The effect of rising interest rates on Swedish condominium prices

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Abstract:

This study examines the effects of rising interest rates on condominium prices in Sweden using the Vector Error Correction Model (VECM). There have been several studies across the globe that have examined the relationship between house prices and interest rates, while the condominium segment has not been greatly covered. This thesis contributes to the literature by studying monthly data between 2005-2020 for the condominium prices in Sweden. Our findings suggest that condominium prices, when accounting for cointegration of variables and excluding great macroeconomic shocks, are highly sensitive to changes in interest rate and thus changes in monetary policy. The inverse relationship between interest rates and condominium prices are in line with general economic theory that describes the relationship between capital goods and real interest rates. Furthermore, the conclusion of this research suggests that condominium owners face severe risks regarding rising interest rates. However, the model shows great sensitivity to model specifications and major macroeconomic shocks.

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Key words

Condominium prices, mortgage rate, interest rate, inflation, unemployment, GDP, equity wipe out, confidence, Animal spirit, VECM, Sweden, rising interest rates.

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1. Introduction

1.1 Background

An investment in a house or a condominium has been something that seems like an obvious investment in most everyday conversations. It is commonly deemed as a low-risk investment that has seen great returns ever since the Swedish housing crash in the 1990s (Ekonomifakta, 2020). Households usually use leverage to buy a home, sometimes only having 15% of the cost available at hand, which is the minimum requirement, the rest is borrowed from the bank using a home mortgage (Finansinspektionen, 2020).

Since 2005 until 2020, the appreciation of Swedish house prices has been approximately 132%, while condominium prices have seen an appreciation of approximately 170% (*Valueguard* 2020). Further, nominal interest rates, as well as real interest rates have seen a substantial fall since 2005 and years before that (SCB, 2020). If households are leveraged and have seen condominium appreciations, then they have likely also seen substantial returns for that leveraged investment. However, if the opposite would have happened, this could have a severe impact on the Swedish household economy.

According to the Swedish Financial Supervisory Authority (FI) only 40% of the Swedish households have a fixed mortgage rate of 1 year (Finansinspektionen, 2020). This makes the general Swedish households extra sensitive to a change in interest rate. A higher rate would first and foremost increase the cost of living of all households with a floating mortgage rate. It could also have an effect on the households' home equity as higher interest rates could lead to a lower demand for house prices in general. Furthermore, Finansinspektionen (2020) calculates that a 15% fall in house prices would cause 4% of the households to have a loan to value-ratio of over 100%, for new mortgage holders[1], meaning that household debt is higher than the market value of the home. In the same scenario, 50% of households will then have a loan to value-ratio of over 85%. In a severe stressful economy however, with a hypothetical

[1] Refers to new mortgage holders between 2013-2019.

fall of house prices by 30%, about half of the Swedish households will have debt higher than the market value of their home, while one third of the households will have a debt to value-ratio of over 85%. This could cause severe problems with debt for the Swedish economy and according to FI these numbers, which are used for stress testing the Swedish households, are higher than prior years (Finansinspektionen, 2020).

Theory regarding monetary policy tells that a low interest rate should correlate with low GDP growth as a lowering in interest rates is usually conducted during recessions (Gottfries, 2013). Human conviction, that may be irrational, can also cause house prices to fluctuate, as emotions and past performance may have an impact on home buyer decisions, all else equal (Shiller, 2015).

The Swedish central bank has for a long time forecasted higher interest rates since the financial crisis in 2008 which has not been realized, with some exceptions (Fredén, 2019). However, it is still a possibility that the historically low nominal interest rates are increased in the future. It is therefore important from both a macroeconomic view as well for the individual household to know what impact this may have on condominium prices and home equity.

If interest rates cause house prices to fall it can therefore lead to severe problems for leveraged Swedish condominium owners based on (Finansinspektionen, 2020) calculations. The question is, if it has an impact, how much of an impact does it have? What are the consequences for condominium owners? Can a rise in interest rates cause condominium prices to fall equal to FI:s scenarios? These issues are captured in the main question of this thesis: What are the effects of rising interest rates on Swedish condominium prices?

1.2 Problem definition

There are several studies around the globe that have examined the relationship between house prices and variables through a macro and micro perspective (Melinder & Melnikova, 2016), (Quyet, 1990), (Fast & Holm, 2014). However, there is a lack of research on the effects of changes in mortgage rates on Swedish condominiums prices in particular and the consequences it has for household's risk of an equity wipe out (Cassel & Persson, 2020).

1.3 Purpose

The purpose of this thesis is to research the effects of rising interest rates on Swedish condominium prices and condominium owners home equity. Additional factors that may have an impact on the condominium price must also be controlled for to see what the effect on a rise in interest rates may have, all else equal.

Just how sensitive are condominium prices to changes in interest rates? Is there reason for concern for condominium owners if the Swedish central bank hikes interest rates? Hopefully, this study will add better understanding if there are any reasons for concern regarding the impact of higher interest rates on households leveraged positions on their condominium assets.

1.4 Delimitations

This thesis has investigated the condominium market and used data from monthly condominium prices between 2005 and 2020 in Sweden (Valueguard, 2020). As there is limited research focused on the relationship between condominium prices and interest rates, this study has chosen to dig deeper into the area. Our timespan captures the global financial crisis of 2008, the euro crisis in the early 2010 and the beginning of the corona crisis in 2020. At first it was of interest to capture the real estate crisis in the 1990, but data from the condominium market (Valueguard, 2020) only reached back to 2005. Data from earlier periods would also have caused issues with OV bias as our variables would not include the same economical environment, i.e new laws and taxes (Bäckström 2014 and Broström & Göransson, 2011).

There are certain variables which are excluded as control variables that may have had an effect on condominium prices, which are worth mentioning, but difficult to include in a regression such as VECM.

1.4.1 Tax deductions

ROT was implemented on the 8th of December 2008. The purpose of the ROT, a tax deduction, is to increase employment by deducting taxes for households that purchase services regarding home improvement upgrades, which could cause certain condominiums to appreciate in value. This implementation has also a purpose to reduce the willingness to use undeclared work (Finansdepartementet, 2015).

1.4.2 Amortization

The amortization requirement was introduced in 2016 and the incentive for the introduction was to create a more sustainable economy and reduce the risk of financial crises. According to Finansinspektionen (2018) calculations, the stricter repayment requirement currently affects around 14% of new mortgage borrowers. Only a small part of the population buys a home or extends their loans every year, this means that annually just under 1% of all mortgage borrowers in Sweden will be affected by the requirement. The proportion is higher in large cities. If the appreciation of housing prices continues, more people will be affected.

