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Abstract

The main purpose of this paper has been to establish whether housing and rent prices share a common trend in the long run. And thus, to determine whether there were speculative bubbles in the Stockholm housing market during the period 1875-1930. This period offered an excellent opportunity for such an investigation due to limited regulation in the housing market. Finally, a newly generated data on Stockholm housing prices from 1875 and data on Stockholm rent prices have given us rare insight into the Stockholm housing market. After applying the statistical procedure of testing for cointegration, we have concluded that Stockholm housing and rent prices share a common trend, i.e. that they return to a long run equilibrium after experiencing an exogenous shock. More specifically, the results indicate a 22% movement back towards equilibrium following a shock to the model, one period later, i.e. one year later. Therefore, we conclude that during the period 1875-1930 there was no indication of a speculative bubble in the Stockholm housing market.

JEL-classification: N93; N94

Key words: housing market; cointegration; economic history

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Speculative bubbles in the Stockholm housing market 1875-1935? ☆

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1 Introduction

During the last decade many European/US/Asian cities experienced unprecedented increases in housing prices some of which resulted in sharp decreases during the second part of the decade. Consequently, attention has turned to the determinants of housing prices and whether loose monetary policy helped cause an unprecedented bubble in the housing market in the early 2000's, a bubble whose inevitable collapse proved a major source of the financial and economic stresses of the past five years.¹

Therefore it stands to reason to investigate whether this housing market turbulence was a unique phenomenon or a common occurrence. In this paper we construct an annual time series index for housing prices from 1875-1935, using data from Stockholm (Capital of Sweden). This data offers a unique opportunity, to make use of the historical perspective as well as the economic one. The main purpose of this paper is to shed a light on whether or not changes in Stockholm's housing prices from 1875-1935 were of a speculative nature or not, i.e. whether the efficient market condition held during this period. Since real estate markets during this period were largely unregulated, the period we have chosen is particularly well suited for inquiries into the efficient market condition in real estate markets.

There are a number of challenges. First, there is very limited consensus concerning the definition of a speculative boom or a bubble. Still, most seem to agree that the housing price increases during the last decade cannot be explained by economic fundamentals alone. Neoclassical investment theory suggests that the asset price of a house is simply the capitalized value of its rent services, given the applicability of the so called efficient market condition. The efficient market condition requires the rational representative agent to equate the real expected return from home ownership to the real homeowner cost of capital.² And if the value of a real estate is the capitalized value of its rental services, rent should equal the homeowner cost of capital. Thus, the real expected return and its capitalized price should be the same. A speculative boom, or a bubble should therefore *not* adhere to this principal.

Second, investigating the long run perspective in real estate markets poses several challenges from a statistical perspective. Since the efficient market condition predicts that capitalized rent determines the asset price of real estate in the long run, they should share an equilibrium relationship where neither variable deviates independently from the other in the long run, i.e. are cointegrated. We will test for cointegration using the Engle Granger (1987) two step method and the Johansen (1995) method. But most importantly, the data is required to be homogeneous, even in the long run. As mentioned before, this paper uses a newly generated data for housing prices in Stockholm which spans the period 1875-1935, a uniquely long time period, something which is quite rare for other metropolitan areas. Moreover, Stockholm is also well suited for this kind of research due to historical reasons. Ever since Stockholm's birth as major city during the latter part of the nineteenth century, the city has enjoyed a relatively large housing stock which has remained somewhat homogeneous during long peaceful periods (unlike many European cities).

A variety of literature on real estate markets has emerged within economic theory in recent decades. The better part of this literature rests on several microeconomic assumptions about consumer behavior, the nature of the housing commodity, and the housing market. A number of factors have been shown to affect housing prices. On the demand side these factors have included changes in demographics, income, growth and employment growth as well as changes in location characteristics such as accessibility to schools or a presence of a high crime rate to name a few. DiPasquale and Wheaton's (1992) four quadrant model offers the most elaborate framework hitherto, of inter-related space and asset markets as well as real estate supply factors such as construction and development. This analytical framework, offers an intuitive understanding of the interaction between capital and real estate markets. The four quadrant model builds on the premise

¹Bernanke, (2010). pp. 1-2.

²Meese & Wallace, (1992). pp. 245.

of an efficient real estate market where markets clear in the long run. Case & Shiller (1989) rejected the efficient market condition in a pioneering study into four US metropolitan areas. Meese & Wallace (1992) extended the previous work in the field by successfully testing for a long run cointegrating relationship between prices and rents in a number of US housing markets.

More precisely, we will attempt the following; To extend the applicability of the PVR analytical framework developed by Meese & Wallace (1994) to the Stockholm housing market from 1875-1935. A long run implication of the PVR theory for housing prices is that prices and capitalized rents share a common trend (are cointegrated). Moreover, by using descriptive analysis as well as the statistical procedures of Engle and Granger (1999) and Johansen (1995) we will be able to shed a light on whether the empirical evidence is in accordance with theory. Second, we will also address the question of a near rational consumption behavior in housing markets which could account for the existence of price bubbles without rejecting the long run consonance between the housing price and the PVR framework. Finally, we will make a comparison between periods the housing market was price regulated and periods in which the market was virtually free of regulation.

The period 1875-1935 offers an excellent opportunity to investigate the efficiency of housing markets, since during this period, housing markets were relatively unregulated by the state and municipalities. Regulation and rent controls tend to drive a wedge between housing and rent prices making this type of research difficult. But not least, we have acquired reliable data on housing and rent prices, which has enabled us create indexes for housing and rent prices respectively during this period. Needless to say, there are numerous topics that are associated with real estate and urban economics, many of which will not be discussed in this paper. Instead this paper will offer a somewhat narrower view, both in terms of economic theory and history focusing on the neoclassical approach.

2 Theoretical considerations

2.1 General framework

Within economic theory there has been considerable consensus regarding the determinants of housing demand.³ Broadly speaking these determinants have included income, price and taste. More specifically because of the difficulty in creating quantifiable indicators for taste, variables such as demographics have been used as a proxy. Moreover, employment growth, location characteristics, financing mechanisms and interest rates have also been used to name a few. Supply has generally been considered to consist of quantity of housing stock along with construction costs.

The choice of these variables is based on the following theoretical assumptions. First, one of the assumptions of utility theory predicts that consumers optimize their utility in light of their income and price decision making. Assuming that household decision making is assumed parallel consumer decision making it is possible to quantify housing demand. Second, the object of consumer decision making is considered to be an unobservable homogeneous commodity called housing services. Third, a perfectly competitive market in housing services is assumed to exist. The theory postulates that rational consumers attempt to maximize their utility with respect to different goods and services, including housing, that they purchase within the constraints imposed by market prices and their income.

Following the discussion above, this paper will herein follow the long run equilibrium demand and supply model framework in the aggregate real estate market, of DiPasquale & Wheaton (1992). This model suggests that to fully account for the demand factors of real estate it is necessary to clarify the simultaneous

³Megbolugbe, Marks & Schwartz, (1991), Page 245.

movements, in the markets for space and assets respectively. The following distinction is most evident when space is not owned by the tenants themselves, but by separate property rental companies. The distinction becomes non-evident when space is occupied by its owners. Hereafter, in order to shed a light on the relationship between capital and real estate markets, we will focus on markets for space and assets respectively.

In the market for real estate use or space, demand comes from the occupiers of space, whether they be tenants, owners or households. The household demand for space depends on income and the cost of occupying that space relative to the cost of consuming other commodities. Thus, rent is determined in the property market for space, not in the asset market for ownership. In mathematical terms this can take the following form. Equation (1) shows the demand for space, denoted by D , Rent, denoted by R , and economic conditions (private income, employment growth, location characteristics, financing mechanisms and interest rates) denoted by Z are a function of D . Rents are particularly sensitive to prevailing economic conditions such as employment levels and the rate of growth in industrial production. Figure 1, which illustrates the four quadrant model as portrayed by DiPasquale and Wheaton (1992), shows demand (D) to be equal to the stock of space, denoted by S . Thus, given such an equilibrium, rent, as denoted by R , can be determined.

