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Real Estate Market: A Hedonic Pricing Model as a tool for real estate valuation

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Εισαγωγή

- Ένας από τους σημαντικότερους κλάδους οικονομικής δραστηριότητας είναι αυτός της διαχείρισης ακίνητης περιουσίας. Ο λόγος για τον οποίο συμβαίνει αυτό δεν είναι άλλος από το γεγονός ότι ο κλάδος ακίνητης περιουσίας επηρεάζει ταυτόχρονα την πραγματική οικονομία, το τραπεζικό σύστημα και τη χρηματοπιστωτική σταθερότητα και τέλος αλλά όχι λιγότερο σημαντικό, τα δημόσια έσοδα.
- Ο δίαυλος μέσω του οποίου ο κλάδος ακίνητης περιουσίας επηρεάζει την πραγματική οικονομία είναι είτε μέσω της οικονομικής / περιουσιακής κατάστασης των νοικοκυριών είτε μέσω του κλάδου των κατασκευών. Αρχικά τα νοικοκυριά επενδύουν σημαντικό μέρος του συνολικού τους πλούτου σε ακίνητα και παράλληλα αφιερώνουν σημαντικό μέρος του διαθέσιμου εισοδήματος τους στην εξυπηρέτηση των στεγαστικών τους δανείων. Απότομες μειώσεις στις τιμές των ακινήτων ή αυξήσεις στο ύψος της μηνιαίας δόσης του στεγαστικού τους δανείου επηρεάζουν άμεσα τα επίπεδα κατανάλωσης του ιδιωτικού τομέα και άρα τους ρυθμούς μεταβολής του ΑΕΠ. Παράλληλα ο κλάδος των κατασκευών οικιστικών ακινήτων είναι άμεσα συνδεδεμένος με την πορεία του κλάδου ακίνητης περιουσίας και ο οποίος με τη σειρά του ασκεί έντονες πολλαπλασιαστικές επιδράσεις στην οικονομική δραστηριότητα. Ταυτόχρονα, ο κλάδος ακίνητης περιουσίας συνδέεται άμεσα με την πιστωτική επέκταση και την πορεία του τραπεζικού κλάδου. Στις ανοδικές φάσεις του κύκλου των ακινήτων οι τράπεζες χαλαρώνουν τα πιστωτικά τους κριτήρια επιτρέποντας στα νοικοκυριά να αυξήσουν τη δανειστική τους μόχλευση γεγονός το οποίο όταν η πορεία του κύκλου αντιστραφεί, οδηγεί σε αύξηση των μη-εξυπηρετούμενων δανείων και κατά συνέπεια πτώση του τραπεζικού δείκτη κεφαλαιακής επάρκειας. Τέλος σε περιόδους άνθισης των συναλλαγών δημιουργούνται πολλαπλές πηγές δημοσίων εσόδων, οι οποίες περιορίζονται δραστικά μόλις αντιστραφεί η πορεία των τιμών και των συναλλαγών.
- Για όλους αυτούς τους λόγους στην Τράπεζα Πειραιώς έχουμε εκπονήσει μια σειρά μελετών αναφορικά με την παρακολούθηση του οικονομικού κύκλου της αγοράς ακινήτων και έχουμε αναπτύξει πλήθος βραχυχρόνιων και μακροχρόνιων προβλεπτικών υποδειγμάτων.
- Στην παρούσα μελέτη χρησιμοποιούμε στοιχεία από αγοραπωλησίες ακινήτων, προκειμένου να εκτιμήσουμε ένα ιδιάζον στατιστικό μοντέλο το οποίο μας επιτρέπει να αποσυνθέσουμε τη συνολική τιμή πώλησης ενός ακινήτου στα επιμέρους χαρακτηριστικά του, δηλαδή τον αριθμό των τετραγωνικών, την τοποθεσία, αριθμό δωματίων, τύπο θέρμανσης, έτος κατασκευή κλπ.

Source: Piraeus Bank Research

Βασικά Συμπεράσματα

- Στα βασικά ευρήματα της ανάλυσής μας είναι ότι η προσέγγιση hedonic pricing, δηλαδή η ιδέα του διαχωρισμού της τιμής πώλησης ενός ακινήτου στα υποκείμενα χαρακτηριστικά του, όπως η τοποθεσία, το μέγεθος σε τετραγωνικά μέτρα (τμ), το είδος του ακίνητου καθώς και οι ανέσεις που παρέχει όπως ο τύπος θέρμανσης, η πισίνα κ.λπ., υποστηρίζεται από τα διαθέσιμα δεδομένα, καθώς το μοντέλο μας είναι σε θέση να εξηγήσει το 82% της μεταβλητότητας των τιμών των ακινήτων σε όλη την Ελλάδα. Πιο συγκεκριμένα τα βασικά συμπεράσματα της ανάλυσης είναι τα ακόλουθα:
- Υπάρχει μια θετική αλλά ανελαστική σχέση μεταξύ του μεγέθους του ακινήτου και της αξίας πώλησής του ούτως ώστε η τιμή ανά τμ μειώνεται όσο αυξάνεται το μέγεθος του ακινήτου, δηλαδή σε ένα ακίνητο 100 τμ η τιμή ανά τμ = 1606 € ενώ σε ένα ακίνητο 50 τμ η τιμή ανά τμ = 1722 €.
- Οι μονοκατοικίες έχουν 6% υψηλότερη τιμή έναντι των διαμερισμάτων, ενώ οι μεζονέτες εκτιμώνται 7% χαμηλότερα.
- Πρόσθετες ανέσεις όπως πισίνα, αυτόνομη θέρμανση, σύνδεση φυσικού αερίου ή ύπαρξη χώρου στάθμευσης / αποθηκευτικού χώρου μπορούν να αποφέρουν ενίσχυση της εκτιμώμενης αξίας μεταξύ 7,5% (στάθμευση) έως 25% (πισίνα) έναντι μιας πανομοιότυπης ιδιοκτησίας που δεν έχει αυτές τις ανέσεις.
- Επιπλέον η παλιά παροιμία «τοποθεσία, τοποθεσία, τοποθεσία» ισχύει και στην περίπτωση των ελληνικών ακινήτων. Τα ακίνητα στα νησιά των Κυκλάδων έχουν υψηλότερη αξία κατά 38% και στα Νότια Προάστια της Αθήνας κατά 36% έναντι ενός ακινήτου με τα ίδια χαρακτηριστικά στο κέντρο της Αθήνας. Αντίθετα, στα ακίνητα που βρίσκονται στη Θεσσαλία ή τη Μακεδονία η τιμή πώλησης είναι 43% και 50% αντίστοιχα χαμηλότερη έναντι ενός ακίνητου στο Κέντρο της Αθήνας.
- Τελευταίο αλλά εξίσου σημαντικό εύρημα όσον αφορά τον διαχωρισμό της τιμής του ακινήτου είναι ότι το μέγεθος του σπιτιού, η τοποθεσία, ο αριθμός των υπνοδωματίων και των μπάνιων καθώς και τα χαρακτηριστικά ενεργειακής απόδοσης (ηλιακός λέβητας, αυτόνομη θέρμανση και φυσικό αέριο) συμβάλλουν τα μέγιστα στην αποτίμηση από πλευράς πώλησης. Μια πιο ήπια σχετική συνεισφορά προκύπτει από τον τύπο του σπιτιού, τον χώρο στάθμευσης/αποθήκη και τον αριθμό των ανέσεων που παρέχονται με το σπίτι.
- Είναι πολύ ενδιαφέρον ότι η ηλικία του ακινήτου, η βαθμολογία ενεργειακού πιστοποιητικού (EPC) και ο όροφος δεν παίζουν πολύ σημαντικό ρόλο για την τιμή πώλησης, παρά το γεγονός ότι αν ληφθούν υπόψη μεμονωμένα έχουν μεγάλο αντίκτυπο στην αξία του ακινήτου.

Source: Piraeus Bank Research

Introduction

- Of all the sectors of economic activity, the real estate sector and in particular the residential real estate exerts a disproportional impact on economic activity and as such merits special attention from all stakeholders i.e. economic policy authorities, banking sector supervisors, monetary policy authorities as well as the commercial banking sector.
- The reason why the residential real estate sector's boom-bust cycles are propagated across the economy and can define the economic trajectory for a number of years is because the real estate sector is able to affect the real economy, the banking sector and financial stability and finally public sector's revenues and the overall position of public finances.
- Starting from its impact on the real economy, households invest a substantial amount of their entire life-time wealth in their real estate assets. Furthermore, they devote a substantial portion of their annual disposable income to servicing their mortgage debt. As a result, fluctuations in the valuations of their houses can create substantial wealth effects, while changes in the cost of servicing their mortgage loans (due to i.e higher policy rates) have an immediate impact on households' disposable income. Both these wealth and income factors affect households' consumption and consequently the level of economic activity and GDP growth (or contraction)
- On top of this direct effect, real estate developments affect economic activity indirectly through the construction sector. New residential real estate developments count directly as the investment (more officially gross fixed capital formation) component of GDP. Furthermore, construction is a highly labour intensive activity, linked to many other sectors in the economy, As such, boom or bust in residential real estate and construction could have a substantial impact on both activity and employment.
- Turning to real estate's impact on banking sector and financial stability, the interaction between house prices and bank lending should be all too well understood by now: Higher house prices create a fear of missing out (FOMO), forcing households to increase their leverage while banks are willing to extend more credit because they take comfort from higher collateral values. This leverage, in turn feeds into a new round of higher prices until an economic slowdown or a policy intervention (i.e. tighter monetary policy) or both, put the cycle into reverse with households facing difficulties servicing these larger mortgages and being unable to deleverage because of negative equity. This in turn leads to higher defaults, banking sector losses, demands from supervisors for higher capital ratios and ultimately financial stability concerns.