1.4.3 Construction cost/ Factor price index

The index measures the inflation for the construction sector specifically. Included are materials, equipment, salaries, transport and more (Boverket, 2014).

1.4.4 More competition around the banking environment, lower margin to repo rate?

The mortgage margin has since the financial crisis increased, however statistical data from Finansinspektionen (2020) present a lower change between the gap in recent years. More actors have also entered the mortgage market. Increased competition could put downwards pressure towards the margins, which could lower rates without the central bank changing monetary policy. However, lower interest rates tend to increase the general debt for the population since it's cheaper to borrow (Swedish Riksbank, 2018)

2. Theory

2.1 Supply and demand

Housing prices are determined by the impacts of supply and demand. Supply is affected by factors influencing the available housing stock such as, availability of land for residential housing development, slow administrative procedures, inconvenient building regulations, construction cost. Demand is determined by the renting/buying considerations of the public such as real interest rate, real disposable income, and demographic developments (Tsai, 2012).

2.2 Wealth effect

Keynes (1936) showed that people tend to increase their consumption in proportion to an increase in their disposable incomes. The changes in the housing market can be a significant factor to show how the economy operates. When house prices rise, households tend to increase their consumption due to the enhanced wealth by saving less or borrowing more through home equity loans. However, when the price depreciates it can trigger financial crises.

"When unexpected changes in wealth occur, consumption will be adjusted accordingly. This is called the wealth effect" (Deng et al, 2018).

2.3 Real GDP Growth

GDP growth, the growth of products and services in relation to the prior year should have an impact on housing prices. This is because the land component of the house price is fixed in a geographical location. Therefore, the price of the land must increase as the supply of goods and services increases, all else equal. Studies have also shown that the GDP component of the house price has a large explanatory power. For example, a study made by Cohen &

Karpavičiūtė (2017), showed that the GDP growth-variable has a greater explanatory power than other common factors, inflation, and interest rates for example.

2.4 Price stability

Jonsson & Reslow (2015), show the relationship between inflation, nominal-, and real interest rate is defined by the Fisher effect and is a fundamental theory in macroeconomics models. Central banks use the basis of this theory in their policy work and forecasting. For instance, real interest rates fall as inflation increases, unless nominal rates increase with the same rate as inflation.

The Swedish Riksbank (2018) introduced the target rate of inflation in 1993 to 2%[2]. The main idea behind having a target rate of inflation is that it should work as a benchmark that guides the expectations that exist in the economy about the future rate of inflation. It also makes it easier for households and companies to make financial decisions and lays the foundation for well-functioning price and wage formation. Since its introduction, the inflation has decreased to a low level and is significantly more stable than in the 1980s. The Riksbank and most other central banks around the world focus on keeping inflation low and stable, as this creates good conditions for favorable economic development. High and fluctuating inflation means that uncertainty about how prices will develop in the future increases, which means that interest rates and borrowing costs will be higher. If the inflation is too low there is risk for deflation and will lower the general price level, which has historically been shown to create major problems in the economy (Swedish Riksbank, 2018).

2.5 Liquidity preference-Money supply (LM)

The level of interest rate in the money market with a given level of production is described by the LM curve. When production increases a higher demand for money will arise which will

[2] With a span between 1-3% since 2017 to be more flexible

lead to an increase of the interest rate, and vice versa. A change in the money supply will shift the LM curve (Gottfries, 2013). When there is an increase in money supply it will lower the interest rate, households will either borrow to invest in the housing market or use the money on hand. To invest in real estate is generally seen to be a good investment and a lower risk than other financial instruments. Further, a rise in the investment of real estate will lead to an increase in the house prices (Chen et al, 2007).

2.6 Animal spirit

The Animal Spirit Theory, first coined by the macroeconomist John Mayard Keynes in his book "The general theory of employment, interest and money", states that consumer behaviour can have a substantial effect on important economic variables such as GDP growth (Keynes, 1936).

Although the Animal Spirit Theory is first and foremost famous for its use in macro economics and business cycle theory, it is uses in explaining shifting demand curves caused by a change in behaviour of consumers and investors has equal value. When households are confident about the economy, this in it of itself should lead to an increase in aggregate demand. This aggregate demand should according to theory also include an increased demand for condominium prices. The reversed effect is also true, if confidence is lost, this should lead to a decreased aggregate demand which should have a negative impact on condominium prices (Gottfries, 2013).

2.7 Long run demand for capital

The long run demand for capital is a model most used for production functions at the natural level of unemployment. The Marginal Production of Capital (MPK) is the slope in an inverse relationship between the value of capital and real interest rates. According to Gottfries (2013), housing investments is a form of capital with a lower depreciation rate that is both used by businesses and individual households and should not be exempted from the same relationship. According to the model, rising real interest rates should cause condominium prices to depreciate, all else equal.

2.8 Loan to Value ratio/Equity wipe out

The Loan-To-Value ratio (LTV) describes how much of an assets value is financed with a loan. A high LTV ratio means that the loan is riskier from the perspective of the financial institution as well as the home buyer. The LTV ratio is also an important metric to analyze how leveraged the typical household is on a macro level (Wong et al, 2004).

An equity wipe-out occurs when a drop in house prices causes the equity of a house owner to be lower than the current loan, meaning an LTV of over 100%. In Sweden this does not necessarily cause the bank to automatically force the owner to file for bankruptcy as the bank also looks at the ability to pay future mortgages. It does however show a great sign of increased risk for both the household in question and for the general economy if the situation is widespread (Finansinspektionen, 2020).

2.9 Expected results.

Studies made on this subject in various countries have been made, which concluded that interest rates do have an effect on condominium prices as well as house prices in general. The question is rather how much of an effect interest rates have compared to other factors.

There is reason to believe that some prior research made on this subject, (Cassel & Persson, 2020) for example, could have understated the effect interest rates have on real estate prices. This is due to the fact that certain control variables such as confidence are not taken into account in the model, which should have a positive correlation with interest rates as they tend to be higher during economic booms. Confidence could therefore cause a positive OV bias for interest rates which should be controlled for. Further, a rate hike in Sweden could unravel the significant risks associated with high leverage rates together with a low duration of the mortgage loans which the Swedish households generally have (Finansinspektionen, 2020).

The Swedish Financial Supervisory Authority believes that a drop in house prices by 15% would cause 4% of those who took out a mortgage loan 2019 to have no equity left (Finansinspektionen, 2020). Based on prior research, there is good reason to believe that higher interest rates could trigger such a scenario.

