The Symbiotic Nature of Zero Rate Policy, the Real Economy and the Asset Markets.

Term Paper ME2720

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Stockholm 2016

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Summary

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September 6, 2016

Abstract

This paper establishes to find how the zero rate policy influence the asset market and in turn how the asset market influences the real economy. We know that the real economy have a strong impact on the asset market, but could this apply vice versa? To investigate the subject an extensive literature study was conducted and as a complement to this a data analysis was performed on GDP, housing and PB indices. The paper cannot find any clear relationship between ZIRP and asset prices. However it concludes that the current asset price inflation is not healthy, and could potentially lead to a bubble.

1 Background

Today uncertainty is high in the world markets. Many prominent investors are going liquid and waiting for better times, they express that "the only winning move is not to play the game"[1]. These investors say that the world's central banks can not save us anymore, believing that the the environment they are creating distorts all asset prices - from stocks to bonds to real estate. In reality the world economy isn't that bad, besides some slowdown and re-balancing of the Chinese economy, low commodity prices and strains in some large emerging market economies[2]. These main issue - slowdown of the Chinese economy - however should not be too surprising, given that eternal compounding growth is unlikely. Also speculations surrounding a Chinese economical slowdown had already been up during 2014 [3]. It however should not have to big of an impact on the world economy, because internally the situation is quite well[4]. So it isn't the economical fundamentals that is awry, but rather the pricing is to high.

Central Banks in the US and Europe have done all that is possible to bring down the rates. Many have used quantitative easing (QE) to reduce the rates to having zero interest rate policy (ZIRP) and some European countries, e.g. Sweden, Denmark Netherlands and Belgium, even negative interest rate policy (NIRP). The result of this is that investors and savers don't have any alternative but to either consume their money, tie them in assets or hold cash. Assuming logical investors always strive for value appreciation, the most natural would be for them to put their cash in assets, forcing even unwilling risk-taker to take on risk. With all the money being tied up in assets, naturally there will be asset inflation above natural levels. In addition the form of unorthodox QE

that Central Banks have begun engage in i.e. large-scale asset purchases further inflates the value of assets[5].

The current situation is thus that even though the economical fundamentals are stable, the stock-market is very unstable. This situation is largely caused by QE. The question is whether or not QE and ZIRP is a sustainable solution. What is the long-term effects of these actions be and what will the results of the undertaken actions be. How does the current economic relate to the QE effects?

2 Problem Description

This term paper proposes to investigate how ZIRP influences the asset markets today and also how the asset market influences the real economy.

3 Method

A natural first step to the problem is establish what has already been found by other researchers to get depth understanding within the topic and to be contemporized. A literature study of previous researches will thus be conducted. When previous research has been sufficiently established a data analysis relating GDP, housing prices and asset prices will be conducted. The data analysis will compromise of plotting and looking for trends and relationships between the variables.

To perform data analysis monthly time series of Swedish GDP, housing price index (HOX), repo rate, and CPI was collected between January 2005 and first quarter 2016. Time series data of US real GDP, housing prices (Case-Schiller)[1], FED rate, PB-ratio and PE-ratio was also collected for corresponding dates. The reason being difficulties in finding relevant equity and real GDP indices for the Swedish market, so the Swedish real GDP was calculated by subtracting the normalised CPI data from the normalised GDP data. All the data was then normalised from 2005 and 2009. The reason for normalising from 2009 is due to wanting to adjust for the effects of the Great Financial Crisis 2008. Data for GDP and PB was only available in quarterly time series, to adjust for this linear interpolation was used to create additional data points. To interpolate following algorithm was used

```
rawdata = [...]

def LinearInt(datalist, i,step):
    try:
        diff = float(datalist[i+1][1])-float(datalist[i][1])
        inc = diff/step
    except:
        inc = 0
    return inc, step

IntData=[]
```

[1]Data for 1st quarter 2016 missing.

```
for i in range(len(rawdata)):
    inc, step = LinearInt(rawdata,i,3)

    for j in range(step):
        IntData.append(float(rawdata[i][1])+j*inc)
```

Where rawdata is the list of in-data and IntData is the interpolated data set. This algorithm basically calculates the increment i

$$i = \frac{x_1 - x_2}{s}$$

where s is how many data points we want and creating extra data points

$$x_1 \mapsto \{x_{1a} = x_1, x_{1b} = x_1 + i, x_{1c} = x_1 + 2 * i + ... + x_{1s} = x_1 + s * i\}$$

The data is collected from Statistiska Central Byrøån, Valueguard and Multpl and then processed with Python and Excel, and analysed with Python and R. A more detailed list of where the raw data was collected will be available in the appendix.

