STOCKHOLM SCHOOL OF ECONOMICS - MASTER'S THESIS IN FINANCE

DETERMINANTS OF HOUSING PRICES

IN URBAN AND RURAL AREAS

Erik Ekstrand 19447 Casper Wrede 19032

ABSTRACT

The aim of this paper is to examine the determinants of housing prices in Sweden's urban and rural areas. For this purpose we compare eight different regions which range from predominantly urban – the Stockholm region, to predominantly rural – the Upper North region, using an error correction model. We find that demographic change and income have the greatest impact in explaining regional house prices in the long run. The same result is found in the short run, even though the magnitude of the co-efficients is less than in the long run. Moreover, the prices of housing in the previous period contribute to explaining the short run prices in all regions. The negative values of the residuals imply that after being exposed to shocks the price of housing reverts to its long term equilibrium trend.

Tutor:	Professor Peter Englund
Dissertation:	June 8, 2006, 10:15
Venue:	Room 342
Discussants:	Johan Mårild and Erik Mattsson

Acknowledgement:

The authors would like to thank our tutor, Professor Peter Englund for his invaluable help with this thesis.

1. Introduction

1.1 Background

The price of housing and especially increases in the price of housing is a vividly debated subject. This is often the case in large cities where prices can increase quite rapidly. In less densely populated areas, however, price increases are often more moderate and sometimes changes in real house prices can even be negative. According to the classic supply and demand model first developed by Alfred Marshall (1890) the price of a good is determined by the interaction between supply and demand and this applies also to the housing market. Since housing is an immobile good its price may also vary across regions. In densely populated areas the relative scarcity of land available to build upon means that supply of housing is restricted not only in short term (the time it takes to build) but also in long-term. In the larger cities most available land is already built on and the remaining land is often protected from building in order to preserve the city environment.

1.2 Purpose

The purpose of this thesis is to investigate how the factors that determine the price of housing differ between urban and rural areas in Sweden. Our hypothesis is that the importance of factors determining house prices differs depending on the region. In urban areas the demand factors are believed to be of greater importance while both supply and demand factors will have an impact in rural areas. Previous research in Sweden has mostly focused on aggregate house price determinants, either on a national level or between several urban areas (see e.g. Hort (1998)) and not on the differences between urban and rural areas. As a consequence we believe that a more specific study of the differences between urban and rural price determinants could be a contribution to understanding the mechanisms of housing prices.

1.3 Outline

This thesis is divided into seven main sections. After the introduction the economic theory behind our model, previous research and the areas investigated are presented. In section three, our method of econometric modelling is described. Section four is the data section where our dependent variable and the independent variables are described. Section five, Empirical Results, describes results from our long run- and short run-model. In section six conclusions are drawn. In section seven suggestions for further research are given.

2. Theory

2.1 Supply and demand factors

Housing is no different from any other good in the sense that the price is determined by the intersection of its supply and demand curves. Suppose that the demand for housing services in a certain region is determined by the labour income of the people living in the region, the population size, the level of leverage used in house purchase and the user costs related to owning a house. The user cost is the expense associated with owning a house. For most house owners the largest cost is interest rate payments on the mortgage, but property tax, maintenance and depreciation are also costs of owning a house. However, in order to simplify the analysis we ignore property tax, maintenance and depreciation and concentrate on the mortgage cost which is the largest expense. Most private dwellings in Sweden are financed through a combination of debt and private savings. Private savings does not incur a direct cost but has an opportunity cost in terms of the forgone return that could have been earned on the capital during the time period. To summarize, the user cost is captured in *equation 2.1*.

$$\text{UC} = Ph \cdot r \,, \qquad \textit{(Equation 2.1)}$$

UC= User Cost, Ph = price of housing, r = interest rate.

.

Section 4.2 contains a more detailed discussion about which interest rate to use. The demand can then be summarized by *equation 2.2*. The variables are logged so that the co-efficients can be interpreted more effectively.

$$LnD \quad = \beta_y \ln Y + \beta_r \ln Ph \cdot r + \beta_{Po} \ln Po \qquad \textit{(Equation 2.2)}$$

Y = income, Ph = price of housing, r = interest rate, Po = Population

If changes in supply are equal to the depreciation plus a variable that captures new construction, as in *equation 2.3* we have

$$\Delta LnS = (1 - depr)S + C \qquad \text{(Equation 2.3)}$$

S = supply, depr = depreciation, C = new construction.

In a steady state the supply is constant and consequently ΔLnS is equal to zero and we can rearrange the terms and arrive at *equation 2.4*.

$$S = C/(1 - depr) \qquad \text{(Equation 2.4)}$$

If we assume C to be a constant elastic function of Tobin's q (ratio of price of existing houses to cost of building) we arrive at the expression for the supply of housing displayed in *equation 2.5*.

$$LnS = \delta LN(Ph/CB) \qquad \text{(Equation 2.5)}$$

Ph = price of housing, CB = Cost of Building

Given that the housing market is in equilibrium, demand will equal supply, hence LnD=LnS holds. Rearranging the two terms above, in order to obtain the price as the dependent factor, yields *equation 2.6*.

$$\ln Ph = \frac{\beta_y}{\delta - \beta_r} LnY + \frac{\beta_r}{\delta - \beta_r} Lnr + \frac{\beta_{Po}}{\delta - \beta_r} LnPo + \frac{\delta}{\delta - \beta_r} \ln CB \qquad \text{(Equation 2.6)}$$

Equation 2.6 allows the co-efficients calculated in the empirical section of this paper to be analysed as elasticities which simplifies the analysis and interpretation of the results.

In this thesis we will examine interest rate, income, size of population and the percentage of income spent on interest payments as demand factors. The interest rate is expected to have a negative impact on the price of housing since higher interest rates increase the cost of capital and thereby reduce demand. All other demand factors are believed to have a positive impact on the price of housing.

Since this thesis aims to investigate the determinants of the price of housing in various regions in Sweden the analysis will focus on the differences in magnitude of the determining factors. Due to higher income in urban areas this variable is believed to contribute to higher house prices. Population size is also believed to be more important in urban areas since a lack of space to build on creates increases in demand. We assume that the cost of building is roughly the same in all areas in Sweden although the price of land to build upon is higher in urban areas. Therefore, with cost of building being relatively larger (compared to the price of land) in rural areas, cost of building is also believed to be more important in determining housing prices in rural areas. The interest rate is believed to be important in all areas, although it is possible that people in urban areas might lend more money than people in rural areas since house prices often are higher in urban areas.

2.2 Previous research

Previous research on the subject of determinants of urban and rural house prices is rather limited, especially for Swedish data. However, several studies have been made on regional house prices and to some extent this corresponds to determinants of urban and rural prices.

Meen (1997) investigates the sources of the ripple effect in the United Kingdom. The "ripple effect" refers to the trend that house prices in Britain exhibit a distinct spatial pattern over time, rising first in a cyclical upswing in the South-East and then spreading over the rest of the country. Although this trend is not seen in Sweden, the study examines regional house prices and concludes that the South-East displays a higher sensitiveness to changes in demand factors such as interest rates, income and unemployment. Meen finds that this is partly because the South-East is more debt geared than the North and hence faces greater short term liquidity constraints as a result of changes in the above mentioned demand factors.

Macdonald and Taylor (1993) analyse regional house prices in the United Kingdom and find that changes in house prices in the most densely populated and most expensive area, Greater London, is a precursor to changes in neighbouring areas. They also found some evidence of segmentation between the North and South of the United Kingdom.

Abelson, Joyeux, Milunovich and Chung (2005) investigate house prices in Australia and develop and estimate a long-run equilibrium model in order to examine the long run determinants of house prices and a short-run asymmetric error correction model for house price changes in the short run. They conclude that in the long run real house prices are positively affected by increases in real disposable income and the consumer price index and negatively by the unemployment rate, real mortgage rates, equity prices and the housing stock. For the short term equilibrium they find that there are significant lags. With quicker growth in house prices result in a quicker return to equilibrium, while the adjustment process takes longer time with static or falling prices.

Ashworth and Parker (1997) use maximum likelihood cointegration methods to analyse determinants of house prices in each of the eleven regions of the U.K. from 1981 to 1992. They find broad similarities in the structure of house price equations across regions in England and Wales, (but not Scotland or Northern Ireland), and conclude that the source of differences in English and Welsh regional house prices should be sought in different regional incomes, opportunity cost and housing starts. The house price income elasticity is found to be between 3 and 4 with a relatively low value in the South East that could be due to the complexity of the densely populated area.

A similar study to Ashworth and Parker on Swedish data has been performed by Katinka Hort (1998) in which determinants of urban house price fluctuations in Sweden 1968-1994 are investigated. Contrary to the purpose of this paper, Hort does not make explicit analysis of the regional differences in the determinants of house prices. Instead she collects data on 20 urban areas in Sweden and combines them for the analysis. By using an error correction model Hort found that the adjustment to the long-run relationship is quite rapid and that real house prices are mostly determined by movements in income, user and construction costs. Hort also included in her model a negative deterministic trend which functions as a proxy for factors which are not adequately accounted for in the model. The deviation from long-run equilibrium was found to have a significant influence on real house prices, even though these fluctuations do not necessarily need to be evidence of speculative behaviour.

A national study on Swedish private housing data is performed by Barot (2001). This paper divides the determining factors in a supply and a demand side. The short run demand is determined by the real after tax long interest rate, financial wealth, employment rate, rents and population. In the long run the determining demand factors are debt to income, debt to financial wealth, private housing stock to income, stock of rental housing to private housing and real after tax long interest rate. On the supply side the ratio of asset prices of existing structures to the cost of new constructions is the determining factor which in turn is decided by the interest rate.

Abraham and Hendershott (1996) build a model that explains the appreciation of houses in metropolitan housing markets in the USA. They divide the determining factors into two groups; one that explains changes in equilibrium prices while the other group accounts for the factors that adjust the price back to equilibrium following price deviations. Among the factors explaining equilibrium price are growth in real income, real construction costs and changes in real after tax interest rate. The other group contains the lag of real house price appreciations and the difference between actual and equilibrium real house price levels. Together these two groups can explain about three fifths of the variation in house prices in 30 US cities 1977-92.

2.3 Areas investigated

The areas investigated are the eight NUTS-2 regions in Sweden. NUTS is a regional division that the European Union uses for statistical purposes where the NUTS-1 division corresponds to a national level and NUTS-2 is a regional division within each country. The more densely populated areas are in the South and South East of the country while the rural areas are located in the North.

We find that NUTS-2 constitutes a good but not perfect division of rural and urban areas. They differ greatly in population density and many official statistical data are divided on NUTS-2 which makes the regional data used very reliable. In *table 2.1* and *2.2* is a short description of each of the eight NUTS-2 regions in Sweden together with a geographical overview in *map 2.1*

Stockholm

The most densely populated area in Sweden with a population of about 1,9 million (2004). Includes Stockholm which is the largest city in Sweden.

East Central Sweden

The fourth most densely populated area in Sweden with a population of about 1,5 million (2004). No major cities but many smaller towns.

Småland and the Islands

This region also includes the two largest islands in Sweden, Gotland and Öland, and have a population of 0,8 million (2004). The region contains no major cities.

Southern Sweden

South of Sweden, part of the densely populated Öresund region including Copenhagen in Denmark and Sweden's third largest city, Malmö. Total population of about 1.3 million (2004).

Western Sweden

The population density in Western Sweden is slightly lower that that of Southern Sweden. The region includes Sweden's second largest city, Göteborg. Total population of about 1,8 million.

North Central Sweden

This area contains to major urban area but several small towns. Total population of about 0,8 million.

Central North

The geographical middle of Sweden is very rural with a few small towns. Total population of about 0,4 million.

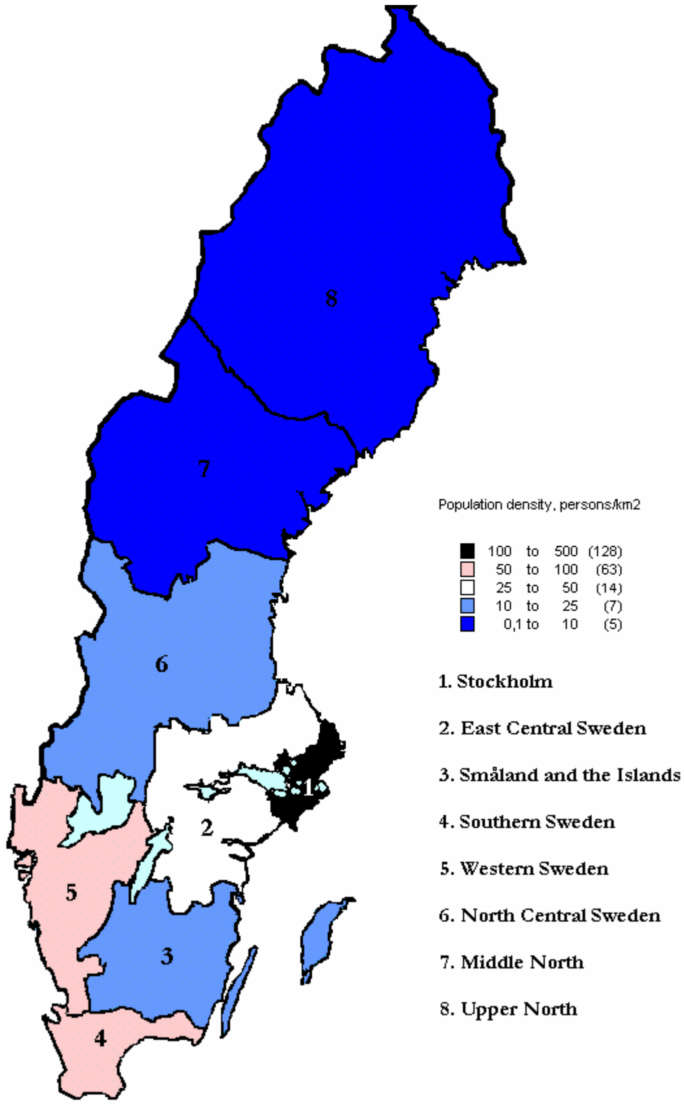
Upper North

The most Northern part of Sweden. A very rural area with a total population of about 0,5 million.