3. Literature review

3.1 International research

In an economic environment with low nominal interest rates while inflation is kept below its target rate in Sweden, borrowing money has never been cheaper. Ever since the financial crises we have also seen substantial returns for financial assets such as stocks or real estate (Swedish Riksbank, 2020). Is there any certainty that the low cost of money does have a clear relationship with these assets in general and condominium prices in particular, all else equal?

There are several studies around the globe that have examined the relationship between house prices and variables through a macro- or microeconomic perspective. After studying the long run relationship between 95 U.S. metropolitan areas over 23 years Gallin (2003) concluded that there is little evidence for cointegration of house prices and fundamentals such as income and population growth at the national level. However, Xu & Tang (2004) found within the UK that GDP, unemployment rate, nominal interest rate, construction cost and bank credit had a positive effect on house prices, while money supply and disposable income had a negative impact in the long run. Adams & Fûs (2010) examined the short-term dynamics and long-term impact of macroeconomic variables on 15 OECD countries over a period of 30 years. Their empirical study showed that a 1% increase in economic activity, increased the house price in the long run by 0,6% while long term interest rates and construction cost had coefficients of -0,3% and 0,6% respectively. Noticeably, Adams & Fûs (2010) also concluded that adjustments for the macro economic variables to the equilibrium price can take up to 14 years.

After studying the difference between Swedish and the UK determinants of house prices during 1970-1998, Frizell & Yazdi (2010), found that countries are affected differently. For instance, they found that a change in debt has a weaker influence in Sweden than in the UK, real and nominal interest rates have a strong impact in both countries.

Chong (2020) used a VECM to find empirical evidence on the long run level of impact on house price in New Zealand between January 2009 and Mars 2017 by using immigration and mortgage interest rate as variables. She found that a 1% increase in the mortgage rate will reduce the housing index by 1,44% and an increase in immigration with 1% would increase the house index by 0,3%.

In a study made by Wong et al, (2004), they found that a high Loan-To-Value (see 2.8) increases the probability of household default. The conclusion they drew from this was a recommendation for the Hong Kong government to allow for a maximum rate of LTV at 70%. Although the researchers also point out that other variables are also important for describing the probability to default.

Although behavioral factors affect asset prices in general is a subject under much debate. There is evidence that shows that households' optimism/pessimism about their own economic situation, as well as the economy in general, has an effect on the house prices. In a paper titled “Overoptimism and house price bubbles“, Abildgren et al (2018) show that changes in house prices in Denmark are partly explained by a change in sentiment controlled for economic fundamentals. This shows that optimism and pessimism in of itself can cause prices to change in the short run which makes it a vital variable in economic and financial research when analyzing changes in house prices. This view is also supported by Nobel prize winner Robert Shiller (2015) which detected correlations in studies made on home buyers and their optimism. The results were that home prices correlated with the amount of people that found real estate “the best investment right now”. Shiller supports the general view that asset prices are partly driven by behavior that can be irrational.

3.2 Swedish research

Frisell & Yazdi (2010) showed that factors such as lower real interest rates and higher disposable income explains almost 90% of all price changes in Sweden between 1997-2009.

Further they argue that the house prices in Sweden were not overvalued. Factors such as sentiment have a stronger influence on price changes. The housing price in Stockholm fell by almost 15% in the second half of 2008 due to buyers withdrawing from the market. However, Geng (2018) found that the Swedish house prices are overvalued by approximately 40% at that time.

Claussen (2013) studied Swedish quarterly data between 1986 and 2011 using the Error Correction Model to analyze the developments on house prices. Since 1996 Claussen found that 62% of the rise in house prices are explained by the increase in real disposable income, another 25% is explained by a fall in real mortgage rates and only 8% real is explained by changes in household's financial wealth. Over the next upcoming years Claussen showed that real house prices will roughly stay unchanged and he argues that the house prices are not overvalued.

4. Data

Our dataset consists of monthly data between September 2005 and September 2020 in Sweden, n=182, T=16. Our intention is to mainly capture changes on the condominium equilibrium price. Our data is secondary, and the variables are summarized in table 1.

4.1 Explanation of variable selection

Our dependent variable is the condominium price. There are several variables that have an impact on condominium prices, but these are the ones that were of most interest in this study.

- Condominium price - An index consisting of monthly Swedish condominium prices from 2005 to present 2020.
- Mortgage rate - The average historical mortgage rate for Swedish borrowers in for a given month. This variable should have a clear relationship with condominium prices as most condominium buyers need a mortgage in order to make the purchase. As the

rate of the mortgage goes up, the demand for taking a loan and making a condominium purchase should be reduced.

- Confidence - Household opinion about the future of the economy as well as the household economy. As confidence improves, the demand for condominium prices should go up, all else equal.
- Unemployment - Unemployment rate is often a sign of a weak economy as households tend to be more careful about their purchases. A high unemployment rate should be negative for condominium prices as aggregate demand falls.
- GDP growth - The Swedish GDP growth was ipolated in stata into monthly data from quarterly data, this was because monthly observational data was missing from the Swedish statistical authority (SCB). As the reasons for the missing values of GDP are independent of the available observations, ipolating or ignoring the missing observations should not cause major issues with the model (Gujarati & Porter, 2008). As more products and services are produced, the price of condominiums should appreciate in relation to those goods and services.
- CPI - There are two measures of Consumer price indexes in Sweden. This thesis uses the CPI that does not include changes in the household mortgage rate, the same measurement used by the Central bank in Sweden (SCB, 2017). Furthermore, including the CPI that takes changes in the mortgage rate into account may cause issues with the model as a change in the mortgage rate is already included in the model.

Table 1 Description of data

Variable name	Description	Source
Condominium_price	Condominium price index measured	Valueguard
Mortgage_rate	Level of the average mortgage rate for new loans	SCB

	made each year	
Confidence	Indexed level of household confidence about the general economy as well as the households own economic situation	Konjunkturinstitutet
Unemployment	Unemployment rate	Ekonomifakta
GDP	Gross domestic product index	Ekonomifakta
CPI	Consumer price index	SCB

5. Methodology

Working with timeseries data with variables that may have evidence of cointegration as stated in the literature review, requires a model that accounts for the cointegration to give both proper coefficients and significance, namely the Vector Error Correction Model (Maitra, 2019).

The prerequisites for conducting a VECM are presented by a step-by-step procedure to finally perform the VECM-regression. Applying VECM is inspired from the work of Melinder & Melnikova (2016), Le Quyet (1990), Cassel & Persson (2020). The underlying interpretation of the mathematical process within the models will not be discussed in this thesis.

