THE EFFECT OF INTEREST RATES ON HOUSING PRICES IN SWEDEN:
The case of one and two dwelling buildings.

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Acknowledgement.

I would like to thank my GOD, for being with me from start to end, all become praiseworthy.

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Habtewold Demewez

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Abstract.

The aim of this paper is to study the effect of interest rates on house price changes in Sweden for the case of one and two dwelling buildings. Basically, three procedures were used for analysis. First, correlation analysis was used to investigate and test if there has been any relationship between interest rates and house price in Sweden in the past two decades. Second, multiple regressions analysis with consideration of hetroskedasticity autocorrelation or HAC (newey-west standard) errors was applied to test the impact of changes of interest rates on house price. Finally, distributed lag model was applied to examine the impact of interest on house price through time. The result shows that there is strong inverse relationship between interest rates (governmental bond rates, mortgage bond rates, lending rates and repo rates) and housing price index. The regression coefficients show that the decrease in the interest rate is followed by corresponding increase in the housing price index for all the given interest rates. The other finding is that more than 92 percent variation in the housing price index is explained by changes in interest rates, changes in net house hold disposable income, inflation rate and supply. The result also shows the lag effects of changes of interest rates on housing price. The major implication of this study is that fluctuations in interest affect homebuyers, home sellers, household incomes and investors. The study also suggests that further detail investigation on house price dynamics is crucial for monetary policy.
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CHAPTER 1- INTRODUCTION.

In the past decades, researchers have been devoting much of their time on the analysis of factors that affect house price dynamics, and it has become the hot issue especially following financial crisis. According to Otrok and Terrones (2005), some of the reasons were the role of housing in an individual portfolio, larger fraction of housing in GDP, larger fraction of household’s expenditures in housing, mortgage debt as the major liability of most households and its effect on affordability. Tsatsaronis & Zhu (2004) illustrated that housing prices influence the business cycle through their effect on the aggregate expenditure and financial system.

Similarly, in Sweden many experts and researchers have been very much apprehensive about house price dynamics. For example, Ingves, Apel & Lentrop (Riksbank, 2010-1) stated that financial crisis affected monetary policy to stabilize credit driven imbalances on the property market. Frisel & Yazdi (Riksbank, 2010) described that housing price fall was not happened in Sweden, even though in countries like US, Ireland and Spain housing prices have fallen by 40 percent after the peak rise in 2006-2007. These particulars provoked the author to work on confirming and finding additional verifications on factors that affect house price dynamics in Sweden.

1.1. Background

According to statistics of Sweden (SCB), the consumer price index was 306.58 in January 2011 compared to 1980. As seen in figure 1.1 & 1.2 real estate price indices for one & two dwellings, multidwellings, and seasonal &secondary use buildings were growing continuously at an increasing rate in late 1980s. However, changes of real estate price indices have been positive since 1995. Similarly, consumer price index has been trending upwards since 1981 and change of consumer price index has remained positive.

Short and long-term interest rates, as seen in figure B.1, have been declining in the past two decades even though there was a peak rise between the years 1992 and 1993. Similarly, Frisel & Yazdi (Riksbank, 2010) described that the bank interest rate margin has decreased for the last 10 years. Since mid-1990 household debts have increased by more than the double, however house
hold real incomes increased only by 50 percent. Housing accounts was more than half of household’s asset and 90 percent of debts have had a house or tenant owner’s right as collateral. Debt-to-income ratio was nearly 87 percent in 1993 and became 170 percent in 2010.

Figure 1.1 Real estate price index in Sweden 1981=100.

![Real estate price index in Sweden 1981=100.](image)

Source: Statistics Sweden

Figure 1.2 Real estate price index as compared to the previous year.

![Real estate price index as compared to the previous year.](image)

Source: Statistics Sweden

Correspondingly, interest-to-income ratio was 147 percent in 1993 and had been decreasing until 2005 that was 70 percent. Afterwards; it has been fluctuating for example in 2008 it raised to 100 percent and 70 percent in 2009. The proportion of variable mortgage increased from 8 percent in
1997 to 69 percent in 2009, and disposable income increased by 76 percent from 1997 to 2009. Inflation rate, as illustrated in Figure B.2, was about one percent in 2004 and it was increasing at very slow rate to reach four percent in 2008. This was followed by immediate fall to negative in 2009, and reversed to positive in 2010 and 2011. As illustrated in figure B-3, the supply of one and two dwelling buildings was increasing up to 1975 and then, it was declining up to 1985. However, in the last two decades the number has not shown a remarkable change. Similarly as shown in figure B-4, gross domestic product (GDP), real gross domestic income (GDI), and real gross national income (GNI) have been continuously increasing at slow rate in the past two decades.

1.2. The problem Description

Previous researchers conducted many studies that were useful for households, policy makers, home buyers and sellers. McGibany & Nourzad (2004) describes that mortgage rate is one of the key components of housing affordability index, and the rise in mortgage rate decreases the index and vice versa. Debelle (2004) also tried to show that most households are very sensitive to changes in interest rates, in the countries with variable mortgage rates like Sweden, because of their greater indebtedness in the past two decades. Similarly, Vries and Boelhouwer (2005) concluded interest rates, income and expected prices as determinants of house price. What triggered the author to conduct this study?

