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(Revised)

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ABSTRACT

This paper describes the sampling methods and estimation techniques employed by the Economics Research Centre (CypERC) for the construction of property price indices for Cyprus. More specifically, the research described here aims at enhancing the existing knowledge on property price behaviour in Cyprus by:

(a) building a new database, using newspaper advertisements of monthly prices and related information about various types of property (houses, flats, plots, etc.) in different districts of Cyprus over the post-2000 period;

(b) developing models for the estimation of property price indices that can provide a measure of the quarterly change in property prices, together with an assessment of the reliability of this measure.

This paper revises the estimation methodology in Karagiannakis et al. (2015) to take into account the effects of different data sources on property prices.

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CONTENTS

I. INTRODUCTION

A house is the largest single asset of most households. Furthermore, assets linked to residential real estate represent an important component of the aggregate portfolio of financial intermediaries. In recent years many countries across the globe (e.g. the USA, UK Japan, Spain) experienced booms and busts in property prices, often associated with movements in macroeconomic factors such as interest rates and economic growth. This cyclical nature of the residential real estate market has been a major topic of discussion over the years (Englund and Ioannides, 1997; Maclennan et al., 1998).

Economic theory suggests that wealth is one of the key drivers of aggregate consumption; therefore, a downturn in the property market is likely to be followed by a decrease in household consumption and, in turn, lower economic growth. Moreover, through the exposure of banks' lending portfolios to the real estate market, large declines in property prices could trigger tight credit conditions with negative effects on economic activity; and, subsequently, adverse financial conditions via increasing default rates and capitalisation needs. Thus, property prices influence the performance of the financial system, through their effect on the profitability and financial performance; and, therefore, they are of key interest to central banks charged with maintaining price and financial stability.

The property market can also impact on government revenue. It is a widely held view that the property tax is a stable revenue source over the business cycles. This is often cited as one of the primary virtues of property taxation. Booms and busts in the property market, however, can change government revenue through various channels, e.g. the property tax and the real estate transfer tax are positively correlated with the value (and the volume) of real estate transactions. Furthermore, the conditions in the property market can have other effects on government revenue, e.g. sales of materials used in construction directly affect VAT revenues; while personal income tax revenues can be affected by the reduction in employment related to construction and real estate activity (Byron et al. 2010).

A question of strong interest in the property and real estate literature is which micro- and macro-economic factors affect the level and change in property prices: the microeconomic approach mainly focuses on the relationship between the price and property characteristics, e.g. size, type, location etc (Carroll et al., 1996; Rodriguez and Sirmans, 1994; Fletcher, et al., 2000; Adair et al., 2000); while the macroeconomic analysis is mostly concerned with factors influencing house prices over time at an economy-wide level, e.g. per capita GDP, interest rate on loans, unemployment inflation, returns in the stock exchange (Adams and Füss, 2010; Bouchouicha and Ftiti, 2012; Ferrara and Koopman, 2010; Brunnermeier and Julliard; 2008).

In the case of Cyprus the literature on how property prices are estimated and which factors affect their evolution is very limited (Pashardes and Savva, 2009; Theodosiou and Thoukididis, 2012; International Monetary Fund, 2014). The most widely known (and used) property price indices are the residential ones published by the Central Bank of Cyprus, in collaboration with the Association of Cyprus Banks. The indices are published quarterly and are based on property valuation data received from independent property surveyors in connection with mortgage transactions, such as housing loans and property characteristics. The research described in this paper aims at enhancing the existing knowledge on property price behaviour in Cyprus by:

(c) building a new database, using newspaper advertisements of monthly prices and related information about various types of property (houses, flats, plots etc.) in different districts of Cyprus over the post-2000 period;

(d) developing scientifically appropriate models for the estimation of property price indices that can provide a measure of the quarterly change in property prices, together with an assessment of the reliability of this measure.

We shall refer to the index resulting from undertaking steps (a)-(b) as the Cyprus Economic Research Centre (CypERC) property price index. This index can add to knowledge about the movements of property prices in Cyprus and contribute to more evidence-based decisions in both the private and public sectors of the economy. In particular, the systematic measurement of property prices via the construction of specialised indices can, inter alia:

- lead to households and firms knowing more about changes in the current value of property, thereby helping them to be better informed participants in the real estate market;
- provide commercial banks and other financial institutions with valuable information for identifying the risk exposure of their portfolios and assessing the levels of capitalisation needs; and
- assist central and local government policy-makers in the design, implementation, monitoring and assessment of property taxation schemes and, in general, property market policies.

The ultimate objective of the property price research at CypERC is to publish a bulletin reporting price indices for different types of property and different districts of Cyprus. The current paper simply serves as an in-depth documentation of the sampling methods and estimation techniques. Moreover, this paper revises the estimation methodology in Karagiannakis et al. (2015) to take into account the effects of different data sources on property prices.

The structure of the paper is as follows: Section II describes the data sources and sampling methods used for the construction of the CypERC database of property prices. Section III presents the econometric model used for the estimation and validation of price indices of various types of properties and in different districts.

II. DATA SAMPLING

II.1 Data sources

The property prices used in this paper are those advertised in newspapers. These, of course, are prices asked by sellers; therefore, the CypERC property price index should be seen as an 'asking price' index. As such it can reflect prices that are likely to be higher than the prices finally agreed with buyers. This, however, is of no consequence when the objective is to investigate not the level but the changes in property prices over time.[2] In fact, using asking property prices has a 'lead' advantage, as the prices finally agreed between the buyer and seller can take a long time to be realised (i.e. the time between placing a property in the market and the completion of the sale).

The property prices and related information were collected from the widely circulated Greek language newspapers Phileleftheros, Politis and Chryses Efkeries; and the English language newspaper Cyprus Mail. The inclusion of newspapers addressed to both Greek and English language readers is thought to be necessary in order to take into account developments in property prices involving not only domestic but also foreign market participants. The sampling units are residential (flats and houses) and non-residential (plot and land) property. The sampling process covers all months of the year and goes back to the year 2000 for both residences and plot/land.

In order to achieve a balanced coverage of the information within a month, the first and third week of each month is sampled. The Sunday issues for daily newspapers and the issue on the circulation day for weekly newspapers are selected. Variations of the sampling date were allowed in cases where no publication was released (New Year's Day, Easter Sunday, Labour Day and the Assumption Day); or whenever the advertisements' section of an issue did not publish enough properties for sale. For these cases the following procedure was employed.

