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House Prices for Real – The Determinants of Swedish Nominal Real Estate Prices

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Abstract

We examined what drives Swedish real estate price changes in general and whether or not Swedish real estate is currently overvalued. We examined if money supply is an important factor in particular. In accordance with previous research in the field, we estimated an Error Correction Model (ECM) using quarterly data from 1987-2011 to determine what factors were significant and used these factors to and their coefficients to explain the Swedish real estate price development in this period.

We found that bank lending rate, financial wealth, disposable income, unemployment and money supply were determining factors in the short- and/or long-run. The first four factors being significant is in accordance with previous studies, whereas money supply is seldom an explanatory variable in previous research using an ECM model. However, the effect of money shocks on real estate prices has been confirmed in a wide range of studies. Possible policy implications of this finding depend on how money is viewed by the policy maker.

Using our long-run model and the actual values of the variables, real estate prices are found to be at their long-run equilibrium and 93.5 percent of the change in real estate prices was explained by the model. We therefore concluded that there is no overvaluation of Swedish real estate.

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1. Introduction

1.1 Background

Swedish nominal house prices have increased by approximately 325% the last 15 years and real house prices about 144% (Claussen, 2012). We are at the same time in one of the largest economic crises in history and the housing market in the United States has been lead in to a disastrous bubble (Sornette & Woodard, 2009). As GDP, the OMX stock market index and employment stagnated and/or decreased, real estate prices reached an all time high with no downturn in sight. Housing costs constitute a major share of each household's expenses and as the inflation rate was said to remain at a stable low level, the money supply was still increasing rapidly. This perceived discrepancy raises the question if the Swedish housing market is facing a disastrous bubble. In more concrete terms; are the Swedish house prices at a "long run equilibrium" or are they overvalued? Could there be a connection between money supply and real estate prices?

1.3 Purpose

The purpose of this paper is to clarify whether money supply affects Swedish real estate prices, and indirectly cause and/or inflate housing bubbles, or not. Further on this paper means to clear out the determinants of Swedish nominal real estate prices and if real estate prices are overvalued, i.e. ultimately if there is a housing bubble to come, or at some kind of equilibrium.

1.4 Issues

- What determines Swedish nominal real estate prices?
- Does money supply affect nominal real estate prices?
- Are Swedish real estate prices overvalued?

2. Theoretical Framework

2.1 What drives housing prices?

When evaluating the literature regarding what determines housing prices, most research performed in the field that we've encountered all point towards similar de facto determinants of housing prices. There appears to be incoherence, however, regarding what factors are driving house prices the most, i.e. to what extent each factor matters. Our view is confirmed by Borowiecki, K. J. (2009), which also reviewed research regarding the determinants of housing prices and came to the same conclusion. Researchers in the field have examined a multitude of factors as determinants of house price changes. Due to the scope of this essay, we will chose to mention only those publications examining macroeconomic factors and alike.

Adams & Füss (2009) used data from 15 OECD countries and saw that macroeconomic activity ("real money supply, real consumption, real industrial production, real GDP and employment"), construction costs and long-run interest rates were the most contributing factors of house prices changes. Two very important conclusion were drawn: i) 9 OECD countries responded to macroeconomic shocks the same way, which means that predictions about the future can be made ii) the predicted time for the house prices to return to long-run equilibrium price was underestimated in previous research (this prediction was 14 years) and that this underestimation occurred due to low levels of aggregation in data.

Even though many factors affect the house prices the same way, structural differences between nations matter. Borowiecki (2009) looked at the case of the Switzerland housing economy. According to the author, real GDP changes only affects house prices to a minor degree in the short term relative to changes in population and construction costs in Switzerland. This goes against other empirical studies, such as Holly & Jones (1997), which determines real income as the largest contributor to an increase in real estate prices in the UK since the 1940s.

Claussen (2012) investigated whether or not Swedish houses were overpriced. He concluded that this was not the case using the models he used. In the same publication, he determined that the determinants of Swedish house price increases were fall of mortgage rate (to the extent of 62 percent), real disposable income increases (25 percent), and, to a lesser extent, increases in the financial wealth of households (8 percent). Claussen, Jonsson & Lagerwall (2011) confirms that these factors are all relevant determinants for the three housing price trends since 1986 and adds that there has been an increase in preference of consumption towards housing consumption driving real estate prices upwards. The authors also ruled out the possibility of construction costs being a relevant determinant of housing prices on the basis of causality: the increased real estate prices drive up construction costs and not the other way around, due to inter alia the low level of competition in the construction sector. The authors point out that the factors determining the real estate price also to a large extent determine the construction cost, why the correlation between the two was ruled out.

Even though the Swiss housing prices appear to be determined by different factors than the UK housing prices (comparing Borowiecki (2009) to Holly and Jones (1997)), the study by Barot and Yang (2002) showed similarities in determinants of the real estate price development between the UK and Sweden between 1970 and 1998. Tobin's q^1 for each country was an important determining factor (in Sweden only in the long run and in the UK in both long run and short run). Household mortgage debt drives prices up, as increased lending increases demand for housing. This effect affected prices less in Sweden than the UK in the short run, but more in the long run. Both nominal and real interest rate increases drives prices downwards in the short and long run and more so in Sweden than the UK.

The studies mentioned above looked at a few decades back of housing price changes. Holly and Jones (1997) on the other hand evaluated different possible

¹ $Tobin's\ q = (Market\ House\ Price\ index)/(Market\ Construction\ Cost\ Index)$ (Barot & Yang, 2002)

determinants of housing prices in the UK between 1939 and 1994, such as real income, demography, interest rates and the housing stock. Amongst the conclusions drawn in this study, real income was the most important determining factor, although real interest rate was also found to be important. Another interesting conclusion was that house prices go to equilibrium faster when above the trend than below.

We conclude that Jacobsen & Naug (2005) confirms the findings of Holly & Jones (1997) when studying the Norwegian housing price development between 1992 and 2005 and naming interest rate and household income amongst the most important factors in determining house prices. Other important factors were housing construction and unemployment. What could be interesting to include from Jacobsen & Naug (2005) to the purpose of setting a theoretical framework is that house price changes have effects on the economy as a whole, which in turn can affect the housing prices. An increase in housing prices would yield positive returns to investment in the construction sector, thus attracting investments, and increased consumption by households through mortgage funding. A decrease in housing prices on the other hand is amplified by decreased lending by banks as a consequence of fewer households servicing the debt and will also lead to lower private consumption, according to the authors.

When looking at the literature in the field, it is abundantly clear that decreasing the interest rate leads to higher housing prices. Other factors matter too, but to which extent is different depending on econometric approach and country of study.

2.2 What is a bubble – do they exist?

Even if many economists on a daily basis are speaking of bubbles, an economic bubble does not have to be a straightforward phenomenon or have an easy definition. However, a general definition of a “bubble”, described by Palgrave (1926), could be: “any unsound commercial undertaking accompanied by a high degree of speculation”“. This can be put in contrast to Stieglitz (1990) where he

defines a bubble as: "...the reason that the price is high today is *only* because investors believe that the selling price will be high tomorrow" and "when fundamental factors do not justify such a price. Only by looking at these two definitions we find it quite difficult to distinguish what a bubble truly is.

When Siegel (2003) considered two of the most famous bubbles in American history, the great depression in 1929 and the oil crisis in 1987, he reached the conclusion that even if these two occasions are generally seen, both by the public and economists, as bubbles, they were in fact not. Siegel compared subsequent cash flows, from future dates, in order to see if prices were overpriced, in relation to returns of future cash flows, or not. He reached the conclusion that cash flows from the 1940's and 1950's justified the stock prices of 1929. In 1987, it was sufficient to reach over a much shorter period of time to see that stock prices were not only justified, but also probably even underpriced, when examining subsequent cash flows. As stated earlier, the determination of a bubble is not an easy task.