Basically, three problems were identified that initiated the author to carry out this study. First, researchers have different perspectives and there has been a gap among findings. Joe Wong, Eddie Hui, & Seabrook (2003) found that lower interest rates were accompanied by higher house prices during the inflation period. However, during deflationary period, lowering interest rate did not have impact on falling real housing prices. Contrary to this, McGibany & Nourzad (2004) found out that there was no short-term effect of mortgage rate on house price changes, but rather the relationship was found to be long-term. They also argue that empirical studies donot provide accurate enlightenment regarding the relationship between mortgage rates and housing prices. Gubta and Kabundi (2009) concluded that house price inflation was negatively responded by positive monetary shock, but the relative effect was diverse in different regions. Therefore, it is
very challenging to give precise verdicts based on previous studies, as there were discrepancies among different findings.

The second problem was that detail studies on these issues have not still been done. It was stated in the article (Riksbank, 2005) that Swedish house price development was related to low interest rate, increasing disposable income and low construction activity. However, it was not fully clear and enough to give accurate judgments, and it should be supported by many more detail scientific studies.

The third problem, as explained in the background section, was that house purchasing in Sweden has been mostly financed by banks and household debts have increased by more than double. The sensitiveness of most households (home sellers) to changes to interest rates (Debelle, 2004) and the sensitiveness of home buyers (McGiban & Nourzad, 2004) to changes in interest rates make it clear to understand the reason why it was necessary to make the study.

The main purpose of this research paper is therefore, to study the effect of interest rate on housing prices in Sweden for the case of one and two dwelling buildings by taking into account the effect of some other macroeconomic factors. It has three objectives.

1. To increase the body of knowledge on previous works on house price & interest rates.

2. To increase knowledge of homebuyers, sellers, mortgage originators, mortgage aggregators and investors about house prices and interest rates in home owning and transferring processes and to increase their awareness.

3. To raise possible research questions recognized in the research process.

At the end of the study, this paper tries to find answers to the following questions.

- Is there any relationship between interest rates and housing price in Sweden? If there, is the relationship positive or negative?
- What is the extent of effects of changes of interest rates on changes of housing prices?
- Is there any lag effect of changes of interest rates on changes of housing prices?

The study benefits stakeholders that are directly affected by house price dynamics, as mentioned earlier homebuyers and sellers, mortgage institutions, brokers and all other investors who need to have homes as the parts of their portfolios. As stated by riksbank identifying the relationship between key interest rates and housing price is important for policymaking. This
study also contributes some supportive idea on previous studies on Swedish house price dynamics.

The scope of this paper was mainly confined to identifying the relationships between housing prices and interest rates, even though other macro-economic factors took part in the analysis. The study has some limitations. The analysis was limited to one and two dwelling buildings despite multidwellings and summer, and other temporary dwellings were included in the general topic. This was made because of absence of quarterly data for the later ones. There are many interest rates (according to riksbank publications); however, governmental bond rates, mortgage bond rates, repo rates, and lending rates were used in the analysis.

The rest of the paper is organized as follows. Chapter two is the literature review that discusses previous works by different researchers. Chapter three is the methodology section that discusses the approaches used by the author to conduct the study. Chapter four is the analysis and discussion section and is all about the main findings of the study in comparison with past similar studies. The last chapter is the conclusion section that is mainly the summary of the study, it raises some future research questions, and it discusses the implication of the study.
CHAPTER 2. LITERATURE REVIEW.

This chapter discusses review of past research works on macroeconomic determinants of house price dynamics. It has two sections. First, it discusses previous literatures on macroeconomic determinants of house price in wider perspective, and the second section reviews previous works on four key macroeconomic factors namely, interest rates, household income, house supply and inflation rate.

2.1 Macroeconomic determinants of housing price.

Tsatsaronis & Zhu (2004) concluded two basic determinants of house price dynamics, long-term and short-term determinants. Long-term house price determinants included growth in disposable income, average level of interest rates (related to long run inflation) and existing house stock, whereas short-term determinants included provision of financing for house purchasing, liquidity of house, taxes, and price expectations. Kim Hin& Cuervo (1997) also studied private house price dynamics in Singapore from 1985 to 1995 and found that there was cointegration between house price with real GDP, prime lending rate and private house price starts. Chen & Patel (1998) concluded that there was long-term relationship between house price and interest rates, household income, house completion, construction cost and stock price index.

2.2 The key macroeconomic factors

Interest rates

Many researchers proved that interest rates have strong influence on house price dynamics. Joe Wong, Eddie Hui, & Seabrook (2003) made an empirical study on the impact of interest rates upon housing prices of Hong Kong’s market. The study was conducted on both inflationary and deflationary periods. The result was that during inflationary period lower interest rates was accompanied by higher house prices, however this was not true during deflationary period and lowering interest rate did not have impact on falling real housing price. Gubta and Kabundi (2009) examined the effect of monetary policy on house price inflation of USA and found that housing price inflation was negatively responded by positive monetary shock. Moreover, the effect was
different among different regions for the reason that sensitivity was not the same. Bonnie (1998) found that mortgage rate was very important determinant of housing price changes and the sensitivity of housing price changes for mortgage rate was found to be very high. He, Hu & Casey (2009) concluded that change in mortgage rates affect American residential real estate market that can affect millions of households and many financial institutions. McGibany & Nourzad (2004) found out that there was long-term relationship between interest rates and changes in house price.

