

The Population Migration in Taiwan, and its Causal Relationship with Labor Market and Housing Market

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This study sets out to empirically examine the interrelationship existing between the labor market, the housing market and domestic interregional migration in Taiwan, with four of the most urbanized population receiving areas, Taipei City, Taipei County, Taichung City and Kaohsiung City, being selected for the study.

An error correction model is constructed for each city/county using time series data covering the period from 1974 to 1999, from which the research results show that each city/county has its own unique relational pattern between population migration, the labor market and the housing market, reflecting their different characteristics and developmental stages.

In Taipei City, the capital city of Taiwan, housing prices are much higher, although this has not been affected by migration or the labor market, since it is instead exogenously determined. In Taipei County, on the other hand, which is part of the Taipei metropolitan area and the major population migration destination, a close interaction exists between housing prices and population migration. As a latecomer in urban development, the relatively better organized city planning in Taichung City was reflected in all variables as being affected by the exogenous variable, local government expenditure. Although the industrialized city of Kaohsiung is faced with the growing

problem of a loss of jobs, along with a housing market recession in recent years, the city's net population migration has thus far been unaffected.

Introduction

According to the Domestic Mobility Survey conducted by the Taiwanese government, ever since the 1980s, about two million people have been moving residence each year in Taiwan. Around half of these migrated as a result of factors related to housing, whilst the other half cited factors related to employment, studies, marriage or other reasons.

Around 80 per cent of those who cited housing reasons remained within the same city or county, whereas around 90 per cent of those who cited other reasons migrated across city or county boundaries. Table 1 provides details of the relationship between reasons for migration and migration destinations, in terms of overall distance.

Table 1: Reasons for Migration and Migration Distance

Reason for Migration	Distance	1986	1989	1992
Moved for employment reasons	intra-city	13.98	16.77	10.90
	inter-city	86.02	83.23	89.10
Moved for housing reasons	intra-city	79.80	80.53	76.58
	inter-city	20.20	19.47	23.42
Moved for education	intra-city	17.69	12.36	11.92
	inter-city	82.31	87.64	88.08

Source: Calculated from 'Domestic Migration Survey of Taiwan Area', DGBAS.

Stimulated by the results of Table 1, Hsueh, et. al. (2000) studied the intra-urban moving in Taiwan, and its relationship with the local housing market. And now we turn our focus of research on the inter-urban moving, in other words, the long-distance migration in this paper.

Some past studies, such as Huang (1991), Bien (1991) and Li (1995), examined the urbanization process in Taiwan, finding that employment opportunities, higher wage rates and lower unemployment rates were major factors affecting the rural-urban mobility rate. However, although a highly urbanized region may provide more employment opportunities, living expenses, particularly housing prices, are also much higher. Thus, from the viewpoint of personal decision-making, the benefits of moving into cities may well be offset by the high costs of accommodation, hence reducing the willingness of people to migrate. If people do decide to move, it is very likely that they will move to the outskirts of an urban city, where housing prices are relatively low and public infrastructure is relatively poor. They

can also choose to migrate to secondary cities where living expenses are considerably lower. In other words, housing prices will affect the locational choice of a migrant; thus, as the recent literature shows, housing prices will not only affect the decision to move, but also the decision on where to move (Gabriel, et. al., 1992; Berger and Blomquist, 1992; Thomas, 1993; and Potepan, 1994).

At an aggregate level, we find that migration also has an affect on both the employment market and the housing market. Promising employment opportunities will undoubtedly attract people to move into a city, thus creating higher demand for housing, and thereby leading to subsequent rises in house prices. The higher price of housing will, in turn, reduce the rate of migration into a country's capital city. Indeed, as the statistics for Taiwan show, the net population change in Taipei City turned negative in 1991. Clearly, the soaring housing prices from the late 1980s stand out as a major factor contributing to such a development.

Population migration, the labor market and the housing market are clearly interrelated at an aggregate level and we argue that the causal relationship between these factors may be different for different cities and in different stages of development. Empirical research in this area is, however, somewhat rare in the literature.

In this paper, therefore, we intend to study the relationship between these three factors in the four most urbanized areas of Taiwan, namely, Taipei City, Taipei County, Taichung City and Kaohsiung City¹. Macro-data covering the period from 1974 to 1999 is collected, with an error correction model being applied to the empirical estimation.

The remainder of this paper is arranged as follows. The next section describes the population changes within these four cities/counties over the past thirty years, followed by the development of a conceptual framework and literature review. The subsequent section presents the empirical model, testing procedures, data sources and variable definitions, then followed by the analysis of empirical results. Finally, it is the conclusions of this study.

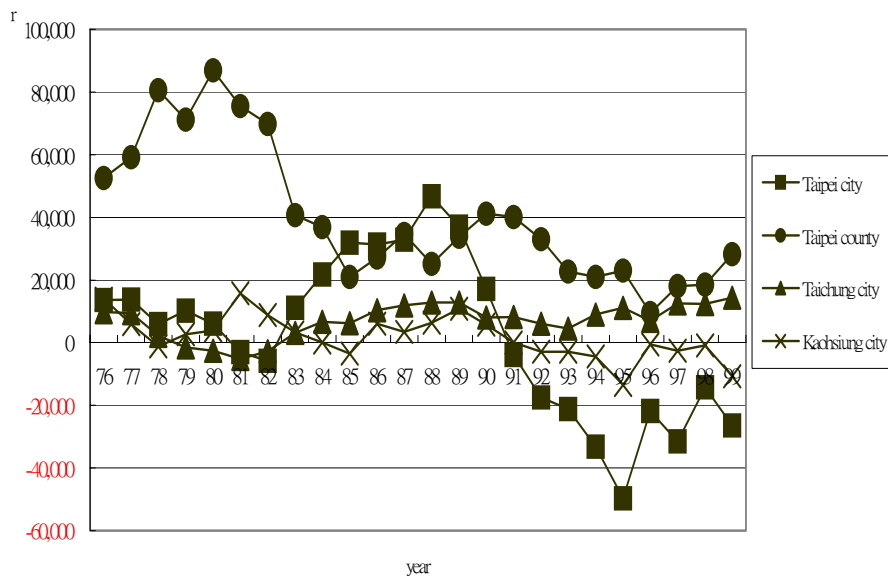
¹ Although Taipei City and Taipei County comprise the Taipei metropolitan area, Taipei County, which in itself consists of several high density townships and cities, has its own independent urban functions, therefore, we consider it as an independent unit for the purposes of this study.

POPULATION CHANGES IN TAIWANESE CITIES/COUNTIES

During the 1970s, population migration to urban areas was significant in Taiwan, with people generally moving to three major metropolitan regions, Taipei City, Taipei County and Taoyuan County in the northern region, Taichung City and Taichung County in the central region, and Kaohsiung City, Kaoshiung County and Tainan City in the southern region. Although this migration has continued, it nevertheless slowed down in the 1980s, with the number of people moving to city outskirts, such as the County areas of Taipei, Taichung and Kaohsiung, being greater than the number of people moving into the metropolitan central city areas. This population movement has largely stabilized in the 1990s, with only the Taichung metropolitan area and Taoyuan County experiencing any significant net population growth.²

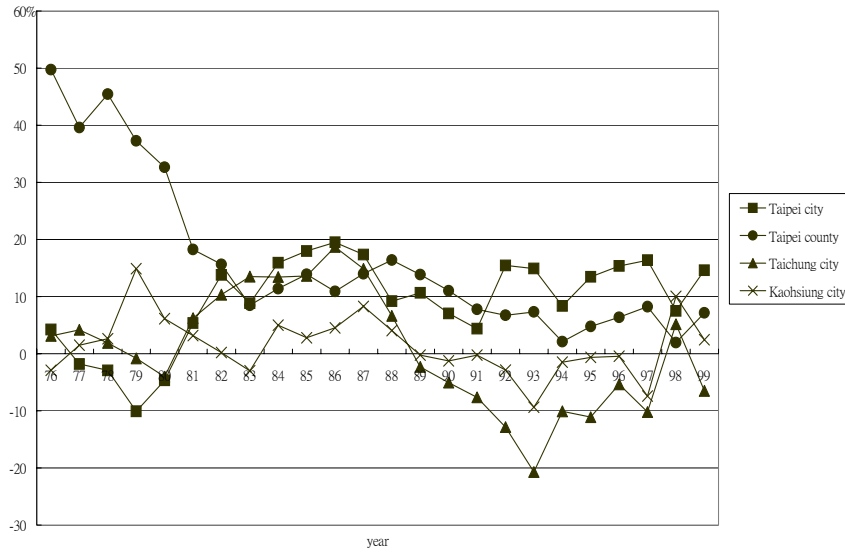
Figure 1 provides details of the net population changes for the period from 1976 to 1999 for each of the cities/counties examined in this study, whilst details of the net migration rate are provided in Figure 2.

