House price developments in Sweden

- The role of fundamentals

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Abstract

House prices in Sweden have been increasing at an unprecedented pace since the mid-1990s. In this study, I examine the main causes behind this increase. Specifically, if the increase in house prices can be explained by movements in so-called fundamental factors. To study these relationships, I deploy a Dynamic Ordinary Least Squares (DOLS) approach. In addition to newer evidence, I also examine the effect of the reduced property tax in 2008 on house prices. The model suggests that the development in the fundamental factors explain the increases in house prices very well. The model indicates negative effects of the property tax pre-2008; however, no indication of capitalization effects of the change in the tax into prices was found.
Acknowledgements

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Table of Contents

1. Introduction..................................................1
2. Literature Review...........................................5
3. Empirical Framework.......................................9
   3.1 Data......................................................10
   3.2 Econometric approach.................................16
4. Results & Discussion......................................19
5. Concluding Remarks & Policy Implications..............23
6. References..................................................26
1 Introduction

Since the mid-1990s we have seen an exceptional increase in house prices in many countries of the world. Ireland, Spain, Norway, Greece, the United States and the United Kingdom have all experienced large increases. For some, heavy collapses in these prices followed (Flam, 2016 and Girouard, 2006). In Sweden, the house prices have increased with well over 100 percent in real terms since 1996 up to today (Flam, 2016). As depicted by the real estate price index in figure 1, Swedish house prices increased in the 1980s and later fell in the early 1990s. Thereafter, around the mid-1990s, the house prices have been rapidly increasing until the financial crises around 2007 and 2012. For many countries, the financial crises implied the end of a long period of increasing prices. The house prices in countries such as the United States, Spain and Ireland have declined almost 40 percent since their peaks before the crisis around 2007 and 2012 (Frisell and Yazdi, 2010). This has not been the case for Sweden. Here, the prices stagnated during and shortly after the crises, but the market nonetheless quickly recovered and prices have continued increasing at an unprecedented pace since. However, as Flam (2016) points out these numbers may differ within regions in Sweden. He shows that the biggest increases in prices have been in the main metropolitan areas such as Stockholm, Gothenburg and Malmö compared to the rest of the country. The price levels in these cities were already in 2010 two and half times as high as in the 1980s (Englund, 2011). Alongside these house price increases, the household indebtedness has also increased heavily over the years. The household debt has increased more than twofold since the mid-1990s, where houses are a substantial part of the collateral. All the while, household income has only seen half of this growth. (Frisell and Yazdi, 2010). Therefore, a large
fall in house prices could have disastrous effects and might be a big reason why policy makers would want to study this phenomenon even more closely.

As Enslund (2011) discusses, there are some general components of house prices common to housing markets. Several countries have experienced an increasing trend in house prices over the last 40 years. The deregulations of credit markets have made owner-occupied housing more attractive, which has contributed to increasing prices. House prices are also characterized by strong cyclicality, meaning that they are predictable in the short- and medium-run. It has also been shown in the literature that house prices are mean-reverting, i.e. that prices over time tend to revert to its long-run development (see for example Gleaser and Nathanson, 2014). Further, Enslund discusses that house prices are correlated across countries and regions within countries. This is apparent in Sweden as well; the reason might be that differences in costs of living might create incentives for migration. Because of mobility, Enslund argues, differences in housing costs tend to offset income opportunities, equalizing income across regions.
The large increase in house prices and the consequential increased indebtedness in Sweden may be of major concern for the government for a number of reasons - in particular because the pattern is similar to the development in the United States before the mortgage market collapse that lead up to the financial crisis around 2007 (Dermani et al., 2016). A collapse, or a burst of the “bubble”, has not only occurred in the United States. This has also been observed in other countries such as Ireland and Spain, as a consequence of remarkable house price increases followed by a sudden fall (Flam, 2016).

A real estate bubble is a situation where price movements cannot be explained by so-called fundamental factors such as income, interest rates, supply or demographics (Fama, 2014). Stiglitz (1990) suggests that a bubble exists if prices are high today simply because agents believe that the selling price will be high tomorrow, and that these increases cannot be explained by fundamental factors. A real estate bubble is typically characterized by the following. Substantial increases in house prices not caused by fundamentals. The increase is persistent and has an inherent force (short-term price momentum) and lastly the increase is followed by a sudden and powerful fall and thereafter prices return to its long-term trend (Glaeser and Nathanson, 2014).

