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Cointegration of Property Prices in Poland

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This paper presents the analysis of cointegration between offer prices and transactional prices on both primary and secondary local real estate markets. 17 Polish biggest cities are considered and the period between 2006 and 2013. Generally, it is found that primary and secondary markets are not cointegrated.

Keywords: *cointegration, primary market, property prices, real estate, secondary market, Poland*

JEL Classification: *R30*

1. Introduction

The aim of this article is to present the outcomes from the statistical analysis of property prices in Poland. Different prices are discussed, i.e. offer and transaction ones. Moreover, they are taken from primary and secondary markets. As a result, 4 types of prices for each city are obtained. It is studied, whether a cointegration relationship can be found between them.

The data (BaRN, 2014) are taken from 17 biggest Polish cities: Białystok, Bydgoszcz, Gdańsk, Gdynia, Katowice, Kielce, Kraków, Lublin, Łódź, Olsztyn, Opole, Poznań, Rzeszów, Szczecin, Warszawa, Wrocław and Zielona Góra. All of them, except Gdynia, are capital cities of voivodeships. The period between 3rd quarter of 2006 and 3rd quarter of 2013 is analysed. Quarterly data are used.

In the first stage all time series are tested for stationarity with a help of Augmented Dickey-Fuller test (Hill et al., 2011). Then for each pair of prices, for a particular city, a linear regression model is evaluated (with one independent variable). In the second stage residuals of this model are tested (also by Augmented Dickey-Fuller test) for stationarity. Because data are quarterly, 4 lags are chosen. The cointegration is present, if both time series are nonstationary and residuals are stationary.

The calculations are done in Gretl statistical package (Gretl, 2013).

2. Literature Review

It is obvious, that when a model of property prices is constructed, it is crucial what prices are used. This might seem trivial at the first sight. However, one can hastily take offer prices, because they are usually easier to collect. For example, from newspapers, etc. But what constitutes the real part of economy are transaction prices. If the difference between offer ones and transaction ones is somehow "stable", then there is no problem.

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Secondly, there is a question, whether there is a "stable" relationship between prices on primary market and secondary market. Secondary market can seem more flexible, whereas primary market can be seen as less negotiable.

The described problem is crucial both in finances and management. For a general review of various methods of modeling property prices, for example, short reviews of Jadevicius (2014) and Brown et al. (2010) can be consulted.

Therefore, it is interesting and important to study the "stability" of the mentioned relationship. For example, Dittmann (2013) considered correlation between different types of prices. Another attempt can be to use the notion of "cointegration", which has just been explained. Actually, this procedure has been proposed by Engle and Granger (1987). Nowadays, it is very common tool in econometrics (Hill et al., 2011).

It is worth to mention that even high correlation do not guarantee long-term relationship. On the other hand, the presence of cointegration means that all differences between time series are random (Alexander, 1999).

The regional approach towards property prices in Poland has already been applied, for example, by Baldowska et al. (2014), Belej and Kulesza (2014), Leszczyński and Olszewski (2014) and Drachal (2014a, 2014b).

3. Analysis and Results

The results from the first stage are presented in Table 1.

Table 1. *P-value of ADF test for initial time series*

	primary		**secondary**	
	offer	**transaction**	**offer**	**transaction**
Białystok	0.0215	0.5343	0.4241	0.8286
Bydgoszcz	0.3259	0.0626	0.9362	0.7616
Gdańsk	0.1902	0.3498	0.7892	0.8789
Gdynia	0.0236	0.0236	0.7853	0.9632
Katowice	0.4502	0.2409	0.0696	0.6748
Kielce	0.1600	0.0030	0.2351	0.2837
Kraków	0.9962	0.8229	0.0511	0.0597
Lublin	0.0010	0.0001	0.1787	0.1288
Łódź	0.9321	0.9380	0.7814	0.5798
Olsztyn	0.2701	0.0838	0.2710	0.5242
Opole	0.5257	0.6643	0.0651	0.2011
Poznań	0.1687	0.0644	0.6132	0.1008
Rzeszów	0.9648	0.4845	0.7790	0.5711
Szczecin	0.0037	0.7671	0.9689	0.5842
Warszawa	0.5453	0.1773	0.9903	0.9533
Wrocław	0.6551	0.5300	0.9148	0.9895
Zielona Góra	0.0668	0.0075	0.6805	0.0014

Source: own elaboration in Gretl

It can be seen that, at 5% significance level, offer prices on the primary market are stationary in Białystok, Gdynia, Lublin and Szczecin. Moreover, in Gdynia and Lublin also transaction prices are stationary. It can be concluded that these two markets are stabilised.