- For the daily newspapers we sampled the next available date following the sequence:
  - one day before (Saturday) the primary sampling date,
  - one day after (Monday),
  - two days before (Friday),
  - two days after (Tuesday), and
  - the following week (Sunday).
- For the weekly newspapers we sampled the next available day the newspaper was in circulation, sometimes the next day or, otherwise, the following week.

Our records consist of copies of the newspapers' sections that contain advertisements of properties (residential and plot/land) for sale.[3]

[2] Normally, there are no reasons to expect the difference between the asking and agreed property prices to change over time. Of course, if one is interested in the level of prices at which property sales are completed, the difference between asking and sale prices can be estimated and the CypERC index adjusted accordingly.

[3] When a newspaper is not available, or does not have the appropriate information, the next sampled newspaper, according to the procedure outlined above, is used. Access to the newspaper is achieved via the internet and the archives of the Press and Information Office for previous years. Hard copies of the advertisements are kept.

II.2 Property types

The selection of observations for our property prices sample is guided by the need to balance the objective of including as many property types as possible with the need to maintain the representation of the property types in the sample constant over time, in order to avoid mistaking changes in property types from one sample period to the next (e.g. large houses in one month followed by small flats in the next) as changes in property prices. For this reason we have excluded from the sample properties for which advertisements in the newspapers are very few and far between, especially at district level, such as houses with five or more rooms or land for commercial use.

Thus, in the case of residential properties the observations selected for inclusion in the sample cover the most popular house and flat types grouped as follows:

(i) houses of up to three rooms,

(ii) houses of four rooms,

(iii) studios and one-room flats,

(iv) flats with two rooms, and

(v) flats with three rooms.[4]

In the case of plot/land properties the observations selected for inclusion in the sample cover:

(i) plot (lot with permission to erect a building) – in Greek 'οικόπεδο',

(ii) land for agricultural use with permission for (limited) human settlement – in Greek 'οικιστικό χωράφι', and

(iii) land for agricultural use without human settlements – in Greek 'αγροτικό χωράφι'.

For brevity, thereafter we shall refer to (ii) as 'settleable land' and to (iii) as 'agricultural land'.

II.3 Sampling

The frequency of observations for each property type and district (Nicosia, Larnaca, Limassol, Famagusta and Paphos) in our sample is proportional to its frequency in the population, as defined by the total number of property advertisements in the selected newspapers at district level. This was determined by performing two separate counting exercises, one for residential properties and one for plot/land. In these exercises we counted the number of property advertisements in newspapers by district and type for selected years in the sample. Then, the resulting counts were combined, whenever available, with information on sales and transfers by district from the Department of Land and Surveys, to determine the proportion of observations to be sampled from each district and type.

[4] In addition to creating irregularities, another problem with including not so popular properties (e.g. one or two bedroom houses, five bedroom flats, etc.) in our sample is the lack of clarity about important characteristics of such properties. For instance sellers of large houses tend to report rooms instead of bedrooms. Similar ambiguities arise for plots and land rarely found in newspaper advertisements (e.g. for commercial use).

II.3.a Residential properties

For the counting exercise of house/flat advertisements we sampled Phileleftheros, Politis, Cyprus Mail, and Chryses Efkeries. We recorded a total of 23806 advertisements by counting them in April and October of 2001, 2003, 2005, 2007, 2009, and 2011. Table II.1 reports the statistics from the counting exercise.

Table II.1: Frequency of residential property advertisements by district and type

	House			Flat			Total	
	Number	Percent		Number	Percent		Number	%
		Distr.	Type		Distr.	Type		
Nicosia	5,437	44.5	46.0	6,773	55.5	56.5	12,210	100
Larnaca	1,785	47.7	15.1	1,954	52.3	16.3	3,739	100
Limassol	3,552	58.9	30.0	2,482	41.1	20.7	6,034	100
Paphos	537	60.5	4.5	351	39.5	2.9	888	100
Famagusta	515	55.1	4.4	420	44.9	3.5	935	100
Total	11,826	49.7	100	11,980	50.3	100	23,806	100

Source: Newspapers Phileleftheros, Politis, Cyprus Mail and Chryses Efkeries

As seen from Table II.1, the district of Nicosia has by far the largest share of houses and flats in the total number of advertisements in the aforementioned newspapers (46% of houses and 56.5% of flats), followed by Limassol (30% of houses and 20.7% of flats), and Larnaca (15.1% of houses and 16.3% of flats); whereas, Famagusta and Paphos are represented in the total number of advertisements by much smaller percentages (together account for 8.9% of houses and 6.4% of flats).

Table II.1 also shows the distribution of property types by district. For Cyprus as a whole, the total number of advertised houses and flats is very close: 11,826 houses and 11,980 flats. There are however notable deviations from this 'fifty-fifty' number between districts. For instance, there are more flats than houses in Nicosia (55.5% vs 44.5%); and the same is also true for Larnaca (52.3% vs 47.7%). In contrast, the number of flats is smaller than the number of houses in Limassol (41.1% vs 58.9%), Paphos (39.5% vs 60.5%) and Famagusta (44.9% vs 55.1%).

Table II.2 reports the frequencies of different property types by district and number of rooms. Again, some marked differences are seen between districts. For instance, relatively large houses are more frequently located in Limassol (28.1% of total properties) and Nicosia (25% of total properties) than in other districts. Also important to note in the same table is that houses are more or less equally distributed between the ≤3- and 4-room categories (25% and 22.2% of total properties, respectively); whereas, in the case of flats, the percentage of total properties is 10.5% for flats with ≤1 rooms, 22.7% for flats with 2 rooms and 17.1% for flats with ≥3 rooms.