Stiglitz further discusses to which extent prices of assets are represented by, so called, fundamental values and the difficulty to determine these fundamental values. He then describes the major problems in determining the fundamental values; estimating returns received over time, estimating terminal values at the end of the period and how to determine the appropriate discount rate. Stiglitz symposium also stresses that even if you believe in the presence of bubbles or not, you still have to face a number of challenges. Those economists that do not believe in bubbles or are convinced of their existence, such as Siegel, still have the challenge to provide solid and reasonable explanations to events like the crashes in the US in 1929 and 1987 (Stiglitz 1990).

To further examine bubbles, it is crucial to try to understand the fundamental market explanations. Market fundamentals is described by Garber (1990) where the fundamental factors of what he describes as the three most famous historical bubbles are analyzed; the Tulip mania (1634-1637), the Mississippi bubble (1719-1720) and the South Sea bubble (1720).

Garber is not convinced of the general explanation of the Tulip mania as a bubble or even as a mania. He asserts that the standard discussion does not take into account what the market fundamental price of bulbs actually should have been. Garber looks at both the price increase prior to the mania and the depreciation after the mania. He finds that the increase of prices was more or less due to an increase in demand for varieties of tulips and bulbs and since of some tulips were extremely rare, they also showed extreme prices. He further examines the prices depreciations for tulips from the time of the mania all the way into the mid of the 18th century. The average annual depreciation rate for bulbs in the 18th century was approximated to 28.5%. This can be compared to annual rate of depreciation for the time of the mania, which was 32%. This small difference lead Garber to the conclusion that this was in fact not a bubble or a mania but simply shift of paradigm and general decrease in demand for tulips.

The common interpretation as Tulip mania as a bubble has lead to relegation of the two vastly more important bubbles, in terms of understanding of financial bubbles; the Mississippi and the south sea bubbles. These bubbles, which are in many ways alike, were characterized by speculators who used the best economic analyses available and speculated with respect to change in view of market fundamentals. Garber also stress that economists often are flawed in their interpretation of bubbles and their speculators, often assuming that the speculators were wrong totally without reason, when they in fact acted rationally and more or less had to speculate. (Garber 1990).

2.3 Housing Bubbles

During a housing bubble, people believe that houses that normally would be too expensive to buy, now is quite affordable, since they take into account a future price increase as something that is given. When the a price increase is considered given, this will also cause people save a lot less, since they feel that increasing housing value will do it for them. It is not hard to see that this kind of behavior could lead to housing bubbles, but a high pace of increasing housing prices do

not alone conclude the existence of a housing bubbles, it can just as well be due to changes in fundamentals (Case & Shiller 2004).

Jacobsen & Naug (2005) describes somewhat of a general cause of housing bubbles. They claim that bubbles may arise if: *“(i) many individuals want to purchase a dwelling today (putting an upward pressure on prices) because they expect house prices to rise in the period ahead and (ii) these expectations are not based on fundamentals”* (Jacobsen & Naug, p 29). If this statement is correct, prices may fall rapidly if the expectation of the housing market declines.

Sjöling (2012) reviews the most frequently discussed indicators of bubble formation in the literature and research. According to Sjöling the most commonly used indicators are: real housing price vs. real disposable income, real housing prices vs. real interest rate, real housing price vs. population and real housing price vs. total housing. In other words, decreasing disposable income, increasing interest rates, increasing population and an inelastic housing supply could all be indicators of a bubble formation.

A commonly used measure of a possible overvaluation in the housing market in comparison to fundamental values is both the ratio between house prices and income, as confirmed by Sjöling (2012), and the ratio between house prices house rents. However, even if these types of ratios will indicate if prices are high in comparison to fundamentals, they might be misleading and flawed. The ratio will not tell you if prices are high due to a bubble or if there has been a general change in the fundamentals (Jacobsen & Naug, 2005). This is also supported, as stated earlier, by Case & Shiller (2004).

To consider an example of macroeconomic factors and movements Jaffee (1994) looks at the Swedish housing bubble in the late 80's and the early 90's. During the boom (1985-1990), a period characterized by a rapid increase in housing prices, all changes were closely connected to the demand side of housing. The boom period was characterized by an increase in GDP, decrease in unemployment, high interest rates and high rate of expansion in loan supply.

When the bubble burst (1990-1993) all these factors went the opposite direction. Two major facts are listed as causes of this boom. Firstly, optimistic investors expected to profit from purchasing and producing real estate. Secondly, optimistic bankers were willing to lend money to these investors for those purposes (Jaffee, 1994).

2.4 The relation between money supply and real estate prices

The main schools of economic thought have differing views regarding to the role of, source of and effects of an increase in money supply. Even though investigating the plausibility of these differing views is outside the scope of this essay, including money supply can still be objectively justified by previous research in the field of house price determination, albeit some studies have not used the ECM framework in proving such statements.

Lastrapes (2001) uses a vector autoregression (VAR) to identify money supply shocks and interprets the effects of these shocks in a dynamic equilibrium model. In the study, monetary shocks were found to have short-term real effects on, inter alia, house prices and sales. A direct link between money supply and these factors was found and this mechanism worked not solely through affecting the user-cost of housing demand through changes in real interest rates, as in the housing market equilibrium model case. This proves that there is a direct link between monetary shocks and housing prices.

Greiber and Setzer (2007) examines the causal relationship between money and macroeconomic (housing) factors, such as net household wealth, in the U.S. and euro area. The link between money and housing can be found to go in both directions. On the one hand, increased household prices, thus also household wealth, could cause an increase in money demand, thus increasing the money supply. On the other hand, increased liquidity itself could cause an increase in asset prices. The study found support for both notions and concludes that there are bidirectional links. As the link between increased liquidity and housing prices was stronger in the U.S. than in the euro area, the study mentions

institutional characteristics of the financial system as a possible explanation of the differing strengths of the asset inflationary process.

(Goodhart & Hofmann, 2008) reinstates the fact that there is a linkage between money supply and other macroeconomic factors but also adds that the effect of money supply to house prices was greater during the time of deregulated financial markets (in their study 1985-2006), especially during a time of rapid house price increase and/or boom.

Regardless of school of economic thought, i.e. the view of how money is created and if it in itself is an explanatory variable able to affect other fundamentals or just a reflection of other macroeconomic factors, numerous studies have concluded that there is an apparent connection between money supply and real estate price levels and/or real estate price changes.

3. Methodology

3.1 Data

To compute our model we have used quarterly data from 1987Q1-2011Q4. We have used only nominal values in all our variables, like in the case of Jacobsen and Naug (2005). There is little reason to suspect that choosing nominal values could alter our result in any way, since the commonly used deflator CPIF (see Figure 2a) has moved linearly throughout the period and therefore does not change the general trends of the variables. As our dependent variable we have used the Swedish Real estate price index. The index measures the prices for Swedish for one- and two-dwelling buildings for permanent living where 1981=100 (SCB). In order to estimate a model for the determinates of house prices we have initially tested nine different explanatory variables, and one by one determining whether they have both economic and statistical significance for determining house prices;

- Bank average interest rate
- Long government rate
- Disposable income
- Financial wealth
- Construction cost
- Unemployment
- GDP
- CPIF
- Money supply

Bank lending rate is the average lending rate provided from Swedish banks including loans with both fixed and floating interest rate. The rate is a volume weighted average, i.e. large loans have more impact than small (Finansmarknadsstatistik Mars 2012, SCB). *Long government rate* is the interest rate of a 5-year government bond (www.riksbanken.se). *Disposable Income* is the household disposable income. It is calculated as the households gross income

minus direct taxes. *Financial Wealth* is measured by the household total financial wealth, including cash and cash equivalents, and different financial assets such as stock holdings and pension insurances (National Accounts, SCB). *Construction cost* is measured by the FPI (Faktorprisindex). It is calculated for one- and two-dwelling buildings for permanent living, in equality to the real estate index (SCB). *Unemployment* is measured in percent and is known as the relative unemployment. It is calculated as the share unemployed, in percentage, in relation to the labor force (Arbetskraftsundersökningen Mars 2012, SCB). *GDP* is the total Swedish gross domestic product. The original values are in years (National Accounts, SCB). Quarterly data has been estimated through interpolation. *CPIF* is a measure of underlying inflation. It is measured as the consumer price index with fixed mortgage rate. Hence, it is not directly affected by mortgage rates (Riksbanken). *Money Supply* is measured as M3 (SCB).