To determine how the asset market influences the real economy a plot and correlation matrix of the real GDP index, housing index and asset index will be done. This data accompanied by the findings from the literature study will be the basis for this part of the analysis. Further a regression with asset prices and houses prices as dependent variable will be made with the federal and repo rates, as well as the rest of the variables as independent variable i.e.

$$Housing = \beta_0 + \beta_1 FED + \beta_2 GDP + \beta_3 PB + \epsilon$$

and

$$PB = \beta_0 + \beta_1 FED + \beta_2 GDP + \beta_3 Housing + \epsilon$$

and likewise. This is to establish how much the zero rate policy has influenced the asset prices. We do not include CPI as we do not want any multicollinearity, as real GDP is adjusted for CPI.

4 Previous Study

4.1 Quantitative easing

The actions undertaken by the central banks should not have come as any surprise as previous research has during the Great Moderation period predicted that the zero lower bound (ZLB) would be a relatively frequent constraint on monetary policy in low inflation environment, one in which we are living in at the moment. Taylor (1993) has found that with a standard inflation target of 2 %, the federal funds rate would be near zero about 5 % of the time and the typical duration for a ZLB period would be four quarters - the so called Taylor rule[6]. A working paper by the European Central Bank (ECB) shows that the distortions induced by the ZIRP are noticeable buy economically insignificant once the inflation target is set at 1 % or higher, concluding that if inflation targets are set below 1 % is unwise however making suggestions that imply low or no economical

consequences of it[7]. Schmitt-Grohé and Uribe even conclude that ZIRP is of no real relevance, establishing the findings of ECB[8]. Reifschneider and Williams (2000) finds that open-market operations alone may be insufficient to restore macroeconomic equilibrium, implying that some fiscal policy and stimulus is needed. They also conclude that ZIRP implies only small stabilization costs and that the detrimental effect can be mitigated is determined using statistical simulations[9]. So many researches believe that residing in the ZBL could be beneficial and see no real long-term dangers if handled correctly. However the current ZBL has lapsed from December 2008 and the episode is thus much longer than historical periods of ZBL[10]. Reifschneider and Williams (2000) suggested that such a period of ZBL is exceedingly rare[9]. However Chung et al. (2012) believe that previous researchers has been ignoring uncertainty about model parameters and focusing too much on the Great Moderation. The model employed by previous researchers do not sufficiently account for tail-events and are sensitive to recent events, thus underestimate the impact and likelihood for periods of ZBL. They also believe that previous researches have been relying on models that are not suited for sustained ZLB periods. Lastly they conclude that while QE materially improve the macroeconomic conditions, they do not prevent the ZLB constraints from having adverse effect on real activity and inflation[11]. So while the phenomenon of ZLB is a thoroughly researched subject, there are still limitations to what previous research has to contribute to the current situation.

4.2 Asset inflation

Investigations of the effects of QE has also been suspect to research. Bhar et al. (2015) finds that while such measures significantly contribute to increases in the stock market, it contributes significantly less to long-term interest rates and unemployment[12]. Suggesting that these measure do little but to add inflation to equity and thus give a sense of false security in the economy. The result of which is increased wealth and consumption rather than increasing investments and reducing unemployment. Another research confirming price inflation induced by ZLB is Kiley (2014)[13]. So previous research has established that at lease the current situation of ZLB induces equity price inflation, as many prominent investors believed[1].

All people however or not equally exposed to the equity market, but most people are exposed to the housing market to some degree, which is also important consider given that ZIRP influence people ability to take and repay loans. Leung (2003) finds that growth in real housing prices can result as economic growth persist, even when population growth is zero. However Leung implies that growth beyond a certain fraction of economic growth rate is not sustainable, giving empirical evidence from the Asian Crisis[14]. Claussen (2013) have finding coherent with Leungs, suggesting that increasing household disposable income and falling mortgage rates are the most important factors behind upswing in prices, however noting that there are no indications of housing bubbles[15]. Furthermore Nissim (2012) has found that there is a clear negative relationship between interest rate and housing prices [16]. Hirata et al. (2012) agrees and further establishes that uncertainty shocks have significant impact on global housing prices. In this case the uncertainty shock was specifically associated the with volatility of stock returns, so that as stock return volatility increased

people tend to shift their portfolios towards safer assets, such as housing[17]. Other findings however point to the fact that assets have long-term equilibrium in price movements i.e. housing prices, stock prices and bond prices co-move in the market[18]. These although these finding can be explained by the fact that the where overall optimism in the frame of the research, thus all the assets where bullish. So as economic fundamentals are stable, housing prices will continue to rise, and the fact that volatility is high in the stock market will further contribute to increased housing prices. So what is the problem? The problem lies not in the increase in value of the asset, but rather in the risk of housing price bubbles. Shi et al. (2014) find that policy rate may not be effective at depressing real housing prices, and further finds some evidence suggesting housing price bubbles[19]. So while all the factors together simultaneously inflates the housing prices, there is no effective measure but to rely on market-powers to depress them again.