Figure 1: Net Population Changes, 1976-1999



² See Appendix Table 1

Figure 2: Net Migration Rate, 1976-1999



Taipei County stands out as the major migration destination in Taiwan for the majority of the past thirty years. Although the number of people migrating into Taipei County peaked in the 1970s, it has nevertheless continued to experience annual net population gains of around 20,000 to 40,000 people. In terms of the migration rate, Taipei County was the highest prior to the 1990s, but has now been caught up by Taichung City.

The peak for migration into Taipei City occurred in the 1980s. From 1982 to 1988, there was a net annual population increase of around 20,000 to 40,000; however, from 1989, people began to move out of Taipei City, mainly as a result of the high housing costs. Taichung City, as a relative newcomer in Taiwan's urban development, has seen steady gains of around 10,000 persons each year since 1981, with an annual migration rate of 10 percent to 20 percent.

As an industrial city, Kaohsiung saw steady growth in its population prior to 1989; however, in the 1990s, there have been signs of some people starting to move out of Kaohsiung. As compared with other places, changes in the size of the total population in Kaohsiung have been relatively small throughout the whole of the data period.

CONCEPTUAL FRAMEWORK AND LITERATURE REVIEW

The relationships between population migration, the labor market and the housing market can be analyzed from a standpoint of individual decision-making or from an overall market perspective. The analysis framework is expressed in Figure 3.

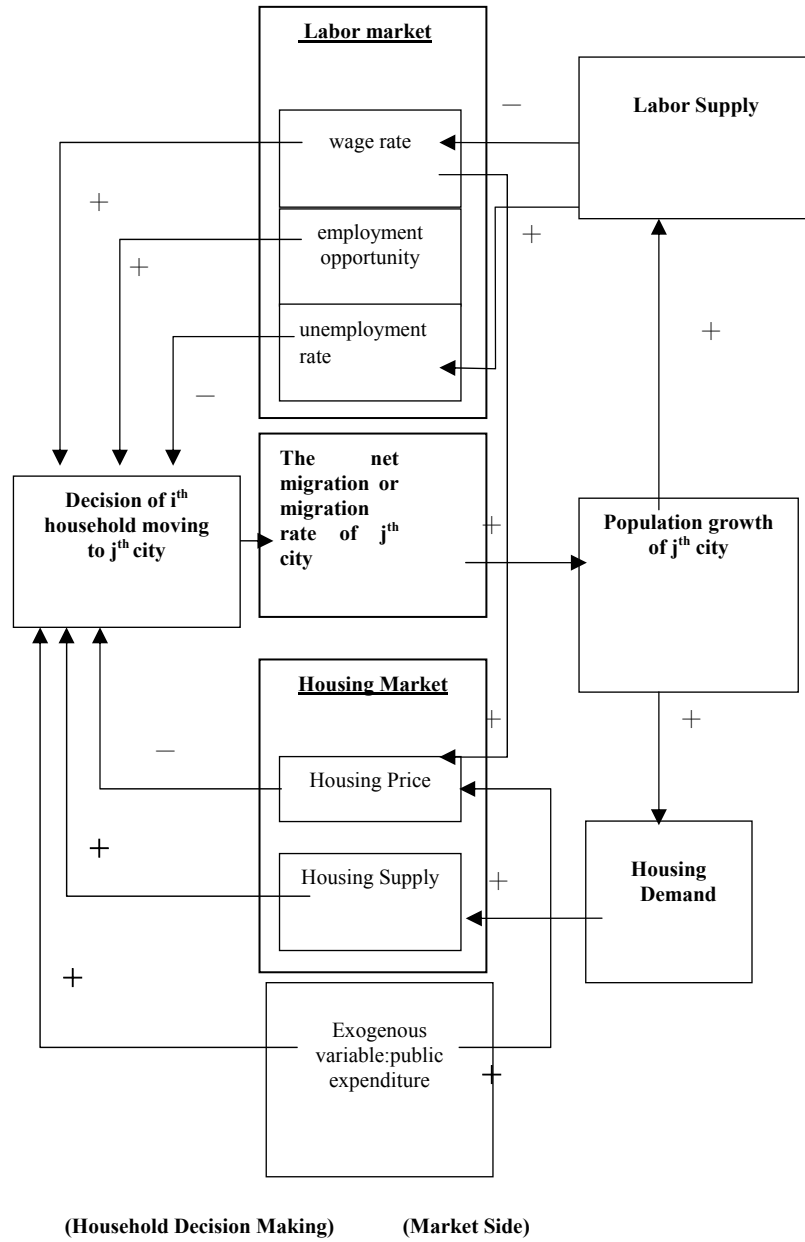
The left hand side of the figure shows that higher wage rates, greater employment opportunities and lower unemployment rates will positively affect a household's decision to move to an urban city, whereas higher housing prices will discourage the move. Factors such as higher public expenditure on infrastructure and education will also positively affect the decision to move. The aggregation of an individual household's final migration decision determines the overall population growth of a city, which in turn determines the available labor force for the local labor market, subsequently forming the overall demand for accommodation.

The right hand side of Figure 3 shows the market side interrelationship between these variables. In terms of housing price, stronger housing demand, higher wage rates, and higher government expenditure all have positive effects. On the other hand, the growth in the city population will negatively affect wage rates and positively affect the unemployment rate.

Through the use of a social welfare function to estimate the effects on rural-urban migration, Huang (1991) found that the rural-urban gap was more important than the distribution of local public expenditure. Hsu (1992) found that wage rates, housing rents and the unemployment rate affected the decision to move and the eventual destination.

Berger and Blomquist (1992) used micro data from the 1980 US Census to estimate the impact of wages, housing costs, quality of life and moving costs on the likelihood of a move, and the selection of the destination, finding that wages and moving costs were of the utmost importance in the eventual decision on whether or not to move. The quality of life, wages and housing prices were, however, all important factors in the choice of destination. Potepan (1994) used a simultaneous equation model to explore the simultaneous relationship between housing prices and inter-metropolitan migration, using data from 1975 to 1980 on fifty-two metropolitan areas in the US. He found that higher net migration rates raised metropolitan housing prices, simultaneously discouraging further net migration.

Figure 3: The Relationship between the Labor Market, Housing Market and Interregional Migration



Thomas (1993) used a logit model to estimate the destination choice of migrants using individual data from the UK Labor Force Survey. He found that job seekers were attracted to areas with high wages but were not affected by the high housing prices in such areas. Regional house price differences did not influence the choice of destination for homemakers but they did influence the choice of destination for retirees.

In summary, the current literature on Taiwan has paid greater attention to determining the extent to which different factors affect rural-urban migration; whereas the English literature finds that wage rates and housing prices affect the individuals' decisions to move and their destination choice. This study aims to further consider the causal relationship between migration, the labor market and the housing market from a market perspective.