3.2. The Error correction model

3.2.1 Presence in research and features

The error correction model (ECM) has been frequently used in research when analyzing housing markets. Examples include Adams & Füss (2010), Borowiecki (2009) and Girouard, et al (2006). The model links equations formulated in levels with equations formulated in of original variables, where levels will represent the long run and the differences represent the short run (Barot and Yang, 2002). The error correction model makes it possible to separate the long run and short run equilibrium prices of the housing market from the fundamental price. The housing supply is more or less constant in the short term and an increase or decrease in demand will have large effects on the equilibrium price. In the long run, however, the supply will, to a higher extent at least, affect the equilibrium price, whereas a change in demand will not affect housing prices to the same extent as in the short run ((Claussen et al, 2011), also confirmed by Englund (2011)).

In 3.2.2 begins a step-by-step explanation of finding an error-correction model². For clarity, an error correction model in general form looks like the following:

$$\Delta y_t = \alpha + \sum \gamma_{i(t-i)} \Delta y_{i(t-i)} + \sum \beta_{i(t-i)} (\Delta) x_{i(t-i)} + \eta r_{t-1} + \varepsilon_t \quad (3.1)$$

$$r_{t-1} = \hat{e}_{t-1} = y_{t-1} - \sum \zeta_{i(t-i)} Z_{i(t-i)} - \chi \quad (3.2)$$

where

α = the constant term ~~received~~ in the ECM regression

$\gamma_{i(t-i)}$ = the coefficient for $\Delta y_{i(t-i)}$

$\Delta y_{i(t-i)}$ = a lagged difference of the dependent variable in period t-i

$\beta_{i(t-i)}$ = the coefficient for $(\Delta) x_{i(t-i)}$

$(\Delta) x_{i(t-i)}$ = a (differenced) independent variable in period t-i

η = the coefficient for the long-run relationship (interpreted as the time for a shock/an error in the long run-relationship to be corrected)

r_{t-1} = the lagged residual of the long-run relationship

$\zeta_{i(t-i)}$ = the coefficient for in $Z_{i(t-i)}$

$Z_{i(t-i)}$ = a long-run independent variable in t-i

χ = the constant term in the long-run relationship

ε_t = the error-term of the ECM.

As noted above through brackets around the delta, the independent variable does not have to be differenced to be included in the ECM, depending on if it's stationary or not. This will be explained later on in this section.

² All explanations and equations regarding the ECM-methodology are attributable to Brooks

depending on if it's stationary or not. This will be explained later on in this section.

3.2.2 The reason for ECM instead of standard OLS

Using an error correction model instead of a standard OLS regression is not only performed out of desire for being able to separate different non-stationary independent variables' long- and short-term effects on a dependent variable, but also out of necessity due to the presence of non-stationarity in many economic variables. (Brooks, 2008) mentions three (3) reasons for why it is important to determine whether or not variables are stationary or not: (i) Shocks have permanent effect on non-stationary variables; (ii) non-stationary data can falsely turn out to be significant in a standard OLS test (spurious regression); (iii) non-stationary data will not follow normal t- and F-distributions in testing.

When differencing once required to make the data stationary, the variable is said to be integrated to order 1 (denoted I(1)). Most economic data is I(1). There could of course be data which is I(2) in which case differencing twice would be required in order to make the variable stationary. In the explanation of the Error-Correction model it will be assumed that the data is I(1) or I(0). Please note that stationary data can be included in the model, as will be explained later on.

In general, there are two different types of non-stationary processes.

1. The random walk model with drift

$$y_t = \mu + y_{t-1} + \varepsilon_t \tag{3.3}$$

which requires differencing once ($y_t - y_{t-1}$) to make the variable stationary and where μ is a drift term.

2. The trend-stationary process

$$y_t = \alpha + \beta t + \varepsilon_t \quad (3.4)$$

which requires “detrending” ($y_t - \beta t$) in order to make the variable stationary and where α is a constant. There could of course be a combination of both. If the first case would be non-stationary, then it is said to have a unit root of d (the solution to the lag equation $\Delta y_t = (1-d)y_t = \mu + \varepsilon_t$, where $dy_t = y_{t-1}$, i.e. the number of times differencing is required in order to make the variable stationary)

3.2.3 Determining stationarity - The augmented Dickey-Fuller test

One test for testing the stationarity of a variable is a Dickey-Fuller test. If a process is non-stationary and follows a random walk, then $\varphi = 1$ in the following equation:

$$y_t = \varphi y_{t-1} + \varepsilon_t \quad (3.5)$$

Or conversely, $\psi = 0$ in

$$\Delta y_t = \psi y_{t-1} + \varepsilon_t \quad (3.6)$$

If there is suspicion of autocorrelation between the residuals in the sample, then time lags can be added in order to remove the suspected autocorrelation (the “augmented part” of the Dickey-Fuller test). If there is a drift (μ) and/or time trend (πt) present, then that also needs to be accounted for. The end equation will look like the following:

$$\Delta y_t = \mu + \pi t + \psi y_{t-1} + \sum a_{i(t-1)} \Delta y_i + \varepsilon_t \quad (3.7)$$

under $H_0: \psi = 0$ (with $H_1: \psi < 0$), i.e. the variable is non-stationary. Critical values are found on a case-to-case basis as assumptions about t- and F-distributions in non-stationary variables cannot be made.

The most common criticism against the Dickey-Fuller model in literature regarding unit root testing revolves around the model's low ability to distinguish between coefficients close to one and one (e.g. $\phi = 0.95$ will be interpreted as $\phi = 1$) in the original equation (3.5). For simplicity, however, this fact is disregarded in conducting hypothesis testing for our model and it is assumed that all rejections and non-rejections of the null hypotheses in fact are true.

3.2.4 Finding cointegration

After determining to what degree each variable is integrated, combinations of the variables must be found such that cointegration exists in order to be able to estimate an ECM. Even though each variable in itself might have a non-stationary random walk pattern, combinations of the variables may explain (the level of) the dependent variable. Since most variables in the economic context are $I(1)$, it can be said that variables are formally cointegrated if there exists a linear relationship between the variables which in turn is stationary.

The rewritten form of (3.2) shows the approach formally.

$$y_{t-1} = \chi + \sum \zeta_{i(t-i)} Z_{i(t-i)} + e_{t-1} \quad (3.8)$$

$$e_{t-1} = y_{t-1} - \chi - \sum \zeta_{i(t-i)} Z_{i(t-i)} \quad (3.9)$$

All variables are cointegrated if a combination of independent variables can be found such that the residual is stationary. There are several techniques for establishing cointegration in practice. The Engle-Granger 2-step method is a straight-forward approach appropriate for the ECM context.

- Step 1: Using OLS, the long-term cointegrating relationship with the proper coefficients is estimated. No inference can be drawn, i.e. the t- and F-values from STATA are invalid. To overcome this problem, the residual is instead tested for stationarity. The Dickey-Fuller method for determining stationarity can also be used in this context, although with other critical values. If the residual is stationary, then there is significant cointegration amongst the variables.
- Step 2: Use the estimated residual and regress the ECM equation (3.1), for clarity again written below:

$$\Delta y_t = \alpha + \sum \gamma_{i(t-i)} \Delta y_{i(t-i)} + \sum \beta_{i(t-i)} (\Delta) x_{i(t-i)} + \eta r_{t-1} + \varepsilon_t \quad (3.1)$$

$$r_{t-1} = \hat{\varepsilon}_{t-1} = y_{t-1} - \sum \beta_{i(t-i)} x_{i(t-i)} - \chi \quad (3.2)$$

In step 2 inferences can be drawn about the parameters, contrary to step 1. It is worth mentioning that any linear transformation of the cointegrating vector $[1 - \sum \zeta_{i(t-i)}]$ will also be cointegrated. Even though the Engle-Granger 2-step model suffers from problems such as the inference issue in step 1 and simultaneous equation bias, it is still commonly used in empirical studies studying house price development.

