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Housing Prices and Transaction Volumes in Taiwan Region's Six Major Cities

Hsiu-Tao Teng, Chien-Hui Lee, Jen-Yao Lee*

Department of International Business, NKUST, Taiwan
Email: *itjylee@nkust.edu.tw

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Abstract

This study examines the long-run and short-run relationships between housing prices and transaction volume in Taiwan Region's six special municipalities using quarterly data from 2011 to 2024. The results indicate that housing prices and transaction volume are cointegrated in all cities, although both the direction of the relationship and the adjustment mechanisms vary across municipalities. In most cities, housing prices and transaction volume exhibit negative long-run co-movement, whereas Taoyuan City displays a positive relationship. The VECM results further reveal that the adjustment process differs across regions: transaction volume drives adjustment in some cities, housing prices in others, and no stable adjustment mechanism is observed in certain cases. Short-run dynamics also vary across municipalities, highlighting substantial heterogeneity in housing market behavior.

Keywords

Housing Prices, Housing Transaction Volume, Real Estate Market, Vector Error Correction Model (VECM), Granger Causality Test

1. Introduction

Under the traditional supply-demand framework, housing prices and transaction volume are jointly determined by market forces, with increases in demand expected to raise both prices and quantities. However, housing markets differ from standard goods markets due to features such as indivisibility, high transaction costs, search frictions, and price stickiness. As a result, market adjustment often deviates from the standard price-quantity mechanism.

In practice, housing prices tend to be sticky due to sellers' loss aversion, reference price effects, and their ability to absorb holding costs in the short run. Consequently, when markets are subject to exogenous shocks—such as interest rate changes, policy interventions, or demand contractions—adjustment typically occurs first through transaction volume rather than prices, giving rise to a dynamic pattern in which quantity adjusts before prices.

Consistent with this view, empirical studies generally find that housing prices and transaction volume are cointegrated in the long run (Hort, 2000; Andrew & Meen, 2003; Shi et al., 2010). At shorter horizons, transaction activity often leads price movements, while price changes exert a stronger contemporaneous effect on transaction volume (Hort, 2000; Genesove & Mayer, 2001; Leamer, 2007). By contrast, the effect of transaction volume on prices tends to be more gradual (Follain & Velz, 1995; Akkoyun et al., 2013; De Wit et al., 2013).

When search frictions or credit constraints are present, transaction volume typically responds more rapidly than prices and thus serves as an early indicator of market adjustment (Haurin, 1988; Stein, 1995; Cheng et al., 2023). Within a search-theoretic framework, Cheng et al. (2023) further show that sellers' pricing and waiting decisions can generate heterogeneous price–volume relationships across market conditions, reinforcing the importance of quantity adjustment in the short run.

Evidence from Taiwan Region also points to dynamic price-volume interactions at the metropolitan level. Hua and Chang (1997) document significant bidirectional causality between housing prices and transaction volume using a VAR framework, while Kao (2014) shows that price-volume imbalances cannot be fully explained by standard supply-demand models and instead depend on trading frictions and market conditions. These findings suggest that housing market adjustment in Taiwan reflects not only macroeconomic fundamentals but also institutional features and trading behavior.

Motivated by the heterogeneity in price-volume adjustment mechanisms documented in both international and Taiwan-based studies, this paper examines Taiwan Region's six major metropolitan areas—Taipei City, New Taipei City, Taoyuan City, Taichung City, Tainan City, and Kaohsiung City—using time-series methods to analyze the dynamic relationship between housing prices and transaction volume. By explicitly comparing adjustment mechanisms across cities, this study contributes to the literature on price-quantity dynamics in housing markets.

The remainder of the paper is organized as follows. Section 2 describes the methodology, Section 3 presents the empirical results, and Section 4 concludes.

2. Methodology

This study aims to examine the long-run and short-run relationships between housing prices and transaction volume in Taiwan Region's six special municipalities. The sample period covers the first quarter of 2011 to the fourth quarter of 2024, yielding a total of 56 quarterly observations. The empirical analysis proceeds by first applying the Augmented Dickey-Fuller (ADF) unit root test to determine the order of integration of the variables. The optimal lag length is then selected based on the Akaike Information Criterion (AIC). Subsequently, the Johansen cointegration test is employed to examine the existence of long-run equilibrium relationships. Depending on the cointegration results, a Vector Autoregression (VAR) or a Vector Error Correction Model (VECM) is estimated, followed by Granger causality tests to analyze the causal relationship between housing prices and transaction volume across the six municipalities.

