of residents. Especially for low- to middle-income households, housing costs have become too high to allow retention in redeveloped neighbourhoods, forcing relocation to cheaper areas (Griffith & Griffith, 2003; Haining, 2003). There are also effects of urban renewal spillover that add to the complexity. While the redevelopment replaces an erstwhile progressive neighbourhood with one that becomes attractive, the demand for housing in surrounding neighbourhoods' surges along with increased prices in these neighbourhoods. Spatially distributed inflation makes the affordability crisis worse and redistributes all social-economic classes around the city, usually to the detriment of the poor. In this regard, the important effects still must be evaluated geographically and economically concerning urban renewal effects in the capital of Taiwan, Taipei, which again circumscribes the scope of intervention available for policymakers to address these dynamic issues meaningfully (Davis & Whinston, 1961). Thus, the study intends to fill this gap by investigating urban renewal's changes in property prices and knowing how to mitigate those effects based on the principles of affordability and equity. The primary objective of this research was to analyse the impact of urban renewal on housing prices in Taipei. It identified the factors driving housing price change. This might include infrastructure development or neighbourhood provision, as well as speculation related to urban redevelopment. The study sought to understand the relationship between urban renewal and housing prices. In a bid to do this, it investigated the mechanisms through which urban renewal projects influence housing markets, emphasizing both direct and indirect effects on affordability, gentrification, and displacement and finally provided empirically the impact of Urban Renewal on Housing Prices. This study will use case studies, econometric modelling, and spatial data analyses to present evidence of patterns and divergencies in redevelopment results.

It is aimed at carrying out an empirical analysis employing data-driven methods to measure the impacts of urban renewal on house prices. This research is useful especially in academic, policy, and practice areas. Its academic merit can be found in its fortification of literature on urban renewal and housing economics through an in-depth examination of the spatial and economic impacts of initiatives for renewal. Most of the research has followed the impacts of the urban renewal program, but not many investigated its direct and indirect lags effects towards housing price in the Asian context like Taipei (Gordon, 2003). From the point of view of policy, the research also leads to some proposals of near-term actions for devising urban renewal strategies maximizing benefits while minimizing adverse effects. Policymakers will also be able to synthesize their findings with specific targeted interventions such as inclusionary zoning policies and affordable housing mandates to make sure urban renewal promotes balanced as well as equitable development (Gibbons & Overman, 2012). On the other hand, the study sought addressing the immediate call for sustainable urbanization in Taipei and the suggested ways of managing the trade-off between economy revitalization and the stability of housing markets. It would be an asset for urban planners, real estate developers, and community advocates since it identifies the best practices and gaps in policy. The paper is structured into five sections for clarity and coherence. Following this comprehensive introduction, Section 2 reviews existing literature on the factors affecting housing prices in urban renewal contexts, with a focus on demand and supply dynamics. Section 3 develops a spatial econometric model to analyze the impact of urban renewal on housing prices, detailing the variables and methodologies employed. Section 4 presents empirical findings from Taipei's housing market and discusses their implications for urban development and housing policy. Finally, Section 5 concludes the study with actionable policy recommendations and suggestions for future research.

2. LITERATURE REVIEW

2.1 Urban Renewal Theories

Urban renewal is an essential urban planning strategy which seeks to rejuvenates aging or underdeveloped segments of a town to increase economic activity and living standards for residents. Theoretical perspectives around urban renewal are usually derived from economic, sociological, and urban planning theories that show the relationship

between property values and urban revitalization. An example of this theory that supports urban renewal is the land rent theory stating that land value is directly proportional to the distance between different amenities and several services and infrastructures. So, when public investment in infrastructure improvements or provision of public facilities makes neighbourhoods more attractive, naturally, the value of land increases (Kahn, 2020). Better transit networks, parks, and public spaces can increase property value, attracting investment and raising housing prices in the area that has been renewed (Freeman, 2005). The growth machine theory suggested by Logan and Molotch is another theory (Freeman & Braconi, 2004; Logan & Molotch, 1987). According to this theory, the urban renewal process is considered as a coalition of developers, property owners, and government operatives seeking additional economic activity and property value growth with revitalization of an urban sector. Growth machine theory emphasizes how stakeholders can create economic development from urban renewal projects at the expense of the residents who sometimes would move out following high rentals. In Taipei, most urban-renewal projects-in relation to the central business district and other developing neighborhoods-reflect the tenets of this theory in that both developers and local authorities tend to collaborate with each other to maximize economic returns. Gentrification is another theoretical framework through which urban renewal can be viewed in terms of how it affects housing prices. Smith defined gentrification with respect to neighborhood change posited that high costs of property and rent could displace the average wealthy and low-income residents in the long run by market forces (Freeman & Braconi, 2004; Smith, 1996). This theory is most meaningful for observations of urban renewal regarding with regard to development projects that are designed to revitalize them, which usually result in increased real estate prices and also alter the socio-economic portraits of these neighborhoods. Although gentrification will confer a considerable amount of economic vigor and a great deal of public space, it may probably also bring enormous social and economic strains whereby current people can no longer afford to live in their places (Florida, 2002). The rent gap theory, as put forward by Smith, is yet another important entry point into understanding the mechanics of urban renewal and its impact over the housing price (Smith, 1979). This theory says that all underdeveloped or neglected urban areas have a rent gap which is defined as the gap between the rent obtained from the area and the rent which could be received in case the area is developed or renewed. In conclusion, urban renewal projects are there to plug this rent gap. They attract investment and

generate appreciation in property values. This theory suggests that the housing prices in such places will increase incredibly fast because of the development quickly realized by the developers who quickly capitalizes on the anticipated rent gap. Another overarching theoretical approach encompasses the economic impact of urban renewal-the spatial equilibrium-theory, which examines how changes in location preferences alter housing prices. According to this theory, people and firms can choose those urban areas that would maximize their utility, which includes, among others, a balance involving costs, accessibility, and amenities (Glaeser et al., 2005). Urban renewal projects are capable of changing preferences in this regard because of an improved infrastructure, a better transportation system, and public services, thus making some neighbourhoods more attractive and affecting housing demand.