3.2.5 Testing for autocorrelation using Durbin-Watson or Breusch-Godfrey

After performing the Engle-Granger 2-step approach, it is important to test for autocorrelation in the residuals. If the residuals are autocorrelated, then

assumption 4 is violated, thus rendering the OLS invalid. This is expressed formally below, where the residuals are autocorrelated if ρ is not 0 in:

$$\varepsilon_t = \rho\varepsilon_t + u_t \quad (3.10)$$

In order to make sure the sample is not autocorrelated, we examined the possibility of employing two different types of tests: the Durbin-Watson (DW) and Breusch-Godfrey (BG). In the former test, $H_0: \rho = 0$ can be rejected if the DW-statistic is below a lower critical value d_L that lies above 0 and below 2. In between the lower critical value d_L and the higher critical value d_U the null hypothesis can neither be rejected nor not be rejected. However, this test is not valid if there are lagged values of the dependent variable on the right hand side of the equation, as is the case of our ECM. We therefore chose the Breusch-Godfrey test, which does not induce the same problem (Nerlove and Wallis, 1966). The Breusch-Godfrey test is F-based and can test processes, which are autoregressive of order 1 or higher by including lags.

$$\varepsilon_t = \sum \rho_i \varepsilon_{t-i} + u_t \quad (3.11)$$

If $H_0: \rho_i = 0$ is violated then the OLS estimated model cannot be used. We conduct a BG-test on each significant ECM (3.1):

$$\Delta y_t = \alpha + \sum \gamma_{i(t-i)} \Delta y_{i(t-i)} + \sum \beta_{i(t-i)} (\Delta) x_{i(t-i)} + \eta r_{t-1} + \varepsilon_t \quad (3.1)$$

In the cases where the null hypothesis was rejected, the ECM was disregarded.

4. Results

4.1 Our variables

Figure 1, 2a and 2b shows our seasonally unadjusted variables, which are all, apart from the unemployment rate and interest rates, logarithmic values. However, seasonal adjustment is taken into account in all tests by using seasonal dummies. The definitions of all variables are to be found in section 3.1.

Figure 1. *Dependent variable 1987q1-2011q4 (in logs)*

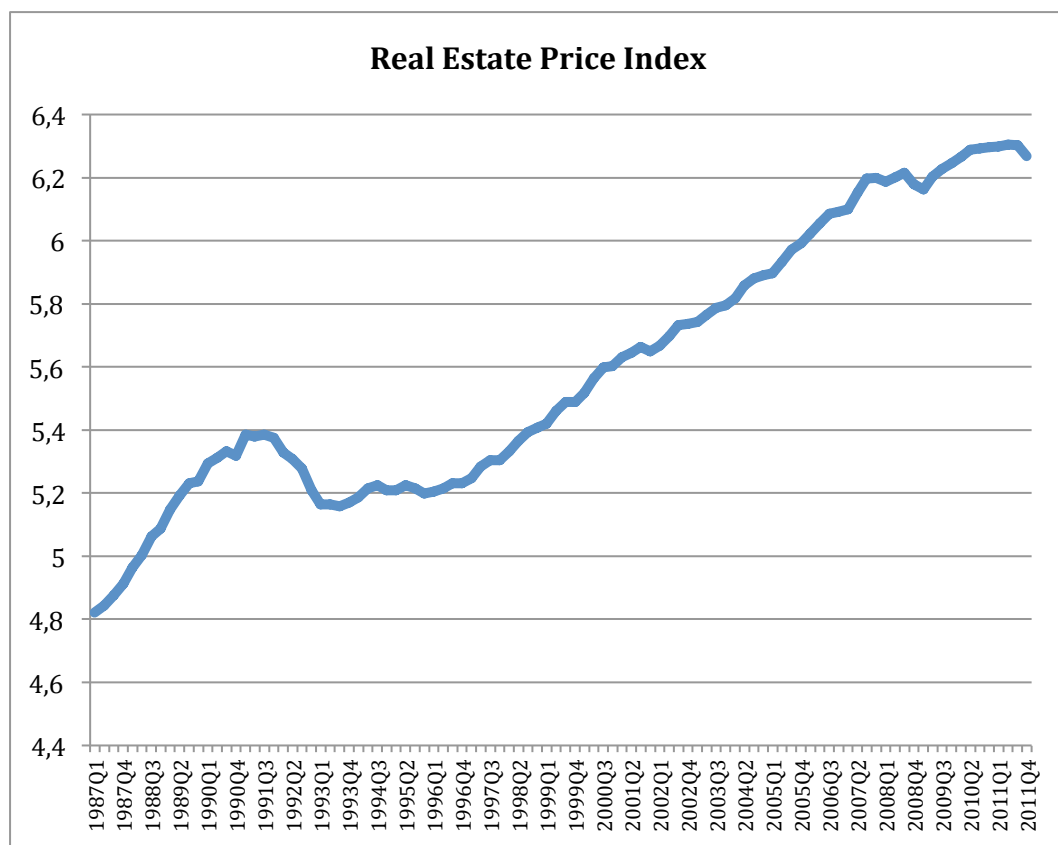


Figure 2a. Explanatory variables 1987q1-2011q4 (in logs)

