



Exploring the Relationship between Residential Rents and House Prices in the  
Portuguese Residential Real Estate Market

by

Sérgio Meira da Cunha Pereira

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Advised by:  
Prof. José Costa

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## **Biography**

Sérgio Meira da Cunha Pereira was born in Barcelos, on the 17th of November, 1992.

He lived in Barcelos until 2010, when he moved to Porto and started his Bachelor degree in Economics at the Faculdade de Economia do Porto, having finished in the year 2014 with a final average of 14 in 20 points. During this period he joined two organizations, AIESEC and U.Dream, that helped him to develop his skills and deepen his knowledge. Under the ERASMUS program, he studied a semester in the Bucharest Academy of Economic Studies. In September of 2014 he continued his studies by entering the Master in Management offered by Faculdade de Economia do Porto.

In October 2015, he started his professional career in NOS, one of Portugal's main telco companies, as a product manager for the residential market.

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## **Abstract**

In the past few years, there has been a lot of media focus in the Portuguese real estate market and its upturn, after years of a real estate recession succeeding the 2007 house crisis. One of the main aspects pointed by the media is the increase in demand and supply of the rental market. Since the 2007 house crisis, we observe a higher percentage of households living in rented homes rather than owner-occupied homes. In this dissertation we examine the Portuguese rental market by comparing the house prices of Portuguese homes and the rents paid by Portuguese people who are living in rented homes. The literature regarding rent and house prices all agree that these variables should be positively correlated. We use time series indexes of both rent prices and house prices to study the long-term relationship between them, using the Engel-Granger Co-integration Model, and to determine if we can predict future changes in one of the variables using the other, using correlation analysis and Granger causality tests. Since there is a lack of studies focusing on the Portuguese real estate market, this study tries to open the door for future analysis in this segment.

**Key-Words:** Portuguese real estate market; House prices; Rent prices; Co-integration; Correlation; Granger Causality

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## **I. Introduction**

The Portuguese real estate market has been one of the main economic topics discussed in the last few years. After several years in decline due to the 2007 economic crisis, since 2015 the Portuguese real estate market has taken a positive turn, and both prices and rents are increasing since. Despite this increased attention on real estate investing in Portugal, still there is not a lot of literature and studies focused on the topic, mainly because not so long ago the real estate market had been in a constant decline. One of the main factors of choosing the theme of this dissertation was this lack of studies/literature, especially concerning the Portuguese residential real estate market. The other reason was my personal interest in the real estate market, focusing on how to use rental residential properties as investment tools.

Shortly before the 2007 house crash, house prices reach their highest levels in most developed countries in the world forming a speculative bubble. At the time, there was a lot of debate between many authors, about the existence of a speculative bubble. One of the main variables used to justify the housing price speculation was the price-rent ratio, a ratio that compares the average price of buying a house and the average price of renting a house, which had also reached historical maximum levels in many countries in the years preceding the 2007 global economic crisis. In the following years after the housing crisis, house prices declined far more than housing rents, thus stabilizing the price-rent ratio.

In this paper we investigate the price-rent ratio exploring the relationship between house prices and house rents in the Portuguese real estate market and we try to answer the following research questions:

- (i) Can we establish any relation between the evolution of house prices and the evolution rents in the Portuguese residential real estate market?
- (ii) Is it possible to predict future changes in rents by using the price index in the Portuguese residential real estate market or vice-versa?

In order to answer the previous research questions, we firstly need to explore the residential rental market in Portugal. We will begin the dissertation with a brief overview of the Portuguese rental real estate market, detailing its evolution since World War 2 to modern days, the reasons of its decline since 1940, and its recent increase after the financial crisis in 2007. Although one of the main characteristics of the Portuguese Real



Estate Market is the high percentage of owner occupied homes (compared with other countries), in the last few years the rental market has been constantly developing, observed through an increase in the percentage of the rented homes compared to owner-occupied homes and an increase of the demand of rental homes by investors, since their returns are far higher than the interest rates they would get in bank deposits.

Housing is either bought by investors, with the objective of earning a return by renting the houses to tenants, or by consumers, that are future home-owners that wish to permanently inhabit the houses. Both groups have different aspirations when buying a house, so we will develop our literature review by exploring two different models that show how rents can drive house prices both to investors and to consumers.

On the investor side we will explore one of the main methods of valuation used by real estate investors, referred as Income Valuation Model. This model tells us that the value of a house is the present worth of future income generated by the asset, in this case rents paid by tenants. The private real investing market is compared by many authors to the stock market, so to an investor point of view, the price-rent ratio in the housing market should be equivalent to the price-dividend ratio of the stock market (Leamer, 2002), since rents are usually considered the yield of investment. In this model, if we assume that the rate of return is stable, to an investor's point of view, an increase in rents would mean an increase in the value of housing.

In the consumers perspective we will analyse the user cost of housing model firstly introduced by Poterba (Poterba, 1984), that shows that in a frictionless market, the price of housing should be such that buyers are indifferent between renting and owning, and as such the rent value should be equal to the cost of housing, that is the monthly cost of a consumer buying and maintaining their house. This model shows that if house rents rise and house price remain static, this will mean that more users will try to buy a house because it is more affordable to buy than to rent, increasing the demand of housing and decreasing the demand for renting. The model argues that in time, the equilibrium between prices and rents will be reached once again either by decreasing the rents or increasing the price of houses.

Both the models explored in this dissertation show that in a perfect frictionless market, the value of housing rents, being one of the fundamental determinants of the value of residential houses, would theoretically follow the value of house prices. This model

shows that, if everything remains constant, whenever the price of houses rises, the amount of money, in form of rents that investors require as the return of investment should also rise. Despite the model, residential house prices have been proven to fluctuate far more than residential rents (Hargreaves, 2008). This has also been proven in the stock market, where the price of stocks also fluctuates more than is fundamentally justified. Many papers attribute the increased fluctuations mainly because of a variety of psychological factors that lead to unexpected increases or decreases of residential house prices (Hott & Jokipii, 2012).

The main objective of this dissertation is to analyse data of the Portuguese house prices and compare it with the data of Portuguese residential rent prices, trying to establish a relationship between them. In order to do so, we will use data in the form of indexes (both to rent prices and house prices) shared by Confidencial Imobiliário, an independent real estate consulting firm focused on satisfying the need for real estate information and the production real estate market indicators in the Portuguese market.

In order to answer our two search issues, we will incur in different econometric and statistic tests. We will attempt to prove the relationship between house prices and rent prices using the Engel Granger co-integration two-step procedure (Engle & Granger, 1987). This test allows us to prove the long-term relationship between two time series. Afterwards we will use correlation and granger causality tests (Granger, 1969) in order to see if one of our time series variables can be used to predict the other. Using these tests with our rent and price indexes we will try to answer our second research question.