To avoid the problem of spurious regression, the **Augmented Dickey-Fuller (ADF)** unit root test is first applied to each variable to examine whether the series is stationary. The ADF test is based on the following regression model:

None: $\Delta Y_t = \alpha_1 Y_{t-1} + \sum_{j=1}^{p} r_j \Delta Y_{t-j} + \varepsilon_t$,

Intercept: $\Delta Y_t = \alpha_0 + \alpha_1 Y_{t-1} + \sum_{j=1}^{p} r_j \Delta Y_{t-j} + \varepsilon_t$,

Intercept and Trend: $\Delta Y_t = \alpha_0 + \alpha_1 Y_{t-1} + \alpha_2 t + \sum_{j=1}^{p} r_j \Delta Y_{t-j} + \varepsilon_t$,

where Δ denotes the first-difference operator, Y_t is the variable of interest, t represents a deterministic time trend (if included), p is the number of lagged difference terms added to correct for serial correlation, and ε_t is a white-noise error term.

The null hypothesis of the ADF test is $H0: r_j = 0$, indicating the presence of a unit root, while the alternative hypothesis $H1: r_j < 0$ implies stationarity.

Akaike (1974) proposes the **Akaike Information Criterion (AIC)** as a model selection criterion, where the model with the smallest AIC value is regarded as the optimal specification. The AIC is calculated as:

$$\text{AIC} = \ln\left(\hat{\sigma}^2\right) + \frac{2k}{T}$$

where $\hat{\sigma}^2$ is the estimated variance of the error term, T is the sample size and k is the number of estimated parameters in the model.

After confirming that all variables are integrated of the same order, I(1), the Johansen (1988) maximum likelihood approach is employed to test for the existence of cointegration among the variables. The number of cointegrating relationships is determined using both the Trace test and the Maximum eigenvalue test.

The Trace test statistic is defined as:

$$\lambda_{trace}(r) = -T \sum_{i=r+1}^{n} \ln\left(1 - \hat{\lambda}_i\right)$$

where T denotes the sample size, n is the number of variables in the system, $\hat{\lambda}_i$ represents the estimated eigenvalues, and r is the number of cointegrating vectors under the null hypothesis.

The Maximum eigenvalue test statistic is defined as:

$$\lambda_{\max}(r, r+1) = -T \ln\left(1 - \hat{\lambda}_{r+1}\right)$$

Let $Y_t = \left(x_t, y_t\right)'$ denote the vector of endogenous variables, where x_t represents housing prices and y_t represents transaction volume. If a cointegration relationship exists, a **Vector Error Correction Model (VECM)** is constructed to capture both the long-run equilibrium relationship and the short-run dynamics among the variables. The general form of the error correction model is specified as follows:

$$\Delta Y_t = \alpha\beta' Y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta Y_{t-i} + \varepsilon_t$$

where Y_{t-1} is a vector of endogenous variables, $\beta' Y_{t-1}$ represents the cointegrating relationship capturing the long-run equilibrium, Γ_i is the adjustment coefficient matrix measuring the speed at which deviations from the long-run equilibrium are corrected, α denotes short-run dynamic coefficients, p is the VAR lag length, and ε_t is a vector of white-noise error terms.

3. Empirical Results and Analysis

3.1. Data Sources

This study primarily examines real estate transaction data covering the period from the first quarter of 2011 to the fourth quarter of 2024, using quarterly observations. Housing prices and transaction volume are obtained from the Real Estate Actual Transaction Price Database of Taiwan Region's Ministry of the Interior. The empirical analysis focuses on six special municipalities—New Taipei City, Taipei City, Taoyuan City, Taichung City, Tainan City, and Kaohsiung City. Housing prices and transaction volume are treated as the endogenous variables. The definitions of the variables used in this study are summarized in **Table 1**.

Table 1. Variable description.

Variable	Description	Variable	Description
NPHP	Housing price in New Taipei City	NPTQ	Transaction volume in New Taipei City
TPHP	Housing price in Taipei City	TPTQ	Transaction volume in Taipei City
TYHP	Housing price in Taoyuan City	TYTQ	Transaction volume in Taoyuan City
TCHP	Housing price in Taichung City	TCTQ	Transaction volume in Taichung City
TNHP	Housing price in Tainan City	TNTQ	Transaction volume in Tainan City
KHHP	Housing price in Kaohsiung City	KHTQ	Transaction volume in Kaohsiung City
CPI	T = 2021, CPI = 100	--	--
Dummy		Description	
Qi	Qi = 0, 1 I = 1, 2, 3	Seasonal dummy variables	
RG	RG = 0 if t ≤ 2020Q3; RG = 1 if t ≥ 2020Q4	Credit control policy dummy	

Notes: Housing prices (HP) are measured in NT$10,000 per unit, and transaction volume (TQ) is measured by the number of units. All data are obtained from the Real Estate Actual Transaction Price Database of the Ministry of the Interior, Taiwan Region.