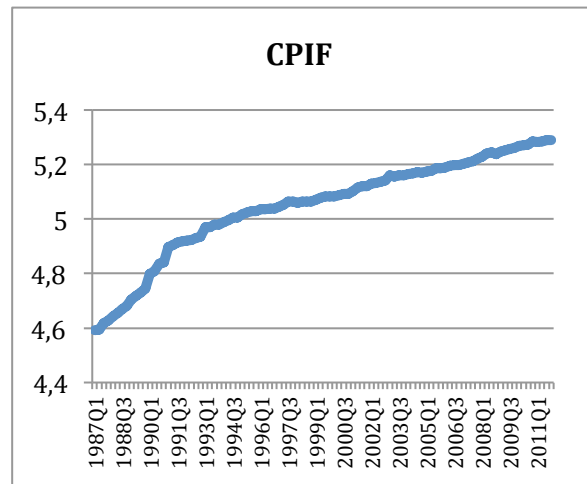
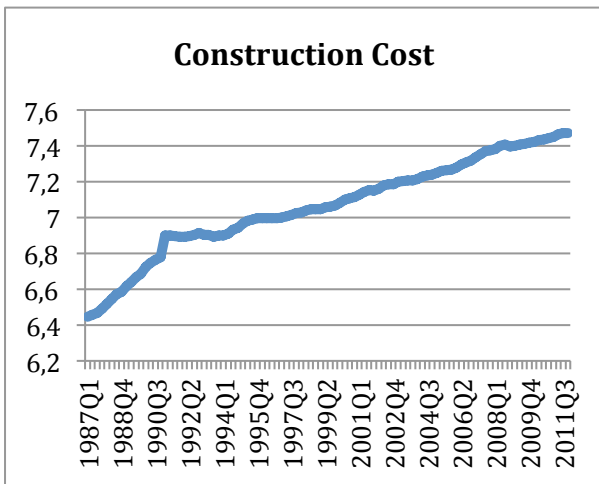
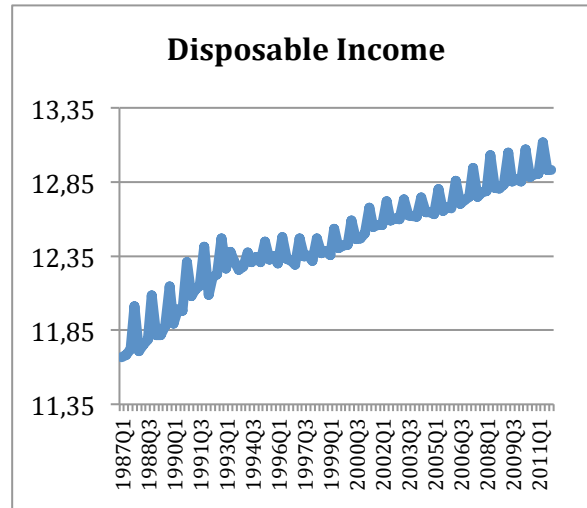
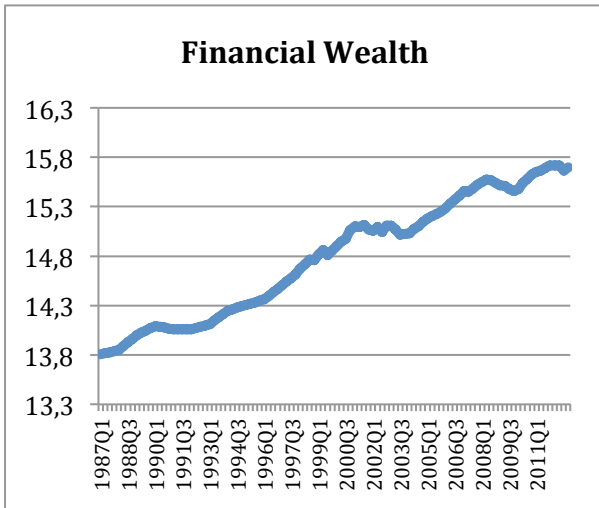
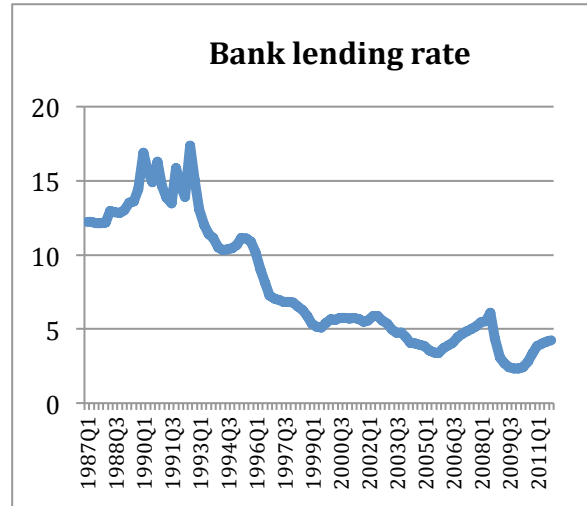
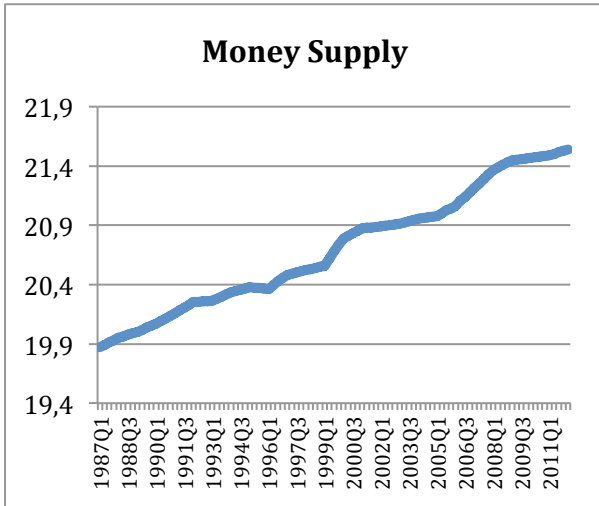
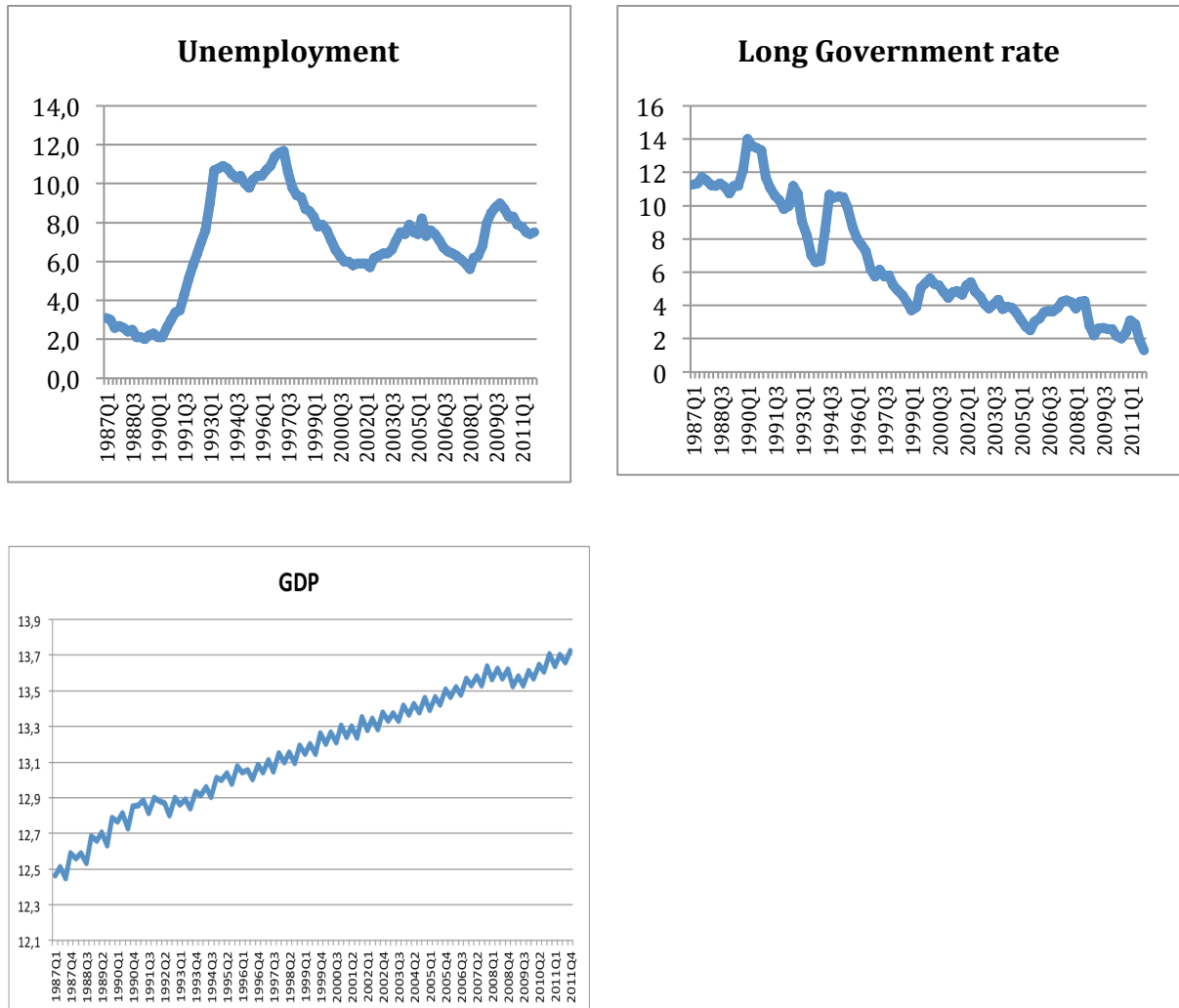


Figure 2b. *Explanatory variables 1987q1-2011q4 (in logs)*



By looking at the graphs we can expect most of our variables to be non-stationary. The variables that by an ocular analysis could be hard to determine whether they are stationary or not are CPIF, GDP, Money Supply, Construction Cost and unemployment. We also see indications of long-term relationships between our dependent and independent variables. The Swedish Real Estate Price index rose from the first quarter of 1987 until the early 90's where prices

began to fall and did so until approximately the first quarter of 1993. From this point and on, the real estate price index has more or less risen consistently throughout the examined period of time.

Some of our explanatory variables show similar developments over the time period. Financial wealth, disposable income, GDP and money supply are the best examples. Even if some variables do not show decreasing values from 1990 to 1993, at least stagnation is easily detected. This could imply a long-term relationship. When examining the graphs of the two interest rates (Bank Lending Rate and Long Government Rate) and the unemployment rate it is hard to draw any obvious conclusion from the graphs. The interest rates have more or less consistently fallen from the beginning of our time period until now and they both have their peak at the point where real estate prices hit its bottom. The unemployment showed a rapid increase at the time of the collapse of real estate prices in the early 90's but has since its peak stabilized on a more moderate level and a relation to real estate prices is, by looking at the graph, not obvious. We leave the rest to our tests for stationarity and cointegration.