All variables are transformed into natural logarithm to easier interpret the results and to reduce outliers. Further researchers have found evidence that macro-economic variables are vulnerable to macroeconomic shocks. This may cause a structural break in the variables during the financial crisis (Ferreira et al, 2013).

5.1 Introduction

Step 1: Lag selection for Augmented Dickey Fuller

Step 2: Graphical representation

Step 3 Augmented dickey fuller (ADF) test

Step 4: Lag selection for Johansen test of cointegration

Step 5: Johansen test of cointegration

Step 6. VECM

Step 7: Test for non-normally distribution and autocorrelation

This thesis aims to find the long run relationship between condominium prices and mortgage rates. When analyzing dynamic economic models over time the stochastic difference equation arises quite naturally. Enders (2004) points out that it is important to develop reasonably simple models capable of forecasting, testing hypotheses concerning economic data and interpreting. By analyzing a stationary series, the approximation by using sufficiently long time series can usually be well estimated.

5.2 Lag selection for ADF

In order to eliminate autocorrelation in the error term among the independent variables the ADF test includes lags (Gujarati & Porter, 2008). The selection of lag length is essential for the test. If there are too many lags the power of rejecting the null hypothesis is reduced, hence the regression will estimate more coefficients that will affect the number of degrees of freedom. Too few lags will increase the probability of serial correlation and not capture the error process in an appropriate way. Further, the standard error of the model will not be well estimated (Gordon, 1995). Johansen (1995) suggests, if a long lag length is required to get white noise residuals, then it may be of interest to reconsider the choice of explanatory variables. A stochastic process has white noise (purely random) if it has constant variance, zero mean and is serially uncorrelated (Gujarati & Porter, 2008). There are several methods of determining the number of lags. The Schwarz Bayesian Information Criterion (SBIC), which has been said to fit macroeconomic variables better than for instance the AIC (Chan, 2014). Hence, SBIC was used to determine the lag selection in this thesis. This study will not involve further discussion of which of the two methods suits the selection of lags in the best way. The SBIC for lag selection was made on the logged variables and the first difference of each variable. The first difference of a variable is the change from one period to the next period. If Y_t denotes the value of the time series Y at period t, then the first difference of Y at period t is equal to Y_t-Y_{t-1} (Cortinhas & Black, 2012).

5.3 Graphical representation

Cortinhas & Black (2012) states that "a *time series data that contains no trend, cyclical, or seasonal effects are said to be stationary".* A graphical representation of the variables were examined separately over time to find out if they had a trend or not. Many economic variables are non-stationary and one common method of dealing with removing both the trend and seasonality is differencing (Johansen, 1995). For the purpose of forecasting, it is important to find if a time series possesses a unit root or a stochastic trend. With non-stationary data, we can only study its behavior for the time of consideration (Guajarati 2008). Hence, the logged variables with and without its first difference were tested.

5.4 Augmented Dickey-Fuller unit root test (ADF)

The Augmented Dickey Fuller test (ADF) with a unit root determines if the variables are stationary or not. A time series with a unit root is considered nonstationary and follows a random walk. A variable that follows a random walk changes unpredictably over time and historical values cannot be used for predicting the future. Consider a drunkard's walk. He's leaving the bar and moves a random distance at time t and continues to walk infinitely. He will gradually drift further away from the bar. The null hypothesis assumes that the test is non-stationary and includes a unit root. The test concludes that the variables are stationary if the null hypothesis was rejected at $P<0,05$ (Gujarati & Porter, 2008).

5.5 Lag selection on Johansen test for cointegration

A new joint lag length has been estimated on all logged variables which is then implemented in the Johansen test of cointegration based on the method of SBIC (Bhatta et al, 2018).

5.6 Johansen-test for cointegration

A regression of a nonstationary time series with another nonstationary time series often gives illegitimate regressions (artificially high t-values for example). One way to protect the model against this is to find if the time series are cointegrated. There are several techniques that deal with cointegration among variables. Cointegration among stationary variables exists if there is a long-term relationship between them. In the short run there may be in disequilibrium. The Granger representation theorem states that *"if two variables Y and X are cointegrated, the relationship between the two can be expressed as Error Correction Mechanism"* (ECM). The ECM unites the short run behavior of an economic variable with its long-run behavior (Gujarati & Porter, 2008).

When dealing with a single cointegration a standard attribute to test for cointegration is a Engle and Granger test. However, the Johansen test for cointegration on our undifferenced variables has been used since it deals with multivariate models where more than one cointegration can exist. The variables tested need to be non-stationary at zero difference and stationery at first difference (Enders, 2004). Those variables that have passed the ADF test for unit root were included in the Johansen test. The number of ranks of cointegration is equal to the number of independent linear cointegrating equations that exist in the model (Johansen, 1995). If evidence for ranks of cointegration was found, the appropriate number of ranks were used to correctly specify the Vector Error Correction Model.

5.7 Vector Error Correction Model (VECM)

The fundamentals of the VECM arise from the Vector Auto Regressive (VAR) model. The model itself is an expansion of the autoregressive model (AR). AR solves the problem appearing when earlier values have predictive power of the next observation. Hence why this study doesn't use a standard linear regression model. VAR involves more than one equation and multiple independent variables. Usually, you are using stationary variables at first difference when dealing with time series by the means of a VAR model. Though, there is a risk of losing information about the connection among integrated series. Differencing the series by using VAR may lead to ignoring important long run relationships. To test for cointegration among our non-stationary variables is a better solution for capturing the long run relationship. A common method used is the Johansen test for cointegration. If cointegration is found the VECM is used instead of the VAR (Maitra, 2019).

Gujarati & Porter (2008) states that the error correction mechanism is the relationship between the Y and X variable if they are cointegrated. The short run pattern in Y may be in disequilibrium and it is explained by the error term. However, the short model should be viewed as a parenthesis as it does not answer the main issue regarding this thesis. This is done in the long model.

The long run relationship is described by the Johansen normalization process in VECM. Noticeably, the coefficient in the Johansen normalization process needs to be analyzed with reverse signs to interpret the relationship of the variables in a proper way. If the coefficient was positive in the test, then the presenting regression equation will have a negative sign (Johansen, 1995).

5.8 Test for non-normally distribution and autocorrelation

The VECM model assumes that the error terms are identically normally distributed and independent. A diagnostic test was done, due to the Johansen cointegration test is sensitive to non-normality and autocorrelation of the residuals (Juselius, 2006). Jarque Bera test of normality and Lagrange Multiplier test for residual autocorrelation are common methods after a VECM has been done (Lütkepohl, 2005).

