Examining the Regional Spatial Spillover Effect of Housing Price in Taiwan –An application of Housing Panel Data

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Abstract: Following the economic booming in Taiwan since 1950's, the housing prices increase in a fast pace, especially in the capital city area (Taipei) in northern region of Taiwan. However, there is an immense difference of rising degree by regions from north to south. The heterogeneity of regional spatial development forms the differences of housing environment attributes and results in different housing price distribution for local regions. In this study, we select three metropolitan municipalities regions in Taiwan, including Taipei, Taichung and Kaohsiung as the empirical areas to construct the so-called the Regional Housing Price Model (RHPM). The RHPM will be constructed empirically in Taiwan area to take into account of the spatial heterogeneity, spatial spillover effects, local environment attributes by metropolitan municipalities regions, and the Taiwan macro-economic factors as well. We investigate how national and regional elements impact on regional housing market by using spatial panel data model. Different from the past studies, this paper considers both spatial heterogeneity and dependency simultaneously. We found that the spatial spillover effect is positive in the northern region, negative in the central region, but insignificant in the southern region of Taiwan. It also shows that the three regions were in distinct stage of development, causing the characteristic of regional housing market to present differently.

Keywords: Housing price, Region Spillover effect, Panel data, Taiwan

Introduction

As seen in Figure 1, The housing price in Taiwan kept increasing in recent years, however the rising of regional housing price is inconsistency. Each housing market has different condition due to the unbalanced development of regions. Taking closer to it, we will discover there is an unbalanced issue in Taiwan. Besides being partial to the construction of western half of Taiwan, government of various periods make development focus region move from south to north (In western half of Taiwan, it can be divided into northern, central and southern regions). In general, unbalanced problem in Taiwan becomes worse and worse, northern region takes role of stronger development core, while central and southern regions are relatively periphery in current situation.

Following upper statements, the regional housing market failure may happen because that the differences of built environment, population, public service and so on, making the mechanism of housing market differs from region to region. The characteristic of regional development plays an important role in housing market, including not only the national and regional factors, but also spatial heterogeneity and spatial dependency.

Previous studies have shown that the national and regional factors have impact on regional housing price. Besides, by the use of panel data (combination of cross-sectional data and time series data, the structural differences(time-invariant) among regional housing market which may causing bias can be controlled. However, the problem of spatial dependency still remains. Instead of operating independently, regional housing market are interlinked, which should be considered in countries or areas where regions are strongly connected to each other. This paper was concerned with the construction of a housing price model that captures not only spatial heterogeneity but spatial dependency.

Spatial panel data can be seen as an extension of panel data with spatial units. By using spatial panel data, the problem of spatial heterogeneity and spatial dependency can be considered at one single model. This study developed a regional housing market model based on previous study, then extended it to spatial panel model to consider not only national and regional factors, but also estimated the spatial spillover effect in northern, central and southern region in Taiwan, with the data in which the spatial units are 19 cities and counties in Taiwan from 2002 to 2014.

The results showed that the three regions were in different stage of regional development, causing the different characteristic of regional housing market. Northern region, where facing the problem of extravagant housing prices, the demand of housing investment affected housing price more than housing consumption. The spillover effect in northern region was positive, meaning that the cities and counties in northern region will affect adjacent cities and counties. The demand of housing investment in central region was not significant, and the spillover effect was negative. The results might due to the reason that the central region is less developed than northern region. In southern region, the elasticity of demand for Housing consumption is the largest in all regions. The spillover effect was insignificant, meaning that there is no spatial interaction in the cities and counties in southern region.