In the very long run we could expect *Bank Lending rate*, *Long Government Rate* and *Unemployment* to be stationary. However, in time periods with similar length as ours, it is not unlikely for the interest or unemployment rates to be non-stationary. Previous studies of Swedish real estate prices have come to the conclusion of interest rates as non-stationary (Claussen 2012, Barot & Yang 2002). Jacobsen & Naug (2005) interprets unemployment as a stationary variable when analyzing the determinants of Norwegian nominal real estate prices. Claussen uses a bank average interest rate as underlying data for his variable, and Barot and Yang uses a five-year bond. Both of these can be comparable to our variables. However, this will be analyzed further when examining the results from our Unit root tests.

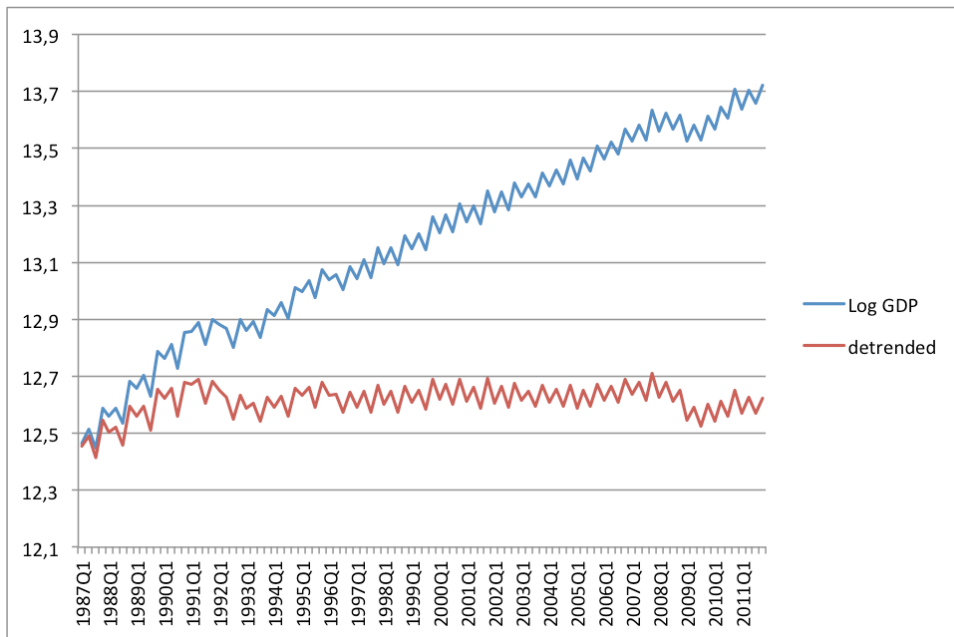
Table 1. *Augmented Dickey-Fuller Test for Unit Roots*

| Variable | I(1) t-value | I(2) t-value |
|-----------------------------|----------------------------|---------------------|
| <i>Real Estate Prices</i> | -1.06 (2.892) ³ | -3.06 (-2.892) |
| <i>Money Supply</i> | -2.47 (3.452) | -11.70 (-2.896) |
| <i>Unemployment</i> | -2.37 (2.893) | -7.21 (-2.895) |
| <i>Construction Cost</i> | -3.17 (-3.451) | -8.18 (-3.452) |
| <i>CPIF</i> | -4.12 (-2,894) | - |
| <i>GDP</i> | -3.85 (-3.455) | - |
| <i>Disposable income</i> | -2.72 (-3.455) | -14.42 (-2.895) |
| <i>Financial Wealth</i> | -2.47 (-3.450) | -6.88 (-2.891) |
| <i>Long Government rate</i> | -0.97 (-2.894) | -7.00 (2.894) |
| <i>Bank Lending rate</i> | -2.56 (-3.454) | -9.99 (-2.896) |

As we presumed earlier, Real Estate Prices, Disposable Income, Financial Wealth and our two interest rates are all non-stationary. This is also the case for unemployment and construction cost. CPIF is stationary and GDP seems to be trend stationary. This means that they cannot be used in our long-term relationship estimation. However, they can still be used to explain our short-term dynamics, where the differences of variables are used instead of levels (see equations in Chapter 3). Figure 3 shows GDP and a “detrended” GDP. As the graph shows, when removing the trend from GDP the variable clearly becomes stationary.

³ Values in brackets are equal to the critical 5% values of respective unit root test. Trend is used when significant.

Figure 3. *Detrended GDP*



We use the variables we can be certain of being integrated of the first order, i.e. Money Supply, Disposable Income, Financial Wealth, Unemployment, Long Government Rate and Bank Lending Rate, in our following cointegration tests. According to our tests, both Long Government Rate and Bank Lending Rate are non-stationary. As we stated earlier, are these variables most likely stationary in the very long run. However, in the shorter run, as in our case, are there is great evidence of the possibility of non-stationarity in different interest rate-variables (Claussen 2012, Hort 1998, Barot & Yang 2002 etc.).

4.2 Estimating our model

When estimating our long run relationship some of the non-stationary variables work better than others. Construction cost does not work well in our model. In every test it shows an unreasonably high coefficient. However, this result is in line with previous research in the field. Claussen (2012) exhibits the same pattern and argues that real construction cost granger-causes deflated real estate prices. This means that lagged values of construction cost has significant

effect on the level of real estate price. It can also be interpreted as real estate prices is driving construction cost and not the other way around. According to our test, the same conclusion can also be drawn for nominal construction cost and real estate prices. When including Money Supply in our model it is hard to find a cointegrating relationship, since other explanatory variables become more or less insignificant, with very low coefficients. We therefore choose to exclude Money Supply from our long run estimation and instead examine it further on in our short run estimations. There is theoretical support for this view, as money supply shocks rather than nominal levels have been determined to affect nominal house prices. We also find that Bank Lending Rates work better than the Long Government Rate.

4.2.2 The Error Correction model

Table 2a. Cointegrating-/Long run relationship (EG-Step one):

| Explanatory variable | Coefficient | t-value |
|--------------------------|---------------|--------------|
| <i>Constant</i> | <i>-11.36</i> | <i>16.58</i> |
| <i>Disposable Income</i> | <i>0.41</i> | <i>4.56</i> |
| <i>Financial Wealth</i> | <i>0.79</i> | <i>9.54</i> |
| <i>Unemployment</i> | <i>-0.03</i> | <i>6.47</i> |
| <i>Bank Lending Rate</i> | <i>0.04</i> | <i>5.76</i> |

Cointegration test

Engle Granger t-statistic: 4.78

The residual is, according to our test, stationary, i.e. there is a long run cointegrating relationship between these variables. If we interpret the coefficient of each independent variable as elasticities, which is supported by many previous studies made on real estate prices (Claussen, 2012, Jacobsen & Naug, 2005, Barot & Yang, 2002 etc), we find that, in the long run, a one percent

increase in households disposable income will lead to a 0.41% increase in nominal real estate prices, a one percent increase in households financial wealth will lead to an increase of 0.79% in nominal real estate prices, and so on. The positive long run relationship between bank lending rates and real estate prices can at first seem implausible from an economic perspective. However, the positive coefficient might not be entirely unexplainable. If interest rate is seen as a proxy for other macroeconomic activity not accounted for in the model, the positive coefficient may prove to be plausible. As this result deviates greatly from other studies, we shall interpret this result with great caution. When excluding bank lending rate we cannot find cointegration and we therefore choose to keep it in our model.