Table II.2: Frequency of advertisements of residential property types by district and room number

Types:	Houses				Flats						Total	
Rooms:	≤ 3		4		≤ 1		2		≥ 3			
	Number	%	Number	%	Number	%	Number	%	Number	%	Number	%
Nicosia	2,380	19.5	3,057	25.0	1,466	12.0	2,916	23.9	2,391	19.6	12,210	100
Larnaca	1,058	28.3	727	19.4	387	10.4	1,024	27.4	543	14.5	3,739	100
Limassol	1,856	30.8	1,696	28.1	459	7.61	1,069	17.7	954	15.8	6,034	100
Paphos	409	46.1	128	14.4	87	9.8	175	19.7	89	10.0	888	100
Famagusta	358	38.3	157	16.8	102	10.9	227	24.3	91	9.7	935	100
Total	6,061	25.5	5,765	24.2	2,501	10.5	5,411	22.7	4,068	17.1	23,806	100

Source: Newspapers: Philelefθeros, Politis, Cyprus Mail and Chryses Efkeries

Setting the number of observations in the sample to 48 per month (144 per quarter), on the basis of the distribution of residential properties in the population reported in Tables II.1 and II.2, our sampling by district and type of property is as presented in Table II.3. The main objective achieved by this sampling is representativeness of the distribution of properties in the total number of advertisements in the newspapers; with a small bias in favour of districts with a small number of observations (Paphos and Famagusta), placed by the restriction that at least one observation per month for each type of property should be collected from a district.

Furthermore, while the number of monthly observations per type in each district may appear small, it should be emphasised that:

(i) price indices are constructed either by district *or* (not and) by property type; and

(ii) price indices are produced at a quarterly frequency i.e. their changes can be analysed on a quarterly basis.

Thus, the district price indices have a minimum of 18, and the property type indices a minimum of 21 observations in each quarterly cell.

Table II.3: The sample of residential properties by district and type

	Monthly						Quarterly					
Type:	Houses		Flats			Total	Houses		Flats			Total
Rooms:	≤ 3	4	≤ 1	2	3		≤ 3	4	≤ 1	2	3	
Nicosia	5	3	2	3	3	16	15	9	6	9	9	48
Larnaca	2	2	1	2	1	8	6	6	3	6	3	24
Limassol	3	3	2	2	2	12	9	9	6	6	6	36
Famagusta	2	1	1	1	1	6	6	3	3	3	3	18
Paphos	2	1	1	1	1	6	6	3	3	3	3	18
Total	14	10	7	9	8	48	42	30	21	27	24	144

II.3.b Plot/land properties

The procedure followed for the sampling of plot/land properties is based on the same principles as the one for residential properties. Namely, first the distribution of land/plot properties in the population (advertisements in the newspapers) is determined; and then a number of

observations are collected so that each type of property in each district is proportional to the corresponding number in the population.[5]

The plot/land population is determined by counting the newspaper advertisements in April and October of 2006 and 2011. The total number of plot/land properties advertised during these four periods is 5765 and is distributed as shown in Table II.4. As seen from this table, there is almost an equal split between plots and land for sale (49.85% and 50.15%, respectively). The picture of equal split between plots and land is also relatively similar across districts, with the exception of Paphos, where plots represent 33% and land 67% of the total number of plot/land advertisements in the newspapers. Another feature of the distribution of the plot/land properties is the very small share of Famagusta (and, to a lesser extent, Paphos) in the total number of advertisements of these property types.

Table II.4: Frequency of advertisements of plot/land property by district and type

	Plots			Land			Total	
	Number	Percent		Number	Percent		Number	%
		Distr.	Type		Distr.	Type		
Nicosia	1,385	52.8	48.2	1,236	47.2	42.8	2,621	100
Larnaca	373	46.3	13.0	432	53.7	14.9	805	100
Limassol	980	50.0	34.1	979	50.0	33.9	1,959	100
Famagusta	33	48.5	1.2	35	51.5	1.2	68	100
Paphos	103	33.0	3.6	209	67.0	7.2	312	100
Total	2,874	49.8	100	2,891	50.2	100	5,765	100

Source: Newspapers: Phileleftheros, Politis and Chryses Efkeries.

It should be noted that advertisements of land for sale in the newspapers are not homogeneous and include land for agricultural, settlement, commercial or industrial use, as well as land for gardening and other plant growing purposes. However, several of these land categories (e.g. commercial use and gardening) are very small in number and rarely advertised for sale in the newspapers. This phenomenon is especially observed in Famagusta and Paphos. For this reason we have decided to include in the sample the two most popular types of land: agricultural and settleable, as defined previously (section II.2). Together, these two types of land account for 83.4% of all land advertisements in newspapers and the expectation is that their price changes are representative of the price changes of all types of land. This is a standard practice in sampling for the estimation of price indices in general; and rationalised by the fact that items with a very small weight in the population cannot have a discernible effect on the overall price index, even when their price changes deviate from the norm.

Table II.5 reports the number of observations of agricultural and settleable land by district and usage. Overall, slightly more settleable land is advertised in the newspapers than land for agricultural use (57.6% vs 42.4%). The distribution of land by these two usages, however, is not uniform across districts: for Larnaca and Paphos is close to the mean; for Nicosia is 49.6%

[5] Cyprus Mail is excluded for land and plot sales due to: (i) the ambiguity of the various terms used to describe the property for sale, i.e. the words 'plot', 'land', and 'land of plot' are, among other, used interchangeably; and (ii) the fact that very few (if any) advertisements of land appear in the newspaper in question.

settleable and 50.6% agricultural; for Famagusta is 52.6% settleable and 47.4% agricultural; and for Limassol 74.6% settleable and 25.4% agricultural.

Table II.5: Frequencies of advertisements of land by district and usage

	Agricultural		Settleable		Total	
	Number	%	Number	%	Number	%
Nicosia	319	50.6	311	49.4	630	100
Larnaca	86	42.2	118	57.8	204	100
Limassol	81	25.4	238	74.6	319	100
Famagusta	9	47.4	10	52.6	19	100
Paphos	31	44.3	39	55.7	70	100
Total	526	42.4	716	57.6	1,242	100

Source: Newspapers: Phileleftheros, Politis and Chryses Efkeries.

The total number advertisements sampled for the purposes of estimating the price index of plot/land is set to 50 per month and is allocated between districts and types (plots, agricultural land and settleable land) on the basis of the weights implied by Tables II.4 and II.5. The resulting number of monthly and quarterly observations for different types of plot/land property in the sample is reported in Table II.6.[6]

Table II.6: The sample of plot/land properties by district and type

	Monthly				Quarterly			
	Plots	Land		Total	Plots	Land		Total
		Agr/ral	Set/ble			Agr/ral	Set/ble	
Nicosia	11	5	5	21	33	15	15	63
Larnaca	3	2	2	7	9	6	6	21
Limassol	9	2	6	17	27	6	18	51
Famagusta	1	0	1	2	3	0	3	6
Paphos	1	1	1	3	3	3	3	9
Total	25	10	15	50	75	30	45	150

A remark that can be made here about the figures presented in Table II.6 is the small number of observations of plot/land property advertised for sale in Famagusta and Paphos: 6 and 9 per quarter, respectively. The reliability of changes in plot/land prices estimated with such a small number of observations is questionable. Although this problem can be somehow ameliorated in the context of the econometric analysis used is this paper (and described in the next section) since all estimated prices changes are assessed for their reliability (statistical significance), we have decided to group these two districts together and construct one plot/land property price index for the two districts in question.