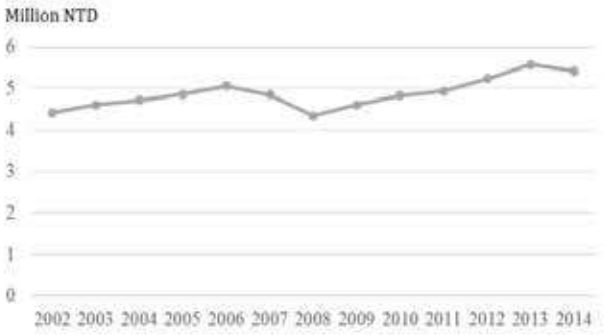

Figure 1 – Average trend of median housing prices in Taiwan counties

Literature Review

In the past, many researches have proved that there were numerous factors which may affect housing price. In terms of supply and demand, if demand of housing is higher than supply relatively, the HP will become higher. Take household as cardinal number, let it be multiplied by income and we will get the result of residential demand (DiPasquale & Wheaton, 1994). A supply and demand equilibrium model was established. The model assumes that HP will reflect changes in national and regional factors differ from regions. Residential demand is regional factors such as new house quality, population, income, employment rate, loan value ratio, etc. With nine regions in the United States as the empirical regions, it is found that the increase in the population or household quantity in six regions will increase the demand for housing, which in turn will increase housing prices (Reichert ,1990).

From the point of housing purchase decision-making, the employment rate and income of the employment market in different regions are distinct. If the employment rate is high, it will have a positive impact on regional housing prices (Reichert,1990; Tabuchi, 1998; Baffoe-bonnie, 1998; Hsueh *et al.*, 2003). In addition, in terms of the maximum utility of housing, public finances and other consumer goods in the region, a model bases on that theoretical basis was established. Then access the cross-sectional data analysis and found that public finances in schools and other areas are one of the factors affecting population migration, which in turn affects housing demand and regional housing prices.

In theory, if interest rates are low, funds tend to flow into the real estate market or other financial markets to fight inflation, so interest rates represent the opportunity cost of investing in the residential market, and the impact on regional housing prices is negative (Reichert, 1990), but interest rates may also change in the same direction with regional housing prices (Ashworth & Parker, 1997; Meen, 1999), similar to the Pigou effect concept proposed by Pigou (1943), that is, if people's actual property increase (for example, due to rising interest rates or falling prices) will stimulate demand for consumer spending, causing suppliers to produce more goods, increase employment opportunities, etc., which is a positive cycle. This concept can explain why interest rate and housing price have same direction. The phenomenon, as the interest rate rises, increases the actual property of people, stimulating the consumption demand of the house, and the Pigou effect appears between the two. In addition, the rapid growth of housing prices can reduce the cost of residential capital, so the rate of change in housing prices is also a factor affecting investment demand (Reichert, 1990).

The cost of building a house is also a decisive factor in the supply of housing. Due to limited land resources and geographical differences in regions, the supply of regional housing is limited, and the results of different regional planning controls also make regional housings have inconsistent supply (Case & Mayer, 1996; Mayer & Somerville, 2000), the elasticity of housing supply has been reduced due to strict planning controls, which in turn has caused residential prices to rise.

Table 1 – Factors affecting HP from literature review

Factors		Expected sign	References
Housing demand	Population, Household	+	Reichert(1990); Tabuchi(1998); Zhang *et al.*(2014); Chang & Chiu(2013); Nanda & Yeh (2013)
	Employment rate	+	Reichert(1990); Tabuchi(1998); Baffoe-bonnie(1998); Hsueh *et al.* (2003); Meen(1999)
	Income	+	Reichert(1990); Mikhed & Zemčík(2009); Ashworth & Parker(1997) Nanda & Yeh (2013)
	Public service quality	+	Case & Mayer(1996); Lin & Lin(1993); Kuo(2011) ; Kang(2012)
Domestic Economic	Interest rate	?	Reichert(1990); Ashworth & Parker(1997); Meen(1999); Chang & Chiu (2013)
	GDP	+	Reichert(1990); Ashworth & Parker(1997); Chang & Chiu (2013)
	Investment	+	Reichert(1990); Meen(1999)
Housing supply	Housing supply quantity	-	Case & Mayer(1996); Mayer & Somerville(2000); Chang & Chiu (2013)

The interaction of the regional housing market is derived from the population and capital flows between the regions, and the characteristics and reasons of the flows can be examined by the interactions triggered by economic activities between different regions of the regional economic system.