Table 2b. Short run dynamics (EG-Step two):

| Explanatory variable | Coefficient | t-value |
|---|---------------|-------------|
| <i>Constant</i> | <i>-0.02</i> | <i>5.79</i> |
| <i>ΔReal Estate Price_{t-1}</i> | <i>0.45</i> | <i>5.03</i> |
| <i>ΔReal Estate Price_{t-2}</i> | <i>0.37</i> | <i>3.96</i> |
| <i>ΔMoney Supply_{t-1}</i> | <i>0.21</i> | <i>3.03</i> |
| <i>ΔBank Lending Rate_{t-1}</i> | <i>-0.004</i> | <i>2.07</i> |
| <i>ΔBank Lending Rate_{t-2}</i> | <i>-0.009</i> | <i>4.27</i> |
| <i>Error correction term</i> | <i>-0.043</i> | <i>2.17</i> |

$R^2 = 0.607$

Serial correlation/Autocorrelation-test

| Autocorrelation ⁴ | F-stat | p-value |
|------------------------------|--------|---------|
| F (1, 86) | 3.054 | 0,084 |
| F (2, 85) | 1.531 | 0,222 |
| F (3, 84) | 1.075 | 0.364 |
| F (4, 83) | 0.808 | 0.523 |
| F (5, 82) | 0.667 | 0.649 |

The Breusch-Godfrey test indicates that no serial correlation exists in the model. When including four lags of our differenced non-stationary variables and four lags of our stationary variables and then excluding insignificant lags one by one we come to the following conclusion: The change in real estate prices is explained by the change in real estate prices in one and two periods before, the change in money supply one period earlier, the change in bank lending rate in one and two periods earlier and our error correction term, i.e. the disequilibrium of the long run relationship. The coefficient of our error correction term tells us the pace for closing the gap between the short run and long run. 0.043 indicates that approximately 17% of the disequilibrium is corrected for within a year.

Table 2c. *The Error Correction Model*

$$\begin{aligned}
 \Delta Real Estate Price_t &= 0.45\Delta Real Estate Price_{t-1} + 0.37\Delta Real Estate Price_{t-2} \\
 &+ 0.21\Delta Money Supply_{t-1} - 0,005\Delta Bank Lending Rate_{t-1} \\
 &- 0.009\Delta Bank Lending Rate_{t-2} \\
 &- 0.045[Real Estate Price_{t-1} - 0.05Bank Lending Rate_{t-1} \\
 &- 0.35Disposable Income_{t-1} - 0.84Financial Wealth_{t-1} \\
 &+ 0.03Unemployment_t] + 0.02S1 + 0.04S2 + 0.02S3
 \end{aligned}$$

⁴ Breusch-Godfrey test for the *p*th order of autocorrelation.

Table 2c gives us the final model consisting of both the long and the short run estimations. S1, S2 and S3 represent the seasonal dummies in the estimates. S1 is equal to one in quarter one and so on.

5. Analysis

5.1 Comparison with previous research

Since most of previous comparable studies are made on “real” values, often deflated by CPIF or an equivalent, exact and appropriate comparisons of coefficients are difficult to make. However, we have tried looking for similar patterns, and our results are in many ways similar to those using deflated dependent and independent variables.

In line with previous research (Claussen 2012, Jacobsen & Naug 2005, Barot & Yang 2002 etc.), financial wealth and interest rates are, according to our model, fundamental factors as determinants of real estate prices. The significance of unemployment is not as obvious as the three earlier mentioned. However, Jacobsen & Naug (2005) is one example of previous studies that have found unemployment to be long run a fundamental factor of real estate prices. Money supply is not widely used in itself as an explanatory variable for determining house prices. However, Adams & Füss (2009) uses it implicitly when constructing a variable that should conduct for macro-economic activity.

Our long run model is facing one obvious problem. In the long run bank lending rate has, according to our model, a positive effect on real estate prices. However, as mentioned earlier, this might be due to the fact that other macroeconomic factors exists, outside and unexplainable by the model, that causes both nominal real estate prices and interest rate in an upward direction. Therefore, interpreting the coefficient of bank lending rate should be done with great caution. When considering the short run relation, it would, however, be harder to justify a positive effect from bank lending rates. A positive effect from the change in bank lending rates on real estate prices would simply not be plausible. Our other long run dependent variables are however roughly in line with previous research.

When estimating our short run dynamics we found that both variables and coefficients that, to some extent, are comparable to previous research. Two lagged differences of both real estate price and bank lending rates, including their coefficients, are for example very similar and comparable to the results of Claussen (2012). When it comes to money supply it is hard to make appropriate comparisons as it is rarely used in itself as an explanatory variable in previous ECM studies. However, our findings can be argued to be valid referring to previous research in the studies concerning the connection between money supply and real estate prices. Money supply has, according to our model, a positive effect on real estate prices in the short run, which is supported by Goodhart & Hofmann (2008).

5.2 Evaluating our model

Figure 4 shows the prediction of our ECM where the actual values of our explanatory variables are used. The prediction is made by adding *Real Estate Price_{t-1}* on both sides of our ECM-equation, which gives us an expression for the levels of real estate price.

Our model is able to predict real estate prices very well. But, it is important to have in mind that this model is strongly affected by lagged values and differences of real estate prices, which as time moves on put the prediction back on track and large deviations from the actual prices will therefore be hard to find. A better way predict our model is to use a dynamic forecast. In this type of forecast, lagged predicted values of real estate prices (using the model) are used instead of the realized values as in the first case (Claussen, 2012). This further means that the problem of lagged values of real estate prices putting the prediction back on track is removed. Figure 5 shows the dynamic forecast with the actual values of 1987 as a starting point for both equations. Our ECM requires two lagged values of both bank lending rate and real estate price, which is why the blue curve starts in 1987q4 instead of 1987q1. Our model is not able to fully predict the rapid increase form 1987-1991 but it does predict the

upswing in prices from 1996-2011 rather well. Simply put, if we in 1987 would have known all the actual values between 1987 and 2011 for the ECM explanatory variables, we would be able to predict the future real estate price levels quite well.

Figure 4. Prediction of ECM

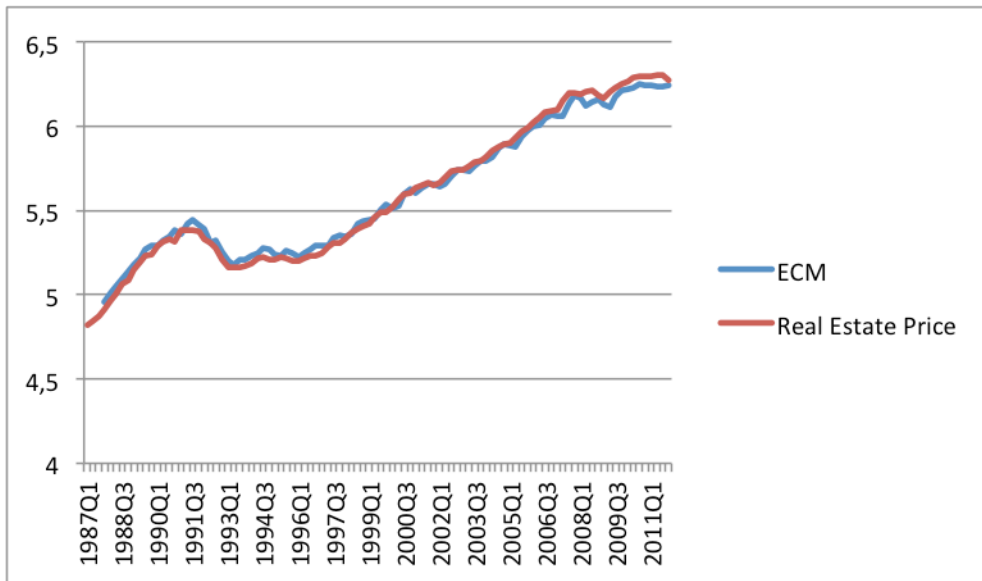
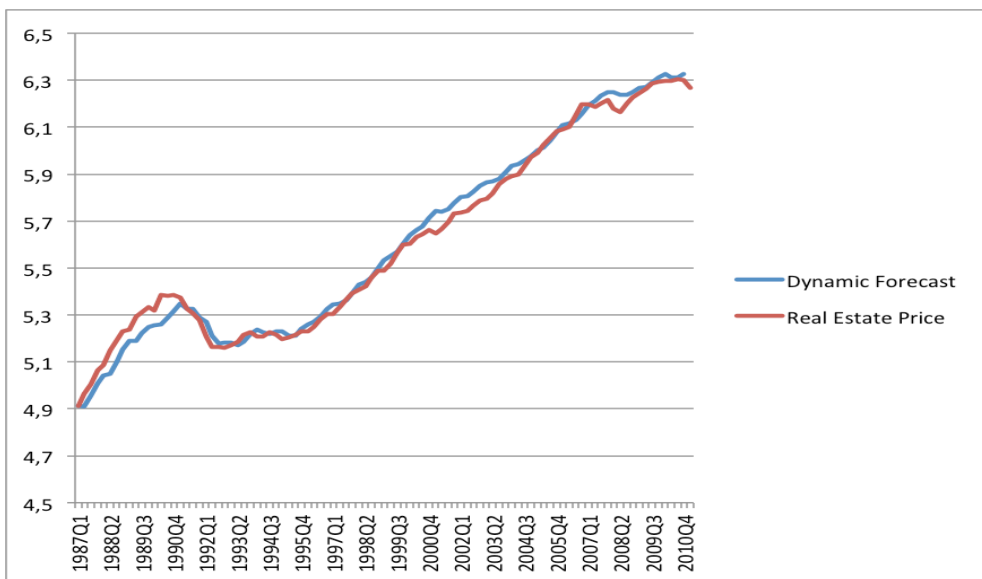