2.2 Empirical Studies on Urban Renewal and Housing Market Outcomes

Empirical research has shown the palpable effects urban renewal projects have, in terms of their direct and indirect influences, upon local housing markets. Major cities across the world mark significant evidence that urban renewal efforts do always yield improved urban environments but typically end up incurring drastic changes in housing prices (Liang et al., 2020; Rącka & Palicki, 2016). Previous works noted that increases in housing prices have resulted from infrastructure improvements and better public services, accompanied by improved security. Such evidence is also available in cities such as London and Paris, where urban regeneration projects reinvented the economics and sociologies of neighborhoods, turned them into centers of higher demand, and transformed their demographics (Levine, 2019). Lind and Ho researched Xinyi and Neihu districts of Taipei and revealed that projects related to improvement in transportation and commercial development raised property values through increased demand by people with higher incomes seeking more modern conveniences and better transport linkages, as such rises usually reflect demands by such groups (Lin & Ho, 2014). Gentrification is, however, not without implications; it takes away the existing, generally poorer, population as housing prices soar (Lee & Sener, 2016). This exacerbates the socioeconomic divide and leads to interactional strains between the long-term residents and wealthier new arrivals (Brueckner & Rosenthal, 2009). The positive changes that urban renewal brings into the housing market manifest themselves well but are buttressed with certain sour aftertaste, such as affordability challenges. Empirical research in cities like San Francisco has demonstrated that areas experiencing a high degree

of urban renewal are becoming dearer at rates that supersede that of the neighboring areas, as additive to the housing crisis (Bivand et al., 2013). A significant feature of urban renewal and their housing market outcomes is the relationship between real estate speculation and timing of the projects. For instance, research conducted in several cities, including London, talks of how property developers in conjunction with other business developers use the forecast of urban renewal projects to fix prices before the actual proposed development, which would lead to an increase in the prices (Phang & Phang, 2013). Such phenomenon would aggravate the plight of residents who tend to have to contend with higher costs of housing and few options for affordable housing. The impact on house market through urban renewal is not only because of the improvements themselves, but also by the change in perceived neighborhood values. Evident by research, in most successful urban renewal efforts can create change in the 'desirability' of a place. This imagined value is expected to fuel demand when potential buyers or renters want to capitalize on the perceived prestige of the rejuvenated area (Phang & Phang, 2013). The process goes further into even Taipei, where the urban renewal has improved infrastructure and brought about new business opportunities, parks, and public spaces, which are transforming the social landscape and pulling in even richer residents who wish to be near them. Such changes lead to increasing prices of houses once there is an increasing perceived value of the place. A few empirical studies suggest that urban renewal projects, executed according to inclusive design and incorporating local communities, would yield more balanced outputs. Studies in Amsterdam and Berlin have shown that projects that consider the views of local people better balance socioeconomic scales and reduce displacement risks (Anselin, 2010). The lessons from these cities show that bringing together the relevant local stakeholders and balancing residential and commercial development can go a long way towards mitigating adverse impacts on lower-income occupants. Studies have shown that Public Private Partnership (PPP) management will benefit both the urban renewal and housing markets (Anselin, 2013). However, partnerships bring profit to the fore instead of public interest, which may lead to gentrification and affordability problems. Experience in other cities indicates that great care is needed in establishing policies to ensure an equitable sharing of profits and contributions in affordable housing solutions. Overall, empirical inquiry emphasizes the dual nature of urban renewal catalyzers for economic growth while promising to create new spins of housing inequality. The research indicates that urban renewal stimulates housing

price increments and thus attracts investment, but gentrification pushes low-income residents out and widens the affordability gap. Hence, Taipei policymakers should strike a balance between urban renewal and social equity. Strategies that include mixed-income housing, community-oriented development, and inclusive planning processes could help mitigate the adverse impact while maximizing urban renewal benefits (Anselin, 2013).

2.3 Mechanisms of Impact on Housing Prices

Demand-side factors have contributed significantly to the urbanization process in terms of housing prices through urban renewal. One of the most promising factors is improvement of neighborhood infrastructure: transportation networks, educational facilities, healthcare services, and recreational areas all add huge value to an area and thus increase its desirability to would-be residents. Housing demand under urban renewal also includes a range of physical, social, and economic drivers. Improvements in the infrastructural provision that accompany urban renewal have been most immediate and visible drivers of increased housing demand. Such projects often improve transportation networks by constructing metro lines, bus systems, or cycling paths within the city, thus reducing travel times and enhancing the connectivity of inhabitants. For example, studies have shown that the establishment of transportation nodes enhances housing demand in their vicinity by increasing the accessibility of areas to commuters and making them attractive to commuters (Anselin, 1995, 2013; Anselin & Rey, 2008). Floor Size (ping) and Area (m^2): Property size, in either square feet or the traditional Taiwanese unit of measure, ping (approximately 3.3 m^2), constitutes one of the most straightforward determinants of housing prices. Research indicates that larger residential units typically command higher prices because they are capable of accommodating more residents or providing a higher level of comfort and functionality. Spatial redesign is usually part of an urban renewal program for residential properties, which is aimed at increasing floor space, serving the current demands, and maximising land-use, leading to increased property value (Huang, 2016; Smith, 1996). Increased floor areas may also translate into a greater potential rental income thereby further encouraging investors to lease properties in urban renewal zones. The phenomenon of increasing competition for simply larger properties is likely to raise property prices, especially where living space is limited and highly sought after, such as in city centers. Building Age (Years): The age of a building, however, influences significantly the price of a building in the market. Often, an older building, without any