Friedmann (1966) divided the regional development into a four-stage Core-Periphery model, as seen in figure 2. In the initial stage of regional development, that is, the first stage, the regions have no relationship and independent development. Later, some regions grow relatively fast due to external factors, and regional development has entered the second stage. Compared with other slower growing regions, the faster growing core area becomes the dominant spatial structure. The resources of other periphery areas have been diluted cause the absorbency from core area, making the core area increasingly strengthened. Periphery area is declining, that is, the absorbing effect is greater than the extension effect, until the resources in the core area overflow to the periphery area, which makes the periphery area stimulated and begins to develop. At this time, the extension effect is greater than the absorbing effect, which is the third stage of spatial structure evolution. In the fourth stage, the region became a multi-core zone, and resources were closely intertwined with each other, and the economic system was integrated.

In the same way, regional housing prices are affected by their own regional factors and overall factors, or because the regions are not closed, population movements and information, resources are circulated between regions, etc., causing regional housing markets to interact with each other to generate extension and absorbing effect.

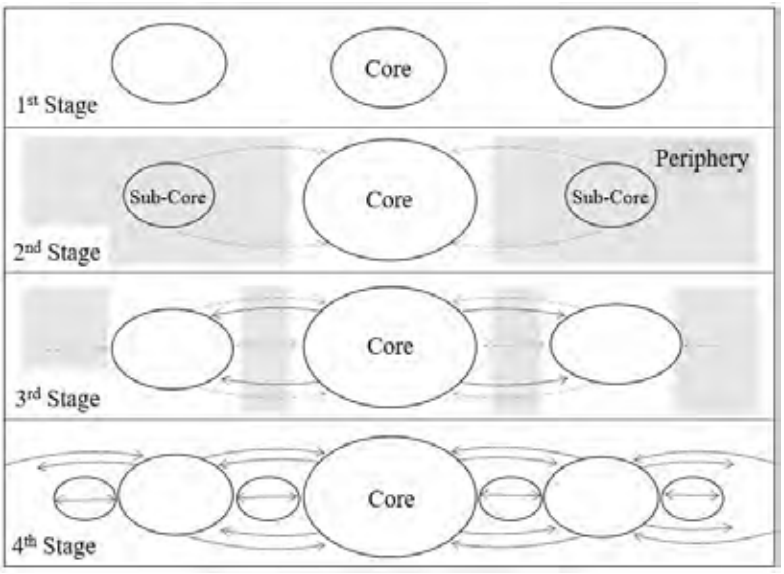

Figure 2 – Friedmann's Core-Periphery theory – model of 4 stages

Reference: Friedmann, J. (1966). Regional Development Policy: A Case Study of Venezuela: M.I.T. Press.

Spatial heterogeneity is unique and complicated characteristic of region. It will affect the housing demand and housing price, and it might be ignored because it is hard to be observed, quantified or only works in specific area. Previous relevant research noticed the existence of spatial heterogeneity, often expressed by the assumption that housing prices in different regions are affected by the same factor. Reichert (1990) established a regional housing price model based on regional housing demand and housing supply, and classified the United States into six regions for empirical analysis. It was found that the effects of overall economic factors and regional factors on regional housing prices were not consistent. Hsiao (1986) proposed to use panel data to solve the problem of bias caused by individual heterogeneity (such as region, person, company, etc.), to exclude the influence of heterogeneity on the explanatory variables, and to exploit the characteristics that heterogeneity does not change with time. After superimposing the cross-section data of different periods, it becomes the comprehensive time-space panel data, and controls the influence of the individual effects on the explained variables. Although the reason for heterogeneity is still can't be identified, the influence of other factors on the explained variables is no longer biased by the heterogeneity.