Source: Piraeus Bank Research

Introduction

- Last but not least in this catalogue of real estate worries is the impact of a real estate boom-bust cycle on public sector finances. On the boom part of the cycle, construction activity and real estate transactions create an abundance of fiscal revenues only for these to evaporate as soon as boom turns into bust. All too often their deterioration in public sector revenues coincides either with an economic recession (due to construction slowdown) or with a need to support the banking sector (due to real estate related loan losses) or both.
- For all those reasons, monetary policy authorities monitor developments in the real estate market quite closely and impose many regulatory limits on commercial banks' mortgage lending activity and conduct frequent and strict stress tests.
- From our side at Piraeus bank we have published an number of studies aimed at better understanding either the developments of the real estate cycle at macroscopic level or at estimating equilibrium real estate levels and forecasting real estate prices in the short and long –run.
- In the current paper, we use a new rich dataset regarding real estate sales to examine the relationship between house prices and the underlying characteristics of these properties. More specifically, we use a hedonic pricing modelling approach to decompose the value of each property (or to be more precise its asking value, given that we use data related to sales) to the implicit (of shadow) price of each and every of the property's characteristics i.e. its size in m^2 , the number of bedrooms , bathrooms, geographical location across Greece, the existence of additional amenities such as parking or storage space, swimming pool, autonomous heating, energy certificate etc.
- Once we have estimated the price of each characteristic in our database, the (asking) price of each property can be estimated as the sum of the value of its underlying parts.
- In other words, by using a hedonic model and data provided by real estate sales, we can calculate the price per square meter, for example of a flat on the 1^{st} floor of an apartments building built in 2002, 100 square meters in size, with two bedrooms, one bath, parking or storage space, solar boiler, secure door and autonomous heating that is located in central Athens and with issued Energy Certificate (ECP) "class G" . At the same time we can estimate how much the same property would had cost if it was on the 2^{nd} or 5^{th} floor or if it had an EPC A+ or if it was located in an another region of Greece.

Source: Piraeus Bank Research

Key Findings

The key finding of our analysis is that our hedonic modelling approach, i.e. the idea of decomposing a property's asking price to its underlying attributes and characteristics such as location, size, property type plus other amenities such as heating type, pool etc., is supported by the data, given that our model is able to explain 82% of the variability of property prices across Greece. More specifically we find that

- There exist a positive but relatively inelastic relationship between property size and sell price so that price per m^2 is a decreasing function of a property's area, i.e. for typical 100 m^2 the price/ m^2 = €1606 while for a 50 m^2 property the price / m^2 =€1722.
- Detached properties command a 6% premium over flats, while maisonettes a 7% discount.
- Extra amenities such as a pool, autonomous heating, natural gas connection or the existence of a parking / storage space can command a premium between 7.5% (parking) to 25% (pool) versus an identical property lacking these amenities.
- Furthermore, the old adage "location, location, location" holds in the case of Greek real estate. Properties in the Cycladic Islands command a 38% price premium and in the South Athens Suburbs a 36% premium over a comparable property in Central Athens.
- Conversely, properties located in Thessalia or Macedonia face a 43% & 50% discount over Central Athens.
- Last but not least, in terms of property price decomposition the house size, location, the number of bedrooms and bathrooms and energy efficiency attributes (solar boiler, autonomous heating and natural gas) contribute the most in a property's sell-side assessment.
- A milder relative contribution is obtained from the house type, parking/ storage place and number of amenities provided with the house.
- Quite interestingly, the property's age, EPC score and floor level do not play a very important role for the sale price despite the fact that if considered individually have a large impact on the property's value.

Source: Piraeus Bank Research

1 **Data Description and Summary Statistics of our Properties' Sample**

2 Hedonic Pricing Model: Methodology

3 Hedonic Pricing Model: Results & Interpretation

4 Hedonic Pricing Model: Decomposition of Property Attribute Importance in Sales Value

Data Description: Database statistics

Our database spans information on asking prices and home attributes for properties that are located in Greece and were recorded in the year 2021.

The full dataset provides information on property characteristics for 74,829 observations such as:

- geographic location characteristics,
- size in square meters,
- construction year and refurbishment year,
- house type,
- floor level,
- number of bathrooms and bedrooms,
- binary variables for the existence of parking, garden, autonomous heating, air-conditioning, solar boiler, pool, awning, elevator and private terrace,
- energy class of the house ranking house properties on a scale from G|H (lowest energy class characterization) to A+ (highest energy class).

Data Description: Database Statistics & Final Sample Selection

Database (# properties) 74,829

Fig.6 **Asking Price Distribution** (total value, € 000)

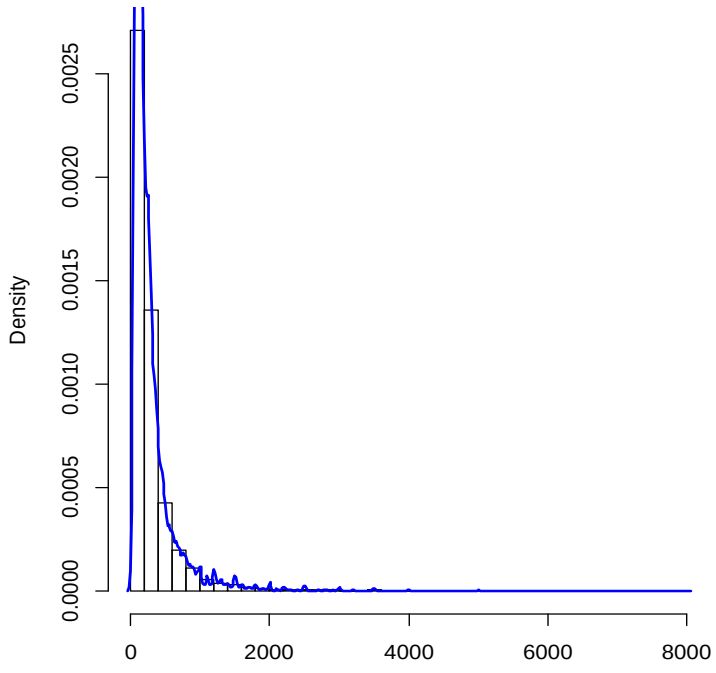


Fig.7 **Real Estate Property Area** (m^2)

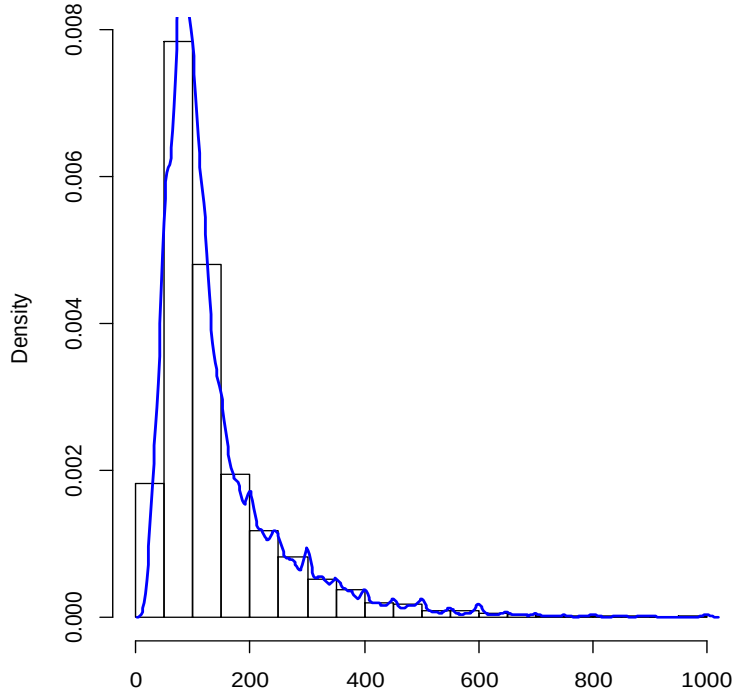
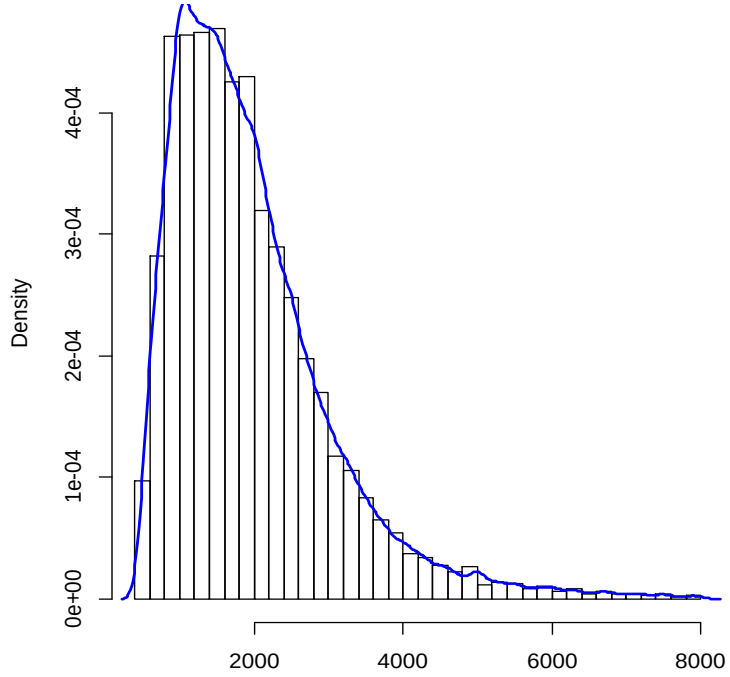


Fig.8 **Asking Price Distribution** (€ per m^2)



Source: Piraeus Bank Research

Data Description: Final Sample Selection

Fig.4 **Number of Bedrooms** (#)