Second, the relationship between housing affordability and mortgage financing was the big concern. According to McCord et al., (2011) the relationship between mortgage finance and affordability has been driven by deregulation of the mortgage market contributing to the rise in the house prices. Furthermore, the new significant capital requirement needed to access the housing market will inevitably prolong affordability pressures for the near future. Debelle (2004) describes that the significant rise in the household debt for the past two decades in the developed countries was found to be lowering interest rates and decreasing the number of credit constraints of mortgage loans. In addition to this, most households having variable mortgages were found to be very sensitive with small changes in interest rates because of the impact on their incomes and asset prices. As stated in the article (Glaeser, Gyourko & Saks, 2005), that home mortgage interest deduction to subsidize homeowners was used as an incentive for typical homebuyer in USA. Ferrer, Gonzalez, & Soto (2010) also supported this fact for the very sensitiveness of the price of high-levered industries like construction and real estate to changes in interest rates. Accordingly, monetary policy strongly affects housing price changes through its effect on mortgage rate changes. It was further notified in the article that the effect of changes of interest rates on house price varies from region to region. This fact was also proved by Reichert (1990).

*Household income*

Bonnie (1998) also had found that fluctuation in employment results change in the income which affects house price changes through its effect on demand. Magne & Rady (2002) describes that buying home requires financing. Changes in incomes especially ability of young households to afford down payment affect house price levels. Glaeser, Gyourko & Saks (2005) concluded that the rising of housing prices was related to increasing incomes. Taltavull & Paz (2003) identified that housing prices were related to family wage incomes and population.
Housing supply

Housing supply was also agreed by researchers to have strong influence on house price dynamics. Glaeser, Gyourko & Saks (2005) concluded that the rising of housing price was related to decrease of new housing construction. Vries and Boelhouwer (2005) describe that the increase in supply triggers a fall in prices. As proved by researchers, house supply can be affected by different factors. As concluded by Singell & Lillydahl (1990), quantity of housing was found to be reduced because of impact fees or development fees imposed to developers or buyers of homes that affects the price of houses. Redfearn & Painter (2002) found out that housing supply was sensitive to changes in interest rates. Warsame, Wilhelmson & Borg (2010) made the study on the impact of interest subsidy on single and multifamily houses in Sweden whether it increased house supply. The study shows that interest subsidy had no effect in production of housing stocks in a highly demanded region, however the effect was reflected in low demanded region and interest subsidy contributed a lot to the production of especially multifamily houses in the country.

Inflation rates

Inflation, especially the anticipated one, was thought by many researchers to have adherence with housing price changes. Kearl (1979) studied the impact of inflation on housing investment and found out that inflation was found to affect house prices. Taltavull and McGreal (2009) tried to study the effect of house price expectations on house price on residential properties. The result of the study indicated that price expectations account for 8 percent of the house price in Spanish house market. Stiglitz (2003) suggested as cited in article (Taltavull and McGreal, 2009) that the reason for price increase was the expectation that higher selling price in future.

Generally, as discussed above researchers have identified many macroeconomic factors that affect house price dynamics. Interest rates, household income levels, housing supply and inflation rates are the main ones that were proved to have influence on house price dynamics. However, these researchers used different approaches to make their investigation. The author of this paper used empirical analysis to conduct the study and the details are discussed in the next chapter.
CHAPTER 3. METHODOLOGY.

The main purpose of this paper is to study the effect of changes in interest rate on house prices in Sweden for the case of one and two dwelling buildings in Sweden. This chapter describes the research methodology and it is organized into three subsections, hypothesis, research design, and data description sections.

3.1 Hypothesis.

The following three null hypotheses were formulated for the study based on the three basic research questions.

- H01. There has not been any relationship between interest rates and house price in Sweden in the decades.
- H02. Changes in the interest rates have no any effect on changes of house prices.
- H03. Changes in the interest rates has no any lag effect on house price changes.

3.2 Research Design.

Different research methods have been used in the analysis of house price dynamics. Joe Wong (2003) used regression analysis and correlation analysis methods to study the effect of interest rates on housing prices in Hong Kong real estate market. He classified the data and analysis in two periods, and the main concern of the author was to study the consistency of the effect of interest rates on housing prices. The method used for the analysis was multivariate regression analysis. Mcgibany & Nourzad (2004) also tried to analyze the relationship between mortgage rates and interest rates using cointegration analysis technique. The choice of analytic method was based on the concern of the authors to study changing behavior of variables through time. Similarly, Kim Hin & Cuervo (1997) used cointegration analysis to analyze the relationship between lending rate and house prices.
The procedures used in this paper were different from Mcgibany & Nourzad (2004) and Kim Hin& Cuervo (1997). However, it has some similarity and difference with Joe Wong (2003). Three procedures were used to study the relationship between dependent and independent variable. First, correlation analysis was used to analyze and test the first hypothesis (H01). This is similar to the procedure used by Joe Wong (2003). Second, multiple regressions analysis with consideration of heteroskedasticity autocorrelation or HAC (newey-west standard errors) was used to test the second hypothesis(H02). The main concern of the author was to determine alternative least square estimator with minimum variance and to compute consistent least square standard errors in simpler way, rather than specification of more complex dynamic error model. Furthermore, the influences of other key macroeconomic factors or variables were allowed in to be incorporated with interest rates. Third, the other concern of the author was the impact of interest on house price through time.