Conversely, the price of houses largely depends on how many households wish to own units and how many houses are available for ownership in the asset market. To purchase an asset is to acquire the current and future income stream it yields. Thus, changes in the price of rent in the property market (equation (1)) immediately affect the price of assets denoted by Equation (2). Equation (2) shows the price function for real estate asset markets where the price of an asset, denoted by P , is a function of R (taken from equation (1)) and the capitalization rate, denoted by i . Equation (2) implies that the investment motive is determined by the capitalization rate, whether the actors are households or investors. The capitalization rate in real estate markets, is primarily determined by four factors. First, the long term interest rate, the expected growth in rental prices, the risk associated with that rental income in the economy and rules concerning taxing of real estate. Figure 1 shows that with a capitalization rate, which is taken to be exogenous, it is rent R from the NE quadrant which will determine the price of assets P , using a capitalization rate i .

Equation (3) shows the change in supply of new real estate, denoted by ΔS , which is a function of the amount of property space to arrive on the property market, denoted by C , along with the depreciation on yearly basis denoted by dS .⁴ Equation (3) depicts the amount of new construction needed to maintain the current stock of real estate. Figure 1 illustrates how a decreasing stock of real estate will result in an increasing asset price. This will take place through the construction market, as shown by equations (1) and (3). If construction increases and the supply of assets grow, not only are prices driven down in the asset market, but rents decline in the property market. Finally, equation (4) illustrates the replacement cost of real estate. The SW quadrant of figure 1 shows how the cost of construction increases with greater activity.

Equation (1): Property demand for residential property

$$S = D(R, Z) \tag{1}$$

Equation (2): Asset price for residential property

$$P = \frac{R}{i} \tag{2}$$

⁴DiPasquale & Wheaton 1992.

Equation (3): Change in supply of residential property

$$\Delta S = C - dS \tag{3}$$

Equation (4): Change in supply of residential property

$$P = f(C) \tag{4}$$

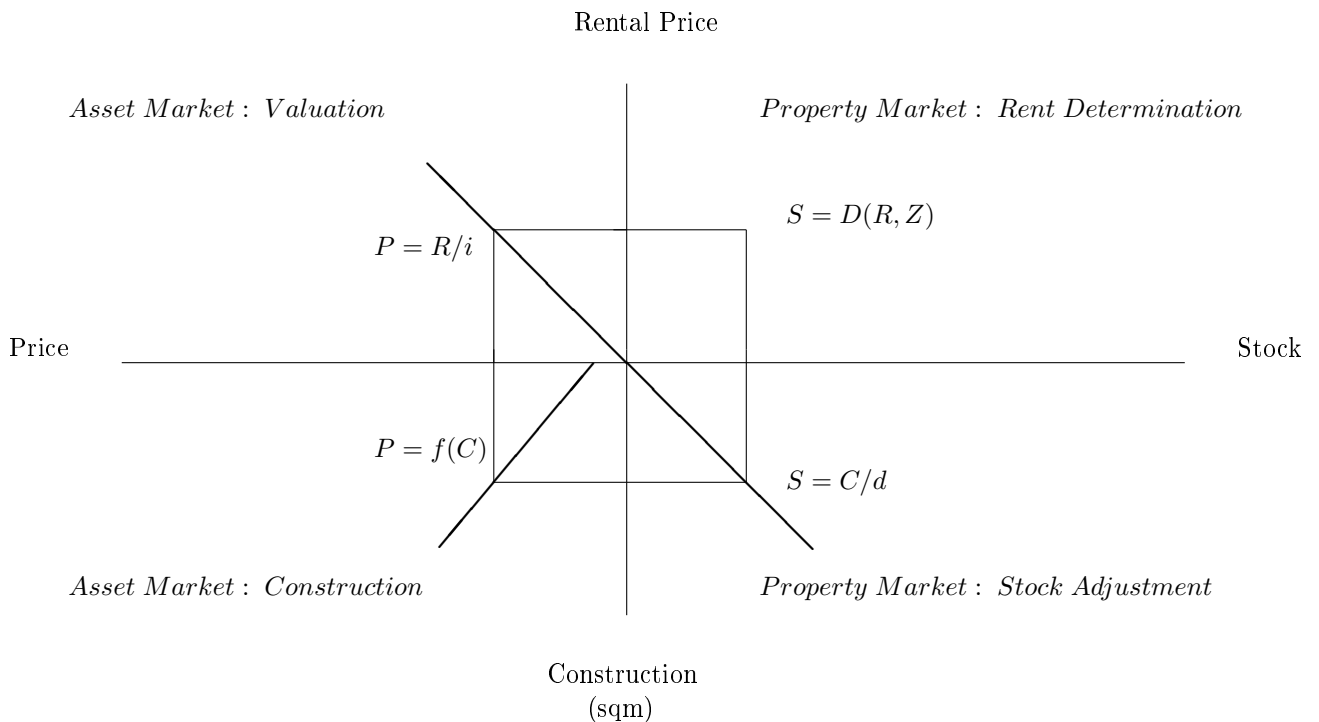


Figure 1: Real estate property and asset markets - Source: Dipasquale and Wheaton

2.2 The The PVR framework

Having established the link between rental and asset prices let's turn our attention to the efficient market condition in real estate. According to the classical theory of asset prices, the price of an asset equals the present value of the stream of income that people expect the asset to pay. Therefore rents are considered a fundamental determinant of the value of housing and as such should not move too far out of line with prices. The efficient market condition (PVR framework) in housing markets follows a similar argument and requires the rational representative agent to equate the real expected return from home ownership to the real homeowner cost of capital. This implies that rents are capitalized prices, and should have a common trend (be cointegrated), at least in the long run. Therefore, the PVR framework implies two testable hypothesis:

- i) Housing markets are at least weakly efficient
- ii) There is a cointegrating relationship between housing and rent prices

Assuming the efficient market condition in real estate, the rational representative agent will equate the real expected return from home ownership to the real homeowner cost of capital (with or without risk adjustment). Consequently, the rent-price ratio could be like the dividend to price ratio in the stock market. But Campbell & Shiller (2001) showed that when stock prices have been high relative to dividends, future price growth for stocks was subdued. A similar statement about the housing market might be true.

However, the very existence of a bubble does not conform with the usual assumptions of efficient markets theory. This need not be a surprise since housing markets are characterized by information asymmetries, high transaction costs, and heterogenous assets and beliefs. Case & Shiller (1989) found the PVR relation in the housing market to be negative in the short run, leaving the question open for what happens in the longer term. On the other hand, Meese & Wallace (1992), showed that in the long run, housing prices and capitalized rents share a common trend (are cointegrated) thus ignoring the presence of asymmetries in the housing market as a ruling factor.

One possible explanation for the long run conformity of the PVR framework is the so called rational asset market bubble. It is possible that rational bubbles in the housing market drive a wedge between the present value housing price and the actual price. A characteristic of rational bubbles is that they do not violate first order conditions for an agent's optimization problem, but they do allow for price dynamics to be driven by self fulfilling expectations. On the other hand, one can question the the rational agent view of housing price determination at any time horizon. Such arguments have been made by Mankiw (1989) that predictable demographic changes affect housing prices even though an efficient market should fully discount those.

The only restriction placed on the predictability of returns by the PVR framework for housing price with high transaction costs is the requirement that returns be mean reverting (covariance stationary). If not deviations of present value price and actual price are not bounded.

