Thailand's RPPI Technical Paper

Introduction

Residential Property Price Index (RPPI) in Thailand is a tool developed to measure the change in the selling price of residential properties. It covers purchases of new and resale of single-detached houses, town houses, and condominiums by household while excluding semi-detached houses and custom-build/self-build houses.

The RPPI is disseminated monthly and is lagged by one month.

Data Sources and Coverage

The RPPI is constructed from mortgage data provided by commercial banks and Government Housing Bank, which are legally obliged to submit individual's loan contract data to Bank of Thailand (BOT) monthly.

The dataset covers around 55% of total residential property transactions in terms of volume and contains information on dwelling characteristics used as variables in the model, including dwelling type, location, land area, built-up area, building age, storey, and developer type. The appraisal price, including both building and land prices, is used as a proxy for the selling price of properties to construct the RPPI.

The index is quality-adjusted using the Time-dummy Hedonic Regression method and comprised of 3 subindexes. The single-detached house and town house price indexes are available nationwide. Meanwhile, the condominium price index is only available in the Bangkok and vicinity, but it accounts for more than 80% of total mortgage transactions for condominiums.

Additionally, geographical coordinates of major points of interest (POIs) in a specific area, such as transportation service points, are acquired from Google Maps. POIs are anchored to measure distances from the center of subdistrict of dwellings. The vector distances then are placed as variables in the model.

Methodology

Data Processing

Filtering Mortgage Transactions

RPPI is constructed using a filtering technique to achieve the price reflecting only residential property. Only transactions with objectives of purchasing new and resale properties are kept in the dataset. Other objectives such as personal consumption, construction of self-builds, and refinancing are excluded. Given that about two-thirds of the data are new properties, the index is inclined to indicate the price change of the new dwellings better than that of the existing ones.

The dataset includes single-detached houses, townhouses, and condominiums, while excluding semi-detached houses due to their low number of transactions.

Outlier Detection

To remove outliers, the mortgage dataset is filtered using rule-based criteria **(Table 1)** to exclude transactions with unusual values due to human errors or uncommon houses in terms of size, built-up area, or building age. Note that land area in Thailand is commonly measured in square wa (sq. w.), and a square wa equals to 4 square meters (sq. m.).

Table 1: Rule-based Filters

Attribute	Single-detached House	Town House	Condominium
Land area	>= 20 sq. w. and <= 99th percentile	>= 16 sq. w. and <= 99th percentile	N/A
Building age	< 50 years old		
Number of storeys (low-rise) Floor number (high-rise)	1 - 3		1 - 73
Appraisal price	>= 1st percentile and <= 99th percentile		
Built-up area	>= 1st percentile and <= 99th percentile		

The detailed explanations are as follows:

- **Land Area**
  According to the Land Development Act and the information from National Housing Authority, a single-detached house and a town house require by law to have the minimum land area of 20 sq. w. and 16 sq. w., respectively. In addition, low-rise dwellings with land area exceeding the 99th percentile of the data each month are treated as outliers and are removed.

- **Building Age**
  The maximum building age of 50 years is based on the estimated age of reinforced concrete, according to the civil engineering practices.

- **Number of Storeys (for single-detached house and town house)**
  The maximum number of storeys for low-rise dwelling is calculated from the 99th percentile of the data in the past ten years, equal to 3.

- **Floor Number (for condominium)**
  The floor number of a unit must not exceed the highest floor of the tallest condominium in Thailand, which is the 73rd floor of the King Power Mahanakhon building. This criterion will be adjusted if the highest floor number changes.

- **Appraisal Price and Built-up Area**
  For appraisal price and built-up area, outliers are defined as the number lower than the 1st percentile or greater than the 99th percentile of the data each month.

The data undergoes a second filtering process based on the Cook's Distance method, which identifies outliers that have a large influence on the regression model. The Cook's Distance method measures how much each data point affects the estimated coefficients of the model.

The final data set, consisting of approximately 10,000 observations per month, is then used to construct the index using the Hedonic Regression method.