EMPIRICAL MODEL, ESTIMATION METHOD AND DATA DESCRIPTION

The error correction model developed by Johansen and Juselius (1990) and Johansen (1991; 1995) is used to explore the causal relationships between the labor market, the housing market and regional migration in Taipei City, Taipei County, Taichung City and Kaohsiung City in Taiwan, using the data period 1974 to 1999.

Empirical Model and Estimation Method

Using Taipei City as an example, let net migration (N), wage rates (W), and house prices (P) represent population migration, the labor market and the housing market, respectively. Assuming the three variables are all I (1) series with a co-integration relationship. Public expenditure (G) is an exogenous variable. A system of error correction model can be expressed as follows:

$$\Delta N_t = \alpha_{11} + \alpha_{12}(EC_{t-1}) + \sum_i w_{1i} \Delta N_{t-i} + \sum_i \phi_{1i} \Delta P_{t-i} + \sum_i \gamma_{1i} \Delta W_{t-i} + \sum_i \theta_{1i} G_{t-i} + \varepsilon_t \dots \dots (1.1)$$

$$\Delta P_t = \alpha_{21} + \alpha_{22}(EC_{t-1}) + \sum_i w_{2i} \Delta N_{t-i} + \sum_i \phi_{2i} \Delta P_{t-i} + \sum_i \gamma_{2i} \Delta W_{t-i} + \sum_i \theta_{2i} G_{t-i} + \varepsilon_t \dots \dots (1.2)$$

$$\Delta W_t = \alpha_{31} + \alpha_{32}(EC_{t-1}) + \sum_i w_{3i} \Delta N_{t-i} + \sum_i \phi_{3i} \Delta P_{t-i} + \sum_i \gamma_{3i} \Delta W_{t-i} + \sum_i \theta_{3i} G_{t-i} + \varepsilon_t \dots \dots (1.3)$$

Where $EC_{t-1} = M_{t-1} - \beta_1 P_{t-1} - \beta_2 W_{t-1}$ is the error correction term of lagged one period, which describes the long-term relationship of these three variables. Coefficients $\alpha_1, \alpha_2, \alpha_3$ describe the adjustment speed when a disequilibrium occurs between the three variables. Coefficients, ω, ϕ, γ , for the first

difference in the lagged explanatory variables represent the short term causal relationship between variables. θ is the coefficient for G, and ε is the error term.

The method used to test the causal relationship between time series in the error correction model is as follows. First of all, a test is conducted to determine whether the time series are stationary. If the series are non-stationary, and are integrated of the same order, then further testing can be conducted to determine whether there is a co-integration relationship. If such a relationship exists within the time series, then the co-integration parameters can be estimated. The co-integration equation obtained can be used for the further construction of an error correction model.

In order to distinguish between the short-term and long-term relationship, we perform separate causality tests for the error correction term and for lagged explanatory variables. A t-test is performed to determine whether the coefficient of the error correction term is significantly different from zero. A significant coefficient means that the variables in the vector have a long-term relationship.

An F-test is performed to determine whether the combined coefficients of all lags of a specific explanatory variable are different from zero. If it is significantly different from zero, we can then say that a relationship of causality exists between the variables on a short-term basis.

When any data series is stationary or a co-integration relationship cannot be found between a vector of data series, the same procedure will be applied to pairs of variables in that vector.

Variable Definition and Data Source

This study uses time series data for the period 1974 to 1999, taking the four main urban areas of Taipei City, Taipei County, Taichung City and Kaohsiung City as the objects of the research. The geographical location and basic information, including the population and size of areas, are provided in Appendix Figure 1.

The variables considered include wage rates, employment opportunities and the unemployment rate (all of which represent the labor market), standard house prices (representing the housing market) and net population migration. Local public expenditure is also included as exogenous variable. The definition of each of these variables and their data sources are listed in Table 2.

Table 2: Definition of Variables and Data Sources

Variables	Definition	Data source
Net Population Migration (N)	Net population migration = total migrating population - Intra-city migrating population - total moving-out population	Statistical Abstract of Cities and Counties (1974-1999)
Wage Rates (W)	Wage rate = Average wages/salaries per household per month ÷ average number of persons employed per household (Adjusted with CPI, 1996 = 100)	Statistical Abstract of Cities and Counties
Employment Opportunities (O)	Number of business enterprises registered	Statistical Abstract of Cities and Counties
Unemployment Rate (E)	Unemployment rate	Statistical Abstract of Cities and Counties Chang and Lin (1999), <i>Housing Information System Integration and Planning</i>
Housing Prices (P)	Value of a standard house	
Local Public Expenditure (G)	Public Expenditure = expenditure on Education, Science and Culture + Police Services + Communication + Public Health	Statistical Abstract of Cities and Counties

Notes:

- 1 Because of the lack of details on the average number of persons employed per household for Taipei county in 1991-1997, we use the data from 'Report on the Survey of Family Income and Expenditure in Taiwan Area of Republic of China', DGBAS.
- 2 There are some differences in items between cities, but all include: Agriculture, Forestry, Fishing, and Animal Husbandry, Mining and Quarrying, Manufacturing, Water, Electricity and Gas, Construction, Commerce, Transport, Storage and Communication Financial, Insurance, Real Estate and Business Services, Social and Personal Services. Because of system changes in data collection, Taipei and Taichung were in a situation of data series disruption in 1990. This research uses the increasing rates per year as the basis for adjustment for years before 1990 and assumes the growth rates between 1989-1990 are the same as previous year. The data series was adjusted backward from 1990 to 1974.
- 3 We calculate the unemployment rate as follows: (Unemployed Population) ÷ (Economically Active Population Aged 15 Years and over).
- 4 The price of standard houses in 1998 is the average price of four seasons and also the price of the first season in 1999.
- 5 The public expenditure amount includes both realized and audited figures. After 1990, expenditure on public health is subdivided into expenditure for health and expenditure for environmental protection.

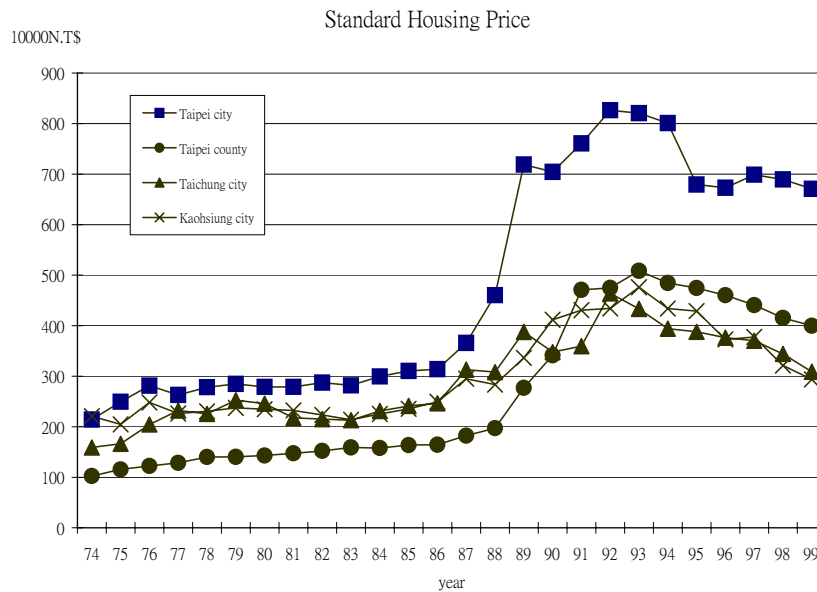
Descriptive Statistics of Variables in the Four Cities/Countries