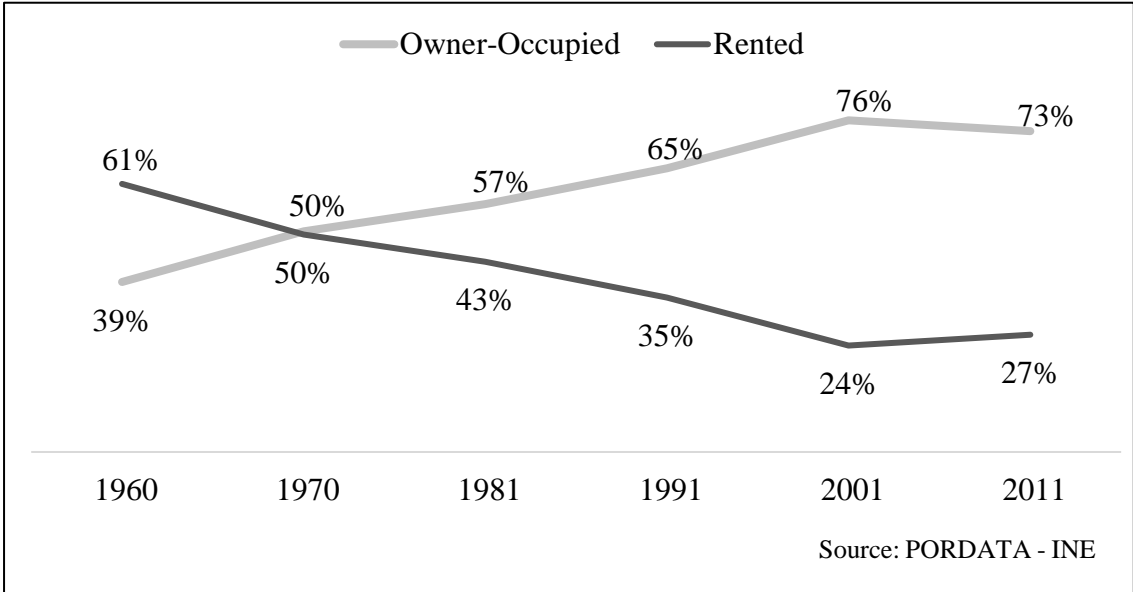
In order to achieve its purpose, the structure of this dissertation will be structured as follows. We will begin, in chapter 2, with an overview of the Portuguese rental real estate market, detailing its evolution since World War 2 to the modern day, the reasons of its declining since 1940, and its recent increase after the financial crisis in 2007. We will follow in chapter 3, with the literature review, first analysing different concepts of the housing market and explaining how different authors have used rents and the rent-price ratio in order to predict future changes in the house prices and see other studies that have already attempted to prove the existence of a long-term relationship between house prices and rents. In the literature review we will also study different methods of evaluating a property value and price, both through an investor's perspective and a consumer's perspective, and then understanding the concept of value of rents. In chapter 4, we will

begin by detailing all the methodological aspects of our research and briefly show the methodology used by similar studies when attempting to establish the relation between house prices and rents,. In chapter 5 we will present the empirical results of this different methods used in the analysis and their interpretation.

## II. Overview of the Portuguese Residential Real Market

In the past few years there has been a great development in the Portuguese residential real estate market, managing to attract more investors and to increase the number of homes rented. Although this has happened, the rental market in Portugal is still not as expressive as the remaining western countries of the European Union. The Portuguese real estate market is still characterized by an imbalance, having a very high percentage of owner-occupied homes versus rented homes, seen in chart (i), justified by the adoption of many policies that disrupted the market and made real estate investor lose interest in rental properties, mainly the freeze of rent prices in several periods.

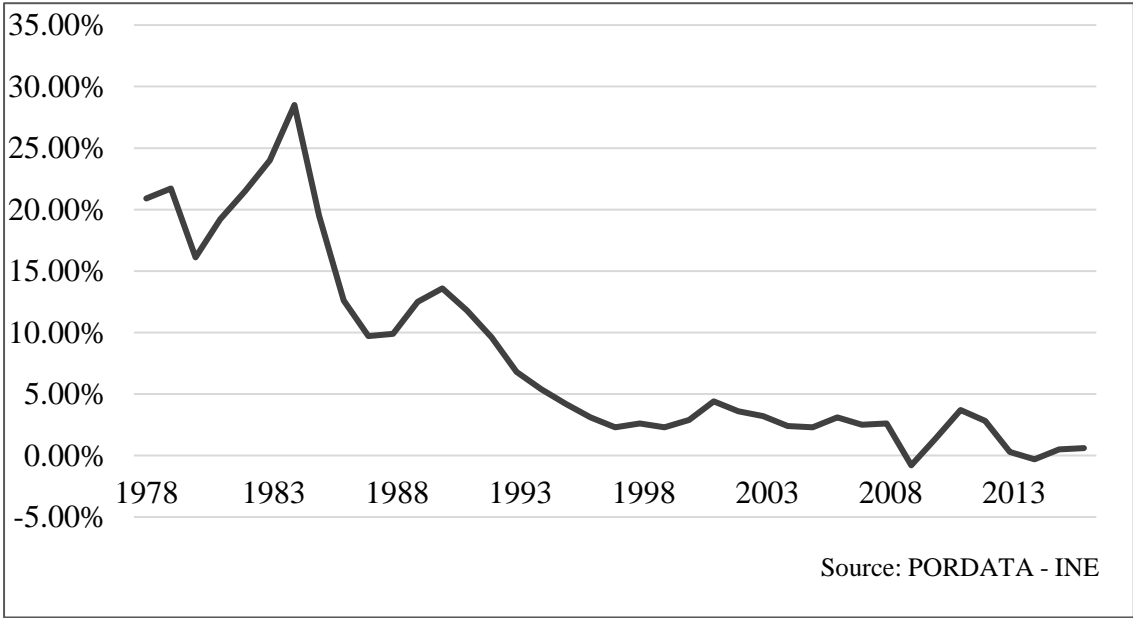
**Graph 1 - Percentage of Owner-Occupied Houses vs Rented Houses – Portugal**



The freeze rent prices policies took place during the Second World War, between 1939 and 1945, in the cities of Lisbon and Porto, and after the Portuguese revolution of 1974, where the policies extended to the whole country. During these decades, there were other policies adopted, which harmed real estate investors, such as the automatic renovation of the rental contracts, which benefitted the contracts that had a fixed rent due to the freeze policies, and anti-eviction policies, which were hard for owners/investors to evict not paying tenants.

The freeze in rents combined with high inflation rate in these decades, seen in graph (ii), created a progressive gap between the rental market prices and the rents that were being paid by tenants, which had their rent price freeze. This gap in prices made the residential rental market not profitable for many current real estate investors, who now weren't financially able to maintain the construction of their houses/assets, resulting in a lot of vacant and degrading buildings in city centres. In addition to this problem, these policies constituted barriers to the entrance of new investors in the rental market, preferring to use their capital in other investments, such as deposits, which had a high interest rate, or the stock market, that after the 1974 revolution started to develop in Portugal. These factors reduced the supply of homes for rent in the next decades, and consumers were nearly forced to start choosing to buy their own house instead of renting. We can see in chart (i) that the percentage of owner-occupied houses have been increasing throughout the years, and an opposing effect in the percentage of rented houses.

**Graph 2 - Inflation rate (Variation rate of Consumer Price Index)**



As mentioned above and as seen in chart (ii), before the decade of 1990, there were recorded high values of inflation. These values, usually around 10-20%, were also one of the main reasons why the percentage of owner-occupied houses increased. Consumers

started to realize the advantages of owning houses instead of renting, hedging against inflation because house prices usually rise according to inflation. Consumers would buy a house through a bank loan, paying a high monthly payment since higher inflation usually is accompanied by higher interest rates, knowing that in a few years, because of inflation, the value of the house bought would soon surpass the loan amount, creating a lot of equity in their homes.

Although we can still feel this imbalance between the amount of rented and owned houses, in the past few years (since 2008) the real estate market has altered. As we can see in graph (i), there has been an increase in the percentage of rented houses in the 2011 Census, something that hadn't happened in more than fifty years. We can explain the shift in the market by three main factors.

First, there have been approved new policies that changed rental regulation, such as the 2006 NRAU (“Novo Regime de Arrendamento Urbano – Lei 6/2006”), which seeks the reduction of the time in the process of evictions, new guidelines of the duration of rent contracts and, most importantly, new rules to update the rent values, of both new tenants and those who still had their rent frozen, and 2012 NLR (“Nova Lei das Rendas” – Lei 31/2012), that seeks the promotion of rental real estate in urban areas. This new regulation gives confidence to new investors to enter the residential real estate market, and consequently, increases the number of houses available for renting.

