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No. 01-19

April 2019

Publication Editor:

Sofia N. Andreou

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Residential property price indices using asking prices: the case of Cyprus *

Sofia N. Andreou ** and Nicoletta Pashourtidou

ABSTRACT

This paper uses micro data on property advertisements published in widely circulated newspapers and online to construct residential price indices for Cyprus. The sample covers the period from 2000Q1 to 2018Q2 and contains information on various property characteristics (e.g. property type, size, location). A regression model is estimated using rolling samples of 12, 20 and 40 quarters. We obtain six sub-aggregate price indices, i.e. for houses and flats located in the districts of Nicosia, Limassol, and in the remaining districts. Using the six sub-aggregate indices, we construct five aggregate price indices, i.e. for (i) houses, (ii) flats, (iii) Nicosia district, (iv) Limassol district, and (v) other districts, as well as an overall property price index for Cyprus. The estimated price indices are juxtaposed with other available property price indices in Cyprus, namely the indices published by the Central Bank, Eurostat, and the Royal Institution of Chartered Surveyors, as well as with a number of macroeconomic indicators relating to the property market. The indices constructed in this paper tend to be associated with slightly larger quarterly percentage changes (higher growth and smaller contraction) compared to similar indices over common periods. The resulting indices are significantly correlated with the corresponding property price indices published by other organisations, and their agreement in the direction of quarterly changes is high. The estimated indices are found to contain leading information vis-à-vis other property price indices, particularly in the case of flats and the district of Limassol. Also, the estimated indices are highly correlated with many key macroeconomic variables, with the results suggesting that the former may lead developments in some macroeconomic series. The properties of the proposed indices together with their timely nature in terms of data availability could make them a useful tool for monitoring the evolution of property prices as well as macroeconomic developments in Cyprus. The estimation of sub-aggregate indices provides information on the key drivers (types, districts) of fluctuations in the domestic property market. As the proposed indices are model-based, the statistical significance of quarterly changes can be computed and confidence intervals can be constructed around these changes to provide an informed depiction of property price fluctuations.

Keywords: residential property prices, price index, rolling window regression

* Research on property prices in Cyprus at the Economics Research Centre was initiated and initially undertaken by the founder and former director of the Centre Professor Panos Pashardes. The Economics Research Centre would like to thank the real estate agency Antonis Loizou and Associates for providing electronic access to online listings. The authors thank Elena Andreou and George Syrichas for comments.

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Σοφία Ν. Ανδρέου και Νικολέττα Πασιουρτίδου

ΠΕΡΙΛΗΨΗ

Το άρθρο χρησιμοποιεί ατομικά στοιχεία από αγγελίες πωλήσεων οικιστικών ακινήτων που δημοσιεύονται σε εφημερίδες ευρείας κυκλοφορίας και στην ιστοσελίδα μεγάλου κτηματομεσιτικού γραφείου, με στόχο την κατασκευή δεικτών τιμών οικιστικών ακινήτων στην Κύπρο. Το δείγμα καλύπτει την περίοδο από το πρώτο τρίμηνο του 2000 μέχρι το δεύτερο τρίμηνο του 2018 και περιέχει πληροφορίες για διάφορα χαρακτηριστικά των ακινήτων (π.χ. τύπος ακινήτου, μέγεθος, τοποθεσία).

Για την κατασκευή των δεικτών εκτιμάται ένα μοντέλο παλινδρόμησης βάσει του οποίου υπολογίζονται αρχικά έξι υποδείκτες, δηλαδή, για σπίτια και διαμερίσματα που βρίσκονται στις επαρχίες Λευκωσίας, Λεμεσού και στις υπόλοιπες επαρχίες (Λάρνακα, Αμμόχωστος, Πάφος). Στη συνέχεια, χρησιμοποιώντας τους έξι υποδείκτες κατασκευάζονται πέντε δείκτες τιμών ακινήτων, για (i) σπίτια, (ii) διαμερίσματα, (iii) επαρχία Λευκωσίας, (iv) επαρχία Λεμεσού και (v) υπόλοιπες επαρχίες, καθώς και ένας γενικός δείκτης τιμών για την Κύπρο συνολικά. Οι εκτιμώμενοι δείκτες αντιπαρατίθενται με άλλους δείκτες τιμών ακινήτων στην Κύπρο, και συγκεκριμένα τους δείκτες που δημοσιεύονται από την Κεντρική Τράπεζα, Eurostat και RICS, καθώς και με μακροοικονομικές μεταβλητές που σχετίζονται με την αγορά ακινήτων.

Οι δείκτες που παρουσιάζονται τείνουν να δίνουν ελαφρώς μεγαλύτερες τριμηνιαίες ποσοστιαίες μεταβολές (μεγαλύτερη άνοδο και μικρότερη συρρίκνωση) σε σύγκριση με παρόμοιους δημοσιευμένους δείκτες. Οι εκτιμώμενοι δείκτες παρουσιάζουν θετική και στατιστικά σημαντική συσχέτιση με αντίστοιχους δημοσιευμένους δείκτες, καθώς και ψηλό βαθμό ομοιότητας ως προς το πρόσημο των τριμηνιαίων μεταβολών. Τα αποτελέσματα δείχνουν ότι οι εκτιμώμενοι δείκτες περιέχουν προπορευόμενες πληροφορίες για την πορεία αντίστοιχων δημοσιευμένων δεικτών ακινήτων, ειδικότερα στην περίπτωση των διαμερισμάτων και της επαρχίας Λεμεσού. Επιπρόσθετα, οι δείκτες που εκτιμώνται εδώ παρουσιάζουν ισχυρή συσχέτιση με μακροοικονομικές μεταβλητές, με ενδείξεις ότι μεταβολές στους δείκτες ενδεχομένως να περιέχουν προπορευόμενες πληροφορίες για κάποιες μακροοικονομικές σειρές. Οι ιδιότητες των προτεινόμενων δεικτών καθώς και ο έγκαιρος χαρακτήρας τους από πλευράς διαθεσιμότητας δεδομένων, τους καθιστούν ένα χρήσιμο εργαλείο για παρακολούθηση των διακυμάνσεων στις τιμές των ακινήτων καθώς και μακροοικονομικών εξελίξεων γενικότερα στην Κύπρο. Η εκτίμηση των υποδεικτών παρέχει πληροφορίες για τους βασικούς παράγοντες (τύποι ακινήτων, επαρχίες) που οδηγούν στις μεταβολές που παρατηρούνται στην εγχώρια αγορά ακινήτων. Καθώς οι προτεινόμενοι δείκτες βασίζονται σε οικονομετρικό μοντέλο, μπορεί να υπολογιστεί η στατιστική σημαντικότητα των τριμηνιαίων μεταβολών τους και να κατασκευαστούν τα σχετικά διαστήματα εμπιστοσύνης, παρέχοντας επιπρόσθετη πληροφόρηση για την αξιοπιστία των παρατηρούμενων μεταβολών στις τιμές.

1. Introduction

Developments in the real estate market, and in particular changes in property prices, affect the financial decisions of private agents (e.g. households, investors, commercial banks) since they form an important part of their assets, as well as monetary and macro-prudential policies. The evolution of property price indices provides indications for growth, economic cycles and financial stability, since price developments affect solvency, collateral value and debt-to-equity ratio. For example, changes in house prices are highly correlated with changes in consumption (Campbell and Cocco 2007) through their impact on either household wealth or the value of a household's mortgage collateral. Furthermore, the property market can also affect government revenue through various channels, such as property tax, transfer tax as well as sales and personal income taxes (Byron et al. 2010).

The monitoring of property price developments is of particular importance to government authorities, central banks and financial institutions in order to recognise and predict potential effects of changes in property prices on the credit market, and economic stability in the country in general (Case and Wachter; 2005, Goodhart and Hofman, 2006). The literature suggests several methods for the construction of property price indices such as the simple average method, the repeat sales method (Case and Quigly, 1991; Shiller, 1991), the hedonic approach (Silver, 2016), the mix-adjustment through stratification (Wood, 2005) and the sale price appraisal ratio (SPAR) method (Bourassa et al., 2006). Each of the abovementioned methods has advantages and disadvantages (Case and Quigley 1991; Hill, 2011, 2013; Eurostat, 2013).

The simplest methods are based on the mean or the median of the distribution of transaction prices in a specific period. As no data on housing characteristics are required for this calculation, a price index can be easily constructed and communicated. Yet, two major weaknesses are the noisy estimates of price changes due to the small sample of properties traded in a given period, and the lack of quality control of the housing stock. [1]

The repeat sales method is more appropriate when there exist frequent re-sales of the same properties or when sample property characteristics are not available in the data. One major problem that arises from the application of the repeat sales method is that neither the depreciation of the property nor the change in the value due to the property renovation is taken into account. On the other hand, the hedonic method is more suitable when a large number of property characteristics is available in the data or when one seeks a more detailed analysis of the residential market. A drawback of the hedonic method is that it requires extensive information on the characteristics of each sampled property. A detailed discussion about alternative methods of constructing property price indices can be found in Silver (2014).

[1] For example, the simple median index will tend to be biased upwards when the average quality of the housing stock improves over time (Eurostat, 2013).

The decision as to which method is the most appropriate depends on the nature of property prices, the coverage of property characteristics in the data (in terms of geographical locations and types of property), the representativeness and volume of the available data, as well as the time lag and cost of the data collection process (Silver, 2012). In practice, the method for constructing a property price index is selected on the basis of the quality and quantity of available data. The construction of property price indices can be based on asking prices (from newspaper advertisements or real estate agencies listings), property appraisals (from mortgage lenders) or actual selling prices (from lawyers, land registers and tax authorities). In the literature, it has become more common to use data collected from state and legal agencies directly involved in property transactions or property valuations rather than data from newspaper or real estate agency advertisements due to the cost involved in the collection and processing of such data. Since property price indices have various uses (e.g. household wealth measures, financial stability indicators, credit exposure measures, inflation indicators), from practitioners' perspective, the planned application of a price index plays a key role in determining the methodology of its compilation. For example, when an index is employed as a financial stability indicator, it is suitable to use valuation data. An index intended as a macroeconomic indicator of inflation should be based on transaction prices, whereas an index that aims to measure consumers' expectations should be compiled using data on asking prices (Theodosiou and Thucydides, 2012). Therefore, no single index can be argued to be the best, but rather, as pointed out by Wood (2005) and Chandler and Disney (2014), a set of property price indices should be available.

In Cyprus, property price indices are currently produced by three organisations on a quarterly basis: the Central Bank of Cyprus (CBC), the Cyprus Statistical Service as part of Eurostat's harmonised house price indices, and the Royal Institution of Chartered Surveyors (RICS). The CBC residential price indices, which cover the whole of government controlled area of Cyprus, are constructed using the hedonic approach and data on property valuations connected with loans granted by commercial banks (CBC, 2011).[2] The CBC indices include an overall index for Cyprus as well as indices by district and type that are available since 2006Q1, while sub-aggregate indices for types of properties in the different districts of Cyprus are available since 2010Q1. The Eurostat index, which covers old and new dwellings in the government controlled area of Cyprus, is based on the hedonic approach and sales/transaction prices from the Department of Lands and Surveys; the data start in 2005Q1 (Housing Price Statistics, Eurostat). The RICS indices, which cover residential (houses and flats) and commercial properties, are based on surveys among professional property valuators (accredited by RICS), active in the real estate market of Cyprus; the indices are available from 2009Q1 onwards. Valuators appraise hypothetical or notional buildings with specific characteristics in each district (for details on the methodology employed by RICS, see McAllister and Fuerst, 2010).