How do we know if a bubble exists on the market? According to Fama (2014), asset prices are determined by fundamentals. Since fundamentals such as interest rates, income and tax regulation seldom dramatically change over time, it is possible with some certainty to assert how they will move in the future (Flam, 2016). If these movements in prices cannot be explained well by
the fundamentals – a bubble might exist. Hence, this might be important for policy makers to study, as Gustafsson et al. (2016) concludes that a heavy decline in house prices could have recession-like consequences on the Swedish economy.

The main purpose of this study is to attempt to explain the causes of the rapid house price increase in Sweden. That is, if this increase can be explained by movements in fundamental factors. If prices don’t follow these movements, this can be proof of a possible bubble on the market. I will look at house prices from the mid-1990s up to today, since it includes the beginning of the forceful upward trend and also to avoid data problems concerning the previously regulated credit market. Due to limited research time I will only look at country-level prices. There are a couple of methods to examine this relationship, however I will use a dynamic ordinary least squares approach to estimate the long-run relationship between the fundamentals and house prices.

Furthermore, In addition to examining more recent data, I will also consider the effect of the change in the property tax in 2008 on house prices. More specifically, I will also try to answer the question of whether there is any evidence of a capitalization effect of the tax cut into prices. This, to my knowledge, is not an explored aspect in studies on Sweden on the subject.¹

The rest of this paper is structured as follows. Section 2 provides a review of related literature. Section 3 provides a description of the data used in this study and some summary statistics along with a walkthrough of the empirical

¹ Tax regulation in general is a sparsely discussed aspect in the literature on Sweden
model. An analysis of the results together with a discussion follows in section 4. Section 5 concludes.

2 Literature Review

Since the crises in the 1990s and in the mid 2000s, much research has been devoted to understanding the driving forces behind the rapid increases of house prices and if a bubble exists in the housing market. Most reviewed studies use variations of Error-Correction Models (ECM) or various regression models to estimate the relationship between the house prices as determined by fundamental demand and supply factors.

Meen (2002) estimated the role of fundamentals on house prices for the United States and the United Kingdom using quarterly data over the years 1981 to 1998. Through an ECM-framework, the authors found that real house prices could be well explained by variables such as the interest rate, housing supply and income in both countries. They did not find any evidence of a possible overvaluation. Further, Himmelberg et al., (2005) measured the annual cost of housing and compared these with local rents and income in order to deduce the price level of housing and if there was an overvaluation. The authors looked at costs of housing in 46 metropolitan areas in the United States over the years 1980 through 2004. In the late 1980s, they found that the cost of homeownership appeared high in relation to incomes and rents. However, this pattern was not obvious in 2004. The authors conclude that any observed differences or evidence of possible overvaluation was of regional nature, and could therefore not be compared with other areas.
Girourard (2006) provides an overview of numerous studies made on the relationship between fundamentals and house prices over the years 1970-2005. Studies show that house prices in countries such as Denmark, Finland, the United States, France and Norway largely followed the pattern suggested by fundamentals (see e.g. Schnure, 2005; Annett, 2005; Jacobsen 2005). On the other hand, evidence from countries such as Ireland and Spain suggest that there might have been a possible overvaluation (e.g. OECD, 2006; Ayuso et al., 2003).

As to my knowledge, the recent literature on Sweden is rather slim. Hort (1998) analyzed 20 urban areas in Sweden between the years 1967 to 1994 using an ECM-framework. Hort used the following variables as demand for house prices; the ratio of net lending to disposable income to account for the regulated credit market. Real income measured as the average adult population times the average pre-tax income, the number of people aged 25-44 and real user costs. Hort, argues that people within the age group 25-44 tend to have an especially high demand for single-family housing, thus including it in the model. The real user cost, i.e. the imputed cost of housing, depends on several other factors such as property tax, mortgage rate, inflation expectations etc. Further, Hort assumes that supply is be determined by real construction costs. By assuming that the market is in equilibrium in the long-run, she found that 80 percent of the changes in the short-term price could be explained by movements in the aforementioned variables. Hort concludes that while the movements in house prices followed that of fundamentals quite closely, the deviation from the long-run equilibrium significantly affected prices. However, the point estimate was too high to be consistent with any asset market model. The variable estimates were consistent with expectations, i.e. construction costs, household income, net-lending ratio and the number of
people aged 25-44 had positive effects on house prices, whereas the mortgage rate and user costs had negative effects. However the estimate for the number of people aged 25-44 was not significant.

For additional similar studies on Sweden around the same time period or earlier see Heiborn (1994), Barot (2001) and Barot and Yang (2002).