Secondly, although the interest rates are still low with the Euribor interest rate reaching negative values in 2016-17, there has been an increase of difficulty in obtaining a house loan after the 2008 financial crisis since one of the main factors that started the economic global crisis were the subprime mortgages in USA. After 2008, banks started increasing the criteria and becoming more selective to whom they granted house loans, which made a lot of families wanting to buy a home forced to rent until they qualify for a lo

Finally, there has been a higher search for rental housing solution by a new generation of young people, who value mobility and freedom. This new class of workers prefer a non-permanent solution, such as buying a house, because mobility is both valued by this new generation and usually required in the present labour market.

### **III. Literature Review**

In this chapter we will explore the main concepts and models that will be further proved and tested in the methodology. Since the objective of this dissertation is to explore the relationship between house prices and rents and test if an increase in either prices or rents can have an effect on the other variable in the Portuguese real estate market, we will firstly begin by reviewing some concepts of the housing market, including how prices usually fluctuate compared to rents, the creation of speculative bubbles in the housing market and how rents are and the price-rent ratio has been used in order to identify housing bubbles.

We will follow the literature review by analysing and detailing two models that explain the relation between house prices and house rents. We will analyse these two models because one of them is used in a consumer's perspective (The User Cost of Housing) and the other in an investor's perspective (Income Method of Real Estate).

It is important to have both these perspectives and analyse both models because (i) the Portuguese real estate market is still characterized by having a high home-owner ratio (compared to rented homes), making consumers the main group that drives house prices and (ii) the percentage of rented homes is increasing each year in the Portuguese real estate market and may increase more in the following years. Although the models are different, they both share the same assumption, that in a frictionless market, the value of housing rents is positively correlated to the value of house prices.

#### **III.1 Housing Market and Irrational Exuberance**

The real estate investing market and the stock market have many similarities. One of the similarities is that both the stock market and the real estate investing market focus on value and income: the stock market by taking into account the price of stocks, dividends and earnings; and the real estate by taking into account the prices of properties and rents. Another similarity is that in both markets it has been proven that both house prices and stock prices usually fluctuate more than house rent prices and dividends/earnings, respectively. There has been a lot of literature focused on how the prices of stocks fluctuate more than is fundamentally justified, usually creating situations where their price is higher than it is possible to justify taking into account economic fundamentals.

Many papers attribute these increasing fluctuations mainly because of a variety of psychological factors and herd-like behaviour that results in an unexpected increase or decrease of residential house prices (Hott & Jokipii, 2012). Published papers account for this unexplained volatility in the housing market, through the unjustified increase of house prices. The irrational exuberance theory of Robert Shiller (Shiller, 2000) tells us that if everyone thinks that house prices will go up in the future, house prices will continue to grow based only on customers' expectations. When house prices are increasing only because people expect house prices to go up, and not because of macroeconomic fundamentals such as income, price-rent ratio, and interest rates justified them, this increase in prices is a bubble.

The return obtained by an investment, in the stock market measured by price-dividend ratio and price-earnings ratio and in the real estate market measured by the price-rent ratio, is usually used as one of the macro-economic fundamentals to test if we are in the presence of a bubble. In the stock market, Shiller (Shiller, 2002) forecast the dot-com burst by showing that the price-earnings ratio had reached historical highs and that it was inevitable that the share prices dropped. Later, Campbell and Shiller (Campbell & Shiller, 1998) proved that when the price-dividend ratio in stocks is higher than fundamentals justify, the future price growth of stock is compromised. More recently, in the years before the housing crisis, Case and Shiller (Case & Shiller, 2003) started focusing on the housing market and concluded that the increasing house prices seen throughout the US could not be explained by fundamentals, such as population, income and rents. Lourenço & Rodrigues (Fradique Lourenço & Rodrigues, 2015) analysed the real estate market of Portugal and Spain in order to test the existence of a speculative bubble in the years before the house crisis, by using data from both countries rent prices, house prices and other economic variables, such as income, population and interest rate. When they compare the price-rent ratio of both Spain and Portugal they conclude that there could be an over-evaluation of Spanish houses, since their price-rent ratio was in an historical high level, meaning that Spanish house prices were rising at a much faster rate than their rent prices. They also explained that the price-rent ratio in Spain had been increasing more rapidly between the years 2000-2007 than the price-rent ratio in Portugal, and it was at a much higher level in 2007 than the Portuguese one. This comparison makes a lot of sense since Spain, along with Ireland, was one of the most affected countries by the housing crisis.



In Spain the price of residential real estate properties reduced approximately 30% in the three next years after the 2007 house crisis, which caused a reduction of the price-rent ratio to more conservative values.

Although the literature regarding real estate investing market is much scarcer than the one regarding the financial stock market, in the past few years there has been an increased interest in this field, mainly fuelled by the events of the US house crisis. Much of the literature comprises, similar to this study, attempts to establish a relationship between house prices and rent prices. Gallin (Gallin, 2008) used North American housing data in order to examine if the rent-price ratio is able to predict future changes in real rents and housing prices. Gallin concluded that when the rent-price ratio is low, meaning that prices are high relatively to rents, “subsequent changes in real rents are larger than usual and subsequent changes in real house prices are smaller than usual”. It was also concluded that the price effect dominates the rent effect, meaning that house prices correct back to rents rather than rents correcting house prices. Carreras-i-Solanas (Carreras-i-Solanas et al., 2004) also studied the relationship between house prices and rents in Barcelona and found that periods that showed higher prices relatively to rents corresponded with periods with an increasing demand of housing from investors. Hargreaves (Hargreaves, 2008) analyses the New Zealand real estate market with the objective to determine if changes in residential rents can be used to forecast changes in house prices. His findings prove that the “highest correlation coefficients between rents and house prices occurred when rents lagged house prices by six month” (Hargreaves, 2008), meaning that rents can be used to forecast house prices and that rents lead prices by six months. Baltagi & Li (Baltagi & Li, 2015) construct a house price index and a rent price index and examine the long term relationship in the Singaporean housing market, by exploring the relationship between house prices and rents. The authors fail to establish this relationship between the home purchase price and rental price based on their constructed indexes.

### **III.2 Investor’s Perspective – Income Valuation Method**

A common saying in real estate investing is “You make your money when you buy, not when you sell”. This means that the price real estate investors pay for a certain investment property is the main factor that will later determine their profit and success. Real estate

investors always try their best to determine the market value of a property and its specific investment value, which is the value of a property to a specific investor. In the residential real estate market there is a significant number of house evaluation methods, but in this paper we will focus in the income evaluation method.

The objective of a rental real estate investor is to acquire a property which will give him a steady income cash-flow and the amount that he is willing to pay for the property, or the price of property, is directly correlated with the amount of income cash-flow that he will receive; in this case in the form of rents paid by tenants. By considering this, in this chapter we will focus in the income method of valuing real estate properties since we are focusing in long-term returns originated by residential rents. The basic principle of the income valuation approach is that the value of an investment is viewed as a product of its future income flow. Many authors have compared the investing real estate market to the stock market (Leamer, 2002), and the fact is that this method of valuation is derived from the share/bond valuation models since it says that a share price is the market's view of the present value of future dividends flow. In the investing real estate market, the value of the property is the present worth of future benefits that can either be the cash-flow that the investor gets with the residential rent paid by the tenant and the proceeds that come from selling the property at the end of the ownership. Since this dissertation focuses on long-term real estate investments, we will make the assumption that investors buy their investment properties in order to rent them permanently, and we will not contemplate the selling of the property at the end of the period. As such, we will use the direct capitalization approach as the investor's formula to estimate a property value. The formula of the direct capitalization is as follows:

$$V = I/r \quad (1)$$

where V is the value of the asset, I is the income obtain by the asset and r is the capitalization rate.