Housing prices (HP) and transaction volume (TQ) are constructed for each of the six special municipalities using quarterly data from the Real Estate Actual Transaction Price Database of the Ministry of the Interior (MOI). Specifically, the housing price variable is measured as the average transaction price per residential unit for each municipality in each quarter (in NT$10,000 per ping), and is expressed in units of NT$10,000. The sample includes only residential property transactions, excluding non-residential types such as commercial or industrial properties.

To enhance comparability across cities and over time, the construction of the housing price variable follows a consistent definition and data filtering procedure for all municipalities. In addition, by aggregating transaction-level data into quarterly averages, short-term fluctuations due to compositional changes in housing types are mitigated, allowing for more reliable comparisons of housing price dynamics across regions and periods.

Table 2 reports the descriptive statistics of housing prices for the six special municipalities, while Table 3 presents the descriptive statistics of housing transaction volume.

Table 2. Descriptive statistics of housing prices in the six special municipalities.

	NPHP	TPHP	TYHP	TCHP	TNHP	KHHP
Mean	32.438	60.874	19.516	20.576	15.915	18.506
Median	31.490	58.725	18.630	19.295	14.570	17.235
Maximum	43.580	76.140	29.120	31.280	25.390	29.110
Minimum	24.000	49.820	12.790	13.270	10.320	12.740
Std. Dev.	4.840	6.466	4.053	4.862	4.285	3.823
Skewness	0.520	0.478	0.604	0.511	0.726	0.978
Kurtosis	2.962	2.371	2.911	2.507	2.416	3.383
Jarque-Bera	2.523	3.051	3.422	2.999	5.714	9.277
Probability	0.283	0.217	0.181	0.223	0.057	0.010
Sum	1816.540	3408.930	1092.900	1152.230	891.240	1036.360
Sum Sq. Dev.	1288.518	2299.335	903.519	1299.977	1009.673	803.661
Observations	56	56	56	56	56	56

Table 3. Descriptive statistics of housing transaction volume in the six special municipalities.

	NPTQ	TPTQ	TYTQ	TCTQ	TNTQ	KHTQ
Mean	15594.640	7808.661	10671.980	11590.180	5601.554	9512.071
Median	14963.000	7348.500	10709.500	11630.000	5426.500	9264.500
Maximum	26228.000	16147.000	14594.000	15998.000	8300.000	13595.000
Minimum	7109.000	3978.000	6106.000	6389.000	3148.000	5713.000
Std. Dev.	3387.840	2054.113	1781.580	2077.652	969.730	1513.010
Skewness	0.560	1.502	0.173	0.013	0.526	0.610
Kurtosis	3.772	6.661	2.676	2.441	3.600	3.599
Jarque-Bera	4.323	52.335	0.523	0.730	3.423	4.311
Probability	0.115	0.000	0.770	0.694	0.181	0.116
Sum	873300	437285	597631	649050	313687	532676
Sum Sq. Dev.	631000000	232000000	175000000	237000000	51720650	126000000

The Central Bank of Taiwan Region has implemented seven rounds of selective credit control measures since December 2020, aiming to curb speculative activities in the housing market. The key policy measures have focused on tightening loan-to-value (LTV) ratios for second and subsequent housing purchases, eliminating grace periods, and raising reserve requirement ratios.

Given that these policies may have induced structural changes in the relationship between housing prices and transaction volume, this study introduces a policy dummy variable. The dummy variable is set to 1 from the fourth quarter of 2020 onward, and 0 for periods prior to the third quarter of 2020. In this study, all variables are expressed in natural logarithms, except for those used in descriptive statistics, in order to smooth the data and stabilize variability.

3.2. Unit Root Test

Table 4 shows that, under the three Augmented Dickey-Fuller (ADF) test specifications, most variables are found to be non-stationary in levels. Although transaction volumes in New Taipei City, Taipei City, and Tainan City appear stationary under certain specifications, the results are not consistent across all testing models. Given that cointegration analysis and VECM (or VAR) estimation require variables to be integrated of the same order, the overall evidence supports treating all variables as non-stationary in levels. This ensures the validity and consistency of the subsequent empirical analysis.

After first differencing, all variables become stationary across specifications. Although the CPI series exhibits non-stationarity under certain specifications, the overall evidence supports treating all variables as stationary in first differences. Therefore, following standard practice and considering the overall evidence across different deterministic specifications, all variables are treated as integrated of order one, I(1), which justifies the use of the Johansen cointegration test and the VECM framework.