Table 2.1

Region	Inhabitans / km^2	Population	Area, km^2
Stockholm	287	1 872 900	6 519
East Central Sweden	39	1 514 549	38 609
Småland and the Isles	24	799 739	33 333
Southern Sweden	94	1 311 254	13 982
Western Sweden	61	1 805 683	29 418
North Central Sweden	13	826 188	63 987
Central North	5	371 619	71 028
Upper North	3	509 460	153 439

Table 2.2



Map 2.1 Sweden's NUTS-2 regions with their population density.

3. Method

3.1 Econometric modelling

Many macroeconomic time series are non-stationary, meaning that the mean, variance and autocorrelation structure change over time. Early econometric models (from the 1970s) containing non-stationary variables were estimated using the Ordinary Least Square techniques with data in levels, (Englund, Persson & Teräsvirta 2003). An example of this model is shown in *equation 3.1* below:

$$y_t = \alpha + \beta_0 x_t + \varepsilon_t \qquad \textit{(Equation 3.1)}$$

In this standard model the y in time period t, (e.g. the price of housing in 1975) is explained by one or several explanatory variables, e.g. income (x_t) and a random variable ε with an expected value of zero. However, this approach assumed that the random term was stationary and consequently did not apply for non-stationary time series. Clive Granger and Paul Newbold (1974) presented the term spurious regression in a paper and showed that the standard OLS technique could indicate significant relations between unrelated variables. They suggested that spurious regression could be avoided by estimating time series in differences rather than in levels as had previously been done. The explanation was due to the fact that differences of macro variables usually are stationary even though non-stationary in levels. Most economic theory, however, is formulated in terms of levels rather than differences and would only capture the short run dynamic and not the long run implications, (Englund, Persson & Teräsvirta 2003).

During the 1980s Clive Granger developed methods that unite the short and long term perspective. The concept of cointegration says that linear combinations of non-stationary time series can sometimes be stationary. If they are, the variables are said to be cointegrated and this means that deviations from a long run cointegration relationship are stationary.

Engle and Granger (1987) demonstrated how the concept of cointegration can be used in practice. The model is estimated in two steps. First the cointegration relation is estimated in level data, and in the second step these estimates are used in an error correction equation.

The method developed by Engel and Granger describes how the dynamics of a dependent variable (e.g. an exchange rate) is determined by two forces, one which levels out any deviation from the long term cointegration relationship (e.g. the long term exchange rate) and one that determines the short term changes in the adjustment path towards the long run equilibrium.

To test our hypothesis we will be using an error correction model described by Engle and Granger (1987). This model contains both a long run (*equation 3.2*) and a short run model (*equation 3.3*) where the lagged residuals from the long run model are included in the short run model and this ties the short run behaviour of house prices to its long run equilibrium.

Long run model:

$$\text{Ln } Ph_t = \beta_0 + \beta_1 \ln Y_t + \beta_2 R_t + \beta_3 \ln CB_t + \beta_4 \ln Po_t + u_t \qquad \textit{(Equation 3.2)}$$

Short run model:

$$\Delta \text{Ln } Ph_t = \beta_0 + \beta_1 \Delta \ln Y_t + \beta_2 \Delta \ln R_t + \beta_3 \Delta \ln CB_t + \beta_4 \Delta \ln Po_t + \beta_5 u_{t-1} + \varepsilon \qquad \textit{(Equation 3.3)}$$

Ph = Price Housing, Y = income, R = *interest rate, CB = Cost of Building, Po = Population*

In *equation 3.2* the long run (cointegration) relationship between house price and the explanatory variables is estimated in level form. The short run dynamics of the relationship is estimated in difference form in *equation 3.3*. The link between the short run behaviour of house prices and the long run equilibrium consists of the residuals from the long run model that are lagged one period and thereafter included in the short run model. These lagged residuals are called an error-correction term.

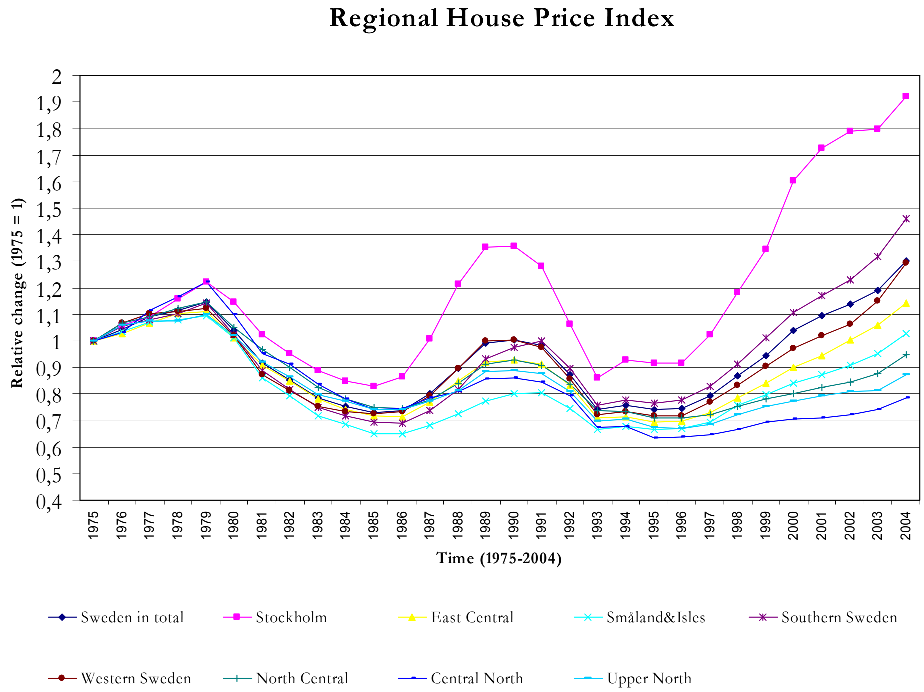
4. Data

The empirical analyses use data from the eight Swedish NUTS-2 regions as well as national data. The price of housing and the income is measured on a regional level, while the interest rate, cost of building and percentage of income are measured on a national level since the these factors do not differ much between the regions.

4.1 Dependent variable

The dependent variable in our regression is the price of housing in the eight different NUTS-2 regions. The data used is the index for housing prices of owner-occupied houses[1]. Around 40 % of all households live in single family houses, almost all owner-occupied (Englund, Hendershott & Turner 1995). Since the most common alternative form of living, apartments, is divided between rental apartments, (occupied by 45% of the population), and tenant owned apartments, (15% of the population), we believe that owner-occupied houses are the most representative form of owner occupied dwellings. Additionally, the price of owner-occupied houses works as a proxy for the price of housing in general. Since the market for apartments is distorted by the price controls on rental apartments we believe that the price of owner-occupied houses is the best measure to use. The price index is deflated with the CPI of the period and the result is shown in the *graph 4.1*on the page 11. The price of housing displays what looks like a cyclical pattern which is increasing in magnitude over time. The Stockholm region increases the most, approximately 92% while *North Central*, *Central North* and *Upper North* show a decrease over the time period investigated.

[1] More information about this source is given in the reference list.



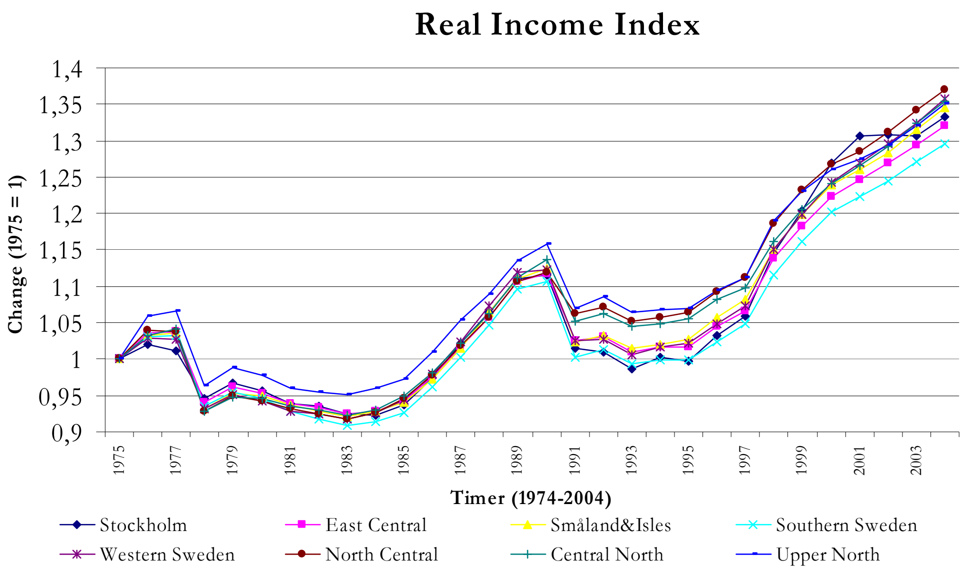
Graph 4.1

4.2 Independent variables

4.2.1 Income

The income variable describes the average labour-income for the population in each of the eight different NUTS-2 regions. This is used as a proxy for disposable income, a variable which is not available on a regional level for the desired time-frame. The income variable has been quite difficult to obtain since there are no series of it covering the whole time-frame which we have investigated. All data for this variable comes from two series from Statistics Sweden (SM-N-1976-1980 for the years 1975-1979 and Statistical Yearbook of Sweden 1977-2006). It has two breaks, 1978/1979 and 1990/1991. The first break, 1978-1979 is due to the fact that Statistics Sweden changed the definition of the data from being work income for the population aged 20 to 64 to being the work income for the population aged 20 and above. This results only in very minor changes, since 64 corresponds roughly to the age of retirement and therefore there are no great changes for income from work by excluding people older than 64. The other change in the data, 1990-1991 is more profound. It is the period when a major tax reform was introduced in Sweden and Statistics Sweden therefore introduced a new measurement of income. From 1991 and onwards, average income is calculated for everyone, including people under the age of 20 and those with an income of 0. This produces a large shift in the level of the data. Statistics Sweden did not discontinue the old series until 1995 and we could therefore adjust our series correspondingly by adjusting the level of the new data to that of the old, this was possible since they moved in parallel. For 1974 to 1978 the data is divided in the eight NUTS regions, from 1979 to 2004, the data is on county (Swedish län) level, which we have added together in accordance with the NUTS-2 regions. The income variable is lagged one period since we noticed that there seemed to be a time lag between change in income and change in house prices.

.



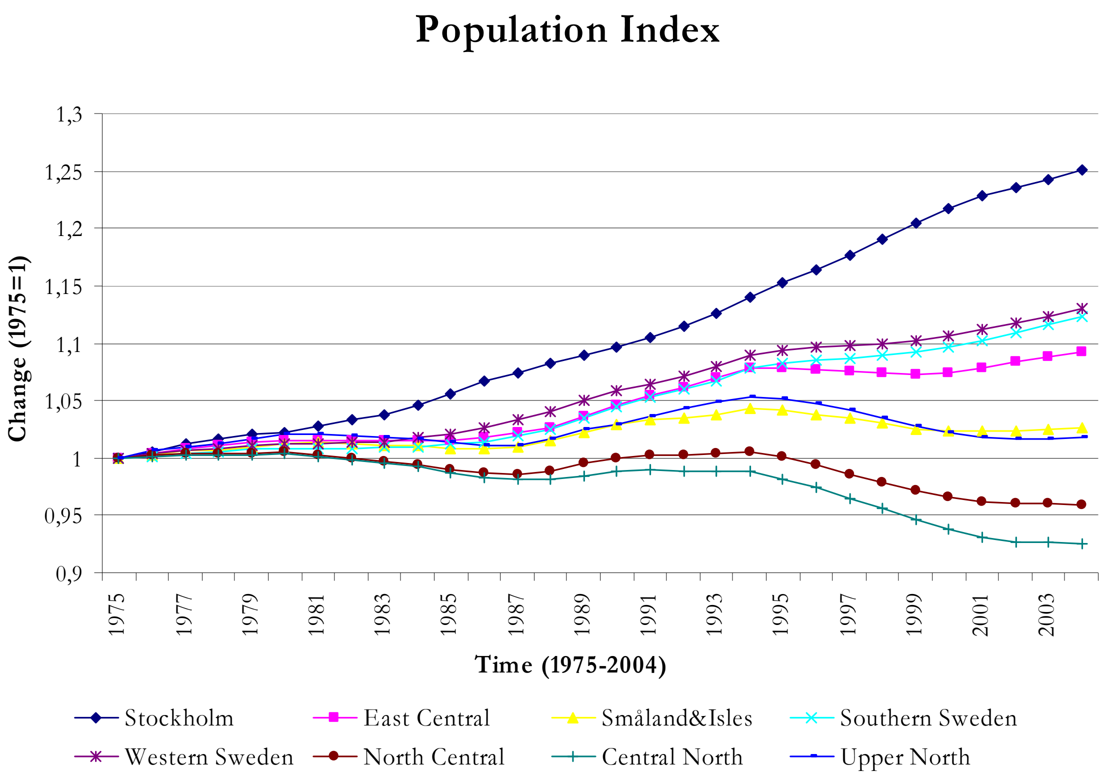
Graph 4.2

The data displayed in *graph 4.2* conveys the image that the real income follows a cyclical pattern with an increasing trend. The most striking feature of the data is the uniform evolution of income changes within the eight different regions investigated. Contrary to what one may believe, a dominantly rural area, *North Central Sweden* has increased income the most during the period by approximately 37%. However, the region with the smallest change in income, the relatively urban *Southern Sweden* increased income by approximately 30%. When interpreting *graph 4.2* one should keep in mind that the NUTS-2 regions may contain considerable regional differences. The Stockholm region not only includes Stockholm city and the affluent suburbs, but also less wealthy suburbs and commuter towns. The latter part of the 1980s show an increasing trend that ends in 1991 and is followed by falling incomes. After a period of relatively constant incomes, 1992 to 1997, real income increases for the rest of the period.