The income in the direct capitalization formula is given by a property rental net operating income, which means that is the total of rents paid by tenants after the deduction of all expenses. In order to reach the Net Operating Annual Income of a Rental Property, we first have to deduce what is the potential gross operating income or the annual rental income of the property, that is the monthly rent paid by the tenant ( $R_t$ ) multiplied by the twelve months of the year. Afterwards we need to account for the vacancy and collection

allowance in the property, since an investing real estate property faces problems such as tenants leaving, usually needing a period of time to find a new tenant, and tenants failing to pay the rent. Then we need to deduce the costs that the investor will have with the property, such as the condominium, insurance and propriety taxes. In the Portuguese case, in most of the rental contracts, these costs are usually secured by the investor (landlord). After deducting the costs of repairs and maintenance with the property we get the Effective Rental Gross Income, which is the rent paid by the tenant minus all the costs that the investor had with the property ( $C_t$ ).

$$\text{Rental Effective Gross Income} = R_t * (1 - v) - T_{pt} - C_t - M_t \quad (2)$$

Where  $R_t$  is the expected annual rent received,  $v$  is the expected percentage of rents not received, either by vacancies or collection allowances,  $T_{pt}$  are the property taxes,  $M_t$  are the repairs and maintenance costs of the propriety and  $C_t$  the other costs, such as condominium and insurance.

Finally, in order to get the Rental Net Operating Income we need to take out the taxes owed. In Portugal, rents are considered as capital gains and, as such, need are subjected to the capital gains tax ( $T_{ct}$ ).

$$\text{Rental Net Operating Income} = [R_t * (1 - v) - T_{pt} - C_t - M_t] * (1 - T_{ct}) \quad (3)$$

Although, the formula for income valuation uses the Net operating income as the value of future cash-flows, most investors are still relatively unsophisticated and still value properties using the potential gross operating income (Wendt, 1974). So, in the investor perspective, we can consider the direct capitalization formula to be:

$$V = R_t / r \quad (4)$$

Where  $V$  stands for the value of the propriety,  $R_t$  for the Annual Rent Received and  $r$  for the capitalization rate.

After defining the income variable in the rental real estate market, we need to focus on the other crucial variable of the formula, which is the rate at which future income streams are discounted. The capitalization rate depends on a number of factors: (i) real estate market conditions, such as the demand and supply of real estate proprieties; (ii) economic

conditions, like interest rates and inflation, (iii) alternative investments, such as the stock market and deposits; (iv) perceived risk by the investor. This rate can vary from investor to investor, since the perceived risk of a rental investment property is higher for some investors than others and usually depends on factors such as experience, ability to leverage and their current financials. Usually an increase in inflation or interest rate increases the capitalization rate for a specific investor and, in turn, reduces the value of the property for the investor. Selecting the appropriate capitalization rate is the main challenge when using the income approach for valuing properties.

In this model, usually used by investors, we can detect that the value of the house (price that the investor is willing to pay) is heavily dependent on the rent prices practiced. If the capitalization rate for a specific investor remains constant, an increase in the rents in a specific area will also increase the price that they are willing to pay for the property. On the other hand, if the price of a housing increases, investors will demand higher rents from the tenants that want to live in their property in order to make up for the higher price paid.

This model is only valid when an investor buys a house specifically to rent purposes. Many of the rented houses available in the market were not bought with the intent of renting, but were rented when the owners decided to move. In the following sub-chapter we will explore a model that explains the relationship between rents and house prices for the cases where people buy a house as their home.

### **III.3 Consumer's Perspective – User's Cost of Housing**

As seen in graph (ii), in the 2011 Census, only 27% of the population lived in rental houses. This means that in Portugal, the majority of real estate propriety buyers don't use the income/investment approach to value their home, since they are not expecting to receive income from the propriety but rather to live in it.

If we take into account conventional economic theory then, in a frictionless market, the price of housing should be such that buyers are indifferent between renting and owning, and as such the rent value should be equal to the cost of housing. If we consider housing as a commodity, then consumers should feel indifferent between renting and buying a house if the price is the same, because both of the options satisfy the same need. There are some limitations to the fact of considering renting and owning indifferent since some

consumers, mostly from younger generations, will value the mobility and freedom given by rented homes while others will put a higher value in owning because they value stability and other intangible factors gained from owning. Despite this limitation, theoretically owning and renting a house are perfect substitutes to consumers, and we will consider them as such in this dissertation. As perfect substitutes, the change in price in renting or buying a house should influence the demand for the other, i.e. if the rental prices in a specific area are too high, then consumers will have more inclination to buy their own house.

The cost of housing, which means the cost of living in a specific property for a year, or “imputed rent”, should be equal to the rent paid to live in the same, or similar, property. Poterba (1984) uses the following formula to define the user cost of housing:

$$\text{Annual Cost of Housing} = P_t * r_{trf} + P_t * w_t - P_t * \tau_t(r_{tm} + w_t) + P_t * \delta_t - P_t g_{t+1} + P_t \gamma_t \quad (5)$$

Where  $P_t$  represents the price of the propriety,  $r_{trf}$  the interest rate that homeowner could have gotten if he hadn't bought the house and instead putted in a risk-free investment,  $w_t$  is the propriety tax rate,  $\tau_t(r_{tm} + w_t)$  means the gains the homeowner gets from buying the house, such as tax saving from the deduction of mortgage interest and property taxes,  $\delta_t$  the annual depreciation and maintenance costs,  $g_{t+1}$  is the capital gain earned from the appreciation of the propriety and  $\gamma_t$  is the value of the additional risk that a homeowner incurs by buying a propriety instead of renting one.

Although this was the formula first presented by Poterba (Poterba, 1984), it has into consideration the North American real estate market and its tax law, which allows mortgage interest and property taxes to be considered as tax savings. In the Portuguese tax law, the property taxes, called IMI, and the interests paid to the bank for the house loan don't allow for significant deductions in the taxes that consumers will have to pay at the end of their fiscal year, IRS. So, we can assume that the Portuguese Consumer Cost of Housing is:

$$\text{Annual Cost of Housing} = P_t * r_{trf} + P_t * w_t + P_t * \delta_t - P_t * g_{t+1} + P_t \gamma_t \quad (6)$$

In order to simplify the formula of the annual cost of housing, we can use the component ut as the user cost of housing. Poterba (Poterba, 1984) defined this user cost as the “sum

of contributions”, calculated as a percentage on the price of the home. The user cost formula, having the same assumptions made previously regarding the Portuguese tax law, is:

$$\text{User Cost of Housing} = r_{trf} + w_t + \delta_t - g_{t+1} + \gamma_t \quad (7)$$

By using the formula of the user cost, we can simplify the annual cost of housing formula as:

$$\text{Annual Cost of Housing} = P_t * u_t \quad (8)$$

Where  $P_t$  represents the price of the propriety and  $u_t$  the value of the user cost of housing.

There will be equilibrium in the housing market when the expected annual cost of housing is equal to the expected annual rent a consumer would have to pay to live in a similar property. Consumers will be indifferent to the choice of owning a home or renting one if this equilibrium prevails. If the annual cost of housing increases, either by an over-evaluation of the properties or by an increase of one of the contributors to the user cost, such as the risk of investment, and it's not accompanied by an increase in the cost of renting, the prices of houses must fall so that potential buyers choose the option of buying a property instead of renting one. On the other hand, an increase in the expected cost of rents, would increase the demand of properties, both by consumers who want to buy a house to occupy it and by investors, who feel that the increase in rent prices will bring higher profits and increase the property value (following the investment method of valuation). The increased demand would increase the price of housing, establishing once again the equilibrium in the real estate market. As explained by Himmelberg, Mayer & Sinai (Himmelberg, Mayer, & Sinai, 2005) this naturally correcting process implies a “no arbitrage” condition that makes the annual cost of housing equal to the annual cost that tenants pay for rent. By using the formulas and statements seen before we can focus on the value of rent by using the following formula:

$$R_t = P_t * u_t \quad (9)$$

Where  $R_t$  is the rent,  $P_t$  is the price of housing and  $u_t$  is the user cost of housing.