4.3 Asset market influence on real economy

It is shown by Fraser (2006) that the real economy has a more pronounced effect on the stock market than vice versa, and that the influence of real economy to the stock market is less important than shocks that are peculiar to the market itself [20]. This fact however should be quite intuitive. The interesting question is what kind of effect does the asset market have on the real economy? A study conducted by Ngare (2014) showed that countries with functioning stock market grows significantly faster than those without, hat developed countries with stock market develops slower than less developed countries with stock market and that stock market development has positive effect on real economy[21]. This is because the stock market functions as a medium to distribute capital from those in search of investment opportunities to those with business ideas in need of capital, which consequently produces real economic effect. The problem though is that in developed country most of the capital allocation has already been made, and thus most of the asset market is a second hand market, which limits the economic impact of capital allocation to useful ideas. However investment returns still influence consumer behavior and thus influence the real economy. Poterba (2000) find that consumption is likely to rise for stock value increase. Even though the distribution of stock ownership is highly skewed and that the stock market implies little to no wealth increase to most households, a strong stock market induces consumer confidence, which will boost consumption amongst all tiers in society[22]. Zhou et al. (2016) confirms these finding and further asserts that rising housing and financial asset values will trigger increased consumer spending. They conclude that housing and stock prices not only influence the respective markets but also the entire economy through its effects on aggregate consumer expenditures. These results are similar to findings from other researchers [23, 24, 25, 26]. Zhou et al. (2016) further state that while increasing housing prices increase the wealth of the house owners, it controversy also creates wealth issues for those trying to save sufficient funds for a down payment. They also find asymmetrical response to stock market value, with upward increases having corresponding positive wealth effect on consumptions and no significant effect of downturn on consumption, and diminishing aggregate consumption with rising house values. The findings indicate that the most negative wealth effect caused by those wanting to enter the housing markets is

stronger than the positive wealth effect of those already in the housing market. Lastly they conclude that housing wealth has limited explanatory power for consumption movements, suggesting looking at non-linear relationship between housing wealth and consumption.

5 Results

First we plot the data series.

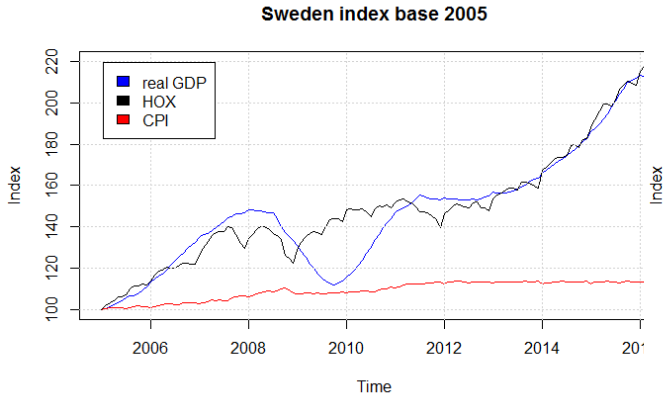

Figure 1: Plot of Swedish indices normalised to 2005.

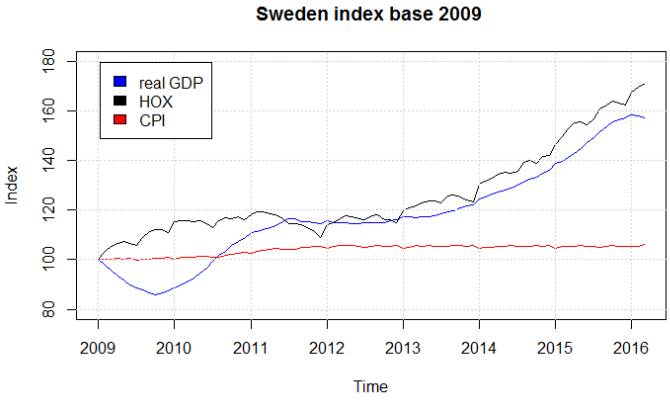

Figure 2: Plot of Swedish indices normalised to 2009.

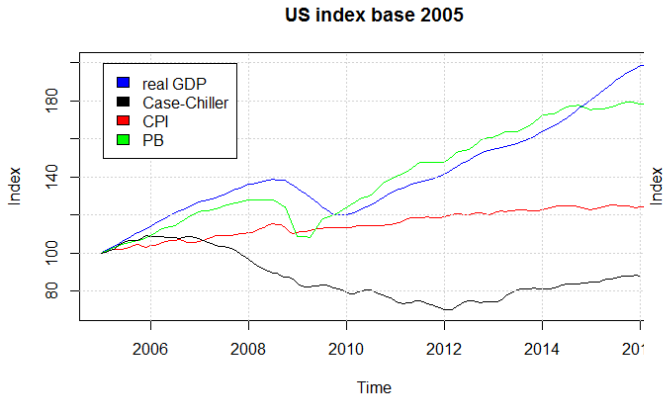

Figure 3: Plot of US indices normalised to 2005.