Figure 5. Dynamic Forecast



5.3 Bubble indications?

Figure 6 shows our predicted long run relationship, i.e the residual term in the final ECM. The relationship is estimated with seasonally unadjusted data. This is simply due to the fact that the seasonal adjustment in our models are made by including seasonal dummies, which not could have been included here. The estimation is made with actual values of the explanatory variables.

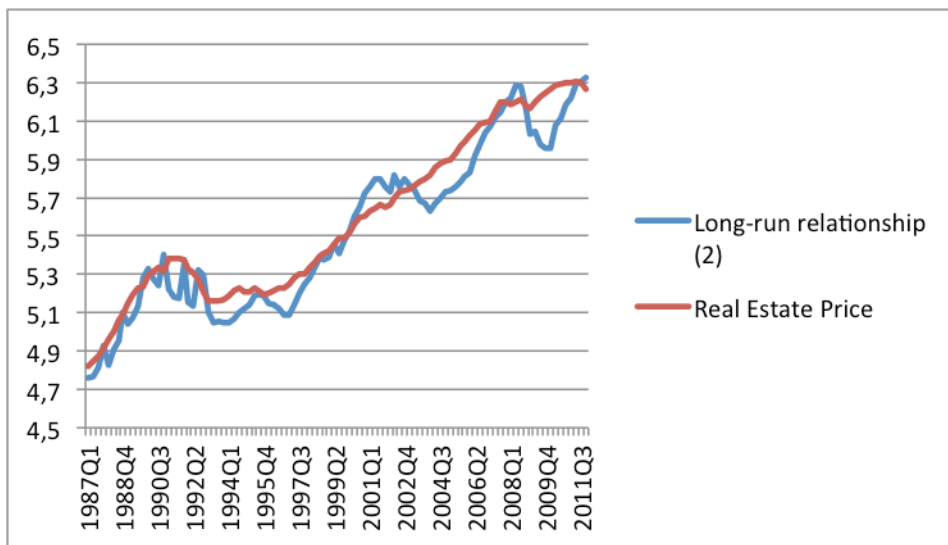
The long run relationship seems to estimate real estate prices rather well. An important distinction is that our long run estimation is much more volatile than actual real estate prices. This implies that small changes in fundamentals vastly affect real estate prices and that our data is greatly affected by season (as can be seen in figure one, e.g. disposable income). When considering whether real estate prices are overpriced or not, we can by looking at the graph in Figure 6 see that the price, according to our model, is at its long run equilibrium. However, due to the high volatility this conclusion is not very useful since relatively small changes in explanatory variables will have major impacts on the long run equilibrium.

Real estate prices are said to be overpriced if i) they are above their long run equilibrium, and/or ii) they cannot be explained by the estimated model. Consequently, can our model explain the real estate prices? We use our long run relationship to make an estimate. We used the difference in nominal real estate prices from 1996Q1 to 2011Q4 as a denominator and the difference between the value of our long-run model using the actual values from the explanatory variables in 2011Q4 and the actual real estate prices in 1996Q1 as a numerator. The ratio of 93.5 percent (see equation 5.1) constitutes the explanatory power our long-run model as to the change in this period, also used by Claussen (2012).

$$\text{Explanatory Ratio} = \frac{\text{Predicted Real Estate Price}_{2011Q4} - \text{Real Estate Price}_{1996Q1}}{\text{Real Estate Price}_{2011Q4} - \text{Real Estate Price}_{1996Q1}} \quad (5.1)$$

Our long run estimation can explain about 93.5 percent of the change in actual real estate prices, in the period of 1996-2011. This further supports our previous conclusion that the upswing in Swedish nominal real estate can be explained by fundamentals and that Swedish real estate is, according to our model, not overpriced.

Figure 6. Long run/cointegrating relationship



5.4 Money supply and real estate prices

Goodhart and Hofmann (2008) states that an increase in property prices in general can have negative distribution effects, benefitting those already in the market and disfavoring those who rent and those who have yet to access the housing market. In our ECM, an increase in money supply has a positive short run effect on nominal real estate prices in Sweden. This can have possible policy implications, different depending on what ideas from which economic school of thought are believed to be the most plausible by Swedish policy makers.

If the policy makers are of the view that money is in the end created exogenously (through central bank policy which extends or contracts credit to banks), then a new central bank policy should perhaps be considered. Also, If money in itself is thought as the driver of real estate price increases, then the implications and regulations regarding the creation of money have to be evaluated.

On the other hand, If money is believed to be created endogenously, then other kinds of measures might be viewed as more effective in reducing an increase in money supply, if desirable. Thus, if a money supply change is believed to be a mere symptom of other underlying factors, then determining which factors these are and to what extent the money supply is affected is of the essence in reducing the growth of the money supply, if it is believed to be a problem.

Regardless of what a policy maker holds as true, knowing the correlation between a money supply increase and real estate prices is crucial in determining the proper policy to perform.

6. Conclusion

Our ECM indicates that bank lending rate, financial wealth, disposable income, unemployment and money supply constitute the fundamental factors of determining house prices and house price changes. This result is to some extent, in line with previous research in the field. Disposable income, financial wealth and interest rates are often said to explain developments in house prices (see Claussen 2012, Barot & Yang 2002 etc.). Unemployment is also found to be an explanatory variable in some studies (see Jacobsen & Naug), whereas money supply is rarely found. We do not find that money supply affects nominal real estate prices in the long run. However, in the short run we find the change in money supply to have a positive effect on the change in real estate prices.

The nominal real estate price is, according to our model, at its long run equilibrium, indicating that real estate prices are not overvalued. But, it is important to know that our long run relation is much more volatile than the actual prices during the period. 93.5 percent of the change between 1996-2011 can be explained by fundamentals, also this indicating that prices are not overvalued. We therefore conclude that real estate prices are, according to our model, not overpriced and we cannot find indications of a bubble formation.

There are of course some problems with our model, including insecurity in method of testing and causal issues, and we therefore cannot say that our predictions can be made with an absolute certainty. However, we find that both our long run relationship and our final ECM are, when using realized actual values of the explanatory variables, able to predict real estate prices rather well.

Our conclusion that money supply affects real estate prices could have possible policy implications. Possible policy implications in Sweden depend upon how the source and effects of money supply changes are perceived. If the money supply is an endogenous factor, as it is often perceived in Sweden, then targeting the macroeconomic factors behind money supply increases and/or constraining banks further could be a way to dampen the trend of increasing house prices.

Further implications of money supply shocks affecting real estate prices could be that banks benefit through their own creation of money, which in turn increases real estate prices. As real estate prices increase by money creation through the credit multiplier, households take up greater loans for consumption and/or renovation by using their real estate as a security, giving greater interest rate revenue to the banks. This theory however is outside the scope of this thesis and would be an interesting topic for further research.

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