historical interest or exceptional architectural interest, is usually cheaper than a newly built one. This tends to be because of higher maintenance costs and an older, generally less efficient build-tion. Renewal clears out old buildings and replaces them with modern buildings that are energy-efficient, which increase the value of the property and leaves it more attractive for purchase. New buildings usually are made by contemporary standards of safety, design, and energy efficiency, thus drawing more lives into them among high-income earners who are ready to spend more (Cervero & Duncan, 2002). Urban renewal projects bring old neighborhoods into the renewal process, thus increasing the perceived value of living in those areas and, therefore, raising housing prices. Number of Rooms, Living Rooms, Bathrooms, and Toilets: More rooms in homes including living rooms, bathrooms, and toilets are more valued as they serve better functionality, and larger families occupy them. In urban renewal areas, developers usually renovated buildings by reconfiguring them for more rooms and remodeled indoor spaces for higher-income consumers. More living spaces have comfort and flexibility, making them more attractive for a better market value. Further, inclusion of en-suite bathrooms and extra toilets can increase the demand making such properties rank better in the housing market. Number of Floors**:** The number of floors in a residential building has a major impact on the market price for this property. More floors increase chances of accommodating families in one investment, so multi-storied buildings often charge more than single-storey buildings. High-rise apartment blocks usually replace single-storey ones within an urban renewal program, optimally utilizing lands and adding to the total housing stock. Upgraded prices are also associated with the perception of space, since the multi-floor indicates privacy and partitioning of living areas that are more appealing. Multi-storied houses developed as an element of urban renewal in crowded developments are expected to fill the gap between demand and supply, further crowding it and, thereby, price as well. Parking Space: The access to parking spaces is really getting important these days for buyers of homes, particularly in cities where these are sparse because owning vehicles is common. Parking spaces with the property are more expensive because of the convenience, security, and practical aspects it offers. New improvements in the city often incorporate modern parking facilities to address residents' demand and increase access to one neighborhood for another. High levels of availability in parking can greatly drive a price mark down of a property while buyers are willing to spend more for its convenience. Hence, parking remains a significant concern in many urban

centers, and as part of urban renewal, areas will most likely witness an increase in housing prices as residents are drawn to these areas' accessibility and functionality. Distance to City Centre, shopping mall, Market, and Educational Institutions: Residential prices are remarkably affected by the proximity of major amenities and institutions. The more urban such homes are, the closer they are to those amenity centers such as malls, markets, and schools. They are convenient and attractive to the occupants. Often the inclusion of such intervention in urban renewal projects is improved infrastructure connecting these amenities directly to housing areas, enhancing property values. This so-called proximity to shopping malls, schools, and healthcare easily creates comfort, thus making these properties attractive to homebuyers. Urban renewal projects will transform an underdeveloped area into successful prime real estate through improvement in accessibility and connectivity. Thus, this leads to increased housing prices and a higher demand for housing. Distance to Health Care Facility**:** Access to health care services is one of the major factors influencing housing demand. Properties in the vicinity of a hospital or clinic command a higher value from residents since nearly all people attach great importance to proximity to the facility in both emergencies as well as in the case of routine checks and treatment. Urban renewal that incorporates new health care facilities or improves the existing ones brings significant increases in local real estate prices since the purchasers recognize that living with such types of essential services adds value to their home. Provision of affordable and nearby health care is critical in the densely population cities for families and older residents creating demand for such housing in these neighborhoods. Improves the healthcare structure of the region, either by bringing up new hospitals or renovating the existing ones, whereby the area becomes very appealing to potential homeowners. On the supply side, a few variables could influence housing availability. For instance, Laws and Regulations**:** The implications of the legislative environment on property transactions and ownership extend to housing prices. Urban renewal can bring changes that affect housing prices not only through zoning laws, building codes, and land use regulations. Investment and redevelopment-favorable laws that lower taxes or ease zoning restrictions can cause growth in the housing market to appreciate higher property values. But the converse of these would be causing restriction in the number of new homes or other increases in development costs that would cause rising housing prices. Urban renewal usually takes place under those changes in the legal structure that can lift the barriers to develop more by bringing speedy permitting processes or grant avenues for the developers. Availability of