Claussen (2013) assume that the demand for houses is determined by the after-tax mortgage rate, household disposable income, and financial wealth and that the supply is determined by construction costs. He uses a Dynamic Ordinary Least Squares regression to estimate the long-run relationship and an ECM to estimate the short-run. Claussen excludes construction costs in the model because of the high elasticity he obtains. The model is estimated on country-level data, where he finds that 62 percent of the price increase between the years 1986 to 2011 can be explained by disposable income. He finds that 26 percent can be explained by the mortgage rate and 8 percent by household wealth. He concludes that the development of house prices follow the movements of the fundamentals included in the model. Further, he assumes that short-term deviations from the long-run equilibrium can be explained by delays in the market from e.g. purchasing and building new houses.

Bergman and Sorensen (2012) use a similar method as Himmelberg et al. (2005) to examine whether or not house prices are overvalued. The authors assume that equilibrium is implied when the imputed cost of housing is equal to the cost of renting a comparable home. Further, the authors use two different models when estimating the house prices. The relationship between the user cost and the rent is assumed to be constant over time in the first
model. In the second model, the user cost is assumed to adapt so that equilibrium between demand and supply is obtained and that the user cost is equal to the realized rents over the estimation period as a whole. The models are estimated on quarterly Swedish house prices over the period 1986-2012 where the authors find no evidence of overvaluation, i.e. that the increase in house prices followed the movements of fundamentals closely.

Furthermore, Englund (2011) tries to evaluate the factors behind the increase in house prices in Sweden between the years 1980-2011. Englund analyzes actual rents and compares these to the user costs for multi-family dwellings, where he finds that these two follow each other relatively closely the period after 1995 up to 2004. However, Englund does find that the user cost exceeds the rent in the following period up until 2011, which he interprets as being due to the fact that house prices during the latter period are partly determined by expectations of future capital gains.

In a more recent study, Dermani et al., (2016) studied the house price developments in Sweden between the years 1990-2015 in two analytical approaches. First, in intent to compare the developments in Sweden in an international perspective, the authors implemented a panel regression for eight different countries including Sweden. They included the variables disposable income, household net financial wealth, mortgage rate, inflation, population growth and residential investment as a fraction of GDP. The authors found that the fundamental variables explained around 75 percent of the movements in house prices for all countries in total. This number increased when they included household indebtedness as a variable. Dermani et al. conclude that prices are in line with the patterns of fundamentals for all countries except for one country where they found evidence of an undervaluation.
In the second approach, the authors examined the price developments in municipalities in Sweden. The authors try to answer the question by studying the patterns of the level of housing costs as a share of income in the different municipalities. Dermani et al., estimate a regression where they assume that housing expenditure share is determined by the earned income relative to the average income in each municipality. The authors do not found any notable price differences between the municipalities.

As to the best of my knowledge, there are no studies on the specific subject of house prices and fundamentals covering the effects of the change of the property tax rates in Sweden in 2008 on house prices. Hort (1998), Bergson and Sorensen (2012) and Dermani et al. (2016) include the property tax in their formulas for the user cost, however, they only use it as an effective rate.

In sum, the literature reviewed has found little evidence of overvaluations in the housing markets. The studies surveyed in the this paper on Sweden are in unison that house prices developments seem to have been following the movements in fundamental factors of supply and demand over the years.

3 Empirical Framework

In this section, the data set used is presented along with a discussion of this. Then, relevant tests are presented. Lastly, the econometric approach will be discussed.
3.1 Data

The model is estimated using quarterly data covering the period 1998Q1-2016Q4. This period is used to capture the start of the significant price movements in the mid-1990s and to avoid difficulties that may arise from using data before the credit market deregulation. In respect to limited time and data availability, the model includes the following five fundamental factors; the logarithm of real disposable income, after-tax real mortgage rate, the number of people aged 25-44 and the property tax as demand side variables and the logarithm of real construction costs on the supply side. These variables have been shown (as seen in the literature review) to be essential when examining house price developments.

*Real house prices* are measured as the real-estate index available at Statistics Sweden, expressed in logs. This measures the price of constant quality one- and two-dwelling buildings for permanent living (for similar studies where this index also has been used as a measure of house prices, see e.g. Claussen, 2013).

*Household real disposable income* is measured as the log of household gross income subtracting taxes and is collected from Statistics Sweden. The positive relationship between income and house prices has been well documented (see e.g. Girouard et al., 2006). The intuition is straightforward- the more we earn the more we spend on housing. This increases housing demand, which in turn leads to higher house prices. Ganoulis and Guiliodori (2011) found a long-run elasticity of house prices with respect to income between 0.7 and 1.5 for a couple of European countries. As discussed, Girourard et al. (2006) and Hort

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2 Data for the average assessed values of houses was only available from 1998, which is why the specific year was chosen.
(1998) also found the elasticity of house prices relative to income to be around one. Therefore, one could expect a positive relationship in this study as well.