Table 4. ADF test.

	Level			First difference		
Mode	None	Intercept & Trend	Intercept	None	Intercept & Trend	Intercept
NPHP	3.332 (1.000)	−1.092 (0.958)	0.037 (0.958)	−5.513*** (0.000)	−6.363*** (0.000)	−6.418*** (0.000)
TPHP	1.223 (0.942)	−1.619 (0.743)	0.958 (0.595)	−6.075*** (0.000)	−6.138*** (0.000)	−6.233*** (0.000)
TYHP	2.855 (0.999)	−0.793 (−1.311)	0.099 (0.963)	−5.962*** (0.000)	−6.750*** (0.000)	−6.825*** (0.000)
TCHP	4.817 (1.000)	−0.875 (1.475)	0.475 (0.984)	−5.806*** (0.000)	−7.216*** (0.000)	−7.172*** (0.000)
TNHP	4.383 (1.000)	−0.958 (0.841)	1.251 (0.998)	−1.509*** (0.122)	−8.811*** (0.000)	−3.583*** (0.000)
KHHP	2.342 (0.995)	1.494 (0.820)	0.010 (0.953)	−5.416*** (0.000)	−5.957*** (0.000)	−6.082*** (0.000)

Continued

NPTQ	−1.175 (0.264)	**3.261*** **(0.080)**	**−3.436**** **(0.014)**	−11.814*** (0.000)	−11.749*** (0.000)	−11.759*** (0.000)
TPTQ	−1.340 (0.165)	**−5.088**** **(0.001)**	**−5.068***** **(0.000)**	−7.590*** (0.000)	−6.606*** (0.000)	−7.594*** (0.000)
TYTQ	−0.300 (0.573)	−2.790 (0.205)	**−2.812**** **(0.063)**	−14.672*** (0.000)	−7.81*** (0.000)	−12.667*** (0.000)
TCTQ	0.240 (0.752)	−1.576 (0.789)	−1.315 (0.616)	−8.311*** (0.000)	−8.640*** (0.000)	−8.664*** (0.000)
TNTQ	−0.158 (0.625)	**−5.609***** **(0.000)**	−2.432 (0.138)	−13.671*** (0.000)	−13.450*** (0.000)	−73.545*** (0.000)
KHTQ	−0.301 (0.573)	−2.849 (0.187)	−2.742* (0.074)	−14.291*** (0.000)	−19.092*** (0.000)	−14.040** (0.000)
CPI	1.868 (0.984)	−2.154 (0.999)	−0.251 (0.990)	−0.257 (0.588)	−2.240 (0.195)	−3.241* (0.089)

Note: *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

3.3. Results of the Cointegration Tests

To mitigate the effects of inflation, seasonal fluctuations, and credit policy interventions, several adjustments are incorporated into the cointegration analysis. First, nominal housing prices are adjusted for inflation to examine the relationship between real housing prices and transaction volume. Second, seasonal dummy variables are introduced to control for seasonal effects in housing prices and transaction activity. Third, a credit control policy dummy variable is included to account for the impact of macroprudential credit regulations on housing prices and transaction volume.

In the cointegration tests and VECM specification, the selection of deterministic components is based on information criteria. Specifically, alternative specifications with different combinations of intercepts and trends are evaluated, and the model with the lowest Akaike Information Criterion (AIC) is selected. The results indicate that the specification including both an intercept and a linear trend provides the best fit. This corresponds to a specification with an unrestricted intercept and linear trend, ensuring consistency between the Johansen test and the VECM estimation.

As reported in Table 5, the results of the Johansen cointegration tests indicate that the null hypothesis of no cointegration is rejected for all six municipalities based on the Trace test. The Maximum eigenvalue test also rejects the null hypothesis in most cases, although it fails to do so for Taipei City and Tainan City, and shows only marginal significance for Taoyuan City.

Despite minor inconsistencies between the two test statistics, the overall evidence supports the existence of a long-run cointegration relationship between housing prices and transaction volume across all six municipalities. Although the Trace test suggests the possibility of more than one cointegrating vector, the bivariate nature of the system implies that at most one cointegrating relationship can exist. Accordingly, the cointegration rank is restricted to one.

Based on these findings, housing prices and transaction volume are considered to be cointegrated in New Taipei City, Taipei City, Taoyuan City, Taichung City, Tainan City, and Kaohsiung City. Consequently, a Vector Error Correction Model (VECM) is employed for each municipality to capture both the long-run equilibrium relationship and the short-run dynamic adjustments between the two variables.