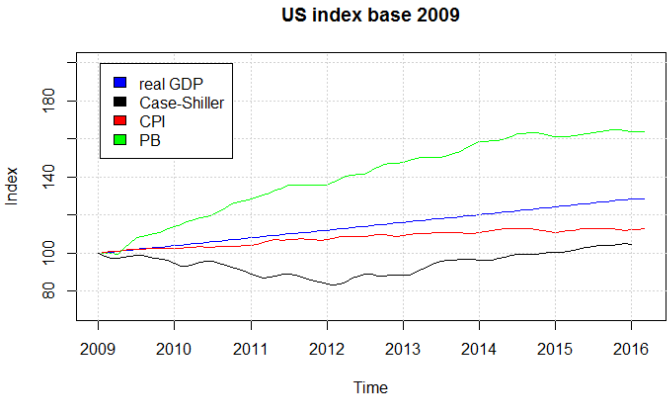

Figure 4: Plot of US indices normalised to 2009.

Figure 5: Plots of all indices.

We see that there clearly is a correlation between the Swedish housing market and the real GDP for both base years. Isolating only these two curves indicates

that the house price levels increase at the same rate as GDP increase, which should indicate that there is no housing bubble, rather people are spending their earnings on houses instead of consumption, resulting in the flat CPI curve.

Now looking at the US housing market it is clear that the housing prices are rather depressed in comparison to how the real economy has evolved as the GDP index has increased significantly more than the Case-Shiller index over both periods. However looking at the equity valuation there seem to be significant overvaluation of stock in comparison to how the real economy has evolved using 2009 as the base year. But using 2005 as base indicates only a stock market correction. It is note-worthy that 1st of January 2009 was when the stock market hit all-time-low, thus generating the seemingly overvaluation of stock seen in the US index base 2009 figure. Even though the equity index deviates from the real GDP, there however still seem to be strong correlation between the two. The following plot will show the correlation matrices

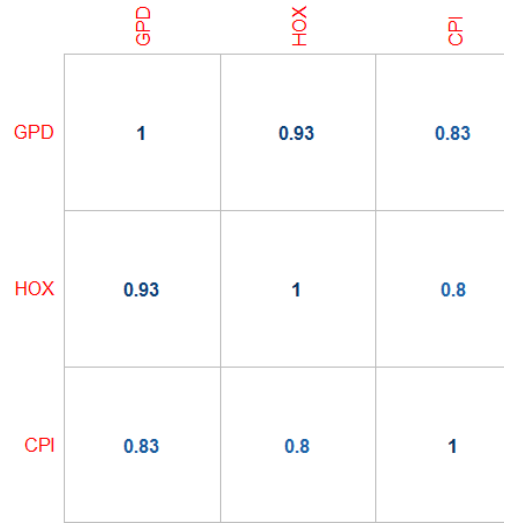

Figure 6: Sweden index base 2005.

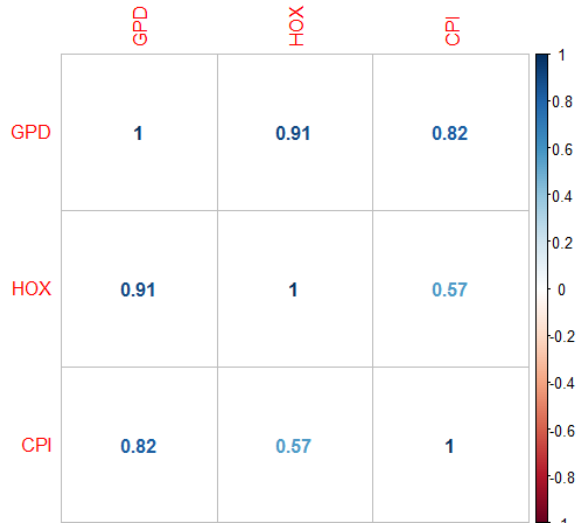

Figure 7: Sweden index base 2009.

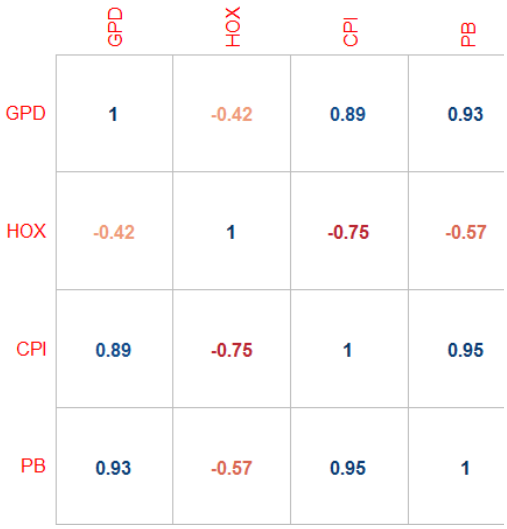

Figure 8: US index base 2005.

