我が国都市圏における住宅投資と利子率に関する実証分析*

An Empirical Analysis of Residential Investment and Interest Rates in Japan's Metropolitan Areas

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1. INTRODUCTION

The real option approach has been studied in various fields including infrastructure planning and management.

As mentioned in Capozza and Li (2001), the possibility of positive responses of investment to increase in interest rates is one of the most interesting predictions of real options models of investment. Capozza and Li (2002) models optimal land development decisions and shows the conditions under which positive responses of investment to interest rate increases can occur.

Capozza and Li (2001) tests for these positive interest rate responses in the context of the Capozza-Li model. Their empirical analysis uses panel data set on residential investment in U.S. during the 1980s and finds that between 25 and 50% of the observations are in the positive response region.

This paper aims to analyse the sensitivity of the residential investment to interest rate in Japan and examine the proposition suggested by Capozza and Li.

2. REVIEW OF THE CAPOZZA-LI (2001) & (2002)

This chapter briefly outlines the Capozza-Li (2002) model and its important implications, then reviews the empirical results shown by Capozza and Li (2001).

Capozza and Li (2002) presents a class of land development models where the net rent or cash flow, $X(t)$, at time *t*, grow geometrically and production function for space, $Q(K)$ is constant elasticity of substitution (CES), where *K* denotes the amount of capital used to construct it. The net rent or cash flow, $X(t)$, at time, *t*, is assumed to evolve stochastically over time following geometric Brownian motion of the form

$$\frac{dX}{X} = gdt + \sigma dz , \qquad (1)$$

where g is the mean growth rate, σ is the volatility of the growth rate, and dz is the increment of a standard Wiener process.

The investor can chose the building size as measure by *K*. The investment problem is formulated to choose the number of units of capital, *K*, and the time of development, $T \geq t$, to maximize the value of the development opportunity:

$$W(X) = \max_{T,K} E_t[V(X,T)e^{-r(T-t)}] \qquad (2)$$

where E_t denotes the conditional expectation.

They derive the conditions under which positive responses of investment to interest rate increases can occur. According to their analytical investigation, high growth rates are sufficient to cause the positive response and high volatility increase the likelihood of positive responses when growth rates are positive.

To test this proposition, Cappozza and Li (2001) analyses residential investment in 64 metropolitan areas in U.S. during the 1980s. The growth rate of population is used as a proxy for the growth rate of the real rents in that area, because data on the implicit rents of homeowners are not available. Their paper chooses the primary conventional home

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mortgage rate to present the nominal interest rate. The real interest rate is calculated as the nominal mortgage rate minus the CPI (Consumer Price Index) rate. The elasticity of residential investment is measured by the interest rate elasticity of building permits per capital issued in metropolitan area *i* for year *t* :

$$RATIO_{it} = GHPC_{it} / GRM_t \quad (3)$$

where

$GHPC_{it}$: the annual growth rate of building permits per capita in percent for single-family homes issued in metropolitan area *i* for year,

GRM_t : the annual percentage change in the real mortgage rate for year *t* .

Cappoza and Li (2001) assigns each metropolitan area to quartiles based on the rankings by their average population growth rates (AGPOP) and their volatilities (SGPOP) to examine what determines the effects of interest rate changes on residential investment. The results imply that they are related to both the mean and the volatility of the growth rates. It is estimated that 25-50% of the observations lie in the positive response regions.

3. DATA SET

(1) Study Area

To investigate whether the proposition suggested by Capozza and Li apply to Japan, we select the Tokyo special wards and ordinance-designated cities (12 major cities) for our empirical analysis. The cities whose ward boundaries were modified frequently are eliminated from the sample.

Real options models do not apply to the situations where growth is negative and a project is either undertaken immediately or never. Thus, those with negative average growth rates from the sample are also eliminated. Similarly in U.S., data on the implicit rents of homeowners in Japan are not available. Therefore, following Capzza and Li (2001), the growth rate of population is used as a proxy for the growth rate of the real rents in that area. Consequently, Yokohama, Kawasaki, Kobe and Fukuoka remain in the sample. Even in these cities, some wards are also eliminated because their boundaries were changed.

(2) Period

The period is 1980-1999. We divide the sample into two data sets, one of which spans the period from 1980 to 1989 and the other from 1990 to 1999. The period is selected and the data is divided for the following reasons. First, the sample used in Capozza and Li (2001) spans the period from 1980 to 1989, that is, 10 years. Exactly speaking, since data on annual change are required, the number of panels corresponding to the years is 9 in their case. In our analysis, the data in 1979 are also used and so the number of panels is 20. Second, as is well known, Japan's bubble economy ends in 1990 when the stock market collapsed, which may have a great impact on the economic structure change.

(3) Data Sources

The sources for the data are summarized in Table 1. All of them are frequently used data for economic analysis.

With respect to housing starts of complex housings, the figures are not based on the numbers of buildings but of houses.

The definition of mortgage rate in the model in the context of empirical analysis is ambiguous because many institutions make loans for housing purposes. Roughly speaking, one-third of the housing loans are provided by the Housing Loan Corporation (HLC). Thus, in this paper, we use the standard interest rate for HLC loans as mortgage rate.