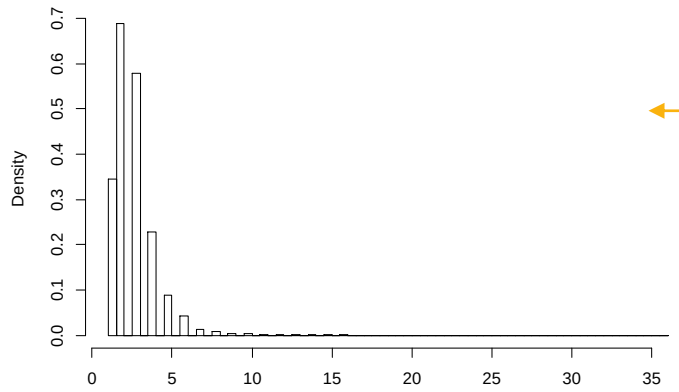
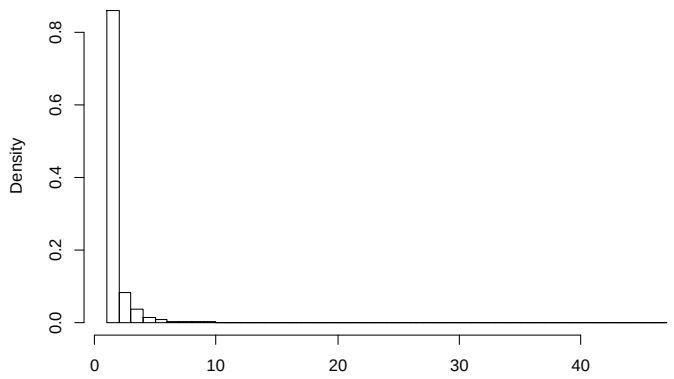
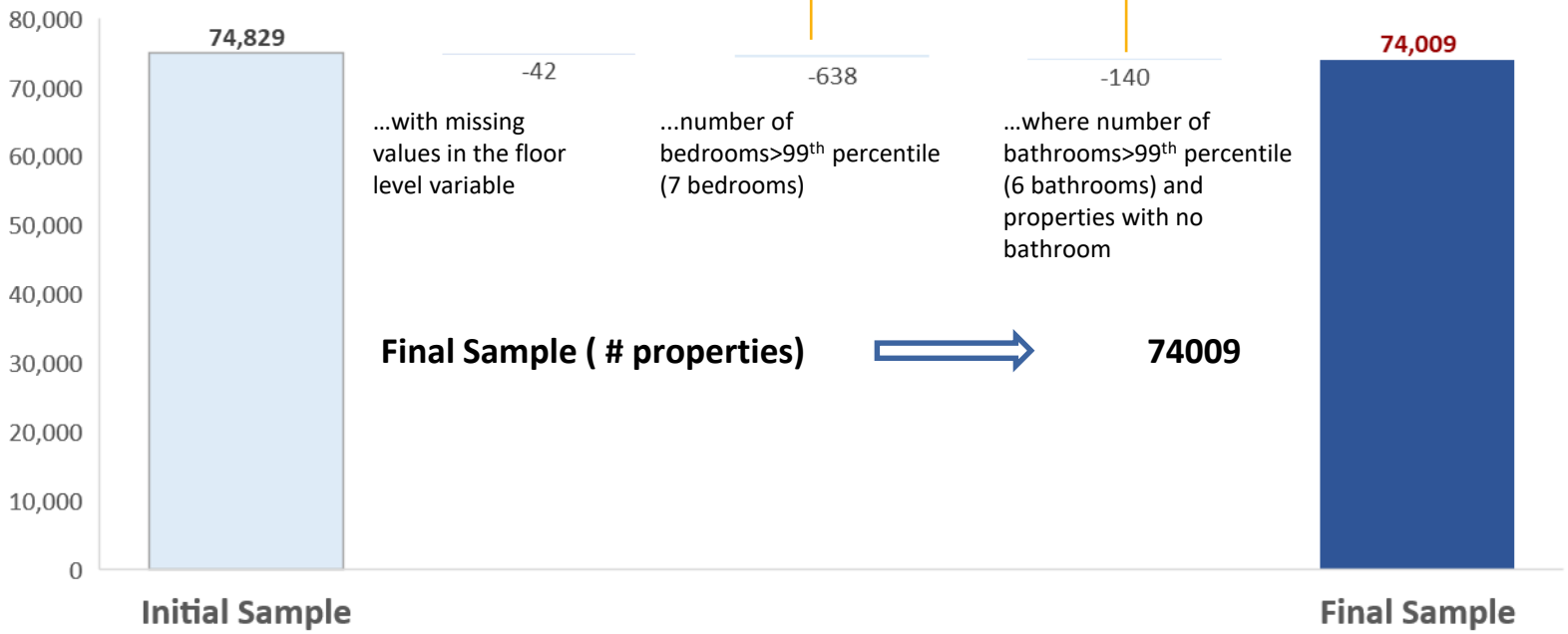


Fig.5 **Number of Bathrooms** (#)





…with missing values in the floor level variable

...number of bedrooms>99th percentile (7 bedrooms)

…where number of bathrooms>99th percentile (6 bathrooms) and properties with no bathroom

Final Sample (# properties) ⇒ **74009**

- Out of the initial 74,829 observations, 820 observations were deleted due to misreported data.
- The final sample utilized in the hedonic pricing model includes 74,009 properties.

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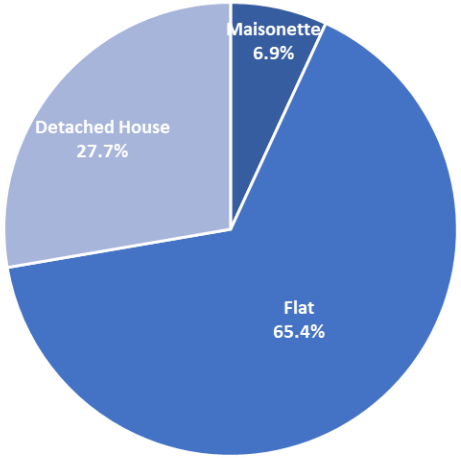
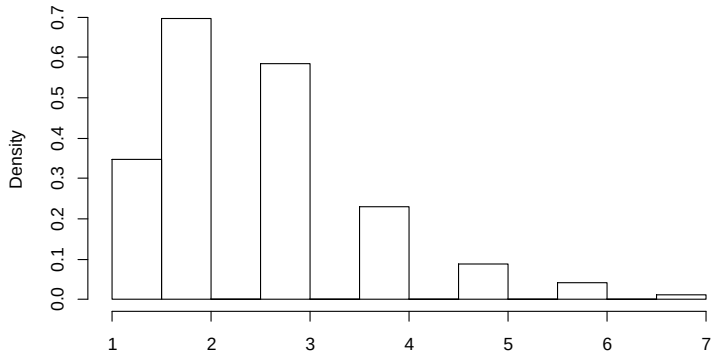
Source: ELSTAT, Piraeus Bank Research

Data Description: Main Characteristics of the Final Sample (74,009 properties)

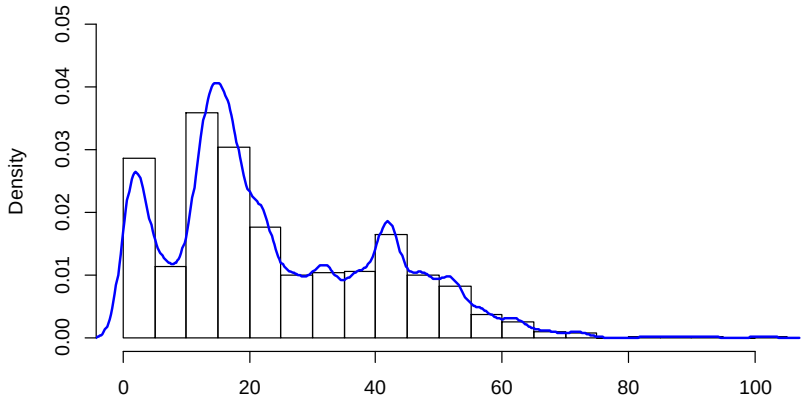


- The majority of the sample's house type are flats
- The median age of the real estate property for sale is 24 years but there is a 16 % of the houses that are refurbished
- The majority of the houses has 2 or 3 bedrooms and 1or 2 bathrooms

Number of Bedrooms (#) – Distributions

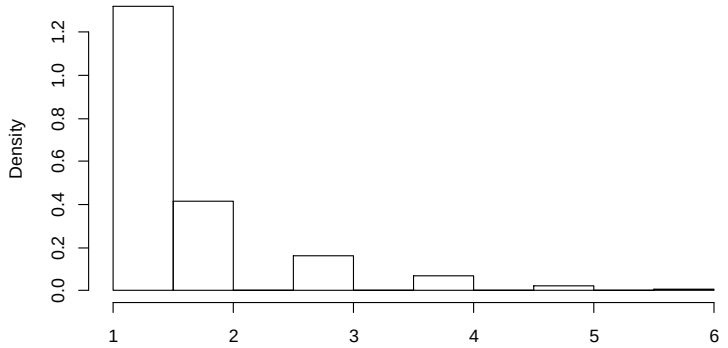


Real Estate Property Age (in years) **- Distribution**



...of which

Number of Bathrooms (#) – Distributions



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Source: Piraeus Bank Research

Data Description: Final Sample Statistics

Database (# properties) 74,009

Fig.6 **Asking Price Distribution** (total value, € 000)

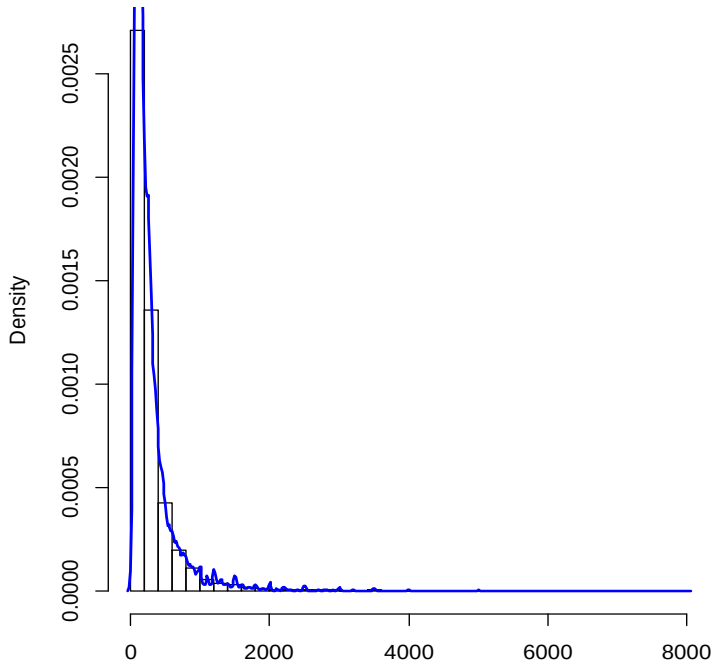


Fig.7 **Real Estate Property Area** (m^2)