[2] Data are received by the Central Bank through local credit institutions and relate to valuations performed by over 100 appraisal offices. These valuations are directly related to mortgage loans (new loans, rescheduling, re-assessment of the value of the collateral, etc.).

The aim of this paper is to enrich the existing pool of property price indices for the Cypriot property market by developing residential price indices based on alternative sources of data, namely micro data on property advertisements published in widely circulated newspapers and on the website of a large real estate agency. The sample covers the period from 2000Q1 to 2018Q2 and contains information on various property characteristics (e.g. property type, size, location). A regression model is estimated using rolling samples and the estimated parameters are used to compute sub-aggregate indices for property types (houses, flats) in different districts as well as type-specific and district-specific aggregate indices, and an overall aggregate index. The estimated price indices are juxtaposed with other published property price indices in Cyprus as well as with a number of macroeconomic indicators relating to the property market.

To the best of our knowledge, asking prices are used in the estimation of house price indices in a limited number of instances (e.g. the UK, Malta, Northern Ireland). For example, in the case of the UK, both Wood (2005) and Chandler and Disney (2014) use (i) different data sources (e.g. registration data from the Land Registry, mortgage lending, property advertisements), (ii) different coverage, and (iii) different methodologies (hedonic approach, mix-adjustment, repeat sales) in order to compare the different indices. Both papers conclude that there is not an ideal index but all indices are useful because they allow observers to examine a range of information sets when assessing past or prospective changes in house prices. In addition, Falzon and Lanzon (2013) employ alternative hedonic model specifications and residential asking prices to estimate annual price indices for Malta. The authors argue that the inherent problem with the use of such data is that advertised prices may be significantly higher than the prices that are actually transacted on the market. Although asking prices may often differ from final sale prices, indices based on the former may be informative of supply and demand forces in the property market and may function as a leading indicator of actual sale prices (Chandler and Disney, 2014).

The estimated indices in this paper reflect asking prices by sellers when properties are first put on the market, rather than property values recorded by lenders during the mortgage application process or final transaction prices reported to the Land Registry. The estimated indices, therefore, measure prices at the beginning of the residential buying and selling cycle, while other published indices in Cyprus measure prices at later stages in the process.

The results show that the estimated indices are significantly correlated with the corresponding property price indices published by other organisations, and their agreement in the direction of quarterly changes is high. The indices constructed in this paper tend to be associated with slightly larger quarterly percentage changes (higher growth and smaller contraction), on average, compared to similar indices over common periods. The estimated indices are highly correlated with many macroeconomic variables. Some of the estimated type-specific and district-specific indices are found to contain leading information vis-à-vis other property price

indices. The properties of the proposed indices together with their timely nature in terms of data availability could make them a useful tool for monitoring the evolution of property prices as well as macroeconomic developments in Cyprus. Furthermore, the estimation of sub-aggregate indices provides information on the key drivers (types, districts) of fluctuations in the domestic property market. As the estimated indices are model-based, the statistical significance of their quarterly changes can be computed, thus providing reliability measures together with the estimated price changes.

The rest of the paper is organised as follows. Section 2 describes the data and section 3 presents the model and estimation process. Section 4 discusses the properties of the estimated indices vis-à-vis other published indices in Cyprus. Section 5 investigates the relation between the estimated indices and macroeconomic indicators relating to the property market. Section 6 concludes the paper.

2. Data

The data used in this study refer to asking/advertised residential prices. The data cover the period from 2000Q1 to 2018Q2.[3] Prices along with property characteristics (geographical district, type of property, size of property measured in square metres, etc.) are collected monthly from advertisements published in newspapers and online. The database contains five types of properties: (i) houses with up to three bedrooms,(ii) four-bedroom houses, (iii) studios and one-bedroom flats, (iv) two-bedroom flats, and (v) three-bedroom flats, covering the whole of the government controlled area of Cyprus. [4]

Until recently, the primary data were collected on a monthly basis from advertisements published in wide-circulation Greek and English language newspapers in Cyprus.[5] Over a given quarter, 144 observations on residential properties were sampled covering the districts of Nicosia, Limassol, Larnaca, Famagusta and Paphos. As of 2017Q3 the number of advertisements collected has been doubled by using both newspaper and online sources.[6, 7] The data are collected through stratified random sampling and the strata are defined by the districts and property types. Table 1 presents the distribution of the quarterly sample of properties over districts and types. The proportion of observations sampled per stratum is

[3] The database covers advertisements on residential property sales only; it does not include advertisements on residential property rentals or sales/rentals of commercial properties (e.g. shops, warehouses, offices).
[4] Houses with more than four bedrooms and flats with more than three bedrooms are excluded from the sample as they are less representative of residential property types in the country.
[5] The newspapers are Philelefttheros, Politis, Chryses Efkeries and Cyprus Mail.
[6] About 85% of advertisements in the sample are drawn from newspapers and the remaining 15% of observations are obtained from online sources. The increase in the sample size improves the coverage across sources, smaller districts and specific property types, and enhances the statistical reliability of the estimated indices.
[7] After a thorough examination of different online sources, the real estate agency Antonis Loizou and Associates, was chosen as the main source of online advertisements due to the extensive coverage of property types and districts. The Economics Research Centre and the real estate agency Antonis Loizou and Associates have a cooperation agreement on the provision of data on property advertisements.

representative of the population of property advertisements over districts and types, adjusted by the distribution of property sales and transfers across districts in Cyprus. [8]

TABLE 1

Distribution of the quarterly sample of residential properties over districts and types

Type	Houses		Flats			Total
District	Up to three bedrooms	Four bedrooms	Studio or one bedroom	Two bedrooms	Three bedrooms	
Nicosia	10.4	6.3	4.2	6.3	6.3	33.3
Limassol	6.3	6.3	4.2	4.2	4.2	25.0
Larnaca	4.2	4.2	2.1	4.2	2.1	16.7
Famagusta	4.2	2.1	2.1	2.1	2.1	12.5
Paphos	4.2	2.1	2.1	2.1	2.1	12.5
Total	29.2	20.8	14.6	18.8	16.7	100.0

In the analysis that follows the three smallest districts are treated as one due to the small number of available advertisements, and because of their geographical and economic similarities (e.g. coastal, resorts). Therefore, the efficiency of the resulting combined indices is enhanced.

Table 2 provides a summary of the sample covering the period 2000Q1 - 2018Q2. The total number of observations over this period is 11,019, with the property price and size being on average 200,407 EUR and 146 square metres, respectively. The mean price of houses in the sample is more than double the mean price of flats, while, on average, the size of houses is about twice that of flats. The district of Limassol is associated with the most expensive properties on average which are about the same size as those offered in Nicosia that are about 14% cheaper on average. The variance of both property price and size is the highest for properties on sale in Limassol. On average, the largest and most pricey houses and flats are located in Limassol and Nicosia, respectively, while cheaper and smaller properties tend to be on sale in the remaining districts. The newspaper specialising in publishing classified property advertisements accounts for the largest percentage of observations (Chryses Efkeries, 39%), followed by widely-circulated newspapers in Greek (Philelefθeros, 23%) and in English (Cyprus Mail, 22%).

[8] The representativeness of the sample with respect to districts and property types is discussed in Karagiannakis et al. (2016). Details of the data collection process can be found in Andreou (2018).

TABLE 2

Summary statistics of the data, 2000Q1 – 2018Q2

	Price (EUR)				Area (square metres)				Number of observations
	Mean	Min	Max	Standard Deviation	Mean	Min	Max	Standard Deviation	
All data	200,407	15,000	1,800,000	151,509	146	27	900	77	11,019
Type									
Houses	280,062	22,500	1,800,000	167,635	196	50	900	73	5,497
Flats	121,113	15,000	1,200,000	72,320	95	27	320	38	5,522
District									
Nicosia	206,518	18,000	1,400,000	127,850	156	37	700	74	3,695
Limassol	234,744	16,000	1,800,000	179,778	155	30	900	85	2,742
Other	174,931	15,000	1,623,171	145,967	132	27	600	71	4,582
Types in districts									
Houses in Nicosia	272,420	48,000	1,400,000	137,187	207	55	700	65	1,841
Houses in Limassol	334,517	34,000	1,800,000	192,752	211	50	900	82	1,369
Houses in Other	253,617	22,500	1,623,171	166,304	179	50	600	69	2,287
Flats in Nicosia	141,078	18,000	594,550	72,784	105	37	270	40	1,854
Flats in Limassol	135,262	16,000	1,200,000	87,681	99	30	270	38	1,373
Flats in Other	96,520	15,000	402,000	51,608	86	27	320	32	2,295
Sources									
Newspaper 1 (Philelefθeros)	217,986	22,211	1,623,171	134,367	153	30	700	73	2,539
Newspaper 2 (Cyprus Mail)	234,439	23,066	1,800,000	173,185	158	27	900	89	2,391
Newspaper 3 (Politis)	175,420	18,794	1,490,000	126,760	133	33	520	67	1,495
Newspaper 4 (Chryses Efkeries)	172,983	15,000	1,350,000	137,758	138	30	600	72	4,259
Real estate agency's website	284,451	50,600	1,300,000	248,022	148	39	606	88	335

3. Model and estimation

3.1 Model

The econometric model is a linear regression whereby price indices for each property type in each district can be estimated. For modelling purposes, we consider two property types (houses and flats) and three districts (Nicosia, Limassol, and collectively Larnaca, Famagusta and Paphos), thus obtaining six sub-aggregate indices. Every quarter, t, a total of N_t observations on property advertisements are collected. Let p_{nijt} denote the asking price (in euro) of property n of type i, located in district j, advertised in quarter t; the log linear regression is given by

$$\ln p_{nijt} = \alpha_0 + \sum_{i=1}^{2}\sum_{j=1}^{3}\beta_{ij}T_{nijt} + \lambda_1 \ln A_{nijt} + \lambda_2(\ln A_{nijt} \times T_{n2jt}) + \sum_{s=1}^{5}\zeta_s S_{nijt}^{(s)} + \sum_{t=1}^{T}\theta_t Q_{nijt} + \sum_{i=1}^{2}\sum_{j=1}^{3}\sum_{t=1}^{T}\gamma_{ijt}\left(T_{nijt} \times Q_{nijt}\right) + e_{nijt}, \quad (1)$$

for $t = 1, \ldots, \tau$, and $n = 1, \ldots, N_t$ with τ denoting the total number of time periods in the sample. More specifically, the subscripts i and j denote the type and district of the property with $i =$

$1, 2$ representing a house or flat, respectively, and $j = 1, 2, 3$ denoting the district of Nicosia, Limassol or other district, respectively. The remaining variables are as follows: T_{nijt} is a dummy variable for property type i located in district j ; A_{nijt} denotes the area of the property in square metres; $S_{nijt}^{(s)}$ is a dummy variable indicating that the property advertisement was obtained from source s; Q_{nijt} is a dummy variable for the time period (in quarters) in which the property was advertised. [9] The error term of the model is given by e_{nijt}. As the model includes dummy variables, the following parameter restrictions are imposed $\beta_{11} = 0$, $\zeta_1 = 0$, $\theta_1 = 0$, $\gamma_{11t} = 0$ (for all t) and $\gamma_{ij1} = 0$ (all i, j).

The characteristics included in the model are constrained by the descriptions provided in newspaper advertisements that need to result in variables that are comparable across sampled advertisements and over time.[10] The effects of characteristics on the property price, shown in the first line of equation (1), are assumed to be constant over time. The effect of the period (quarter) in which the property was advertised is captured by quarter-specific dummies (θ_t), and this effect is allowed to vary across property types in different districts (γ_{ijt}).