4.2.2 Population

Changes in the population are widely used as a variable to explain price changes since more people increases the demand. Population increases are due to two factors, either an increase of the existing population due to a higher birth rate than mortality rate, or an increase due to immigration. The impact of the first factor on demand for housing has a time lag associated with it, while immigration has a more immediate impact. Moreover, in urban areas the lack of land available to build on will also contribute to price increases as a result of population expansion. Mankiw and Weil (1990) claimed in a controversial article that changes in price are almost exclusively determined by changes in the population. Even though this article was lately widely criticised, population is still believed to have a significant impact on house prices.

Our population variable consists of data from Statistics Sweden describing the number of inhabitants in the 70 different A-regions of Sweden at the 31st of December for each year. In order to obtain the data for NUTS-2 regions the relevant A-regions have been added together. The result is shown in the *graph 4.3* on page 14.



Graph 4.3

As can be seen in the graph the change of population varies substantially over the period investigated. All areas except *North Central Sweden* and *Central North* have a larger population in 2004 than in 1975. The Stockholm region shows the by far largest population increase over the period, approximately 25%, followed by *Western Sweden* and *Southern Sweden*, with a population increase of about 13%. *East Central Sweden* increased by 9% and the population in *Småland and the Islands* and *Upper North* increased by about 3%. Overall, the more densely populated areas show the most significant population increases over the period

4.2.3 User Cost - Interest Rate

Following the discussion about the user cost of owning a house we summarize the user cost in *equation 4.1*.

$$UC = Ph \cdot r, \qquad \textit{(Equation 4.1)}$$

UC= User Cost, Ph = Price of house, r = interest rate.

The interest rate used is the rate on 5 year mortgage bond rate offered by one of the largest Swedish banks; Föreningssparbanken, also known as Swedbank. During the last years it has become increasingly common to use a floating rate on mortgages, but for the main part of the time period investigated houses have been financed mainly through fixed term loans. Consequently we found it most relevant to use a fixed 5 year mortgage rate. Unfortunately we could only find historical values of the 5 year mortgage rate since 1985. As a consequence, the values for the period 1975 to 1984 have been estimated as the long term government bond of the year plus the average difference between the government bond and the 5 year mortgage rate 1985 to 2004[2].

When discussing the effect of the interest rate on house prices there are two complicating factors that need to be taken in account. First is the effect of inflation and second the effect of the income tax shield. Inflation decreases the real rate of interest and makes it cheaper in real terms to borrow. A nominal interest rate of 10 percent and an inflation rate of 10 percent make the real interest rate practically zero and hence it is free to borrow in real terms. However, it is questionable if individuals calculate with the real interest rate when considering the cost of buying a house. That would mean assuming that individuals have perfect foresight regarding future inflation (although they may form expectations it is questionable how accurate those are) and that they have no liquidity constraints. Both are very strong and unrealistic assumptions.

The second complicating factor is the income tax shield. According to Swedish tax law interest paid on loans can be deducted from the taxable income. The rate at which the interest payments can be deducted from taxable income has varied throughout the period investigated. From 1991 a flat tax rate of 30% has been used, irrespective of the tax rate of the borrower, (Agell, Englund, & Södersten, 1995).

In 1980 however, the tax system was more complicated and it was possible to deduct at the marginal tax rate which could be up to 79% (applicable to 20% of all homeowners) while the median homeowner could deduct interest payments at a marginal tax of 51% (Englund,

[2] More information about this source is given in the reference list.

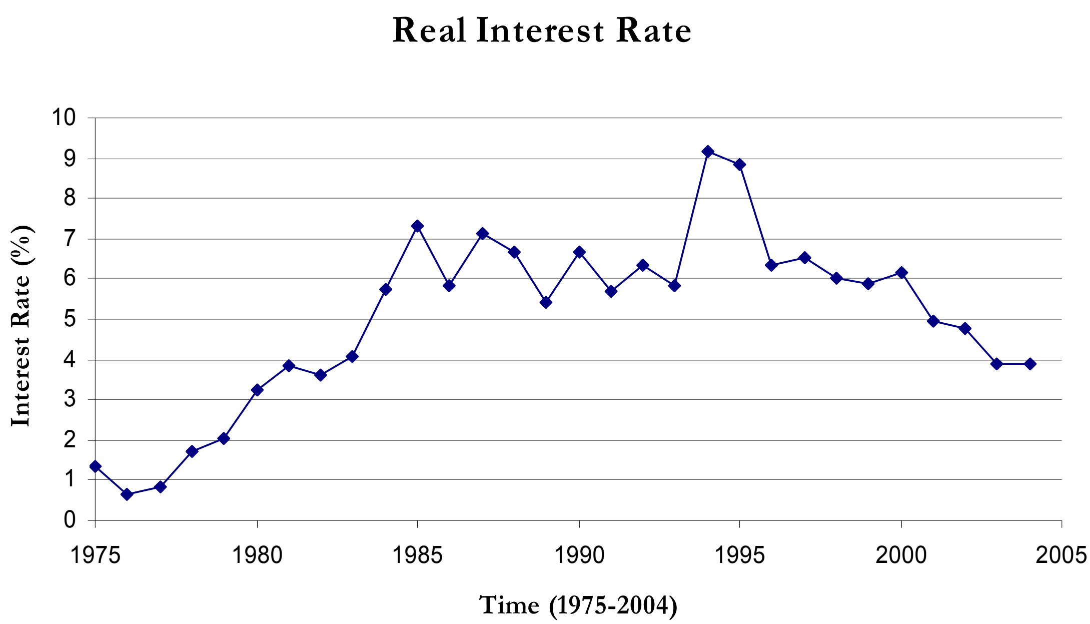
Hendershott & Turner 1995). A tax reform fully implemented by 1985 reduced the full deductibility to 50% even though the marginal tax rate could still be higher. In general, the tax system during the late 1970s and 1980 encouraged heavy borrowing as a means of financing property.

When using the interest rate as a factor to explain the development of prices of housing it is not clear which interest to use. One approach would be to use the real interest rate after tax, (i.e. making allowance for both inflation and tax effects) since this is the rate paid by the borrower in nominal terms. The problem is further complicated by the large changes in the level of tax deductibility that have taken place during the period investigated and the variation of applicable marginal tax rates over the regions.

To find out which interest rate to use we performed regressions using the log of the real interest rate deflated by changes in the CPI of previous years and also future years. We also investigated the real interest rate after tax and the log of the post tax nominal interest rate. The argument for using the latter is that private investors maybe do not take the effect of inflation into account since it is unpredictable and difficult to quantify in advance. Our tests showed that the rate that gave the best fit of the regression (measured as the adjusted R^2) was the log of the interest rate minus the change in CPI of the last two years, the present year and the next year.[3] Thus it seems as if investors take past inflation more into consideration than the future, which is logical given that the inflation rate two years in the future is difficult to predict. It should also be noted that the fit of the regressions involving some type of effective interest, i.e. with allowance for the tax shield had an adjusted R^2 that was close to the R^2 obtained from the interest rate minus the change in CPI of the last two, present and next year, (see section 9.4 in the appendix for further information). Finally, the fit of the chosen rate is not completely satisfactory and one should be aware of this when interpreting the results.

Graph 4.4 displays the deflated interest rate used in the empirical section. As can be seen the real interest rate has varied considerably over the time investigated.

[3] All interest rates tested are shown in secton 9.3 in the appendix.



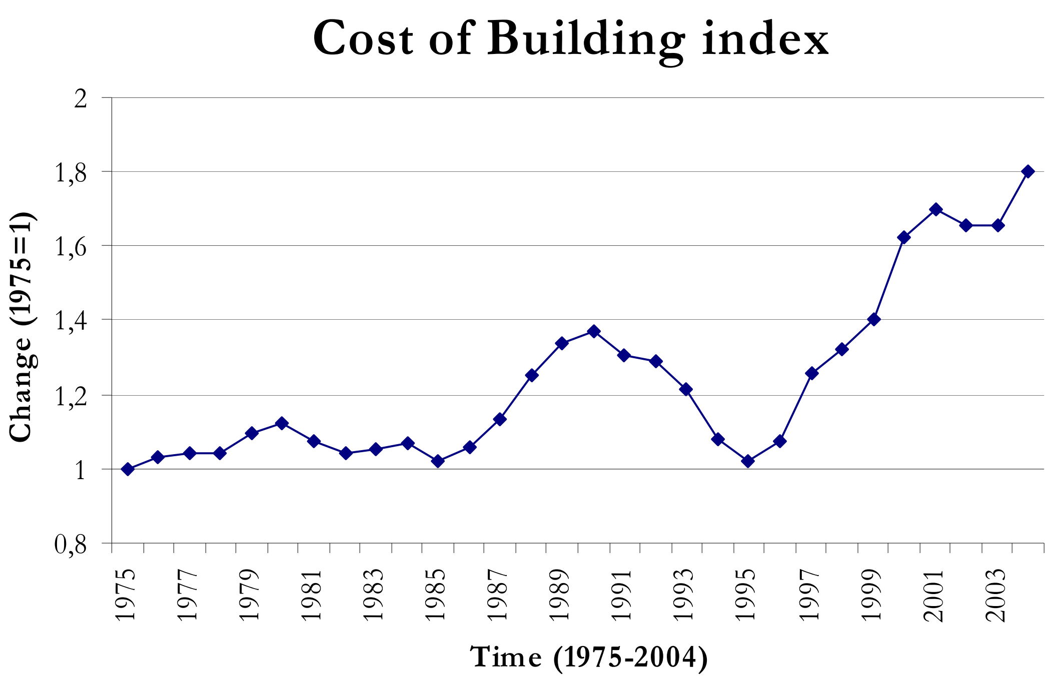
Graph 4.4

Given that the level of interest rate has a linear relationship with the cost of capital for owning a house, the interest rate can also be used as a proxy for the lending rate. Lower interest rates would indicate a higher lending ratio and vice versa.

4.2.4 Cost of building

Especially in rural areas the cost of building is thought to be of importance. This is because in rural areas land is relatively cheap and hence the cost of building constitutes a large portion of the total cost of a new house. In urban areas however, land is much more expensive and consequently the cost of building is a smaller fraction of the total cost. Moreover, with the supply of land being rather limited in urban areas, the cost of building is thought to be less important, since in many instances there simply may not be any available land to build on. In this thesis we have used the building price index developed by Statistics Sweden[4] and deflated the series by the CPI of the year. Since our analysis focuses on regional differences it would have been better to use regional building price indices for each of the eight NUTS-2 regions. However, we did not find any good regional index for cost of building that corresponded to the NUTS-2 regions and the required timeframe.

[4] More information about this source is given in the reference list.