If we rearrange the formula above, we see that the equilibrium rent-price ratio should equal to the user cost of housing,

$$R_t / P_t = u_t \tag{10}$$

To conclude, this model also shares the same assumption present in the investment valuation model. If the user cost of housing remains constant, an increase in house prices need to be followed by an increase in rents paid by tenants.

## IV. Methodology and Data

In this chapter we will deepen the different econometric and statistical models that we will use in order to answer our two research questions:

(i) Can we establish any relation between the evolution of house prices and rents in the Portuguese residential real estate market?

(ii) Is it possible to predict future changes in rents by using the price index in the Portuguese residential real estate market or vice-versa?

We will firstly introduce the Engel-Granger Cointegration Model (Engle & Granger, 1987), that will test if the two variables are co-integrated, meaning that they cannot move independently of each other for long, attempting to prove their relationship.

Then, in order to answer our second research question, we will try to prove if one of the variables can predict the other we will use a correlation test with lead/lagged values and a Granger Causality test (Granger, 1969).

We will finish the chapter by explaining the different data that we will use in the models previously discussed.

### IV.1 Cointegration Test and Error Correction Model

The Engel-Granger regression model (Engle & Granger, 1987) shows that if two unit root variables are co-integrated then they cannot move independently from one another for long. The co-integration regression may be assumed to have the following form:

$$Y_1 = \alpha_0 + \alpha_1 Y_2 + \epsilon_t \quad (11)$$

Where  $Y_1$  and  $Y_2$  are variables with the same order of integration and  $\epsilon_t$  is the error term.

According to the Engel-Granger two step procedure, to test the co-integration of two variables, we first have to see if variables that we will use are of the same order of integration by doing Augmented Dickey Fuller unit root tests (ADF-tests). If our variables are not of the same order of integration we cannot prove the co-integration.

After that, we will use an OLS regression in equation (1) and test the stationary (or the presence of a unit root) of the residuals ( $\epsilon_t$ ) by performing once again ADF tests. The usual critical values for ADF tests cannot be used in this testing. We should instead use



the critical values for cointegration tests generated by Davidson and MacKinnon (Levin, Davidson, & MacKinnon, 1994), found in the appendix [Table I of the Annexes]. If the residuals ( $\varepsilon_t$ ) are found to be stationary then the null hypothesis of no co-integration between Y1 and Y2 is rejected, proving the relation between the two variables. If there is a unit root in the residuals then we cannot reject the null hypothesis of no co-integration. Engel & Granger explain that after proving the cointegration between two time series variables we then use the Error Correction Model (ECM). Rearranging the model we get the following equation:

$$\Delta Y1 = \alpha_0 + \alpha_1 \Delta Y2 + \alpha_2 \varepsilon(t - 1) \quad (12)$$

The ECM has many advantages, such as providing an estimation of the magnitude of the error correction term. If we have already proved that the variables Y1 and Y2 are co-integrated, the ECM incorporates the short-term and long-term effects, by giving information on how is the process of adjustment of the variables and their return to the point of equilibrium, by analysing the value of the  $\alpha_2$ . The value of  $\alpha_2$  must be negative to prove the co-integration and both long and short relation between the two variables. We can obtain this value by doing an OLS regression in equation (12).

There has been some studies that have already used the co-integration method in order to prove the relationship between house prices and rent prices. Baltagi & Li (Baltagi & Li, 2015) constructed home price and rental price index in the Singaporean private residential condominium market and analysed their long term relationship by doing Engel-Granger co-integration tests. Tsai (Tsai, 2012) used co-integration test in order to test the relationship between the house price index, the building costs index, representing the supply of housing, and the rental price index, representing the demand of housing. There has also been literature using Engel-Granger co-integration tests in order to see if in a specific period of time there has been a presence of a speculative bubble. Since a speculative bubble is defined by an increase of housing prices without being accompanied by an increase in fundamentals, these articles try to examine if the fundamental variables, such as rental prices, are not co-integrated with house prices. If the null co-integration cannot be rejected then there is no relationship between the increase in house prices and their variables, and we prove the existence of a speculative bubble. Mikhed & Zemcik

(Mikhed & Zemčík, 2009) and Clark & Coggin (S. P. Clark & Coggin, 2011) both tried to prove the existence of a bubble in the US market prior to the 2007 house crisis by examining the period of rapid increase in house prices and attempting to establish co-integration between house prices and fundamental variables. Both these articles used rent prices as one of the fundamental variables in their study.

## IV.2 Correlation Tests and Granger Causality Tests

In order to establish if either the movements in the price of housing can be used to predict the future fluctuations of house rents or vice-versa, we will firstly incur in a correlation analysis with both lags and lead of the variables, followed by granger causality tests (Granger, 1969).

In a correlation analysis, we will estimate the correlation coefficient between the two variables that shows us the strength of the linear association between the two variables. The formula for the correlation coefficient is defined as:

$$[E(X - \mu_x)(Y - \mu_y)] / (\sigma_X \sigma_Y) \quad (13)$$

where X and Y are the two variables, E is the expected value operator,  $\mu_y$  and  $\mu_x$  are the expected value and  $\sigma_X \sigma_Y$  are the standard deviations.

The coefficient ranges between -1 and +1. If the correlation coefficient of the two variables is positive we assume that higher values of one variable will originate in a higher value of the other. On the other hand, if the correlation coefficient is negative we have to assume that higher values of one variable will result in lower values of the other.

In our analysis we will estimate the correlation coefficient between one variable and both lagged and lead series of another variable. If we conclude that the correlation coefficient increases when correlating variable X with lagged values of Y, then that means Y causes X. On the other hand if we conclude that the correlation coefficient increases when correlating X with lead values of X, then X causes Y. In this analysis we will use different lag and lead periods (1Q, 2Q, 3Q and 4Q) in order to also see which of the time series has a higher correlation coefficient.

Hargreaves (Hargreaves, 2008) does a correlation analysis between house prices and lead/lagged rent prices in the New Zealand real estate market. He proves that the

correlation coefficient between house prices and 6Months lagged rent prices have a higher correlation than the unadjusted correlation, thus concluding that rents drive house prices. In our analysis, in order to see if either one of our variables may be used to predict another, we will also use Granger Causality Tests. They were first introduced by Granger (Granger, 1969) and has the objective of proving if one time series variable can be used to forecast another. Granger's approach to explain the causality between one variable and the other (whether X causes Y) involves, through the use of t-test and F-tests, seeing how much of the time series variable Y can be explained by their own past values and then introducing the lagged values of the time series of X to test if it can improve the explanation. In order to prove the causality of one variable to another we will have to run bivariate regressions, using both variables as dependent and independent, on Eviews of the form:

$$Y_t = \sum_{j=1}^m \alpha_j Y_{t-j} + \sum_{i=1}^m \beta_i X_{t-i} + D_t + \varepsilon_t \quad (14)$$

$$X_t = \sum_{j=1}^m \alpha_j X_{t-j} + \sum_{i=1}^m \beta_i Y_{t-i} + D_t + \varepsilon_t \quad (15)$$

Where  $\alpha_j$  is the regression coefficient on the lagged values of the dependent time series variable,  $\beta_i$  is the regression coefficient on the lagged values of the independent time series variable,  $D_t$  are the deterministic and  $\varepsilon_t$  is the random error value.