4. EMPIRICAL RESULTS

To compare the results with Capozza and Li (2001), we calculate RATIO and make tables based on quartile analysis. Table 3 reports the subgroup means of RATIO at the period 1980-1989, and the Table 4, 1990-1999. The shaded region in these tables

Table 1 The Sources of Data

	This paper	Capozza, D. R. and Li, Y.(2001)
Study Area	Tokyo and the ordinance-designated cities (12 major cities), JAPAN	Metropolitan Statistical Areas (MSAs), U.S.
Period	1980 (1979) -1999	1980-1989
Housing Starts	Annual Reports of Builiding Construction, Ministry of Construction 建築統計年報	The Building Permits Branch of the Bureau of the Census
Population	The Handbook of Population in Japan derived from the Basic Resident , Ministry of Home Affairs 住民基本台帳人口要覧	The Bureau of Economic Analysis of the U.S. DOC
Mortgage Rate	The standarad interest rate for Housing Loan Corporation loans 住宅金融公庫基準金利	The primary conventional home mortgage rate CITIBASE data
Consumer Price Index	Economic survey of Japan, Ministry of Finance 経済白書	The CRSP tape from the University of Chicago

Table 3 & 4 Means of RATIO in Quartiles Ranked by Average Growth Rate and Volatility

Table 3 During the 80s

		AGPOP				Ave.
		0.003	**0.011**	**0.019**	**0.030**	0.008
SGPOP	**0.004**	**21.32**	**37.68**	**NA**	**77.45**	39.09
		20	**20**	**0**	**10**	50
	0.008	**-38.97**	**24.10**	**-90.46**	**161.90**	14.14
		10	**10**	**10**	**10**	40
	0.017	**97.91**	**-138.37**	**NA**	**378.96**	109.10
		20	**10**	**0**	**10**	40.00
	0.282	**NA**	**NA**	**-5.59**	**-9.29**	-6.52
		0	**0**	**30**	**10**	40
Ave.	0.008	39.90	-9.73	-26.81	154.58	39.51
		50	40	40	40	170

Table 4 During the 90s

		AGPOP				Ave.
		0.002	**0.004**	**0.009**	**0.022**	0.009
S	**0.004**	**-2.57**	**1.74**	**3.25**	**NA**	1.78
		10	**20**	**30**	**0**	60
	0.005	**-0.34**	**2.58**	**4.77**	**3.83**	2.66
		10	**30**	**10**	**10**	60
	0.006	**5.21**	**NA**	**4.82**	**13.69**	6.49
		30	**0**	**20**	**10**	60
	0.010	**-0.12**	**5.35**	**NA**	**4.60**	3.94
		10	**10**	**0**	**40**	60
A	0.006	2.10	2.76	4.03	5.99	3.72
		60	60	60	60	240

AGPOP: The average growth rate of population in percent in a ward.
SGPOP: The volatility (standard deviation) of the growth rate of population in percent in a ward.

highlights the cells where RATIO is positive. Positive responses to interest rates are also observed in Japan. It is not only possible but also very common especially during the 1990s.

Table 5 shows the corresponding results extracted from Capozza and Li (2001). This table clearly implies that high growth rates and high volatility increase the likelihood of positive responses, which is consistent with the prediction of Capozza-Li

Table 5 Results from Capozza and Li (2001)

		AGPOP				
		Lowest	**Second**	**Third**	**Highest**	All
SGPOP	**Lowest**	**-2.22**	**-2.88**	**-2.65**	**-1.54**	-2.34
	Second	**-1.14**	**-2.59**	**-0.69**	**0.13**	-1.05
	Third	**-0.39**	**-0.83**	**0.55**	**0.89**	0.06
	Highest	**3.52**	**2.77**	**4.20**	**1.13**	3.04
	All	-2.40	0.28	1.55	0.27	-0.07

model. Table 3 implies that this does not hold in Japan during the 1980s. Furthermore, it is difficult to find a patter in this table. As compared with their results, Table 4 does not show any clear tendency either. However, roughly speaking, it presents that high growth rate promotes positive response.

5. CONCLUDING REMARKS

In this paper, we have analysed the sensitivity of the residential investment to interest rate in Japan during the 1980s and 1990s. Our empirical results imply positive responses, namely, residential construction is increasing when interest rates increase, are observed especially after Japan's bubble economy collapses. The results during the 1990s are more similar to the ones of U.S. during the 1980s.

Since we have just started this study, there remain many things to do.

Investigation of data and trial and error is needed. As shown in Table 3, the range of RATIO during the 1980s are so large. This is because the denominator of $RATIO_{it}$, GRM_t , is nearly zero during 1983-1985. Introduction of CPI for each city could improve this problem.

It is also required to review many empirical researches that deal with residential investment in Japan, and interpret the results from their viewpoints.

As well as Capozza and Li (2001), we have used the growth rate of population as a proxy for the growth rate of the real rents in that area. This is based on the proposition that in metropolitan areas of U.S., a major determinant of the growth rate of the real rents is the growth rate of population in that area. Applicability of this proposition to Japan should be examined. (One of the authors also tried an empirical analysis of UK. However, there are only a few districts whose population increase for at least several years.)

Several types of data on rents are available in Japan. Further investigation into their availability is expected.

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