To take into account structural breaks in the time-invariant parameters in equation (1), the model is estimated using rolling windows of size w, where $2 \leq w \leq \tau$. More specifically, the model is initially estimated by applying Ordinary Least Squares to pooled data pertaining to the first w quarters in the sample, $t = 1, \dots, w$. Subsequently, the estimated parameters are used to compute the disaggregate and aggregate indices for the first w quarters; the indices are expressed relative to the first quarter, i.e. with $t = 1$ as the base period.

The disaggregate price indices for property type i in district j relative to the first period, i.e. $t = 1$ are given by the general form

$$\hat{P}_{ijt} = \exp(\hat{\theta}_t + \hat{\gamma}_{ijt}) \ , \quad t = 1, \dots, w \tag{2}$$

which reduces to $\hat{P}_{ij1} = 1$ for all i, j and $t = 1$ as $\theta_1 = 0$ and $\gamma_{ij1} = 0$, and $\hat{P}_{11t} = \exp(\hat{\theta}_t)$ for $i = 1$ and $j = 1$, and $t = 2, \dots, w$ as $\gamma_{11t} = 0$.

The symbol ∧ is used to denote parameter estimates or price indices computed using parameter estimates. All indices are calculated assuming constant property characteristics between time periods.

It follows from (2) that the aggregate price indices for property type i relative to the first period, i.e. $t = 1$, are computed as

$$\hat{P}_{i(j)t} = \exp\left(\hat{\theta}_t + \sum_{j=1}^{3} \hat{\gamma}_{ijt} \bar{T}_{i(j)}\right) = \prod_{j=1}^{3} (\hat{P}_{ijt})^{\bar{T}_{i(j)}}, \text{ for } i = 1, 2 \text{ and all } j \tag{3}$$

where the subscript in parentheses indicates the characteristic (type or district) over which aggregation is applied, $\bar{T}_{i(j)} = \bar{T}_{ij} / \sum_{j=1}^{3} \bar{T}_{ij}$, $\bar{T}_{ij}$ is the share of properties of type i in district j representative of the population, and $\sum_{i=1}^{2} \sum_{j=1}^{3} \bar{T}_{ij} = 1$.

[9] The five different sources from which advertisements are drawn, $s = 1, 2, 3, 4, 5$, are the newspapers Philelefthеros, Cyprus Mail, Politis and Chryses Efkeries, and the website of a real estate agency, respectively.
[10] The introduction of additional information in the model, such as the condition of the property (new or resale) or more detailed location characteristics, would severely limit the number of available observations for estimation.

Similarly, the aggregate price indices for properties in district j and the overall aggregate price index relative to the first period are given respectively by equations (4) and (5)

$$\hat{P}_{(i)jt} = \exp\left(\hat{\theta}_t + \sum_{i=1}^{2} \hat{\gamma}_{ijt} \bar{T}_{(i)j}\right) = \prod_{i=1}^{2} (\hat{P}_{ijt})^{\bar{T}_{(i)j}} \quad \text{for } j = 1, 2, 3 \text{ and all } i \tag{4}$$

where $\bar{T}_{(i)j} = \bar{T}_{ij} / \sum_{i=1}^{2} \bar{T}_{ij}$,

$$\hat{P}_{(i)(j)t} = \exp\left(\hat{\theta}_t + \sum_{i=1}^{2} \sum_{j=1}^{3} \hat{\gamma}_{ijt} \bar{T}_{ij}\right) = \prod_{i=1}^{2} \prod_{j=1}^{3} (\hat{P}_{ijt})^{\bar{T}_{ij}}, \quad \text{all } i, j. \tag{5}$$

The aggregate property price indices given in equations (3) – (5) are the geometric weighted averages of their sub-aggregate indices due to the log-linear form of the model. The percentage changes of aggregate and disaggregate indices between two consecutive periods are functions of the parameter estimates obtained from the regression model and therefore the statistical significance of these changes can be computed for each time period.

Going back to the rolling estimation procedure, the model is re-estimated using the second rolling window of size w formed by dropping the data for the first period and adding the data for period $t = w + 1$ to the estimation sample, which covers the period $t = 2, \ldots, w + 1$. To avoid revisions to the price indices due to rolling estimation, only the percentage changes of the indices from period w to $w + 1$ are used to compute the indices in period $w + 1$, leaving the values of the indices obtained from the first rolling window estimation unchanged. The re-estimation of the model and the computation of the indices for the newly added period is repeated for successive rolling windows that cover the periods $t = 3, \ldots, w + 2$, $t = 4, \ldots, w + 3$ and so on, up to the last rolling window $t = \tau - w + 1, \ldots, \tau$, which includes the final period in the sample, τ. Thus, the values of the indices for $t > w$ obtained from the application of a rolling window of size w over the sample period $t = m, \ldots, w + m - 1$, $m = 2, 3, \ldots, \tau - w + 1$, are given by

$$\hat{P}_{ij\tau-w+1} = \exp(\hat{\theta}_{\tau-w+1} + \hat{\gamma}_{ij\tau-w+1} - \hat{\theta}_{\tau-w} - \hat{\gamma}_{ij\tau-w})\, \hat{P}_{ij\tau-w} \tag{6}$$

where $\hat{P}_{ij\tau-w}$ is the value of the index computed following the estimation of the model over the sample period $t = m - 1, \ldots, w + m - 2$. The aggregate indices can then be computed using equations (3) – (5).

The size of the rolling window should be chosen so as to allow sufficient degrees of freedom but also to capture changes in the structure in a timely fashion. There is a trade-off between estimation efficiency, favouring larger windows, and timely absorption of structural changes by the estimated parameters (bias), requiring smaller windows.

3.2 Estimation

In estimations, alternative sizes of rolling windows are considered and the statistical properties of the resulting indices are examined. Table 3 presents the results of model estimations using rolling windows of 12, 20 and 40 quarters. The estimated effects of various property characteristics which are treated as time-invariant in the model over a given time period (i.e. estimation window), are summarized by their means and standard deviations across

iterations, i.e. rolling window regressions. For each characteristic, the percentage of significant coefficients across iterations is also shown.

TABLE 3

Regression results using rolling windows

Size of rolling window (w) in quarters	w=12			w=20			w=40		
Characteristics with time-invariant coefficients	Mean	Standard deviation	Significance across iterations %	Mean	Standard deviation	Significance across iterations %	Mean	Standard deviation	Significance across iterations %
Types in districts [Houses in Nicosia]									
Houses in Limassol	0.17	0.11	59	0.17	0.12	58	0.18	0.13	60
Houses in Other	0.02	0.14	33	0.04	0.14	42	0.07	0.17	57
Flats in Nicosia	0.70	0.27	84	0.67	0.17	100	0.66	0.12	100
Flats in Limassol	0.65	0.32	79	0.60	0.25	84	0.52	0.24	82
Flats in Other	0.46	0.31	59	0.45	0.22	75	0.47	0.18	83
Area in square metres									
All properties (houses and flats)	0.95	0.06	100	0.95	0.04	100	0.95	0.03	100
Flats	-0.15	0.06	95	-0.15	0.04	100	-0.15	0.03	100
Sources [Newspaper 1 (Philelefthеros)]									
Newspaper 2 (Cyprus Mail)	0.04	0.13	75	0.05	0.10	75	0.07	0.06	83
Newspaper 3 (Politis)	-0.01	0.03	25	-0.01	0.02	13	-0.01	0.01	14
Newspaper 4 (Chryses Efkeries)	-0.13	0.12	79	-0.12	0.11	78	-0.10	0.07	100
Real estate agency's website	0.12	0.03	75	0.16	0.03	100	0.16	0.03	100
Constant	7.36	0.54	100	7.38	0.46	100	7.19	0.36	100
Observations	1719	—	—	2855		—	5694	—	—
Root mean squared error	0.28	0.02	—	0.27	0.02	—	0.27	0.01	—
Adjusted R-squared	0.81	0.02	—	0.81	0.02	—	0.82	0.02	—
Number of iterations (rolling windows)	63	—	—	55	—	—	35	—	—

Note: The characteristics in square brackets are those excluded from the regression (reference categories).

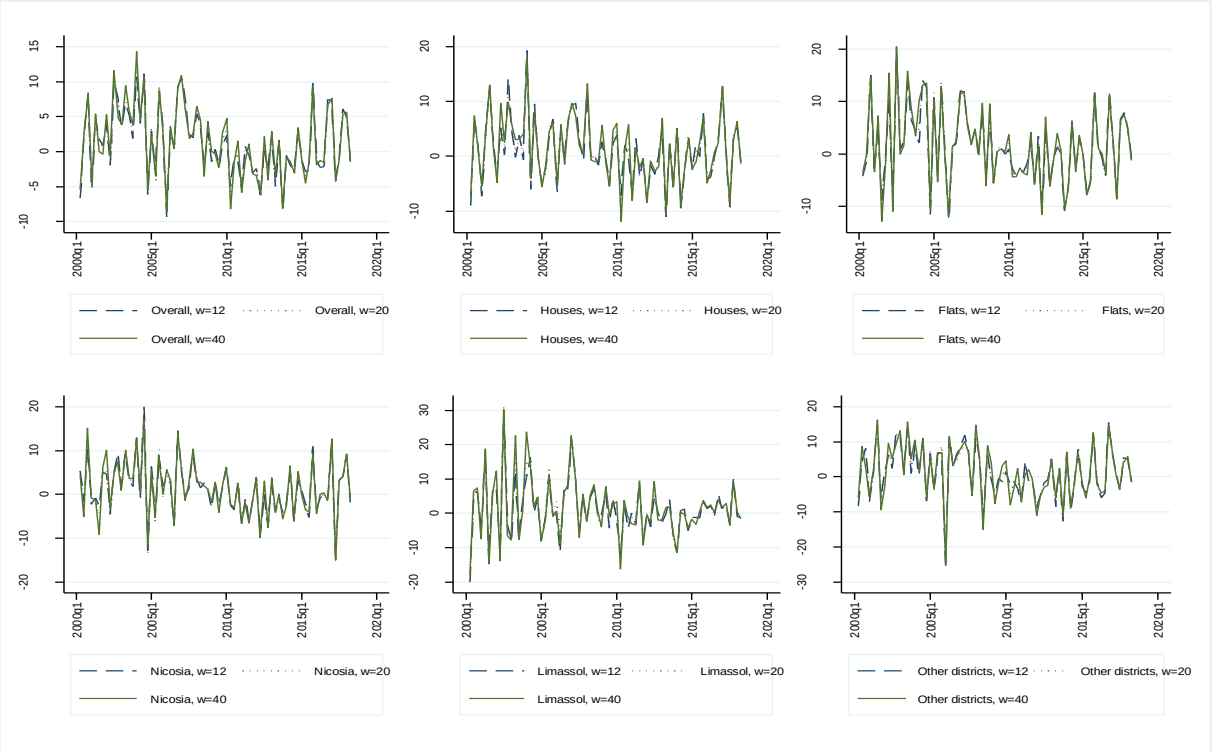
The estimation results show that flats in Nicosia and Limassol tend to be the most expensive kind of property compared to other properties with similar characteristics in the pool. The size of the property (in square metres) significantly affects its price. The elasticity of price with respect to 1% increase in property size is close to unity in the case of houses. The estimated price elasticity is below unity for flats, i.e. a change of 1% in the area of a flat leads to a smaller percentage change (about 0.8%) in its asking price. Differences in the prices of properties are also found across advertising sources. Properties advertised in the newspaper specialising in publishing classified advertisements only, are significantly cheaper; houses or flats for sale listed on the real estate agency's website tend to be more expensive compared to similar properties advertised in daily or weekly newspapers. Overall, as expected, estimated effects exhibit larger variations across iterations when the size of the rolling window is smaller, indicating a trade-off between estimation uncertainty and the speed with which structural changes are incorporated in the indices. The percentage of variation in property prices explained by the characteristics included in the model is about 80%, and it is similar for all window sizes used.