[6] As the number of land observations was too small for Famagusta to be included in the sample, we subtracted one observation from each land category in Nicosia and added it to the respective category in Famagusta.

II.4 Collected information

The information collected for each residential property includes:

- asking price[7],
- area (for houses the area of the plot is also included, if available),
- type of unit (detached or semi-detached house, flat),
- number of rooms,
- district (and any additional information on location),
- month and year of the advertisement,
- whether the unit is labelled as new or used, and
- whether the price includes VAT.

The information to be collected for each plot/land unit includes:

- asking price,
- area,
- type of unit (plot or land),
- district (and any additional information on location),
- month and year of the advertisement,
- building and coverage factors, and
- whether the land is agricultural or settleable.

Table II.7 reports selected statistics of the sample covering the period 2000Q1 - 2014Q4 for the residential properties and the period 2005Q1 - 2014Q4 for the plot/land properties.[8]

- In the case of residential properties the total number of observations over this period is 8500, the mean price around 200 thousand euro, the mean size in square meters 148 and the mean number of rooms 2.7. Furthermore, 31% of the collected properties are new, 13% are in Famagusta, 17% in Larnaca, 25% in Limassol, 33% in Nicosia and 12% in Paphos. As said earlier in this section, residential properties are more or less equally split between houses and flats; and Chryses Efkeries accounts for 36% of observations, followed by Cyprus Mail (27%), Phileleftheros (26%) and Politis (11%).

- In the case of plot/land properties the total number of observations over the aforementioned period is 5797, the mean price 290 thousand euro and the mean size in square meters 5900, including both plots and land. Furthermore, 4% are in Famagusta, 14% in Larnaca, 34% in Limassol, 41% in Nicosia and 5% in Paphos. Properties are more or less equally split between plots and land; and Chryses Efkeries accounts for 64% of observations, followed by an equal percentage of 17% for each of the two remaining collected newspapers, Phileleftheros and Politis.

[7] On January 1, 2008 Cyprus joined the euro area. All prices that were reported in Cyprus pounds were converted into euros using the following exchange rate: CYP 1 = EUR 1.708601.

[8] These statistics are calculated after the removal of outliers and the estimation of missing values for the area of the structure, as described in the following sub-sections.

Table II.7: Sample statistics (2000-2014)

	Observations		Mean		Std. Deviation		Minimum		Maximum	
Variables	Resid-ential	Plots-land	Resid-ential	Plots-land	Resid-ential	Plots-land	Resid-ential	Plots-land	Resid-ential	Plots-land
Price (in thousands)	8500	5797	199	290	151	464	4.7	3.8	1800	14500
Area of structure (sq.m.)	8500	N/A	148	N/A	77	N/A	25	N/A	900	N/A
Area of plot (sq.m.)	660	N/A	677	N/A	1056	N/A	68	N/A	10500	N/A
Area (sq.m., in thousands)	N/A	5797	N/A	5.9	N/A	118.6	N/A	0.13	N/A	6263
Number of rooms	8500	N/A	2.7	N/A	0.98	N/A	0	N/A	4	N/A
New	7279	N/A	0.31	N/A	0.46	N/A	0	N/A	1	N/A
Famagusta	8500	5797	0.13	0.04	0.33	0.19	0	0	1	1
Larnaca	8500	5797	0.17	0.14	0.37	0.34	0	0	1	1
Limassol	8500	5797	0.25	0.34	0.43	0.47	0	0	1	1
Nicosia	8500	5797	0.33	0.41	0.47	0.49	0	0	1	1
Paphos	8500	5797	0.12	0.05	0.33	0.23	0	0	1	1
House	8500	N/A	0.47	N/A	0.50	N/A	0	N/A	1	N/A
Semi-detached house	8500	N/A	0.03	N/A	0.16	N/A	0	N/A	1	N/A
Flat	8500	N/A	0.50	N/A	0.50	N/A	0	N/A	1	N/A
Plot	N/A	5797	N/A	0.50	N/A	0.49	N/A	0	N/A	1
Land	N/A	5797	N/A	0.49	N/A	0.49	N/A	0	N/A	1
Settleable	N/A	3486	N/A	0.67	N/A	0.46	N/A	0	N/A	1
Agricultural	N/A	3486	N/A	0.32	N/A	0.46	N/A	0	N/A	1
Coverage factor	N/A	381	N/A	41.9	N/A	16.6	N/A	0.5	N/A	100
Building factor	N/A	2950	N/A	61.5	N/A	35.5	N/A	1.2	N/A	180
Filelefttheros	8500	5797	0.26	0.17	0.44	0.37	0	0	1	1
Cyprus Mail	8500	N/A	0.27	N/A	0.44	N/A	0	N/A	1	N/A
Politis	8500	5797	0.11	0.17	0.31	0.38	0	0	1	1
Chryses Efkeries	8500	5797	0.36	0.64	0.48	0.47	0	0	1	1

Source: Newspapers: Philelefttheros, Politis, Cyprus Mail and Chryses Efkeries.

A question regarding the residential properties is whether the average size of house/flat and plot/land units has changed over time. For example, as seen in Graph II.1 there is a small decline in the square metres of both houses and flats over the period 2000 and 2014 in Cyprus.