At present, some studies in Taiwan have explored the reason of regional housing price differences. Kuo (2011) used housing price ratios of each two houses in the six metropolitan areas of Taiwan as explanatory variables, with eight indicators within economic and social aspects, and access the panel data explores the relationship between residential price differences and socio-economic development gaps, and finds that employment opportunities have the greatest impact on regional price differences, followed by public expenditures. Although panel data allows the inclusion of individual heterogeneity, if the individual is a spatial unit, there is another obvious problem, that is, the spatial units are non-closed and may interact with each other. Although the previous researches considered the spatial heterogeneity and apply the panel data, due to the study of regional housing prices, the assumption that the regions are independent of each other is unlikely to be established in reality. There are often populations, industrial resources flowing between adjacent regions, and regional residential markets change simultaneously. Therefore, this study intends to introduce the concept of spatial econometrics, further expand the panel data into spatial panel data, and incorporate the possibility of spatial dependence into the model.

Empirical Approach

To consider both spatial heterogeneity and spatial dependency, this study modified a housing price model based on an investment decision model referred to Meen (1999) with fixed effect and spatial spillover effect. For city i in time period t, the 7 independent variables were interest rate $(IRATE)$, the number of household (HH), income (INC), the unemployment rate (UER), the amount of housing supply (HS), capital gain (CP), and amenities (AMT). γ_i represented spatial time-invariant heterogeneity in city i. λ is spatial spillover effect, if it is significant index, it can prove that there is the impact the housing price in contiguity city j have on city i.

$$HP_{it} = \gamma_{1i} + \lambda \sum_{j=1}^{N} w_{ij} HP_{jt} + \gamma_2 IRATE_t + \gamma_3 HH_{it} + \gamma_4 INC_{it} + \gamma_5 UER_{it} + \gamma_6 HS_{it} + \gamma_7 CP_{it} + \gamma_8 AMT_{it} + \varepsilon_{it} \quad (1)$$

The data included 19 cities and counties (6 metropolitan municipalities, 3 provincial cities and 10 counties) in Taiwan from 2002 to 2014. The data was collected from Construction and Planning Agency Ministry of the Interior and National Development Council.

Table 2 – Narrative statistics of variables

Variables	Average	Standard deviation	Maximum	Minimum
Housing price, HP (NT$)	4,878,000	2,202,000	16,060,000	2,370,000
Income, INC (NT$)	784,000	175,000	1,344,000	475,000
Amenities, AMT (NT$/person)	39,064.9	9,621.5	70,778.7	19,321.3
Household, HH (unit)	400,116.4	372,035.2	1,497,018.0	74,353.0
Housing supply, HS (m2)	1,630,709.3	1,783,541.2	10,494,515.0	90,081.0
Unemployment rate, UER (%)	4.500	0.607	6.000	3.400
Capital gain, CP (%)	0.016	0.104	0.354	-0.371
Interest rate, $IRATE$ (%)	1.962	0.567	3.375	1.250

Results and Discussion

After empirical test, the final model is as followed:

$$ln[HP_{it}) = \gamma_{1i} + \lambda \sum_{j=1}^{N} w_{ij}\, ln[HP_{jt}) + \gamma_2 ln[HH_{it} INC_{it}) + \gamma_3 ln[HS_{it} HH_{it}) + \gamma_4 CP_{it} + \gamma_5 ln[IRATE_{it}) + \gamma_6 ln[AMT_{it}) + \varepsilon_{it} \quad (2)$$

As seen in Table 3, the results show that the spatial spillover effect of housing prices in Taiwan's counties and cities is significantly negative. It means that if one county's housing price increases, the adjacent counties' housing prices will decrease. It is inferred that on average, the absorbing effect of Taiwan's county and city housing markets is stronger than the extension effect. Because the high price of the county or the city means that they are more attractive, which stimulates the concentration of housing demand. Capital also flows into the more attractive counties and cities from the areas which has relatively weaker attractiveness. The gap in attractiveness is increasing, the number of high housing prices continues to increase, and those with low housing prices continue to decline, making the effect of space spillover negative.