2.3 The existence of bubbles?

Let us now focus on the empirical question of the existence and detection of a housing bubble. Despite its popularity the term is seldom defined. According to Case & Shiller (2004), a bubble refers to a situation in which excessive public expectations of future price increases cause prices to be temporarily elevated.⁵ For instance, during a housing bubble, home buyers think that a home that would be normally too expensive for them now an acceptable purchase because they will be compensated by a significant future price increase. They will not need to save as much as they otherwise would, because they expect the the increased value to do the saving for them. Moreover, the expectation of large price increases may also have a strong impact on demand, if people think that housing prices are unlikely to fall.

What is the origin of a bubble? In a nutshell, speculative bubbles are caused by precipitating factors that change public opinion about markets or that have an immediate impact on demand by amplification mechanisms that take the form of price to price feedback.⁶ Even so, the real estate bubbles in recent decades have mainly been characterized by general economic expansion, best proxied by employment gains, which drove demand up. What happens? In the short run, those increases in demand encountered an inelastic supply of housing, and vacancy declined. As a consequence, prices accelerated. This provided an amplification as it led purchasers to anticipate further gains and the bubble was born.

Although neoclassical economic theory offers the most advanced framework within which real estate prices can be explained, it is unavoidable to look elsewhere for answers to why bubbles occur. The very existence of bubbles indicates that human beings are not the lightning calculators of pleasures and pains as indicated

⁵Case & Shiller, (2004.)

⁶Case & Shiller, (2004.)

by the neoclassical framework.⁷ In the absence of a self adjusting neoclassical market one can for example turn to a proposed a theory of endogenous financial crisis, where the consequences of a boom and bust cycle are in line with Schumpeter ´s central observation about creative destruction. More specifically a bubble can also be portrayed as the missing step in the standard Keynesian theory where the explicit consideration of capitalist finance within a cyclical and speculative context where finance sets the pace for the economy.⁸ In other words, sharp swings in asset markets drive real economy boom and bust cycles in financial as well as real estate markets.

3 Data, methodology and definitions

3.1 Data

There are four key variables required for this type of research. These variables are: Stockholm housing prices (House), Stockholm rent prices (Rent), the homeowner cost of capital, proxied by the Swedish long run government bond yield (Long), and inflation in Sweden (inflation).

We have assembled data on Stockholm housing prices (House) from 1875-1935. The data on house prices between 1875-1935 was registered manually from the so called ledgers of property. The data on house prices from 1875-1935 was used to calculate the purchase price coefficient. These ledgers of properties contained information concerning, both value estimate of houses on behalf of the tax authorities and list of purchases in the real estate market. The ledgers were published after a government ordinance was put in place in 1857. The chronologically ordered ledgers also contain a information concerning the size of a real estate, year of construction along with information whether a central heating was in place or not.⁹

The purchase price ratio is based about 150-200 observations of property sales each year which have been drawn from the ledgers. The purchase price ratio was calculated by dividing the purchase price to the taxation assessment value. The state officials were supposed to give a tax assessment which should be set according to the value of the property in the area in question, which was called the general sales value. This was defined as; "the amount that a sensible buyer would be assumed to pay for such a property, if it was sold within the circle of clients that would be expected for such a property, and bought for a suitable use with regard to the character of the estate".¹⁰ Information on the average change in taxation values from one assessment to the next was drawn from a sample of 190-346 properties which have been followed during at least two assessment years in the period 1876-1935. Although the ledgers containing this information have been available at Stockholm´s City Archives (Stockholms Stadsarkiv) and the National Library of Sweden (Kungliga Biblioteket) in Stockholm, they have not been used for this purpose before.

Municipalities are the focus of of this paper because real estate markets are usually regulated at this level. However, the administrative borders of Stockholm have changed during the period of question. Several suburban areas were incorporated during the midst of the twentieth century such as Brännkyrka, Bromma, Enskede and Spånga. The housing price index from 1875-1935 presented herein excludes these areas which have been left aside in the data.

Since there is little hope of obtaining historical time series on implicit rents of owner occupied houses, or housing cost, I will use publicly available information on rental prices. Our data on Stockholm rental prices originates from three sources. First, from 1875-1930, time series on rental prices were acquired from

⁷Veblen, 1898.

⁸Minsky, 1975.

⁹köpeskillingskoefficienten) Söderberg, Edvinsson and Author, (2014

¹⁰Söderberg, Edvinsson and author, 2014.

the *National Income of Sweden 1861-1930* Lindahl, Dahlgren and Kock (1937). More specifically, between 1894-1930 this series contains the actual rent price derived from the annual rent per room (yearly average) in Stockholm. During the period 1875-1893 however, rent prices were proxied by the cost of construction in Stockholm. Second, from 1930-1935, information about rent prices in Stockholm was acquired from the *Swedish National Accounts* (Historiska nationalräkenskaper för Sverige: Privata tjänster och bostadsutnyttjande 1800-1980) Krantz (1991).

There are three things to keep in mind about the rent price (Rent) series used for this paper. First, the rent price used herein is *not* adjusted for quality (number of rooms, central heat, lavatories etc.), the same way as the housing price (House) is (see chapter 3.2). Second, the rent price series used from 1875-1935 applies to Stockholm inner-city. Third, from 1917-1923 legislation was put in place (by the state) preventing residential rent prices from increasing in excess of a certain amount, thus preventing the market price mechanism from determining the price. This legislation however was both rendered useless due to the deflationary circumstances of the 20's (see chapter 4.1).

The long run yield (Long) used herein is a long run government bond yield, available at Sweden's Riksbanks homepage.¹¹ From 1887-1918 the series contains a yearly average of returns (bond's price divided by the bond's coupon) on government bonds without maturity. Between 1918-1935, the long run government bond yield was measured as the consol yield. I consider the consol yield to a viable measurement of the cost capital used for real estate investments. The inflation series (Inflation) used herein is available at Sweden's Riksbank homepage.¹² Finally data on income (Income) which is used to calculate the ratio House divided with income originates from Rodney Edvinsson, Growth, Accumulation, Crisis, Almqvist och Wiksell, Stockholm, pp. 323-326. All variables are presented in real terms herein, i.e. deflated by inflation series (Inflation).

3.2 Building price indexes

Empirical testing of any theoretical approach to house price determination is plagued by the problem of measurement error in price indices. Housing is a hedonic good and the rent price of any individual unit must take into account this heterogeneity. The estimation of hedonic indices is a well studied procedure initiated by Griliches (1961) and introduced into housing economics by Ridker and Henning (1967).

There are several methods to take account of the heterogenous nature of the housing good. A well known procedure is the repeat sales method, which calculates the price of the same real estate over time. Another method is the so called hedonic regression approach in which the value of a home can be determined by looking at the value of the constituent components of a home. A hedonic approach would run a regression model to fit a relationship between the sales price of a home, the number of square meters of the home, number of rooms, location, and the time period of the home's sale to name a few factors. As mentioned in chapter 3.1, we have chosen the same method as used by the Swedish official statistical agency, SCB, which has collected price data for residential houses since 1952. Based on this data, SCB has published a housing price series called the purchase price ratio (s: köpeskillingskoefficienten K/T-talet). The purchase price ratio, is a ratio between the sales price and the taxation assessment value and reveals the quota between the tax assessment and the actual sales price. These are based on certificates of registration of ownership titles, "lagfartsbevis". Since the tax assessment takes account of the quality (location, size, age) of the real estate, it controls for some of the measurement problems posed by the heterogeneity of housing. By the same token, the sales price ratio adjusts the bias posed by different units of housing being sold at different times. For example, when the price goes up in a certain neighborhood, as a rule the more expensive units are sold first. Even if the less attractive units are then sold at a higher price the average price index would show a decrease in price. Since the purchase price ratio is a quota, it automatically accounts for the heterogeneity caused by assets of

¹¹Daniel Waldenström, 2006.