As Englund (2011) describes, the housing shortage in Sweden has increased in the main metropolitan areas. Fewer available houses and a growing population contribute to higher house prices. As shown, as a measure of housing supply, many studies use real construction costs when studying its effects on house prices (see Hort, 1998; Adam & Füss, 2010; Claussen, 2012 and Bergman & Sorensen, 2012). If building houses become more expensive, fewer houses will be built, hence house prices and construction costs can be expected to have a positive relationship. Real construction costs will be measured as the log of Statistics Sweden’s construction cost index.

The relationship between interest rates and house prices has also been well documented in the literature. Intuitively, with a higher interest on the mortgage, fewer people will afford to buy houses, effecting house prices negatively. Studies have measured the effect of mortgage rates on house prices directly through the rate itself or indirectly through the cost of housing. In sum, Boverket (2013) found that in some regions in Sweden, the cost of housing had a large negative impact on house prices, mainly through the decreasing mortgage rate. Meen (1990), Drake (1993) Claussen (2013) and Hort (1998) report negative significant effect of the mortgage rate on house prices. It is therefore reasonable to expect that this variable will have a negative impact on house prices in this study as well. A lower real interest rate will lower the cost of owning a house since debt-financing costs for households will be lower (Himmelberg et al., 2005). The mortgage rate is measured as the real after-tax mortgage rate, collected from the Riksbank.
As considered earlier, house owners are affected by a number of taxes. These taxes have an impact on the cost of housing and ultimately the valuation of the housing assets (Englund, 2011). The state property tax has been significantly lowered since its reconstruction into a regional property fee in 2008, going from approximately 1 percent of the assessed value of the house to 0.75 percent today (Skatteverket, 2017). This induced a significant decrease in the tax for owner-occupied houses. The lowered property tax may lead to a capitalization effect, driving house prices upward. Several studies on property tax capitalization have been made where degrees of capitalization in house prices have been found (see e.g. Hilber, 2011). The rationale is that house buyers tend to take the cost of living into account and when this is reduced due to decreasing taxes, they will be willing to pay a higher price (Elinder and Persson, 2014). Therefore one could expect that there is a positive relationship between the decrease in the property tax and house prices. However, the general effect of the property tax itself pre-2008 can be expected to be negative since the tax will mean that there will be less money is leftover for housing consumption. The property tax is measured as the product of the property tax rate and the average assessed value of sold single-family dwellings for permanent living and has been collected from Statistics Sweden and the Swedish Tax Agency. The effects of the property tax will be divided into two parts. First, the total effect of the property tax on house prices before the year of 2008 is examined. Secondly, the effect of the reduction in the tax is examined. This is done by creating a dummy variable where it takes the value of zero if before 2008, one if 2008 and after. Then a so-called interaction term is created to be able to study the effect of the change, which is simply the tax variable multiplied by the time-dummy.

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3 The change has meant a reduction in the tax for single-family dwellings (småhus)
As mentioned in the introductory part, demographic factors are sometimes included as fundamental determinants of house prices. Housing demand has been shown to vary with age, where younger households are referred to as net demanders and older households as net suppliers. Younger households typically start off with smaller homes where they eventually move to larger dwellings as they get older. (Englund, 2011). To summarize from the literature review, Girouard (2006), Hort (1998) and Heiborn (1994) found a positive relationship between age structures and house prices. On the basis of these results, the number of people aged 25-44 can be expected to have a positive relationship with house prices. *Demographic demand* is collected from Statistics Sweden as the number of people aged 25-44. This variable is only available at an annual level, although, I argue that this will be sufficient since there will be almost no variation at quarterly level.

<table>
<thead>
<tr>
<th>Table 1. Summary statistics</th>
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<tr>
<td>Obs</td>
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</tr>
<tr>
<td>Real house prices</td>
</tr>
<tr>
<td>Household real disposable income</td>
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<tr>
<td>Real construction costs</td>
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<tr>
<td>After-tax real mortgage rate</td>
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<tr>
<td>Demographic demand</td>
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<tr>
<td>Property tax</td>
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</table>

Table 1 provides some summary statistics of the variables in the study. As we see, the data set consists of 73 observations of each variable in total over the period 1998Q1-2016Q1. We can also observe that the mean house price according to the real-estate price index is approximately 428 thousand SEK. Further, the average household disposable income over the period is 393,078 SEK. As we also see, the mean value of the property tax (i.e. the average assessed value of a house in 1000 SEK times the property tax rate) is 2.23.
As discussed previously, other variables have been included in studies on Sweden. For instance, Hort (1998) includes the net-lending ratio as a variable. However, as Claussen (2013) argues, Hort covers a period where the credit market was regulated and hence that variable will not be reasonable since house prices are accommodated by credit today. Further, household wealth has been used in studies such as Claussen (2012) and Dermani et al. (2016). Unfortunately data for household wealth was not available for the selected time period on quarterly level. Moreover, I could not find data on household wealth excluding the value of the house.