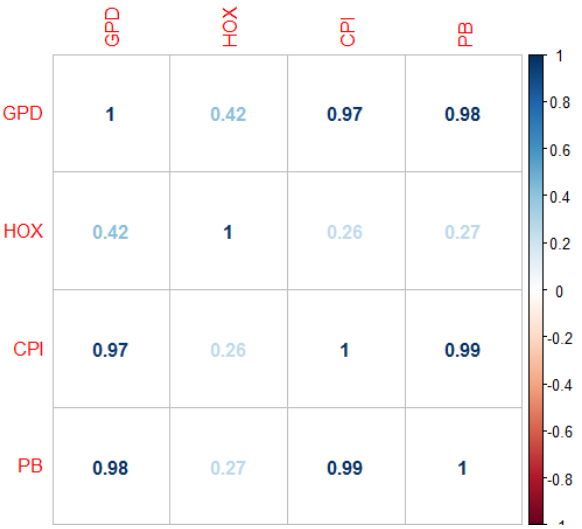

Figure 9: US index base 2009.

Figure 10: Plots of all indices.

Looking at the correlation matrices we confirm the finding above. The correlation between GDP and housing prices are nearly perfect for Swedish housing market and real GDP, and US equity market and real GDP.

Now looking the influence of ZIRP on housing index and equities index we perform a regression analysis as mentioned in the method section. Regression is performed with Housing index and PB as independent variable, having the rest of the variables as dependent. The following results are presented in the

appendix. They show that Swedish housing prices are affected negatively by repo rates and positively affected by real GDP growth. The same applies using both 2005 and 2009 as base year. The US housing market is affected positively by the FED (strongly) and real GDP and affected negatively by PB using 2005 as base year. Using 2009 as base year the difference is that now FED rate has a strong negative impact on US housing prices. Looking at the PB rates having 2005 as base indicates strong positive relation between FED rates, however using 2009 as base it indicates a very strong negative influence from the FED. Knowing that there might be multicollinearity between the independent variables testing for individual independent variables against the dependent variable gave the results. These results thus will not be presented.

6 Discussion and analysis

Two things where to be investigated in this term paper i) whether ZIRP influence the asset markets today and ii) whether the asset market influence the real economy.

6.1 Does ZIRP influence the asset market today?

We know from previous studies that asset markets are influenced by real economy and that ZIRP has the potential to stabilize the real economy during certain circumstances. This should implicate a positive long-term impact on the asset market due to ZIRP. However our current ZLB is unique in that the episode has lapsed longer then previous ZLB episodes. This makes previous research of limited value to establish whether or not the ZLB will be genuinely good for the economy or if will lapse us into a more obvious recession. Therefore we cannot state through previous research whether or not the ZIRP influences the asset market in our current situation. Nevertheless many researchers has found that QE inflates asset prices, by increasing wealth amongst the household and thus increasing the consumption[12, 13]. This asset inflation however does influence non-asset owning people negatively by increasing the cost for them to become asset owners, and thus lowering their consumption. Note-worthy is that there are also quite a few researches who have found negative impact of QE on housing prices[16, 17].

The findings indicate low repo rates have negative impact on Swedish housing market. Testing with simple regression yielded the same result. However knowing that repo and fed rates do have some positive impact on real GPD from empirical evidence and knowing GDP affects housing prices positively should indicate multicollinearity, however non that was detected. Moving on to analysing the US market, the results were mixed. Depending on whether the regression was performed with data series prior to the Great Financial Crisis or after the FED rate influence told completely opposite things. The same applies for when analysing the regression with PB as dependent variable. An explanation for this is that the FED rate after the Great Financial Crisis have been relatively non-moving until recent times (2015) when the increased the FED. This led that single event having huge impact in the regression. A summation of this can be that the results are as incoherent as the findings from the researchers. Depending on which time frame used it is possible to find different results, which

gives us an indication of how previous results could have changed depending on conduction. An example of this is the plot showing overvaluation of the US stock with index based on 2009. Choosing one or two year later as index, would clearly show much less overvaluation than choosing the staring point at all-time-low.

The only coherent finding in my results is that real GDP has positive influence on all asset classes, which thus should be considered the to be the only strong finding in regards to this part of the paper.

6.2 Does the asset market influence the real economy?

Previous studies have shown that asset market do definitive influence real economy while they provide efficient capital allocation between investors who are seeking investment opportunities and business ideas in need of capital[21]. The effect is less for developed countries however increased wealth among investors will still contribute to the real economy. Poterba (2000) found that even though not all households are engaged in the capital markets, a good stock market environment inspires consumer confidence which have positive impact on real economy [22]. Many other researchers confirm this findings[27, 24, 23, 25, 26]. These studies also find that housing wealth has limited explanatory power for consumption pattern in real economy. Thus previous studies indicate that equity markets influence real economy positively. The same cannot be said for the housing market.