¹²Edvinsson and Söderberg, 2006.

a different quality sold at different times. The purchase price ratio therefore overcomes two obstacles at the same time. It takes into account the age of different assets (unlike the repeat sales method) and corrects (manually) for quality of different assets. Of course, the methodology used to calculate the purchase price ratio is based on estimates acquired by manually inspecting the assets. Consequently, there is room for human error (unlike the repeat sales and hedonic method). Moreover, since the valuations were used as basis for taxation, one can also claim that there were incentives to exaggerate the value estimates used for taxation.

4 Historical background and descriptive analysis

4.1 Historical background

I have chosen the period between 1875-1935 for my research period. There are both practical as well as historical reasons for my choice. First, as already mentioned, the data on rent prices between 1875-1930 originates from the same source i.e. *The National Income of Sweden* Lindahl, Dahlgren and Kock and Krantz (1937). Second, at the end of the 1930 's, extensive rent control regulation was introduced in Sweden with price caps being put into place with legislative measures by the state. Moreover, at the end of the 1930 's, changes in the organizational structure of the housing market ("bostadsrätten") also took place. The period 1875-1935 on the other hand, was characterized by limited market regulation, where rent price was determined by supply and demand in the market.¹³ Hence, the period 1875-1935 offers an excellent opportunity to investigate whether or not the efficient market condition was present in the Stockholm housing market (in the long run), i.e. whether housing price is the capitalized value of rent. Finally, Stockholm 's history in the late nineteenth century coincided with Sweden 's great leap towards industrialization between 1880 and 1900, in which time the population of the city doubled.¹⁴ This industrialization of Sweden followed the industrial revolution in Northern Europe during which time many of Europe 's cities were being built. There may therefore be room in which the results of this paper can be used for a wider generalization for other cities of similar size.

Historical records show that during this period, the Stockholm housing market bore all the characteristics of a laissez faire market. During this era, Sweden's industrialization was rapidly turning Stockholm into a major European city with a rapidly growing housing market which was characterized by brief periods of boom and busts. This coincided with an unprecedented expansion in construction between 1883-1893, during which around 40% of Stockholm's housing stock was built. In 1885, this expansion led to an oversupply of housing with a consequent decrease in housing prices. The price decrease wreaked havoc among property owners and contractors many of which went into default causing banks to withdraw lending and raise interest rates. Those who did not perish due to the price decreases were faced higher interest rates and further demands for guarantees. Since the building industry tends to be heavily reliant on short term funding many contractors faced a certain default during this period causing distress to many financial institutions. The housing crisis in 1885 was in many way similar to a modern housing crisis coinciding with a credit squeeze resulting in a credit crisis among banks and other financial institutions.¹⁵ Five years later, in 1890 vacancy was still historically high at 6%. In 1895 however, demand was on the rise again.¹⁶

There were other similar periods of turbulence in the market, such as the downturn in housing prices in 1906 and 1907 following a contraction in the real economy which also coincided with a credit squeeze. Consequent bankruptcies of many construction companies took place as interest rates rose. Construction and new building activity contracted substantially in the following years.¹⁷ Compulsory sales of property in Stockholm rose strongly in 1907 and the two subsequent years.¹⁸ In 1910 however, housing prices were rising and real interest rates were decreasing.

In 1914 the Scandinavian Monetary Union (Skandinaviska myntunionen), formed by Sweden, Norway and Denmark ceased to exist. The currency union which lasted from 1873-1914 relied on the gold standard to maintain price stability. The countries involved pegged their currencies to gold, 2,48 kronor per gram of gold. In 1914 the currency union came under duress due to increased government spending during the First World War. Since the countries did not have a common state budget, guarantees to uphold their mutual

¹³Jacobsson, 1996, bls 113.

¹⁴Schön, (Schön)

¹⁵Jacobsson, 2006, pp. 66.

¹⁶Jacobsson, 2006, pp. 104.

¹⁷Edvinsson, 2005, pp. 319.

¹⁸Perlinge, 2012, pp. 15-43; Fritz 1994, pp. 291-305

commitments broke down. In August 2014, Sweden abandoned the tie to gold on, and without a fixed exchange rate the free circulation came to an end. The result was a considerable increase in inflation in which real housing prices were driven down reaching a low point in 1920. During this period, investment in new construction was at a standstill, due to a rise in real interest rate and uncertainty among investors concerning the economic outlook. The high inflation also caused social upheavals which resulted in a limited rent control legislation from 1917-1923.¹⁹ However, the rent control was short lived, due to the deflation period of the early 1920's which made rent control next to irrelevant and the heavy resistance among owners of residential property as well as several renowned economists.²⁰

After the abolishment of rent controls in 1923, the rental market was virtually unregulated until 1938. Between 1920-1935 there were simultaneous increases in housing and rent prices, where housing prices almost doubled in real terms (albeit not recovering from the decrease during 1WW) and rent prices almost tripled. Generally speaking in the early 1920's, there is little doubt, that increased certainty concerning future prospects, paved way for a correction in asset markets. Despite the high inflation during the 1WW, Sweden's economic fundamentals were not altered in any meaningful way. After all, no fighting had taken place in Sweden which upheld its neutrality during the conflict. More specifically, the increase in housing and rent prices were mainly due to lack of supply of housing and a considerable demographic change in Stockholm's population in the early 1920's. During the 1WW uncertainty and high inflation resulted in a lack of investment in new construction. The lack of investment created a severe shortage of housing after 1920. This coincided with an unusually large in-migration to Stockholm where demand for middle sized flats increased substantially. Notably, an increase in quality may also have played a part in the the increase in rent prices since apartments now offered increased quality such as access to bathrooms, and central heating systems. Finally during the 1920's a substantial decrease in interest rate took place in which the average yield on a government bond (Long) decreased from 4.6% (average yield from 1914-1920) to 3.4% (average yield from 1920-1935) (see: Figure 2). Not surprisingly, construction resumed during the 1920's with emphasis on small and middle sized flats some of. It was not until after 1930 that housing and rent prices decreased again, and then after the Great Depression which had taken a foothold in Europe.

4.2 Descriptive analysis

Figure 2 depicts the four key variables used for this thesis, House, Rent, Long, Inflation along with two ratios, Houseincome (House divided by Income) and Housetorent (House divided by Rent). House, Rent are shown as indexes starting in 100 in 1875. Houseincome and Housetorent are fixed at 1 from 1875. All variables are presented in real terms. Moreover, there are both historical and macroeconomic grounds to divide the 60 year period into the following three phases since it is necessary to isolate an unusual outlier during the 1WW and the subsequent inflation/deflation which is considered an exogenous shock with little relevance to the topic of this paper.

- i) Phase 1: 1875-1914
- ii) Phase 2: 1914-1920
- ii) Phase 3: 1920-1935

The period from 1875-1914 when housing prices more than doubled. From 1914-1920 figure 2 shows that real housing prices (House) decreased substantially as result of rising inflation. During the third phase, between 1920-1935, housing prices recovered from the inflationary crisis during the first World War. From 1875-1914, rent prices increased considerably albeit not as much as housing prices. The inflation period during the First World War, from 1914-1920, caused rent prices to decrease considerably. In the third phase, from 1920-1935, rent prices saw a significant increase. Figure 2 shows a relatively stable inflation from 1875

¹⁹Jacobsson, 2006, pp. 161.

²⁰Forsell, 2003, pp. 286-295.

to 1914 with the inflation rate reaching more than 40% during the 1WW. This period was followed by severe deflation which lasted into the early 1920's until prices stabilized again. Similarly, Long (the real long run yield) was relatively stable until the 1WW when high inflation resulted in a negative yield until inflation stabilized in the early 1920's when the long run yield (Long) reverted to a lower level than before 1WW.