The key factor affecting the housing prices in Taiwan's counties and cities is the capital gain rate (CP). Considering the definition of the variables in this study, the capital gain rate is calculated by deducting the last year's housing price from the current year's housing price, then divided by the last year's housing price. If the current housing price changes by 1% compared with the previous period, it will increase the current housing price by 22.3%. This conclusion is similar to the conclusion that Reichert (1990) uses the United States as an empirical region.

The income scale of the area (HHINC) has a significant positive impact on the housing prices of the county. The variable is defined as the average disposable income per household multiplied by the number of households, which represents the sum of the income of each household in the area. If the income scale increases by 1%, the average housing price in Taiwan will rise by 1.059%, and the degree of change between the two is equivalent. The amenities (AMT) measures the quality of public services. The model results are in line with expectations. It positively affects housing prices. It is inferred that people will measure the quality of public services in area when they choose their place of residence. In the case of a city with better public services, there are naturally more people willing to move to the city.

Moreover, the rise in interest rates (IRATE) will lead to an increase in housing prices in the region. This conclusion conflicts with the assumption that deposits and residential market investments are substitutes. However, the model results show that the higher the interest rate, the higher the housing price in the region. This conclusion supports the theory of the Pigou effect, which increases the actual wealth of people due to rising interest rates, stimulating housing demand and increasing housing prices.

Table 3 – HP models by regions

Variables	Taiwan (pooled)		Region					
			Northern (Taipei)		Central (Taichung)		Southern (Kaohsiung)	
	$\widehat{\gamma_k}$		$\widehat{\gamma_k}$		$\widehat{\gamma_k}$		$\widehat{\gamma_k}$	
$\boldsymbol{\lambda}$	-0.178	***	0.291	***	-0.235	*	-0.001	
	(-3.478)		(4.220)		(-2.297)		(-0.017)	
$\boldsymbol{ln(HHINC)}$	1.059	***	0.890	***	1.357	***	1.430	***
	(9.867)		(8.346)		(67.085)		(9.261)	
$\boldsymbol{ln(HSHH)}$	0.012		—		—		—	
	(0.563)							
$\boldsymbol{CP}$	0.223	***	0.177	**	0.202		0.104	
	(3.064)		(2.481)		(1.370)		(0.971)	
$\boldsymbol{ln[IRATE)}$	0.235	***	0.086	***	0.113	***	0.069	*
	(3.585)		(3.266)		(2.739)		(1.739)	
$\boldsymbol{ln(AMT)}$	0.107	***	0.261	***	0.264	***	0.350	***
	(3.978)		(3.228)		(3.396)		(3.215)	
$\boldsymbol{R^2}$	0.929		0.946		0.937		0.920	
$\boldsymbol{N}$	228		72		60		60	

Note： *P<.1, **P<.05, ***P<.01,

In the three major regions of north, central and south, only northern and central region have significant spillover effect index. Northern area is positive, while central area is negative. As seen in figure 3, there is a schematic diagram to show the spillover effect result of this empirical study. In this figure, red color means increasing housing price, blue color means decreasing housing price and gray color means no change of housing price. In terms of northern area, if core city's (Taipei City) housing price is on the rise, adjacent regions' (New Taipei City which covered by red) housing price increase, too. The spatial spillover effect of northern region has a value λ of 0.291, which means that if the price of one city in northern area increases by 1%, the housing price of the neighboring counties in northern area will rise by 0.297%. However, central area has negative index, it means that if core city's (Taichung City) housing price is on the rise, but adjacent regions' (Nantou County, Changhua County and Miaoli County which covered by blue) housing price decrease. If the price of one city in central area increases by 1%, the housing price of the neighboring counties in central area will fall by 0.235%. On the other hand, southern area has insignificant spillover effect index. It indicates that there is no spillover effect happening. In summary, the result of spillover effect shows that the three regions were in different stage of regional development, causing the different characteristic of regional housing market.