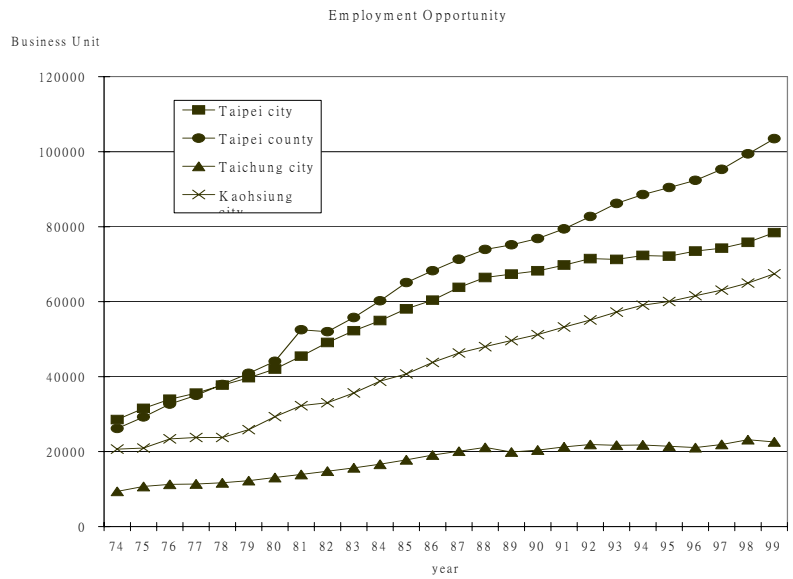
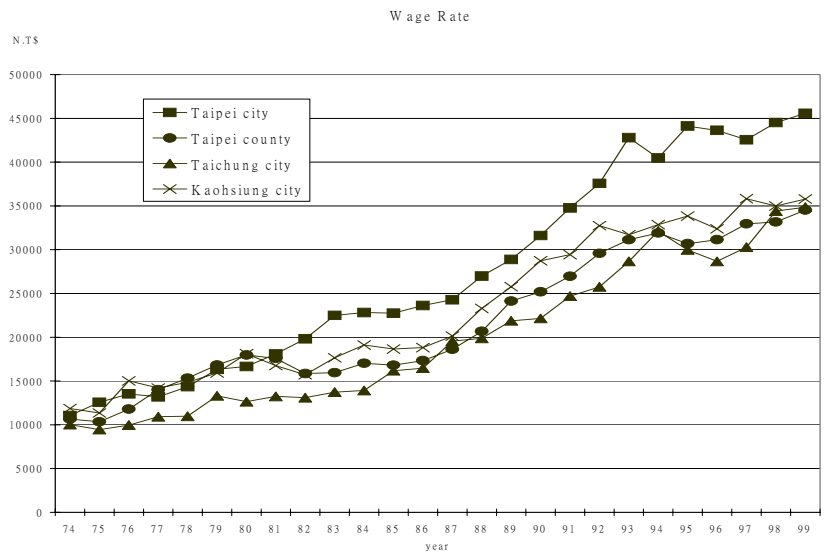
The average values of the variables in the four cities/counties are presented in Table 3, whilst the data series of the variables are plotted in Figure 4.

Table 3: Average Value of Variables

Variables	City/County			
	Taipei City	Taipei County	Taichung City	Kaohsiung City
N (persons)	1821	38544	7204	2401
P (NT\$ x 10,000)	480.44	267.94	294.03	303.03
W (NT\$)	27502.94	21857.57	19879.33	23291.54
E (per cent)	2.43	1.96	2.30	2.81
O (business unit)	57462	65956	17705	43423
G (NT\$ x 1,000)	47,099,300	18,172,198	7,513,646	16,158,265

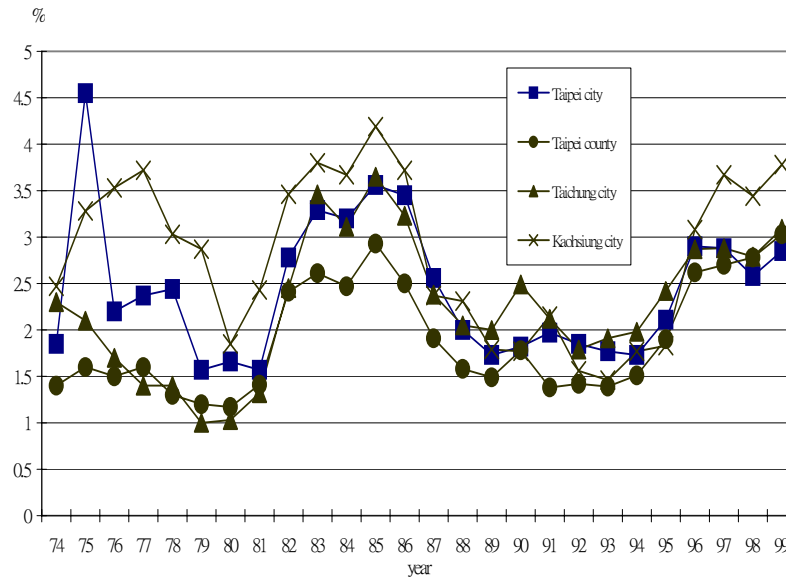
Figure 4: Variable Trends



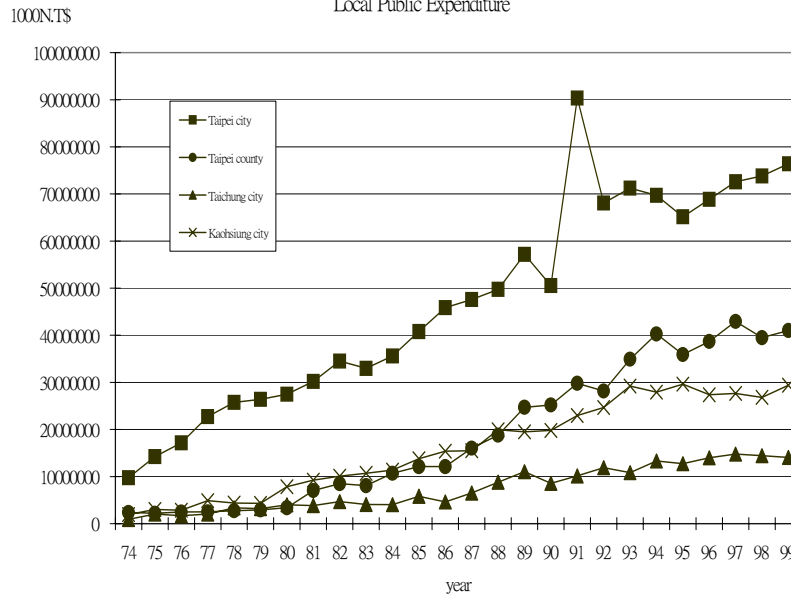


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Unemployment Rate



Local Public Expenditure



Throughout the data period, the standard housing prices (P) for Taipei were the highest among all four cities/counties. During the late 1980s, there was a dramatic increase in housing prices in all four cities/counties, but they gradually declined in the 1990s; nevertheless, prices in Taipei City increased the most, and have subsequently declined the least. Prior to 1980, housing prices in Taipei County were the lowest amongst the four; but prices have climbed during the 1990s, making it now the second highest, after Taipei City. Price trends in Taichung City and Kaohsiung City have been quite similar throughout the period.

Average wage rates (W) in Taipei City have become distinctly higher than those of the other three cities/counties since 1984, with Kaohsiung City ranking second, Taipei County third, and Taichung City the lowest. Nevertheless, wage rates in all four cities/counties grew steadily throughout the period, with particularly rapid rises during the period from 1987 to 1993, a time when wages grew by 43 per cent in Taipei City, 40 per cent in Taipei County, 31 per cent in Taichung City, and 36 per cent in Kaohsiung City.

The number of business registrations (O) within a particular area can represent the available employment opportunities; this has grown fastest in Taipei City and Taipei County. However, the growth rate slowed down in the 1990s in Taipei City. Of all four cities/counties, Taipei County has seen the highest number of business registrations since 1982, with Taipei City ranking second, Kaohsiung City third, and Taichung City fourth.