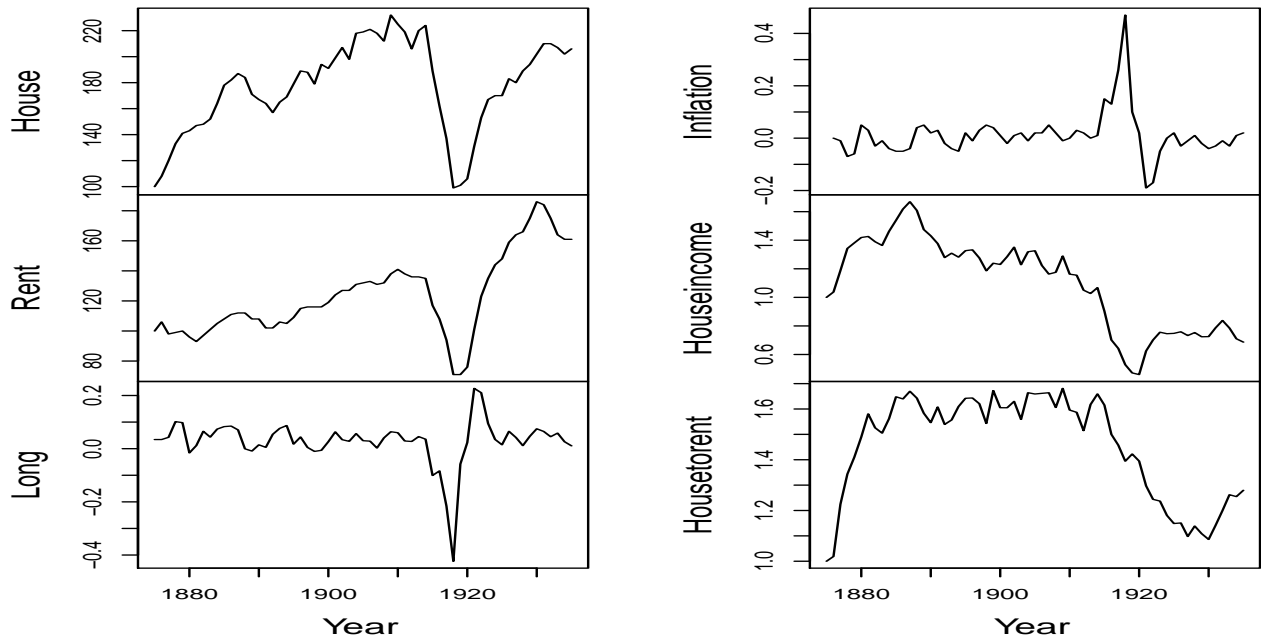


Figure 2: *Key variables.*

- House: Stockholm real price house index, 1875=100. Source: Real property prices in Stockholm (2013). Söderberg, Edvinsson and Author. Department of Economic History Stockholm University. Sveriges Riksbank.
- Rent: Stockholm real rent price index, 1875=100. Source: The National Income of Sweden (1937). Lindahl, Dahlgren, Kock and Krantz.
- Long: Swedish long run government bond real yield. Source: Svenska aktiekurser, aktieavkastningar och obligationsräntor 1856-2006 (2007). Waldenström. Department of Economic History Uppsala University. Sveriges Riksbank.
- Inflation: Swedish inflation rate. Source: Historical Monetary and Financial Statistics for Sweden: Exchange Rates, Prices, and Wages, 1277-2008 (2011). Edvinsson. Department of Economic History. Sveriges Riksbank.

4.3 Statistical inference

Now, let's look closer at the research period. Figure 3 shows the index for Stockholm housing prices (House) between 1875-1935, figure 7 shows the the index for rent prices between 1875-1935. As already mentioned there I have divided the 60 year period into three phases. Figures 3 and 7 show a similar upward trend for both variables although housing prices increased faster, until the 1WW when both variables took a sizable hit due to high inflation. From 1920-1935 both variables recovered in a similar pace.

It's useful to look at return from the perspective of investors as well as rent prices from the perspective of tenants. Tables 1-3 show the average, accumulated and total changes in Housing and rent prices during the three periods mentioned before. The tables give an idea how much an investor increased/decreased his asset value during the periods in question as well as how rapidly rent changed in the same periods. Notably, housing prices increased more rapidly than rent, from 1875-1914. Housing prices increased each year by 5.4% in real terms, on average compared with a 2% increase in rent prices in real terms, during the same period.

Table 1 shows that there were significant gains to made in the Stockholm housing market during this period whereas price of rent does not seem to have followed the rapid gains in the asset market for housing. Investors may have been preoccupied with construction and speculative asset gains instead of trying to increase rent, or/and the average tenant's ability to pay higher rent may have been limited considering economic circumstances growth in purchasing power at the time.

Between 1914-1920 however, all asset markets experienced a sizable decrease following the inflationary crisis during the the First World War with a more than 50% decrease in housing and rent prices in six years. Remarkably, rent prices decreased by a similar amount as housing prices during this periods, or by 3.8% a year on average compared to 4.9% a year for housing prices showing itself to be just as vulnerable to inflation as asset prices.

Phase 3 on the other hand, saw significant increases of housing prices by 4.6% a a year (on average) as well as rent prices, with rent increasing by more than 6.3% year, on average from 1920-1935. Table 4 shows the same results for the whole period from 1875-1935. Finally, figure 5 shows the ratio between rent and housing prices from 1875-1935. This ratio can be interpreted as the dividend to price ratio for stocks, and can be used as an indicator about the price of a real estate relative to the cash flow it produces.



Figure 3: House: Stockholm real price house index, 1875=100. Source: *Real property prices in Stockholm (2013)*. Söderberg, Edvinsson and Author. Department of Economic History Stockholm University. Sveriges Riksbank.

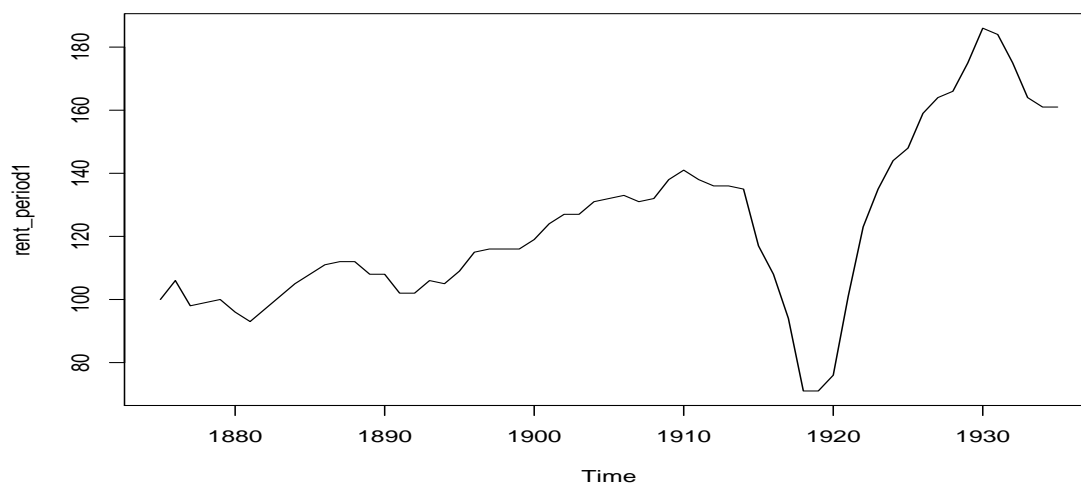


Figure 4: Rent: Stockholm real rent price index, 1875=100. Source: *The National Income of Sweden (1937)*. Lindahl, Dahlgren, Kock and Krantz.

1875-1914	Yearly change on average	Accumulated increase/decrease	Total increase/decrease
House	5.4%	102.8%	120.4%
Rent	2%	31.7%	34.9%

Table 1: Average, accumulated and total increase/decrease in real rental and housing price in Stockholm 1875-1914.