Graph 4.5

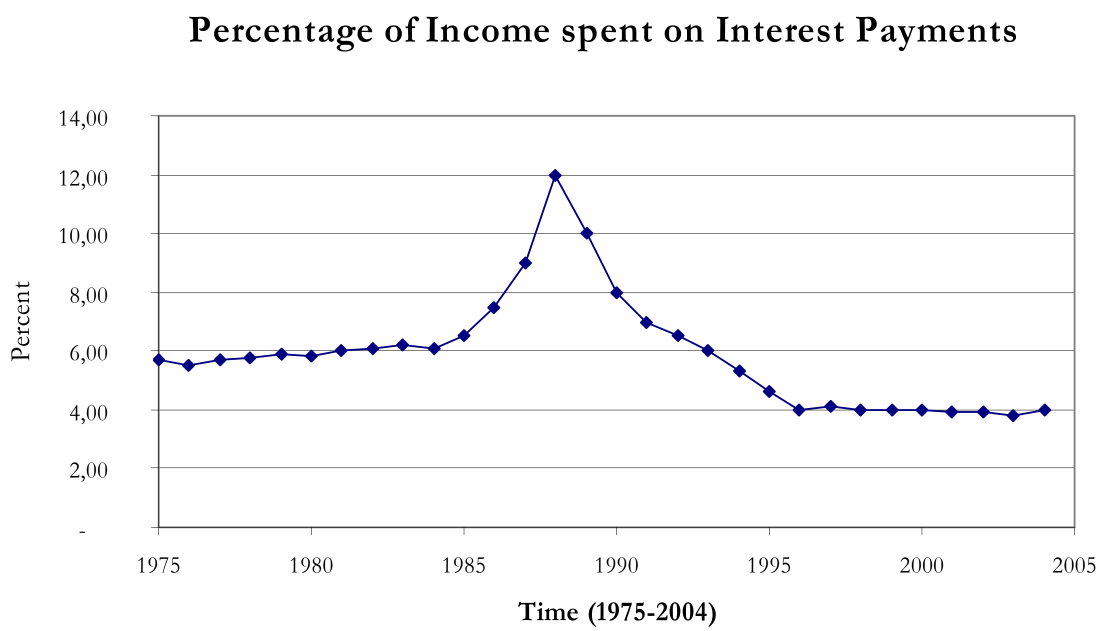
As can be seen in *graph 4.5*, the real cost of building increased by approximately 95% over the period. However, it is worth noting that in 1995 the real cost was about the same as in 1975, following a sharp decline during the 1990s. During the ten year period 1995 to 2004 the cost of building increased with 76% in real terms.

4.2.5 Percentage of Income spent on Interest

This variable describes the percentage of disposable income which is spent on payments of interest after tax, (i.e. the interest rate paid makes allowance for the tax shield)[5]. The series contains actual data from 1980 to 2004 while the period 1975-1979 is estimated with ratio of total debt of households to GDP (Englund 1993). Since most loans taken by household relate to housing this is taken as a proxy for the percentage of disposable income spent on interest payments

[5] More information about this source is given in the reference list.

As discussed in 4.2.1 the Swedish tax system has been altered during the survey period. Especially during the late 1980s it was more efficient to borrow heavily since the interest cost could be deducted against the marginal tax rate that amounted to 79% in higher tax brackets. Since additional borrowing increases the price a bidder can pay the tendency to borrow heavily ought to have a positive impact on the price of houses. In an attempt to capture the effect of changes in the amount of borrowing we use a measurement of the percentage of disposable income paid in interest. As can be seen in *graph 4.6* the ratio increases substantially in the late 1980s.



Graph 4.6

We were not able to find separate ratios for the different NUTS-2 regions and as a result the same ratio is used in all areas. However, we believe that that house buyers in the urban areas, especially Stockholm, tend to borrow more when purchasing a dwelling, although we did not find a proper variable to measure test this hypothesis with.

5. Empirical results

5.1 Stationarity

Most macroeconomic variables are non-stationary, which is why we use the error-correction model which relies on the assumption of non-stationary variables. To test for non-stationarity in our variables we perform a standard Dickey and Fuller test with the following equation:

$$\Delta \ln Y_t = \beta_1 + \beta_2 T + \beta_3 \ln Y_{t-1} + u_t \qquad \textit{(Equation 5.1)}$$

Where $\Delta \ln Y_t$ is the first-difference of the logged series and Y_{t-1} is the log of the series lagged one period. Our null hypothesis is therefore $H_0 : \beta 3 = 0$ (the series are non-stationary, i.e. they contain a unit root) and our alternative hypothesis $H_1 : \beta 3 < 0$. *Equation 5.1* is then estimated with OLS for all of our variables. The resulting t-value for the coefficient β_3 follows the τ (tau) distribution and the results indicate that we can not reject the null hypothesis of non stationarity on a five percent level for any of our variables. More information about the Dickey Fuller test with the results can be found in the appendix in section 9.1. Since we could not reject the null, we perform the test again using the first difference of the variables. This test gives fairly dubious results, since we can only reject the null hypothesis for 10 of 27 variables.

5.2 Long run model

5.2.1 Defining the long run model

In order to define the long run model for the development of regional house prices we regress the variables discussed in section four against the development of the house price index for each of the eight regions. The results of the regressions are shown in the *tables 5.1* and *5.2*. In order to obtain a more precise model variables with a large standard error or variables with an unexpected sign are removed if the errors occur in all of the eight regions. Since the aim of this thesis is to investigate how the determinants of house prices differ between regions, a variable that is insignificant in one or a few regions will not be excluded in order to allow for comparison with the other regions. According to theory, positive changes in income, population, cost of building, and percentage of disposable income spent on interests ought to have a positive effect on the price of housing. User costs and hence interest rates ought to have a negative effect since higher interest rates translate into more expensive costs for buying and owning a house. In order to perform the regressions according to the theory described in *section 2,1* all variables have been logged. The first regression run displayed negative values for the population co-efficient which is confusing and goes against theory[6]. This result has been found by e.g. Hort (1998) as well and by explicitly adding a trend to the equation the sign of the population co-efficient was reversed. The trend indicates that the model is missing something and that the chosen variables do not capture all the factors affecting prices of housing. The model is summarized in *equation 5.2* and the results are shown in *table 5.1*.

$$\text{Ln Ph}_t = \beta_0+\beta_1\ln Y_{t-1}+\beta_2 \text{ LnPo}_t+\beta_3\text{Ln CB}_t+\beta_4\text{LnR}_t+\beta_5\text{LnIncInt}_t+\beta_6 T+u_t \qquad \textit{(Equation 5.2)}$$

Ln Ph_t = Ln Price of Housing, Ln Y_{t-1} = lagLn Income, LnPo = Ln Population, LnCB $_t$ = Ln Cost of Building, LnR_t = Ln Real Interest Rate, $LnIncInt_t$ = Ln Percentage of disposable income spent on interest, T = time trend.

	Stockholm			***East Central Sweden***			***Småland & Islands***			***Southern Sweden***		
	Adjusted R2=0,936			Adjusted R2=0,875			Adjusted R2=0,882			Adjusted R2=0,925		
Model 1	Co-eff	St. err	Sig	Co-eff	St. err	Sig	Co-eff	St. err	Sig	Co-eff	St. err	Sig
Constant	36,662	10,994	0,003	31,249	14,105	0,037	-2,450	21,280	**0,909**	2,298	11,846	**0,848**
LagLnincome	1,585	0,478	0,003	1,253	0,459	0,012	1,076	0,444	0,024	1,143	0,415	0,011
LnPopulation	5,547	2,945	0,072	3,055	1,695	0,085	5,308	1,938	0,012	7,185	1,834	0,001
LnCostofBuild	0,858	0,228	0,001	0,826	0,216	0,001	0,782	0,214	0,001	0,965	0,192	0,000
LnRealInterest	**0,074**	0,052	**0,168**	-0,002	0,052	**0,973**	-0,041	0,051	**0,431**	**0,027**	0,051	**0,598**
LnIncInterest	0,049	0,083	**0,562**	**-0,114**	0,066	0,098	**-0,282**	0,073	0,001	**-0,133**	0,060	0,036
T	-0,061	0,024	0,017	-0,040	0,010	0,000	-0,037	0,008	0,000	-0,054	0,011	0,000

	Western Sweden			***North Central Sweden***			***Central North***			***Upper North***		
	Adjusted R2=0,882			Adjusted R2=0,893			Adjusted R2=0,884			Adjusted R2=0,912		
Model 1	Co-eff	St. err	Sig	Co-eff	St. err	Sig	Co-eff	St. err	Sig	Co-eff	St. err	Sig
Constant	27,450	13,165	0,048	-1,164	24,752	**0,963**	15,637	30,975	**0,618**	35,377	13,166	0,013
LagLnincome	1,317	0,458	0,009	0,680	0,410	**0,111**	0,798	0,451	0,090	0,850	0,342	0,021
LnPopulation	4,184	2,202	0,070	3,570	1,454	0,022	3,578	1,733	0,050	1,814	1,041	0,095
LnCostofBuild	0,785	0,222	0,002	0,754	0,180	0,000	0,827	0,212	0,001	0,635	0,157	0,001
LnRealInterest	0,004	0,058	**0,943**	-0,022	0,049	**0,655**	**0,015**	0,053	**0,781**	-0,027	0,037	**0,474**
LnIncInterest	**-0,069**	0,069	**0,328**	**-0,102**	0,066	**0,133**	**-0,169**	0,081	0,049	**-0,062**	0,052	**0,249**
T	-0,046	0,014	0,004	-0,025	0,007	0,001	-0,033	0,008	0,000	-0,031	0,005	0,000

Table 5.1

The results from *table 5.1* show that the percentage of income variable (*LnIncInterest*) has a negative impact on the price of housing in all areas except *Stockholm* which is not consistent with theory since more income spent on housing ought to increase the price. However, *LnIncInterest* has a large standard error relative to the size of the co-efficients and is

[6] Section 9.3 displays the result of this regression.

insignificant in five of the eight regions. Moreover, this variable can increase also due to higher interest rates, which could have a negative effect on house prices as the regression shows. Nevertheless, since this variable was included in the analysis in an attempt to capture the effect of a tax system that favoured debt as a means financing housing the results do not support the anticipated hypothesis. As a result, we exclude this variable in the next regression that is modelled according to *equation 5.3*. The result is displayed in *table 5.2*. Bold figures are either insignificant or show the unexpected sign.

$$\text{Ln } Ph_t = \beta_0 + \beta_1 \ln Y_{t-1} + \beta_2 \text{ LnPo}_t + \beta_3 \text{Ln } CB_t + \beta_4 R_t + \beta_5 T + u_t \qquad \textit{(Equation 5.3)}$$

Ln Ph_t = Ln Price of Housing, Ln Y_{t-1} = lagLn Income, LnPo = Ln Population, LnCB $_t$ = Ln Cost of Building, LnR_t = Ln Real Interest Rate, T = time trend.

	Stockholm			***East Central Sweden***			***Småland & Islands***			***Southern Sweden***		
	Adjust R^2=0,938			Adjust R^2=0,865			Adjusted R^2=0,814			Adjusted R^2=0,913		
Model 2	Co-eff	St. err	Sig	Co-eff	St. err	Sig	Co-eff	St. err	Sig	Co-eff	St. err	Sig
Constant	38,220	10,523	0,001	20,688	13,223	**0,131**	1,077	26,706	**0,968**	-15,700	9,356	**0,106**
LagLnincome	1,689	0,439	0,001	0,988	0,450	0,038	0,581	0,534	**0,287**	0,764	0,409	0,074
LnPopulation	4,434	2,226	0,058	2,433	1,723	**0,171**	1,791	2,148	**0,413**	7,594	1,970	0,001
LnCostofBuild	0,853	0,224	0,001	0,761	0,221	0,002	0,512	0,254	0,055	0,964	0,208	0,000
LnRealInterest	**0,081**	0,050	**0,120**	-0,067	0,037	0,081	-0,176	0,047	0,001	-0,042	0,043	**0,336**
T	-0,054	0,020	0,014	-0,029	0,008	0,001	-0,013	0,006	0,033	-0,047	0,011	0,000

	Western Sweden			***North Central Sweden***			***Central North***			***Upper North***		
	Adjusted R^2=0,882			Adjusted R^2=0,858			Adjusted R^2=0,878			Adjusted R^2=0,910		
Model 2	Co-eff	St. err	Sig	Co-eff	St. err	Sig	Co-eff	St. err	Sig	Co-eff	St. err	Sig
Constant	20,333	11,077	0,079	3,102	25,319	**0,904**	28,819	32,356	**0,382**	31,518	12,861	0,022
LagLnincome	1,140	0,422	0,012	0,536	0,412	**0,205**	0,517	0,459	**0,271**	0,712	0,324	0,038
LnPopulation	3,632	2,131	**0,101**	2,488	1,314	0,070	1,673	1,570	**0,297**	1,419	0,994	**0,166**
LnCostofBuild	0,755	0,220	0,002	0,634	0,168	0,001	0,632	0,204	0,005	0,580	0,151	0,001
LnRealInterest	-0,040	0,038	**0,309**	-0,068	0,040	**0,104**	-0,048	0,046	**0,308**	-0,057	0,027	0,044
T	-0,038	0,012	0,004	-0,019	0,006	0,002	-0,026	0,007	0,002	-0,026	0,003	0,000

Table 5.2 – Model 2

The final results in *model 2* still display some imperfections. The interest rate variable shows the unexpected sign in the *Stockholm* region and is only significant in *East Central, North Central* and *Upper North*. However, given the complicating effect of inflation and tax shield on the interest rate discussed in section 4.2.3. it is not surprising that the interest rate displays some anomalies. The population variable also displays large standard errors and insignificant variables in all regions except *Stockholm*, *Southern Sweden* and *North Central Sweden*. Finally, the income coefficient also displays large standard errors for *Småland and the Islands, North Central* and *Central North*. It can also be noted that since the removal of the variable for percentage of disposable income spent on interest expenses the adjusted R^2 has generally decreased slightly (from an average of 0.899 to 0.882).