The parameters of the model that are allowed to change every quarter are used to compute the property price indices as shown in equations (2) – (6). The six aggregate indices, namely

the overall index and the indices for houses, flats, the district of Nicosia, the district of Limassol and collectively other districts, are shown in Figure 1. The indices plotted are obtained using rolling windows of size 12, 20 and 40 quarters in estimations. There are no noticeable differences between indices estimated with different rolling window sizes. As the estimated indices measure asset prices, they exhibit high volatility, especially over the period from 2000 to 2008, which coincides with the upswing in the Cypriot housing market. Volatility is also reinforced by the fact that the indices are derived from individual data. The prices of flats as well as the prices of residential properties in Limassol and other coastal districts are associated with the largest fluctuations.

FIGURE 1

Quarterly changes (time-varying parameters), aggregate indices



In order for the indices to provide as accurate signals on the direction of quarterly changes in residential prices as possible, we compute a smoothed version of the indices. More specifically, the smoothed version of a sub-aggregate index is given by the four-quarter backward-looking exponential moving average, i.e.

$$\hat{P}_{ijt}^{MA} = (\hat{P}_{ijt}\hat{P}_{ijt-1}\hat{P}_{ijt-2}\hat{P}_{ijt-3})^{\frac{1}{4}} \text{ , all } i,j,t \qquad (7)$$

and therefore the quarterly change in the smoothed index can be computed as

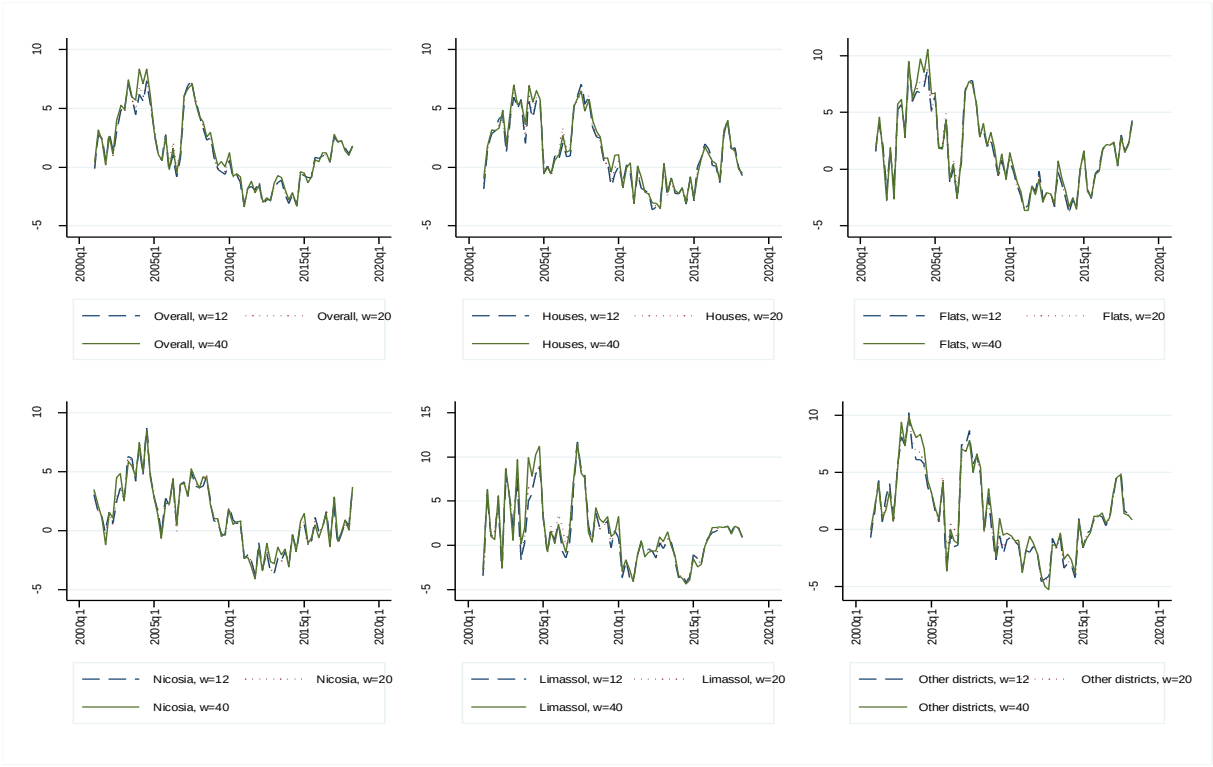
$$\ln\left(\frac{\hat{P}_{ijt}^{MA}}{\hat{P}_{ijt-1}^{MA}}\right) = \frac{1}{4}\ln\left(\frac{\hat{P}_{ijt}}{\hat{P}_{ijt-4}}\right) \text{ , all } i,j,t. \qquad (8)$$

[11] Following European Central Bank (2012) and Shiskin (1960), decompositions of the indices into irregular and regular (trend-cycle) components show that the application of a four-quarter moving average improves the noise-

The quarterly changes in the aggregate indices are given by the weighted quarterly changes of the sub-aggregate indices. Thus, the choice of the exponential moving average smoother makes it easy to express changes (in both sub-aggregate and aggregate and indices) in terms of estimated model parameters and test their statistical significance.

FIGURE 2

Quarterly changes, four-quarter moving averages, aggregate indices



The smoothed versions of the six aggregate indices in Figure 1 are plotted in Figure 2.[12] Volatility is approximately halved when the moving average filter is applied, resulting in statistically significant changes more frequently. The boom-and-bust cycles become more discernible with the smoothed version of the indices. Between 2002 and 2004 residential prices rose vigorously, mainly driven by increases in the sale prices of flats as well as by rising property prices in the smaller, costal districts of Cyprus. Subsequently, over the period 2005 to 2006, the housing market cooled off as a result of slower growth in the prices of houses, and the prices of properties in Limassol and other smaller districts. Price increases in all property types in all districts accelerated considerably over 2007 and 2008, leading to a housing boom, followed by a bust in 2009.[13] The decline in housing prices was protracted, lasting until 2015, and was primarily driven by large downward adjustments in the prices of

to-signal ratios. Application of an eight-quarter moving average does not improve on the noise-to-signal ratios vis-à-vis the four-quarter moving average and accentuates the backward-looking nature of the indices.

[12] Statistical tests show that the indices do not contain seasonal components.

[13] Statistical tests for a structural break at an unknown date suggest the presence of a break in all indices (aggregates and sub-aggregates) with the break date lying between 2008 and 2009. In the case of one sub-aggregate index (houses in Limassol) and an aggregate index (district of Limassol) the break date is estimated in 2010Q2 when the largest rolling window is used.

flats and the prices of properties in smaller districts, while house prices in the largest districts were more resilient. The recovery of the property market has slowly began in 2016, as a result of rising prices for flats and residential properties in the district of Limassol.

4. Comparison with other property price indices

In this section we compare the statistical properties of the smoothed version of the estimated indices to the properties of other published indices for the Cypriot housing market. The comparisons are constrained by the availability of other published indices, which span a shorter period compared to the indices estimated in this paper. More specifically, the overall price index of residential dwellings published by Eurostat begins in 2005Q1, while the overall, district-specific (Nicosia, Limassol, Larnaca, Famagusta, Paphos) and type-specific (houses, flats) residential property price indices published by the CBC start in 2006Q1.[14, 15] The series of type-specific price indices for houses and flats published by RICS start in 2009Q4.

4.1 Descriptive statistics

Tables 4 and 5 present some summary statistics for the quarterly percentage changes (q-o-q) of the estimated aggregate indices and other available indices for the Cypriot housing market.[16] The estimated indices are associated with more optimistic quarterly growth rates than the existing indices. Moreover, indices estimated using larger rolling windows result in higher quarterly changes. The estimated indices tend to have a slightly smaller variation in their quarterly growth rates over the period 2006Q2 – 2018Q2 than those published by the CBC, except in the case of the indices for flats and smaller districts. The release of the RICS indices coincided with the onset of the downturn in the property market, thus all type-specific indices registered on average negative growth rates over 2010Q1 – 2018Q2. Nevertheless, the estimated indices point to faster increases in residential prices during the recovery period, i.e. after 2015. In the case of houses, the CBC index declined, on average, the most, while the RICS index decreased the least. In the case of flats, the estimated indices exhibited the smallest contraction on average, while the RICS index registered the largest losses. After 2009, all type-specific indices exhibit smaller variations in their quarterly evolution.

The evolution of the quarterly changes in the estimated indices is juxtaposed with the quarterly developments in other similar indices published by the CBC, Eurostat and RICS in Figure A1. The collapse of the property market in 2008 – 2009 estimated by the CBC and Eurostat indices was deeper and more abrupt than the declines registered by the estimated indices. The break dates for the indices published by the CBC and Eurostat are found to precede those for the estimated series. During the downturn, between 2010 and 2014, the estimated overall and

[14] A simple average of the CBC indices for Larnaca, Famagusta and Paphos is computed in order to make comparisons with the estimated district-specific index that refers to “other districts”.
[15] The series of sub-aggregate indices for flats and houses located in the different districts begin in 2010Q1.
[16] The corresponding table for the sub-aggregates is given in the Appendix (Table A1).

district-specific indices registered more severe price declines than the indices by the CBC and Eurostat. Over the same period, the estimated indices for houses decreased at rates similar to those reported by the RICS index, but at a faster pace than the corresponding CBC index. Between 2010 and 2014 the most negative developments in the prices of flats were associated with the RICS index followed by the estimated indices. Compared to published indices, the estimated indices were the first to recover from the recession, picking up more strongly and signalling increasing momentum in the residential property market.

TABLE 4

Summary statistics, overall and district-specific indices, q-o-q (%), 2006Q2-2018Q2

	Mean	Standard deviation	Min	Max
Index				
Overall				
w=12	0.33	2.61	-3.32	7.41
w=20	0.39	2.59	-3.32	7.12
w=40	0.47	2.56	-3.37	7.02
CBC	0.21	2.78	-5.34	8.16
EUROSTAT	0.02	2.46	-4.06	5.43
District-specific				
Nicosia				
w=12	0.31	2.41	-3.70	5.02
w=20	0.32	2.46	-3.75	5.35
w=40	0.39	2.43	-4.09	5.20
CBC	0.11	2.82	-4.61	12.39
Limassol				
w=12	0.57	3.19	-4.23	11.73
w=20	0.76	3.18	-4.13	11.53
w=40	0.78	3.19	-4.35	11.49
CBC	0.41	3.23	-10.95	8.98
Other				
w=12	0.19	3.25	-4.56	8.64
w=20	0.23	3.12	-4.44	7.80
w=40	0.35	3.13	-5.25	7.77
CBC	0.05	2.70	-3.95	7.89

TABLE 5

Summary statistics, type-specific indices, q-o-q (%)

Period	2006Q2-2018Q2				2010Q1-2018Q2			
	Mean	Standard deviation	Min	Max	Mean	Standard deviation	Min	Max
Index (type-specific)								
Houses								
w=12	0.31	2.67	-3.64	7.04	-0.74	1.89	-3.64	4.00
w=20	0.39	2.66	-3.48	6.66	-0.72	1.89	-3.48	4.05
w=40	0.48	2.58	-3.53	6.49	-0.63	1.86	-3.53	3.98
CBC	0.27	3.07	-5.46	8.64	-0.92	1.02	-2.96	0.48
RICS	—	—	—	—	-0.70	1.68	-5.09	2.08
Flats								
w=12	0.35	2.92	-3.89	7.78	-0.63	2.18	-3.89	4.27
w=20	0.40	2.88	-3.77	7.69	-0.61	2.17	-3.77	4.20
w=40	0.46	2.90	-3.66	7.71	-0.56	2.17	-3.66	4.09
CBC	0.02	2.58	-4.73	6.78	-0.90	1.29	-3.24	1.52
RICS	—	—	—	—	-1.14	2.10	-5.56	2.86

The direction of change in the estimated indices in a given quarter is compared with that signalled by other existing indicators. The percentages of cases in which the estimated indices change in the same direction (increase, no change, decrease) as other corresponding

published indices are reported in Table 6. For the overall residential price indices, the highest percentage of agreement in terms of directional change (84%) is achieved between the estimated index with the largest rolling window and the overall index by the CBC, while agreement between the estimated indices and the Eurostat index is lower, particularly when the largest window is used. In the case of district-specific indices, the direction of change tends to match that of the corresponding CBC index for Limassol and other districts, especially when the medium-sized window is used. The estimated type-specific indices more often agree with the direction of change in the CBC and RICS indices for flats, while agreement is less strong for house price indices. The highest percentage of changes in the same direction is reached between the estimated indices for flats, particularly for small to medium sized windows, and the corresponding RICS index. Moreover, the directional agreement between the estimated indices and the CBC index for flats strengthened after 2009.