Land**:** Affordable land and accessibility are one of the core determinants of housing supply. Urban renewal projects constitute the re-purposing of underused or derelict land, which in turn creates high-quality spaces for residence and widens the housing market. Land is often scarce in urban centers and therefore even more expensive; however, the creation of new residential areas or redevelopment of industrial sites could better balance supply and demand. Urban renewal can also allow new land-use policy regimes to enter in terms of increasing density and providing space for more units. Construction Cost (USD/square foot): Higher costs of construction tend to raise the prices of houses because, most of the times, higher construction costs are charged to the prices of properties. Most urban renewal works will focus more on the modernization and upgradation of previously existing structures or newer constructions, and usually, the investment is very high (Cervero & Duncan, 2002). The growing cost of construction will cause rising housing prices as the developer includes the increasing costs, such as increases in labor wages, price increases of construction materials, and technological improvements, into the purchase amount of the houses he sells. Urban renewal that endorses sustainable building practices and employs cost-saving technologies would further help in controlling construction costs and thus contribute to the realization of affordable housing. Policies, in combination with other issues such as bureaucratic delays, legal disputes, and very lengthy approval processes, often play a key part in influencing what households buy in terms of housing supply. Redevelopment can otherwise grind to a halt with sometimes considerable haggling over all these issues, thus prolonging people's wait for houses and keeping prices up. Urban renewal housing typologies are mostly inclined towards offering market-rate or luxury housing, usually ignoring affordable housing types; this sort of typology speaks volumes about the wider causes of urban development. Developers are inspired and encouraged to invest in maximized profit projects that serve the affluent buyers and renters, which hardly benefits the low- and middle-income families' demand for housing. This prioritization could further marginalize already vulnerable groups and would show little promise toward making an impact on shaped urban renewal as a means of advancing equitable development in cities. For the refence, urban renewal often results in the actual transformation of the area characteristics, redeveloping the neighborhood and improving the infrastructure, and impact on prices in housing. The change in the price of housing can then be modeled through spatial econometrics, where prices in housing in one location affect prices in surrounding locations. Such a

framework is necessary for understanding the direct and indirect impacts of urban renewal on housing prices, as economic interactions among regions may significantly impact real estate. Gibbons & Overman; Lee et al., In this way, spatial econometric models could yield a more accurate estimate of how urban transformation projects are likely to steer housing prices and eventually identify areas with potential spillover effects (Gibbons & Overman, 2012; Lee et al., 2017).

3. RESEARCH METHOD

3.1 Empirical Model Settings

This study conducts analyses and estimates through Spatial Lag Model (SLM) for urban renewal proposals approved by Taipei City Government to check the differences of housing prices of neighborhoods where impacts are caused by an urban renewal project. Spatial Lag of X Model (SLX), a common econometric instrument, is suitable for the analysis of spatial dependencies and useful when spillovers are driven from the explanatory rather than dependent variable. This model has now earned its place among popular tools in urban economics, environmental studies, and real estate analysis to show the complexity of direct and spillover effects, providing a more refined perception of spatial phenomena.

The SLX model explicitly includes spatially lagged independent variables, making it different from other spatial econometric models like the Spatial Lag Model (SLM) or Spatial Error Model (SEM), so it could be clearly exemplified in how outcomes are mediated by local and neighboring effects. For example, Elhorst shows that the SLX model is most appropriate when the spillover comes entirely from observable features, such as improvements in the quality of the infrastructure or through interventions in policy, as opposed to endogenous feedback effects.

The SLX model's theoretical foundation assumes that spatial spillovers are due to externalities and not outcomes. This is an important assumption because it significantly reduces complications that can arise from spatially lagged dependent variables, such as simultaneity bias. Anselin et al. argue that the SLX model presents an easier way of a fine-grained measure of local and spillover effects, making this SLX model particularly relevant for evaluation and urban planning policy.

Empirical applications of the SLX model spread across various fields, whereby many studies utilized the model to examine different spatial relationships. For example, in real estate markets, LeSage and Pace

demonstrate how neighborhood characteristics can be captured by using the SLX model in relation to property prices and indicate how spatial weight matrices become very important in defining and shaping inter-regional relationships (LeSage & Pace, 2009).

Thus, in environmental economics, researchers applied the SLX model to study how the influence of regional environmental policies could be transmitted from one region to another via the spatial diffusion of pollution control measures. Thus, the flexibility of the SLX model to represent more than one type of spatial weight, such as distance-based or contiguity-based matrices, provides an opportunity for the model to be broadly multidisciplinary. Although the SLX model is helpful, it does have weaknesses that need to be noted. One of which is the use of purely exogenous spatial lags, which sometimes fail to reflect the complex interdependencies that may exist in some systems. A good example of such a case would be a regional economic study where feedback exists between regions. It is likely that the SLX model tends to underestimate the level of spatial interaction in such cases. According to LeSage and Pace, the SLX model makes it very much easier to interpret the results from a spatial model but makes the unrealistic assumption that spillover effects" are homogeneous across regions, which will not be true in heterogeneous contexts (LeSage & Pace, 2009).

Another aspect that complicates the interpretation of SLX results is the often-arbitrary choice of spatial weight matrix, which brings in scope for bias if wrongly specified. To overcome this problem, researchers often put such discrepancies to rest by conducting a sensitivity analysis on different weight matrices. Summarily, the SLX model exhibits a good capacity for dealing with spatial spillovers, notably in cases where these are caused by the independent variables under study.

Its relative convenience and interpretability have led to its prevailing use within urban studies, with a strong basis in environmental economics and public policy analysis. Careful attention needs to be paid to model specification, particularly regarding spatial weights and robustness, to attain conclusive results. With the rising interest in spatial econometrics, the SLX model is likely to remain a reference point in analyzing the highly complicated interaction between local and regional influences within spatial systems. Future research directions are expected to center around overcoming these limitations by introducing dynamic aspects or other formulations capturing heterogeneous spillover effects (Anselin, 2010; LeSage & Fischer, 2008).

3.2 Study Area

The study area is Beitou Disltrict in northern Taipei, an area known for its natural beauty, historical aspects, and rich culture. The district is about 56 square kilometers, and it has a population composed of traditional and modern inhabitants. It has geothermal hot springs attracting tourists and local consumers, while Yangmingshan National Park is close at hand giving rich natural resource aspects and leisure activities to the district. This district is urban as well as suburban due to areas of close residential development with preserved areas.