Before the analysis is conducted, the stationary properties of the variables are tested using the Augmented Dickey-Fuller (ADF) unit root test. The ADF test by Dickey and Fuller (1979, 1981) tests the null hypothesis that the variable contains a unit root against the alternative that it follows a stationary process. The ADF is an extension of the regular Dickey-Fuller test in the sense that it accounts for some forms of serial correlations (Greene, 2012). According to Greene, the test consists of estimating the following model below.

\[
y_t = \mu + \beta t + \gamma y_{t-1} + \gamma_1 \Delta y_{t-1} + ... + \gamma_p \Delta y_{t-p} + \varepsilon_t \tag{1}
\]

Where the \( \mu \) is the constant, \( \beta \) is the coefficient on a time trend \( t \), and the lag order of the autoregressive process is denoted \( p \). The null hypothesis of the test is that \( \gamma = 0 \) against the alternative that \( \gamma < 0 \).

As an alternative unit root test to the ADF test, the Phillips-Perron (PP) test is also conducted on the variables. Phillips (1987) and Phillips and Perron
(1988) suggested a non-parametric method that can account for serial correlation without using the lagged difference of the dependent variable. The PP test will be used in addition to the ADF test because it is more robust to serial correlation because it includes Newey-West (1987) heteroskedasticity and autocorrelation standard errors.

Table 2. Unit root tests.

<table>
<thead>
<tr>
<th></th>
<th>ADF</th>
<th>PP</th>
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<tbody>
<tr>
<td><strong>Real house prices</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I(0)</td>
<td>-1.620</td>
<td>-1.968</td>
</tr>
<tr>
<td>I(1)</td>
<td>-5.933***</td>
<td>-5.728***</td>
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<tr>
<td><strong>Real disposable income</strong></td>
<td></td>
<td></td>
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<tr>
<td>I(0)</td>
<td>-2.451*</td>
<td>-2.72*</td>
</tr>
<tr>
<td>I(1)</td>
<td>-5.087***</td>
<td>-5.924***</td>
</tr>
<tr>
<td><strong>Real construction cost</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I(0)</td>
<td>0.557</td>
<td>0.458</td>
</tr>
<tr>
<td>I(1)</td>
<td>-6.631***</td>
<td>-7.000***</td>
</tr>
<tr>
<td><strong>Real mortgage rate</strong></td>
<td></td>
<td></td>
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<tr>
<td>I(0)</td>
<td>-2.966</td>
<td>-2.538</td>
</tr>
<tr>
<td>I(1)</td>
<td>-6.703***</td>
<td>-6.585***</td>
</tr>
<tr>
<td><strong>Property tax</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I(0)</td>
<td>-3.222*</td>
<td>-3.302*</td>
</tr>
<tr>
<td>I(1)</td>
<td>-8.970***</td>
<td>-9.151***</td>
</tr>
<tr>
<td><strong>Demographic demand</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I(0)</td>
<td>-0.135</td>
<td>-0.318</td>
</tr>
<tr>
<td>I(1)</td>
<td>-8.059***</td>
<td>-6.723***</td>
</tr>
</tbody>
</table>

In this table, the t-statistics for the ADF and the PP test are presented. The null hypothesis is that the variables contain a unit root against the alternative that they do not. I(0) indicates integration of order 0 and I(1) integration of the first order. *, ** and *** denotes significance at one, five and ten percent respectively.

A non-stationary process is said to be integrated of order $p$ if it has to be differenced $p$ times in order to achieve stationarity. For instance, If a series $y_t$ is integrated of order 1, denoted I(1), then $y_t$ is non-stationary but its first difference is (Greene, 2012).
The unit root tests presented in table 2 above shows that the test statistics for all variables exceed the critical values at a one and five percent significance level. This means we fail to reject the null hypothesis that the variables contain a unit root. Only property tax and real disposable income show significant test statistics on a ten percent level. However, testing the first differences of the variables produces significant test statistic values for all variables. This means that we can reject the null hypothesis that the first differences contain a unit root on a one, five and ten percent significance level. Hence, we can conclude that the variables contain a unit root in levels but become stationary after first difference, i.e. that the variables are integrated of the first order I(1).