The results indicate that Swedish economy has positive correlation between housing prices and GDP. In the US the same cannot be said, however there is a positive correlation between the equity market and GDP. This indicates that people are putting their money on assets rather than consumption. Previous studies have shown that the reason for improvement in real economy due to positive asset returns is due to increased consumption. This means that the only positive effect caused by asset market on real economy is now negated. Considering the high growth in Swedish economy it must be noted that previous research has shown that growth beyond a fraction of economic growth in housing is not sustainable for prolonged period[14]. Thus the findings are such that in the current situation the asset market do little to add value to the real economy, and as such there are potential signs for a current bubble brewing. From the results it can also be derived that GDP is more volatile than housing index, this could in part explain the spread widening because of investors seeking safe haven in less volatile assets, such as housing

7 Conclusion

This study was not able to show a significant effect of ZIRP on the asset markets, proxied by stock markets and a housing index. A conclusion that could be drawn is that the asset inflation has not had a significant positive effect on the real economy. This could be interpreted as a sign showing that the asset inflation is not healthy, and could potentially lead to a bubble. The latter thesis is supported by literature and economic theories regarding interest rates and malinvestments[28].

8 Appendix

8.1 Regression results

```
Call:
lm(formula = SWE_HOX ~ SWE_REPO + SWE_GDP_real)

Residuals:
     Min       1Q   Median       3Q      Max
-12.5256  -4.3915  -0.4333   3.9034  16.2270

Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept)  52.27691    3.68456   14.19   <2e-16 ***
SWE_REPO     -1.59093    0.10539  -15.10   <2e-16 ***
SWE_GDP_real  0.77295    0.02071   37.32   <2e-16 ***
---
Signif. codes:  0  ***  0.001  **  0.01  *  0.05  .  0.1

Residual standard error: 6.151 on 132 degrees of freedom
Multiple R-squared:  0.9486,    Adjusted R-squared:  0.9478
F-statistic:  1218 on 2 and 132 DF,  p-value: < 2.2e-16
```

```
Call:
lm(formula = SWE_HOX_2009 ~ SWE_REPO_2009 + SWE_GDP_real_2009)

Residuals:
    Min      1Q  Median      3Q     Max
-7.3310 -1.9499  0.1265  1.4709  9.2602

Coefficients:
                  Estimate Std. Error t value Pr(>|t|)
(Intercept)       62.16820    2.77196   22.43   <2e-16 ***
SWE_REPO_2009     -2.19156    0.11744  -18.66   <2e-16 ***
SWE_GDP_real_2009  0.68745    0.01886   36.45   <2e-16 ***
---
Signif. codes:  0  ***  0.001  **  0.01  *  0.05  .  0.1

Residual standard error: 3.065 on 84 degrees of freedom
Multiple R-squared:  0.9711,    Adjusted R-squared:  0.9704
F-statistic:  1410 on 2 and 84 DF,  p-value: < 2.2e-16
```

```
Call:
lm(formula = US_CaseShiller ~ US_FED[1:133] + US_GDP_real[1:133] +
    US_PB[1:133])

Residuals:
    Min      1Q  Median      3Q     Max
-7.9637 -3.8167 -0.1023  2.9775  9.4896

Coefficients:
                   Estimate Std. Error t value Pr(>|t|)
(Intercept)        78.41506    2.84227  27.589  < 2e-16 ***
US_FED[1:133]       5.33479    0.23699  22.511  < 2e-16 ***
US_GDP_real[1:133]  0.29568    0.04384   6.745 4.65e-10 ***
US_PB[1:133]       -0.28834    0.04501  -6.406 2.56e-09 ***
---
Signif. codes:  0    ***    0.001    **    0.01    *    0.05    .    0.1

Residual standard error: 4.187 on 129 degrees of freedom
Multiple R-squared:  0.8841,    Adjusted R-squared:  0.8814
F-statistic: 328.1 on 3 and 129 DF,  p-value: < 2.2e-16

Call:
lm(formula = US_CaseShiller_2009 ~ US_FED_2009[1:85] + US_GDP_real_2009[1:85] +
    US_PB_2009[1:85])

Residuals:
   Min     1Q Median     3Q    Max
-9.950 -2.014  0.212  2.549  5.838

Coefficients:
                       Estimate Std. Error t value Pr(>|t|)
(Intercept)            -72.7022    13.5842  -5.352 7.91e-07 ***
US_FED_2009[1:85]       -9.2378     9.5077  -0.972    0.334
US_GDP_real_2009[1:85]   2.7835     0.2482  11.213  < 2e-16 ***
US_PB_2009[1:85]        -1.0663     0.1066 -10.000 8.47e-16 ***
---
Signif. codes:  0    ***    0.001    **    0.01    *    0.05    .    0.1

Residual standard error: 3.438 on 81 degrees of freedom
Multiple R-squared:  0.664,    Adjusted R-squared:  0.6516
F-statistic: 53.37 on 3 and 81 DF,  p-value: < 2.2e-16
```

```
Call:
lm(formula = US_PB[1:133] ~ US_FED[1:133] + US_GDP_real[1:133] +
    US_CaseShiller[1:133])

Residuals:
    Min      1Q  Median      3Q     Max
-23.680  -2.907   1.108   4.072  10.686

Coefficients:
                       Estimate Std. Error t value Pr(>|t|)
(Intercept)             78.6349    10.6713   7.369 1.83e-11 ***
US_FED[1:133]            2.8750     0.8599   3.344  0.00108 **
US_GDP_real[1:133]       0.9217     0.0310  29.729  < 2e-16 ***
US_CaseShiller[1:133]   -0.8370     0.1307  -6.406 2.56e-09 ***
---
Signif. codes:  0  ***  0.001  **  0.01  *  0.05  .  0.1

Residual standard error: 7.133 on 129 degrees of freedom
Multiple R-squared:  0.9196,    Adjusted R-squared:  0.9178
F-statistic: 492.1 on 3 and 129 DF,  p-value: < 2.2e-16

Call:
lm(formula = US_PB_2009[1:85] ~ US_FED_2009[1:85] + US_GDP_real_2009[1:85] +
    US_CaseShiller_2009[1:85])

Residuals:
    Min      1Q  Median      3Q     Max
-5.9914 -1.8407  0.3277  1.9051  4.0591

Coefficients:
                           Estimate Std. Error t value Pr(>|t|)
(Intercept)               -89.33233    4.78005 -18.689  < 2e-16 ***
US_FED_2009[1:85]         -23.72485    6.12265  -3.875 0.000215 ***
US_GDP_real_2009[1:85]      2.46545    0.03711  66.428  < 2e-16 ***
US_CaseShiller_2009[1:85]  -0.51813    0.05181 -10.000 8.47e-16 ***
---
Signif. codes:  0  ***  0.001  **  0.01  *  0.05  .  0.1

Residual standard error: 2.396 on 81 degrees of freedom
Multiple R-squared:  0.9863,    Adjusted R-squared:  0.9858
F-statistic:  1944 on 3 and 81 DF,  p-value: < 2.2e-16
```