Before moving on to analyse the explicit result of the regressions we need to clarify the interpretation of the co-efficients. The theoretical model outlined in *section 2.1* resulted in *equation 2.3* seen below:

$$\ln Ph = \frac{\beta_y}{\delta - \beta_r} LnY - \frac{\beta_r}{\delta - \beta_r} Lnr + \frac{\beta_{Po}}{\delta - \beta_r} LnPo + \frac{\delta}{\delta - \beta_r} \ln CB$$

(Equation 2.6)

Since all terms are logged, and co-efficients are elasticities and a one percentage point's growth in one variable will result in a percentage increase in the price of housing index by the magnitude of the co-efficient in *table 5.2*, given that all other variables are kept constant. Taking for instance the income variable, the fraction $\frac{\beta_y}{\delta - \beta_r}$ corresponds to the co-efficient given in *table 5.2*, e.g. 1.689 for the *Stockholm* region. Since we are aiming to investigate how the factors determining house price differ between urban and rural areas we are most interested in the relative size of co-efficients in different areas.

5.2.3 Income

A income co-efficent on 1.689, (as in the *Stockholm* region) means that a percentage point's increase in income will result in a 1.689 percentage points increase in the price of housing, given that all other variables are kept constant. As expected, the most densely populated area, Stockholm, has the highest income co-efficient. The income co-efficients are also relatively high in *Western Sweden* (1.14) and *East Central Sweden* (0.988) which could all be termed semi urban areas, (population density of 61 and 39 inhabitants per square kilometre respectively). The income co-efficients are lower in the more rural areas like *Småland and the Islands*, (0.581, population density of 24 inhabitans/km^2) *North Central Sweden,* (0.536, population density of 13 inhabitans/km^2) and the very rural *Central North,* (0.517, population density of 5 inhabitans/km^2). It is somewhat surprising that the second most densely populated area *Southern Sweden*, (94 inhabitans/km^2) have an income co-efficient of 0.764, almost equal to that of the most rural area, *Upper North,* (income co-efficient 0.712, 3 inhabitans/km^2). Given the proximity of *Southern Sweden* to Denmark and the tendency of Germans to buy summer houses in the South of Sweden the regional income may not adequately reflect the total impact of income changes. However, despite the somewhat puzzling results from *Upper North* and *Southern Sweden* the income co-efficient seem to be of greater magnitude in the more urban areas. Hort (1998) found the Ln(total real income) to be 0.969 but this study only incorporates urban areas.

5.2.4 Population

When interpreting the population co-efficients it should be remembered that the changes in population throughout the period investigated have been quite moderate. A population co-efficient of 4.434 (as in the *Stockholm* region) means that an percentage point's increase in population will result in a 4.434 percentage points increase in the price of housing, given that all other variables are kept constant. Population increases have ranged, on a yearly basis, between 0.7% (for *Stockholm*) and negative 0.2% (for *Upper North*). See *graph 4.4* for further information.

The population co-efficent is clearly more pronounced in the more urban areas compared to the the rural. The magnitude is greatest in *Southern Sweden*, (7.595) followed by *Stockholm* (4.434) and *Western Sweden*, (3.632). In the three most densely populated areas the population co-efficient is consequently also the highest of the eight regions. As can be seen in *graph 4.3* on page 15 these regions have also experienced the largest population increases over time. The very rural areas have the lowest co-efficients (1.419 for *Upper North* and 1.673 for *North Central Sweden). East Central Sweden*, which could be termed semi-urban, has a co-efficient of 2.433, which is almost the same as the semi-rural *North Central Sweden*, 2.488. The co-efficient of semi rural *Småland and the Islands* of 1.791 is in line with the general finding that population changes is of greater importance in the more densely populated an areas. Hort (1998) only included population aged between 25 and 44 years, and found the co-efficient to be 0,217 hence considerably less than our values.

5.2.5 Cost of Building

According to expectations the cost of building variable should be smaller in urban areas then rural since this cost of building constitutes a smaller proportion of the total cost of a house in an urban area. Compared to the other variables, the Cost of Building co-efficient differs relatively little between the lowest value, (0.512 in *Småland and the Islands*) and the highest

(0.964 in *East Central Sweden*). The highest values are found the urban regions, *Southern Sweden* (0.964) Stockholm (0.853), and *Western Sweden* (0.755), while the rural and semi rural areas have the lowest values; 0.512 for *Småland and the Islands*, 0.580 for *Upper North,* 0.632 for *Central North* and 0.634 for *North Central Sweden*. The semi-urban *East Central Sweden* falls in between with a value of 0.761. This trend is contradictory to theory but when analysing the results one should keep in mind that the variable used is a national index of cost of building, that consequently do not take account of regional differences. Furthermore, the co-efficients are relatively similar in magnitude and the given the size of the standard errors the different magnitudes should not be given too much attention. Hort (1998) found the construction cost co-efficient to be 0.583 and hence our figures for the construction cost are slightly higher on average.

5.2.6 Interest Rate

All interest rate co-efficients except for *Stockholm* are negative. The result for *Stockholm* is puzzling, but could be due to the fact that the interest rate used is a national measure that does not take account of regional tax effects. Another explanation could be that increasing interest rates are a sign of a booming economy, driving house prices up despite increasing borrowing costs. Regarding all other regions but *Stockholm*, the interest co-efficient is relatively small in absolute magnitude compared to the other variables. However, the interpretation of the logged regression equation yields that an a one percentage point's growth in the real interest rate, will in *East Central Sweden* result in a decrease of house prices by 0.067 percentage points. This seems like a very small number, but given that interest rate are normally given in percentage units, a change in the real interest rate from 5 percentage units to 5.5 percentage units corresponds to a 10 percent increase and consequently a 0.67% decrease in house prices in *East Central Sweden*.

The highest absolute values of the interest rate co-efficient is found in *Småland and the Islands* (-0.176), followed by *North Central Sweden* (-0.068), *East Central Sweden* (-0.067) and *Upper North* (-0.057). The lowest values are found in *Western Sweden* (-0.040), *Southern Sweden* (-0.042) and *Central North* (-0.048). A weak tendency for lower absolute magnitudes in the more urban areas can be noted. However, with the exception of *Småland and the Islands* there are fairly little differences between the highest and lowest values. Given that the standard errors are of almost the same magnitude as the co-efficients themselves, the regional difference in the impact of interest rates on prices of housing seems weak, although definitely negative. To compare, Hort (1998) found the real user cost co-efficient to be -0.020.

To summarize the general findings of the long run model, changes in income and population contribute most to explain the different prices in urban and rural regions while the cost of building differ less. It proved difficult to draw any clear conclusions regarding the interest rate except that it has a negative impact on the price of housing.

5.3 Cointegration

The error correction model requires a long run equilibrium relationship among the variables used – that they are cointegrated. If the variables are not cointegrated, there is no long-run relationship among them. The regression in the long run model might then be spurious. To test for cointegration we performed an Engle-Granger test. The result of the test was that we were able to reject the hypothesis of non-stationarity for *East Central Sweden*, *Småland and the Islands*, *North Central Sweden* and *Upper North*. The test and its results are described in more detail in *section 9.2* the appendix.

5.4 Short run model

In order to estimate the short run dynamics, we regress the first difference of each variable together with an error-correction variable that corresponds to the lagged residuals from the long run model. The components of the short run model were determined by exclusion of insignificant variables as described in *section 5.2*. We have also added the first lag of the price of housing in order to investigate how the price of housing the previous period influences the present price. The second lag of the house price, i.e. the price two years ago was also included but this variable proved small and insignificant and was hence excluded. The population co-efficient was also omitted since this variable was insignificant in all regions and negative in four of them (the regressions including omitted variables are shown in section 9.4 in the appendix). The resulting short run model is hence modelled according to *equation 5.4*.

$$\Delta \text{Ln Ph}_t = \beta_0 + \beta_1 \Delta \text{LnPh}_{t-1} + \beta_2 \Delta \ln Y_{t-1} + \beta_3 \Delta \ln CB_t + \beta_4 \Delta \ln R_t + \beta_5 u_{t-1} + \varepsilon_t \qquad \textit{(Equation 5.4)}$$

The resulting coefficients and standard errors are presented in *table 5.4*. All residuals are negative, between -0.390 and -0.917 and highly significant which indicate that the price of housing reverts fairly quickly to its long term equilibrium. Hort (1998) found the error correction term to be -0.836 when examining urban house prices in Sweden, and our findings are hence in line with these findings. Figures in bold are either of the wrong sign as suppose to expectations or not significant at the 10% level.

	Stockholm			***East Central Sweden***			***Småland & Islands***			***Southern Sweden***		
		Adjusted R^2=0,765			Adjusted R^2 0,665			Adjusted R^2=0,640			Adjusted R^2=0,669	
	Co-eff	St. err	Sig	Co-eff	St. err	Sig	Co-eff	St. err	Sig	Co-eff	St. err	Sig
$\Delta LnPriceHousing_{t-1}$	0,321	0,137	0,028	0,444	0,153	0,008	0,472	0,145	0,004	0,360	0,148	0,024
$\Delta LagLnincome_t$	0,794	0,340	0,029	0,276	0,263	**0,305**	0,089	0,232	**0,705**	0,262	0,281	**0,362**
$\Delta LnCostofBuild_t$	0,868	0,199	0,000	0,474	0,177	0,014	0,313	0,145	0,043	0,689	0,206	0,003
$\Delta RealInterest_t$	**0,070**	0,040	0,097	-0,010	0,035	**0,775**	-0,039	0,032	**0,245**	-0,023	0,038	**0,563**
$Residual_{t-1}$	-0,917	0,184	0,000	-0,562	0,157	0,002	-0,390	0,113	0,002	-0,748	0,196	0,001

	Western Sweden			***North Central Sweden***			***Central North***			***Upper North***		
		Adjusted R^2=0,650			Adjusted R^2=0,627			Adjusted R^2=0,570			Adjusted R^2=0,621	
	Co-eff	St. err	Sig	Co-eff	St. err	Sig	Co-eff	St. err	Sig	Co-eff	St. err	Sig
$\Delta LnPriceHousing_{t-1}$	0,400	0,160	0,020	0,510	0,149	0,002	0,363	0,159	0,033	0,341	0,154	0,037
$\Delta LagLnincome_t$	0,390	0,299	**0,207**	**-0,099**	0,228	**0,668**	**-0,221**	0,245	**0,377**	0,015	0,223	**0,948**
$\Delta LnCostofBuild_t$	0,585	0,197	0,007	0,352	0,136	0,017	0,455	0,164	0,011	0,447	0,131	0,002
$\Delta RealInterest_t$	-0,012	0,038	**0,762**	-0,020	0,028	**0,495**	-0,001	0,034	**0,981**	-0,022	0,028	**0,455**
$Residual_{t-1}$	-0,667	0,187	0,002	-0,499	0,147	0,003	-0,637	0,143	0,000	-0,723	0,168	0,000

Table 5.4

In the short run, the price of housing the previous year seem to have a definite effect on the house price, with co-efficients of the lag of prices of housing ranging from 0.321 to 0.510. A co-efficient of 0.527, like in *North Central Sweden* means that if the price of housing increased by one percentage point last period, they will increase by 0.527 percentage points the present year In the semi rural areas like *East Central Sweden*, *Småland and the Islands* and *North Central* the price of housing of the previous year is relatively more important in determining this year's prices. Hort (1998) found the first lag of real house prices to have a co-efficient of 0.590 but contrary to our study found the second and third lag to have a relevant impact on short run dynamics, (co-efficients of 0.373 and 0.265 respectively). Abraham and Hendershott (1996) investigated the factors explaining real price appreciation of housing in the USA 1978-1992 and found that the lag of real price appreciation of housing had a co-efficient of 0.362. In the urban and very rural areas the price of last year is of less relative importance although the difference compared to other regions is quite small.

In the short run, income appears to most important in *Stockholm* in particular and in the more urban areas in general. *North Central Sweden* and *Central North* even display negative highly insignificant income variables. Except for *Stockholm*, the income variables are insignificant and much lower than in the long run model which suggests that income is not a very important variable in the short run.