Quality Adjustment

Dwelling prices are influenced by various factors, such as their characteristics, macroeconomic conditions, demand, speculation, and government policies. Dwellings are heterogeneous goods, meaning that they differ in many aspects and are not perfectly substitutable. Therefore, their prices cannot be directly compared over time without accounting for the changes in their quality. To construct a price index that reflects the pure price movements, it is necessary to adjust for the quality differences of dwellings, such as size, age, location, and type. This technique is called "quality adjustment."

There are three main methods to deal with quality adjustment: the repeat sales method, the stratification method, and the hedonic regression method. The repeat sales method is not suitable for Thailand, as dwellings, especially single-detached houses and townhouses, are rarely resold in the short- and medium-term periods. The stratification method groups similar houses together and calculates a weighted median price. This method is effective when house characteristic data is limited but it does not adjust for property-mix change within strata. The hedonic regression method controls the price changes determined by changes in house characteristics. This method is well suited for Thailand's RPPI compilation, as it requires a rich data set on dwelling characteristics and provides an efficient adjustment.

Hedonic regression

*Hedonic regressi*on model

The Thailand's hedonic regression method uses a log-linear functional form. The equation is as follows:

$$\ln(P) = c + \sum_{k=1}^{n} \hat{\beta}_k x_k + \sum_{j=2}^{12} \hat{\alpha}_j TD_j$$

Where P is the price of the dwelling;

c is the constant term;

$\hat{\beta}_k$ is the regression coefficient of regression variable;

x_k is a regression variable (see more details in the next section);

$\hat{\alpha}_j$ is a time period coefficient;

TD_j is a time dummy variable.

To measure the change in the price between two consecutive periods, the value of the price index for period *t* is given by

$$\text{Index}_t \quad = \quad \frac{\exp(\alpha_{12_t})}{\exp(\alpha_{11_t})} \text{ x Index}_{t-1}$$

Where $Index_t$, $Index_{t-1}$ are the index values in the current and preceding periods.

Regression variables

The regression variables used in the hedonic regression model are shown in the **Table 2** and **Table 3**.

Table 2: Regression Variables for RPPI Compilation

Variables	Description	BKK and vicinity	Other regions
ln (LA)	Land area (Only for low-rise)	/	/
ln (AU)	Area utilization of dwelling	/	/
ln (Location)	Displacement from significant place (Details in Table 4)	/	/
Location dummy	The location where dwelling was located (Details in Table 4)	-	/
Zone	The zone where dwelling was located (Only for condominium in Bangkok and vicinity) cbdd: Inner Bangkok zone cd: Middle Bangkok zone ed: Eastern Bangkok zone nd: North Bangkok zone sd: South Bangkok zone td: Thonburi zone d11: Samut Prakan province d12: Nonthaburi province d13: Pathum Thani province d73: Nakhon Pathom province d74: Samut Sakhon province	/	-
Developer dummy (DD)	Listed or Non-listed company	/	/
Storey	Low-rise: Number of floors High-rise: Floor number	/	/
Age	Age of building	/	/
GD	Loan from commercial or government bank	/	/

Table 3: Location Variables

Regions	Location (Displacement from the center of subdistrict of dwellings to …)	Location dummy (Located in…)
Bangkok and vicinity	Rapid train station such as BTS[1], MRT[2], and ARL[3].	-
Central (Excl. Bangkok and vicinity)	The prime area of each region, which positively affects housing prices.	A subdistrict that is close to the beach.
North		Chiang Mai province
Northeast		Nakhon Ratchasima, Udon Thani, Ubon Ratchathani, and Khon Kaen provinces
South		Koh Samui and Koh Phangan, Asia Road, and Khanom District

Note: [1] BTS = Bangkok Mass Transit System, [2] MRT = Metropolitan Rapid Transit, [3] ARL = Airport Rail Link

The rolling time dummy approach

The RPPI employs a 12-month rolling time dummy regression model. This model updates the regression coefficients every month by shifting the data window one month forward, while keeping the same 12-month length. This allows for more observations and reduces the short-term volatility in price changes. This also enables the model to capture the changing preferences of buyers over time.