TABLE 6

Agreement between indices on the direction of change (%)

Indices	w=12	w=20	w=40
Overall			
CBC [1]	77.55	77.55	83.67
EUROSTAT [1]	67.35	67.35	61.22
District-specific			
Nicosia			
CBC [1]	69.39	67.35	69.39
Limassol			
CBC [1]	75.51	79.59	77.55
Other			
CBC [1]	71.43	73.47	71.43
Type-specific			
Houses			
CBC [1]	77.55	79.59	73.47
CBC [2]	76.47	79.41	67.65
RICS [2]	73.53	76.47	70.59
Flats			
CBC [1]	81.63	79.59	77.55
CBC [2]	85.29	82.35	79.41
RICS [2]	91.18	88.24	85.29

Notes: [1] Correlation coefficients are computed over the period 2006Q2 – 2018Q2.
[2] Correlation coefficients are computed over the period 2010Q1 – 2018Q2.

Table 7 presents the correlation coefficients between the estimated aggregate indices and other residential property price indices in Cyprus. [17] The correlations are computed contemporaneously as well as at various lags and leads of the indices produced by other organisations, and the peak correlation is reported. All estimated indices are positively and significantly correlated with other existing indices, with correlations ranging from 0.6 to 0.8. The aggregate overall index estimated here is more closely correlated with the corresponding index by the CBC than with the Eurostat index, with correlations peaking at lags, suggesting that existing indices could contain leading information for the evolution of the estimated indices. The estimated district-specific indices exhibit the highest correlation with the

[17] The corresponding table for the sub-aggregates is given in the Appendix (Table A2).

corresponding CBC indices in the case of smaller districts; however in the case of Limassol, there is evidence of leading information in the estimated index. The correlations between the estimated type-specific indices and the corresponding CBC indices are similar in the case of houses and flats for the period 2006Q2 – 2018Q2.

After 2009, the correlation between the estimated index for houses and the corresponding CBC index declined, but remained significant. In the case of flats, the correlation between the estimated index and the CBC index did not change much after 2009, although there are indications of leading information in the estimated index. The indices published by RICS have strong correlation with the estimated indices with the coefficient being higher for flats vis-à-vis houses. However, the estimated index for houses appears to lead the corresponding RICS index but the opposite seems to occur for flats.

TABLE 7

Correlation between the estimated indices and other published indices

Indices	w=12		w=20		w=40	
	Correlation [3]	Lag/Lead [4]	Correlation [3]	Lag/Lead [4]	Correlation [3]	Lag/Lead [4]
Overall						
CBC [1]	0.74**	-1	0.76**	-1	0.75**	-1
EUROSTAT [1]	0.55**	-3	0.56**	-3	0.55**	-3
District-specific						
Nicosia						
CBC [1]	0.60**	-1	0.61**	-1	0.60**	-1
Limassol						
CBC [1]	0.55**	1	0.62**	1	0.55**	1
Other						
CBC [1]	0.73**	-1	0.75**	-1	0.72**	-1
Type-specific						
Houses						
CBC [1]	0.70**	-1	0.71**	-1	0.71**	-1
CBC [2]	0.60**	-1	0.62**	-1	0.64**	-1
RICS [2]	0.65**	2	0.65**	2	0.64**	2
Flats						
CBC [1]	0.68**	-1	0.68**	-1	0.66**	-1
CBC [2]	0.71**	1	0.70**	1	0.65**	1
RICS [2]	0.81**	-4	0.80**	-4	0.79**	-4

Notes: [1] Correlation coefficients are computed over the period 2006Q2 – 2018Q2.
[2] Correlation coefficients are computed over the period 2010Q1 – 2018Q2.
[3] The symbols ** denote statistical significance of the correlation coefficient at 5% level.
[4] Positive and negative numbers denote leads and lags, respectively.

4.2 Granger causality

We investigate the dynamic relationships between the aggregate estimated indices and other available property price indices by estimating Vector Autoregression (VAR) models and carrying out Granger causality tests. We focus on the aggregate indices (overall, district-specific and type-specific) for which we can obtain sufficiently long time series for published indices, namely the CBC and Eurostat indices. The VAR models include the quarterly percentage changes of an estimated aggregate index, the changes of the corresponding published index (or indices), and the growth rate of real output (GDP) in Cyprus to control for real effects and limit biases.

Tables 8 and 9 present the results of Granger causality tests, which are used for checking whether the lagged changes in a given residential price index contain information for the current changes in another index, beyond that conveyed by its own past values and past changes in real economic activity.

TABLE 8

Granger causality tests, p-values, overall indices

	Endogenous variables, overall indices[1]		
	w=12 / w=20 / w=40	CBC	EUROSTAT
Lags of:			
w=12	—	0.09	0.87
CBC	0.01	—	0.27
EUROSTAT	0.72	0.04	—
w=20	—	0.07	0.95
CBC	0.01	—	0.30
EUROSTAT	0.71	0.04	—
w=40	—	0.08	0.87
CBC	0.00	—	0.25
EUROSTAT	0.68	0.04	—
p-value [2]	0.60 / 0.53 / 0.56		

Notes: [1] The null hypothesis is that the coefficients on all the lags of the endogenous variable j are jointly equal to zero in the equation for index i. The tests are carried out in VAR models of order one, estimated using 48 observations over the period 2006Q3-2018Q2.
[2] The p-values for the Lagrange Multiplier test for the absence of autocorrelation in the residuals of the VAR models.

In Table 8, the hypothesis that past changes in the CBC overall index are not informative for the current changes in the estimated indices cannot be rejected at 5%, whereas the opposite is found in the case of the Eurostat index. Moreover, past changes in the estimated indices and, perhaps more so, past fluctuations in the Eurostat index appear to contain useful information for current changes in the CBC index. Neither the CBC index nor any of the estimated indices are useful for forecasting the evolution of the Eurostat index.

Turning to the district-specific and type-specific indices (Table 9) we find some evidence of bi-directional causality between the CBC and estimated indices for Nicosia, while the feedback between the CBC and estimated indices is stronger in the case of smaller districts and flats. The estimated indices for property prices in Limassol are found to contain leading information with respect to future changes in the CBC index. Conversely, the estimated indices for houses do not contain useful signals for the future evolution of the CBC house price index, but the latter is found to lead the former. Evidence based on a broader information set, i.e. by utilising also the RICS type-specific indices, but limited to the post-2009 period, shows that (i) the leading properties of the CBC house price index with respect to the estimated indices remain strong, (ii) the estimated indices for flats appear to contain leading information with respect to the corresponding indices produced by the CBC and RICS, and (iii) the RICS index for flats seems to lead the corresponding CBC index (Table A3).

TABLE 9

Granger causality tests, p-values, district-specific and type-specific indices

District-specific indices [1]

	Endogenous variables, indices for Nicosia		Endogenous variables, indices for Limassol		Endogenous variables, indices for other districts	
Lags of:	w=12 / w=20 / w=40	CBC	w=12 / w=20 / w=40	CBC	w=12 / w=20 / w=40	CBC
w=12	—	0.06	—	0.00	—	0.01
CBC	0.08	—	0.25	—	0.00	—
w=20	—	0.07	—	0.00	—	0.01
CBC	0.04	—	0.24	—	0.00	—
w=40	—	0.03	—	0.00	—	0.02
CBC	0.04	—	0.22	—	0.00	—
p-value [2]	0.46 / 0.54 / 0.58		0.43 / 0.53 / 0.37		0.18 / 0.13 / 0.13	

Type-specific indices [1]

	Endogenous variables, indices for Houses		Endogenous variables, indices for Flats	
	w=12 / w=20 / w=40	CBC	w=12 / w=20 / w=40	CBC
Lags of:				
w=12	—	0.22	—	0.04
CBC	0.01	—	0.01	—
w=20	—	0.18	—	0.02
CBC	0.01	—	0.01	—
w=40	—	0.24	—	0.05
CBC	0.01	—	0.01	—
p-value [2]	0.33 / 0.21 / 0.19		0.05 / 0.07 / 0.11	

Notes: [1] The null hypothesis is that the coefficients on all the lags of the endogenous variable j are jointly equal to zero in the equation for index i. The tests are carried out in VAR models of order one, estimated using 48 observations over the period 2006Q3-2018Q2.
[2] The p-values for the Lagrange Multiplier test for the absence of autocorrelation in the residuals of the VAR models.

5. Relation to macroeconomic series

This section examines the relation between the estimated indices and a number of macroeconomic series relevant to the property market. We consider, among others, variables from the National Accounts, price indices, particularly indices for building materials, data from the Department of Lands and Surveys relating to property transactions, data on building permits and housing loans as well as survey data.

Table 10 shows the correlation coefficients between the estimated overall indices and macroeconomic variables. The correlations of the corresponding published indices with the same macroeconomic series are also computed and used as a benchmark. All property price indices are expressed in terms of quarterly percentage changes. The macro variables are transformed into quarterly percentage changes or quarterly differences; survey variables are in levels. The correlations are computed contemporaneously as well as at various lags and leads of the macro variables, and the peak correlation is reported.

The estimated indices exhibit positive and significant correlation with key macroeconomic variables such as real GDP, real gross fixed capital formation relating to housing, the value added of the construction sector, and employment in construction. Moreover, the estimated indices are negatively and significantly correlated with the unemployment rate as well as with

the number of registered unemployed in the construction sector. The correlations between the estimated indices with the abovementioned macro series are similar with or slightly stronger than those computed for the CBC and Eurostat indices.

The estimated price indices do not correlate significantly with overall consumer inflation measures in Cyprus, namely the Consumer Price Index (CPI) and the Harmonised Index of Consumer Prices (HICP), whereas both the CBC and Eurostat indices result in positive and significant correlations. However, the components of the CPI measuring rental costs for housing, and dwelling repair and maintenance costs are positively and significantly correlated with the estimated indices but less so with the CBC and Eurostat indices. Other indices measuring the evolution of costs/prices related to the construction sector, such as a labour cost index, an index of output prices, and the deflator of the sector's value added are also positively and significantly correlated with the estimated indices. Looking at price indices of building materials, we find that the estimated indices are significantly correlated with the indices for concrete and sand only, whereas the CBC index exhibits significant correlations with the price indices for various materials (e.g. concrete, iron, steel, oil).