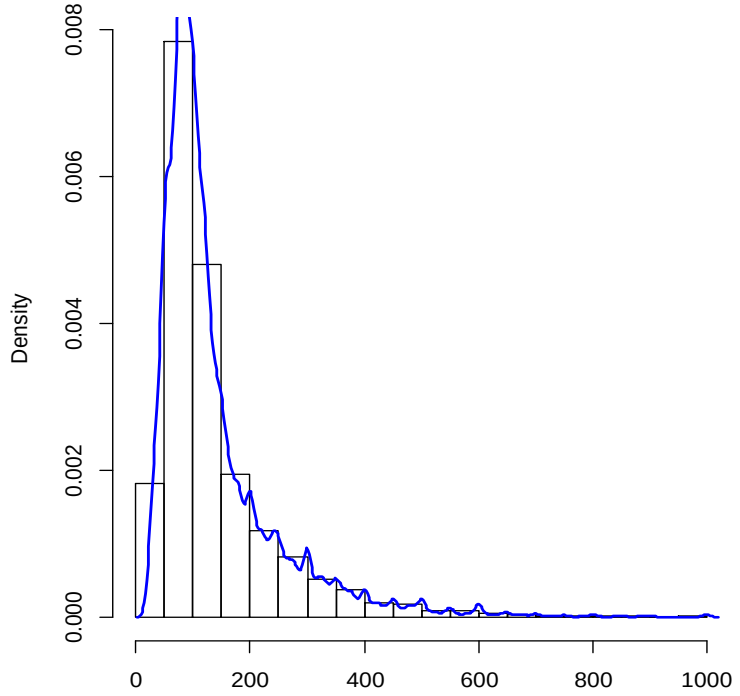
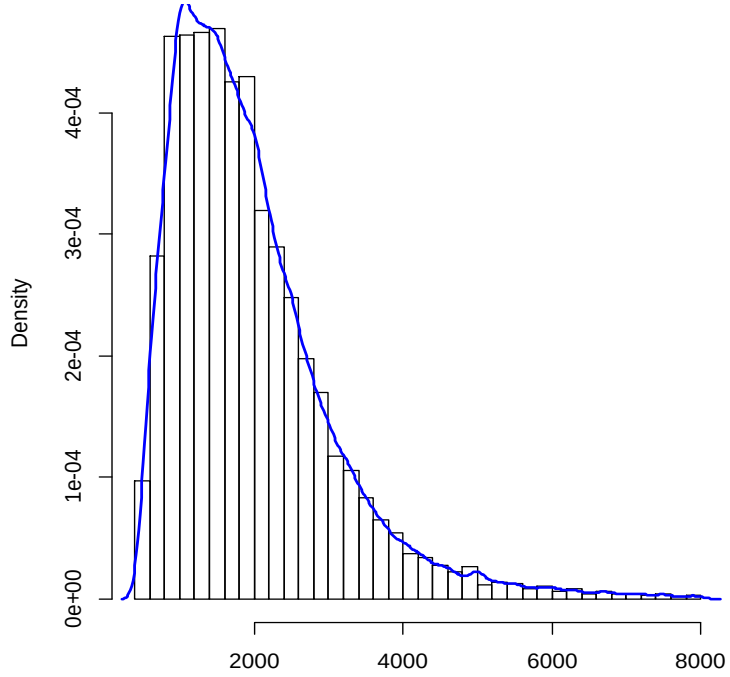


Fig.8 **Asking Price Distribution** (€ per m^2)



Variable	Average	std. dev.	Min	Q25	Median	Q75	Max
Price in 000's €	290	354.54	12	100	185	330	8000
Area in sq. meters	139	106.77	24	75	104	160	1000

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Source: Piraeus Bank Research

Characteristics of the Sample: Geographical Location & House Attributes

Fig.9 **Geographical Allocation:** Final Sample (% of the total 74,009 properties)

- The vast majority of home sales refers to the mainland and especially in Attica, where c.58% of the properties for sale is located.

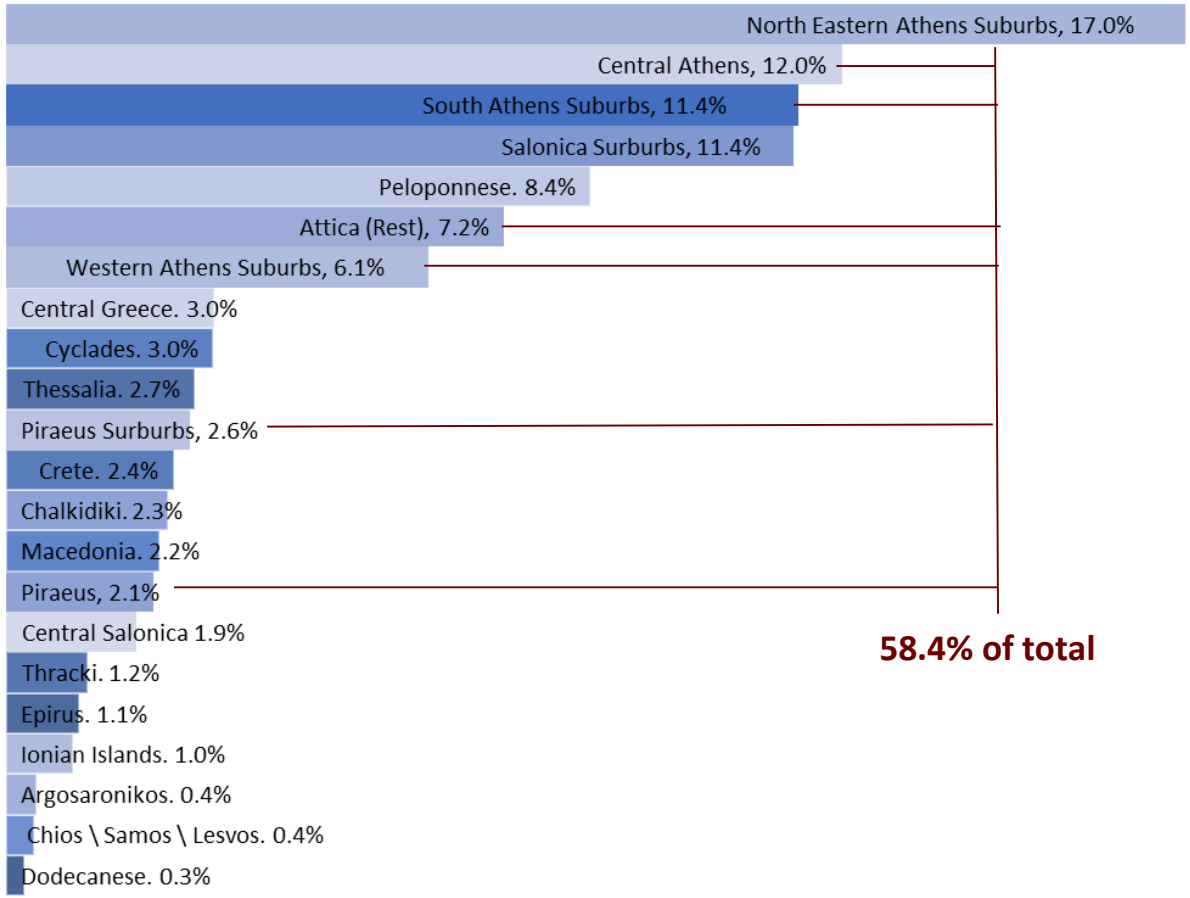
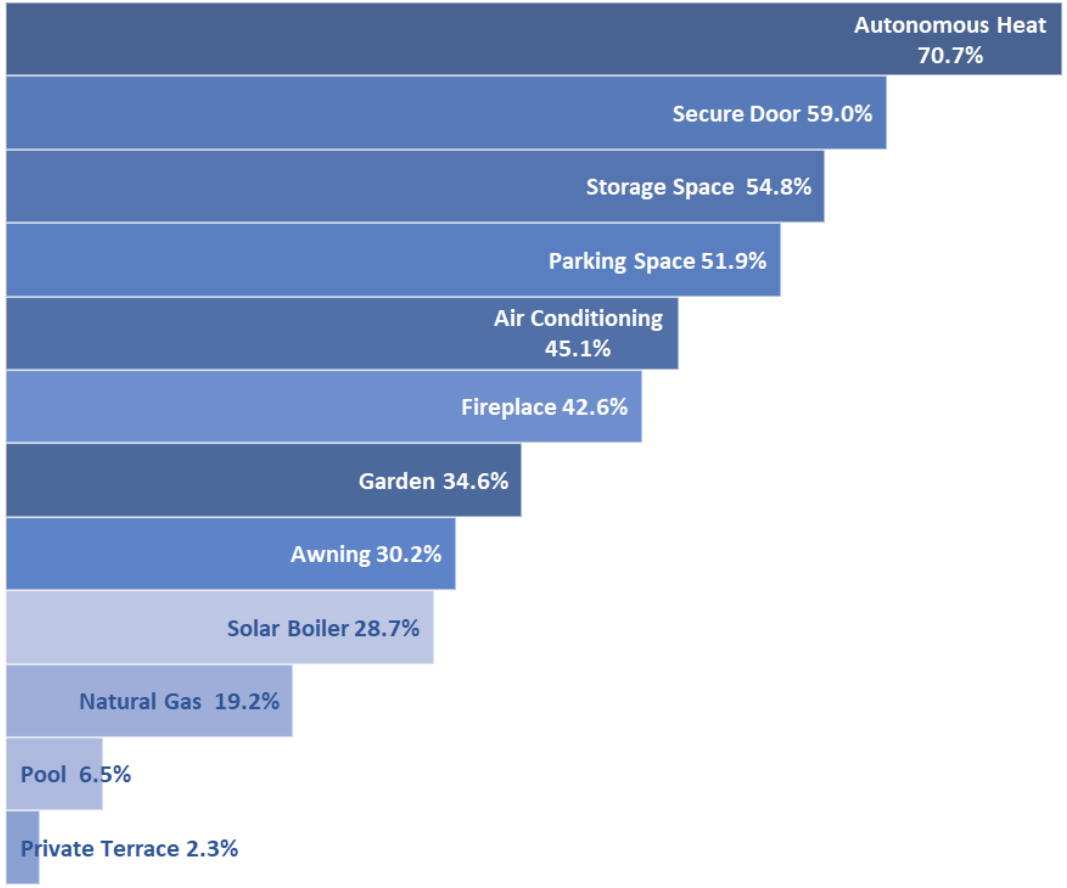


Fig.10 **House Attributes:** Final Sample (% of the total 74,009 properties)