8.2 Data Sources

Swedish GDP data

http://www.scb.se/sv_/Hitta-statistik/Statistik-efter-amne/Nationalrakenskaper/Nationalrakenskaper/Nationalrakenskaper-kvartals--och-arsberakningar/

http://www.ekonomifakta.se/Fakta/Ekonomi/Tillvaxt/BNP---Sverige/?graph=/14515/1/all/

Swedish Housing index (HOX)

http://www.valueguard.se/index

Swedish CPI

http://www.scb.se/sv_/Hitta-statistik/Statistik-efter-amne/Priser-och-konsumtion/Konsumentprisindex/Konsumentprisindex-KPI/33772/33779/Konsumentprisindex-KPI/287612/

Swedish federal fund rate

http://www.ekonomifakta.se/Fakta/Ekonomi/Finansiell-utveckling/Styrrantan/?graph=/1554/1/a

All US data except FED rates

http://www.multpl.com/

US FED rates

https://research.stlouisfed.org/fred2/series/FEDFUNDS#

9 Appendix - Python Code

```
import csv

#Read in files
rawdata = []
with open('BNPSverige.csv') as csvfile:
    reader = csv.reader(csvfile, delimiter = ";")
    for row in reader:
        rawdata.append(row)


#Linear intepolation function - step between
def LinearInt(datalist, i,step):
    try:
        diff = float(datalist[i+1][1])-float(datalist[i][1])
        inc = diff/step
    except:
        inc = 0
    return inc, step

#Fill new datalist with all data point incl. interpolated points
IntData=[]
for i in range(len(rawdata)):
    inc, step = LinearInt(rawdata,i,3)

    for j in range(step):
        IntData.append(float(rawdata[i][1])+j*inc)

ReverseIntData=[]
REVERSE ORDER FOR US
for i in reversed(IntData):
    print(i)

# DEFINE CSV-WRITER FUNCTION
def csvWrite(data, file):
    with open(file, 'a', newline='') as csvfile:
                writer = csv.writer(csvfile, delimiter = ";")
                writer.writerow([data])
    return

for i in IntData:
    csvWrite(i,"File.csv")
```