Model development & Variable specification

The following model was used as the basis for this study. The main concept was developed from literature review, however the concepts of model development were modified from Reichert (1990), Jud &Winkler (2002) and Taltavull &McGreal (2009)

\[ HP_t = f (IR_t, NDI_t, INF_t, SUPP_t, e_t ) \] ………………………………….. (1).

Where \( HP_t \) = House price during period t,
\( IR_t \) = Nominal interest rate \(^3\) during period t,
\( NDI_t \) = Net household disposable income during period t,
\( INF_t \) = Inflation during period t,

\(^1\) Heteroskedasticity and autocorrelation are the two related terms where heteroskedasticity in this context simply refers that variances are not same for each observations and autocorrelation refers to effects of lag in the error terms. (Hill, Griffiths &Lim, 2007).

\(^2\) Newey-west standard errors are assumed to be true errors that are little bit higher and confidence of interval are wider than multiple regressions without considering HAC. (Hill, Griffiths &Lim, 2007).

\(^3\) According to Lagerwall (2008), “Nominal interest rates reflect the value in Kronor at various points in time. They give a nominal amount in the future in relation to a nominal amount today.”
Further modifications were made to equation 1 to develop the actual model specification of the study. In order to identify the nature of relationships between dependent and independent variables two ways scatter diagram was examined and no direct linear relationship has been observed, but rather curve like relationship has been observed. Literatures recommend applying logarithm in the analysis model as one option when scatter diagram relationship is not observed to be linear or if it seems bowed. The different model options for using logarithm in the model are log-log model, log-linear model and linear log models (Hill, Griffiths & Lim, 2007). However, log-linear was found to be more appropriate. Because, as can be seen in figure 1.1, the long term trend of housing price index was examined to be an increasing function with an increasing rate. Finally, the following two basic models were used for analysis.

Model 1.

The purpose of the model was to run multiple regression of housing price index on interest rates, net household disposable income, inflation rates and supply.

\[ \ln(y) = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \varepsilon \]  \hspace{1cm} (2)

Where \( y \) = housing price index

\( X_1 \) = different interest rates, governmental bonds with 10yr, 7yr, 5yr, 2yr maturity; mortgage bond rates for 5yr and 2 yrs maturities; lending rates and repo rates.

\( X_2 \) = net household disposable income. \( X_3 \) = inflation. \( X_4 \) = supply.

\( \alpha \) = constant. \( \beta \) = unit changes in \( y \) for every unit change in \( X \).

Since logarithm applied in dependent variable, in this case for every unit change in \( X \) there is corresponding hundred times \( \beta \) or \((100* \beta)\) percentage change in \( y \).
Model 2.

The second model is Finite Distributed Lag Model, and this model helps more to understand the impacts of changes of interest rates on housing price changes, with the assumption that the impact of changes is not only reflected at specific time but through finite periods of time. (Hill, Griffiths & Lim, 2007)

\[ \ln (y) = \alpha + \beta_1 X_t + \beta_2 X_{t-1} + \beta_3 X_{t-2} + \beta_4 X_{t-3} + \beta_4 X_{t-4} + \epsilon_t \]  

Where, \( y \) = housing price index

\( X_{t-p} \) = different interest rates, governmental bonds with 10yr maturity; mortgage bond rates for 5yr maturities, and lending rates.

\( \alpha \) = constant, \( \beta \) = unit changes in \( y \) for every unit change in \( X_{t-p} \), where \( t-p \) represents lag periods with value that \( p \) ranges from 0 to 4.

3.3 Data.

The data used in this study were house price indices for one and two dwelling buildings, interest rates, net household disposable income, inflation rates, and house supply. Data for house price index, net household disposable income, inflation rate and house supply were obtained from Swedish Statistics (SCB), however data for inflation rates were obtained from riksbank. The data used for analysis were from 1993 to 2010.

According to riksbank, there are many interest rates but this paper focuses on the following interest rates for analysis; riksbank interest rates (repo rate\(^4\) and lending rate\(^5\)) and Swedish market rates\(^6\)(government bond rates and mortgage bond rates) which are the components of its

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\(^4\) Repo rate as described by riksbank is “the rate at which banks can borrow or deposit funds at the riksbank for a period of seven days”.

\(^5\) Lending rate as described by riksbank is “the rate of interest banks pay when they borrow overnight funds from the riksbank and is 0.75 percentage higher than repo rate.”

\(^6\) Swedish market rates as described by riksbank is rates for paying credits; governmental bond is issued to meet governments medium and long term borrowing requirements where as mortgage bond is a promissory note issued by governmental mortgage institution to finance long term home lending requirements.
monetary policy. All interest rates used in this study were in nominal forms. Real estate price index for one and two dwelling buildings has been used in the analysis instead of house prices.

The first challenge of data collection was to use either quarterly or yearly data. Using yearly data could help to conduct the study analysis on both one&two dwelling buildings and multidwelling buildings, however the number of data collected was small (only 14 year) which could increase sample variance affect validity of the result. Theoretically, increasing sample size paybacks to increase confidence interval and reliability of confidence interval of the precision of parameter needed. Here the number of observation is higher for quarterly data. However, quarterly data of house price index was available only for one and two dwelling buildings. It was due to these reasons that the author limited the study to conduct on one and two dwelling buildings. The second challenge of was variation in the number of data collected for dependent and independent variables. In order to balance this variation the number of data for house price index and some independent variables were decreased.