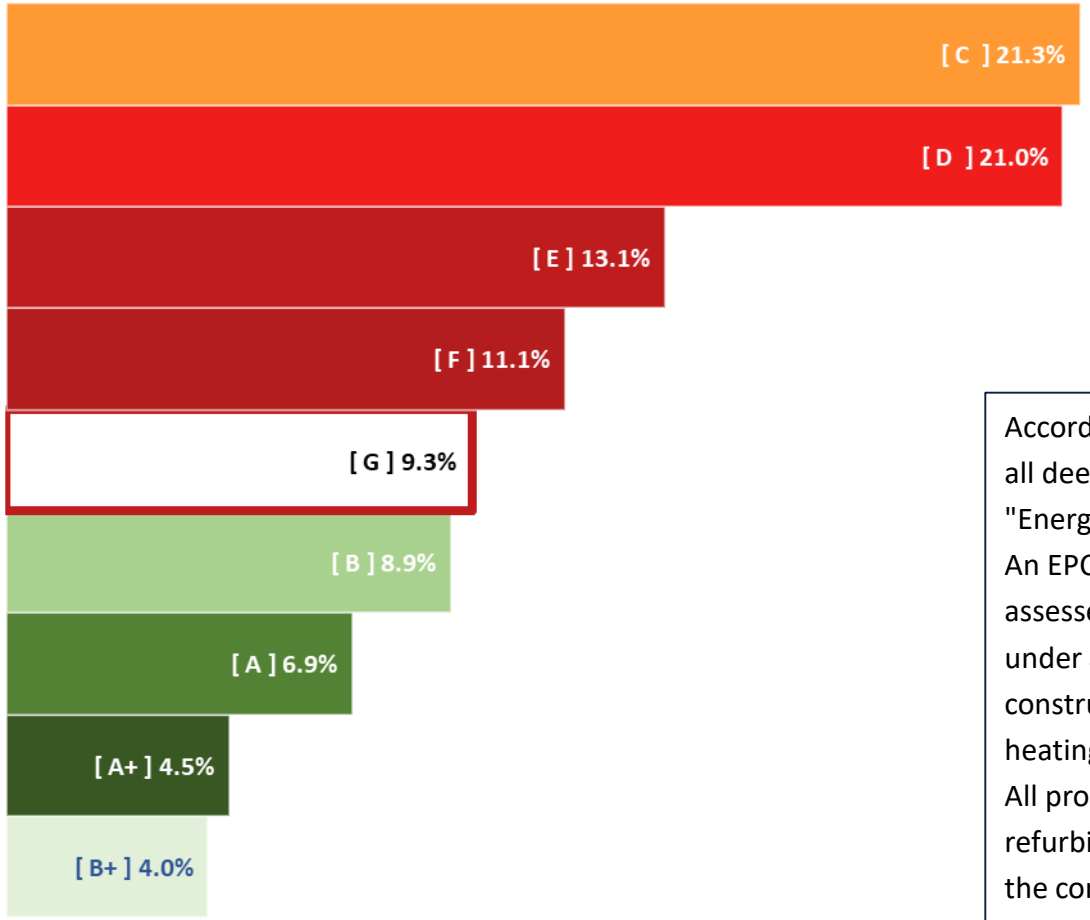
- The vast majority of home sales (c. 70%) refers to properties with autonomous heating. However c.20% of the properties rely on natural gas and only c.30% have a solar boiler.
- Almost half of the sample has access to storage and parking space.
- Finally the sample contains 6.5% of luxury houses with a pool.



Source: Piraeus Bank Research

Characteristics of the Sample: Energy Performance Certification [EPC]

Fig.11 **Energy Performance Certification:**
Final Sample (% of the total 74,009 properties)



- In the sample, c.20% of the properties have been issued an EPC: [F] or [G] meaning that are considered as properties built before 1979 with very low energy consumption efficiency, incurring significant costs for the owner.
- In the middle category, with EPC scores [C], [D] and [E] lies 55% of the sampled properties related to properties built after 1979 under the thermal insulation regulation.
- The remaining 25% of the properties have been issued an EPC: [B] to [A+] indicating new modern properties accompanied by ideal technical characteristics in energy performance.

According to the Greek Law, effective as of January 9, 2012 when selling and of July 9, 2011 when renting, all deeds of conveyance and rental agreements for existing buildings are complete and valid only after an "Energy Performance Certificate" is issued and submitted to the Greek Tax Office or notary public.
An EPC is a certificate accredited by the Greek Ministry of Environment & Energy (YPEN), on which the assessed building's (building unit's) energy performance is described. On the EPC, the building is classified under an "energy class", ranging from A+ to G, depending on its overall energy performance, based on the construction of the building envelope as well as the building services systems used to provide space heating, cooling, domestic hot water, ventilation, lighting.
All properties in the sample are accompanied by an EPC since its issuance is mandatory for all new built and refurbished buildings (including those with floor area below 50 sqm.) as well as all existing buildings after the completion of a major refurbishment or a purchase / sale or rental, of an entire building or part of a building. In addition, the issue of EPCs is mandatory for house owners wishing to apply for funding under the "Energy Efficiency at Household Buildings Program".

Source: Piraeus Bank Research

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Hedonic Pricing Model: Methodology I

To assess the asking price of a property as a function of its underlying characteristics, we employ the following semi-logarithmic (or log-linear) statistical hedonic functional form:

Equation 1: $$Asking\ Price_i = \exp(\beta_0 + \beta_1 \mathrm{X}_{1,i} + \beta_2 \mathrm{X}_{2,i} + \cdots + \beta_k \mathrm{X}_{k,i} + \varepsilon_i)$$

or

Equation 2: $$\ln(Asking\ Price_i) = \beta_0 + \beta_1 \mathrm{X}_{1,i} + \beta_2 \mathrm{X}_{2,i} + \cdots + \beta_k \mathrm{X}_{k,i} + \varepsilon_i$$

The log – linear form has several useful properties:

(i) Its estimated parameters have an intuitive interpretation in the form of what is the % change in the asking price of a property if we change by one unit an explanatory characteristics i.e. what is the % change in price when we add an extra bedroom or a parking space,

(ii) it allows for a curved (i.e. non-linear relationship between asking price and characteristics, i.e. price and size of the property and

(iii) it allows for a simple additive relationship between a property's sale value and its features.

The principal advantage when using this specification is that it allows the value of a given attribute (the number of bathrooms, for example) to vary proportionately with the value of other characteristics (the number of bedrooms).

Source: Piraeus Bank Research

Hedonic Pricing Model: Methodology II

- Given the aforementioned model we run a simple OLS regression of the natural logarithm of a house property offer value on various house attributes related to the property's type, characteristics, energy certificate and geographic location. We compute robust standard errors employing White's variance-covariance matrix to account for heteroscedasticity.
- Given that we estimate the model in log-linear form (see equation 2) the marginal value of each characteristic is retrieved as $[\exp(\beta_i) - 1] \times 100$ representing the percentage change in a property's value from a change in one of its attributes given that all other features of the property remain the same.
- For dummy variables - that take the values of 1 or 0 - the % change in the asking value of a property from the existence of this characteristics refers to the value difference versus a benchmark case. For example the beta coefficient for the dummy variable "pool" indicates the price difference of a property that has a pool relative to its reference case where there is no pool (i.e. existence of a pool versus no pool).

Hedonic Pricing Model: Model Specification & Variables [Table 1]

- Our regression model's independent variables can be categorized into four categories.

Equation 4 $$ln(Value) = \beta_0 + \beta_1\, Attributes\ + \beta_2\, Amenities + \beta_3\, Energy\ Certificate + \beta_4\, Geographic\ Region + \varepsilon$$

	House Attributes	Amenities	ECP	Geographical Region
a.	Natural logarithm of house size	Dummy variables indicating the existence of additional property amenities	Eight (8) Dummy variables represents each house energy classification, namely, A+, A, B+, B, C, D, E, F relative to the lowest energy efficiency score indicated by category G.	Twenty-two (22) dummy variables representing the location of each property relative to a property in Central Athens: 1. NE Athens Suburbs 2. South Athens Suburbs 3. Salonica Suburbs 4. Peloponnese 5. Attica (rest) 6. Western Athens Suburbs 7. Central Greece 8. Cyclades 9. Thessalia 10. Piraeus Suburbs 11. Crete 12. Chalkidiki 13. Macedonia 14. Piraeus 15. Central Salonica 16. Thraki 17. Epirus 18. Ionian Islands 19. Argosaronikos 20. Western Athens Suburbs, 21. Chios / Samos / Lesvos, 22. Dodecanese
b.	Floor level	Ten (11) Dummy variables indicating the existence of: 1. Fireplace 2. Solar Boiler 3. Air-conditioning 4. Secure Door 5. Garden 6. Private Terrace 7. Parking or Storage space 8. Awning 9. Pool 10. Autonomous heating 11. Natural gas		
c.	House age depending on construction year or recent refurbishment year.			
d.	House age squared to account for non-linear effect of house age			
e.	Dummy variable indicating that the house is refurbished			
f.	Dummy variables indicating if the property type is maisonette, detached house relative to flat.			
g.	Number of Bedrooms			
h.	Number of Bathrooms			

Source: Piraeus Bank Research

1 Data Description and Summary Statistics of our Properties' Sample

2 Hedonic Pricing Model: Methodology

3 Hedonic Pricing Model: Results & Interpretation

4 Hedonic Pricing Model: Decomposition of Property Attribute Importance in Sales Value

Hedonic Pricing Model: Regression Output [Table 2]

		House Attribute	Estimate	Std. Error	t-statistic	
	1	(Intercept)	7.770	0.021	371.41	***
A	2	log(Area)	0.899	0.005	164.37	***
	3	Floor Level	0.044	0.001	46.79	***
	4	House Age	-0.012	0.000	-34.38	***
	5	House Age^2	0.000	0.000	20.72	***
	6	Refurbished	-0.133	0.005	-25.66	***
	7	Bedrooms	0.007	0.002	2.79	**
	8	Bathrooms	0.038	0.003	14.64	***
B	9	Maisonette	-0.069	0.006	-11.83	***
	10	Detached House	0.059	0.005	11.47	***
C	11	Parking or Storage Space	0.076	0.004	20.65	***
	12	Fireplace	0.075	0.004	20.95	***
	13	Solar Boiler	-0.004	0.003	-1.12	
	14	Airconditioning	0.071	0.003	23.87	***
	15	Autonomous Heating	0.069	0.004	18.35	***
	16	Natural Gas	0.121	0.004	33.36	***
	17	Secure Door	0.043	0.003	12.76	***
	18	Garden	0.023	0.004	6.08	***
	19	Private Terrace	-0.011	0.009	-1.18	
	20	Awning	-0.005	0.003	-1.72	*
	21	Pool	0.256	0.007	34.83	***
D	22	A+	0.092	0.009	9.97	***
	23	A	0.073	0.008	8.90	***
	24	B+	0.079	0.009	8.71	***
	25	B	0.058	0.007	7.80	***
	26	C	0.042	0.006	6.61	***
	27	D	0.050	0.006	8.17	***
	28	E	0.040	0.006	6.22	***
	29	F	0.013	0.007	2.02	**

		House Attribute	Estimate	Std. Error	t-statistic	
	30	Dodecanese	0.116	0.037	3.12	***
	31	Epirus	-0.322	0.012	-26.06	***
	32	Thessalia	-0.433	0.009	-45.82	***
	33	Thraki	-0.390	0.013	-29.52	***
	34	Crete	-0.061	0.010	-6.02	***
	35	Cyclades	0.379	0.012	31.09	***
	36	Macedonia	-0.497	0.011	-46.48	***
	37	Chios/Lesvos/Samos	-0.217	0.023	-9.32	***
	38	Chalkidiki	-0.069	0.013	-5.51	***
	39	Argosaronikos	0.212	0.027	7.99	***
E	40	Ionian Islands	0.057	0.017	3.28	***
	41	Peloponnese	-0.424	0.007	-62.62	***
	42	Central Greece	-0.349	0.010	-35.32	***
	43	Central Salonica	-0.111	0.011	-10.22	***
	44	Salonica Surburbs	-0.363	0.006	-59.23	***
	45	Piraeus	-0.085	0.009	-9.68	***
	46	Piraeus Surburbs	-0.195	0.008	-23.93	***
	47	Attica (Rest)	-0.136	0.007	-18.20	***
	48	North Eastern Athens Suburbs	0.174	0.006	31.08	***
	49	Western Athens Suburbs	-0.174	0.006	-28.10	***
	50	South Athens Suburbs	0.362	0.006	63.17	***
	51	Adj. R squared	0.820			

Table 2 presents the estimated coefficients as well as their statistical significance and the adjusted R squared of the regression.