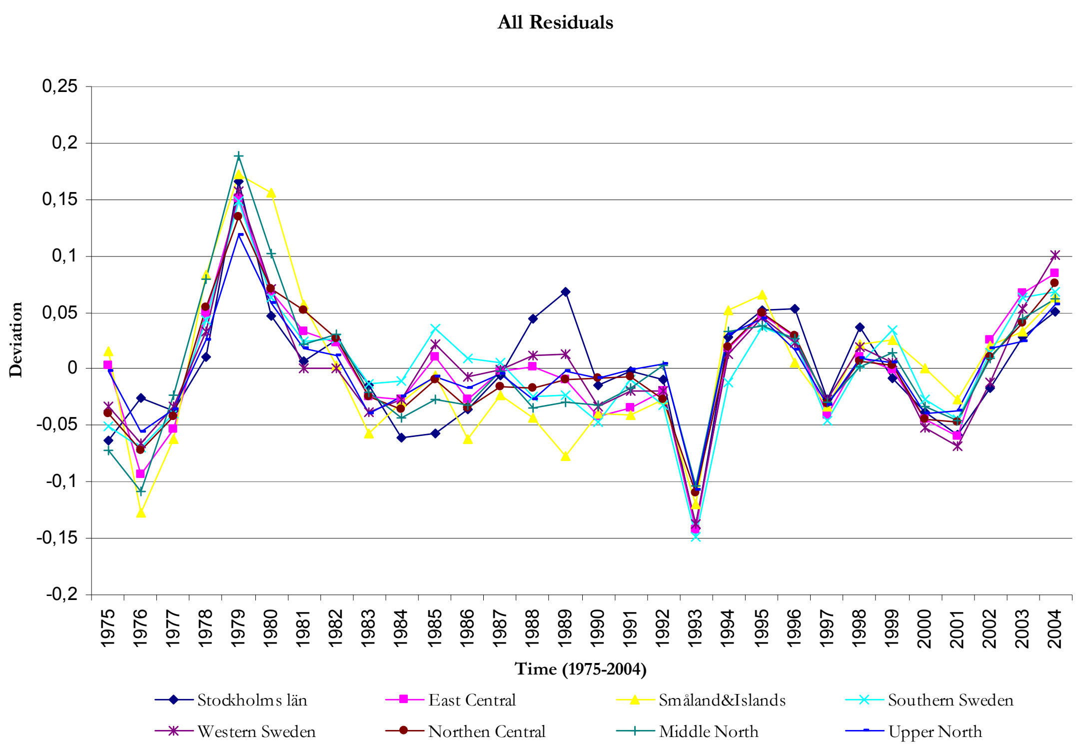
As in the long run model, the cost of building co-efficient is greater in the more urban areas with Stockholm showing the largest value this time. The rural areas have smaller co-efficients and it should also be noted that the magnitude of the co-efficients are generally lower than in the long run model.

The real interest rate still has a negative effect on the price of housing in all regions except *Stockholm*, although the absolute magnitudes of the co-efficients are considerably smaller than in the long run model and all insignificant. No clear relationship between the magnitude of the interest rate co-efficient and the population density of the region can be spotted.

To summarize the analysis of the short run determinants of house prices the price of housing in the previous period, income and cost of building seem to be the most important factors. Income and the cost of building are relatively more important in the more urban areas while price of housing in the previous period show a weak tendency to be more important in the semi urban areas. Overall, the co-efficients are smaller than in the long run model.

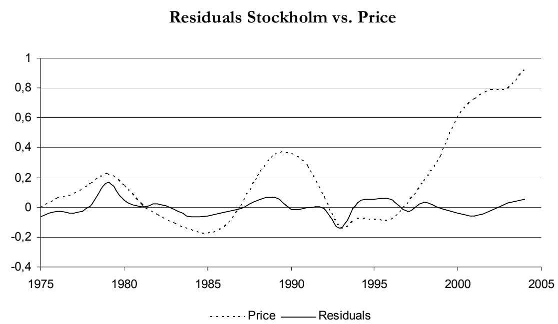
5.5 Deviations from long run equilibrium prices

The residuals from the long run model can be interpreted as the deviations from the steady state level of real prices of housing. *Graph 5.1* below shows the combined residuals of the regressions for all the eight NUTS -2 regions and *graph 5.2* and *5.9* shows the residuals for each region, plotted against the change in the index of real house prices. *Graph 5*.1 indicates mainly two trends. Firstly, the periods when the model over or under estimates the price of housing are fairly consistent for all of the areas investigated. In 1979 the model underestimates the price of housing and in 1993 it overestimates the price. There are quite considerable differences in the over and under estimation of the model depending on the area except for the 1979 underestimation where the magnitude is roughly the same in all areas. *Southern Sweden*, however, seems to lag one period and has the highest deviation in 1980. Regarding the rest of the period, *East Central Sweden* has the highest deviations from the model. The deviations from zero in the model indicate that the model misses something. This could possibly be the effect of tax changes which are quite considerable during the period investigated.

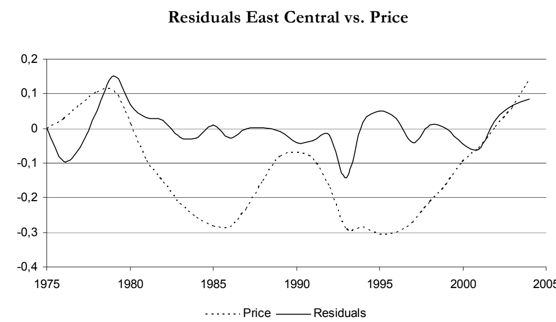


Graph 5.1

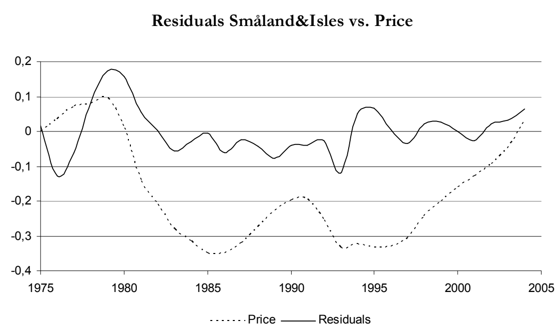
In *graph 5.2* to *5.9* the residuals (solid line) is plotted against the change in the index of house prices, and the residuals tend to mimic the movements of the real house price. This is especially true for the deviation in 1979, but also the overestimation of the model in the beginning of 1990 occurs simultaneously as a drop in real house prices. This result has also been found by Hort (1998) and has been regarded as evidence of speculative behaviour. However, Hort argues that short term deviations from the long run equilibrium may occur also in the absence of bubbles.



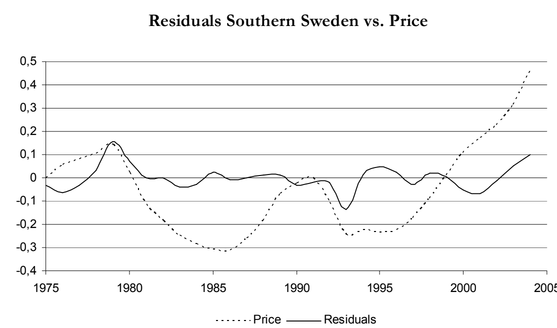
Graph 5.2



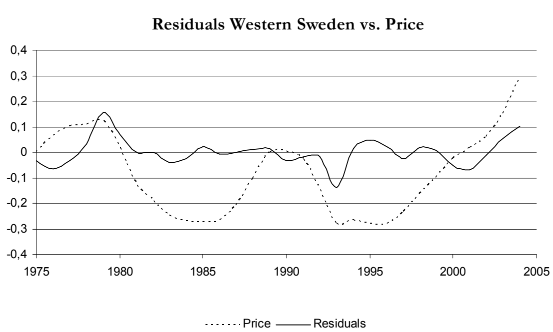
Graph 5.3



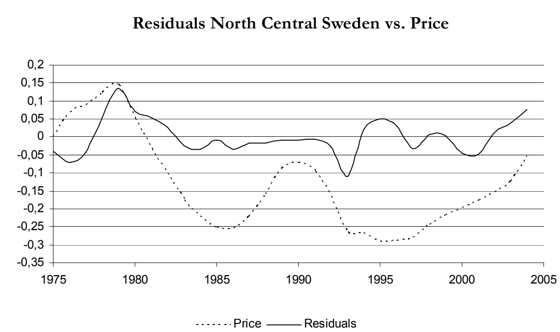
Graph 5.4



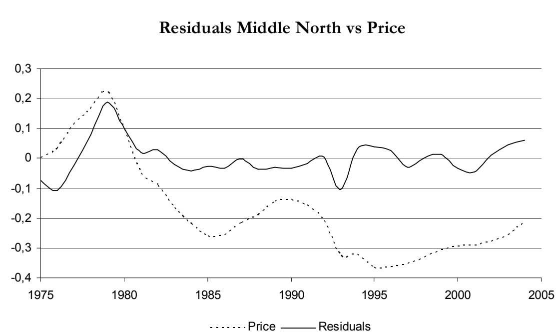
Graph 5.5



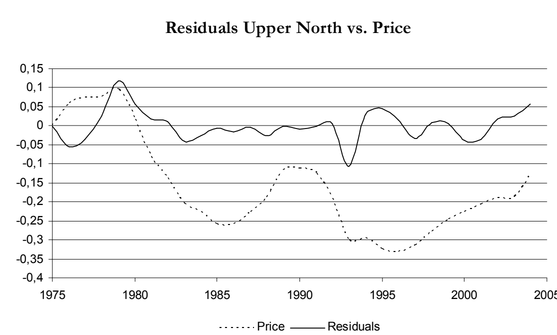
Graph 5.6



Graph 5.7



Graph 5.8



Graph 5.9

6. Conclusion

The aim of this thesis was to investigate the determinants of regional house prices in urban and rural areas in Sweden. During the period 1975 to 2004 the price of housing has increased considerably more in urban areas than in rural. Through elimination of statistically insignificant variables our long term model uses the income, cost of building, interest rate and population to explain the development of house prices. Of the variables, the rate of interest on loans for housing proved to be the most problematic since it needs to capture both the effect of a tax shield and inflation. By examining which rate that resulted in the best fit of the regression (measured as adjusted R^2) we found that the rate of the year deflated by the average of the change in CPI of the last two years, the present and the next gave the best result.

The general result of the error correction model in the long run all is a change by one percentage point in all factors yields greater changes in the price of housing in the urban areas than in the rural. More precisely, the demographic variable and the lag of income differs the most between urban and rural areas while cost of building differed less. The interest rate variable showed even less differences between regions and no clear relationship between urban and rural areas.

In the short run model the price of housing the previous period proved important as well as income and the cost of building. The population variable was excluded due to low significance. However, the magnitudes of all factors were considerably lower then in the long run model which indicate a lower impact of changes in variables in the short run. The error-correction term is negative and significant for all regions. This implies that if the explanatory variables are exposed to shocks, the price of housing reverts back to its long run equilibrium level.

The comparisons with Hort (1998) regarding the magnitudes of the co-efficients turned out roughly in line with our findings, except for the population co-efficient. However, it should also be noted that Hort's study only incorporates urban areas, uses another investigation period and slightly different explanatory factors.

7. Suggestions for further research

In order to more precisely examine the determinants of urban and rural house prices a few considerations would need to be accounted for. First of all a longer time frame would probably allow the econometric model to give a more stable result thanks to a larger number of observations. Regarding the supply and demand factors examined modifications could be to the interest rate, cost of building and income. The interest rate could be modelled on a regional level in order to take account of different marginal tax rates and the associated tax deductions that follow from debt financing a house. Hopefully this procedure would yield more significant results for the interest variable. Concerning the cost of building regional indices could be used instead of a national in order to reflect different regional cost of building. A measure of disposable income, i.e. making allowance for the marginal tax rate in each region would better reflect the effect of income on the prices of housing. Finally, more investigation of the effects of tax changes during the period would be interesting in order to attempt to explain the deviations of the residuals noted in *section 5.5*.

In an attempt to capture the incentive to dept finance a dwelling that characterised to Swedish tax system in the 1980 a variable of the percentage of disposable income spent on interest payments was included. Even though this variable proved unfit to be included in the final model, some measure of the effect of the tax system on house prices would be interesting to include. This becomes particularly important when examining data over an even longer time than the 29 years span investigated in the thesis given that the tax system has been altered several times. The effect of unemployment to prices of housing in a region could also add explanatory power to the model.

Finally, given that not only regional data have an impact on prices of houses a measure of foreign impact would need to be included. In the South-eastern parts of Sweden many Danes live and commute to Copenhagen and many Germans have chosen to buy second homes in Southern Sweden lately.

8. References

Literature

Abraham, Jesse. & M. Hendershott, Patric, H. (1996): Bubbles in Metropolitan Housing Markets, *Journal of Housing Research*, v 7, issue 2.

Abelson, Peter., Joyeux, Roselyne., Milunovich, George. & Chung, Demi.. (2005): Explaining House Prices in Australia: 1970-2003, *The Economic Record*, Vol. 81 Pages 96-103.

Agell, Jonas., Englund, Peter. & Södersten, Jan. (1995): Svensk skattepolitik i teori och praktik. 1991 års skattereform, SOU 1995:104 .

Ashworth, John. & Parker, Simon C. (1997): Modelling Regional House Prices in the UK, *Scottish Journal of Political Economy* - Vol. 44 Issue 3. Page 225-247.

Barot, Bharat (**2001):** An Econometric Demand–Supply Model For Swedish Private Housing, *European Journal of Housing Policy, Taylor and Francis Journals*, vol. 1(3), pages 417-444, December

Cecchetti, Stephen G. & Ehrmann, Michael. (1999): Does inflation targeting increase output volatility? An international comparison of policymakers' preferences and outcomes, Working Paper 7426, National Bureau of Economic Research.

Engle, Robert, & Granger, Clive, (1987): Co-integration and Error Correction: Representation, Estimation and Testing. *Econometrica* 55:2 pages. 251-276.

Englund, Peter. (1993): Den gynnade bostadssektorn, in **Werin, Lars** *Från räntereglering till inflationsnorm* pp. 325-31.

Englund, Peter, Persson, Torsten. & Teräsvirta, Timo. (2003): Statistiska metoder för ekonomiska tidsserier, *Ekonomisk Debatt*, 31:8, pp. 5-15.

Englund, Peter. Hendershott, Patric H. & Turner, Bengt., (1995): The Tax Reform and the Housing Market, Swedish Economic Policy Review 2.