Other variables relating to the property market, such as building permits, exhibit low correlation with both the estimated indices and the CBC index, whereas the various measures of building permits are significantly correlated with the Eurostat index. Variables on property transactions (amount, number) do not yield significant correlations or correlations with the expected sign; the only exception is the correlation between the Eurostat index and the number of sale contracts. The estimated indices are strongly correlated with the stock of loans for house purchase; the corresponding correlation coefficient is slightly higher for the CBC index but considerably lower for the Eurostat index. The interest rate on loans for house purchase is positively and significantly correlated with the CBC index and, to a lesser degree, with the Eurostat index.

The estimated indices as well as the published indices considered are strongly and positively correlated with relevant survey variables. The estimated indices show particularly high correlations with the business confidence indicator in construction, the assessments of construction firms regarding the current levels of their order books, and the selling price expectations stated by construction firms. All property price indices are found to be strongly correlated with survey variables on consumers' intentions to buy, build or renovate a house.

TABLE 10

Correlations between overall property price indices and macroeconomic variables

Indices, overall	w=12		w=20		w=40		CBC		EUROSTAT	
Macroeconomic series	Correlation [1]	Lag/lead [2]	Correlation [1]	Lag/lead [2]	Correlation [1]	Lag/lead [2]	Correlation [1]	Lag/lead [2]	Correlation [1]	Lag/lead [2]
Gross Domestic Product (constant prices)	0.62**	-3	0.63**	-3	0.59**	-3	0.57**	0	0.40**	-2
Gross fixed capital formation: housing construction (constant prices)	0.58**	-4	0.59**	-4	0.56**	-4	0.43**	-3	0.53**	-1
Gross Value Added: construction (constant prices)	0.46**	-3	0.47**	-3	0.44**	-3	0.35**	-3	0.38**	-3
Employment (number of persons): construction	0.66**	-2	0.67**	-2	0.65**	-2	0.52**	0	0.43**	2
Unemployment rate	-0.48**	-4	-0.48**	-4	-0.47**	-4	-0.35**	-3	-0.29**	-1
Registered unemployed (number): construction	-0.30**	-3	-0.28**	-3	-0.26*	-3	-0.35**	0	-0.34**	0
Index of Production: construction	0.16	-1	0.16	-1	0.16	-3	0.22	0	0.21	0
Consumer Price Index	0.22	2	0.22	2	0.22	4	0.35**	0	0.24*	0
Consumer Price Index: housing, water, electricity and gas	0.25*	3	0.25*	3	0.26*	3	0.28*	1	0.25*	1
Consumer Price Index: actual rentals for housing	0.57**	3	0.59**	3	0.59**	4	0.44**	0	0.30**	1
Consumer Price Index: goods and services for routine household maintenance	0.54**	4	0.54**	4	0.53**	4	0.41**	4	0.19	3
Harmonised Index of Consumer Prices	0.15	2	0.15	2	0.14	2	0.25*	0	0.44**	4
Harmonised Index of Consumer Prices: housing, water, electricity and gas	0.22	3	0.22	3	0.23	3	0.33**	0	0.28*	1
Index of labour cost in construction	0.32**	4	0.32**	4	0.33**	4	0.30**	-1	-0.30**	-3
Index of output prices in construction	0.33**	1	0.34**	1	0.31**	3	0.46**	1	0.31**	0
Deflator, Gross Fixed Capital Formation: housing construction	0.18	-1	0.18	-1	0.20	-1	0.24*	1	0.24	2
Deflator, Gross Value Added: construction	0.53**	-1	0.54**	-1	0.52**	-4	0.66**	0	0.44**	2
Price index for input materials in construction: crushed sand for concrete	0.34**	4	0.34**	4	0.35**	4	0.34**	4	-0.20	-2
Price index for input materials in construction: bricks	0.14	4	0.14	4	0.14	4	0.15	-4	0.18	3
Price index for input materials in construction: iron	0.18	-2	0.17	-2	0.17	-2	0.41**	0	0.26*	0
Price index for input materials in construction: gravel	0.24	1	0.24	1	0.25*	1	0.24*	2	0.26*	4
Price index for input materials in construction: sand	0.24*	1	0.24*	1	0.26*	1	0.22	2	0.26*	-4
Price index for input materials in construction: gravel and sand	0.21	1	0.21	1	0.22	1	0.19	2	0.26*	3
Price index for input materials in construction: steel	0.16	-1	0.17	-1	0.15	-1	0.45**	1	0.28*	1
Price index for input materials in construction: cement	-0.16	0	-0.16	0	-0.15	0	-0.28*	1	-0.28*	-2
Price index for input materials in construction: asphalt	0.17	2	0.15	2	0.16	2	0.31**	0	-0.27*	3
Price index for input materials in construction: fuel	0.15	2	0.14	2	0.15	2	0.32**	0	0.25*	0
International commodity prices: Brent crude oil (EUR)	0.14	2	0.13	2	0.14	1	0.28*	-1	0.26*	0
International commodity prices: Crude oil futures (EUR)	0.18	2	0.16	2	0.17	2	0.24	-1	0.23	0
International commodity prices: West Texas intermediate oil price (EUR /Barrel)	0.18	2	0.16	2	0.17	2	0.24*	-1	0.24*	0
Share price: Vassilico Cement Works	-0.34**	4	-0.35**	4	-0.37**	4	-0.38**	3	0.35**	-1
Share price: Cyprus Cement	0.36**	-3	0.36**	-3	-0.34**	3	0.34**	-4	0.46**	-3

TABLE 10 (continued)

Indices, overall	w=12		w=20		w=40		CBC		EUROSTAT	
Macroeconomic series	Correlation [1]	Lag/lead [2]	Correlation [1]	Lag/lead [2]	Correlation [1]	Lag/lead [2]	Correlation [1]	Lag/lead [2]	Correlation [1]	Lag/lead [2]
Building permits authorised (value in EUR)	0.22	-3	0.23	-3	0.23	-3	0.22	-2	0.30**	-2
Building permits authorised (number)	0.17	3	0.15	3	0.14	2	0.21	-2	0.33**	-2
Building permits authorised (area in square metres)	0.26*	-2	0.26*	-2	0.25*	-2	0.23	-4	0.33**	2
Transfers of sales, total amount accepted by the Department of Lands and Surveys	-0.22	4	-0.21	4	-0.20	4	-0.23	3	-0.36**	3
Transfers of sales, total amount declared at the Department of Lands and Surveys	-0.23	4	-0.22	4	-0.21	4	-0.26*	3	-0.33**	3
Total number of transfers of sales (Number of cases, Department of Lands and Surveys)	-0.17	4	-0.17	4	-0.16	4	-0.23	3	-0.36**	3
Total number of parcels (Number of items, Department of Lands and Surveys)	-0.18	4	-0.17	4	-0.17	4	-0.25*	3	-0.37**	3
Sale contracts (Number, Department of Lands and Surveys)	-0.23	4	-0.22	4	-0.22	4	-0.23	3	0.40**	-2
Housing loans (outstanding amounts)	0.61**	4	0.64**	4	0.64**	4	0.67**	1	0.34**	2
Interest rates on euro-denominated loans (new business): lending for house purchase	0.21	4	0.21	4	0.19	4	0.36**	4	0.27*	1
Economic Sentiment Indicator	0.73**	-1	0.74**	-1	0.72**	-1	0.56**	1	0.42**	2
Confidence Indicator, construction	0.86**	0	0.88**	0	0.85**	-1	0.80**	1	0.55**	2
Assessments of firms in construction: building activity over the past three months	0.63**	-1	0.64**	-1	0.62**	-2	0.47**	1	0.41**	2
Assessments of firms in construction: current overall order books	0.83**	0	0.86**	0	0.83**	0	0.83**	1	0.52**	3
Expectations of firms in construction: selling prices over the next three months	0.75**	-1	0.78**	-1	0.75**	-1	0.72**	0	0.57**	2
Expectations of firms in construction: number of employees over the next three months	0.74**	-1	0.74**	-1	0.71**	-1	0.60**	0	0.50**	2
Intentions of consumers: buy or build a house over the next 12 months	0.66**	2	0.70**	2	0.70**	2	0.76**	3	0.44**	4
Intentions of consumers: spend large amounts on home improvements or renovations over the next 12 months	0.69**	1	0.69**	1	0.70**	1	0.65**	3	0.36**	4

Notes: [1] The symbols * and ** denote statistical significance of the correlation coefficient at 10% and 5% level, respectively.
[2] Positive and negative numbers denote leads and lags, respectively.

Correlations are also computed for type-specific indices and are compared with those achieved by the corresponding indices published by the CBC and RICS and therefore refer to the period after 2009 (Tables A4 and A5). The pattern is similar to that for the overall aggregate index. All type-specific indices exhibit significant correlations with key macroeconomic variables. Some variables that do not correlate significantly with the overall aggregate index are found to correlate significantly with the estimated indices for houses and flats (e.g. building permits, price indices of construction materials such as steel, iron and oil, international oil prices), while the opposite is also found in a smaller number of cases (e.g. index of labour cost in construction, loans for house purchase).

The correlation coefficients provide some preliminary evidence that the estimated indices could lead developments in some macroeconomic series, such as consumer inflation (particularly inflation components relating to housing expenditure), prices of building materials, labour cost in construction, output prices in construction, housing loans, and consumer intentions regarding house purchase, construction or renovation. Moreover, the strong positive correlation between the estimated indices and selling price expectations stated by construction firms suggests that the former embody reliable signals about developments in the domestic property market.

6. Conclusions

The aim of this paper is to expand the set of available property price indices in Cyprus by estimating residential property indices using asking prices, collected from newspaper advertisements and online listings on a quarterly basis. A set of sub-aggregate indices for houses and flats in the different districts of Cyprus is estimated through a linear regression model. Subsequently, aggregate type-specific and district-specific indices, and an overall property price index are constructed. As the resulting indices are model-based, the statistical significance of their quarterly changes can be computed and confidence intervals can be constructed around these changes to provide an informed depiction of property price developments. Moreover, the availability of sub-aggregate indices can reveal the drivers of fluctuations in the residential property market.

Asking prices used in the estimation of the indices in this paper, could differ from property prices used as inputs into other published indices, for example, final transaction prices employed in the Eurostat index, mortgage valuations utilised in the CBC indices, and notional appraisals of a sample of professional valuators used in the RICS indices. Nevertheless, the estimated indices are found to be highly correlated and to exhibit strong directional agreement with the abovementioned indices published by other organisations. Our results suggest that some of the estimated indices, particularly those for Limassol and for flats, exhibit leading properties vis-à-vis other published indices. Furthermore, compared to published indices, the proposed indices here, were the first to recover after the recent recession, showing a strong pickup. The estimated property indices are found to be highly correlated with macroeconomic series and various aggregate indicators relating to the construction sector; there are also indications that changes in the proposed indices may lead developments in macroeconomic indicators, particularly in components of consumer inflation relating to housing expenditures, cost and price indicators for the construction sector as well as survey indicators on consumers' intentions regarding property purchase, construction or renovation.

One limitation of the indices in this paper compared to other available residential price indices is that their estimation involves a relatively small number of property characteristics as the inclusion of additional characteristics would severely reduce the number of available observations for estimation. Comparing the estimated indices with those obtained using the simple average or median price per square metre in the data, we find that the latter exhibit larger variability, result in noisier series, and tend to exaggerate expansions and contractions during boom and bust periods.[18] The model and estimation method used here, however, can easily allow the inclusion of additional property characteristics, which could be obtained by gradually shifting data collection from traditional newspaper sources to a wider set of online sources that provide systematic information on properties on sale.

