Residential property price index (RPPI) – technical note

1. Background

The residential property price index (RPPI) measures the price evolution for residential properties in Chisinau. Reliable property price indexes are essential for the National Bank of Moldova to assess developments and risks in the real estate market and to understand the linkages between residential real estate markets and financial soundness.

2. Coverage

The coverage of the RPPI is limited to Chisinau city and region and covers both the primary (new dwellings) and the secondary (existing dwellings) market. The primary and secondary market indexes are aggregated using weights based on transaction data from the Land Registry to obtain an overall index.

3. Data sources

The National Bank of Moldova collects listing data from popular real estate listings websites to obtain the necessary microdata to allow for the compilation of the RPPI. The data is obtained automatically using web scraping for both the secondary and the primary market. Data is scraped every two weeks. Land Registry data is used to compile the weights for the primary and secondary market.

4. Periodicity

The RPPI is disseminated on a quarterly basis. The RPPI is compiled based on data for dwellings that were listed online during that quarter. Weights are updated annually and are based on the average of the total transaction value of the last 3 years for the primary and secondary market in Chisinau.

5. Base period

The RPPI is an annually chain-linked Laspeyres-type price index that uses the year 2019 as reference year. The average of the quarterly indexes for 2019 equals 100.

6. Dissemination

An overall residential property price index is disseminated, as well as the sub-indexes for the primary and the secondary market.

The RPPI is released on a quarterly basis, the index of a quarter is released during the next quarter. The weights of the primary and secondary market are updated annually with the index release of the first quarter of every year.

7. Methodology - Conceptually

To compile an RPPI, key characteristics of the dwellings are required to assure a constant quality index. As with any price index the target is to follow the price trend by comparing like-with-like. For property price indexes this is particularly challenging since a direct price comparison requires comparable dwellings or the same dwelling to be available in consecutive periods. This is generally not the case with

residential properties where the same residential property is only sold every couple of decades. Given the infrequent sale and the heterogeneity of residential properties, quality adjustment techniques are required to derive measures of pure price change. This means that the data requirements for a high quality RPPI are extensive and rely heavily on detailed characteristics about each property given there are a wide range of characteristics that can influence the price of a dwelling.

8. Methodology – Characteristics Hedonic Method

To adjust for the quality-mix of dwellings from quarter to quarter a "characteristics hedonic method" is used. The characteristics hedonic method measures the price evolution of a "typical" dwelling. This "typical" dwelling is estimated by averaging the characteristics of all the properties in a stratum (primary or secondary market) for a reference period. The reference period for the current year is the 4th quarter of the previous year.

A log-linear specification is used for each stratum and the regression is estimated every quarter using ordinary least squares. The variables included in the hedonic model are for instance the surface and the number of rooms. A "shadow" price is then estimated for each characteristic in the current quarter and in the reference quarter. The price index is calculated by comparing the price of the typical property in the current quarter with the price of the "typical" property in the reference quarter.

The long time series for all levels (stratum indexes and overall index) are obtained by chaining the current period by the chained index of the last period of the previous year.

The weights are updated annually and are based on average the transaction number of the last 3 years in Chisinau for the primary and secondary market.

9. Methodology – mathematical specification of the hedonic model

The log-linear specification for each stratum is the following:

$$\ln(p_n^t) = \beta_0^t + \sum_{k=1}^{K} \beta_k^t z_{nk}^t + \varepsilon_n^t$$

- $\ln(p)$: logarithm of the price
- t: period (quarter)
- n: number of dwellings in period t
- β_0^t: intercept in period t
- β_k^t: "shadow" price of characteristic k in period t
- z_{nk}^t: (quantity of) characteristic k in period t and for n dwellings
- ε_n^t: random error term for period t and n dwellings

Separate regressions are estimated on the data of the reference period (0) and the current period (t) for each stratum (primary and secondary market) to obtain the estimated parameters $(\hat{\beta})$ for each quarter in a stratum. This gives, after exponentiating, the predicted prices of the dwellings, for period the reference period (0):

$$\hat{p}_n^0 = \exp\left(\hat{\beta}_0^0\right) \exp\left[\sum_{k=1}^{K} \hat{\beta}_k^0 z_{nk}^0\right]$$

And for the current period (t):

$$\hat{p}_n^t = \exp\left(\hat{\beta}_0^t\right) \exp\left[\sum_{k=1}^{K} \hat{\beta}_k^t z_{nk}^t\right]$$

The index is compiled by comparing the predicted price for the "typical dwelling" in the current period (t) and in the reference period (0). The typical dwelling is defined by the average characteristics of the dwellings in the reference period $(\bar{z}_k^0)$.

The average characteristic for a numerical variable is obtained by taking the mean. For categorical variables the typical property is obtained by calculating (for each variable) the relative frequencies of all possible options. The sum of the relative frequencies for every categorical variable therefore adds up to one.

The index can then be obtained in two mathematically equivalent methods.

The first option is by dividing - for the typical dwelling $(\bar{z}_k^0)$ of the reference period - the predicted price in the current period (t) by the predicted price for the reference period (0):

$$I_t = \frac{\exp\left(\hat{\beta}_0^t\right) \exp\left[\sum_{k=1}^{K} \hat{\beta}_k^t \bar{z}_k^0\right]}{\exp\left(\hat{\beta}_0^0\right) \exp\left[\sum_{k=1}^{K} \hat{\beta}_k^0 \bar{z}_k^0\right]}$$

The second option compiles the index as the exponentiated difference between the estimated regression coefficients of the current period (t) and the reference period (0). For the characteristics parameters (β_k) the resulting differences are then multiplied by the characteristics of the typical dwelling $(\bar{z}_k^0)$. These values are then summed and exponentiated to obtain the index:

$$I_t = \exp\left(\hat{\beta}_0^t - \hat{\beta}_0^0\right) \exp\left[\sum_{k=1}^{K} (\hat{\beta}_k^t - \hat{\beta}_k^0) \bar{z}_k^0\right]$$

10. Chaining

The average characteristics $(\bar{z}_k^0)$ of the typical dwelling are updated every year. The average characteristics of the fourth quarter of the previous year are used to compile the index for the four quarters in the current year. The fourth quarter therefore acts as a chain link quarter. An example is given in the table below (using fictional data).

Quarter	Typical dwelling from 2018Q4 (=100)	Typical dwelling from 2019Q4 (=100)	Typical dwelling from 2020Q4 (=100)	Chained Index (2019=100)
2019Q1	100.5			97.9 = (100.5/102.7)*100
2019Q2	101.5			98.9 = (100.5/102.7)*100

2019Q3	105.4			102.7 = (105.4/102.7)*100
2019Q4	103.2	100.0		100.5 = (103.2/102.7)*100
2020Q1		99.1		99.6 = 99.1 * (100.5/100)
2020Q2		99.5		100.0 = 99.5 * (100.5/100)
2020Q3		101.2		101.7 = 101.2 * (100.5/100)
2020Q4		100.8	100.0	101.3 = 100.8 * (100.5/100)
2021Q1			100.4	101.7 = 100.4 * (101.1/100)
2021Q2			100.8	102.2 = 100.8 * (101.1/100)
2021Q3			99.8	101.1 = 99.8 * (101.1/100)
2021Q4			100.5	101.8 = 100.5 * (101.1/100)