5.8.1 Jarque Bera test of normality

Lütkepohl (2005) states that "*normality of the underlying data generating process is needed, for instance, in setting up forecast intervals. Non-normal residuals can also indicate more generally that the model is not a good representation of the data generation process*." This is examined by the Jarque Bera test. The null hypothesis states that the residuals are normally distributed. If the null hypothesis is rejected, then our model may not be a good representation of the data generation process (Gujarati & Porter, 2008).

5.8.2 Lagrange multiplier (LM) test for autocorrelation

Gujarati & Porter (2008) defines autocorrelation as *"lag correlation of a given series with itself, lagged by a number of time units".* The null hypothesis states that the residuals have no autocorrelation. If the null hypothesis is rejected, then the model cannot be seen as fully credible and needs to be adjusted to meet non-autocorrelation assumptions (Johansen, 1995).

6. Result

6.1 Augmented Dicky-Fuller test

The test for stationarity, using the Augmented Dicky Fuller test, on the natural logarithm of the variable as well as the first difference of logged variables showed us that all variables were deemed as stationary at the first difference. Consequently, all variables were included in the model.

6.1.1 Condominium prices

The first test of stationarity was made on the HOX-condominium index (table 2). A trend component was taken into account with a lag selection of 8. However, it did not pass the test for stationarity at the critical value of 5% as the p-value was equal to 0,8.

When testing the for stationarity at the order of first difference I(1) (table 3), with no trend component and a lag selection of 7, the variable passed the stationarity test as $p < 0{,}05$.

Table 2 Test for stationarity Condominium Price (with trend)

Augmented Dickey-Fuller test for unit root   Number of obs   =   172

	Test Statistic	Interpolated Dickey-Fuller 1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	**-1.554**	**-4.016**	**-3.440**	**-3.140**

MacKinnon approximate p-value for Z(t) = **0.8099**

Table 3 Test for stationarity Condominium Price (no trend, first difference)

Augmented Dickey-Fuller test for unit root   Number of obs   =   172

	Test Statistic	Interpolated Dickey-Fuller 1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	**-5.203**	**-4.016**	**-3.440**	**-3.140**

MacKinnon approximate p-value for Z(t) = **0.0001**

6.1.2 Mortgage rate

The second test of stationarity (table 4) was made on the mortgage rate and was conducted with a lag selection of 4 and with a trend component taken into account. However, it did not pass the test for stationarity at the critical value of 5% as the p-value was equal to 0,088.

When testing the for stationarity at the order of first difference I(1), with no trend component and a lag of 7 (table 5), the variable passed the stationarity test as $p < 0,05$.

Table 4 Test for stationarity Mortgage rate (with trend)

Augmented Dickey-Fuller test for unit root   Number of obs   =   176

	Test Statistic	Interpolated Dickey-Fuller 1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	**-3.182**	**-4.015**	**-3.440**	**-3.140**

MacKinnon approximate p-value for Z(t) = **0.0880**

Table 5 Test for stationarity Mortgage rate (no trend, first difference)

Augmented Dickey-Fuller test for unit root   Number of obs = 176

	Test Statistic	Interpolated Dickey-Fuller 1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	**-3.672**	**-3.485**	**-2.885**	**-2.575**

MacKinnon approximate p-value for Z(t) = **0.0045**

6.1.3 Confidence

The third test of stationarity (table 6) was made on the index of household confidence and was conducted with a lag selection of 1 and without a trend component taken into account. However, it did not pass the test for stationarity at the critical value of 5% as the p-value was equal to 0,0663.

When testing the for stationarity at the order of first difference I(1), with no trend component and a lag of 0 (table 7), the variable passed the stationarity test as $p < 0,05$.

Table 6 Test for stationarity Confidence (no trend)

Augmented Dickey-Fuller test for unit root   Number of obs = 179

	Test Statistic	Interpolated Dickey-Fuller 1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	**-2.747**	**-3.484**	**-2.885**	**-2.575**

MacKinnon approximate p-value for Z(t) = **0.0663**

Table 7 Test for stationarity Confidence (no trend, first difference)

Dickey-Fuller test for unit root   Number of obs = 179

	Test Statistic	Interpolated Dickey-Fuller 1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	**-12.936**	**-3.484**	**-2.885**	**-2.575**

MacKinnon approximate p-value for Z(t) = **0.0000**

6.1.4 Consumer price index

The fourth test of stationarity (table 8) was made on the CPI and was conducted with a lag selection of 9 and with a trend component taken into account. However, it did not pass the test for stationarity at the critical value of 5% as the p-value was equal to 0,7648.

When testing the for stationarity at the order of first difference I(1), with no trend component and a lag of 8 (table 9), the variable passed the stationarity test as $p < 0,05$.

Table 8 Test for stationarity Consumer Price Index (with trend)

Augmented Dickey-Fuller test for unit root   Number of obs = **171**

	Test Statistic	Interpolated Dickey-Fuller 1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	**-1.668**	**-4.016**	**-3.441**	**-3.141**

MacKinnon approximate p-value for Z(t) = **0.7648**

Table 9 Test for stationarity Consumer Price Index (no trend, first difference)

Augmented Dickey-Fuller test for unit root   Number of obs = **171**

	Test Statistic	Interpolated Dickey-Fuller 1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	**-5.246**	**-3.486**	**-2.885**	**-2.575**

MacKinnon approximate p-value for Z(t) = **0.0000**

6.1.5 Gross domestic product

The fifth test of stationarity (table 10) was made on the GDP-index and was conducted with a lag selection of **7** and with a trend component taken into account. However, it did not pass the test for stationarity at the critical value of 5% as the p-value was equal to 0,1272.

When testing the for stationarity at the order of first difference I(1), with no trend component and a lag of 6 (table 11), the variable passed the stationarity test as p < 0,05.

Table 10 Test for stationarity Gross Domestic Product (with trend)

Augmented Dickey-Fuller test for unit root   Number of obs   =   173

	Test Statistic	Interpolated Dickey-Fuller 1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	**-3.018**	**-4.016**	**-3.440**	**-3.140**

MacKinnon approximate p-value for Z(t) = **0.1272**

Table 11 Test for stationarity Gross Domestic Product (no trend, first difference)

Augmented Dickey-Fuller test for unit root   Number of obs   =   172

	Test Statistic	Interpolated Dickey-Fuller 1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	**-5.269**	**-4.016**	**-3.440**	**-3.140**

MacKinnon approximate p-value for Z(t) = **0.0001**

6.1.6 Unemployment

The last test of stationarity (table 12) was made on the unemployment rate-index and was conducted with a lag selection of 9 and without a trend component taken into account. However, it did not pass the test for stationarity at the critical value of 5% as the p-value was equal to 0,5055.