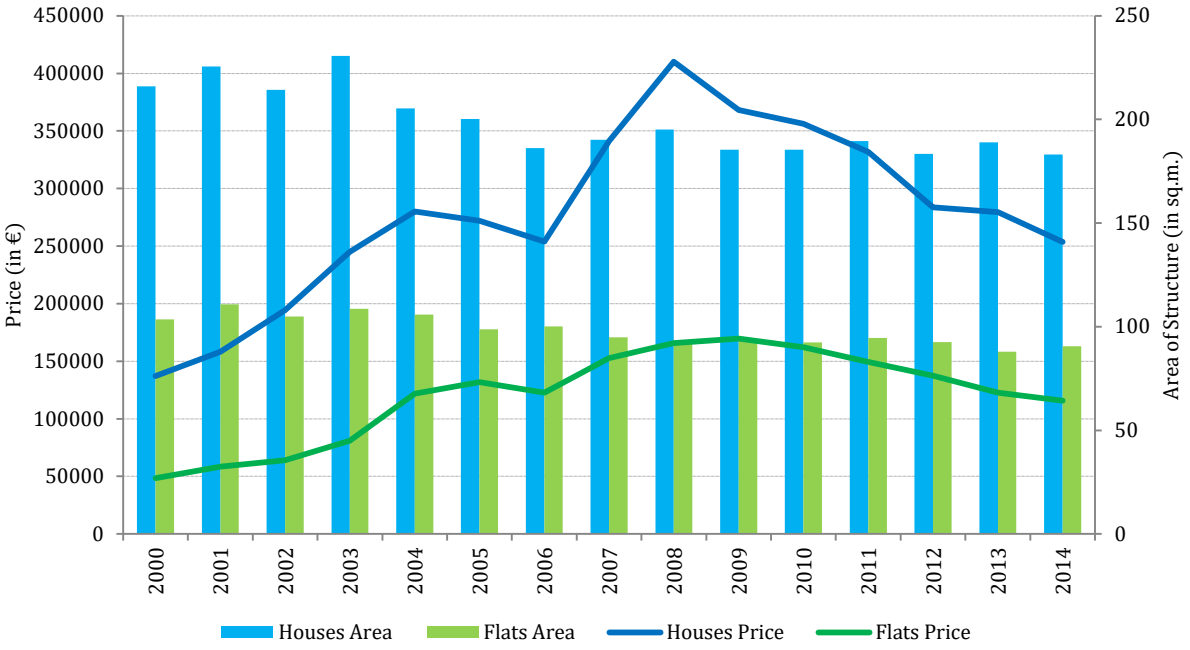
This problem can be solved in two ways:

(i) estimate changes in properties per square metre, or

(ii) consider the property type (houses with up to three rooms, houses with four rooms, etc.) to be unit of analysis and estimate price changes controlling for changes in the square metres of the property.

In the case of both residential and plots/land property we adopt the latter approach. Thus, the estimated price changes over time pertain to property types with the same number of square metres.

Graph II.1: Average price and area for flats and houses



II.5 Removal of outliers

The need to remove outliers from the sample arises due to the rather small number of observations of some property types at district level and the large price heterogeneity observed in some districts. For instance, houses for sale in Limassol can exceed three million euro so that the estimated mean price change can be affected from these properties entering or exiting the sample rather than from changes in the price of properties themselves.

To remove outliers from the residential sample we follow the standard statistical practice of excluding observations with three or more standard deviations from the mean price. This is done separately for each quarter and each residential property type (i.e. houses with up to three rooms, houses with four rooms, studios and flats with one room, flats with two rooms and flats with three rooms). The discarded observations are then replaced with new ones of the same property type and in the same district. The presence of outliers is then re-checked and the same procedure is repeated until the number of observations excluded as outliers is below 2% of those allocated to the particular quarter in the sample.[9]

In the plot/land sample, due to greater heterogeneity among the various land properties, the procedure followed is slightly different. In particularly, to remove outliers from the plot/land sample we exclude observations that are equal to, above or below the mean price per square meter by (a) three standard deviations for plots and (b) two standard deviations for land. This procedure is used separately for each quarter. Also, to account for the greater heterogeneity among the advertised land properties, the removal of outliers is applied separately for settleable and agricultural land.

[9] In particular, as mentioned earlier 144 residential units area included in each quarter. Thus, the procedure for excluding outliers should at worst reduce this number to 142.

II.6 Missing observations[10]

In order to comply with the sampling rules described earlier in this section, we have to occasionally collect advertisements of residential properties that do not report the area of their structure. For these observations the missing area is predicted from the following (hedonic) equation, which is estimated using the observations in the sample that contain this information,

$$\ln A_{i(t)} = \alpha_1 \ln p_{i(t)} + \alpha_2 \left(\ln p_{i(t)}\right)^2 + \alpha_3 R_{i(t)} + \alpha_4 \left(R_{i(t)}\right)^2 + \sum_{t=1}^{T} \beta_t \, Q_{i(t)} + \sum_{k=1}^{K-1} \gamma_k \, D_{i(t)}^{k} + \sum_{m=1}^{M-1} \delta_m \, U_{i(t)}^{m} + \varepsilon_t,$$

where:

$A_{i(t)}$ denotes the area of the property (square metres),

$p_{i(t)}$ the observed asking price (in euro) of property i in quarter t,

$R_{i(t)}$ the number of rooms of property i in quarter t, and

$Q_{i(t)}$, $D_{i(t)}^{k}$ and, $U_{i(t)}^{m}$ denote three sets of dummy variables for quarters, districts and property types, respectively.

The missing area (rounded to the closest integer) is filled with the (exponential of the) fitted values obtained from the equation above for 1340 residential properties in the sample (8500 observations). Some statistics comparing the actual with the estimated area values are shown in Table II.8 below.

Table II.8: Descriptive Statistics for the Area of the Structure

Variable	Obs	Mean	Std. Dev.	Min	Max
Actual	7160	154.00	79.15	25	900
With fitted values	8500	145.18	66.58	27	461

Source: Authors' calculations.

Notably, the mean area of residential properties is lower when the fitted values of squared meters are also included in the sample. This is not surprising because the residential properties which are advertised for sale without mentioning the number of their square meters are more likely to be those with a relatively smaller area compared to other properties of similar type.

[10] The estimation of missing area is performed: (i) every time a new quarter is included in the sample; (ii) only for the missing area of observations in this quarter (i.e. the fitted area in the past data is treated as actual); and (iii) for estimating the missing area of residential properties. The missing area problem does not arise in the case of plot/land properties because the area is always included in advertisements for the sale of these properties.

III. ESTIMATION OF PROPERTY PRICE INDICES

This section describes the methods used for the estimation of price indices for different types of property and for different districts. This estimation is essentially based on the so called hedonic analysis, where one tries to associate the property price with its main characteristics such as the type of property, size, location etc.