Index Aggregation

Regional Index Aggregation

The regional house price indexes are calculated by applying the 12-month rolling time dummy regression model to the data from selected provinces, depending on dwelling types. The **Table 4** shows the provinces that are included in the regional index calculation.

Table 4: Provinces Selected and Coverage for Regional Index

Regions	Provinces selected and coverage (% of regional mortgage data)		
	Single-detached House	Town House	Condominium
Bangkok and vicinity	Bangkok, Nonthaburi, Pathum Thani, Samut Prakan, Nakhon Pathom and Samut Sakhon (100%)		
Central region	Chonburi and Rayong (51%)	Chonburi (57%)	none
North	Chiang Mai, Chiang Rai, Phitsanulok, Nakhon Sawan and Lamphun (68%)	none	none
Northeast	Nakhon Ratchasima, Khon Kaen, Ubon Ratchathani and Udon Thani (55%)	none	none
South	Songkhla, Phuket, Surat Thani, and Nakhon Si Thammarat (71% for Single-detached House and 81% for Town House)		none

National Index Aggregation

The regional house price indexes are aggregated to obtain the national level house price indexes for each dwelling type. The aggregations are done by weighting the regional house price indexes by the total appraisal value of each region, which reflects the relative importance of each region in the housing market. The weights are computed by taking the rolling average of the current and previous 11 months, which is consistent with the 12-month rolling data used in the RPPI model. This method allows for capturing the changes in the structure of the housing market over time.

$$I^t = \frac{\sum_{i=1}^{n} w_i \times I_i^t}{\sum_{i=1}^{n} w_i} \qquad \text{and} \quad w_i = \frac{(\sum_{t-11}^{t} V_i^t)/12}{(\sum_{i=1}^{n} \sum_{t-11}^{t} V_i^t)/12}$$

Where I^t is the national RPPI in period t;

I_i^t is the index of region i in period t;

w_i is the value weight of region i with 12 months moving average;

V_i^t is the transaction value of region i in period t.

The final step of the RPPI calculation is to apply the 3-month moving average technique to all indexes, which smooths out the short-term fluctuations in the data before dissemination. The RPPIs are accessible at https://app.bot.or.th/BTWS_STAT/statistics/BOTWEBSTAT.aspx?reportID=920&language=ENG

Revision Policy

The RPPI is regularly updated to reflect the current conditions of the housing market. One of the aspects that is constantly updated is the location variables of the model, which capture the effects of significant changes in the surrounding areas of the dwellings, such as the construction of new rapid transit stations or landmarks. The index is also periodically reviewed to enhance its coverage and methodology. This may involve incorporating new data sources, modifying the outlier criteria, and improving the model. When these changes are implemented, the index is revised as far back as possible, which may result in a revision of the entire series of the index.

When data errors or incompleteness are detected, which may occur in rare circumstances such as a pandemic, the index will be revised in the subsequent release.

Other Real Estate Indicators and Use Cases

In addition to the RPPI, BOT compiles the Land Price Index (LPI) to measure the change in land price at appraisal price. However, users should note that the mortgage data used to calculate the LPI includes land with buildings, where the land price is indirectly estimated and may deviate slightly from the actual value. Alternatively, the Empty Land Price Index published by the Real Estate Information Center (REIC) is based on the selling price of vacant plots transferred by corporations and may be more suitable for some use cases, such as monitoring developer costs.

Other than the price indexes, BOT and REIC also disseminate various indicators that provide information on the property market, both demand and supply sides, such as total dwellings transferred, housing construction permits, unsold units, etc. BOT uses these indicators, along with the RPPI, to monitor the real estate market and to support policy formation, ensuring financial stability.

Contacts

Mrs. Jaruphan Wanitthanankun   jaruphav@bot.or.th

Mr. Kiattikhun Samritpiam   kiattiks@bot.or.th

Mr. Poonna Pipatpanukul   poonnap@bot.or.th

Bank of Thailand