Table 5. Cointegration test results and model selection (VAR or VECM).

	lag	Trace test: Null hypothesis None At most1	The Maximum eigenvalue test: Null hypothesis None At most1	Model Selection
New Taipei City	3	0.0001*** 0.0012***	0.0047*** 0.0012***	VECM
Taipei City	3	0.0098*** 0.0036***	0.1097 0.0036***	VECM
Taoyuan City	3	0.0062*** 0.0052***	0.0579* 0.0052***	VECM
Taichung City	3	0.0007*** 0.0017***	0.0152** 0.0017***	VECM
Tainan City	2	0.0173** 0.0042***	0.1614 0.0042***	VECM
Kaohsiung City	4	0.0034*** 0.0628**	0.0071*** 0.0628**	VECM

Note: Reported values are *p*-values. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

3.4. Results of VECM Estimation

Table 6 reports the estimation results of the Vector Error Correction Model (VECM) for real housing prices and transaction volume across the six special municipalities, incorporating seasonal dummy variables and a credit control policy dummy variable.

The long-run cointegrating relationships indicate that transaction volume enters the real housing price equation significantly in most cities, confirming the existence of a long-run equilibrium relationship between real housing prices and transaction activity. Specifically, the cointegrating coefficients on transaction volume are positive in New Taipei City, Taipei City, Taichung City, Tainan City, and Kaohsiung City, while it is negative in Taoyuan City, reflecting regional heterogeneity in housing market structures.

Given that the cointegrating vector is normalized on real housing prices, the estimated relationship can be rearranged such that real housing prices depend on transaction volume. A positive coefficient on transaction volume therefore implies a negative long-run relationship, whereas a negative coefficient indicates a positive relationship. In New Taipei City, Taipei City, Taichung City, Tainan City, and Kaohsiung City real housing prices and transaction volume exhibit negative co-movement, suggesting that rising prices are not supported by an expansion in effective demand but are more closely associated with supply-side constraints such as land scarcity that limit transaction activity. By contrast, in Taoyuan City, the cointegrating coefficients of transaction volume are negative, suggesting that real housing prices and transaction volume move in the same direction.

With respect to short-run dynamics, the error correction term (CointEq1) exhibits heterogeneous adjustment patterns across municipalities. When the sign of housing quantity in cointegration vector is negative, a negative (positive) and statistically significant error correction coefficient in the housing price (transaction volume) equation indicates stable adjustment toward the long-run equilibrium, whereas a positive (negative) coefficient implies an unstable response to disequilibrium. When the sign of transaction volume in cointegration vector is positive, a negative (negative) and statistically significant error correction coefficient in the housing price (transaction volume) equation indicates stable adjustment toward the long-run equilibrium, whereas a positive (positive) coefficient implies an unstable response to disequilibrium.

In particular, for Taichung City, Tainan City, and Kaohsiung City, the error correction terms are negative and statistically significant in the transaction volume equations, indicating that transaction volume plays the primary role in restoring the long-run equilibrium following short-run shocks.

In New Taipei City and Taipei City, the error correction terms are negative and statistically significant in both the housing price and transaction volume equations, suggesting that neither variable exhibits a stable adjustment toward the long-run equilibrium.

By contrast, although the error correction term is statistically significant only in the housing price equation for Taoyuan City, indicating that only real housing prices respond to deviations from the long-run equilibrium, while transaction volume does not exhibit a significant adjustment. The negative sign of the adjustment coefficient suggests that real housing price does contribute to stabilizing the long-run equilibrium in those cases.

Overall, in terms of real housing prices, these results reveal substantial cross-city heterogeneity in long-run adjustment mechanisms, with stable error correction observed in most municipalities.

Furthermore, the coefficients on the lagged first-difference terms indicate significant short-run interactions between real housing prices and transaction volume. In Taipei City and Kaohsiung City, lagged changes in real housing prices exert a significant effect on transaction volume, implying a unidirectional influence from prices to volume. In contrast, in Taoyuan City, lagged changes in transaction volume significantly affect real housing prices in the short run.

In Taichung City, lagged changes in transaction volume significantly affect real housing price movements, while lagged real housing price changes also influence transaction volume, indicating bidirectional interactions between transaction volume and real housing prices. In New Taipei City and Tainan City, no significant short-run interaction between the two variables is found. Overall, these results suggest that short-run dynamics vary across regions.

Overall, the VECM results confirm that real housing prices and transaction volume in Taiwan's six special municipalities are linked by both long-run equilibrium relationships and short-run adjustment mechanisms.

Table 6. VECM estimation results for real housing prices and transaction volume.