3.2 Econometric approach

Following Claussen (2013), it may be useful to think of house prices in the context of a demand and supply relationship. Housing supply is assumed to depend on house prices and construction costs. Housing demand depends on real household disposable income, the mortgage rate, property tax and demographic demand. By assuming that equilibrium holds between demand and supply, the relationship can be expressed as

\[ p_t = \beta_0 + \beta_1 X_{1t} + \ldots + \beta_k X_{kt} + \varepsilon_t \quad (2) \]

where the house price \( p_t \) is a function of a set of \( k \) fundamental factors at time \( t \).

To avoid reporting spurious relationships, we can turn to cointegration analysis. This allows us to check for long-run relationships between the
variables. If house prices and the fundamental factors are cointegrated, we can say that a long-run relationship between them does indeed exist\textsuperscript{4}. Hence, we will be able to answer the question of what has caused the increase in house prices – if the change in price has followed movements in the fundamental factors. More formally, Cointegration means that despite permanent changes in the individual elements of the time series can be caused by developments, there is some long-run relationship connecting the individual components together (Hamilton, 1994). In other words, if the variables in the vector $X_t = [x_1, x_2, \ldots, x_k]$ are non-stationary, but their first differences are, and the linear combination of the variables in (2) is stationary, then the coefficients $\beta_i$ form the \textit{cointegrating vector} (Engle and Granger, 1987). There are a several tests that can be run when checking for cointegration, however, a widely used test is the Engle-Granger (EG) test for cointegration as proposed by Engle and Granger (for relevant studies where this has been used see e.g. Claussen, 2013). The EG test is conducted as follows. Suppose we run the regression in (2) and the residuals are calculated. Then, the first difference of the residuals is regressed on the lagged level of the residual without the constant. The null hypothesis of the test is that there is no cointegration against the alternative that the variables are cointegrated (Engle and Granger, 1987).

To estimate this long-run relationship I have adopted a Dynamic Ordinary Least Squares (DOLS) approach. Saikkonen (1991) and Stock and Watson (1993) suggested using DOLS as an alternative approach to the regular OLS for cointegrated time series. Simply estimating the relationship with the standard OLS procedure may cause a few issues. While the OLS estimator is consistent in presence of serial correlation in the error term, its estimates can be biased in small samples. Further, endogeneity problems may arise between

\textsuperscript{4} The expected relationships are explained in section 3.1
the dependent variable and the explanatory variables and problems with spurious long-run relationships might also occur (Stock and Watson, 1993). If the variables are cointegrated, then estimating a long-run economic time series reduces to estimating cointegrating vectors (Stock and Watson, 1993). The DOLS solves the problems of endogeneity, bias and serial correlation by including leads and lags of the first differences of the explanatory variables in the cointegrating vector. Using the DOLS approach, the long-run relationship is modeled as follows.

\[ p_t = M_t \beta' + \sum_{i=-L}^{L} \phi_i \Delta x_{t-i} + \varepsilon_t \quad (3) \]

Where \( p_t \) is the log of real house prices, \( M_t = [1, x_1, x_2, ..., x_5, D_t, I] \), i.e. the fundamental factor vector where \( x_1 \) denotes the household real disposable income, \( x_2 \) real construction costs, \( x_3 \) the mortgage rate, \( x_4 \) demographic demand and the property tax is denoted \( x_5 \). The time-dummy for the property tax is denoted \( D_t \) and the interaction term is denoted \( I \), which is the time-dummy multiplied by the property tax. Further, \( \beta = [\beta_0, \beta_1, ..., \beta_7] \) and \( L \) is the number of lags and leads of the regressors. Finally, \( t \) is the time indicator, \( \phi \) is the autoregressive process, \( \Delta \) is the change operator and \( \varepsilon \) is the error term. In contrast to the standard linear OLS regression, this dynamic OLS specification allows the effects of the fundamental factors on house prices to occur over time instead of concurrently by including lags and leads. Instead we are also able to capture “delayed” effects on prices. Hence, we will be able to determine how well the change in price has followed movements in the fundamental factors over time.
The optimal lag length of the differences included, $\mathcal{L}$, can be determined through a number of procedures and tests. There is no superior test when it comes to choosing lag length— it all depends on model specificities. Similar to Bergman and Sorensen (2012), and Claussen (2013), I will use a general-to-specific approach. First, the regression is carried out with a specified number of lags, $\mathcal{L}$. If the last lag is significant at a pre-determined confidence level, then the lag length is set to $\mathcal{L}$. If it is insignificant however, the last lag will be dropped and the procedure redone. This will be repeated until there is only one lag left and if that should also be zero, the lags will be set to zero (Hayashi, 2000).