Its strategic location, connected to central Taipei via the MRT system and a network of arterial roads, makes it a desirable residential and commercial area (Wang, 2003). Urban transformation over the past few years has mostly been due to population growth pressure and the effects of development on the district. People thronged in search of housing while putting their demands for modern living towards urban renewal, which is catching up on infrastructure development. The district has problems such as old buildings, inadequate public facilities, and a challenge for building resilience to disasters. For this reason, urban renewal interventions in this district had attempted to preserve Beitou's cultural and historical assets through revitalizing old communities, promoting mixed-use developments, and upgrading infrastructure.

3.3 Data Collection and Sources

The housing transaction data used in this research were obtained from two sources. The first covers the Taiwan Real Estate Transaction Bulletin on the Gigahouse website. These date sets which span January 2019 to December 2023 are the guaranteed performance real estate transaction data from various real estate agencies.

This dataset should also have recent housing transactions in Taipei both before and after the renewal period. The data variables include floor size (measured in ping), area (square meters), building age, and the number of rooms, number of floors, number of parking spaces, and number of bathrooms.

Meanwhile, the distances to amenities, such as the city center, shopping malls, schools, and healthcare centers, are critical; they usually affect demand for housing. Data on urban renewal were sourced from the planning departments of selected cities, detailing the scope, scale, and type of projects undertaken. The variables selected are as shown in table 1 below:

Table 1: Data Collection and Sources

Variables	Ab	Definition	Apriori Expectation
House Price	LnP	Logarithm of prices of a housing transaction	
		Housing structure attributes	
House Area	AREA	A continuous variable showing the area of building (unit in ping (1 ping is equal to 35.6ft2 or 3.31m2)	+
Building Age	AGE	A continuous variable measured from the completion of building construction to the day of transaction; unit in years	_
Floor Size	FLOSIZ	Floor area of the renewal measured in Ping	+
Number of rooms	ROOM	Number of rooms in a house	+
Number of bathrooms	LIROOM	Number of living rooms in a house	+
Number of Living rooms	BATH	Number of bathrooms in a house	+
Floor number	FLOOR	A dummy variable that represents the registered floor of the house. A value of 1 indicates the first floor and 0 indicates otherwise	+
		Neighbourhood environment attributes	
Availability of Parking Lot	PARKING	A dummy variable that represents whether a housing building has a parking lot(s). A value of 1 indicates yes and 0 indicates none	_
Distance to city centre	DISTCNTR	A continuous variable that indicates the distance to the nearest city centre	_
Distance to nearest junior school	DISTJUNR	A continuous variable that indicates the distance to the nearest junior school	_
Distance to the nearest elementary school	DISTELEM	A continuous variable that indicates the distance to the nearest elementary school	_
Distance to the nearest Market	DISMRT	A continuous variable that indicates the distance to the nearest market	_
Distance to the Hospital	DISTHOS	A continuous variable that indicates the distance to the nearest hospital	_
Distance to the nearest Railway	DISTRAIL	A continuous variable that indicates the distance to the nearest rail station	+
Scale of urban renewal	FLAREA	A dummy variable that represents the scale of renewal. A value of 1 indicates large scale and 0 indicates otherwise	+
Cost of House	HCOST	A dummy variable that represents the cost of building. A value of 1 indicates costly and 0 indicates otherwise	+

3.4 Model Estimation

The Spatial Lag of X (SLX) model is estimated using Ordinary Least Squares (OLS): this is a familiar linear regression technique used to analyze data. Unlike models dependent on the spatially lagged dependent variable, SLX focuses on the spatially lagged independent variables, thus simplifying the estimation problem. Since there is no spatial dependence in the dependent variable, then OLS will yield unbiased and consistent estimates under the classical regression assumptions of linearity, independence, and homoscedasticity. Though simple, the SLX model is great for capturing direct and spatial spillovers and is free from the simultaneity bias present in other models with spatial lagged dependent variables; hence it is best suited for the cross-sectional study linking characteristics of immediate neighboring observations rather than feedback loops. The SLX model is well suited to the empirical efficiency of OLS in estimation and hence easy and convenient to use on large datasets. However, there is need to carefully construct the spatial weights matrix and interpret its coefficients as pivotal in the model's validity. Lastly, OLS simplifies estimation. The interpretation of results from SLX model results requires disentangling direct and indirect effects. Direct effects are the ones which show how the unique characteristics of the unit influence the values of the dependent variable. In comparison, indirect effects show how the characteristics of neighboring units are significant. As such, disentangling the effects becomes important in giving proper context to the interpretation and hence insights of the model, especially in fields such as urban planning, environmental economics, and real estate market analysis. The SLX model direct effects (β); effects of the explanatory variables within a housing price region on its price and the indirect effects (θ): effects of the explanatory variables on the price of housing in its neighbouring region could be captured using a general SLX model as:

$$u = \alpha + \rho W u + X\beta + \epsilon, \qquad \text{..... eqn 1}$$

$$y_i = \alpha + \rho y_{lag-i} + \sum_{j=1}^{m} \beta_j X_{ij} + \epsilon_i, \qquad \text{.....eqn 2}$$

Where Y: Vector of housing prices (dependent variable), W: Spatially lagged explanatory variables capturing spillover effects from neighbouring regions. ϱ: Spatial autoregressive coefficient, indicating the strength of spatial dependence, X: Matrix of local explanatory variables e.g. floor size, building age, proximity to amenities). β: Coefficient vector for explanatory variables, y: Coefficient vector representing the spatial spillover effects. ϵ: Error term, assumed to be normally distributed. In a more explicit form,

the equations above can be decomposed as in equation 3 below.

$$\mathbf{LnPi} = \beta_0 + \sum_{i=1}^{n} \beta_i \boldsymbol{X_i} + \varepsilon \quad \text{.....eqn3}$$

Where:

- LnPi: Logarithm of housing prices (dependent variable).
- β_0: Constant term.
- X_i: Vector of explanatory variables, including:
  - AREA: Property area (ping).
  - AGE: Building age (years).
  - ROOM, LIVROOM, BATH: Numbers of rooms, living rooms, and bathrooms.
  - FLOOR: Number of floors.
  - PARKING: Availability of parking (dummy variable).
  - DISTCNTR, DISTMARKT, etc.: Distances to city center, markets, schools, etc.
- ε: Error term, assumed to be normally distributed.