The unemployment rate (E) can be used to measure the business cycle. The cyclical patterns of the four cities/counties are quite similar, and the difference between them is becoming smaller. Although the unemployment rate was rather high during the mid-1980s, due to the energy crisis, it also started climbing again in the late 1990s, due to changes in the industrial structure of Taiwan. In general, Taipei County has had the lowest unemployment rate since the mid-1980s, whereas Kaohsiung City has had the highest.

The amount of local public expenditure is defined as including expenditure on science and education, police, transportation, public health and environment protection, each of which are considered to be the most relevant items to the quality of life in a city. The amount of public expenditure has been much higher in Taipei City than in each of the other cities/counties, due to its special status as the capital city of Taiwan.

EMPERICAL RESULTS

Unit Root Tests

Prior to undertaking the co-integration test between the variables, we must first determine whether the variable series are not stationary. This study uses the Dickey-Fuller (DF), Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) methods for testing; t-tests are also used to determine whether to include a deterministic trend. The results of the unit root tests shows that with the exception of O for Taipei City and N for Kaohsiung City, all other variables pass at least two of the three tests at the 10 per cent significance level for not stationary. After taking the same tests for the first difference of these data series, they are found to be I (1) series (see Table 4). The first difference in O for Taipei City passes all three testing methods, hence ΔO is used with other variables to construct the error correction model. However, the N for Kaohsiung City passes only one test method, and the first difference in N cannot pass any of the three tests, therefore, it is considered to be a stationary series, which cannot be used to construct an error correction model in the next step.

Co-integration and Causality Tests

As mentioned earlier, wage rates (W), employment opportunities (O) and the unemployment rate (E) will be used, in turn, with house prices (P) and net population migration (N) to perform the co-integration test and subsequently, the causality test. If a co-integration relationship does not exist for a set of variables, the error correction model cannot be constructed and the causality test cannot be performed. Where this occurs, the same test procedure will be applied to pairs of variables.

For the sake of brevity and ease of reading of the main text, all of the tables showing the test results of the co-integration relationship are included in the Appendix to this paper. These tables provide details of the trace statistics, Jarque-Bera statistics, the normalized co-integration vector and the optimal lagged periods.

The trace statistics are used to determine the number of co-integration equations between the variables, and the Jarque-Bera statistics are used to determine whether the residual terms are of normal distribution, so as to enable selection of the optimal lagged periods. The results of the three sets of co-integration and causality tests are reported as follows:

Table 4: Unit Test Results

Variables	Test in level			Test in 1 st difference			Test in 2 nd difference			Tr ²	I(n)	
	DF	ADF ¹	PP	DF	ADF ¹	PP	DF	ADF ¹	PP			
Taipei City	N	-1.926	-2.484(2)	-2.014	-5.598***	-3.679*(6)	-5.588***	-	-	-	Y	I(1)
	W	-2.052	-2.664(3)	-2.090	-5.534**	-0.914(10)	-5.566***	-	-2.938*(5)	-	Y	I(1)
	P	-0.939	-0.461(6)	-1.036	-3.573*	-2.565(5)	-3.654**	-	-4.873***(1)	-	N	I(1)
	O	-3.132	-1.172(8)	-2.426	-2.360	-1.679(6)	-2.340	-	-1.536(7)	-	N	I(2)
	E	-3.328	-2.357(2)	-3.443	-8.850***	-2.948*(3)	-7.855***	-	-	-	N	I(1)
Taipei County	N	-1.364	-2.208(2)	-1.378	-5.597***	-3.402***(4)	-5.569***	-	-	-	Y	I(1)
	W	0.040	-2.582(3)	-0.125	-3.246**	-3.009*(5)	-3.276**	-	-	-	Y	I(1)
	P	-0.750	-1.872(2)	-0.920	-2.775*	-2.375(2)	-2.874*	-	-1.289(9)	-	N	I(1)
	O	-1.876	0.020(7)	-1.841	-5.583***	-4.188***(1)	-5.604***	-	-	-	N	I(1)
	E	-0.942	-3.119(3)	-1.330	-3.361**	-2.196(4)	-3.333**	-	-3.147***(3)	-	N	I(1)
Taichung City	N	-1.612	-1.817(2)	-1.744	-4.706***	-3.806***(4)	-4.728***	-	-	-	N	I(1)
	W	-2.466	-1.851(3)	-2.436	-5.223***	-3.760***(1)	-5.273***	-	-	-	Y	I(1)
	P	-1.689	-0.957(7)	-1.676	-5.069***	-3.371***(1)	-5.071***	-	-	-	N	I(1)
	O	-1.942	-2.521(8)	-1.894	-3.705**	-1.381(8)	-3.686**	-	-3.640***(4)	-	N	I(1)
	E	-1.544	-1.593(6)	-1.774	-3.260**	-2.942*(5)	-3.242**	-	-	-	N	I(1)
Kaohsiung City	N	-3.960**	-2.076(5)	-3.984**	-	-3.826***(1)	-	-	-	Y	I(0)	
	W	-2.166	0.252(6)	-2.146	-6.285***	-1.898(5)	-6.227***	-	-1.855(5)	-	N	I(1)
	P	-1.131	-2.203(3)	-1.260	-4.083***	-1.481(4)	-4.173***	-	-4.332***(9)	-	N	I(1)
	O	-2.164	-1.840(3)	-2.309	-4.251***	-2.898*(2)	-4.241***	-	-	-	Y	I(1)
	E	-1.659	-1.799(6)	-1.965	-4.052***	-2.934***(3)	-4.048***	-	-	-	N	I(1)

Notes:

- 1 The truncation lag in the ADF test is shown in parentheses, and the criterion for selection is to minimize AIC. The Newey-West automatic truncation lag selection is used in the PP test, with a truncation lag number of 2 for all PP tests.
- 2 Each test regression includes a constant: a 'Y' in the Tr column indicates that a linear trend is included, an 'N' indicates that it is not.
- 3 *, **, *** indicate that the series does not include a unit root, with significance at 10 percent, 5 percent and 1 percent, respectively.
- 4 Cells containing a hyphen (-) indicate that the series is stationary.

The First Set - Wage Rates as a Labor Market Variable

Appendix Table 2 shows that a co-integration relationship exists within this set of variables for Taipei City, Taipei County and Taichung City. The results of causality tests from the error correction model for these three cities are shown in Tables 5 to 7.

For Taipei City, net population migration (N) is affected by the error correction term, which means N, P, and W have a long-term relationship. As for short-term causality, N affects W, and G affects P. G also affects N at the 10 per cent significance level.

Table 5: The EC Model Results for Taipei City (W)

Right-hand side variables	Explanatory variable				
	EC	N	P	W	G
N	-0.938668 (-4.01591)		0.322641 (0.808987)	0.249393 (0.860111)	3.029062 (0.109647)
P	-0.000416 (-0.28612)	1.564819 (0.253418)		1.451692 (0.280970)	7.095436 (0.022040)
W	0.048524 (1.56619)	3.253357 (0.063604)	2.138434 (0.153280)		0.328455 (0.578098)

Notes:

- 1 The value in the 'EC' column is the coefficient of the error correction term; t-value is in parentheses. The value in the 'explanatory variable' column is the F-value of the Histogram Normality test; P-value is in parentheses.
- 2 The truncation lag of variables in the EC model is the same as that in the co-integration test.
- 3 The two-tailed t-statistics is 1.706 at the 10 per cent significance level.

For Taipei County, N is also affected by the error correction term. As for the short-term relationship, both W and N affect P.