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Variables description</th>
</tr>
</thead>
<tbody>
<tr>
<td>hpit</td>
<td>House price index for one-or two buildings.</td>
</tr>
<tr>
<td>gvbt10yr</td>
<td>Governmental bond rate-10yr maturity</td>
</tr>
<tr>
<td>gvbt5yr</td>
<td>Governmental bond rate-7yr maturity</td>
</tr>
<tr>
<td>gvbt5yr</td>
<td>Governmental bond rate-5yr maturity</td>
</tr>
<tr>
<td>gvbt2yr</td>
<td>Governmental bond rate-2yr maturity</td>
</tr>
<tr>
<td>qvbt5yr</td>
<td>Mortgage bond rate-5yr maturity</td>
</tr>
<tr>
<td>mbt2yr</td>
<td>Mortgage bond rate-2yr maturity</td>
</tr>
<tr>
<td>lrt</td>
<td>Average lending rate-</td>
</tr>
<tr>
<td>rrt</td>
<td>Average Repo- rate-</td>
</tr>
<tr>
<td>ndit</td>
<td>Net House hold disposable Income.</td>
</tr>
<tr>
<td>infl</td>
<td>Inflation</td>
</tr>
<tr>
<td>hsupply</td>
<td>House supply</td>
</tr>
</tbody>
</table>

Table 3.1. Descriptions of variables
CHAPTER 4. RESULTS OF ANALYSIS AND DISCUSSIONS.

The main purpose of this research paper is therefore to study the effect of interest rate on housing prices in Sweden considering other macroeconomic factors. The research questions in this the paper are as mentioned earlier, first to examine the relationship between interest rates and housing prices and second to identify the effect of changes of interest rates on housing prices for the case of case one & two dwelling.

This section of the paper contains four parts. The first part examines descriptive statistics of the data and the main results of analysis are presented in the next three sections. Analysis of correlation between housing price index and interest rates are presented in the second section. Results of the multiple regression analysis with considering heteroskedasticity and autocorrelation are presented in the third section. The lag effect of interest rates on housing prices is discussed in last section. The analysis was conducted using STATA software.

4.1 Descriptive Statistics.

Table 4.1 describes summary of quarterly time series data that were used for the analysis of the effect of interest rates on housing prices for one and two dwelling buildings. The numbers of observations used were 65. However, in some parts of the analysis the numbers were higher for example as seen in the table 4.2. The reason was that the numbers of observations for each variables were not the same and missing variables were not used in the analysis, but rather the number of observations were deducted to avoid the problem. The mean of housing price index is 332 with standard deviation of 119. The mean of governmental bond rate with ten-year maturity is 5 percent with standard deviation of 2. The mean of quarterly net household disposable income is 310 558 SEK with standard deviation of 67000. The mean of inflation is 1.25 with standard deviation of 1.19.
4.2 Correlation between housing price index and interest rates.

Correlation analysis was carried to examine the relative degree of co-movement between housing price index and different interest rates and to identify whether there exists positive or negative relationship between them. The analysis also helps us to predict future behaviors of house price index based on interest rates.

The null hypothesis for this analysis was zero correlation coefficient of house price index with interest rates and the alternative hypothesis was correlation coefficient different from zero which was two-tailed test. The result is shown below in table 4.2. As seen in table, the three numbers indicate coefficients of correlation, p value for the given level of significance 0.05 for which the test was conducted and lastly the number of observation.

The results indicate that there is strong inverse relationship between interest rates (governmental bond rates, mortgage bond rates, lending rates and repo rates) and housing price index of one and two dwelling buildings. The coefficients of correlation between housing price index and interest rates range between -0.769 and -0.688 for governmental bond rates with 10 years maturity and mortgage bond rates with 2 years maturity.
Table 4.2 Correlation between variables for one two dwelling buildings

<table>
<thead>
<tr>
<th></th>
<th>hpi</th>
<th>gvb10yr</th>
<th>gvb7yr</th>
<th>gvb5yr</th>
<th>gvb2yr</th>
<th>qmbt5yr</th>
<th>mbt2yr</th>
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</thead>
<tbody>
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<td>hpi</td>
<td>1</td>
<td>0</td>
<td>-0.769*</td>
<td>-0.767*</td>
<td>-0.751*</td>
<td>-0.733*</td>
<td>-0.714*</td>
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<td>0</td>
<td>0</td>
<td>0</td>
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<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
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<td>67</td>
<td>0.997*</td>
<td>0.976*</td>
<td>0.983*</td>
<td>0.985*</td>
<td>0.986*</td>
</tr>
<tr>
<td>gvb2yr</td>
<td>67</td>
<td>67</td>
<td>0.997*</td>
<td>0.976*</td>
<td>0.983*</td>
<td>0.985*</td>
<td>0.986*</td>
</tr>
<tr>
<td>qmbt5yr</td>
<td>67</td>
<td>67</td>
<td>0.997*</td>
<td>0.976*</td>
<td>0.983*</td>
<td>0.985*</td>
<td>0.986*</td>
</tr>
<tr>
<td>mbt2yr</td>
<td>67</td>
<td>67</td>
<td>0.997*</td>
<td>0.976*</td>
<td>0.983*</td>
<td>0.985*</td>
<td>0.986*</td>
</tr>
<tr>
<td>lrt</td>
<td>67</td>
<td>67</td>
<td>0.997*</td>
<td>0.976*</td>
<td>0.983*</td>
<td>0.985*</td>
<td>0.986*</td>
</tr>
<tr>
<td>rrt</td>
<td>67</td>
<td>67</td>
<td>0.997*</td>
<td>0.976*</td>
<td>0.983*</td>
<td>0.985*</td>
<td>0.986*</td>
</tr>
</tbody>
</table>

Note:*sign indicates significance.