* : Statistical significance at 10%
** : Statistical significance at 5%
***: Statistical significance at 1%

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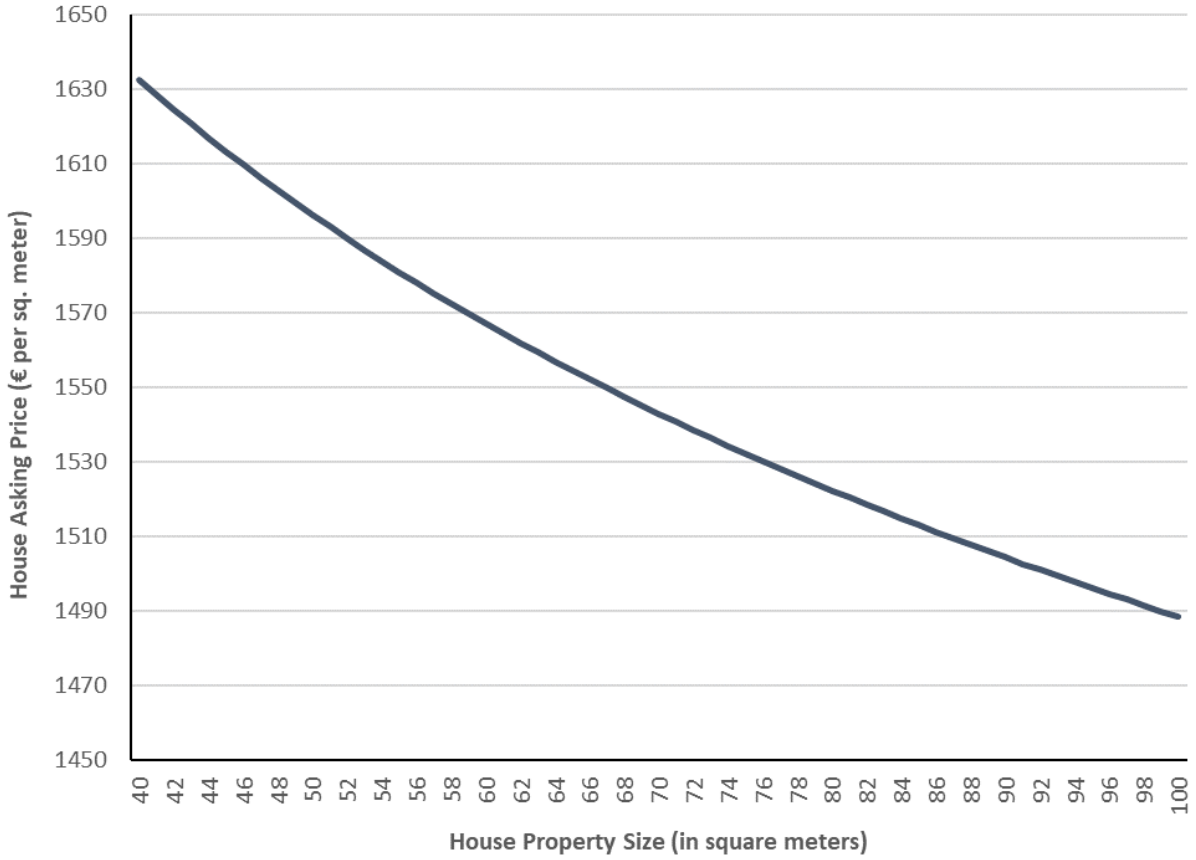
Source: Piraeus Bank Research

Hedonic Pricing Model - Section A: Area's disproportional effect

Fig.12 **House Asking Price** (€ per m^2) **Vs House Property Size** (in m^2)



There exist a positive but relatively inelastic relationship between property size and sell price so that price per m^2 is a decreasing function of a property's area.

The total price of a house increases by 0.9% when the area of the house increases by 1% *(Table 2, Section A: line 2)* but the price per m^2 is decreasing.

We set the benchmark as a flat in the 1st floor at the central of Athens with a EPS [G], assuming all other attributes remain constant.

If this flat is 100 m^2, then its hypothetical price is €160,607 i.e it costs €1606 per m^2

If this flat is 50 m^2, then its relative price is €86,112 i.e it costs € 1722 per m^2

Source: Piraeus Bank Research

Hedonic Pricing Model - Section A: Property's age non-linear effect

Fig.13 **House Asking Price** (€ per m^2) **Vs House Property Age** (in years)

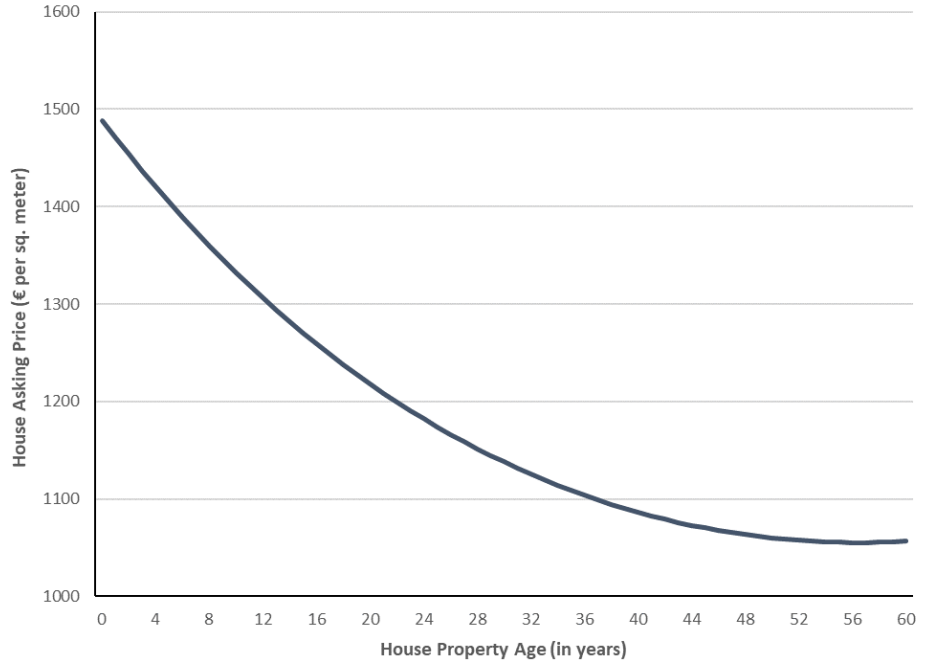
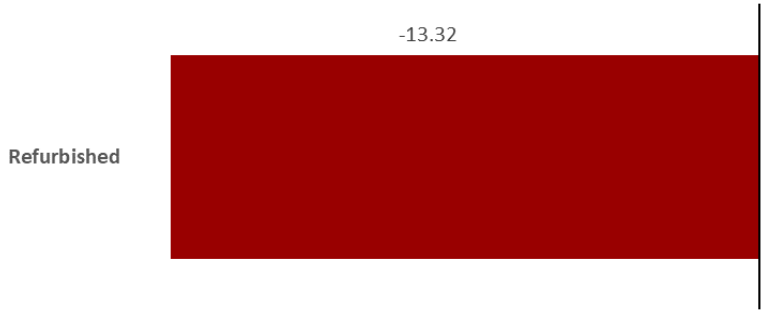


Fig.14 **Discount of property being Refurbished versus a new build at the same year**



A house's asking price and its age are inversely related but the relationship is nonlinear *(Table 2, Section A: lines 4-5)* as the price discount exhibits a slowdown as the property's age increases (i.e the discount is not proportional to its age increase).

We set the benchmark as a flat in the 1st floor in the central of Athens with a EPS [G]. Assuming all other attributes remain constant:

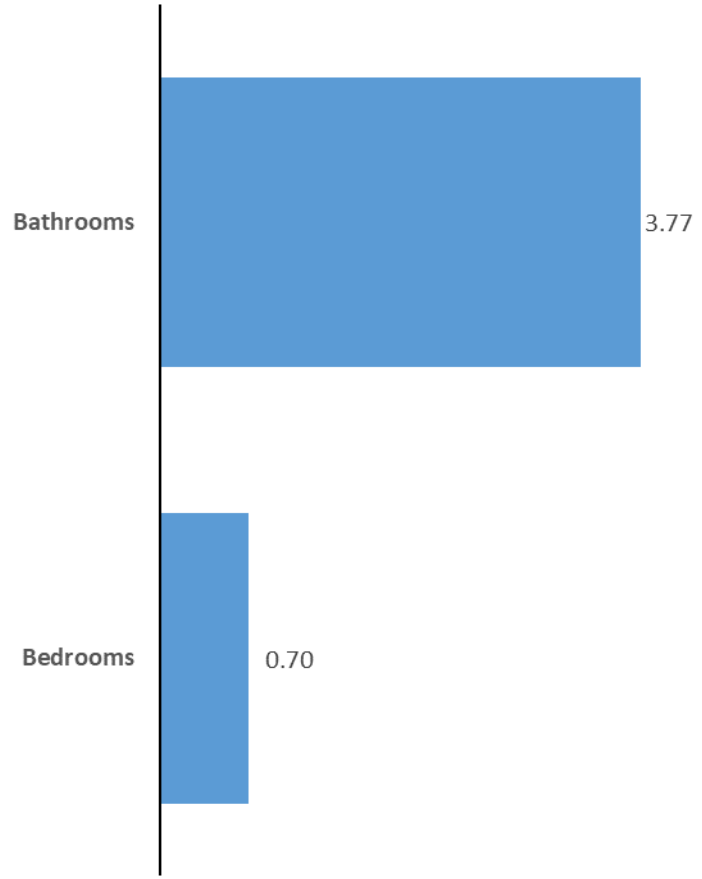
- a 10 year old flat is sold at a discount of 10.9% [C.1] relative to a new built flat, but
- a 20 year old flat is sold at a discount of 18.7% [C.2] relative to a new built flat.

The negative sign for the coefficient for the dummy variable indicating the property was refurbished *(Table 2, Section A: line 6)* might seem counter-intuitive. In fact, our convention in measuring house age by either construction year or recent refurbishment year might explain this. To be more concise consider an example of a house constructed in 2010 and a house refurbished in 2010 have the same age in our model. However, a refurbished house would be sold with a discount of 13.3% relative to a non-refurbished house of the same age according to our estimates which is logically consistent.