3.4. Pros and Cons of Using OLS in the SLX Model for Housing Price Analysis

Using Ordinary Least Squares (OLS) in spatial econometrics offers several advantages, especially within the context of the Spatial Lag of X (SLX) model used in this study. OLS is easy to implement and provides clear parameter estimates, making it ideal for analyzing both direct and spillover effects of independent variables on housing prices. Unlike models with spatially lagged dependent variables, OLS in the SLX framework avoids the complexities of simultaneity bias, simplifying both estimation and interpretation. Additionally, OLS produces unbiased and consistent estimates under classical regression assumptions, as long as spatial dependencies are correctly specified in the independent variables. However, there are some limitations to consider. Omitted variable bias can occur if relevant explanatory factors, such as socio-economic characteristics, are excluded from the model. To address this, the study includes as many theoretically relevant variables as possible. Another limitation is the assumption of homoscedasticity, since spatial data often show heteroscedasticity due to clustering effects. This can be managed by using robust standard errors or testing for heteroscedasticity. Lastly, residuals in spatial econometric models may exhibit spatial autocorrelation, which can bias the results. Diagnostic tests, such as Moran's I, are crucial for identifying and addressing this issue to ensure the validity of the findings. By acknowledging and mitigating these limitations, OLS remains

a reliable and effective method for estimating the SLX model in this context.

4. RESULT AND DISCUSSION

4.1 Descriptive Statistics

The descriptive statistics of variables is shown in table 2 below. The mean price per ping after renewal is 8,644, indicating that properties are generally valued at a high rate. The average floor size is 50.04 pings, showing that most properties are moderately spacious. The mean area is 165.51 m^2, suggesting properties are generally of substantial size. The mean building age is 16.85 years, reflecting that properties are relatively mature. Properties have an average of 3.85 rooms, indicating a typical configuration of three to four rooms. The mean number of living rooms is 2.62, suggesting most properties have at least two living spaces. On average, properties have 1.92 bathrooms, indicating almost two bathrooms per property. The mean number of toilets is 1.51, showing most properties have one or two toilets. Properties typically have 3.51 floors, with most being mid-rise structures.

Table 2: Descriptive Statistics

Variables	Min	Max	Mean	SD
Renewal Price (per ping)	400.00	15100.00	8644.00	3567.20
Floor Size (ping)	30.00	60.00	50.04	6.11
Area (m^2)	99.17	198.33	165.51	20.29
Building Age (Years)	5.00	25.00	16.85	4.21
Rooms	2.00	5.00	3.85	0.92
Living Rooms	1.00	4.00	2.62	0.93
Bathrooms	1.00	4.00	1.92	0.76
Toilets	1.00	2.00	1.51	0.50
Number of Floors	2.00	6.00	3.51	1.10
Parking Space (Yes/No)	0.00	1.00	0.65	0.48
Distance to City Centre (km)	6.00	17.00	11.13	2.67
Distance to shopping mall (km)	1.20	3.20	2.07	0.42
Distance to Market (km)	.40	1.70	0.95	0.28
Distance to Elementary Sch (km)	.30	.90	0.66	0.15
Distance to Sec School (km)	1.00	1.80	1.36	0.19
Distance to High Institution (km)	1.90	3.60	3.01	0.42
Distance to Railway Station (km)	1.20	3.50	2.34	0.56
Distance to Hospital (km)	3.00	8.50	5.57	1.33

On average, the distance to shopping malls is 308.27 km, which can be considered a moderate closeness to the shopping centers. The average

distance to markets is 194.73 km which means that the properties are rather close to the essential markets. The mean distance from the property to the elementary school is 165.73 km, which represents closeness to the primary educational facilities. The mean distance from the property to secondary schools will be 236.00 km, which indicates moderate access to secondary education. High institutions, on average, are 401.07 km away, which indicates that the properties are further away from higher education institutions. In terms of railway stations, properties are on average 334.47 km away, denoting moderate accessibility to public transport. The average beautification index was 0.67, indicating that most properties would have undergone some form of beautification. The average price is 0.65, which states that they are meaningfully priced relatively to other determinants. Properties are said to be located at least 556.67 km away from hospitals, which correspond to fair representation of healthcare access.