4 Results & discussion

The results of the long-run relationship estimated by the DOLS regression is presented table 3 below. The general-to-specific approach to find the optimal lag length for the regression was found to be 2. The result of the Engle-Granger tests suggests that we can reject the null hypothesis of no cointegration the model. Implying that there is in fact a long-run relationship between house prices and the chosen fundamental factors variables. Overall, the model did a good job in explaining the variation in house prices, suggesting that the price developments during the time period have mostly followed movements in the fundamentals\(^5\). That is, revealing no evidence of a possible bubble in the market in the long-run.

\footnote{The noteworthy high reported $R^2$ is an evident characteristic of cointegrated regressions. For similar results, see e.g. studies surveyed in the literature review.}
Table 3: Long-run relationship

<table>
<thead>
<tr>
<th></th>
<th>Coefficient</th>
<th>t-statistic</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Real disposable income (in logs)</td>
<td>1.98</td>
<td>4.47</td>
<td>0.00</td>
</tr>
<tr>
<td>Real construction cost (in logs)</td>
<td>2.07</td>
<td>5.41</td>
<td>0.00</td>
</tr>
<tr>
<td>Mortgage rate</td>
<td>-0.020</td>
<td>-2.51</td>
<td>0.03</td>
</tr>
<tr>
<td>Demographic demand</td>
<td>0.0006</td>
<td>1.87</td>
<td>0.06</td>
</tr>
<tr>
<td>Property tax</td>
<td>-0.009</td>
<td>-3.15</td>
<td>0.00</td>
</tr>
<tr>
<td>Interaction term</td>
<td>-0.04</td>
<td>-2.30</td>
<td>0.02</td>
</tr>
<tr>
<td>Time-dummy</td>
<td>0.28</td>
<td>-3.76</td>
<td>0.00</td>
</tr>
</tbody>
</table>

Engle-Granger -4.45 (-44.11)
Adjusted $R^2$ 0.96

In this table, the long-run relationship of the DOLS regression is presented. The reported statistic for the Engle-Granger test is the tao-statistic with the z-statistic in parenthesis.

In line with the literature, the long-run relationship between household disposable income and house prices is positive as presented in table 3. Since a higher income will enable households to afford to allocate more money on housing and more expensive housing, this estimate was well expected. The estimate for household disposable income is 1.98, meaning that a one percent increase in income would induce an increase in house prices with 1.98 percent. Although most studies have also found close positive relationships between income and house prices, they do not follow each other exactly 1:1. A reasonable explanation is that housing consumption generally is dependent upon permanent income rather than other consumption choices that are rather linked to current income (Englund, 2011).

The large significant estimate of construction costs is in line with prior expectations. This result coincides with Hort (1998), Claussen (2013) and
Adam and Füss (2010) who also found positive relationships between construction costs and house prices in Sweden. The model suggests that a one percent increase in construction costs would cause an increase in house prices with 2.07 percent. However, this estimate can be compared with that of Claussen (2013) who found the elasticity between construction costs and house prices to be 1.5. He argues that this is not likely since competition in the construction industry and construction costs is exogenous and therefore the elasticity should be around 1 or even smaller.

Further, the model generated negative but small, significant estimate for the mortgage rate. The obtained coefficient estimate shows that a one percent increase in the mortgage rate is associated with 0.02 percent decrease in house prices\(^6\). Similarly, Claussen (2013) also found that the mortgage rate has a negative impact on house prices, as well as most studies surveyed in Girouard et Al., (2006) report negative elasticities with house prices and mortgage rates.

Analogous to Hort (1998), the estimate for demographic demand was positive as expected beforehand. It shows that if the number of people aged 25-44 increases by one person, house prices will increase with 0.06 percent. This result suggests that housing demand is strong in these cohorts. However, this variable was only significant at a 10 percent level.

The interpretation of the coefficient of the property tax is different since the interaction term is included. What the property tax coefficient now tells us is the extent of the effect of the tax on house prices, before 2008. We can see that it is a small but negative as expected, implying that people afford to spend less on housing because of the tax, which in turn drives prices down.

\[3\% \Delta p = 100 \times (e^\beta - 1)\]
Signs of this effect have mainly been captured in models where the tax is included in the cost of housing (see e.g. Hort, 1988; Dermani et al., 2016, Girouard et al., 2006). However, the property tax is usually only measured as an effective rate, where much of the effect might not be captured since it is not allowed to vary over time.