[18] Moving averages of four quarters are used to ensure comparability with the estimated indices.

The estimated indices provide a longer time series compared to other published indices for the Cypriot property market; they can therefore be reliably used in forecasting, and analysing factors affecting the residential property market. Also, new quarterly data on the proposed indices can be produced and made available within at most three weeks after the end of the reference quarter; indices by other organisations are published with a delay vis-à-vis the reference quarter that ranges between three to six months. The proposed indices are not subject to revisions and may convey leading information about existing property market indices and macroeconomic series, making them a useful tool for policy makers, practitioners and investors.

Appendix

TABLE A1

Summary statistics, type-and-district-specific indices, 2010Q2-2018Q2

	Mean	Standard deviation	Min	Max
Index (type-and-district-specific)				
Houses in Nicosia				
w=12	-0.779	1.728	-4.270	3.042
w=20	-0.803	1.724	-4.352	3.270
w=40	-0.726	1.727	-4.360	3.591
CBC	-0.899	1.019	-2.684	0.999
Houses in Limassol				
w=12	-1.165	3.078	-7.964	5.250
w=20	-1.143	3.050	-7.909	5.102
w=40	-1.083	3.166	-7.839	5.202
CBC	-0.763	0.965	-2.797	0.683
Houses in other districts				
w=12	-0.524	3.398	-5.402	9.578
w=20	-0.499	3.374	-5.635	9.445
w=40	-0.405	3.352	-6.313	9.255
CBC	-0.909	1.387	-3.946	1.468
Flats in Nicosia				
w=12	-0.819	2.377	-5.685	3.930
w=20	-0.826	2.355	-5.689	3.924
w=40	-0.733	2.325	-5.129	3.805
CBC	-0.745	1.172	-2.813	2.240
Flats in Limassol				
w=12	-0.073	3.508	-5.184	7.359
w=20	-0.023	3.498	-5.159	7.470
w=40	-0.006	3.549	-5.034	7.404
CBC	-0.561	1.784	-4.292	2.222
Flats in other districts				
w=12	-0.920	2.460	-5.192	3.378
w=20	-0.917	2.468	-5.127	3.333
w=40	-0.886	2.567	-5.184	3.402
CBC	-1.393	1.607	-5.592	1.740

FIGURE A1

Estimated aggregate indices vis-à-vis other published indices, quarterly changes

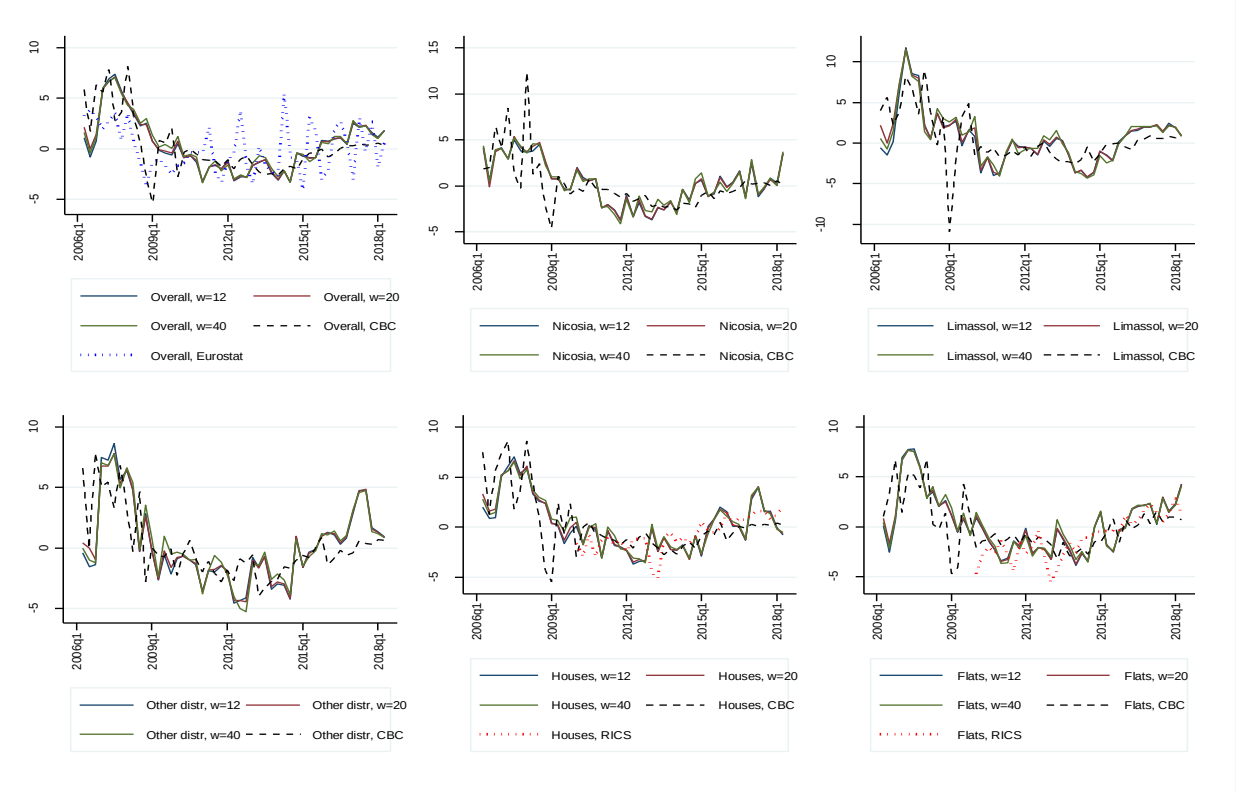


TABLE A2

Correlation between type-and-district-specific indices, 2010Q2-2018Q2

Indices	w=12		w=20		w=40	
	Correlation [1]	Lag/Lead [2]	Correlation [1]	Lag/Lead [2]	Correlation [1]	Lag/Lead [2]
Houses in Nicosia						
CBC	0.57**	2	0.56**	2	0.46**	0
Houses in Limassol						
CBC	0.43**	4	0.43**	4	0.39**	4
Houses in other districts						
CBC	0.57**	0	0.57**	0	0.54**	0
Flats in Nicosia						
CBC	0.60**	2	0.59**	2	0.52**	2
Flats in Limassol						
CBC	0.62**	-3	0.62**	-3	0.63**	-3
Flats in other districts						
CBC	0.70**	1	0.71**	1	0.67**	1

Notes: [1] The symbols ** denote statistical significance of the correlation coefficient at 5% level.
[2] Positive and negative numbers denote leads and lags respectively.

TABLE A3

Granger causality tests, p-values, type-specific indices

	Endogenous variables, indices for Houses[1]			Endogenous variables, indices for Flats[1]		
	w=12 / w=20 / w=40	CBC	RICS	w=12 / w=20 / w=40	CBC	RICS
Lags of:						
w=12	—	0.57	0.50	—	0.01	0.02
CBC	0.01	—	0.46	0.13	—	0.97
RICS	0.38	0.24	—	0.36	0.02	—
w=20	—	0.42	0.52	—	0.01	0.02
CBC	0.01	—	0.44	0.13	—	0.94
RICS	0.34	0.25	—	0.37	0.02	—
w=40	—	0.34	0.45	—	0.02	0.02
CBC	0.01	—	0.44	0.12	—	0.84
RICS	0.40	0.25	—	0.49	0.01	—
p-value [2]	0.32 / 0.26 / 0.17			0.14 / 0.22 / 0.45		

Notes: [1] The null hypothesis is that the coefficients on all the lags of the endogenous variable j are jointly equal to zero in the equation for index i. The tests are carried out in a VAR model of order one, estimated using 33 observations over the period 2010Q2-2018Q2.
[2] The p-value for the Lagrange Multiplier test for the absence of autocorrelation in the residuals of the VAR model.

TABLE A4

Correlations between type-specific property price indices and macroeconomic variables, houses

Indices, overall	w=12		w=20		w=40		CBC		EUROSTAT	
Macroeconomic series	Correlation [1]	Lag/lead [2]	Correlation [1]	Lag/lead [2]	Correlation [1]	Lag/lead [2]	Correlation [1]	Lag/lead [2]	Correlation [1]	Lag/lead [2]
Gross Domestic Product (constant prices)	0.69**	2	0.69**	2	0.70**	2	0.74**	-3	0.68**	0
Gross fixed capital formation: housing construction (constant prices)	0.56**	-3	0.56**	-3	0.54**	-3	0.69**	-3	0.72**	0
Gross Value Added: construction (constant prices)	0.61**	2	0.61**	2	0.60**	2	0.55**	-3	0.55**	0
Employment (number of persons): construction	0.61**	-1	0.61**	-1	0.59**	-1	0.70**	-3	0.72**	1
Unemployment rate	-0.61**	0	-0.60**	0	-0.56**	0	-0.55**	-3	-0.67**	-4
Registered unemployed (number): construction	-0.49**	0	-0.48**	0	-0.46**	0	-0.50**	0	-0.63**	0
Index of Production: construction	0.26	2	0.27	-3	0.29	-3	0.27	0	0.27	-1
Consumer Price Index	0.32*	4	0.31*	4	0.3	4	0.23	0	-0.25	-4
Consumer Price Index: housing, water, electricity and gas	0.51**	4	0.51**	4	0.52**	4	0.34*	4	-0.36**	-4
Consumer Price Index: actual rentals for housing	0.57**	4	0.57**	4	0.57**	4	0.60**	-1	0.58**	0
Consumer Price Index: goods and services for routine household maintenance	0.48**	3	0.49**	3	0.48**	3	0.54**	4	0.60**	3
Harmonised Index of Consumer Prices	-0.21	-4	-0.21	-4	-0.21	-4	0.16	3	-0.22	-4
Harmonised Index of Consumer Prices: housing, water, electricity and gas	0.53**	4	0.52**	4	0.53**	4	0.39**	4	-0.35**	-3
Index of labour cost in construction	0.31	4	0.29	4	0.3	4	0.41**	-2	0.44**	1
Index of output prices in construction	0.35**	1	0.34*	1	0.34**	1	0.40**	1	0.29	3
Deflator, Gross Fixed Capital Formation: housing construction	-0.35*	3	-0.34*	3	-0.35*	2	-0.37**	-4	-0.39**	-1
Deflator, Gross Value Added: construction	0.36**	-4	0.35**	-4	0.35**	-4	0.41**	-2	0.58**	1
Price index for input materials in construction: crushed sand for concrete	-0.34*	1	-0.35**	1	-0.33*	1	-0.39**	-3	-0.47**	4
Price index for input materials in construction: bricks	-0.53**	2	-0.53**	2	-0.53**	2	-0.31*	0	-0.47**	-3
Price index for input materials in construction: iron	0.45**	2	0.44**	2	0.44**	2	0.51**	2	0.32*	2
Price index for input materials in construction: gravel	-0.27	4	-0.27	4	-0.30	4	-0.39**	-1	-0.39**	1
Price index for input materials in construction: sand	-0.25	4	-0.24	4	-0.26	4	-0.36**	-1	-0.35**	1
Price index for input materials in construction: gravel and sand	-0.25	4	-0.24	4	-0.27	4	-0.38**	-1	-0.37**	1
Price index for input materials in construction: steel	0.58**	4	0.57**	4	0.53**	4	0.52**	3	0.34*	3
Price index for input materials in construction: cement	-0.27	-2	-0.27	-2	-0.24	-2	-0.43**	-3	-0.48**	1
Price index for input materials in construction: asphalt	0.46**	4	0.45**	4	0.44**	4	0.35**	-4	0.25	2
Price index for input materials in construction: fuel	0.37**	4	0.38**	4	0.38**	2	0.29	3	-0.24	-1
International commodity prices: Brent crude oil (EUR)	0.40**	2	0.41**	4	0.41**	2	0.35**	2	-0.25	-4
International commodity prices: Crude oil futures (EUR)	0.44**	2	0.43**	2	0.45**	2	0.29	2	-0.22	-4
International commodity prices: West Texas intermediate oil price (EUR /Barrel)	0.43**	2	0.42**	2	0.44**	2	0.29	2	-0.22	-4
Share price: Vassilico Cement Works	0.47**	-3	0.46**	-3	0.44**	-3	-0.31*	2	0.37**	-2
Share price: Cyprus Cement	-0.20	3	-0.21	3	-0.22	3	0.30*	-4	0.22	-3