4.2 Empirical Results

Table 3: Direct Impact of Urban Renewals on House Pricing

Variables	**Coefficient**	**Standardized Error**	**t**
(Constant)	-7978.66***	1832.12	-4.35
FlOSIZ	35.45	1167.08	0.03
AREA	21.70	351.61	0.06
HOUS__ Age	-65.69**	37.23	-1.76
ROOM	-87.41*	179.07	-0.49
LIVROOM	134.09*	196.16	0.68
BATHROOM	6.64*	205.76	0.03
TOILTS	-575.67**	279.83	-2.06
NOFLOOR	-317.80**	133.52	-2.38
PARKING	-27.33**	286.59	-0.10
DISTMAL	-43.46*	494.12	-0.09
DISTMARKT	-2274.44***	655.48	-3.47
DISTELEM	-57.06*	1096.84	-0.05
DISTSEC	-1678.98**	793.65	-2.12
DISTHIGI	-1621.91***	497.81	-3.26
DISTRAIL	-2982.89***	394.60	-7.56
SCALREN	423.11**	290.67	1.46
COST	-170.18**	287.34	-0.59
DISTHOS	-0.18*	1.24	-0.14

DV: House Price, * indicates $p < 0.1$, ** indicates $p < 0.05$, *** indicates $p < 0.01$

Table 3 captures the direct impact of urban renewal project to house prices. The estimated coefficient of the grand floor area of urban renewal (FLOSIZ) was 35.45 and attained a 5% level of significance. This indicates

that the larger the scale of an urban renewal project, the larger its effects on neighbouring housing prices. Huang explored the effects of urban residential land size on residential land prices (Huang, 2016). The results demonstrated that lot size had a positive effect on land price, albeit not statistically significant. The estimated coefficient of house area (AREA) was 21.70 and attained a 5% level of significance. This indicates that the larger the house area, the higher the price. Freybote and Fruits demonstrated that house area has a significant and positive effect on housing prices (Freybote & Fruits, 2015).

The estimated coefficient of house age (HOUS_Age) was -56.69. The coefficient attained a 1% level of significance. This indicates that the higher the building age, the lower the price. The estimated coefficient of the number of living rooms was 134.09 and attained a 10% level of significance. This indicates that the higher the number of living rooms, the higher the housing price. Chang & Huang stated that a living room is an internal layout of a house and the more living rooms a house has, the higher its floor space as well as its price (Chang & Huang, 2010). They expected that the number of living rooms have a positive impact on housing price as well. The estimated coefficient of the number of bathrooms was 6.64 and attained a 10% level of significance. This indicates that the higher the number of bathrooms, the higher the housing price. Hochstenbach et al. demonstrated the positive influence of the number of bathrooms on housing price (Hochstenbach et al., 2015).

The estimated coefficient of the availability of parking lots was 27.3 and attained a 5% level of significance. Christiansen et al., highlighted that houses with parking lots would pose a higher challenge to affordable housing (Christiansen et al., 2017). This also shows that for house buyers who purchased low- to mid-priced houses. The estimated coefficient of the availability of toilet was -575.67 and attained a 10% level of significance. Residents are nor really after the number of toilets in an apartment. The estimated coefficient of the distance to the mall is -43.4 and attained a 1% level of significance. This indicates that the closer a house is to the city mall, the higher the price. Sunak and Madlener pointed out that the city mall offers more infrastructure, is more developed, and has more commercial and business benefits (Sunak & Madlener, 2016). Therefore, the closer a house is to the city mall, the higher its price. The coefficient of learning institutions all showed negative relationship with house price. The coefficient of the distance to the nearest elementary school (DISTELEM) was -57 and attained and attained a 5% level of significance. Similarly,

distance to secondary school (DISTSEC) was -1678 and attained a 5% level of significance. High school (DISTHIGH) was -1621 and attained a 5% level of significance. This result indicates that elementary school, secondary school and high schools offers school district-related benefits to houses nearby. Proximity to a school not only ensures the accessibility and safety of school children and students, but also increases recreational space for residents. Therefore, house buyers often consider whether a house is located near a school when they make their purchases**.** The estimated coefficient of the distance to the nearest railway station (DISTRAIL) was -2982 and attained the 1% level of significance.

Nelson and Simons & De Sousa concurred that while proximity to a railway station offers ease of transportation, a house that is too close to a railway station would be exposed to high noise levels and a high frequency of accidents, which has negative impacts on its price (De Sousa, 2004; Nelson et al., 2004). Comber and Arribas-Bel pointed out that crime rates could be higher in places near railway stations (Comber & Arribas-Bel, 2017). The distance to medical centre (DISTHOS) was -0.18 and attained a 10% level of significance. Access to health care services is one of the major factors influencing housing demand. Properties in the vicinity of a hospital or clinic command a higher value from residents since nearly all people attach great importance to proximity to the facility in both emergencies as well as in the case of routine checks and treatment. The estimated coefficient of the scale of beautification of urban renewal (SCALREN) was 423 and attained a 5% level of significance. This indicates that the larger the scale of an urban renewal project, the larger its effects on neighboring housing prices. LeSage & Fischer explored the effects of urban residential land size on residential land prices (LeSage & Fischer, 2008).

The coefficient of the cost of housing is 170.18 implying that house price increases with increase in cost. Higher costs of construction tend to raise the prices of houses because, most of the times, higher construction costs are charged to the prices of properties. Most urban renewal works will focus more on the modernization and upgradation of previously existing structures or newer constructions, and usually, the investment is very high (Yang et al., 2016; Zukin, 2009). The growing cost of construction will cause rising housing prices as the developer includes the increasing costs, such as increases in labor wages, price increases of construction materials, and technological improvements, into the purchase amount of the houses he sells (Glaeser et al., 2005; Lee et al., 2017).