But in Białystok and Szczecin transaction prices are nonstationary. So it can be concluded that although developers have offered the same prices, the transaction prices have been changing.

Another interesting fact can be observed in Kielce and Zielona Góra. They are transaction prices, which are stationary and offer ones that are nonstationary. It means that developers have been changing offer prices, but transaction prices have been the same.

All time series of offer prices on secondary market are nonstationary. It means that suppliers have been changing their prices. In case of transaction prices only in Zielona Góra the time series is stationary. In consistency with previous analysis, this market is stabilised. However, suppliers (both on primary and secondary market) have been changing their prices.

In other cities prices of both types on secondary market have been changing.

The results from the second stage of the cointegration testing are presented in table 2. The following abbreviations are used: op – offer prices on primary market, os – offer prices on secondary market, tp – transaction prices on primary market, ts – transaction prices on secondary market.

Table 2. *P-value of augmented Dickey-Fuller test for residuals*

	op, tp	**op, os**	**op, ts**	**tp, os**	**tp, ts**	**os, ts**
Białystok	0.9932	0.8594	0.6770	0.9237	0.1893	0.8322
Bydgoszcz	0.4908	0.9876	0.9282	0.9560	0.9721	0.3103
Gdańsk	0.5689	0.7003	0.7316	0.7074	0.7155	0.8347
Gdynia	0.0000	0.0385	0.5141	0.0385	0.5141	0.4060
Katowice	0.7112	0.6656	0.3815	0.6913	0.6714	0.8127
Kielce	0.3984	0.0000	0.0168	0.2162	0.7466	0.1475
Kraków	0.4939	0.9459	0.9842	0.8708	0.9769	0.8363
Lublin	0.4938	0.4783	0.7645	0.1384	0.6579	0.5200
Łódź	0.2728	0.8545	0.4947	0.8994	0.6572	0.7552
Olsztyn	0.3702	0.6642	0.5415	0.5520	0.4363	0.5937
Opole	0.8091	0.4916	0.6156	0.8338	0.8872	0.6692
Poznań	0.3652	0.2487	0.1209	0.2392	0.2263	0.0494
Rzeszów	0.9285	0.9876	0.9746	0.6554	0.4341	0.8447
Szczecin	0.4845	0.4519	0.5928	0.4835	0.7463	0.2125
Warszawa	0.3644	0.5665	0.4544	0.1506	0.0011	0.7631
Wrocław	0.7139	0.8555	0.9164	0.9427	0.9748	0.6884
Zielona Góra	0.3192	0.5916	0.6950	0.3388	0.1004	0.4273

Source: own elaboration in Gretl

The majority of considered pairs indicate no presence of cointegration (at 5% significance level). The only "candidates" are:

1. offer and transaction prices on primary market in Gdynia,
2. offer prices on primary and secondary market in Gdynia,
3. offer prices on primary and secondary market in Kielce,
4. offer prices on primary and transaction prices on secondary market in Kielce,
5. transaction prices on primary and offer prices on secondary market in Gdynia,
6. transaction prices on primary and transaction prices on secondary market in Warszawa,
7. offer prices on secondary market and transaction prices on secondary market in Poznań.

But considering results in table 1, it can be seen that pair 1 consists of stationary time series, therefore there is no indication of cointegration. In pairs 2 and 5 one of the time series is stationary. But pairs 3 consists of nonstationary time series, therefore cointegration is positively verified. The same is true for pairs 4, 6 and 7.

4. Discussion and Conclusion

The striking result is that empirically found cointegration relationship is not transitive. But it is clear that from the definition of this relationship it is transitive, indeed. Such a situation can be the result of taking relatively short time series and bias in testing procedure (Alexander, 1999).

Nevertheless, it has been found that there is practically no cointegration between two types of prices considered on two types of markets. This conclusion indicates that taking different type of property prices can significantly affect a constructed property price model in Poland. It is also important in case of constructing any universal property price index. Managers and financiers should take great care of this.

From the theoretical point of view, it is also worth to mention that there are known other cointegration testing procedures, e.g. Johansen test, which could give different results (Hill et al., 2011).

Finally, please notice that the discussed relationship is based on the assumption of linear relationship, which is some limitation.

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