When testing the for stationarity at the order of first difference I(1), with no trend component and a lag of 8 (table 13), the variable passed the stationarity test as p < 0,05.

Table 12 Test for stationarity Unemployment (no trend)

Augmented Dickey-Fuller test for unit root Number of obs = **171**

	Test Statistic	Interpolated Dickey-Fuller 1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	**-1.556**	**-3.486**	**-2.885**	**-2.575**

MacKinnon approximate p-value for Z(t) = **0.5055**

Table 13 Test for stationarity Unemployment (no trend, first difference)

Augmented Dickey-Fuller test for unit root Number of obs = **171**

	Test Statistic	Interpolated Dickey-Fuller 1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	**-7.067**	**-3.486**	**-2.885**	**-2.575**

MacKinnon approximate p-value for Z(t) = **0.0000**

6.2 Lag selection for cointegration

To conduct the next step, namely a Johansen test of cointegration, a proper lag length must be chosen for all variables. It is important to avoid this choice from being arbitrary, thus we move forward with the same methodology for choosing individual lags as before using the Schwartz-Bayes Information Criterion for optimal lags. The results in table 14 gave us an optimal lag of 4.

Table 14 Lag selection using SBIC

Selection-order criteria
Sample: 9 - 181 Number of obs = 173

lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	1088.570	0.000	-12.515	-12.471	-12.406			
1	2571.470	2965.800	36	0.000	0.000	-29.242	-28.932	-28.477
2	2733.610	324.280	36	0.000	0.000	-30.701	-30.124	-29.279
3	2821.660	176.110	36	0.000	0.000	-31.302	-30.459	-29.225
4	2923.840	204.360	36	0.000	0.000	-32.068	-30.958	-29.3335*
5	2987.990	128.290	36	0.000	0.000	-32.393	-31.017	-29.003
6	3069.760	163.550	36	0.000	0.000	-32.922	-31.280	-28.876
7	3159.780	180.030	36	0.000	0.000	-33.547	-31.6387*	-28.844
8_	3201.390	83.22*	36	0.000	1.1e-22*	-33.6114*	-31.437	-28.253

Endogenous: Condominium_price, Mortgage_rate, Confidence, CPI, GDP, Unemployment
Exogenous: _cons

6.3 Johansen test of cointegration

To determine if we have cointegration between variables we conduct a Johansen test of cointegration with a lag selection of 4, based on the SBIC.

Table 15 Johansen test of cointegration (maximum rank)

Johansen tests for cointegration
Trend: constant Number of obs = 177
Sample: 5 - 181 Lags = 4

maximum rank	parms	LL	eigenvalue	trace statistic	5% critical value
0	114	2917.6995	.	157.5046	94.15
1	125	2949.8233	0.30440	93.2569	68.52
2	134	2974.088	0.23980	44.7274*	47.21
3	141	2985.4785	0.12077	21.9465	29.68
4	146	2992.4847	0.07611	7.9341	15.41
5	149	2995.8277	0.03707	1.2481	3.76
6	150	2996.4517	0.00703		

In the cointegration test in table 15 the null hypothesis was rejected of zero ranks of cointegration as the trace statistic is higher than the critical value. We also reject the null hypothesis of one cointegrating equation in our model. However, we fail to reject the null hypothesis at two ranks of cointegration. This means that two cointegrating equations are taken into account in our final model. It also means that a VAR model cannot be used to estimate the causal effect of interest rate on condominium prices as there are cointegrating variables, thus VECM must be used.

6.4 Vector Error Correction Model

The VECM output shows the variables effect on the condominium's equilibrium price. The model has the additional option of modeling a short model describing equilibrium corrections and how fast that happens. The short model is presented in the Appendix 3&4 and should be viewed as a parenthesis as it does not answer the main issue regarding this thesis. This is done in the long model.

6.4.1 Long model - Including the Great Recession

In a long model with two ranks of cointegration equations one variable is omitted in the VECM model. Regarding the choice of which variable is omitted, we chose unemployment for this model on the basis that we already have a total of three variables explaining changes in business cycle: Real GDP, Unemployment and Household confidence. Therefore, removing one of these would intuitively cause the least changes in our model as slow/high economic growth are already explained by changes in Real GDP and Household confidence.

Table 16 VECM Long model (Including the Great Recession)

```
Vector error-correction model

Sample:  5 - 181                          Number of obs     =        177
```

Johansen normalization restrictions imposed

beta	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
_ce1						
Condominium_price	1	.	.	.	.	.
Unemployment	0	(omitted)				
Mortgage_rate	-1.456027	1.389156	-1.05	0.295	-4.178723	1.26667
GDP	-12.77321	8.346513	-1.53	0.126	-29.13208	3.585653
Confidence	21.30236	3.760528	5.66	0.000	13.93186	28.67286
CPI	1.809588	11.98612	0.15	0.880	-21.68277	25.30195
_cons	66.51794	.	.	.	.	.

The output in the table 16 shows us the betas that explain variation in condominium prices. In the VECM output the condominium price is shown to have a beta of "1", meaning that the variable is part of the regression's independent variables. Therefore, to make a more intuitive presentation, the model can therefore be written as follows, showing it's reversed signs.

$$Condominium\ price_t = -66{,}51794 + 1{,}456027 * Mortgage\ rate_t + 12{,}77321 * GDP_t - 21{,}30236 * Confidence_t - 1{,}809588 * CPI_t$$

The model shows that a change in mortgage rate by 1% causes condominium prices to increase by 1,46%. However, all variables except confidence show a statistically insignificant p-value at α = 0,05, therefore this model cannot be used to model condominium prices effectively.

6.4.2 VECM (long model) - Excluding the Great Recession

Prior research shows that analysis conducted using cointegration models can sometimes have issues when dealing with variables measured over periods during great macroeconomic shocks, such as the Great Recession of 2008 (Ferreira et. al, 2013). We therefore computed a model on a sample period starting from July 2009, the time when the Great Recession officially ended (Rich, 2013). During this period, all variables are stationary at the first difference I(1). The same method for lag selection (SBIC) showed an optimal lag of 2 (appendix 1) and the number of cointegrated equations from the Johansen test was equal to 1 (appendix 2).