1914-1920	Yearly change on average	Accumulated increase/decrease	Total increase/decrease
House	-4.9%	-51.7%	-52.6%
Rent	-3.8%	-52.3%	-43.8%

Table 2: Average, accumulated and total increase/decrease in real rental and housing price in Stockholm 1914-1920.

1920-1935	Yearly change on average	Accumulated increase/decrease	Total increase/decrease
House	4.6%	78.1%	95.2%
Rent	6.3%	106.8%	148.6%

Table 3: Average, accumulated and total increase/decrease in real rental and housing price in Stockholm 1920-1935.

1875-1935	Yearly change on average	Accumulated increase/decrease	Total increase/decrease
House	1.2%	113.7%	103.9%
Rent	1.1%	79.5%	88.5%
Long	3.99%	150%	-%

Table 4: Average, accumulated and total increase/decrease in real rental and housing price in Stockholm and Swedish Government bond real yields 1875-1935.

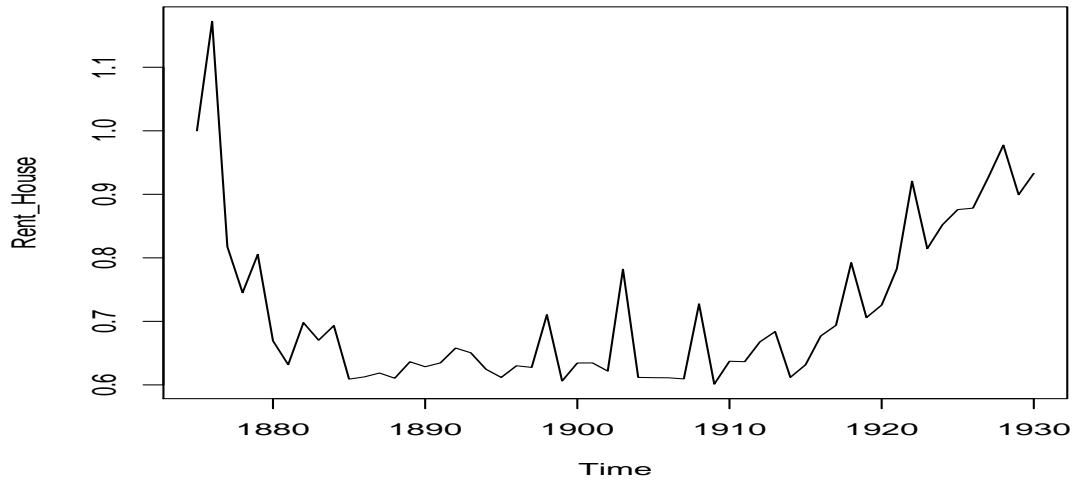


Figure 5: Real housing price divided by real rent. Source: Lindahl, Dahlgren, Kock and Krantz. and House: Stockholm real price house index, 1875=100. Source: Real property prices in Stockholm (2013). Söderberg, Edvinsson and Author. Department of Economic History Stockholm University. Sveriges Riksbank.



Figure 6: Real housing price divided by real income. Source: Lindahl, Dahlgren, Kock and Krantz. and House: Stockholm real price house index, 1875=100. Source: Real property prices in Stockholm (2013). Söderberg, Edvinsson and Author. Department of Economic History Stockholm University. Sveriges Riksbank.

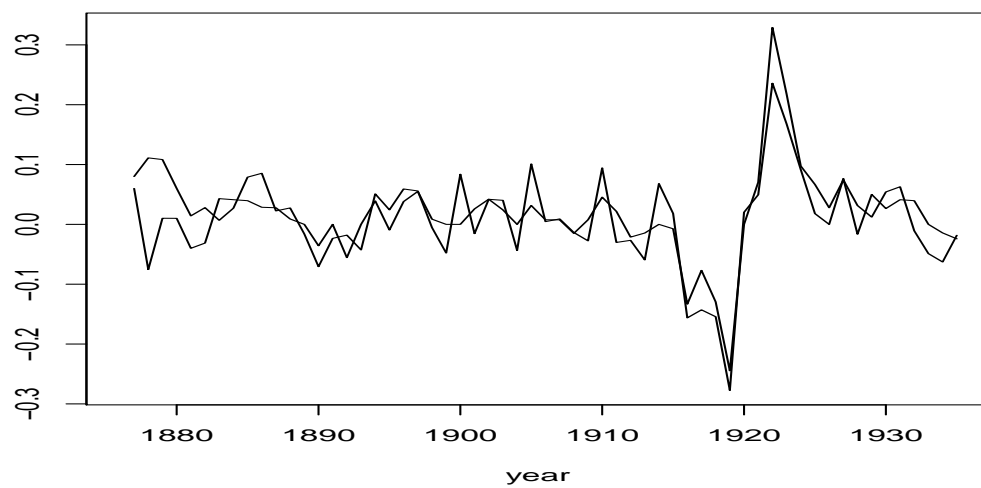


Figure 7: *Stockholm housing and rent prices, YTY change* Source: *The National Income of Sweden (1937)*. Lindahl, Dahlgren, Kock and Krantz.

5 Econometric analysis

5.1 Cointegration

Since our task is to investigate whether Stockholm housing and rent prices share a common trend (are cointegrated). The statistical concept of cointegration is in many ways closely related to the theoretical concept of a long run equilibrium. Consider two I(1) stochastic processes. These processes are said to be cointegrated if and only if they have a common (stochastic) I(1) factor and idiosyncratic components. Imagine now that X_t and Y_t are in fact, related to each other in the following form:

$$\begin{aligned}X_t &= X_{t-1} + \varepsilon_{xt}, \varepsilon_{xt} IID(0, 1) \\Y_t &= \beta X_{t-1} + \varepsilon_{yt}, \varepsilon_{yt} IID(0, 1)\end{aligned}$$

The variables X_t and Y_t are still both I(1). They are still both random walks. But now there exists a "true" relationship between them. The relationship between X_t and Y_t can be characterized by the vector $[1 - \beta]$ (since $1 * Y_t - \beta * X_t = E(\varepsilon_{yt}) = 0$). This vector is called the cointegrating vector and β is the cointegrating parameter. It defines the long run, or, equilibrium relationship between these two variables.

The variables X_t and Y_t are said to be cointegrated since there exists a linear combination of the two variables, $Z_t = Y_t - \beta X_t$, which is a stationary, I(0) variable. (In this example, Z is equal to ε_{yt} which is an I(0) variable — by construction). When the two variables are cointegrated, OLS is a super consistent estimator of β .

Now, let's look at the concept of a long run equilibrium. To demonstrate this, let us first define an equilibrium relationship between Y_t and X_t as follows:

$$Y_t = \alpha + \beta X_t$$

Then we can define $z_t = Z_t - \alpha = Y_t - \beta X_t - \alpha$, to be the "equilibrium error", which tells us how far the value of Y_t is from its equilibrium value (given X_t). If z_t is stationary and fluctuating around zero, then the system will be in equilibrium on average, despite the fact that both Y_t and X_t are trending. On the other hand, if z_t is non-stationary, the equilibrium error will wander widely and zero crossing will be rare (i.e. the system will rarely be in equilibrium — if ever).

The concepts of cointegration and error correction are closely related. An error correction model for two variables relates the changes in the variables to lagged changes and a lagged linear combination of levels.²¹ This type of model was introduced by Phillips (1954) and Sargan (1964) and has been promoted by Davidsson, Hendry, Srba and Yeo (1978), Hendry and Richard (1983), Hendry (1983, 1986). Engle and Granger (1987) showed that two variables which are cointegrated of order (1,1) have an error correction representation. The linear combination of levels which enters the error correction is just that combination which is stationary in levels.

There is also a less formal link between cointegration and error correction. At the least sophisticated level of economic theory lies the belief that certain pairs of economic variables should not diverge from each other by too great an extent, at least in the long run. Thus, such variables may drift apart in the short run or according to seasonal factors, but if they continue to be too far apart in the long run then economic

²¹Engle & Granger, 1987.

forces, such as the market mechanism or government intervention will bring them together again.²² Hence error correction models for cointegrated economic variables can be interpreted as reflecting the partial adjustment of one variable to another.