If  $\beta_i=0$  (for  $i=1,2,\dots,n$ ) then the independent variable fails to Granger-cause the dependent variable. In order to check the Granger causality, F-tests must be done to reject the null hypothesis of non-causality,

$$H_0: \beta_1 = \beta_2 = \dots = \beta_n = 0 \quad (16)$$

The null hypothesis that we will test in Eviews is that the time series variable X does not Granger-cause Y (equation 4) and that Y does not Granger-cause X (equation 5). Granger causality tests can only be performed using stationary time series variables.

Granger tests have been used in many analysis since 1969 when Granger introduced them (Granger, 1969). There have been papers using this method in both the financial market as in the real estate market. Zemčik (Zemčik, 2011) tested the present value model in the Czech housing market by comparing house prices and future cash flows, considered

as rental income. In his paper Zemcik used panel data causality tests since he used cross-sectional data of the Czech market. Since we will consider house prices and house rents as time series variables, we will incur in simple Granger Causality testing to prove if one of our variables is “Granger-causing” the other.

### **IV.3 Data Used**

In order to do our analysis and establish a relationship between house prices and rent prices in the Portuguese real estate market, we attempted to find both a house price and rent price index that illustrated the reality of Portugal. The amount of information relating to the Portuguese real estate market is rather scarce and often incomplete, being only available for short lengths of time. Besides, there are not many sources and websites that contain the information that was needed to advance with our analysis. We tried to gather all the available information both by conducting a search on the INE (Instituto Nacional de Estatística) website and by asking a real estate consultant company (Ci - Confidencial Imobiliário) for the information that was needed.

INE is the main public data company in Portugal and has the responsibility of creating and disseminating official national information that is available for all Portuguese citizens. Although there are available both house price and rent indexes, we decided not to analyse them because of their different ways of gathering the data and constructing the indexes. One of the indexes was made based on surveys (the rent index), while other was done by the repeated sales method (the house price index). Since we will incur in different econometric methods to compare both indexes, they should have the same methodology in their construction.

In our analysis we will focus on the data that has been provided by Confidencial Imobiliário (Ci). Ci is a Portuguese private company that specializes in the creation of real estate information and sells it to different organizations and other real estate professionals, such as investors or realtors. Their goal is to create a databank with real estate information that can be used to satisfy the needs of the different Portuguese real estate players. Ci is known for their specialty that is the making of real estate indexes, such as the Residential rent index and the Residential House price index. Since 2015, Ci adopted a new index composition methodology based on repeated sales information and transaction prices collected from real estate agents and integrate them in their platform

called SIR (Sistema de Informação Residencial - System of Residential Information). In their methodology, asking prices are also used for quality adjustment by hedonic prices regressions. Confidencial Imobiliário shared with us their nationwide data and local data, from the metropolitan area of both Porto and Lisbon. They shared these three Residential house price index and Residential rent index, which will allow us to test the relationship not only on a national level, but also a local one. Although the information in the indexes that was sent by Ci are both reliable and all share the same methodology, it's still a short time series, with information from the National and Lisbon rent and price indexes from the first quarter of 2010 to the first quarter of 2016 (25 observations), and the information of Porto rent and price indexes from the first quarter of 2011 to the first quarter of 2016 (21 observations).

We will not share the specific values of the indexes provided by Confidencial Imobiliário because of confidentiality purposes.

## V. Results

### V.1 Is there a relationship between House Prices and Rent Prices in the Portuguese Market?

Since our first research question was to find if we could establish a relationship between Portuguese house prices and Portuguese rental prices, we began our analysis by testing the long-term and short-term relationships between these two indexes, by incurring in the Engel-Granger (Engle & Granger, 1987) cointegration tests.

According to the Engel-Granger two-step procedure, before starting conducting empirical tests, we must test the stationarity of the indexes that we will use in our analysis. Only if the time series variables that we will use are in the same order of integration can we continue to prove the co-integration between these same variables. So we start by conducting Augmented Dickey Fuller unit root tests (ADF-tests) with a null hypothesis being of a unit root variable.

Since we will attempt to prove the relationship between the data collected from Confidencial Imobiliário with both National, Lisbon and Porto indexes we need to test the stationary in all these six variables. We will test the stationary of the original values of the indexes and their growth values. Our analysis will be more focused on the growth values since that's what we want to relate. In other words we want to test if increases in the Portuguese house prices are related to increases in Portuguese rent prices. We can see the summarized results of the Augmented Dickey Fuller Test in table 1.

**Table 1 - Summarized Augmented Dickey Fuller (ADF) tests**

Confidencial Imobiliário Data				
	Variables in level		Variables in difference	
	Indexes	Growth	Indexes	Growth
NHPI	-1.957	-2.708	-2.668*	<b>-5.462**</b>
NRPI	-2.183	-0.533	-0.574	<b>-16.708**</b>
LHPI	-0.259	-1.934	-1.659	<b>-6.630**</b>
LRPI	-0.384	-1.284	-1.305	<b>-8.801**</b>
PHPI	-4.831*	-2.409	-2.436	<b>-6.575**</b>
PRPI	-2.419	<b>-6.919**</b>	-0.574	-10.959**

Notes: (1) The optimal lag length is selected based on the Schwarz Info Criterion. (2) The null hypothesis is that of a unit root. (3) Significance at the 1%, 5%, and 10% levels is denoted as \*\*\*, \*\*, and \*, respectively. (4) NHPI – National House Price Index; NRPI – National Rent Price Index; LHPI – Lisbon House Price Index; LRPI – Lisbon Rent Price Index; PHPI – Porto House Price Index; PRPI – Porto Rent Price Index.

As we can see in the table above, according to the Engel-Granger (Engle & Granger, 1987) model we may attempt to establish a relationship of the following scenarios:

the growth rate of national house price and the growth rate of national rent price data since they're in the same integration order (both the variables are stationary, and thus have no unit root, after a one time difference,  $I(1)$ );

The growth rate of Lisbon house prices and the growth rate of Lisbon rent price data since they're in the same integration order (both the variables are stationary, and thus have no unit root, after a one time difference,  $I(1)$ );

We cannot establish a relationship of co-integration with the data of Porto real estate gathered from Confidencial Imobiliário since one of the variables (growth of PRPI) is stationary at level –  $I(0)$  and the other variable (growth of PHPI) is stationary at first difference –  $I(1)$ . The low amount of observations in this specific time series can be one of the explanations for the fact that we cannot attempt to prove a co-integration relation. By using the Schwarz Info Criterion the number of lags to test the stationary of the growth of the indexes of Porto's data is four, meaning that we are testing the stationary of the variable with only 16 observations. The stationary tests below 20 observations usually don't have accurate p-value and critical values.

As such, we will only attempt to test the long-term and short-term relationship between the variables in the scenarios described in (a) and (b). We will continue our analysis by making regressions between the two variables and testing the residuals obtained to test the co-integration. If the residuals of the regression are stationary then we can conclude that the variables are co-integrated. The results of the ADF-tests in the residuals obtained are summarized in the table 2 below and can be seen with more detail in the Annexes chapter (table II and III).

**Table 2 - Data cointegration tests – Testing the residuals for stationary**

Sample	ADF t-value
NHPIg – NRPIg	-4.681***
LHPIg - LRPIg	-4.118***

Notes: (1) The critical values are from Davidson and MacKinnon (1993). See table I in the annexes. (2) The optimal lag length is selected based on the Schwarz Info Criterion. (3) The null hypothesis is that of no cointegration. (4) Significance at the 1%, 5%, and 10% levels is denoted as \*\*\*, \*\*, and \*, respectively. (4) NHPIg – NRPIg: national house price index growth rate - national rent price index growth rate; LHPIg – LRPIg: Lisbon house price index growth rate - Lisbon rent price index growth rate.