	New Taipei City		Taipei City		Taoyuan City		Taichung City		Tainan City		Kaohsiung City	
	Long run relationship (coefficients in cointegration vector)											
HP	1.000		1.000		1.000		1.000		1.000		1.000	
TQ	3.1836*** (4.8697)		0.2423* (1.7195)		−1.9169*** (−3.5315)		1.7626*** (4.1402)		0.3909*** (2.7513)		2.5098*** (4.3640)	
Trend	−0.0062		−0.0011		−0.0064		−0.0164		−0.0151		−0.0120	
C	−322.947		−6.2543		14.9392		−18.9946		−5.6926		−25.5395	
	Short run relationship											
	ΔHP	ΔTQ	ΔHP	ΔTQ	ΔHP	ΔTQ	ΔHP	ΔTQ	ΔHP	ΔTQ	ΔHP	ΔTQ
CointEq1	−0.0315*** (2.7513)	−0.1380** (−2.0090)	−0.1364* (−1.7137)	−1.1702*** (−3.0294)	−0.1016*** (−3.0078)	0.1846 (1.4112)	0.0154 (0.4849)	−0.4433*** (−3.3620)	−0.1088 (−1.2757)	−1.2762*** (−3.2830)	−0.0017 (−0.0566)	−0.3677*** (−3.8147)
ΔHP_{-1}	−0.3865** (−2.0968)	0.9689 (0.8766)	−0.1807 (1.1076)	1.5051* (1.9004)	−0.0960 (−0.6021)	0.8594 (1.3908)	−0.1531 (−0.7492)	2.1199** (2.5055)	−0.3353* (−1.8116)	0.0814 (0.0964)	−0.1897 (−0.8223)	1.5048** (2.0264)
ΔHP_{-2}	−0.2157 (−1.1281)	1.9168 (1.6718)	0.1175 (0.6966)	1.1083 (1.3530)	−0.2467 (−1.7004)	0.1071 (0.1906)	−0,3209 (−1.5548)	1.0733 (1.2562)	−0.0921 (−0.5273)	0.3708 (0.4655)	−0.1606 (−0.7335))	1.2670* (1.7974)
ΔHP_{-3}	−0.3573* (−1.8512)	−1.1500 (−0.9936)	0.2252 (1.3333)	1.3686 (1.6696)	−0.0461 (−0.3084)	−0.6812 (−1.1753)	0.1475 (0.7527)	1.0330 (1.2731)	--	--	−0.4314* (−1.7504)	−0.0159 (−0.0200)
ΔHP_{-4}	--	--									−0.1684 (−0.7343)	−0.2958 (−0.4009)
ΔTQ_{-1}	−0.0403 (−1.3282)	−0.0966 (−0.5316)	0.0181 (0.6023)	−0.4693*** (−3.2227)	−0.2275*** (−3.6530)	−0.4364** (−1.8087)	−0.0830* (−1.8408)	−0.1959 (−1.0488)	0.0559 (1.6002)	−0.2248 (−1.4109)	−0.0177 (−0.2916)	0.0229 (0.1170)
ΔTQ_{-2}	−0.0223 (−0.7794)	−0.0088 (−0.0511)	0.0174 (0.5654)	−0.4383*** (−2.9268)	−0.1622** (−2.4981)	0.0750 (0.2981)	−0.0209 (−0.4943)	−0.0052 (−0.0298)	0.0175 (0.5551)	−0.0095 (−0.0662)	0.0207 (0.3473)	0.2277 (1.1872)
ΔTQ_{-3}	−0.0037 (−0.1549)	0.1405 (0.9804)	0.0088 (0.3111)	−0.1052 (−0.7665)	−0.0300 (−0.5919)	0.1730 (0.8799)	−0.0314 (−0.8273)	−0.0693 (−0.4410)	--	--	−0.0009 (−0.0152)	0.3072 (1.6380)
ΔTQ_{-4}	--	--									0.0039 (0.0757)	0.1188 (0.7133)
C	0.0167 (1.2008)	0.1221 (1.4641)	0.0126 (0.7833)	0.0274 (0.3522)	0.0194 (0.9052)	0.1119 (1.3478)	0.0070 (0.3434)	0.1442 (1.7121)	0.0321** (2.4265)	0.1064* (1.7640)	0.0221 (0.9143)	0.1625** (2.0861)
Trend	0.0001 (0.1283)	−0.0020 (−0.7191)	−0.0008 (−1.2747)	−0.0002 (−0.0828)	0.0011 (1.3602)	−0.0014 (−0.4707)	−0.0001 (−0.1621)	−0.0044 (−1.5920)	−0.0007 (−1.2794)	−0.0048* (−1.8137)	−0.0009 (−1.1016)	−0.0070** (−2.5899)

Note: t-statistics in ( ); *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

3.5. Robustness of the VECM Estimation Results

In this subsection, we examine the long-run and short-run relationships between nominal housing prices and transaction volume to assess the robustness of the VECM estimation results. Table 7 reports the estimation results of the Vector Error Correction Model (VECM) for nominal housing prices and transaction volume across the six special municipalities, with seasonal dummy variables and a credit control policy dummy variable included in the specification.