Table 6: The EC Model Results for Taipei County (W)

Right-hand side variables	Explanatory variable				
	EC	N	P	W	G
N	-2.275235 (-4.21137)		0.207980 (0.888078)	0.478230 (0.706255)	0.001608 (0.968995)
P	-0.003205 (-1.22157)	3.104572 (0.088910)		3.927005 (0.054087)	0.940328 (0.360594)
W	0.107886 (1.05346)	1.159375 (0.383329)	2.254472 (0.159244)		0.186738 (0.677057)

Notes: The same as Table 5.

For Taichung City, P is affected by the error correction term. As for the short-term relationship, P affects N, and G affects W.

Table 7: The EC Model Results for Taichung City (W)

Right-hand side variables	Explanatory variable				
	EC	N	P	W	G
N	-0.280693 (-0.90474)		3.526794 (0.052195)	1.413396 (0.291042)	0.863781 (0.372629)
P	0.009284 (3.93871)	0.968922 (0.441930)		1.376614 (0.301096)	2.204525 (0.165689)
W	0.060404 (0.67413)	0.661173 (0.592910)	0.835118 (0.502211)		9.340144 (0.010927)

Notes: The same as Table 5.

The Second Set – Employment Opportunities as a Labor Market Variable

We find that a co-integration relationship exists between employment opportunities (O), housing prices (P) and net population migration (N) for Taipei City, Taipei County and Taichung City (see Appendix Table 3).

The results of the error correction model estimation show that for Taipei City, ΔO is affected by the error correction term; for Taipei County, P is affected by the error correction term, and G affects N in the short run; for Taichung City, O is affected by the error correction term with G affecting N and O in the short term (see Tables 8 to 10).

Table 8: The EC Model Results for Taipei City (ΔO)

Right-hand side variables	Explanatory variable				
	EC	N	P	ΔO	G
N	-0.200003 (-0.52581)		1.210470 (0.386072)	0.946839 (0.490587)	0.044111 (0.839629)
P	-0.002206 (-1.69275)	0.791231 (0.566335)		0.920785 (0.502497)	0.850119 (0.387193)
ΔO	-0.117737 (-1.85620)	0.319950 (0.856197)	0.376147 (0.819139)		0.425195 (0.535173)

Notes: The same as Table 5.

Table 9: The EC Model Results for Taipei County (O)

Right-hand side variables	Explanatory variable				
	EC	N	P	O	G
N	-0.509446 (-0.89373)		1.877177 (0.219310)	2.279832 (0.160827)	3.939312 (0.085958)
P	-0.003835 (-1.82496)	1.287732 (0.360419)		0.645530 (0.647493)	0.249914 (0.632465)
O	0.012109 (0.11817)	1.243858 (0.374735)	0.439717 (0.777048)		0.369809 (0.562312)

Notes: The same as Table 5.

Table 10: The EC Model Results for Taichung City (O)

Right-hand side variables	Explanatory variable				
	EC	N	P	O	G
N	0.088493 (1.23066)		1.140918 (0.410981)	2.690894 (0.119881)	19.77699 (0.002982)
P	-0.000227 (-0.23328)	1.472930 (0.306658)		2.090139 (0.185595)	0.195771 (0.671505)
O	0.016542 (1.90402)	0.594269 (0.678321)	1.114134 (0.421057)		20.39036 (0.002747)

Notes: The same as Table 5.

The Third Set – Unemployment as a Labor Market Variable

The tests show that co-integration does exist between the three variables, E, P and N, for Taipei County and Taichung City, but it does not exist for Taipei City. Co-integration tests for pairs E and P, and E and N were then conducted, with no co-integration found between E and P (see Appendix Tables 4 and 5).

The estimation results of error correction model show that for Taipei City, E is affected by N in the long term (see Table 11).

Table 11: The EC Model Results for Taipei City (E, N)

City	(N,E)					
	EC	N → E N	G	EC	E → N E	G
Taipei City	-1.202410 (-4.25677)	1.256562 (0.327101)	5.159654 (0.039422)	2206.999 (0.16831)	0.318323 (0.811976)	0.113863 (0.740794)

Notes:

- 1 The value in the 'EC' column is the coefficient of the error correction term; t-value is in parentheses. The value in the 'variable' column is the F-value of the Histogram Normality test; P-value is in parentheses.
- 2 The truncation lag of variables in the EC model is the same as that in the co-integration test.
- 3 The two-tailed t-statistic is 1.706 at the 10 per cent significance level.
- 4 E → N means E Granger Cause N.

For Taipei County, N and E are both affected by the error correction term. As for the short-term effect, N affects E, and G affects P (see Table 12).

Table 12: The EC Model Results for Taipei County (E)

Right-hand side variables	Explanatory variable				
	EC	N	P	E	G
N	-1.666580 (-2.29969)		0.990879 (0.444673)	0.869405 (0.495798)	0.007966 (0.961074)
P	-0.001111 (-0.49302)	0.689207 (0.583649)		0.745757 (0.554447)	3.740414 (0.089166)
E	-0.000109 (-3.18129)	4.046962 (0.050541)	1.890134 (0.209692)		0.001713 (0.967999)

Notes: The same as Table 5.

For Taichung City, N is affected by the error correction term. As for the short-term effect, N affects E, and G affects all three variables, N, E and P (see Table 13).

Table 13: The EC Model Results for Taichung City (E)

Right-hand side variables	Explanatory variable				
	EC	N	P	E	G
N	-0.953787 (-2.25723)		0.647579 (0.606133)	1.490411 (0.289180)	3.618054 (0.093662)
P	0.002973 (0.41951)	2.535356 (0.130210)		1.788046 (0.227182)	14.09009 (0.005595)
E	0.000067 (0.86000)	3.282957 (0.079418)	0.309850 (0.817901)		4.801511 (0.059806)

Notes: The same as Table 5.

The Estimation for Kaohsiung City

Because N is stationary, it cannot be co-integrated with the other variables; therefore, the co-integration test is only performed between pairs of variables, W and P, O and P, and E and P. The results show that co-integration exists for all three pairs of variables (see Appendix Tables 6 to 8)

The estimation results of the error correction model show that in the long term, W and O affect P. P affects E in both the short term and the long term. In addition, G affects E (see Table 14 to 16).

Table 14: The EC Model Results for Kaohsiung City (P, W)

City	(P, W)					
	P → W			W → P		
	EC	ΔP	G	EC	ΔW	G
Kaohsiung	1.410305 (0.10500)	2.360734 (0.117150)	0.746925 (0.405903)	-0.483487 (-2.93084)	0.454989 (0.767181)	0.102733 (0.754580)

Notes: The same as Table 11.

Table 15: The EC Model Results for Kaohsiung City (P, O)

City	(P, O)					
	P → O			O → P		
	EC	ΔP	G	EC	ΔO	G
Kaohsiung	-4.045450 (-0.54912)	2.523115 (0.101174)	0.365804 (0.557571)	-0.757246 (-3.24067)	0.635936 (0.647489)	0.203173 (0.660927)

Notes: The same as Table 11.

Table 16: The EC Model Results for Kaohsiung City (P, E)

(P, E)

City	P → E			E → P		
	EC	ΔP	G	EC	ΔE	G
Kaohsiung	-0.014134 (-4.81964)	3.688819 (0.038025)	9.162876 (0.009053)	0.070392 (0.29183)	0.758882 (0.535569)	0.414475 (0.530113)

Notes: The same as Table 11.

Discussion of the Results

For convenience in synthesizing the estimation results, all of the results from the error correction model estimation are depicted in Figure 5, from which we can determine that each of the cities/counties has its own unique relational pattern between population migration, the labor market and the housing market.