The results obtained from correlation analysis were similar to results of trend analysis seen in figure 4.2 of trend analysis of variables. As seen in the figure 4.2 house price index trends upwards while interest rates trend downwards a with different degree which is negative relationship.

This finding supports the theory that there is inverse relationship between interest rate and house price changes, but it is different from the finding by Joe Wong (2003) in Hong-king real estate market. In the later study there was no consistent correlation between nominal interest rates and housing prices, which means inverse relation was happened only during inflationary period and low interest rate was very much correlated with low house price during deflationary period. In Sweden, there was continuous increase of house price in the past two decades and this study was actually made on inflationary period, moreover the inverse relation was stronger than what was in Hong Kong.
4.3 Multiple regressions with consideration of hetroskedasticity and autocorrelation or HAC (newey-west standard) errors.

With number of lags=4

Repeated multiple regression analysis, mainly with consideration of newey-west standard errors, was conducted for each interest rate to investigate the extent of effect of change of interest rates on changes of housing price index for one and two dwelling buildings. The logarithm of housing price index was regressed on interest rates, net household disposable income, inflation rate and supply. Tables 4.3.1 - 4.3.3 describe the main findings of the regression analysis for the three interest rates, governmental bond rate with ten-year maturity, mortgage bond rate with five-year maturity, and lending rates. The rest of the results of regression analysis are shown in the appendix A.

The null hypothesis was that changes in interest rates have no any effect on change in the housing price index, which means coefficients are assumed to be zero. The alternative hypothesis
was that changes in interest rates have significant effect on changes of housing price index, which means coefficients are assumed to be different from zero and it is two-tailed test.

The regression coefficients show that a decrease in the interest rate is followed by corresponding increase in the housing price index for all the given interest rates. As seen in tables 4.3.1 & 4.3.2, the regression coefficients for governmental bond rate with ten-year maturity and mortgage bond rate with five-year maturity are -0.05999 and -0.0573. Similarly, as seen in the table 4.3.3 the regression coefficient for lending rate is -0.0787.

The results are interpreted as follows. When there is one percent decrease in governmental bond rate this is accompanied by corresponding increase in the housing price index of one and two dwelling building by 5.99 percent or approximately six percent. When five years maturity mortgage bond rate decreases by one percent then it follows corresponding increase in the housing price index by 5.73 percent. Similarly, when lending rate decreases by one percent then it follows the corresponding increase in the housing price index by 7.87 percent. The effect of changes in lending rate was found to be the highest in this analysis when compared with other interest rates.

The other finding is that more than 92 percent variation in the housing price index is explained by changes in interest rates, changes in net household disposable income, inflation rate and housing supply for all regression results as indicted by $R^2$ in table A.6. The analysis was conducted at 0.05 level of significance, and both p value and two tailed test rejection rules were applied for rejection of the null hypothesis. Therefore, 0.025 level of significance was for the former. The T-critical for degree of freedom of 66 was 1.997 for the later. Therefore, using both rejection rules null hypothesis is rejected and we accept the alternative hypothesis that changes in the interest rates have effect on changes in the housing price index for one and two dwelling buildings.

The coefficients of net household disposable income, inflation rate and housing supply, as seen in the tables A.4.3.1 - 4.3.2 & tables A.1-6, show that increase in net household disposable incomes and inflation are accompanied by increase in housing price index. However, housing supply had no any significant effect in reduction of housing prices in Sweden for the past two decades.
### Table 4.3.1 Regression with newey-west standard errors using government bond rate with 10 yrs maturity.

| Inhplit   | Coef.   | Std. Err. | t     | P>|t| | 95% Conf. Interval |
|-----------|---------|-----------|-------|-----|-------------------|
| gvt10yr   | -0.0573498 | 0.0152903 | -3.75 | 0.001 | -0.0697276--0.0268219 |
| ndit      | 3.97e-06  | 2.99e-07  | 12.47 | 0.000 | 3.13e-06--4.32e-06  |
| infl      | 0.0242891 | 0.0154887 | 1.57  | 0.122 | -0.0066336--0.0552118 |
| hsupply   | 0.0003132 | 0.0000223 | 1.4   | 0.167 | -0.0000134--0.0000759 |
| _cons     | 4.7877775 | 0.1680044 | 28.5  | 0.000 | 4.4523433--5.123207  |