Source: Piraeus Bank Research

Hedonic Pricing Model - Section A: Remaining Property Characteristics

Fig.14 **Premium of property based on characteristics**



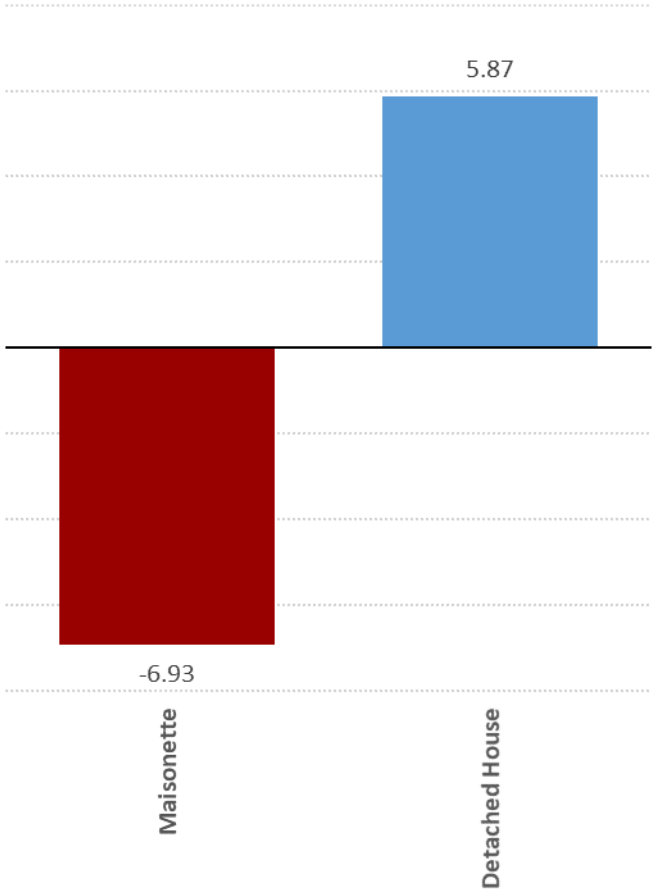
As expected both attributes display a positive relation to a house price as each extra bedroom adds a 0.7% mark-up in the property's value. Similarly assuming all other factors remain unchanged, an extra bathroom leads to a house value increase equal to 3.8%.

It should be noted that the number of bathrooms or bedrooms is positively correlated with a property's size as well as with each other. It is therefore natural to observe a part of the effect of each factor to be absorbed by the other factor or the property's number of square meters. As a result, a comparison between the beta-implied price of bathrooms and bedrooms might be puzzling. A more clear picture regarding factor importance in a property's value arises in figure 19 in pg.28, where we account for interrelations between explanatory factors.

Source: Piraeus Bank Research

Hedonic Pricing Model - Section B: House Type Valuation

Fig.15 **Premium (or Discount) of properties versus a flat**



The question of which type of house to look for is perhaps the most important from the point of view of a property buyer. Clearly, each type comes with its pros and cons. According to our regression analysis, we compare a maisonette's or detached house value relative to the value of a flat irrespective of all other factors.

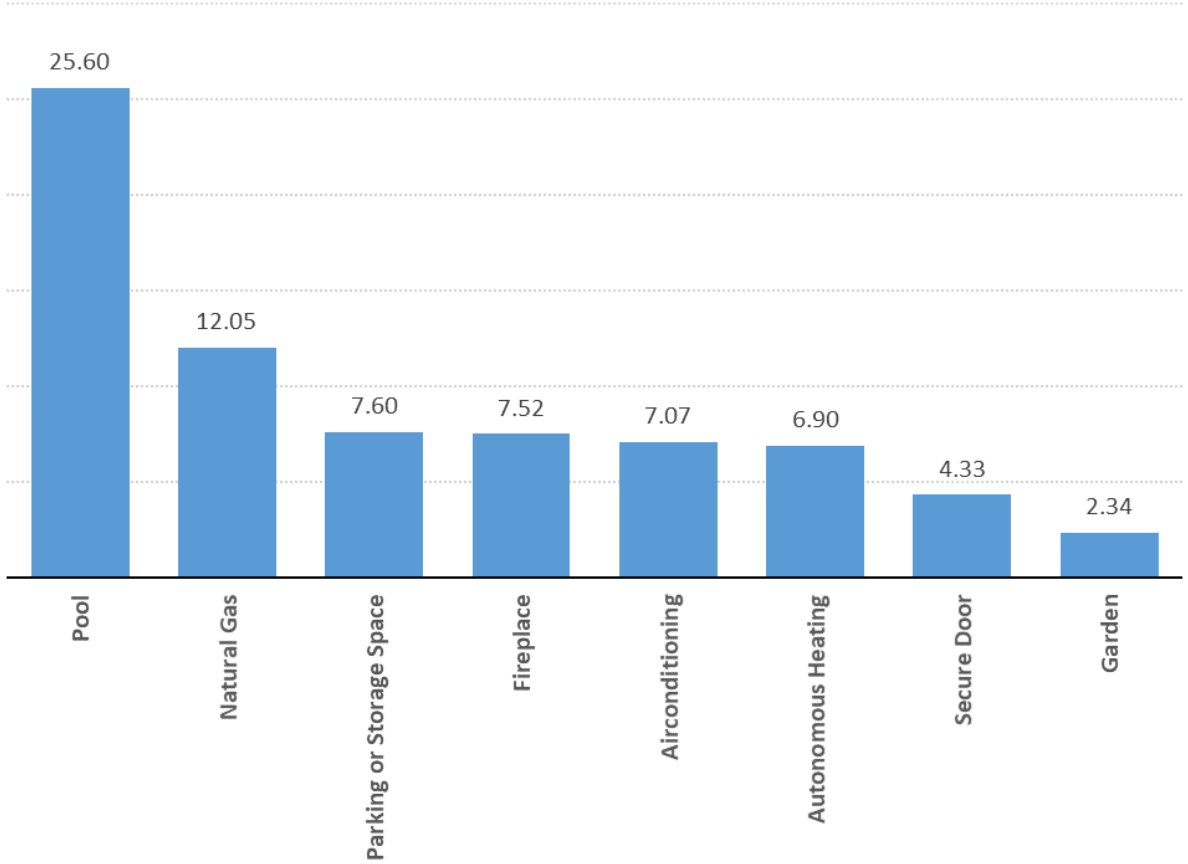
Given that all other factors remain fixed, our model's estimates imply that maisonettes are offered at a value discount relative to flats whereas a detached house is sold at a higher value than that of a flat.

In particular, a maisonette's larger operating cost (e.g. electricity and heating) as well as lack of elevator tend to lower demand and thus has an asking price almost 7% lower relative to a flat. In contrast, a detached house offers more flexibility relative to a flat so that is offered at a 6% premium relative to a flat.

Source: Piraeus Bank Research

Hedonic Pricing Model – Section C: Amenities

Fig.16 **Premium over a property with no Amenities**



As expected additional amenities such as the existence of a swimming pool, garden and autonomous heating increases the asking price of a property.

All signs of the regression coefficients are in-line with the expected marginal impact. *(Table 2, Section C: lines 11-21)*. Considering the amenities associated with the provision of heating or hot water, all parameters are statistically significant with the exception of solar boiler. The majority of all the other amenities are statistical significant in the determination of the price except of those of private terrace, awning. (i.e awning or solar boiler or private terrace are not significant factors in determining a house's offered price)

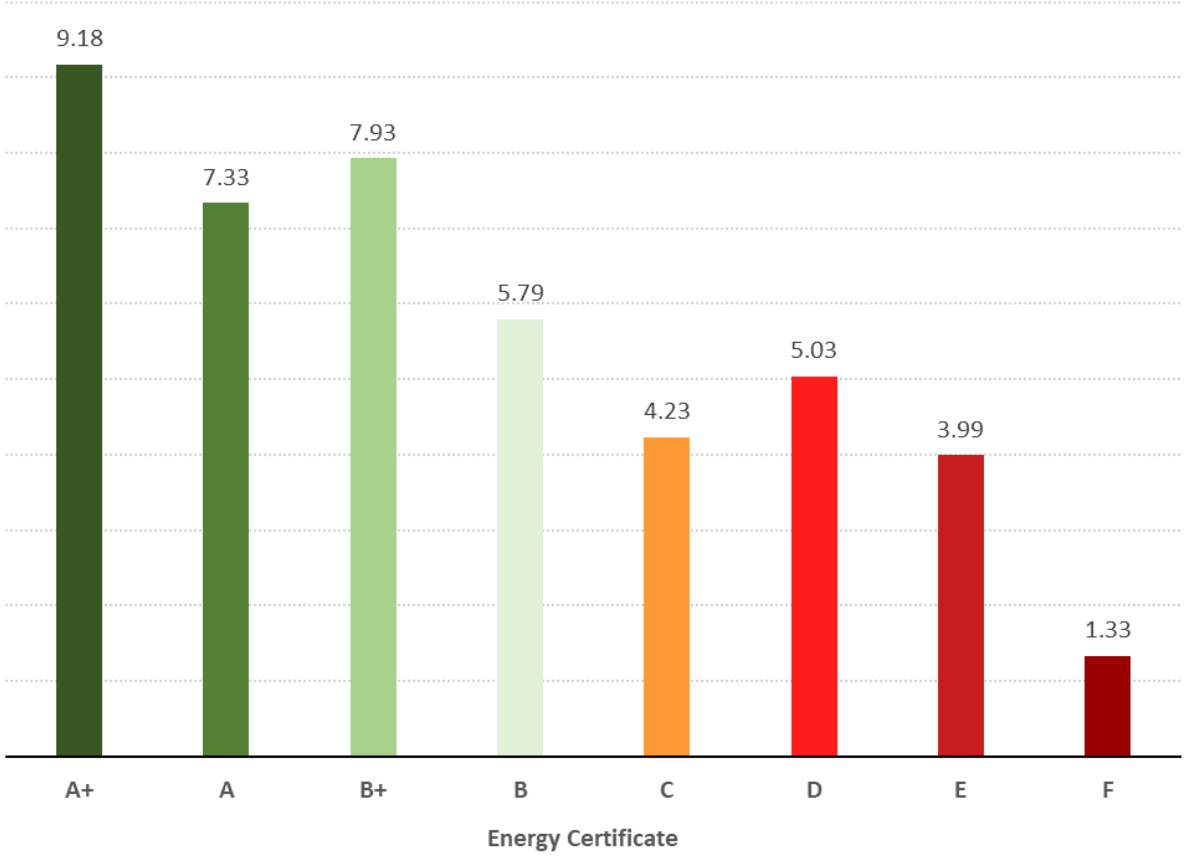
Setting a property with no amenities as benchmark then:

- For an identical property with Natural Gas its asking price is 12% higher.
- For an identical property with parking space or storage space its asking price is 7.6% higher.