Comparing the values shown in the table above and the table I from the Annexes, which shows the critical values generated by Davidson and MacKinnon (Levin et al., 1994), we can conclude that the null hypothesis of no co-integration is rejected, proving the existence of a co-integration relationship between:

- a) National house prices and national rent prices;
- b) Lisbon house prices and Lisbon rent prices.

When they wrote their article, Engel Granger (Engle & Granger, 1987) explained that the second step in their two-step module procedure in order to prove the co-integration was to estimate the error correction model. Since we proved the co-integration with the variables in scenario (a) and (b) we need to use the error correction model in these scenarios.

After adjusting formula (12) to our scenarios (a) and (b) and making OLS regressions we obtain the following values of coefficient presented in the table 3. For more detailed information of the OLS regression we can check the Tables IV and V in the Annexes.

**Table 3 - Outputs of the OLS Regression - Error Correction Model**

Sample	Coefficient Value	p-Value
NHPIg – NRPIg	-0.894	0.0017
LHPIg – LRPIg	-0.692	0.0282

Notes: (1) NHPIg – NRPIg: national house price index growth rate - national rent price index growth rate; LHPIg – LRPIg: Lisbon house price index growth rate - Lisbon rent price index growth rate.



As we can see in the table above, both the values of the coefficient are negative and have a p-value below 5%, thus finalizing the Engel Granger two-step procedure and proving long term equilibrium between the variables in scenario (a) – National House Prices and National Rent Prices gathered from Confidencial Imobiliário - and scenario (b) – Lisbon House Prices and Lisbon Rent Prices gathered from Confidencial Imobiliário.

## **V.2 Predictability power of the variables in the Portuguese real estate market**

Our second research question was whether we could predict future changes in Portuguese real estate market using one of our two variables (house prices and rent prices). Our literature review proved that house prices and rents should be positively correlated. However, there have been some studies (Hargreaves, 2008) that proved that there was a stronger correlation between the time series when we adjust the correlation to different time series, either lagged or leading.

In our analysis we estimate different correlations with the information that we had available from Confidencial Imobiliário in order to see if the correlation coefficient that we obtain from correlating with lead and lagged variables is higher than the unadjusted/original indexes correlation. Since our information is in quarterly form we will correlate the house price index values, and their growth values, with both lead and lagging rent price index, and their growth value. We will also use lead/lag periods to see if we can increase our correlation if we increase the lead/lag periods. If the correlation between house prices (or house price growth) and lagged rent prices (or lagged rent growth) is higher than the original correlation then we can conclude that rents are driving house prices. On the other hand, if the correlation between house prices (or house price growth) and lead rent prices (or lead rent growth) is higher than the original correlation then we can conclude that house prices are driving rents.

In the tables 4 and 5 below, we can see the summarized outputs between the correlations of all the variables. The values in the table are the specific coefficient of the correlation. Since the research question that we are trying to answer is if we can predict future changes, we should not compare the correlation of the indexes but the correlation between the growth values of the indexes. This means that we should see if we can predict future changes in house prices using an increase of rent prices and vice-versa.

**Table 4 - Correlation Coefficient between House Price Index and Rent Price Index**

	Index		
	National	Lisbon	Porto
Unadjusted	0.8792	0.9023	0.1612
3M Lag	0.8030	0.7276	-0.0642
6M Lag	0.7417	0.5255	-0.1643
9M Lag	0.6636	0.3576	-0.1320
12M Lag	0.9714	0.1392	-0.2057
3M Lead	<b>0.9733</b>	<b>0.9674</b>	0.2555
6M Lead	0.9619	0.8793	0.4310
9M Lead	0.9287	0.7170	0.5040
12M Lead	0.9352	0.5785	<b>0.5227</b>

Notes: (1) Quarterly information gathered from Confidencial Imobiliário; (2) Value in bold are the higher values of correlation.

**Table 5 - Correlation Coefficient between the Growth of House Price Index and the Growth of Rent Price Index**

	Growth		
	National	Lisbon	Porto
Unadjusted	<b>0.4786</b>	0.6330	<b>0.4982</b>
3M Lag	0.0607	0.4726	-0.0662
6M Lag	0.2258	0.4142	-0.0571
9M Lag	0.0883	0.5376	0.0175
12M Lag	0.4554	0.5478	0.0159
3M Lead	0.3335	<b>0.7395</b>	-0.0550
6M Lead	0.3361	0.5494	0.0525
9M Lead	0.4134	0.4464	0.0631
12M Lead	0.4102	0.1423	0.0396

Notes: (1) Quarterly information gathered from Confidencial Imobiliário; (2) Value in bold are the higher values of correlation.

When looking for the time series gathered from Confidencial Imobiliario, although the correlation coefficient in the indexes are all higher by correlating house prices and three month lagged house rents, the same only happens in Lisbon area when using the growth of indexes. Both the national data and Porto data have a higher coefficient with the

original time series correlation than with any of the correlation using lead or lagged variables when using the variation values of the indexes. This means that we cannot conclude that we have higher coefficients with lead/lagged values than with the original correlation, and we cannot conclude that the growth in one variable can be used to forecast the future movement of the other. Other conclusion that we obtain by analysing table 5 is that the growth of house prices and the growth of rent prices are positively correlated with each other in the three data sets that we analysed. This is in accordance with the models in the literature that we have previously discussed.

The other method that we will use in order to see if the growth of one of our indexes can be used to predict the future changes of the other is Granger Causality Tests. As explained in the methodology chapter, Granger Causality tests can only be performed between stationary variables. Since our time series variables need to be stationary, we will only attempt to perform the tests between the following variables:

- a) The growth rate of national house prices and the growth rate of national rent prices;
- b) The growth rate of Lisbon house prices and the growth rate of Lisbon rent prices;

Since both these variables are  $I(1)$ , we will need to perform the tests using the first difference. It makes sense to only try to perform the causality tests between these two scenarios since these were the ones that we had already established as a short-term and long-term relationship, using the Engel-Granger co-integration approach.

In table 6 we can see the output of the Granger Causality tests for scenario (a) and (b). Since we are working with a small number of observations we will use one lag in our causality testing. The null hypothesis is that one of our time series variables doesn't granger-cause the other time series variable.

As we see in table Y, we can only reject the null hypothesis of non-granger causality when testing if Lisbon house price growth is causing Lisbon rent price growth. This means that we can assume that an increase in house prices in the Lisbon area can cause a future increase in rent prices. In all the other scenarios, we cannot reject the null hypothesis and thus conclude that an increase in Lisbon rent price does not cause an

increase in the Lisbon house prices, nor, does an increase in national house prices cause an increase in national rent prices.

**Table 6 - Outputs of Granger Causality Tests**

Null Hypothesis:	Obs	F-Statistic
D(NHPIg) does not Granger Cause D(NRPIg)	22	0.14
D(NRPIg) does not Granger Cause D(NHPIg)		1.11
D(LHPIg) does not Granger Cause D(LRPIg)	22	4.99**
D(LRPIg) does not Granger Cause D(LHPIg)		1.08

Notes: (1) Significance at the 1%, 5%, and 10% levels is denoted as \*\*\*, \*\*, and \*, respectively. (2) Number of lags used in Granger causality testing: one; (3) NHPIg: National House Price Index growth rate; NRPIg: National Rent Price Index growth rate; LHPIg: Lisbon House Price Index growth rate; LRPIg: Lisbon Rent Price Index growth rate. (4) First difference of the time series used due to their stationary level – I(0).

If we compare at the correlation tests done in this chapter and the granger causality tests, we came to a similar conclusion. We proved that in the Lisbon real estate market, house prices can help to predict rent prices.

## **VI. Conclusion**

In this dissertation we attempt to deepen our knowledge in the Portuguese real estate market. In the past few years, there has been a lot of attention focused on this specific market, especially as an investment tool. Increases in both the property prices, the percentage of rented homes and tourism in Portugal are usually identified as the main factors for this increased attention in the past few years. In this paper we focused in the Portuguese investment real estate market by attempting to establish a relationship between rents, viewed as the return of the investment, and the price of houses.