### Table 4.3.2 Regression with newey-west standard errors using quarterly mortgage bond with 5yrs maturity.

| Inhplit   | Coef.   | Std. Err. | t     | P>|t| | 95% Conf. Interval |
|-----------|---------|-----------|-------|-----|-------------------|
| gm05yr    | -0.0573498 | 0.0152903 | -3.75 | 0.001 | -0.0697276--0.0268219 |
| ndit      | 3.97e-06  | 2.99e-07  | 12.47 | 0.000 | 3.13e-06--4.32e-06  |
| infl      | 0.0242891 | 0.0154887 | 1.57  | 0.122 | -0.0066336--0.0552118 |
| hsupply   | 0.0003132 | 0.0000223 | 1.4   | 0.167 | -0.0000134--0.0000759 |
| _cons     | 4.7877775 | 0.1680044 | 28.5  | 0.000 | 4.4523433--5.123207  |

### Table 4.3.3 Regression with newey-west standard errors using lending rate.

| Inhplit   | Coef.   | Std. Err. | t     | P>|t| | 95% Conf. Interval |
|-----------|---------|-----------|-------|-----|-------------------|
| lrt       | -0.0787012 | 0.0121084 | -6.5  | 0.000 | -0.1029055--0.0544968 |
| ndit      | 2.91e-06  | 2.59e-07  | 9.73  | 0.000 | 2.31e-06--3.51e-06  |
| infl      | 0.0632511 | 0.0179573 | 3.68  | 0.000 | 0.0288775--0.0976249 |
| hsupply   | 0.0000466 | 0.0000223 | 2.02  | 0.042 | 4.69e-06--9.00e-05  |
| _cons     | 5.006416  | 0.1319992 | 37.93 | 0.000 | 4.742553--5.270278  |

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Coefficients for net household disposable income, inflation rate and supply range between 3.72e-06 & 2.91e-06, 0.0634 & 0.01886, and 0.0000616 & 0.0000312. Therefore, when there is one percent (1%) increase inflation rate this is accompanied by an average increase of housing price index by 3.7 percent. Similarly, the one thousand units (Swedish Crown) increase in net household disposable income is accompanied by an average increase of 0.33 percent increase in the housing price index. Coefficients for housing supply are positive which is contradictory to the theory that increase in the housing supply is followed by decrease in the house price index. The result shows that the effect of housing supply in Sweden was insignificant in reduction of house prices in the past decade. All coefficients are statistically significant using both p value rejection rules and two tailed test rejection rules.

There are some previous works that support and contradict these findings. These finding agree with the findings by Jud and Winkler (2002) that there was strong influence of real changes income and interest rates on house price changes, however Jud and Winkler did not clearly put the sign of relationship. Megibany & Nourzad (2004) concluded that there was no short run influence of mortgage rates on house price changes, and it was inelastic response of house price to mortgage rate changes. Accordingly, the impact of interest rates was rather long term. In this paper, the impact of interest was analyzed in four-quarter lags of time and the impact was observed in these periods as seen in the table 4.4.1.

Joe Wong (2003) found inverse relationship between house price and interest rates in inflationary period and direct relationship during deflationary periods in Hong Kong using bivariate regression analysis and R² was very low compared to this study. According to Chen and Patel (1998) 34 percent of variations of house prices were found to be caused by variation in five determinant factors, population change, house hold income, short term interest rates, stock price index, construction cost and house completions. This is different from the current finding in this paper that 92 percent of the variations of house prices are explained by changes in net household disposable income, interest rates, inflation rates and house supply.

In this paper, housing supply was found to have no significant effect to decrease house price. This corroborates the findings by Warsame, Wilhelmsson & Borg (2010) that interest subsidy for new housing construction was ineffective in the regions where demand was high. Contrary to this, Vries and Boelhouwer (2005) found that the increase in supply triggers a fall in prices.
However, the reason why housing supply was found to have no effect needs more investigation. Inflation was found to have significant effect in this paper, which confirms the finding by Kearl (1979), Stigliz (2003), and Taltavull and McGreal (2009).

4.4 The lag effects of interest rates.

Finite distributed lag model was used for regression housing price index with their four lags for each interest rate to examine the lag effects of changes in interest rates on house price index through time using governmental bond rates, mortgage rates and lending rates.

The model has limitation of assumptions and the effect of other key macroeconomic factors was not considered. As a result, the values of the coefficients as seen in table 4.4 obtained are different from those that are mentioned in tables 4.3.1- 4.3.3. The main concern of this analysis was only to examine whether there exists lag effects of interest or not, but not to measure the extent of the effects. The coefficients listed under delayed value show the past effects of changes of interest rates on changes of housing price index assuming changes of interest rates to be constant in other times. However, as seen from the analysis interest rate attains specific value for each period as a result we add the subsequent values to get the cumulative effect at any time t as seen under interim value.

Result of the analysis shows that there exists lag effects of changes of interest rates on changes of housing price index. Interpretation of results was made with mentioned limitation of assumptions. For example, when there is one percent decrease in governmental bond rate with ten-year maturity this leads to an immediate increase in the housing price index by 4.8 percent, one quarter lagged increase by 2 percent, and two quarter lagged increase by 6.5 percent, three quarter lagged increase by 0.2 percent and four quarter lagged increase of housing price index by 10.7 percent and similar interpretation can be used for others despite the limitation of assumptions.