Table 18 VECM Long model (Excluding the Great Recession)

```
Vector error-correction model

Sample:  49 - 181                               Number of obs     =        133

                    Johansen normalization restriction imposed
```

beta	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
_ce1						
Condominium_price	1	.	.	.	.	.
Mortgage_rate	.347188	.0817775	4.25	0.000	.1869071	.5074689
Unemployment	.0475601	.1355048	0.35	0.726	-.2180245	.3131448
GDP	-4.491625	.4003615	-11.22	0.000	-5.276319	-3.706931
Confidence	.8326409	.2797816	2.98	0.003	.2842791	1.381003
CPI	4.804953	.9764269	4.92	0.000	2.891191	6.718714
_cons	27.36689	.	.	.	.	.

The results in table 18 from the long model, based on observations starting after the Great Recession, differ from the previous long model. All variables except for Unemployment show statistically significant p-values at α = 0,05. The equation can now be written as follows:

$$Condominium\ price_t = -27{,}36689 - 0{,}347188 * Mortgage\ rate_t - 0{,}0475601 * Unemployment_t + 4{,}491625 * GDP_t - 0{,}8326409 * Confidence_t - 4{,}804953 * CPI_t$$

The output shows that there exists an inverse relationship between condominium prices and the mortgage rate. According to the model, if the mortgage rate were to increase by 10% the ceteris paribus effect on condominium prices would be -3,47%. Furthermore, the results show that all variables except for GDP have an inverse relationship with condominium prices.

6.5 Diagnostics

6.5.1 Lagrange Multiplier test for autocorrelation

The results in table 19 from the Lagrange Multiplier test were conducted for up to 15 lags. The output presented in table 19 shows that the null hypothesis of no autocorrelation was rejected at all lags except at lag order 8 at α = 0,05. This implies that our model may have too few lags to get rid of autocorrelation.

Table 19 Lagrange Multiplier Test for autocorrelation

Lagrange-multiplier test

lag	chi2	df	Prob > chi2
1	117.0649	36	0.00000
2	141.7869	36	0.00000
3	129.4261	36	0.00000
4	76.9369	36	0.00008
5	95.9649	36	0.00000
6	84.9220	36	0.00001
7	121.7509	36	0.00000
8	50.0261	36	0.06018
9	124.1637	36	0.00000
10	86.1550	36	0.00001
11	75.4483	36	0.00013
12	275.3336	36	0.00000
13	86.3742	36	0.00001
14	77.7688	36	0.00007
15	127.6564	36	0.00000

H0: no autocorrelation at lag order

6.5.2 Jarque Bera - test for normality

The results from the Jarque Bera test are presented in table 20. The output shows at α = 0,05, that all variables reject the null hypothesis assumption of normally distributed error terms, except unemployment and condominium price.

Table 20 Jarque Bera Test for normality

Jarque-Bera test

Equation	chi2	df	Prob > chi2
D_Condominium_price	3.752	2	0.15318
D_Mortgage_rate	128.182	2	0.00000
D_Unemployment	11.494	2	0.00319
D_GDP	10.757	2	0.00461
D_Confidence	22.897	2	0.00001
D_CPI	7.189	2	0.02747
ALL	184.272	12	0.00000

The diagnostic tests above showed that none of the assumptions was fulfilled, hence our interpretation of the results must be taken with a grain of salt.

7. Analysis

This study examines the relationship of mortgage rates and condominium prices in Sweden by using the Johansen tests for cointegration and VECM (Vector Error Correction Model). There have been several studies across the globe that have examined the relationship between house prices and interest rates but not many on condominium prices specifically. This thesis contributes to the literature by studying monthly data between 2005-2020 for the condominium prices in Sweden. However, because of the issues with severe macroeconomic shocks on the cointegration models used, described by Feerreira et al (2013) for example, a decision to recognize the model conducted with data after the Great Recession as closer to the true model was made.

The inverse relationship between interest rates and assets similar to condominiums are also well established in prior research as well as in general economic theory. This is another indicator that the true model for the ceteris paribus effect on a change in interest rate is closer to the results in the model conducted after the financial crises. In this model (post Great Recession), a change in the mortgage rate by 10% would lead to a decline in the price of condominiums by 3,47%.

The relationship between interest rates and condominium prices are also modeled in the 'Long run demand for capital', treating condominiums as a capital good as suggested by Gottfries (2013). The model states that real interest rates and the value of capital should have an inverse relationship. Because inflation is held constant in the VECM output when looking at the mortgage rate coefficient, the ceteris paribus effect of an increase in the nominal mortgage rate is therefore equivalent to a real increase in the mortgage rate.

This research used short term interest rates, in the form of mortgage rates, to establish a relationship between condominium prices and the interest rate. However, expectations of a change in interest rates in the future that are incorporated in the condominium price today are not taken into account and could have caused OV-bias for some of our variables. This could be the case for the CPI variable as the model states it has an inverse relationship with condominium prices, meaning that when the CPI increases by 1% the condominium price should decrease by 4,8%. However, because the central bank has a fixed target rate of inflation, the central bank then has an obligation to raise interest rates as inflation increases, meaning that it could rather be an expectation of higher interest rates that is causing a depreciation of condominium prices in the model. The same can be said for the coefficient of Confidence which is -0,84, as Confidence is an indicator of the future economic growth. If condominium prices are highly sensitive to a change in interest rate in the true model, an indicator showing a better economic outlook for the future could also mean a more likely expectation for rate hikes in the future. The suspicion of OV bias in some of the control variables makes it difficult to determine if the theory behind the variables in question (namely Animal Spirit) have an effect in the true model of the causal relationship of condominium prices.

Looking at Real GDP however, the relationship shows that an increase in Real GDP by 1% increases condominium prices by 4,49%. Real GDP is not a variable indicating future expectations which means it is not necessarily causing a change in expectations, meaning that we find it safe to assume that this relationship is close to the true model. However, because the missing observations were replaced by linear functions, this could have had an impact on the coefficient.

Because the mortgage rate is a function of the Riksbanks repo rate, and as the average duration of mortgages for Sweden is equal to one year, the average household owning a condominium asset is highly sensitive to a rate hike. In the report mentioned earlier in this thesis, published by Finansinspektionen (2020), the economy of Swedish households is stress tested using a hypothetical change in house- and condominium prices and how that would affect the households balance sheet. Using the output from the VECM, a change in the mortgage rate by 86,5% would lead to a fall of condominium prices by 30%. The consequence of this change in condominium prices, according to Finansinspektionen (2020), is that half of the Swedish households that took out a mortgage loan between 2013-2019 would then have debt higher than the market value of their home, which could lead to a negative wealth effect causing households aggregate demand to drop. In this situation a severe problem of household debt would also occur and could possibly limit the central bank's ability to conduct contractive monetary policy.