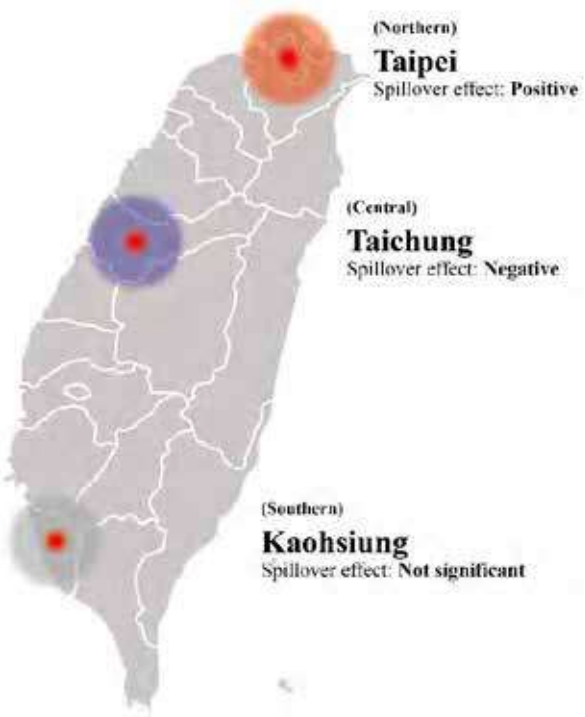

Figure 3 – Spillover effect of housing price in Taiwan

According to Friedmann's Core-Periphery theory, the development current situation of northern region from housing market which belongs to 3rd or 4th stage. In addition, the capital gain rate (CP) of northern region has a significant positive impact on housing price. If CP increases by 1 unit, housing price will rise up by 17.7%. It means that the demand of housing investment affects housing price more than housing consumption.

The demand of housing investment in central region is not significant, and the spillover effect is negative. The results may due to the reason that the central region is less developed than northern region, and central region may absorb resources from neighboring regions. It belongs to 2nd stage of Friedmann's Core-Periphery theory.

In southern region, it is inferred that although southern region developed earlier, but economic development and resources were weaker than northern and central region in late period. Development of region still belongs to 1st stage of Friedmann's Core-Periphery theory. Moreover, compare to the other two regions, the income scale (HHINC), amenities (AMT) have biggest effect among three regions, while capital gain rate (CP) has least effect. It means that household of southern region will be stimulated by increase of actual property. And southern region also has least Pigou effect.

Conclusion

The cities and counties in Taiwan not only have specific characteristic, but also spatial interaction due to the convenient transport facilities and high density population. This study combines panel data model and spatial model to consider both spatial heterogeneity and dependency. The results show that there are structural differences in regional housing market. Through literature review, the differences of regional development are the main reason.

The study limitation

First, this study can only collect data from 2002 to 2014. The number of samples is not sufficient enough to consider more independent variables and discover more phenomenon in housing market, such as the relationships between real estate cycle and the characteristic of regional housing market. Second, this study assumes that the housing price will reflect the changes of the dependent variables in the same period, but it may take times to reflect the changes in reality. Finally, in the model, the interest rate and capital gain are hypothesis to have impact on housing price without considering the possibilities that housing price may also influence interest rate and capital gain.

The study contribution

To investigate the regional differences of housing price in Taiwan, this study combined panel data model and spatial model to consider spatial heterogeneity and dependency simultaneously, finding out that not only the impact of the key factors but also the spatial spillover effect on housing price differed from region to region.

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