Furthermore, as presented in table 3, one can see the effect of the change in the tax, which is the interaction term plus the time-dummy. Opposite to prior expectations, this implies that the change has had an even larger negative effect on house prices, which is counterintuitive. The reason behind this result is presumably due to the variable definition. Namely, that at the same time as the property tax rate has decreased in 2008, the average assessed value of a house has increased over the years. The net effect of this is positive, i.e. that the variable values have also been increasing over the years. Hence, the observed effect is negative.

The effect of the change of property tax was also tested as a one-time effect, namely that the dummy variable takes the value 1 if 2008 and zero otherwise. Here, the interaction term is omitted and the change is assumed not to have an effect on the price once the tax has been altered. However, this also produced unsatisfactory results. The coefficient value was low and the variable was only significant on a 10 percent significance level. I suspect that this result may be explained in the same manner as before, that this has to do with the way the variable has been constructed - the increasing average assessed values and the decreased property tax almost cancel out.
5 Concluding Remarks & Policy Implications

The main objective of this study was to examine what has caused the house price increase in Sweden since the mid-1990s, that is, if the change in prices has followed the movements in fundamental factors and then if not, being able to say something about a possible bubble in the market. In addition, I also looked at the effect of the 2008 change in the property tax on house prices and if there is any indication of a capitalization effect into prices. Important factors considered contained household disposable income, construction costs, population aged 25-44, mortgage rate and the property tax. The analysis of the long-run relationship house prices and the fundamental factors was carried out using a DOLS regression approach. The findings can be summarized as follows. The model is able to explain the developments in house prices very well, showing no indication of a possible bubble. Household disposable income, construction costs, population aged 25-44 all had positive significant effects on house prices in accordance with prior expectations. The mortgage rate had negative effects on house prices. Moreover, the property tax had negative effects on house prices pre-2008, however, the effect of the change is negative counter to prior expectations as indicated by the model. No capitalization effect into prices could be found.

Coinciding with the broader literature, these results tells us that there does not seem to be any indications of a bubble on the market in the long-run. However, the result should be interpreted with caution since the model does not account for possible short-term deviations from the long-run price. This has been observed in some studies within the field, which is to be considered as a flaw with the current model.
As discussed, it has been found that a substantial fall in house prices could have recession-like consequences on the Swedish economy and that this would be exacerbated if a global economic decline would coincide. The fact that falling house prices have substantial macroeconomic effects and that macro-prudential policy remain widely discussed, policy makers ought to be interested in analyzing the effects of policy on the determining factors of house prices. Moreover, house prices could fall even in absence of a bubble since the fundamental factors behind house prices can change (although they seldom dramatically do). Hence, further investigating the movements of house prices should be of great interest for those studying the Swedish economy.

The rising household indebtedness as a consequence of increasing house prices is also a reason why examining the factors behind the increase might be interesting to policy makers. Finochiarro et al. (2011) argues that large-scale household indebtedness could also worsen a possible financial crisis. Glick and Lansing (2010) show that countries with larger debt experience larger depressions. Furthermore, Finochiarro et al. argue that a considerable fall in house prices could reduce home equity to a level where the mortgage debt on a property surpasses its market value.

For further analysis, it would be interesting to do an analysis on a regional level. As Flam (2016) points out, country level studies can be misleading since house prices vary greatly over the country as a whole. As to my knowledge, very few studies have done this. Additionally, extending the approach to an ECM framework could also be interesting in order to investigate short-term bubble tendencies by examining short-run deviations in price in relation to the
long-run. In my DOLS I only look at the long-run relationship, hence an ECM would be even more interesting if time would allow. More variables could be added such as immigrant rates or immigrant population as they exert a proportion of housing demand. A measure of credit-availability could also be included since this could also be a factor driving house prices. Further investigating effects of tax regulation on house prices are also an aspect worth exploring, such as the abolishment of the wealth tax and the inheritance tax. One could think that combinations of these taxes might have joint effects on house prices. The amortization requirement in this context might also be worthwhile investigating. Lastly, examining tenant-owned apartment prices would also be a very interesting aspect, as I only examined house prices.
6 References


Englund, P (2011), ”Swedish house prices in an international perspective”, *the
Riksbank’s commission of inquiry into risks on the Swedish housing market, Sveriges riksbank, Stockholm.