The stress tests are however not exclusively done for condominiums only but rather the whole Swedish housing market. Furthermore, the output from the VECM analysis should be taken with a grain of salt as the model is sensitive to model specifications, specifically the number of lags used as well as the amount of cointegrating variables. The SBIC methodology should find an optimal number of lags in the model, however diagnostics conducted show problems of autocorrelation and non-normality of the residuals with the given lag suggested by SBIC. However, we find it safe to assume that the inverse relationship between condominium prices and mortgage rates are well established and that condominium prices are highly sensitive to a change in interest rate, which puts some Swedish households at severe risk.

8. Further research

This thesis used the mortgage rate to see what the variables' ceteris paribus effect on condominium prices are. Because the mortgage rate is a function of factors other than just the nominal interest rate set by the central bank, such as competition between financial institutions, further research could attempt to create a model accounting for this effect.

Furthermore, researchers should compare or control for different types of interest rates such as the long-term interest rate to see if the suspicion of OV bias for some of the common control variables are valid.

Taking this research's conclusion about the risks rising interest rates have on condominium prices, a study focusing on how changes in interest rates affect the Swedish households' ability to pay their mortgage and the risks associated with the household income statement could be sensible. This thesis mainly focuses on the households' balance sheet, leaving out the household income statement for further research.

Regarding the model specifications, building a model with a different methodology of lag selection could be sensible to compute a model without issues with autocorrelation and non-normality. Because VECM can be sensitive to model specifications, finding a methodology to conduct lag selection without problems with the diagnostics and without an arbitrary selection of lags is difficult but very valuable.

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10. Appendix

Appendix 1 Lag selection using SBIC

Selection-order criteria
Sample: **55 - 181** Number of obs = **127**

lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	978.041				9.1e-15	-15.3077	-15.2531	-15.1734
1	1993.12	2030.2	36	0.000	1.8e-21	-30.7262	-30.3441	-29.7856
2	2145.08	303.93	36	0.000	2.9e-22	-32.5525	-31.8428	-30.8057*
3	2220.39	150.61	36	0.000	1.6e-22	-33.1715	-32.1342	-30.6184
4	2300.68	160.59	36	0.000	8.1e-23	-33.869	-32.5042	-30.5098
5	2353.59	105.81	36	0.000	6.4e-23	-34.1353	-32.4429	-29.9698
6	2427.75	148.32	36	0.000	3.7e-23	-34.7362	-32.7162	-29.7644
7	2490.35	125.21	36	0.000	2.6e-23*	-35.1552*	-32.8077*	-29.3772
8	2519.25	57.792*	36	0.012	3.1e-23	-35.0433	-32.3682	-28.4591

Endogenous: Condominium_price Unemployment Mortgage_rate GDP Confidence CPI
Exogenous: _cons

Appendix 2 Johansen test of cointegration (maximum rank)

Johansen tests for cointegration
Trend: constant Number of obs = **133**
Sample: **49 - 181** Lags = **2**

maximum rank	parms	LL	eigenvalue	trace statistic	5% critical value
0	42	2159.8685	.	146.6057	94.15
1	53	2199.8731	0.45205	66.5966*	68.52
2	62	2216.7706	0.22438	32.8016	47.21
3	69	2224.1597	0.10516	18.0233	29.68
4	74	2230.8314	0.09546	4.6800	15.41
5	77	2232.5011	0.02480	1.3405	3.76
6	78	2233.1714	0.01003		

VECM (short model) - Including the Great Recession

As with economic theory in general, equilibrium is often reached in the long run as short run economic relationships can deviate from its equilibrium for a limited time.

Appendix 3 VECM Short model (Including the Great Recession)

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
D_Condominium_price						
_ce1 L1.	-.0002103	.0007579	-0.28	0.781	-.0016957	.0012751
_ce2 L1.	.0148646	.0093446	1.59	0.112	-.0034505	.0331797
D_Unemployment						
_ce1 L1.	.0054476	.0045929	1.19	0.236	-.0035544	.0144496
_ce2 L1.	-.4209886	.0566302	-7.43	0.000	-.5319818	-.3099953
D_Mortgage_rate						
_ce1 L1.	.0020315	.0006674	3.04	0.002	.0007234	.0033395
_ce2 L1.	-.012493	.0082285	-1.52	0.129	-.0286206	.0036346
D_GDP						
_ce1 L1.	.0041555	.0008339	4.98	0.000	.002521	.0057899
_ce2 L1.	-.053968	.0102821	-5.25	0.000	-.0741205	-.0338156
D_Confidence						
_ce1 L1.	-.0003504	.0022524	-0.16	0.876	-.0047649	.0040642
_ce2 L1.	-.0324012	.0277716	-1.17	0.243	-.0868324	.0220301
D_CPI						
_ce1 L1.	.0005112	.0001743	2.93	0.003	.0001696	.0008527
_ce2 L1.	-.0029833	.0021487	-1.39	0.165	-.0071947	.0012281

The short model of the VECM indicates what variables cause the cointegration of variables to adjust to its long-term equilibrium price and how fast that happens. The mortgage rate lagged by one month is significant on the first cointegrated equation and is shown to cause the system to adjust by 0,203% per month, compared to GDP which has a coefficient of 0,415% on the same equation. This can be interpreted as how fast the mortgage rate and the GDP is adjusting the other variables from a deviation when the system is above is below its equilibrium.

However, most variables for this purpose are shown to be insignificant at α = 0,05, which makes it difficult to interpret any meaningful results. The short model should be viewed as a parenthesis as it does not answer the main issue regarding this thesis. This is done in the long model.

VECM Short model - Excluding the Great Recession

Appendix 4 VECM Short model (Including the Great Recession)

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
D_Condominium_price						
_ce1						
L1.	-.0280688	.0075136	-3.74	0.000	-.0427953	-.0133423
D_Mortgage_rate						
_ce1						
L1.	-.0045891	.0056625	-0.81	0.418	-.0156875	.0065092
D_Unemployment						
_ce1						
L1.	-.0217792	.0560754	-0.39	0.698	-.131685	.0881266
D_GDP						
_ce1						
L1.	.1279944	.0138439	9.25	0.000	.1008609	.1551279
D_Confidence						
_ce1						
L1.	-.0206149	.0230185	-0.90	0.370	-.0657302	.0245005
D_CPI						
_ce1						
L1.	-.003212	.0024433	-1.31	0.189	-.0080007	.0015768

The short model based on observations starting after the Great Recession does not show any difference regarding the number of significant variables at $\alpha = 0{,}05$. In this model, only changes in condominium prices and real GDP have a significant effect on adjusting the system to equilibrium.