The methodology used in our analysis is guided by the need to extract as much information as possible from the data, given that the sample we use can be rather small for certain types of properties in some districts (e.g. agricultural land in Paphos or Famagusta). Furthermore, it enables one to obtain the property price indices together with their statistical significance, so as to have a measure of reliability associated with them. The changes shown by the property price indices are quarterly and are estimated separately for residential and land properties.

III.1 Property price model

The equation used for the estimation of the property prices has the hedonic form

$$\begin{aligned}\ln p_{ikm\ell(t)} = \alpha_0 + \alpha_1 \ln A_{i(t)} + \sum_{m=1}^{M-1} \varphi_m U_{i(t)}^m \ln A_{i(t)} + \sum_{\ell=1}^{L-1} \lambda_\ell S_{i(t)}^\ell \\ + \sum_{t=1}^{T} \beta_t Q_{i(t)} + \sum_{m=1}^{M-1} \delta_m U_{i(t)}^m + \sum_{k=1}^{K-1} \gamma_k D_{i(t)}^k \\ + \sum_{t=1}^{T} \sum_{k=1}^{K-1} \theta_{tk} Q_{i(t)} D_{i(t)}^k + \sum_{t=1}^{T} \sum_{m=1}^{M-1} \rho_{tm} Q_{i(t)} U_{i(t)}^m + e_{i(t)} \end{aligned} \quad (3.1)$$

where $\ln p_{ikm\ell(t)}$, the dependent variable, is the logarithm of the observed asking price (in euro) of property i in district k, in quarter t; the remaining subscripts m and l denote the type of property and the source of the observation, respectively.[11] The Greek lowercase letters in the equation are parameters capturing the effect of the following variables:

$A_{i(t)}$ is the area of the property (in square metres);

$U_{i(t)}^m$ takes the value one if the observation refers to property type m and zero otherwise,

$S_{i(t)}^\ell$ takes the value one if the observation is obtained from source ℓ and zero otherwise

$D_{i(t)}^k$ takes the value one if the observation refers to district k and zero otherwise,

$Q_{i(t)}$ takes the value one if the observation refers to quarter t and zero otherwise,

the random error term of the model is given by $e_{i(t)}$.

Note that the dummy variables $D_{i(t)}^k, U_{i(t)}^m$, are allowed to interact with $Q_{i(t)}$, so for a given quarter we can estimate a separate price index for each type of property in each district.[12]

The model parameters, as said above, are denoted by Greek lowercase letters and represent the percentage effects of each variable on the property price. For example β_t, γ_k, δ_m and λ_l capture

[11] For each quarter $t = 0,1,2,\ldots,T$ there are $n(t)$ property prices in the sample $(i = 1(t), 2(t), \ldots, n(t))$ and in total $T + 1$ quarters are considered, with $t = 0$ being the first quarter in the sample.

[12] For every set of dummy variables (i.e. $+1$, K, M, L quarter, district, property type, and source dummy variables, respectively) one variable is excluded from the model, so the estimated parameters are interpreted as percentage price differences from the excluded quarter, district or property type.

time, district, type and source percentage effects on price, respectively; θ_{tk} and ρ_{tm} measure how the percentage impact of district and type on price, respectively, changes over quarters.

III.2 Estimation

Equation (3.1) is quite general in the sense that a number of sub-indices for different property types in the various districts can be constructed.[13]

III. 2a Property price index by district and property type

The log price of property type m in district k and time t can be computed using the predicted values obtained from equation (3.1) for $D^k_{i(t)} = 1$ and $U^m_{i(t)} = 1$ for all values of i and t, that is

$$\ln p_{km(t)} = \hat{\alpha}_0 + \hat{\alpha}_1 \overline{\ln A} + \hat{\varphi}_m \overline{\ln A} + \sum_{\ell=1}^{L-1} \hat{\lambda}_\ell \bar{S}^\ell + \hat{\beta}_t + \hat{\gamma}_k + \hat{\delta}_m + \hat{\theta}_{tk} + \hat{\rho}_{tm} \qquad (3.2)$$

where the symbol "^" denotes the estimated parameters, $\overline{\ln A}$ is the average value of the area (in logarithm) for property type m in district k and $\bar{S}^\ell$ denotes the average proportion of observations obtained from source ℓ across all quarters in the sample. [14]

The price index of property type m in district k for time t can then be computed by dividing the fitted values $p_{km(t)}$ in each quarter by those corresponding to the quarter chosen as reference (base) quarter, e.g. $t = 0$,

$$P_{km(t)} \equiv \frac{p_{km(t)}}{p_{km(0)}} = exp(\hat{\beta}_t + \hat{\theta}_{tk} + \hat{\rho}_{tm}), \quad \text{for } t = 0, 1, \dots, T \qquad (3.3)$$

The price index is, therefore, defined by the estimated time (quarter), district and property type parameters.

III. 2b Grouped indices

Aggregate price indices, can be computed by estimating equation (3.1) including only the dimensions over which the index is defined, i.e. exclude the dummies for which we wish the index to be aggregated. Below we show how the property price index is estimated for each district, each property type and for the country as a whole.

Property price index for each district:

Estimate equation (3.1) imposing the restrictions $\rho_{tm} = 0$ and $\delta_m = 0$ for all values of m and t, i.e.

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[13] As explained in the previous section, the sampling process adopted is based on the population weights so that the data collected are representative of the distribution of property prices over districts and types in the country. Nevertheless, the proposed methodology can be also applied to cases where the sample weights differ from the population ones simply by using Weighted Least Squares (WLS) instead of Ordinary Least Squares (OLS).

[14] The choice of the value(s) at which the predicted values $\ln p_{km(t)}$ are computed (e.g. the average proportion of observations from different sources across all quarters, a specific source ℓ, the proportion of observations from the different sources at base period, etc.) does not affect the calculation of the price index; hence the subscript ℓ is dropped in equation (3.2) and in property indices that follow. This feature of the index follows from the assumption that the effect of source on price does not vary over time (from quarter to quarter) and therefore no interactions of time dummies with the sources are included in the model. The same reasoning also holds for square meters; thus any other value instead of the average $\ln A$ in equation (3.2) would yield the same price index.