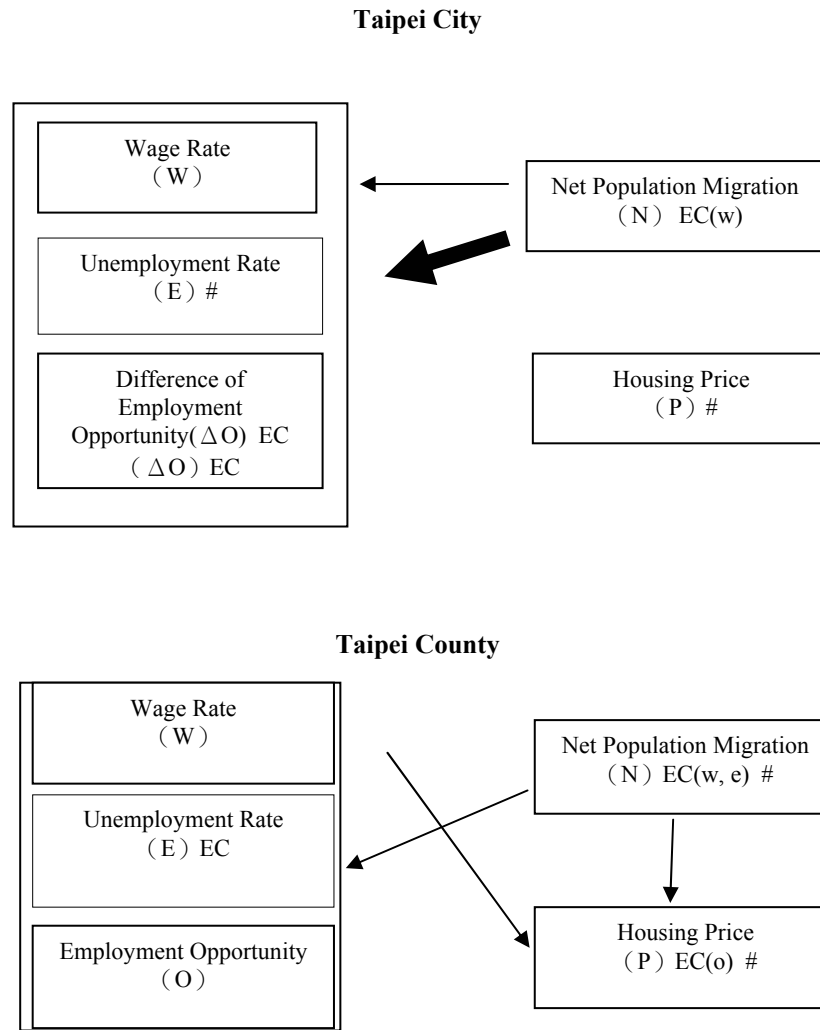
Basically, with the exception of Kaohsiung City, net population migration has been affected by the other two markets on a long-term basis which confirms the central theme of this study.

In terms of individual cities/counties, we find that Kaohsiung City is a special case. Its net population migration is stationary, which implies first of all that the change in net migration has not been affected by other factors, and secondly, that it has no influence on other markets. However, the labor market and housing market interact closely, in both the short and long term. The increase in wage rates raises the demand for housing quality, which in turn increases housing prices. The data trend prior to 1990 coincides with this development, but during the 1990s, the traditional manufacturing industries in Taiwan, which were centered around Kaohsiung City, started to lose their competitiveness, and many subsequently moved overseas. The loss of job opportunities weakened the housing market in the 1990s, and thus dampened housing prices. Statistics show that the number of construction firms in Kaohsiung declined tremendously throughout the 1990s, contributing to the overall increase in the unemployment rate.

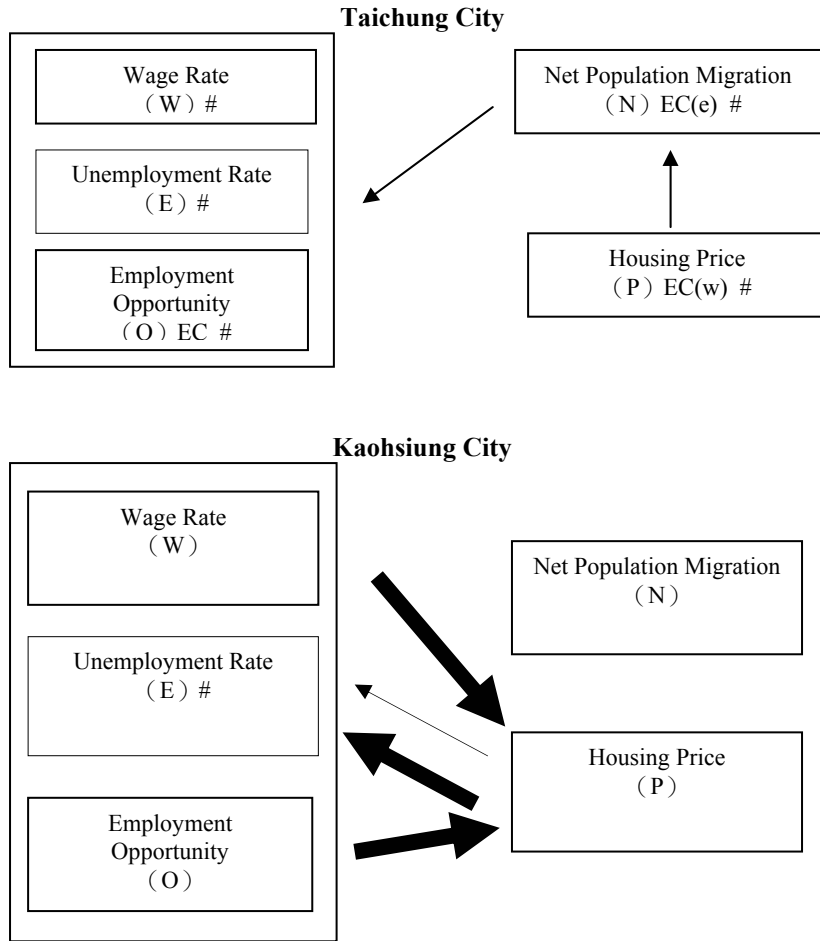
In Taipei City, high housing prices were basically affected exogenously, and net population migration has been negative since the late 1980s, due to these high housing prices. However, high wage rates have continued to attract people to move into the Taipei Metropolitan areas, some choosing to live in Taipei County, which in turn, has affected housing prices there. This development is confirmed by the fact during the 1990s, housing prices in Taipei County have been rising faster than in Taichung City and Kaohsiung

City³. We also find a close interaction between housing prices and population migration in Taipei County, in both the short and long term.

Figure 5: The Relationship between the Three Markets of the Four Cities/Countries



³ Ongoing research by the co-authors studies the interactive relationship existing between the labor market, housing market and the choice of migration destination between Taipei City and Taipei County.



Note:

EC (i): means the coefficient of EC term is significant in that EC model, $i = W, E, O$ illustrates which variables of the labor market have long-run relationship with migration and the housing market.

: means exogenous variable (G) affects the market.

→ means long-run effect.

→ means short-run effect.

As for Taichung City, the interaction pattern between the labor market, the housing market and population migration can be characterized as a stable and long-term relationship. Net population migration, housing prices and employment opportunities are all affected by the error correction term,

which implies a long-term relationship. Relatively low housing prices have also attracted people to move into Taichung in recent years. Furthermore, all variables are affected by local public expenditure, reflecting the better organized city planning and development of Taichung City, and its relatively abundant cultural and education resources.

In addition, we find that with the exception of Kaohsiung City, all other housing prices are affected by public expenditure. This is more or less the evidence of the capitalization of public goods. Unemployment rates in all four places are themselves affected by the other variables, but do not have any reciprocal effect, which may imply that unemployment has not been a serious issue in Taiwan, thus it has not been a factor for consideration in the decision-making process of whether to move or whether to purchase a house.