TABLE A4 (continued)

Indices, overall	w=12		w=20		w=40		CBC		EUROSTAT	
Macroeconomic series	Correlation [1]	Lag/lead [2]	Correlation [1]	Lag/lead [2]	Correlation [1]	Lag/lead [2]	Correlation [1]	Lag/lead [2]	Correlation [1]	Lag/lead [2]
Building permits authorised (value in EUR)	0.38**	-2	0.37**	-2	0.36**	-3	0.40**	-2	0.38**	1
Building permits authorised (number)	0.35*	3	0.34*	3	0.29	3	0.34*	-4	0.39**	0
Building permits authorised (area in square metres)	0.42**	-2	0.42**	-2	0.40**	-2	0.36**	-2	0.42**	1
Transfers of sales, total amount accepted by the Department of Lands and Surveys	-0.16	4	-0.17	4	-0.19	4	0.30*	-4	0.19	-1
Transfers of sales, total amount declared at the Department of Lands and Surveys	-0.18	4	-0.19	4	-0.2	4	0.30*	-4	0.17	-1
Total number of transfers of sales (Number of cases, Department of Lands and Surveys)	0.12	2	-0.12	4	-0.14	4	0.23	-4	0.18	-1
Total number of parcels (Number of items, Department of Lands and Surveys)	0.13	2	-0.13	4	-0.14	4	0.25	-4	0.20	-1
Sale contracts (Number, Department of Lands and Surveys)	0.21	2	0.21	2	0.22	2	0.41**	-4	0.30*	-3
Housing loans (outstanding amounts)	-0.12	-2	0.13	4	0.14	3	0.24	-3	-0.36**	-4
Interest rates on euro-denominated loans (new business): lending for house purchase	-0.26	-2	-0.26	-2	-0.27	-2	-0.26	-4	-0.31*	1
Economic Sentiment Indicator	0.71**	2	0.71**	2	0.68**	2	0.77**	-3	0.80**	0
Confidence Indicator, construction	0.76**	2	0.75**	2	0.72**	2	0.74**	-3	0.81**	0
Assessments of firms in construction: building activity over the past three months	0.71**	2	0.71**	2	0.68**	2	0.76**	0	0.84**	0
Assessments of firms in construction: current overall order books	0.78**	2	0.78**	2	0.76**	2	0.71**	2	0.73**	3
Expectations of firms in construction: selling prices over the next three months	0.75**	2	0.74**	2	0.72**	2	0.72**	-2	0.85**	0
Expectations of firms in construction: number of employees over the next three months	0.64**	0	0.64**	0	0.61**	0	0.71**	-3	0.82**	0
Intentions of consumers: buy or build a house over the next 12 months	0.46**	2	0.49**	2	0.56**	2	0.54**	3	-0.52**	-4
Intentions of consumers: spend large amounts on home improvements or renovations over the next 12 months	0.52**	4	0.51**	4	0.48**	4	0.47**	0	0.37**	0

Notes: [1] The symbols * and ** denote statistical significance of the correlation coefficient at 10% and 5% level, respectively.
[2] Positive and negative numbers denote leads and lags, respectively.

TABLE A5

Correlations between type-specific property property price indices and macroeconomic variables, flats

Indices, overall	w=12		w=20		w=40		CBC		EUROSTAT	
Macroeconomic series	Correlation [1]	Lag/lead [2]	Correlation [1]	Lag/lead [2]	Correlation [1]	Lag/lead [2]	Correlation [1]	Lag/lead [2]	Correlation [1]	Lag/lead [2]
Gross Domestic Product (constant prices)	0.59**	-3	0.58**	-3	0.58**	1	0.72**	-3	0.67**	0
Gross fixed capital formation: housing construction (constant prices)	0.60**	-4	0.59**	-4	0.55**	-4	0.74**	-4	0.70**	-1
Gross Value Added: construction (constant prices)	0.54**	-1	0.54**	-1	0.53**	1	0.62**	-1	0.59**	-3
Employment (number of persons): construction	0.71**	-2	0.70**	-2	0.66**	-2	0.81**	-3	0.69**	-2
Unemployment rate	-0.63**	-4	-0.62**	-4	-0.64**	2	-0.66**	-4	-0.69**	1
Registered unemployed (number): construction	-0.45**	-2	-0.46**	1	-0.45**	1	-0.50**	0	-0.64**	-3
Index of Production: construction	0.27	1	0.27	1	0.27	1	0.31*	-1	0.31*	0
Consumer Price Index	0.20	3	0.20	3	0.18	3	0.24	4	-0.25	-3
Consumer Price Index: housing, water, electricity and gas	0.23	3	-0.23	-4	-0.23	-4	0.31*	4	-0.32*	-3
Consumer Price Index: actual rentals for housing	0.44**	1	0.43**	1	0.41**	3	0.59**	0	0.52**	1
Consumer Price Index: goods and services for routine household maintenance	0.57**	-1	0.58**	-1	0.59**	-1	0.54**	3	0.60**	4
Harmonised Index of Consumer Prices	-0.16	-1	-0.16	-1	-0.18	-1	0.16	4	-0.23	-1
Harmonised Index of Consumer Prices: housing, water, electricity and gas	-0.25	-4	-0.27	-4	-0.28	-4	0.36*	4	-0.33*	-3
Index of labour cost in construction	0.22	-4	0.22	-4	0.23	-4	0.30*	1	0.36**	2
Index of output prices in construction	0.41**	4	0.41**	4	0.43**	4	0.30*	0	0.30*	-1
Deflator, Gross Fixed Capital Formation: housing construction	-0.25	-4	-0.24	-4	-0.19	-4	-0.35**	-3	-0.34*	-1
Deflator, Gross Value Added: construction	0.30*	-2	0.29*	-2	0.27	-2	0.38**	-4	0.43**	2
Price index for input materials in construction: crushed sand for concrete	-0.38**	-2	-0.38**	-2	-0.40**	-2	-0.39**	-2	-0.44**	4
Price index for input materials in construction: bricks	-0.46**	-2	-0.45**	-2	-0.44**	-2	-0.46**	2	-0.50**	3
Price index for input materials in construction: iron	0.30*	1	0.31*	1	0.31*	1	0.42**	3	0.25	2
Price index for input materials in construction: gravel	-0.35**	-3	-0.36**	-3	-0.40**	-3	-0.35**	0	-0.39**	1
Price index for input materials in construction: sand	-0.33*	-3	-0.33*	-3	-0.36**	-3	-0.32*	0	-0.36**	1
Price index for input materials in construction: gravel and sand	-0.34*	-3	-0.34*	-3	-0.37**	-3	-0.34**	0	-0.37**	1
Price index for input materials in construction: steel	0.37**	4	0.37**	4	0.37**	4	0.46**	4	0.31*	3
Price index for input materials in construction: cement	-0.36**	0	-0.36**	0	-0.38**	0	-0.32*	-4	-0.40**	-4
Price index for input materials in construction: asphalt	0.36**	2	0.36**	3	0.35**	2	0.40**	4	-0.20	-3
Price index for input materials in construction: fuel	-0.31*	-4	-0.33*	-4	-0.36**	-4	0.36*	4	-0.30*	-2
International commodity prices: Brent crude oil (EUR)	0.35**	1	0.36**	1	0.37**	1	0.42**	4	-0.19	-4
International commodity prices: Crude oil futures (EUR)	0.32*	1	0.32*	1	0.34*	1	0.38**	4	0.17	3
International commodity prices: West Texas intermediate oil price (EUR /Barrel)	0.31*	1	0.31*	1	0.34*	1	0.38**	4	0.17	3
Share price: Vassilico Cement Works	0.46**	-4	0.47**	-4	0.49**	-4	0.30*	-3	0.46**	-2
Share price: Cyprus Cement	0.17	-3	0.18	-3	0.17	-3	-0.22	1	0.26	-3

TABLE A5 (continued)

Indices, overall	w=12		w=20		w=40		CBC		EUROSTAT	
Macroeconomic series	Correlation [1]	Lag/lead [2]	Correlation [1]	Lag/lead [2]	Correlation [1]	Lag/lead [2]	Correlation [1]	Lag/lead [2]	Correlation [1]	Lag/lead [2]
Building permits authorised (value in EUR)	0.29*	-3	0.29*	-3	0.29*	-3	0.44**	-2	0.28	-2
Building permits authorised (number)	0.45**	0	0.45**	0	0.43**	0	0.29*	0	0.42**	0
Building permits authorised (area in square metres)	0.38**	-2	0.37**	-2	0.36**	-2	0.52**	-2	0.41**	-4
Transfers of sales, total amount accepted by the Department of Lands and Surveys	0.17	-3	0.18	-3	0.17	-3	-0.14	4	0.19	-4
Transfers of sales, total amount declared at the Department of Lands and Surveys	0.10	-2	0.10	-2	0.10	-2	0.10	-4	0.18	-4
Total number of transfers of sales (Number of cases, Department of Lands and Surveys)	0.08	-2	0.08	-2	0.08	-2	0.10	3	0.17	4
Total number of parcels (Number of items, Department of Lands and Surveys)	0.09	-2	0.09	-2	0.09	-2	0.11	-3	0.19	4
Sale contracts (Number, Department of Lands and Surveys)	0.27	-2	0.27	-2	0.27	-2	0.23	-2	0.31*	-2
Housing loans (outstanding amounts)	-0.28	-4	-0.28	-4	-0.29*	-4	-0.21	-1	-0.40**	-4
Interest rates on euro-denominated loans (new business): lending for house purchase	-0.19	1	-0.20	1	-0.22	-2	0.19	3	-0.18	1
Economic Sentiment Indicator	0.74**	-3	0.73**	-3	0.67**	-3	0.86**	-4	0.84**	0
Confidence Indicator, construction	0.78**	-2	0.77**	-2	0.72**	-2	0.85**	-3	0.81**	1
Assessments of firms in construction: building activity over the past three months	0.78**	-2	0.77**	-2	0.72**	-2	0.87**	-1	0.86**	1
Assessments of firms in construction: current overall order books	0.74**	0	0.73**	0	0.69**	0	0.80**	2	0.73**	4
Expectations of firms in construction: selling prices over the next three months	0.73**	-1	0.72**	-1	0.69**	1	0.84**	-2	0.86**	0
Expectations of firms in construction: number of employees over the next three months	0.72**	-3	0.71**	-3	0.64**	-3	0.87**	-4	0.82**	0
Intentions of consumers: buy or build a house over the next 12 months	0.41**	4	0.41**	4	0.41**	4	0.35*	3	-0.59**	-4
Intentions of consumers: spend large amounts on home improvements or renovations over the next 12 months	0.34*	3	0.35*	3	0.35*	3	0.43**	1	0.33*	1

Notes: [1] The symbols * and ** denote statistical significance of the correlation coefficient at 10% and 5% level, respectively.
[2] Positive and negative numbers denote leads and lags, respectively.

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