<table>
<thead>
<tr>
<th>Lag</th>
<th>gvbt10yr Multipliers</th>
<th>qmbc 5yr Multipliers</th>
<th>hr Multipliers</th>
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<td>Interim</td>
<td>Delay</td>
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<td>-0.048</td>
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<td>-0.023</td>
</tr>
<tr>
<td>3</td>
<td>0.063</td>
<td>-0.002</td>
<td>0.044</td>
</tr>
<tr>
<td>4</td>
<td>-0.105</td>
<td>-0.107</td>
<td>-0.087</td>
</tr>
</tbody>
</table>

*Table 4.4.1. The effects of lagged values of interest rates on changes of housing prices.*
CHAPTER 5. CONCLUSIONS

This paper investigates the effect of interest rate on house prices in Sweden for the case of one and two dwelling buildings. The study was undertaken using the following riksbank interest rates, governmental bond rates, mortgage bond rates, lending rates and repo rates using correlation analysis and regression analysis. Regression analysis was applied with consideration of hetroskedasticity and autocorrelation (HAC) errors. Moreover, regression analysis using definite distributed lag model was applied to analyze the lag effect of interest rates on house price changes through time.

The main finding in this paper that there is strong inverse relationship between interest rates and house price changes and strong impact of changes interest rates on house prices. Moreover the study also found out the lag effect of interest rates through limited periods( four quarters). The study was undertaken with considerable limitations. Quartely data of house price index of one and two dwellings was taken because of availability of data of other residential buildings in different forms which makes this findings limit to one and two dwellings.

Result of this study has some consistency and discrepancy with previous findings. The findings of this paper has some consistency with the findings by Joe Wong (2003) that there is inverse relationship between interest rates and house prices during inflationary periods but in the later study analysis was also made on deflationary periods that shows the opposite direct relationship between interest rates and house prices. In this paper, the analysis was conducted for the past inflationary periods.

This study may raise the following future research questions. How is consistency of the result during deflationary periods? Shall the opposite increase in interest rates lead to house price fall? What will be the relationship between mortgage financing and affordability in the forthcoming periods? Alternatively, will it remain consistent for predictable future? Is there any expected risk of house price fall related to changes in interest rates? What is the effect of changes of mortgage rates on household incomes?

The author’s perspective towards this finding is that changes of interest rates have significant effect on house price changes. Eventhough interest rates, net household disposable incomes, inflation have predominantly significant effect on house price changes more investigation should
be done on housing demand and supply factors as stated in articles (Reichert, 1990) and (Jud & Winkler, 2002). Moreover, additional investigations should be done on consistency of determinant factors.

The major implication of this study is that fluctuations in interest affects, investors, homebuyers, home sellers and household incomes (Debelle, 2004). As stated in the article (Ferrer, Gonzalez, Soto, 2010), this study also suggests that detail investigation on house price dynamics is crucial for government monetary policy.
References


## Appendix A - Results of Analysis sheet.

<table>
<thead>
<tr>
<th>Table A.1</th>
<th>Regression with newey-west standard errors using government bond rate with 7 yrs maturity.</th>
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<tr>
<td><strong>Inhpi1t</strong></td>
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<table>
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<tr>
<td>hsupply</td>
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</tr>
<tr>
<td>_cons</td>
<td>4.755264</td>
</tr>
</tbody>
</table>
Table A.4. Regression with newey-west standard errors using quarterly mortgage bond with 2 yrs maturity

| Inhpi1t | Coef. | Std. Err. | t     | P>|t| | [95% Conf. Interval] |
|---------|-------|-----------|-------|------|------------------|
| qmbt2yr | -0.0950583 | 0.0130499 | -4.53 | 0.000 | -0.0851365, -0.0921801 |
| ndlt    | 3.43e-06  | 3.28e-07  | 10.47 | 0.000 | 2.78e-06, 4.08e-06  |
| infl    | -0.0536482 | 0.0176821 | 3.03  | 0.000 | 0.0293134, 0.083983 |
| hsupply | 0.0000372 | 0.0000217 | 1.72  | 0.106 | -6.12e-06, 0.0000805 |
| _cons   | 4.798003  | 0.1443826 | 33.23 | 0.000 | 4.509478, 5.086529 |

Table A.5. Regression with newey-west standard errors using repo rate

| Inhpi1t | Coef. | Std. Err. | t     | P>|t| | [95% Conf. Interval] |
|---------|-------|-----------|-------|------|------------------|
| rrt     | -0.074227 | 0.0125599 | -5.91 | 0.000 | -0.099332, -0.0491221 |
| ndlt    | 3.12e-06  | 3.20e-07  | 9.75  | 0.000 | 2.46e-06, 3.76e-06  |
| infl    | 0.0634232 | 0.0167304 | 3.79  | 0.000 | 0.0291357, 0.0965067 |
| hsupply | 0.0000435 | 0.0000215 | 2.03  | 0.029 | 4.30e-06, 0.0000825 |
| _cons   | 4.864805  | 0.1319907 | 36.86 | 0.000 | 4.600599, 5.128651 |

Table A.6. Summary of coefficients of multiple regression with out considering newey-west standard errors.
Appendix B - Graphs of trends of macroeconomic factors.

Figure B.1. Short and long-term interest rates.  
Source: Statistics Sweden.

Figure B.3 Number of completed dwellings in Sweden  
Source: Statistics Sweden.

Figure B.2. Inflation rate according to CPI Percent change over twelve months  
Source: Statistics Sweden.

Figure B.4. Gross Domestic Product (GDP), real gross domestic income (GDI) and real gross national income (GNI). Volume index year 2005=100  
Source: Statistics Sweden.