Conclusions

The purpose of this research is to examine the interrelationship existing between the labor market, the housing market and interregional migration in Taiwan, selecting as the targets for our empirical study, four of Taiwan's most urbanized population receiving areas, Taipei City, Taipei County, Taichung City and Kaohsiung City. An error correction model was constructed for each of the cities/counties using time series data for 1974 to 1999.

The research results show that each of the cities/counties has its own unique relational pattern between population migration, the labor market and the housing market, reflecting the different characteristics and stages of development. The much higher housing prices in Taipei City, the capital city of Taiwan, have been affected not by migration and the labor market, but determined exogenously. On the other hand, in Taipei County, a part of the Taipei metropolitan area and the major population migration destination, a close interaction exists between housing prices and population migration. As a late comer to urban development, Taichung City's relatively better organized city planning is reflected in all variables as being affected by the exogenous variable, local government expenditure. In recent years, the industrialized Kaohsiung City has been faced with the problems of a declining job market and a housing market recession; however, net population migration has thus far been unaffected.

Taiwan has been going through dramatic economic structural changes in recent years, moving towards a service economy with a declining manufacturing employment market. This change may have also induced changes in the quality of the population and the composition of city

populations, which in turn, has an impact on the housing market; however, the overall effects of this change are beyond the scope of this research and constitute an area for in-depth study in the future.

Acknowledgments

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Appendix Table 1 Net Population Migration in Taiwan Area
The Population Migration in Taiwan, and its Causal Relationship 1

Region	1976	1979	1982	1985	1988	1991	1994	1997	1999
Northern Region	83358	76442	49300	60212	59875	11831	3920	27347	30944
Taipei City	5837	-3049	21731	32935	17097	-21179	-21777	-26475	-17284
Taipei County	80615	75335	36903	34768	41101	22626	9503	26298	24785
Ilan County	-4380	-5452	-5520	-5632	-3087	-2132	-2964	-3300	-3628
Taoyuan County	13219	20332	11943	3939	11807	12315	17887	23939	22561
Hsinchu County	-6397	-8223	-4827	-4067	-3299	48	2637	1379	923
Keelung City	-5396	-2941	-2990	-4549	-3408	-402	-1267	1704	595
Hsinchu City*	-	-	-1340	2818	1664	751	-699	1802	2992
Central Region	-38404	-43806	-27402	-23073	-27208	1512	-841	-6445	-8670
Taichung City	2144	-3243	6706	11938	8016	4527	7055	14329	13530
Miaoli County	-7383	-11033	-7530	-7483	-7252	-3064	-4066	-4893	-4304
Taichung County	3193	12827	5522	4073	10396	13895	13409	3367	1115
Changhua County	-11580	-14905	-11298	-11381	-13132	-4385	-4816	-7590	-6638
Nantou County	-9230	-8346	-6487	-4634	-6126	-2801	-3878	-4215	-4578
Tainlin County	-15348	-19106	-14315	-15806	-19110	-6860	-8345	-7443	-7795
Southern Region	-33789	-41991	-21684	-19913	-28733	-6373	-7720	-3393	-22415
Kaohsiung City	-1189	15737	23	3497	5712	-2909	-485	-10969	3716
Tainan City	1882	2853	5916	1350	3728	255	3269	525	1821
Chiayi City*	-	-	-2675	-1757	-1086	-979	-619	-2606	428
Chiayi County	-16390	-19282	-9555	-703	-10768	-3236	-3839	-3239	-7054
Tainan County	-12488	-15511	-8781	-5701	-8193	47	1703	-1179	-2868
Kaohsiung County	3351	7103	3302	-1715	-83	1700	2437	7324	-5172
Pingtung County	-7191	-10667	-8471	-9914	-7624	-3808	-4953	-6976	-6477
Penghu County	-3051	-3454	1821	-1880	-2085	-1076	-3068	477	-844
Eastern Region	-10118	-9634	-6169	-6339	-14301	-3782	-4446	-5783	-3869
Taiwang County	-6305	-6434	-3810	-3066	-3280	-2525	-2341	-2774	-3239
Hualien County	-3813	-3200	-2339	-3293	-3021	-1257	-1905	-3009	-2610

Note: * No data are available for Hsinchu and Chiayi cities for 1976 and 1979.

Source: Calculated from Taiwan-Fukien Demographic Fact Book of various years.

Appendix Table 2: Cointegration Results (W)

City/County ₁	Trace statistic	Variables (N, P, W)			Log Likelihood ³
		Jarque-Bera ²			
		N	P	W	
Taipei City	11.45789	1.271199 (0.529618)	1.808567 (0.404832)	0.074723 (0.963328)	-510.1276 (3)
Taipei County	7.594276	0.769784 (0.680524)	0.774211 (0.679020)	0.345210 (0.841470)	-485.8518 (3)
Taichung City	14.59147	0.636779 (0.727319)	4.16066 (0.134252)	0.356654 (0.836669)	-476.1644 (3)

Notes:

1 No linear trends are included.

2 The Jarque-Bera null-hypothesis is that the residual is normally distributed (P-values are in parentheses).

3 The truncation lag is shown in parentheses.

Appendix Table 3: Cointegration Results (O)

City/County ₁	Trace statistic	Variables (N, P, O)			Log Likelihood ³
		Jarque-Bera ²			
		N	P	O	
Taipei City	4.132486	1.345483 (0.510308)	2.718783 (0.256817)	1.514205 (0.469023)	-489.0233 (4)
Taipei County ⁴	8.567959	2.432702 (0.296309)	0.892337 (0.640076)	3.903997 (0.141990)	-468.0641 (4)
Taichung City	12.57166	1.152370 (0.562038)	0.121889 (0.940876)	0.330272 (0.847778)	-428.4377 (4)

Notes:

1 No linear trends are included.

2 The Jarque-Bera null-hypothesis is that the residual is normally distributed (P-values are in parentheses).

3 The truncation lag is shown in parentheses.

4 The labor market variable for Taipei City is ΔO .

Appendix Table 4: Cointegration Results (E)

City/County ₁	Variables (N, P, E)				Log Likelihood ³
	Trace statistic	Jarque-Bera ²			
		N	P	E	
Taipei County	4.827570	3.302768 (0.191784)	2.406176 (0.300266)	1.087543 (0.580555)	-225.122 (3)
Taichung City	4.635763	1.978253 (0.371901)	1.028569 (0.597958)	3.238619 (0.326505)	-258.7890 (3)

Notes: The same as Appendix Table 2.

Appendix Table 5: Cointegration Results for Taipei City (N, E)

City/County ₁	Variables (N, E)			Log Likelihood ³
	Trace statistic	Jarque-Bera ²		
		N	E	
Taipei City	19.27835	0.820567 (0.663462)	1.099071 (0.577218)	-242.0376(3)

Notes: The same as Appendix Table 2.

Appendix Table 6: Cointegration Results for Kaohsiung City (P, W)

City/County ₁	Variables (P, W)			Log Likelihood ³
	Trace statistic	Jarque-Bera ²		
		P	W	
Kaohsiung City	0.88244	1.975090 (0.372490)	2.326524 (0.312465)	-263.9688(4)

Notes: The same as Appendix Table 2.

Appendix Table 7: Cointegration Results for Kaohsiung City (P, O)

City/County ₁	Variables (P, O)			Log Likelihood ³
	Trace statistic	Jarque-Bera ²		
		P	O	
Kaohsiung City	1.692106	0.749557 (0.687442)	0.811977 (0.666318)	-249.4936

Notes: The same as Appendix Table 2.

Appendix Table 8: Cointegration Results for Kaohsiung City (P,E)

City/County ₁	Trace statistic	Variables (P, E)		Log Likelihood ³
		Jarque-Bera ² P	E	
Kaohsiung City	2.598295	0.282000 (0.868489)	1.340099 (0.511683)	-109.4426(3)

Notes: The same as Appendix Table 2.

Appendix Figure 1: Location of Areas Studied