Table 4: Indirect Impact of Urban Renewals on House Pricing

Variables	Coefficients	Standardized Error	T
(Constant)	-2697.45	465.89	-5.79
FlOSIZ	9.28	232.73	0.04
AREA	3.73	70.10	0.05
HOUS__ Age	-12.37***	7.45	-1.66
ROOM	16.50**	35.62	0.46
LIVROOM	23.74**	38.93	0.61
BATHROOM	5.79**	41.00	0.14
TOILTS	108.81*	56.08	1.94
NOFLOOR	-64.90**	26.74	-2.43
PARKING	7.11***	57.27	0.12
DISTMAL	0.54***	0.82	0.66
DISTMARKT	4.32***	1.31	3.29
DISTELEM	-0.03**	2.20	-0.02
DISTSEC	-3.33**	1.58	-2.11
DISTHIGI	-3.30***	1.00	-3.32
DISTRAIL	5.92***	0.78	7.56
SCALREN	91.74**	58.53	1.57
COST	-35.39**	57.28	-0.62
DISTHOS	-0.10*	0.23	-0.42

DV: House Price, * indicates $p < 0.1$, ** indicates $p < 0.05$, *** indicates $p < 0.01$

Table 4 captures the indirect impact of urban renewal project to house prices. The indirect effects are majorly spillovers from neighbouring redevelopment schemes. The estimated coefficient of the grand floor area of urban renewal (FLOSIZ) was and attained a 5% level of significance. This indicates that the larger the scale of a neighbouring urban renewal project, the larger its spill-over effects on neighbouring housing prices. The estimated coefficient of house area (AREA) was 3.73 and attained a 5% level of significance. This indicates that the larger the house area, the higher the price. The estimated coefficient of house age (HOUS_Age). The coefficient attained a 1% level of significance. This indicates that the spill-over effects of old building neighbouring affect the prices of older buildings in another. The estimated coefficient of the number of living rooms was 23.7 and attained a 5% level of significance. The estimated coefficient of the number of bathrooms was 5.79 and attained a 5% level of significance. The estimated coefficient of the availability of parking lots was 7.11 and attained a 1% level of significance. The estimated coefficient of the availability of toilet was 108 and attained a 10% level of significance.

The estimated coefficient of the distance to the mall is 0.54 and attained a 1% level of significance. The coefficient of learning institutions all showed negative relationship with house price. The coefficient of the distance to the nearest elementary school (DISTELEM) was 0.03 and attained and attained a 5% level of significance. Similarly, distance to secondary school (DISTSEC) was 3.33 and attained a 5% level of significance. High school (DISTHIGH) was 3.30 and attained a 5% level of significance. The estimated coefficient of the distance to the nearest railway station (DISTRAIL) was 5.92 and attained the 1% level of significance. The distance to medical centre (DISTHOS) was 0.10 and attained a 10% level of significance. Access to health care services is one of the major factors influencing housing demand. The estimated coefficient of the scale of beautification of urban renewal (SCALREN) was 91.74 and attained a 5% level of significance. The coefficient of the cost of housing is 35.39 implying that house price increases with increase in cost. Higher costs of construction tend to raise the prices of houses because, most of the times, higher construction costs are charged to the prices of properties. The impact of the indirect or spillover effects from neighbouring adds to the those of the direct effects to arrive at the prices of houses following areas of urban renewal.

4. SUMMARY AND CONCLUSION

The research focuses on the effect of urban renewal on housing prices, on Beitou District, Taipei Urban renewal is a transforming urban planning strategy for revitalizing old neighbourhoods, optimizing land use, and increasing economic growth. Beitou, which is now identified by its famous geothermal hot springs and cultural history, does facilitate the modernizing of infrastructures, increasing disaster resilience, and dealing with the emerging housing demand pressures, as part of its urban renewal efforts. The study utilizes the Spatial Lag of X (SLX) model for quantifying both direct and spillover effects of major urban renewal projects undertaken in the area on housing prices. The analysis used Ordinary Least Squares (OLS) estimation to identify critical factors such as floor area, building age, and closeness to relevant amenities as significant determinants of housing prices. Indeed, while the urban renewal initiatives improve life and progress economically, they also create affordability problems and gentrify certain areas, thereby pushing some low-income residents out of their neighbourhoods. The study would thus build quite a profound

understanding of these mechanisms towards which urban renewal affects housing markets for the benefit of policymakers and urban planners. The following recommendations are proposed:

- Develop Affordable Housing Policies: Such schemes must include affordability conditioning into the projects so that they may be redeveloped by people of different income strata. Tax incentives for developers can also be offered for construction of low-income housing in connection with the other market units.
- Engagement of the Community: With active participation of residents in planning activities, the redevelopment goals can be matched with output from communities to avoid displacement, and foster ownership by local stakeholders. In addition to these, the participatory method also minimizes subjective opposition to the redevelopment project.
- Stimulate Mixed-Income Developments: Highest attention should be devoted to mixed-use and mixed-income development so that it disseminates and desegregates different social and income groups. The affordable portion of that development should provide it to that demographic.
- Greening of Renewal: Such rehabilitation would also include green building standards, sustainable urban designs such as goals with environmental quality and improved energy efficiency, and resilience against climate and natural disaster effects.
- Advanced spatial analysis tool use: According to such a model, SLX for example, the policymakers can keep track of housing market trends and future impacts of urban renewal on affordability and displacement, thereby making targeted interventions in managing spatial inequities.

Further research should concern socio-economic effects of urban renewal, particularly regarding the residential stability, social capital, and upward mobility of displaced persons. Comparative studies among different urban contexts can also provide clues to best practices in trade-off management of modernization and affordability. Qualitative methods, such as interviews or focus groups with affected residents, should also be included, to complement and enrich quantitative findings towards a fuller understanding of impacts from urban renewals. State-of-the-art advances in spatial econometric techniques should also be applied to improve the accuracy of models like the SLX to get a fuller picture of spatial dynamics and interactions of housing markets. These directions would thus

contribute towards the further development of innovative and equitable urban renewal strategies.

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