$$\ln p_{ik\ell(t)} = \alpha_0 + \alpha_1 \ln A_{i(t)} + \sum_{m=1}^{M-1} \varphi_m U_{i(t)}^m \ln A_{i(t)} + \sum_{\ell=1}^{L-1} \lambda_\ell S_{i(t)}^\ell + \sum_{t=1}^{T} \beta_t Q_{i(t)} + \sum_{k=1}^{K-1} \gamma_k D_{i(t)}^k + \sum_{t=1}^{T} \sum_{k=1}^{K-1} \theta_{tk} Q_{i(t)} D_{i(t)}^k + \varepsilon_{i(t)} \quad (3.4)$$

and then compute the property price index in quarter t for each district k,

$$P_{k(t)} \equiv \frac{p_{k(t)}}{p_{k(0)}} = \exp\left(\tilde{\beta}_t + \tilde{\theta}_{tk}\right) \quad \text{for } t = 0, 1, \dots, T \quad (3.5)$$

Property price index for each property type:

Estimate equation (3.1) imposing the restrictions $\theta_{tk} = 0$ and $\gamma_k = 0$ for values of k and t, i.e.

$$\ln p_{im\ell(t)} = \alpha_0 + \alpha_1 \ln A_{i(t)} + \sum_{m=1}^{M-1} \varphi_m U_{i(t)}^m \ln A_{i(t)} + \sum_{\ell=1}^{L-1} \lambda_\ell S_{i(t)}^\ell + \sum_{t=1}^{T} \beta_t Q_{i(t)} + \sum_{m=1}^{M-1} \delta_m U_{i(t)}^m + \sum_{t=1}^{T} \sum_{m=1}^{M-1} \rho_{tm} Q_{i(t)} U_{i(t)}^m + \eta_{i(t)} \quad (3.6)$$

and then compute the property price index in quarter t for each property type m,

$$P_{m(t)} \equiv \frac{p_{m\ell(t)}}{p_{m\ell(0)}} = \exp\left(\check{\beta}_t + \check{\rho}_{tm}\right), \text{ for } t = 0, 1, \dots, T \quad (3.7)$$

Aggregate property price index:

Estimate equation (3.1) imposing the restrictions $\rho_{tm} = 0$, $\delta_m = 0$, $\theta_{tk} = 0$ and $\gamma_k = 0$ for all values of k, m and t i.e.

$$\ln p_{im\ell(t)} = \alpha_0 + \alpha_1 \ln A_{i(t)} + \sum_{m=1}^{M-1} \varphi_m U_{i(t)}^m \ln A_{i(t)} + \sum_{\ell=1}^{L-1} \lambda_\ell S_{i(t)}^\ell + \sum_{t=1}^{T} \beta_t Q_{i(t)} + v_{i(t)} \quad (3.8)$$

and then to compute the property price index in quarter t,

$$P_{G(t)} \equiv \frac{p_{(t)}}{p_{(0)}} = \exp\left(\check{\beta}_t\right), \text{ for } t = 0, 1, \dots, T \quad (3.9)$$

Smoothing

Once the price index - aggregate, district and property type - is estimated for each quarter as described above, we construct a four-period moving average (MA4) series in order to smooth 'spikes' in the data that arise from the small sample size and, possibly, seasonality. The smoothed index is given by

$$\bar{P}_{j(t)} = \frac{1}{4}\left(P_{j(t)} + P_{j(t-1)} + P_{j(t-2)} + P_{j(t-3)}\right), \text{ for } t \geq 3 \quad (3.10)$$

where $j = k, m, G$ denoting the district, type and aggregate index respectively.

III.3 Rolling sample estimation and the effect of data sources

As explained in the previous section, the data used for the estimation of the property price indices come from different newspapers and - due to limitations in the available information - it is not always possible to collect the same number of observations for each property type and district from each newspaper. Not maintaining the proportion of observations collected from

each source, however, can introduce bias in the estimation if the quality of properties advertised in different newspapers is not the same. For example, due to advertising costs it is plausible to expect the properties advertised in Philelefthеros to be of higher quality than those advertised in Chryses Efkeries. However, the effects of the characteristics which explain quality differences (such as age, neighbourhood, building block, etc.) are not possible to include in (3.1) because they are either not available or impossible to quantify. Then, a change in the number of observations coming from these two different data sources can be mistaken as a change in property prices.

To avoid the bias described above, we include the term $\sum_{\ell=1}^{L-1} \lambda_\ell \, S_{i(t)}^{\ell}$ in the estimation of the hedonic price equation (3.1) - and all its versions corresponding to district (3.4), type (3.6) and aggregate (3.8) property prices. The parameters λ_ℓ absorb the effect of data sources on property prices, so that the aggregate property price index (3.9) as well as the price indices by district (3.5) and property type (3.7) are not contaminated by differences in property prices across data sources that are attributed to unobserved differences in quality characteristics.

The effects of data sources on property prices might change over time as a result of various factors; for example a source that has traditionally been advertising medium-low quality properties may gradually shift towards promoting higher quality properties and vice versa, or new sources of advertisements such as the internet, could be exploited. To take into account possible time variations in the effects of sources on prices, a rolling sample estimation technique is applied.

The time series of the property price indices are obtained via estimation of equations (3.4), (3.6), and (3.8) using a rolling sample of 40 quarters as follows.[15]

- First, we obtain the price index for the first 40 quarters by estimating the price equations using the sample from 2000Q1 to 2009Q4. This produces price indices for the aforementioned period, setting as base period the first quarter in the sample (2000Q1). The percentage changes of the indices along with their statistical significance are also computed.
- In the second step, we use an iterative procedure of rolling the estimation sample. More specifically, the observations for the new quarter (e.g. 2010Q1) are added and the data for the furthest period (e.g. 2000Q1) are dropped, maintaining a sample of 40 periods in each iteration. The sample is used for the estimation of the quarter-on-quarter percentage change of the price indices, together with the corresponding statistical significance, relating to the newly added quarter in each iteration.[16]
- The estimated quarterly changes in each iteration are subsequently used to derive the level of the indices for each new quarter, starting in 2010Q1 (second iteration) and adding to the time series of indices 2000Q1-2009Q4 constructed at the first iteration.

[15] The size of the rolling window is chosen so as to allow sufficient degrees of freedom but also to capture possible time effects of sources by always confining the estimation to a 40-quarter period.

[16] For example, the quarterly percentage change between 2009Q4 and 2010Q1 is computed via estimation of the price equations using the sample covering the period 2000Q2-2010Q1.

The resulting time series for the property price indices cover the period from 2000Q1 until the current quarter, but the historical values of the series are not subject to revisions with the addition of new quarterly data.