Comparing Table 6 and Table 7, the long-run coefficients associated with transaction volume exhibit noticeable differences in magnitude between the real and nominal specifications. In particular, the effect of transaction volume becomes stronger in some municipalities (notably Taichung and Kaohsiung) when nominal prices are used, suggesting that nominal factors may amplify demand-driven price dynamics. Nevertheless, the signs of the cointegration coefficients remain unchanged across specifications, indicating that the long-run relationships are qualitatively robust.

Table 7. VECM estimation results for nominal housing prices and transaction volume.

	New Taipei City		Taipei City		Taoyuan City		Taichung City		Tainan City		Kaohsiung City	
Long run relationship (coefficients in cointegration vector)												
HP	1.000		1.000		1.000		1.000		1.000		1.000	
TQ	1.6329*** (5.1039)		0.2307 (1.3538)		−2.0470*** (−3.3663)		4.2042*** (3.6461)		0.6360** (2.6135)		3.4978*** (4.3544)	
Trend	−0.0077		−0.0038		−0.0090		−0.0267		−0.0193		−0.0163	
C	−18.9550		−6.0502		16.2403		−41.4493		−7.6574		−34.4270	
Short run relationship												
	ΔHP	ΔTQ	ΔHP	ΔTQ	ΔHP	ΔTQ	ΔHP	ΔTQ	ΔHP	ΔTQ	ΔHP	ΔTQ
*CointEq*1	**0.0204** **(1.2100)**	**−0.3604***** **(−3.7834)**	−0.1331* (−1.8263)	**−0.8975**** **(−2.4707)**	**−0.0872***** **(−2.8209)**	0.1687 (1.4071)	0.0086 (0.6446)	**−0.1570***** **(−2.7081)**	−0.0796 (−1.3644)	**−0.8718***** **(−3.0766)**	0.0033 (0.1548)	**−0.2625***** **(−3.6284)**
ΔHP_{-1}	−0.1383 (−0.7687)	1.8452* (1.8134)	0.1300 (0.8294)	**1.5197*** **(1.9459)**	−0.0668 (−0.4101)	0.9402 (1.4900)	−0.1914 (−0.9661)	**1.4759**** **(2.0372)**	−0.3362* (−1.6959)	0.4084 (0.4241)	−0.2135 (−0.9466)	**1.5641**** **(2.0264)**
ΔHP_{-2}	0.0323 (0.1775)	**2.3003**** **(2.2391)**	0.2146 (1.3082)	1.1028 (1.3489)	−0.1971 (−1.3001)	0.0515 (0.0877)	−0.2603 (−1.2542)	0.6597 (0.7346)	0.0774 (0.3623)	0.6340 (0.6105)	−0.1433 (−0.6655))	**1.1731** **(1.6056)**
ΔHP_{-3}	--	--	0.180352 (1.0933)	0.6177 (0.7517)	−0.0549 (−0.3524)	−0.8602 (−1.4241)	0.0881 (0.4470)	0.3884 (0.4556)	0.2303 (1.2078)	0.1438 (0.1553)	**−0.4424*** **(−1.8623)**	−0.1403 (−0.1740)
ΔHP_{-4}	--	--	--	--							−0.2418 (−1.0988)	−0.2250 (−0.2013)
ΔTQ_{-1}	−0.0130 (−0.4642)	−0.0900 (−0.5699)	0.0251 (0.8401)	−0.4927*** (−3.3146)	−0.2067*** (−3.3687)	−0.4492* (−1.8890)	−0.0733 (−1.5927)	−0.2442 (−1.2270)	0.0749* (1.9565)	−0.1568 (−0.8429)	−0.0258 (−0.4299)	0.0182 (0.0891)
ΔTQ_{-2}	−0.0048 (−0.1972)	−0.0040 (−0.0285)	0.0172 (0.5582)	−0.4340*** (−2.8301)	−0.1478** (−2.3476)	0.0709 (0.2907)	−0.0392 (−0.9269)	−0.0373 (−0.20366)	0.0404 (1.0729)	0.0618 (−0.3377)	0.0104 (0.1810)	0.2195 (1.1236)
ΔTQ_{-3}	--	--	0.0097 (0.3457)	−0.0886 (−0.6316)	−0.0359 (−0.7363)	0.1695 (0.8974)	−0.0319 (−0.8553)	−0.0367 (−0.2276)	0.0205 (0.6352)	0.1019 (0.6508)	−0.0148 (−0.2670)	0.2918 (1.5500)
ΔTQ_{-4}	--	--									0.0081 (0.1627)	0.1182 (0.7039)
C	0.0134 (1.1837)	−0.0119 (0.1859)	0.0075 (0.4618)	0.0078 (0.0966)	0.0174 (0.8358)	0.1038 (1.2866)	0.0125 (0.6194)	0.1506 (1.7198)	0.0228 (1.3533)	0.1167 (1.4264)	0.0190 (0.8414)	**0.1377*** **(1.7952)**
Trend	−0.0003 (−0.6507)	−0.0011 (−0.4533)	−0.0008 (−1.4071)	0.0009 (0.2909)	0.0009 (1.1131)	−0.0013 (−0.4457)	−0.0002 (−0.2783)	−0.0036 (−1.2531)	−0.0007 (−1.1955)	−0.0044 (−1.5733)	−0.0010 (−1.2537)	**−0.0067**** **(−2.4951)**