Granger, Clive, Newbold, Paul, (1974): Spurious Regressions in Econometrics. *Journal of Econometrics*, 2, pp 111-120.

Hort, Katinka. (1998): Determinants of Urban House Price Fluctuations in Sweden 1968-1994", *Journal of Housing Economics* 7, 93-120.

Macdonald, Donald. & Taylor, Mark, P,. (1993) Regional House Prices in Britain: Long-run Relationships and Short Run Dynamics, *Scottish Journal of Political Economy*, vol 40, No 1.

Mankiw, Gregory. & Weil, David N. (1991): The Baby Boom, The Baby Bust, and the Housing Market; *Regional Science and Urban Economics*, December, v. 21, iss. 4, pp. 573-79

Malpezzi, Stephen., (1999): A Simple Error Correction Model of House Prices**,** *Journal of Housing Economics* 8, 27-62 (1999).

Marshall, **Alfred.** (1890): *Principles of Economics,* Macmillan and Co. 1890, London

Meen, Geoffrey. (2002): The time series behavior of house prices: a transatlantic divide? *Journal of Housing Economics* 11, 1-23.

Data sources

Price of housing

The *Price of Housing* variable is obtained from Statistics Sweden's index of price of detached houses. The series is available (April 2006) at:

http://www.scb.se/templates/tableOrChart____39157.asp

CPI

The Consumer price index used to deflate the variables is obtained from Statistics Sweden. The series is available (April 2006) at:

www.scb.se/Statistik/PR/PR0101/_2005M12/PR0101_2005M12_DI_06-07_SV.xls

Income

The regional income variable is obtained from Statistics Sweden's publications SM-N-1976-1980 for the years 1975-1979 and Statistical Yearbook of Sweden 1977-2006 for the years 1975-2004.

Population

The population variable is the population in the Swedish A regions for each of the years. The series is obtained from Statistics Sweden and available (April 2006) at:

http://www.ssd.scb.se/databaser/makro/Visavar.asp?yp=tsrklz&xu=C0379001&huvudtabell=Befolkning&deltabell=LalderT&deltabellnamn=Befolkningen+efter+l%E4n%2C+civilst%E5nd+och+k%F6n%2E+%C5r&omradekod=BE&omradetext=Befolkning&preskat=O

&innehall=Folkmangd&starttid=1968&stopptid=2005&Prodid=BE0101&fromSok=Sok&Fromwhere=S&lang=1&langdb=1

Cost of building

The *Cost of Building* variable is obtained from Statistics Sweden's cost of building index for housing, offer prices. "Byggnadsprisindex för bostäder, anbudspriser" .
The series is available (April 2006) at:
http://www.ssd.scb.se/databaser/makro/Visavar.asp?xu=C0379001&yp=tsrklz&inl=&prodid=PR0501&preskat=O&omradekod=PR&omradetext=Priser%20och%20konsumtion&tabelltext=Byggnadsprisindex+f%F6r+bost%E4der+%28BPI%29%2C+inkl+merv%E4rdesskatt+efter+hustyp+och+indexslag%2E+%C5r&huvudtabell=ByggIndexAr&starttid=1975&stopptid=2004&langdb=&lang=1&fromSok=Sok&innehall=ByggIndex&deltabell=%20&deltabellnamn=Byggnadsprisindex%20för%20bostäder%20(BPI),%20inkl%20mervärdesskatt%20efter%20hustyp%20och%20indexslag.%20År

Interest rate

The nominal interest variable for the period 1985 to 2005 is the 5 year mortgage rate obtained from Swedbank. The series is available (April 2006) at:
http://www.fsb.se/sst/inf/out/infOutWww/0,,103764,00.html

The rate from 1975 to 1984 is calculated as the average difference between the long term government bond (10 year bond prior to 1980 and 5 year bond after 1980) given in Statistics Sweden's annual publication (*Statistic Yearbook of Sweden*) and the average difference between the government long term bond from 1985 to 2004.

Percentage of income spent on interest payments.

The percentage of income spent on interest payments from 1980 to2004 is calculated by the Swedish Konjukturinstitutet and given to us by Olle Holmberg of the research department of SEB. For the period 1975 to 1980 this ratio is estimated by the ratio of household dept to total GDP given in Englund (1993) and aligned with the series starting 1980.

Websites

www.scb.se
www.fsb.se

9. Appendix

9.1 Stationarity

The Dickey-Fuller tests performed in *section 5.1* are based on the following equation:

$$\Delta Ln\ Y_t = \beta_0 + \beta_1 T_t + \beta_2 LnY_{t-1} + \mu_t \qquad \textit{(Equation 9.1)}$$

Where $\Delta Ln\ Y_t$ is the first difference of LnY at time t, T is a time trend and LnY_{t-1} is the value of LnY lagged one period.

The null hypothesis of the test is that the series contain a unit root, H_0: $\beta_2 = 0$. The alternative hypothesis being H_1: $\beta_2 < 0$. The decision rule for the test is to reject the null hypothesis if the t-value (which follows the τ (tau) distribution) of the estimated coefficient, is smaller than the critical τ-value which for a 5% significance level is – 3.567.

As can be seen in the table below we can not reject the null hypothesis of non-stationarity for any of the variables on the 5% level. Therefore we calculated the first differences of the variables and performed the regression according to the following equation:

$$\Delta\Delta Ln\ Y_t = \beta_1 T_t + \beta_2 \Delta LnY_{t-1} + \mu_t \qquad \textit{(Equation 9.3)}$$

Using the first differences, the hypothesis of a unit root could be rejected for all income variables. It could also be rejected for the Interest Rate. The null could not be rejected for any of the Housing Price variables, the Cost of Building or the Population variables.

Variable	t-value	Decision	First difference	t-value	Decision
PRICE OF HOUSING					
LnPoHStockholm	-0,83	Do not Reject	ΔLnPoHStockholm	-2,51	Do not Reject
LnPoHEastCentralSweden	-0,03	Do not Reject	ΔLnPoHEastCentralSweden	-2,37	Do not Reject
LnPoHSmålandAndIslands	0,04	Do not Reject	ΔLnPoHSmålandAndIslands	-2,64	Do not Reject
LnPoHSouthernSweden	-0,13	Do not Reject	ΔLnPoHSouthernSweden	-2,63	Do not Reject
LnPoHWesternSweden	-0,11	Do not Reject	ΔLnPoHWesternSweden	-2,48	Do not Reject
LnPoHNorthCentralSweden	-0,29	Do not Reject	ΔLnPoHNorthCentralSweden	-2,47	Do not Reject
LnPoHMiddleNorth	-0,76	Do not Reject	ΔLnPoHMiddleNorth	-2,91	Do not Reject
LnPoHUpperNorth	-0,46	Do not Reject	ΔLnPoHUpperNorth	-2,92	Do not Reject
INCOME					
LagLnIncomeStockholm	-1,12	Do not Reject	ΔLagLnIncomeStockholm	-3,89	Reject
LagLnIncomeEastCentralSweden	-1,23	Do not Reject	ΔLagLnIncomeEastCentralSweden	-4,61	Reject
LagLnIncomeSmålandAndIslands	-1,24	Do not Reject	ΔLagLnIncomeSmålandAndIslands	-4,73	Reject
LagLnIncomeSouthernSweden	-1,21	Do not Reject	ΔLagLnIncomeSouthernSweden	-4,60	Reject
LagLnIncomeWesternSweden	-1,10	Do not Reject	ΔLagLnIncomeWesternSweden	-4,35	Reject
LagLnIncomeNorthCentralSweden	-1,28	Do not Reject	ΔLagLnIncomeNorthCentralSweden	-4,72	Reject
LagLnIncomeMiddleNorth	-1,39	Do not Reject	ΔLagLnIncomeMiddleNorth	-4,93	Reject
LagLnIncomeUpperNorth	-1,44	Do not Reject	ΔLagLnIncomeUpperNorth	-5,02	Reject
INTEREST RATE					
LnRate	-1,13	Do not Reject	ΔLnRate	-7,73	Reject
POPULATION					
LnPopStockholm	-2,28	Do not Reject	ΔLnPopStockholm	-1,82	Do not Reject
LnPopEastCentralSweden	-1,05	Do not Reject	ΔLnPopEastCentralSweden	-1,54	Do not Reject
LnPopSmålandAndIslands	-0,76	Do not Reject	ΔLnPopSmålandAndIslands	-2,00	Do not Reject
LnPopSouthernSweden	-1,79	Do not Reject	ΔLnPopSouthernSweden	-2,07	Do not Reject
LnPopWesternSweden	-1,70	Do not Reject	ΔLnPopWesternSweden	-1,87	Do not Reject
LnPopNorthCentralSweden	-0,71	Do not Reject	ΔLnPopNorthCentralSweden	-1,52	Do not Reject
LnPopMiddleNorth	-0,83	Do not Reject	ΔLnPopMiddleNorth	-1,18	Do not Reject
LnPopUpperNorth	-0,53	Do not Reject	ΔLnPopUpperNorth	-1,34	Do not Reject
COST OF BUILDING					
LnCostOfBuilding	-1,15	Do not Reject	ΔLnCostOfBuilding	-2,92	Do not Reject

Table 9.1

9.2 Cointegration

To test for cointegration the Dickey-Fuller test is applied to the resulting residuals ($\hat{\mu}_t$) from each regional long-run model (*model 5.2*) in an Engle-Granger test according to the equation below:

$$\Delta \hat{\mu}_t = \beta_1 + \beta_2 \hat{\mu}_{t-1} + \varepsilon_t$$ *(Equation 9.4)*

The null hypothesis of the test is that the series contain a unit root, H_0: $\beta_2 = 0$. The alternative hypothesis being H_1: $\beta_2 < 0$. The decision rule for the test is to reject the null hypothesis if the t-value of the estimated coefficient, is smaller than the critical τ-value which for the 5% and 10% significance levels is – 3,34 and -3,04 respectively. The results from the test are depicted in *table 9.2*.

Variable	*t-value*	*Decision* a=5%	a=10%
LnPoHStockholm	-3,22	Do not reject	Reject
LnPoHEast Central Sweden	-4,03	Reject	Reject
LnPoHSmåland & Islands	-3,37	Reject	Reject
LnPoHSouthern Sweden	-2,66	Do not reject	Do not reject
LnPoHWestern Sweden	-2,97	Do not reject	Do not reject
LnPoHNorth Central Sweden	-3,47	Reject	Reject
LnPoHCentral North	-3,04	Do not reject	Do not reject
LnPoHUpper North	-3,56	Reject	Reject

Table 9.2

As can bee seen in the table, Southern Sweden, Western Sweden and Central North are the only variables which cannot be rejected on a 10% significance level. This means that the results from these three models and possibly also Stockholm, which could not be rejected on the 5% level, might be spurious.

9.3 Augmented Dickey-Fuller Test

When performing the Dickey-Fuller test, it is assumed that the error term, u, is uncorrelated. If the error terms in fact are correlated, a test termed the augmented Dickey-Fuller test (ADF) is used where the lagged values of the dependent variable are included in the equation (Gujarati 2003). In our ADF we include three lagged variables which results in the following equation:

$$\Delta \text{Ln } Y_t = \beta_0 + \beta_1 T_t + \beta_2 \text{Ln}Y_{t-1} + \beta_3 \Delta \text{Ln}Y_{t-1} + \beta_4 \Delta \text{Ln}Y_{t-2} + \beta_5 \Delta \text{Ln}Y_{t-3} + \mu_t \qquad \textit{(Equation 9.5)}$$

In the ADF we test if β_2 is zero. The test follows the same distribution as the regular Dickey-Fuller test, so the same critical values are used.

9.4 Determining which interest rate to use

In order to determine which interest rate to use the logged price of housing was regressed against the logged income, logged cost of building and logged population and four different interest rates according to *equation* 9.5.

$$\text{Ln } P_t = \beta_0 + \beta_1 \ln Y_{t-1} + \beta_2 \text{LnPop}_t + \beta_3 \text{Ln } CB_t + \beta_4 R_t + \beta_5 T + u_t \qquad \textit{(Equation 9.5)}$$

Ln P_t = LN Price of Housing, LN Y_{t-1} = LagLN Income, + LnPop = LN Population, Ln $LnCB_t$ = LN Cost of Building, R = Interest rate – tested variable, T = time trend.

Eight differently deflated interest rates were tested for each of the regions and the regressions were then evaluated against the adjusted R^2. The differently deflated interests rates tested are shown in *table 9.3*: All rates preceded by Ln are logged after the deflation calculations have been performed.

Interest Rate	Explanation
LnRate Deflated -3, -2, -1	The interest rate deflated by the average of the change in CPI from the three last years
LnRate Deflated -2, -1, 0, 1	The rate deflated by the average of the change in CPI from the two last years, the present and the next year
LnRate Deflated -1,0	The interest rate deflated by the average of the change in CPI last year and the present year.
LnRate Deflated -1,0, 1	The interest rate deflated by the average of the change in CPI last year, the present and next year.
LnRate Deflated -1, 0, 1, 2	The interest rate deflated by the average of the change in CPI last year, this year, and the two coming years.
LnRate Deflated 0, 1, 2	The interest rate deflated by the average of the change in CPI present year and the two coming years.
Eff Rate Post Tax, Deflated -2,-1,0,1	The interest rate after tax deflated by the average change in CPI of the two preceding years, the present and coming year.
Ln Nom Rate Post Tax	The nominal interest rate after tax.