By employing rolling sample estimation, instead of estimating each equation using the full sample, we allow the effects of sources on prices to vary across different periods. [17,18] In other words, this methodology ensures that the price index estimates are not affected by past collection or quality property patterns with respect to data sources that are no longer relevant. Furthermore, it is worth noting that as the effects of sources on prices are estimated separately for each rolling window, one does not necessarily need to use the same data sources for all quarters in the sample. Thus, data from new sources (e.g. the internet) can be added to the sample without worrying that data from these sources are not available for previous quarters.

III.4 Statistical significance tests

The property price indices estimated using the methodology described above can also generate confidence intervals for these indices, as they are obtained from parameters that are estimated with (heteroskedasticity and autocorrelation robust) regression methods. This is done by using the variance-covariance of the standard errors of these parameters estimators. Furthermore, hypothesis tests of the statistical significance of the changes of property price indices over different dimensions (time, district, type) can be performed.[19]

More specifically, a question of particular interest is how reliable are the estimated changes in the property price index (a) from one quarter to the next, and (b) from one quarter in a given year to the same quarter in the following year. To answer this question we estimate the statistical significance of these changes as follows.

The percentage change of the MA4 index between quarter t and quarter t-s, where s=1 or s=4 is given by

$$\Delta \ln \bar{P}_{j(t)} = \ln\left[\frac{\bar{P}_{j(t)}}{\bar{P}_{j(t-s)}}\right]$$

$$= \ln\left(P_{j(t)} + P_{j(t-1)} + P_{j(t-2)} + P_{j(t-3)}\right) - \ln\left(P_{j(t-s)} + P_{(t-s-1)} + P_{(t-s-2)} + P_{(t-s-3)}\right),$$

where $j = k, m, G$.

In the case where the statistical significance is tested for the percentage change in the price index of district k between quarter t and quarter t-s

[17] The effects of sources on property prices are time invariant at a given iteration (estimation window), but change over iterations and therefore vary over the full sample period.

[18] An alternative method to allow for time variation in the effects of data sources on property prices would be to include interactions of time dummies with source dummies. This, however, would entail either the construction of source-specific indices which would have to be aggregated in order to obtain an overall indices, or the evaluation of the property price indices at some specific value (proportion) for each data source. Rolling estimation circumvents these cumbersome steps, and at the same time allows the effects of data sources on prices to vary over time.

[19] In some cases the computation of sub-indices (e.g. for specific property type in a given district) is based on a relatively small number of observations and their reliability might be limited.

$$\Delta \ln \bar{P}_{k(t)}$$
$$= \ln\left(\frac{exp\left(\tilde{\beta}_t + \tilde{\theta}_{tk}\right) + exp\left(\tilde{\beta}_{t-1} + \tilde{\theta}_{(t-1)k}\right) + exp\left(\tilde{\beta}_{t-2} + \tilde{\theta}_{(t-2)k}\right) + exp\left(\tilde{\beta}_{t-3} + \tilde{\theta}_{(t-3)k}\right)}{4}\right)$$
$$- \ln\left(\frac{exp\left(\tilde{\beta}_{t-s} + \tilde{\theta}_{(t-s)k}\right) + exp\left(\tilde{\beta}_{t-s-2} + \tilde{\theta}_{(t-s-2)k}\right) + exp\left(\tilde{\beta}_{t-s-3} + \tilde{\theta}_{(t-s-3)k}\right) + exp\left(\tilde{\beta}_{t-s-4} + \tilde{\theta}_{(t-s-4)k}\right)}{4}\right),$$

and the null hypothesis $\Delta \ln \bar{P}_{k(t)}=0$ is tested as

$$\ln\left(exp\left(\tilde{\beta}_t + \tilde{\theta}_{tk}\right) + exp\left(\tilde{\beta}_{t-1} + \tilde{\theta}_{(t-1)k}\right) + exp\left(\tilde{\beta}_{t-2} + \tilde{\theta}_{(t-2)k}\right) + exp\left(\tilde{\beta}_{t-3} + \tilde{\theta}_{(t-3)k}\right)\right) -$$
$$\ln\left(exp\left(\tilde{\beta}_{t-s} + \tilde{\theta}_{(t-s)k}\right) + exp\left(\tilde{\beta}_{t-s-1} + \tilde{\theta}_{(t-s-1)k}\right) + exp\left(\tilde{\beta}_{t-s-2} + \tilde{\theta}_{(t-s-2)k}\right) + exp\left(\tilde{\beta}_{t-s-3} + \tilde{\theta}_{(t-s-3)k}\right)\right) = 0.$$

Similarly, the statistical significance of the percentage change in the price index of property type *m* between quarter *t* and quarter *t-s* (i.e. the null hypothesis $\Delta \ln \bar{P}_{m(t)}=0$) is tested as,

$$\ln\left(exp\left(\check{\beta}_t + \check{\rho}_{tm}\right) + exp\left(\check{\beta}_{t-1} + \check{\rho}_{(t-1)m}\right) + exp\left(\check{\beta}_{t-2} + \check{\rho}_{(t-2)m}\right) + exp\left(\check{\beta}_{t-3} + \check{\rho}_{(t-3)m}\right)\right) -$$

$$\ln\left(exp\left(\check{\beta}_{t-s} + \check{\rho}_{(t-s)m}\right) + exp\left(\check{\beta}_{t-s-1} + \check{\rho}_{(t-s-1)m}\right) + exp\left(\check{\beta}_{t-s-2} + \check{\rho}_{(t-s-2)m}\right) + exp\left(\check{\beta}_{t-s-3} + \check{\rho}_{(t-s-3)m}\right)\right)=0$$

and the statistical significance of the percentage change in the aggregate property price index (i.e. the null hypothesis $\Delta \ln \bar{P}_{G(t)}=0$) as

$$\ln\left(exp\left(\check{\beta}_t\right) + exp\left(\check{\beta}_{t-1}\right) + exp\left(\check{\beta}_{t-2}\right) + exp\left(\check{\beta}_{t-3}\right)\right) -$$

$$\ln\left(exp\left(\check{\beta}_{t-s}\right) + exp\left(\check{\beta}_{t-s-1}\right) + exp\left(\check{\beta}_{t-s-2}\right) + exp\left(\check{\beta}_{t-s-3}\right)\right) = 0$$

The size of the resulting statistic obtained from the application of the above test indicates the reliability of the estimated price change. All of the above hypotheses are non-linear and are tested using Wald-type tests.

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