Rents are either the price that tenants pay in order to live in a house and the return that an investor pays when he buys an investor property. In both perspectives (consumers and investment), we assume that the price of rents should follow the price of housing. For consumers, if we assume that buying a house and renting one are substitutes since they satisfy the same need, we conclude that an increase in house prices will result in an increase in the demand for renting, thus increasing rent prices. For an investor, it is logical that if house prices rise, while everything else remains constant, the return in form of rents demanded also rises.

To our knowledge there isn't any study attempting to establish this relationship using Portuguese data. One of the main reasons justifying the lack of studies for the Portuguese case is the lack of data regarding the real estate Portuguese market. In this paper we use data, in the form of house price indexes and rent price indexes, provided by Confidencial Imobiliário, a real estate consultant company that specializes in the gathering and treatment of real estate information and sells them to real estate professionals, such as realtors, contractors or investors. Even with the help of Confidencial Imobiliário, the amount of data used in our study is still very limited. Despite the lack of studies in the Portuguese market, there have been many published papers which explore the relationship between house prices and house rents using data from other countries, mainly the US, and using different methodologies.

In this paper we tried to establish the relationship between house prices and rent prices using data from national indexes, Lisbon and Porto indexes, and the Engel-Granger co-integration method. We successfully reject the null hypothesis of no co-integration using the data from National and Lisbon indexes, providing empirical evidence on the long-

term relationship between house prices and house rents. We were not able to proceed with the co-integration test using Porto data since the time variables were not in the same integration order. Some studies have already proven this relationship using co-integration analysis. Although Baltagi & Li (Baltagi & Li, 2015) failed to prove the relationship between house prices and rent prices using a co-integration model and aggregate national data, we did succeed in proving the relationship using cross-sectional data and area-specific home purchase and real indexes.

We conclude our analysis with correlation and Granger causality tests, in order to determine if one of our variables, rent or house prices, are causing the other and to see if we can predict future changes in house prices by using house rents. Our empirical evidence is inconclusive since using data for Lisbon, we obtain a result saying that prices are causing rents both by correlation and Granger causality tests, while using National data, neither of the variables is causing the other, thus not being possible to predict prices with rents. The results obtained using Lisbon house prices and rent prices indexes contradict the ones found by Hargreaves (Hargreaves, 2008). In his paper, the author concludes that in the New Zealand real estate market rents cause house prices.

There are limitations to our work. The main limitation is the lack of data used in the different econometric and statistical tests. Some papers use data sets with a lot more observations. When attempting to establish a long-term relationship between house prices and house rents in the Singaporean real estate market using co-integration analysis, Baltagi & Li (Baltagi & Li, 2015) used data from the first quarter of 2000 to the fourth quarter of 2012, with a total of fifty two observations (more than the double of the observations that we used in our study).

Another limitation in our analysis is the fact that the data used in our analysis is based on high-frequency data (quarterly data). Some authors, like Clark (T. E. Clark, 1995) point out that when using high-frequency data, we are more exposed to inefficiencies. The fact that transaction costs are much higher in the real estate market than the stock market, may affect the short-term predictability when comparing rents and house prices. Many authors use low-frequency data when analyzing the real estate market in order to prevent considering these inefficiencies. Carreras-et-Solanas (Carreras-i-Solanas et al., 2004) used annual data from 1970 to 2002 when trying to explore the evolution between rent prices and house prices in the Barcelona market. When trying to see how the rent-price

ratio can affect future rent growth, Clark (T. E. Clark, 1995) uses decennial data so that he can completely eliminate these inefficiencies.

In this paper we have contributed for a new line of research of the Portuguese real estate market by exploring the relationship between rents and house prices. Because of the inexistence of articles in this area, this study opens doors for future similar analysis. As we mentioned above, the use of high-frequency data can provoke inefficiencies, so we should also do a high-frequency analysis, using yearly data, in order to prevent these inefficiencies to impact our results. Since our study was focused on national, Lisbon and Porto data it would be interesting to analyse if the same relationship can be observed when using cross-sectional data from different cities around Portugal. Many authors, such as Miked & Zemčik (Mikhed & Zemčik, 2009), have already used cross-sectional data in order to incur in econometrical methods using panel data, such as panel data co-integration tests and panel data granger causality tests.

Finally, in our study we focused in one of the variables that can explain the movements of house prices. In future works, other macro-economic variables that may have an impact in the model should be added, such as interest rates, population and income. The introduction of these variables could have an impact in the empirical results, so it would add value to future works if we consider them.

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## Annexes

**Table I – Critical Values for testing the residuals in Engel-Granger tests**

m	Level of Significance			
	1%	3%	5%	10%
2	-3.90	-3.59	-3.34	-3.04
3	-4.29	-4.00	-3.74	-3.45
4	-4.64	-4.35	-4.10	-3.81
5	-4.96	-4.66	-4.42	-4.13
6	-5.25	-4.96	-4.71	-4.42

Notes: (1) values in the table are only constant. (2) m is the number of I(1) variables in the equation (including the dependent variable. (3) Source: Davidson, R. e MacKinnon, J. G. (1993), Estimation and Inference in Econometrics, p. 722, Oxford University Press.

**Table II – Output of ADF test of Residuals – Cointegration test with National Indexes**

Null Hypothesis: RESID01 has a unit root

Exogenous: Constant

Lag Length: 0 (Automatic - based on SIC, maxlag=5)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-4.680	0.0012
Test critical values:		
1% level	-3.753	
5% level	-2.998	
10% level	-2.639	

**Table III – Output of ADF test of residuals – Cointegration test with Lisbon Indexes**

Null Hypothesis: RESID02 has a unit root  
 Exogenous: Constant  
 Lag Length: 0 (Automatic - based on SIC, maxlag=5)

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	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-4.1184	0.0044
Test critical values:		
1% level	-3.7529	
5% level	-2.9981	
10% level	-2.6388	

**Table IV – OLS Regression Output - Error Correction Model with National Indexes**

Dependent Variable: D(NHPIg)  
 Method: Least Squares  
 Date: 07/25/17 Time: 21:30  
 Sample (adjusted): 2010Q3 2016Q1  
 Included observations: 23 after adjustments

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Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.000	0.003	0.076	0.940
D(NRPIg)	0.175	0.155	1.130	0.272
RESID01(-1)	-0.894	0.248	-3.611	0.002

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R-squared	0.400	Mean dependent var	0.001
Adjusted R-squared	0.340	S.D. dependent var	0.017
S.E. of regression	0.013	Akaike info criterion	-5.657
Sum squared resid	0.004	Schwarz criterion	-5.509
Log likelihood	6.806	Hannan-Quinn criter.	-5.620
F-statistic	6.665	Durbin-Watson stat	1.662
Prob(F-statistic)	0.006		

**Table V – OLS Regression Output - Error Correction Model with Lisbon Indexes**

Dependent Variable: D(LHPIg)  
Method: Least Squares  
Date: 07/25/17 Time: 21:21  
Sample (adjusted): 2010Q3 2016Q1  
Included observations: 23 after adjustments

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Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.001	0.004	0.224	0.825
D(LRPIg)	0.254	0.222	1.145	0.266
RESID01(-1)	-0.692	0.292	-2.366	0.028

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R-squared	0.226	Mean dependent var	0.003
Adjusted R-squared	0.149	S.D. dependent var	0.022
S.E. of regression	0.021	Akaike info criterion	-4.810
Sum squared resid	0.008	Schwarz criterion	-4.662
Log likelihood	5.832	Hannan-Quinn criter.	-4.773
F-statistic	2.921	Durbin-Watson stat	1.970
Prob(F-statistic)	0.077		