Table 9.3

Since investors are thought to take into account not only the past level of inflation but also the expectations of future inflation, we have included interest rates deflated by future inflation as well. We have also made an allowance for the tax shield. The tax rate used is 30 % for the period 1991 to 2004 and 50% for the period 1975-1991. During certain time periods it was possible to deduct the interest expenses against the marginal a tax rate of 79%, but this only applied in the highest tax brackets and as an average we have chosen 50%. The rate *Post Tax Deflated -2, 1, 0, 1*, i.e. the real effective rate making allowance for both inflation and tax effects, is not logged since this rate for certain years during the 1980s is negative. The rate *Ln Nom Post Tax* is included since we wanted to investigate if investors really only care about the nominal rate they have to pay, without making allowance for inflation which can be difficult to anticipate correctly. The adjusted R^2 of the regressions using the different interests rates tested is shown in *table 9.4*. The interest rate that displays the highest R^2 value is *LnRate Deflated , -2, -1, 0, 1*, (adjusted R^2 = 0.882) i.e. the interest rate deflated by the average of the inflation of the last years, the present year and the two future years. Consequently, it seems as if investors make allowance for the inflation in the past and the near future when deciding how much to borrow. Even though it is the future inflation that will have in impact of the real rate of interest when borrowing, past inflation is used to predict future inflation.

LnRate Deflated -3, -2, -1	Adjusted R^2	LnRate Deflated -2, -1, 0, 1	Adjusted R^2
Stockholm	0,934	Stockholm	0,938
East Central	0,860	East Central	0,865
Småland and the Islands	0,753	Småland and the Islands	0,814
Southern Sweden	0,916	Southern Sweden	0,913
Western Sweden	0,883	Western Sweden	0,882
North Central Sweden	0,854	North Central Sweden	0,858
Middle North	0,889	Middle North	0,878
Upper North	0,900	Upper North	0,910
Average	**0,874**	Average	**0,882**

LnRate Deflated -1, 0	Adjusted R^2	LnRate Deflated -1, 0, 1	Adjusted R^2
Stockholm	0,942	Stockholm	0,940
East Central	0,849	East Central	0,856
Småland and the Islands	0,739	Småland and the Islands	0,779
Southern Sweden	0,910	Southern Sweden	0,910
Western Sweden	0,877	Western Sweden	0,877
North Central Sweden	0,843	North Central Sweden	0,845
Middle North	0,873	Middle North	0,873
Upper North	0,896	Upper North	0,904
Average	**0,866**	Average	**0,873**

LnRate Deflated -1, 0, 1, 2	Adjusted R^2	Post Tax, Deflated -1, 0, 1, 2	Adjusted R^2
Stockholm	0,931	Stockholm	0,898
East Central	0,862	East Central	0,925
Småland and the Islands	0,769	Småland and the Islands	0,872
Southern Sweden	0,910	Southern Sweden	0,872
Western Sweden	0,879	Western Sweden	0,870
North Central Sweden	0,845	North Central Sweden	0,866
Middle North	0,873	Middle North	0,881
Upper North	0,904	Upper North	0,896
Average	**0,872**	Average	**0,885**

Ln Nom Rate Post Tax	Adjusted R^2	LnRate Deflated 0, 1, 2	Adjusted R^2
Stockholm	0,872	Stockholm	0,932
East Central	0,915	East Central	0,854
Småland and the Islands	0,841	Småland and the Islands	0,745
Southern Sweden	0,883	Southern Sweden	0,910
Western Sweden	0,866	Western Sweden	0,877
North Central Sweden	0,850	North Central Sweden	0,841
Middle North	0,838	Middle North	0,874
Upper North	0,880	Upper North	0,899
Average	**0,868**	Average	**0,867**

Table 9.4

9.4 Omitted co-efficients in the models

This section contains the regressions that are mentioned in text but are not presented since they are not explicitly analysed. *Table 9.5* shows the long run model without the time trend and the resulting negative population co-efficents. *Table 9.6* shows the short run model including the population variable and the time trend. As can be seen, the population co-efficient is highly insignificant in all areas and even negative in *East Central Sweden. Table 9.7* shows the short run model including a second lag of the price of housing.

	Stockholm			East Central Sweden			Småland & Islands			Southern Sweden		
	Adjusted R2=0,920			Adjusted R2=0,789			Adjusted R2=0,776			Adjusted R2=0,864		
Model 1	Co-eff	St. err	Sig	Co-eff	St. err	Sig	Co-eff	St. err	Sig	Co-eff	St. err	Sig
Constant	18,951	10,022	0,071	38,869	20,978	0,076	4,905	30,022	**0,872**	25,035	18,522	**0,189**
LagLnincome	1,709	0,501	0,002	**0,792**	0,567	**0,175**	-0,098	0,525	**0,853**	**1,139**	0,539	0,045
LnPopulation	**-1,772**	0,775	0,031	**-2,794**	1,537	0,082	**-0,205**	2,230	**0,928**	**-1,965**	1,398	**0,173**
LnCostofBuild	0,815	0,264	0,005	0,408	0,248	**0,113**	0,469	0,282	**0,109**	0,563	0,225	0,019
LnRealInterest	**0,001**	0,054	**0,987**	-0,153	0,052	0,007	-0,238	0,042	0,000	-0,115	0,055	0,046
IncInterest	-0,052	0,083	**0,537**	0,011	0,078	0,887	-0,023	0,064	**0,717**	-0,144	0,091	**0,127**

	Western Sweden			North Central Sweden			Central North			Upper North		
	Adjusted R2=0,832			Adjusted R2=0,793			Adjusted R2=0,818			Adjusted R2=0,766		
Model 1	Co-eff	St. err	Sig	Co-eff	St. err	Sig	Co-eff	St. err	Sig	Co-eff	St. err	Sig
Constant	36,104	17,625	0,052	-57,891	21,127	0,011	-67,305	22,786	0,007	0,156	20,640	**0,994**
LagLnincome	1,204	0,527	0,031	**-0,528**	0,324	**0,116**	0,892	0,277	0,004	**-0,338**	0,448	**0,458**
LnPopulation	**-2,678**	1,300	0,050	4,352	1,508	0,008	**-0,199**	0,031	0,000	0,242	1,575	**0,879**
LnCostofBuild	0,416	0,230	0,083	0,764	0,225	0,002	0,023	0,080	**0,778**	0,329	0,245	**0,192**
LnRealInterest	-0,125	0,053	0,028	-0,199	0,022	0,000	-0,656	0,388	**0,104**	-0,234	0,035	0,000
IncInterest	0,008	0,078	**0,918**	0,040	0,060	**0,510**	5,350	1,697	0,004	0,154	0,056	0,011

Table 9.5

	Stockholm			East Central Sweden			Småland & Islands			Southern Sweden		
	Adjusted R^2=0,747			Adjusted R^2 0,667			Adjusted R^2=0,651			Adjusted R^2=0,654		
	Co-eff	St. err	Sig	Co-eff	St. err	Sig	Co-eff	St. err	Sig	Co-eff	St. err	Sig
Constant	-0,171	3,290	**0,959**	-2,182	2,545	0,401	-4,123	2,515	0,117	-2,097	3,112	**0,508**
ΔLnPriceHousing$_{t-1}$	0,352	0,150	0,029	0,503	0,170	0,008	0,371	0,160	0,031	0,296	0,169	0,095
ΔLagLnincome$_t$	0,704	0,377	0,076	0,225	0,266	**0,408**	0,046	0,230	**0,842**	0,244	0,290	**0,411**
ΔLnPopulation$_t$	3,039	4,920	**0,544**	**-3,246**	2,917	**0,279**	1,418	2,697	**0,605**	2,351	4,391	**0,598**
ΔLnCostofBuild$_t$	0,843	0,210	0,001	0,384	0,192	0,060	0,356	0,152	0,029	0,709	0,218	0,004
ΔRealInterest$_t$	0,080	0,050	**0,122**	**0,008**	0,042	**0,856**	-0,004	0,038	**0,907**	0,000	0,047	**0,998**
Residual$_{t-1}$	-0,846	0,217	0,001	-0,582	0,169	0,003	-0,355	0,117	0,006	-0,639	0,238	0,014
t	0,000	0,002	0,968	0,001	0,001	0,401	0,002	0,001	0,117	0,001	0,002	**0,512**

	Western Sweden			North Central Sweden			Central North			Upper North		
	Adjusted R^2=0,640			Adjusted R^2=0,610			Adjusted R^2=0,539			Adjusted R^2=0,595		
	Co-eff	St. err	Sig	Co-eff	St. err	Sig	Co-eff	St. err	Sig	Co-eff	St. err	Sig
Constant	-1,979	3,009	**0,518**	-2,351	2,279	0,315	-1,529	2,745	0,584	-1,701	2,239	**0,456**
ΔLnPriceHousing$_{t-1}$	0,371	0,172	0,043	0,473	0,181	0,017	0,312	0,180	0,099	0,324	0,171	0,073
ΔLagLnincome$_t$	0,357	0,313	**0,267**	-0,133	0,237	**0,581**	-0,237	0,257	**0,367**	**-0,004**	0,237	**0,987**
ΔLnPopulation$_t$	1,441	4,197	**0,735**	0,840	2,398	**0,730**	1,709	2,638	**0,525**	0,208	1,943	**0,916**
ΔLnCostofBuild$_t$	0,591	0,210	0,011	0,364	0,156	0,030	0,505	0,188	0,014	0,447	0,147	0,006
ΔRealInterest$_t$	**0,008**	0,047	**0,872**	**0,000**	0,035	**0,989**	**0,007**	0,042	**0,862**	-0,007	0,035	**0,854**
Residual$_{t-1}$	-0,596	0,217	0,012	-0,455	0,156	0,009	-0,624	0,150	0,000	-0,691	0,179	0,001
t	0,001	0,002	0,522	0,001	0,001	**0,316**	0,001	0,001	**0,586**	0,001	0,001	**0,460**

Table 9.6

	Stockholm			***East Central Sweden***			***Småland & Islands***			***Southern Sweden***		
	Adjusted R^2=0,763			Adjusted R^2 0,647			Adjusted R^2=0,616			Adjusted R^2=0,665		
Model 1	Co-eff	St. err	Sig	Co-eff	St. err	Sig	Co-eff	St. err	Sig	Co-eff	St. err	Sig
Constant	-0,012	0,011	**0,272**	-0,009	0,010	**0,380**	-0,004	0,009	**0,648**	-0,006	0,011	**0,583**
ΔLnPriceHousing$_{t-1}$	0,342	0,150	0,034	0,453	0,171	0,016	0,487	0,161	0,007	0,385	0,159	0,026
ΔLnPriceHousing$_{t-2}$	0,085	0,139	**0,549**	0,113	0,189	**0,557**	-0,001	0,186	**0,995**	**-0,037**	0,180	**0,841**
ΔLagLnincome$_t$	0,741	0,363	0,055	0,276	0,282	**0,340**	0,487	0,161	0,007	0,304	0,305	**0,332**
ΔLnCostofBuild$_t$	0,853	0,208	0,001	0,435	0,198	0,041	0,308	0,162	0,072	0,696	0,217	0,005
ΔRealInterest$_t$	**0,099**	0,054	0,081	-0,597	0,176	0,003	-0,032	0,043	**0,475**	-0,013	0,052	**0,812**
Residual$_{t-1}$	-0,984	0,202	0,000	-0,597	0,176	0,003	-0,414	0,127	0,004	-0,797	0,216	0,002

	Western Sweden			***North Central Sweden***			***Central North***			***Upper North***		
	Adjusted R^2=0,654			Adjusted R^2=0,631			Adjusted R^2=0,413			Adjusted R^2=0,530		
Model 1	Co-eff	St. err	Sig	Co-eff	St. err	Sig	Co-eff	St. err	Sig	Co-eff	St. err	Sig
Constant	-0,010	0,011	**0,374**	-0,005	0,008	**0,589**	-0,016	0,012	**0,177**	-0,011	0,009	**0,248**
ΔLnPriceHousing$_{t-1}$	0,448	0,177	0,020	0,540	0,165	0,004	0,252	0,197	**0,216**	0,327	0,185	0,093
ΔLnPriceHousing$_{t-2}$	0,016	0,187	**0,933**	0,154	0,199	**0,448**	0,030	0,164	**0,856**	0,116	0,183	**0,533**
ΔLagLnincome$_t$	0,392	0,328	**0,247**	**-0,139**	0,249	**0,583**	**-0,210**	0,285	**0,470**	**-0,070**	0,274	**0,802**
ΔLnCostofBuild$_t$	0,569	0,209	0,013	0,301	0,146	0,053	0,475	0,201	0,029	0,451	0,158	0,010
ΔRealInterest$_t$	**0,011**	0,052	**0,841**	-0,016	0,037	**0,665**	-0,043	0,048	**0,382**	**0,018**	0,044	**0,681**
Residual$_{t-1}$	-0,726	0,207	0,002	-0,531	0,157	0,003	-0,592	0,212	0,012	-0,501	0,151	0,004

Table 9.7