5.2 Empirical results

A first step is to test for the presence of unit root for each of the three periods defined in refda2. The augmented Dickey Fuller test (ADF) is applied to the data sample of House and Rent for the three respective periods. Using the general to specific method to determine the appropriate number of lags, the results are given in table 5.2.4 — 5.3.7 in Appendix.

The ADF test follows a null hypothesis assuming a unit root, i.e. $\phi_3 = (\beta_1, \beta_2, \pi) = (\beta_1, 0, 0)$

The hypothesis is tested by a usual F-type test. Zero restrictions are placed on the time trend and the lagged value. The results for period 1 are shown in tables 5.2.4-5.2.7. Housing prices (House) has a test statistic of 3.14 and rent (Rent) has a test statistic of 4.61. Hence, the hypothesis cannot be rejected, which implies that both variables contain a unit root. This finding is reiterated by a t ratio for housing prices of -2.49 for the lagged endogenous variable in levels, -2.992 for rent. The conclusion is that a unit root is present and both variables are integrated by the order one for all of the respective periods, but contain neither a linear trend nor a drift is present in the data generating process. Tables bla and bla in Appendix show the test results for periods 2 and 3 respectively.

This thesis follows the procedure of Holden and Perman (1994) in applying the Engle Granger two step method enabling an estimation of the long run relationship of housing prices (House) and rent prices (Rent). Housing and rental prices (House and Rent) are entered separately as endogenous variables and estimated by ordinary least squares (OLS). The residuals of these two long run relationships are stored as objects. An augmented Dickey Fuller (ADF) type test is applied to the residuals of each equation in order to test whether the variables are cointegrated or not (using the critical values found in MacKinnon (1991)). Tables bla show the results for the ADF test which confirms that the residuals from equation bla are stationary but also shows that the residuals from equation bla are not stationary. Table bla show the results from the Jarque Bera test which shows that normality in the residuals for equation bla can not be rejected. On the other hand, normality in the residuals for equation bla is strongly rejected. The results enable us to proceed with equation bla. On the other hand, the model shown by equation bla can not contain any meaningful relationship between Housing prices (House) and rent prices (Rent).

I estimate a well well specified, single equation, error correction model. Table 5.3.1 shows that the test statistics imply cointegration for error term of housing prices (House) to rent (Rent) which is significant at the 5% level since -2.47 is less than -1.95 (MacKinnon 1991), but not for the error term of rent (Rent) to housing prices (House). Furthermore, Table 5.3.1. shows that the Jarque Bera test indicates that the null hypothesis of normality in the residuals can not be rejected for housing prices (House) to rent (Rent), but not the other way around. The conclusion is that the residuals from housing prices (House) to rent (Rent) are stationary but the residuals from rent (Rent) to Housing prices (House) are non-stationary. Thereby rent could be considered as stationary with a broken trend. This is confirmed by figure 5.3.2. which shows a broken trend in the residuals for rent (Rent).

For us to know here is more to come as :

- Figure 5.2.1. — Residuals: House equation
- Figure 5.2.1. — Residuals: House equation

²²Granger, 1986.

Variable	ADF	JB p-value	5%
House	0.044	0.8924e - 07	1.95
Rent	-2.47	0.22	-1.95

Table 5: Table 5.2.1

- Figure 5.2.2. — Residuals: Rent equation

Next I specify an error correction model (ECM) for housing prices (House) and rent (Rent) in equation BLA. It should be restressed at this point that if two series are cointegrated, then there should be Granger causation in at least one direction. That is, at least one coefficient of the error term should enter equations BLA significantly and with a correct sign (i.e. negative). Hence, even if the lagged differences of the Housing prices (House) and rent (Rent) regressors do not enter significantly, the levels might have an impact through the residuals and hence Granger cause housing prices (House) and/or rental prices (rent). Tables 5.2.2 and 5.2.3. show the regression results.

As might be expected from earlier tests the coefficient of the error correction term in the rental price (Rent) function in table 5.3.3. does not enter significantly and has the wrong sign. On the contrary, the error correction term in table 5.3.2. does enter significantly and has the correct sign in the housing price (House) equation. The error of the period is worked of by -0.22 and the remaining regressor does also enter significantly into the ECM. These results imply Granger causation from rental prices (Rent) to housing prices (House).

Variable	Estimate	Std. Error	t-value	Pr
Intercept	0.30	2.20	0.14	0.88
Error ecm2	-0.22	0.08	-2.52	0.01
Rent__period 1.d	1.04	0.29	3.53	0.00

Table 6: `house_period1.d~error.ecm1+house_period1.d+rent_period1.d`

Variable	Estimate	Std. Error	t-value	Pr
Intercept	1.28	0.90	1.42	0.16
Error ecm2	0.06	0.05	1.05	0.29
House__period 1.d	0.18	0.04	3.82	0.00

Table 7: `lm(formula=rent_period1.d~error.ecm1+rent_period1.d+house_period1.d)`

The result in table 5.2.2. establishes the long run relationship of housing prices (House) and rental prices (Rent) and shows that changes in this two variable system relate the change in housing prices (House) to past equilibrium errors, as well as past changes in both housing prices (House) and rental prices (Rent). The error correction term tells us the speed with which our model returns to equilibrium following an exogenous shock. It should be negatively signed, indicating a move back towards equilibrium. A positive sign indicates movement away from equilibrium. The coefficient should lie between 0 and 1, 0 suggesting no adjustment one time period later, 1 indicates full adjustment. The error correction term can be either the difference between the dependent and explanatory variable (lagged once) or the error term (lagged once), they are in effect the same thing. The coefficient of -0.22, suggests 22% movement back towards equilibrium following a shock to the model, one time period later.

6 Conclusions

The main purpose of this paper has been to establish whether housing and rent prices share a common trend in the long run. And thus, to determine whether there were speculative bubbles in the Stockholm housing market during the period 1875-1930. This period offered an excellent opportunity for such an investigation due to limited regulation in the housing market. Finally, a newly generated data on Stockholm housing prices from 1875 and data on Stockholm rent prices have given us rare insight into the Stockholm housing market.

According to theory established in chapter 4.3, a speculative bubble does not conform with the usual assumptions of efficient market theory (PVR framework). Consequently, according to the efficient market theory, capitalized rents should determine housing prices, at least in the long run.

Descriptive analysis in chapter ?? indicated that housing (House) and rent (Rent) prices enjoyed a similar trend between 1875-1930. During this period three phases were detected, i.e. from 1875-1914, 1914-1920 and 1920-1930. Further analysis in chapter 4.3 supported our initial suspicion that housing and rent prices trended in a similar way. In the first phase housing prices rose on average by 4.5% a year doubling the real value of the housing stock in less than 40 years. Rent prices also rose during this period, albeit less. The second phase saw a considerable decrease in the real value of housing and rent prices, by more than 50%, due to high inflation which caused a severe decrease in value in all asset markets. Finally, the phase from 1920-1930 can only be described as a general economic expansion in which housing and rent prices increased by 4.4% and 6.2% a year respectively.

After applying the statistical procedure of testing for cointegration, we have concluded that Stockholm housing and rent prices share a common trend, i.e. that they return to a long run equilibrium after experiencing an exogenous shock. More specifically, the results indicate a 22% movement back towards equilibrium following a shock to the model, one period later, i.e. one year later. Therefore, we conclude that during the period 1875-1930 there was no indication of a speculative bubble in the Stockholm housing market.

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Appendix



Figure 8: *Long*: Swedish long run government bond real yield. Source: *Svenska aktiekurser, aktieavkastningar och obligationsräntor 1856-2006 (2007)*. Waldenström. Department of Economic History Uppsala University. Sveriges Riksbank.