Source: Piraeus Bank Research

Hedonic Pricing Model – Section D: Energy Performance Certificate effect

Fig.17 **Premium per EPC category versus EPC category "Class G"**



There is a clear and statistically significant positive relation between Energy Performance Certificate (EPC) classification and the property's valuation, especially at the high – end of Energy Performance Certification *(Table 2, Section D: lines 22-29)*

Higher EPC scores are associated with a higher asking price per m^2, relative to the lowest classification of "G". For example a property with "E" class. For example a property with "E" level of classification gives a property a premium of 4% vs an initial "G" classified property while an "A+" classification increases the premium to 9.2%.

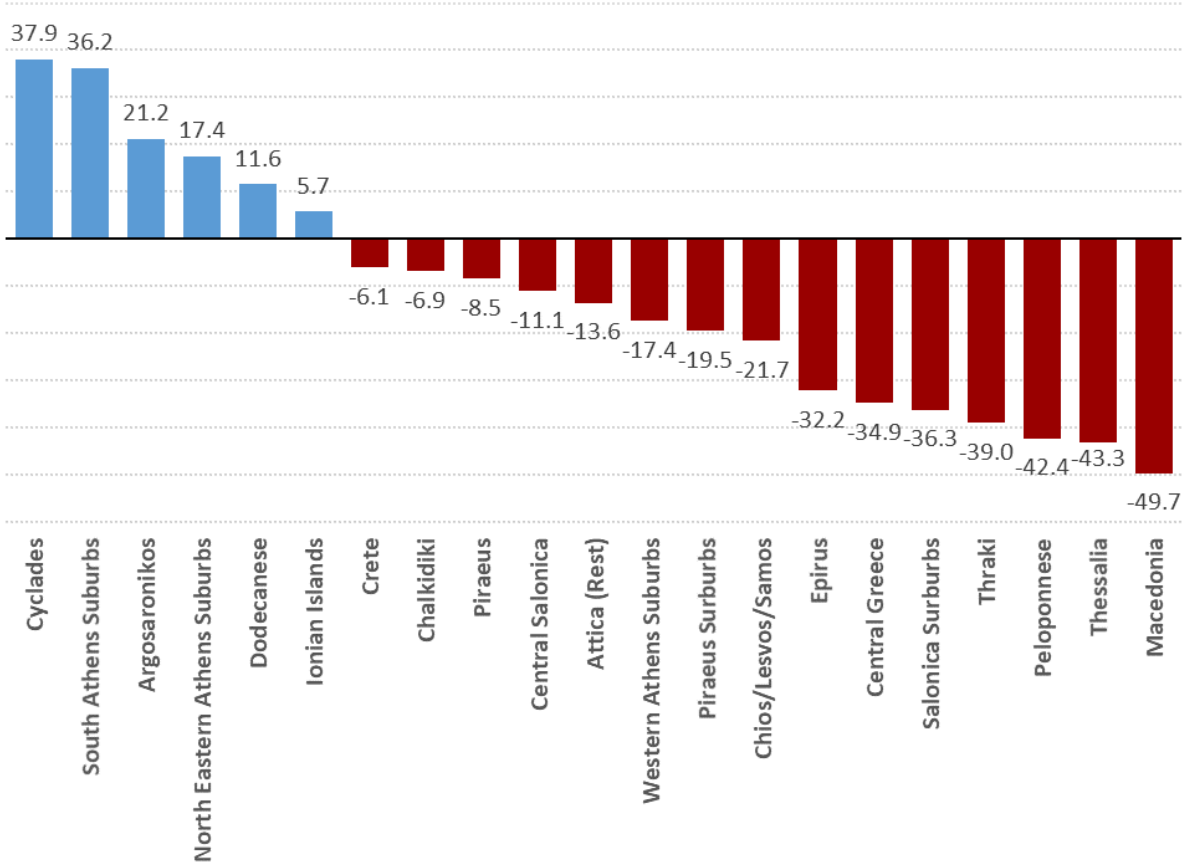
Setting a property with "G" ECP classification as the benchmark and keeping all other amenities & attributes constant then:

- For a property upgraded to "C" class" EPC, its hypothetical price per m^2 increases by 4.23%
- For a property upgraded to "A+" class" EPC, its hypothetical price per m^2 increases by 9.18%

Source: Piraeus Bank Research

Hedonic Pricing Model – Section E: Geographical location

Fig.18 **Premium (or Discount) of properties versus Central Athens**



Finally, all geographical location variables are statistically significant given the importance of location for property valuation *(Table 2, Section E: lines 30-50)*

Figure 18 illustrates the geographical heterogeneity in asking prices with house properties located in North and South Athens as well as properties in Cyclades and Attica islands being offered at a price premium relative to properties located in Central Athens.
In contrast properties in Peloponnese, Macedonia and Central Greece as well as in the Western Athens Suburbs are offered at a discount that can surpass 40% relative to Central Athens.

Setting a property in Central Athens as a benchmark and keeping all other amenities & attributes constant our result indicate that:

- For an identical property located in South Athens suburbs, its hypothetical price per m^2 will be 36.2% higher.
- For an identical property located in Crete, its hypothetical price per m^2 will be c. 6% lower.
- For an identical property located in Macedonia, its hypothetical price per m^2 will be near half the price relative to Central of Athens.

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Source: Piraeus Bank Research

1 Data Description and Summary Statistics from Database

2 Hedonic Pricing Model: Methodology

3 Hedonic Pricing Model: Results

4 Hedonic Pricing Model: Decomposition of Property Attribute Importance in Sales Value

Hedonic Pricing Model – Decomposition of Property Attribute's Importance in Sales Value

Equally important to the evaluation of a property's sale price is the identification of each property's attribute relative importance to the sale value of a house. However, the coefficient estimates from our regression model do not provide us with such information.

Assessment of relative importance in regression models is simple, as long as all attributes are uncorrelated; each regressor's contribution is just the R^2 from univariate regression, and all univariate R^2 values add up to the full model R^2.

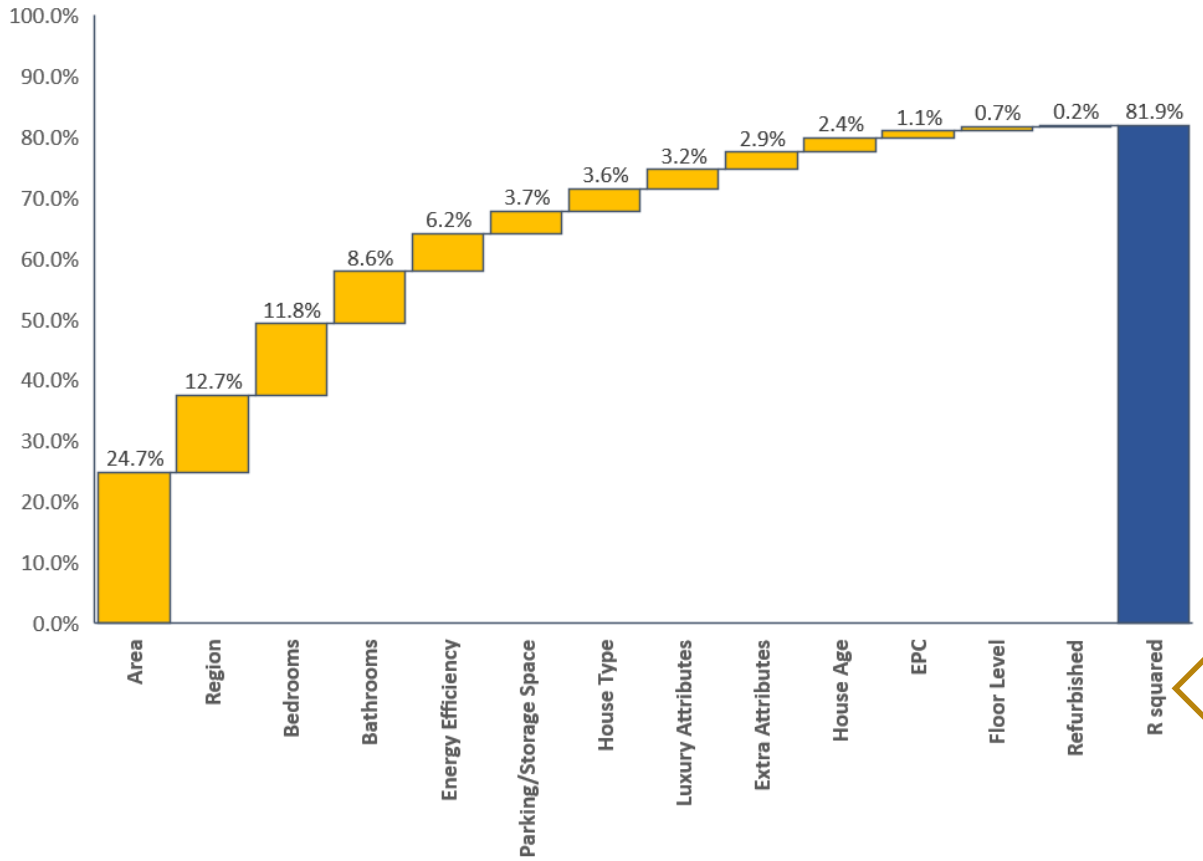
However, in our analysis of home sales price, property attributes are typically correlated, so that it is no longer straightforward to break down model explained variation into contributions from the individual property characteristics.

One alternative is to think in terms of each property's attribute contribution to asking price variation that is measured as each attribute's contribution in our model's R squared. To estimate that we consider both its direct effect (i.e., its correlation with the house value) and its indirect effect when combined with the other variables in the regression equation.

Source: Piraeus Bank Research

Decomposition of Property Attribute Importance in Sales Value: Results

Fig.19 Property Attribute Relative Contribution



See Table 2. line 51

Figure 19 illustrates the resulting relative contributions.

In terms of importance in variation of property sale price, house area, Geographical location, the number of bedrooms and bathrooms and energy efficiency attributes (solar boiler, autonomous heating and natural gas) contribute the most in a property's sell-side assessment.

A milder relative contribution is obtained from the house type, parking / storage space, and number of amenities provided with the house.

Quite interestingly, the property's age, EPC score and floor level do not play a very important role for the sale price despite the fact that if considered individually have a large impact on the property's value.

Source: Piraeus Bank Research

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