Note: t-statistics in ( ); *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

In the short run, the adjustment dynamics are broadly similar between the two models. One notable exception is New Taipei City, where the error correction term becomes statistically insignificant under the nominal specification. In addition, the absolute magnitude of the adjustment coefficients is generally smaller in the nominal model, implying a slower speed of convergence toward the long-run equilibrium.

Overall, these findings indicate that both the long-run relationships and short-run dynamics are largely robust to the choice between real and nominal housing prices. However, the adjustment process appears to be more efficient when housing prices are measured in real terms.

4. Conclusions and Remarks

This study examines the long-run and short-run relationships between housing prices and transaction volume in Taiwan Region's six special municipalities using quarterly data from 2011 to 2024. Based on ADF unit root tests, Johansen cointegration tests, Vector Error Correction Models (VECM), and robustness checks, several key findings emerge.

First, the empirical results indicate that housing prices and transaction volume are cointegrated in all six municipalities, suggesting the presence of a stable long-run equilibrium relationship. However, the direction of this relationship differs across cities. In New Taipei City, Taipei City, Taichung City, Tainan City, and Kaohsiung City, housing prices and transaction volume exhibit negative long-run co-movement, implying that rising prices are not necessarily accompanied by an expansion in effective demand and may instead reflect supply-side constraints or asset-based pricing behavior. In contrast, Taoyuan City displays positive long-run co-movement, suggesting that housing prices and transaction activity are more closely aligned with demand-side or asset-driven factors.

Second, the VECM results reveal substantial heterogeneity in long-run adjustment mechanisms across municipalities. In Taipei City, Taichung City, Tainan City, and Kaohsiung City, transaction volume plays the primary role in restoring long-run equilibrium. In Taoyuan City, housing prices serve as the dominant adjustment variable. In New Taipei City, neither housing prices nor transaction volume exhibits a statistically significant error-correction mechanism, indicating that deviations from the long-run equilibrium may persist. These findings suggest that the adjustment burden is unevenly distributed across cities and variables.

Third, short-run dynamics exhibit notable variation across municipalities. In Taoyuan City, lagged changes in transaction volume significantly influence housing price movements, indicating a unidirectional effect from volume to prices in the short run. In contrast, in Taipei City and Kaohsiung City, lagged changes in real housing prices have a significant impact on transaction volume, suggesting a unidirectional influence from prices to volume. Meanwhile, Taichung City displays bidirectional interactions between housing prices and transaction volume. Overall, these findings underscore substantial regional heterogeneity in short-run price-volume dynamics.

The robustness analysis, incorporating inflation adjustment, seasonal controls, and a credit control policy dummy, confirms that the main findings are largely insensitive to the choice between real and nominal housing prices. In particular, while the magnitude of coefficients differs, the qualitative patterns of long-run relationships and short-run dynamics remain unchanged.

From a policy perspective, these findings suggest that housing market monitoring should not rely solely on price indicators. Transaction volume provides important information on market liquidity, adjustment pressure, and potential disequilibrium, and should therefore be incorporated into housing market surveillance and early-warning systems. Moreover, given the substantial heterogeneity in adjustment mechanisms across municipalities, housing policies should be designed on a region-specific basis rather than applied uniformly nationwide. In cities where transaction volume serves as the primary adjustment mechanism, policies targeting market liquidity may be more effective, whereas in cities where housing prices dominate adjustment, policy attention should focus more directly on price formation and supply constraints.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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