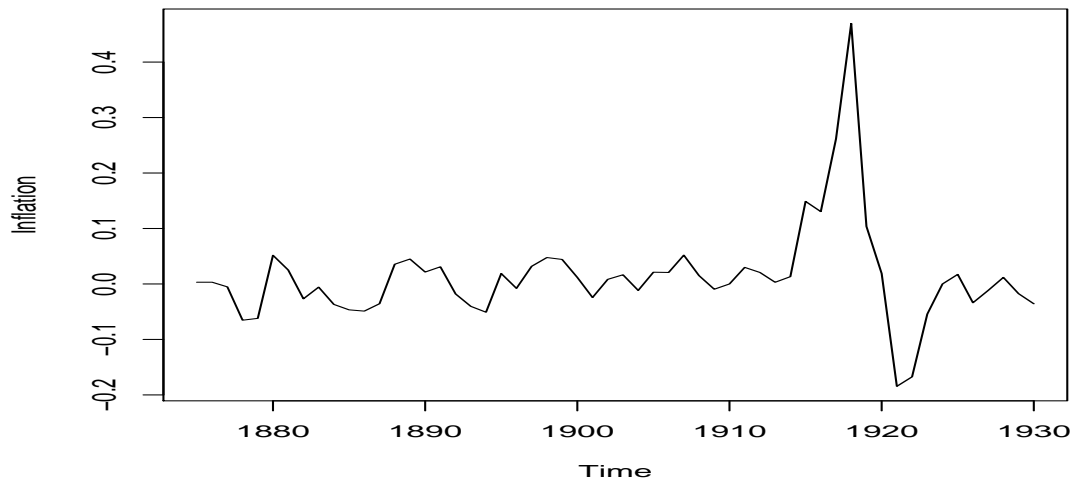


Figure 9: *Inflation*: Swedish inflation rate. Source: *Historical Monetary and Financial Statistics for Sweden: Exchange Rates, Prices, and Wages, 1277-2008 (2011)*. Edvinsson. Department of Economic History. Sveriges Riksbank.

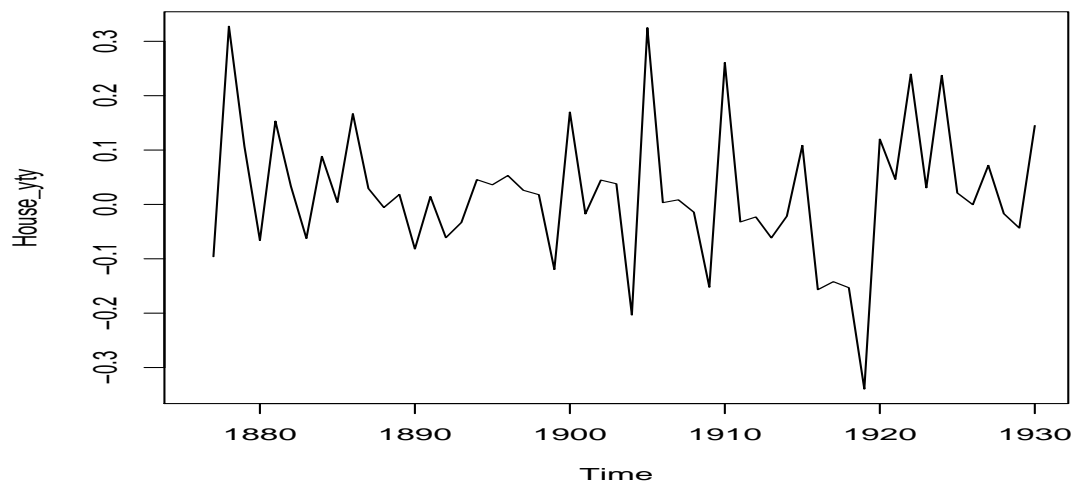


Figure 10: *House: Year to Year real change.* Source: Johan Söderberg, Rodney Edvinsson and Author at Department of Economic History Stockholm .

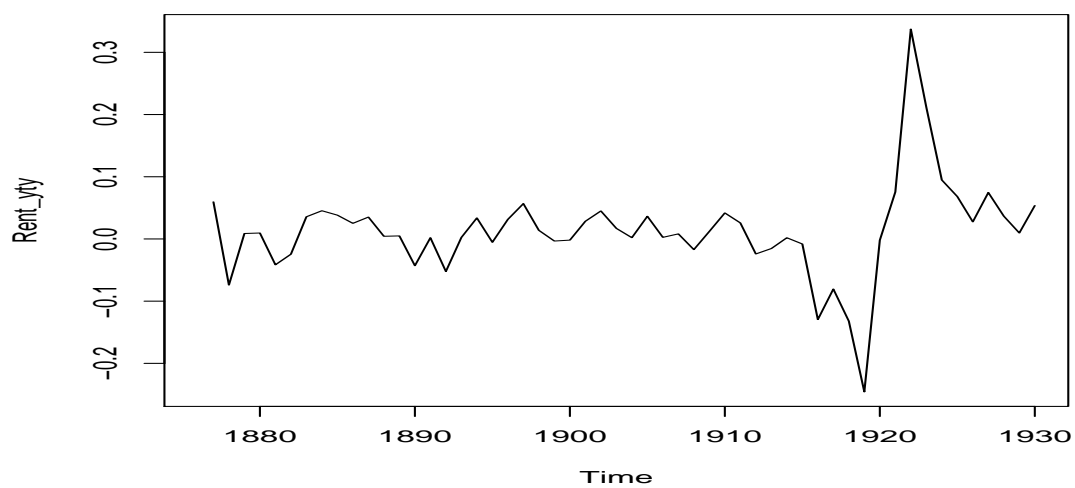


Figure 11: *Rent: Year to Year real change.* Source: Lindahl, Dahlgren, Kock and Krantz.

1875-1890	Yearly increase on average	Accumulated increase/decrease	Total increase/decrease
House	3.7%	63%	71.5%
Rent	0.5%	8.5%	7.8%
Long	3.7%	73.6%	-%

Table 8: Average, accumulated and total increase/decrease in real rental and housing price in Stockholm and Swedish Government bond real yields 1875-1890.

1890-1905	Yearly increase on average	Accumulated increase/decrease	Total increase/decrease
House	1.5%	33.9%	25.7%
Rent	1.3%	20.9%	21.9%
Long	2.8%	52.4%	-%

Table 9: Average, accumulated and total increase/decrease in real rental and housing price in Stockholm and Swedish Government bond real yields 1875-1930.

1905-1920	Yearly increase on average	Accumulated increase/decrease	Total increase/decrease
House	-4.7%	-54.9%	-51.5%
Rent	-3.6%	-48.7%	-48.7%
Long	-4.5%	-49.6%	-%

Table 10: Average, accumulated and total increase/decrease in real rental and housing price in Stockholm and Swedish Government bond real yields 1905-1920.

1920-1930	Yearly increase on average	Accumulated increase/decrease	Total increase/decrease
House	4.4%	75.8%	91.2%
Rent	6.2%	105.5%	145.8%
Long	4.2%	84.4%	-%

Table 11: Average, accumulated and total increase/decrease in real rental and housing price in Stockholm and Swedish Government bond real yields 1920-1930.

House 1875-1930	1pct	5 pct	10pct
tau3= -2.49	-4.04	-3.45	-3.15
phi2= 2.20	6.50	4.88	4.16
phi3= 3.14	8.73	6.49	5.47

Table 12: Table 5.2.4 (5 lags)

Rent 1875-1930	1pct	5 pct	10pct
tau3= -2.99	-3.45	-3.45	-3.15
phi2= 3.15	4.88	4.88	4.16
phi3= 4.61	6.49	6.49	5.47

Table 13: Table 5.2.6 (1 lag)