10 Appendix - R Code

```
rm(list = ls())
layout(matrix(c(1,1,1,1),1,1,byrow=TRUE))
getwd()

SWE_GDP<-ts(read.csv("BNP_IP_raw.csv", sep = ";", header = F),
frequency = 12, start = 2005)
SWE_HOX<-ts(read.csv("HOX_index_raw.csv", sep = ";",header = F),
frequency = 12, start = 2005)
SWE_CPI<-ts(read.csv("KPI_raw.csv", sep = ";",header = F),
frequency = 12, start = 2005)
SWE_REPO<-ts(read.csv("SWE_repo_raw.csv", sep = ";",header = F),
frequency = 12, start = 2005)

SWE_GDP_2009<-ts(read.csv("BNP_IP_2009_raw.csv", sep = ";",header = F),
frequency = 12, start = 2009)
SWE_HOX_2009<-ts(read.csv("HOX_index_2009_raw.csv", sep = ";",header = F),
frequency = 12, start = 2009)
SWE_CPI_2009<-ts(read.csv("KPI_2009_raw.csv", sep = ";",header = F),
frequency = 12, start = 2009)
SWE_REPO_2009<-ts(read.csv("SWE_repo_2009_raw.csv", sep = ";",header = F),
frequency = 12, start = 2005)

US_GDP<-ts(read.csv("US_GDP_Q_raw.csv", sep = ";",header = F),
frequency = 12, start = 2005)
US_GDP_real<-ts(read.csv("US_GDP_real_Q_raw.csv", sep = ";",header = F),
frequency = 12, start = 2005)
US_CPI<-ts(read.csv("US_CPI_raw.csv", sep = ";",header = F),
frequency = 12, start = 2005)
US_CaseShiller<-ts(read.csv("US_CaseShillerHousing_raw.csv", sep = ";",header = F),
frequency = 12, start = 2005)
US_PE<-ts(read.csv("SP_PE_raw.csv", sep = ";",header = F),
frequency = 12, start = 2005)
US_PB<-ts(read.csv("SP_PB_IP_Q_raw.csv", sep = ";",header = F),
frequency = 12, start = 2005)
US_FED<-ts(read.csv("US_FED_raw.csv", sep = ";",header = F),
frequency = 12, start = 2005)

US_GDP_2009<-ts(read.csv("US_GDP_Q_2009_raw.csv", sep = ";",header = F), frequency = 12, s
US_GDP_real_2009<-ts(read.csv("US_GDP_real_Q_2009_raw.csv", sep = ";",header = F), frequen
US_CPI_2009<-ts(read.csv("US_CPI_2009_raw.csv", sep = ";",header = F), frequency = 12, sta
US_CaseShiller_2009<-ts(read.csv("US_CaseShillerHousing_2009_raw.csv", sep = ";",header =
US_PE_2009<-ts(read.csv("SP_PE_2009_raw.csv", sep = ";",header = F), frequency = 12, start
US_PB_2009<-ts(read.csv("SP_PB_IP_Q_2009_raw.csv", sep = ";",header = F), frequency = 12,
US_FED_2009<-ts(read.csv("US_FED_raw_2009.csv", sep = ";",header = F), frequency = 12, sta



#Functions for TS analysis
```

```
RegTrend <- function(x) {
  t = seq(1:length(x))
  reg = lm(x~t)

  return(reg)
}

RegSeason <- function(x,p) {
  t = seq(1:length(x))
  regSes = lm(x~sin(2*pi*t/p)+cos(2*pi*t/p))

  return(regSes)
}
#
library("xts")

# Plots
plot(SWE_GDP, col = "blue")
plot(100+SWE_GDP-SWE_CPI, col = "blue", ylim = c(100,220), ylab = "Index",
main = "Sweden index base 2005")
lines(SWE_HOX)
lines(SWE_CPI, col = "red")
grid()
legend('topleft', c('real GDP',"HOX", "CPI"), fill=c('blue',"black", "red"),
inset=0.04)

plot(SWE_GDP_2009, col="blue")
plot(100+SWE_GDP_2009-SWE_CPI_2009, col = "blue", ylim=c(80,180), ylab = "Index",
main = "Sweden index base 2009 ")
lines(SWE_HOX_2009)
lines(SWE_CPI_2009, col = "red")
grid()
legend('topleft', c('real GDP',"HOX", "CPI"), fill=c('blue',"black", "red"),
inset=0.04)

plot(US_GDP, col = "blue", ylim=c(0,500))
lines(US_GDP - US_CPI, col = "purple")

plot(US_GDP_real, col = "blue", ylim=c(70,200), ylab = "Index",
main = "US index base 2005")
lines(US_CPI, col = "red")
lines(US_PB, col = "green")
lines(US_CaseShiller)
grid()
legend('topleft', c('real GDP',"Case-Chiller", "CPI", "PB"),
fill=c('blue',"black", "red", "green"), inset=0.04)

plot(US_GDP_real_2009, col = "blue", ylim=c(70,200), ylab = "Index",
main = "US index base 2009")
lines(US_CPI_2009, col = "red")
```

```
lines(US_PB_2009, col = "green")
lines(US_CaseShiller_2009)
grid()
legend('topleft', c('real GDP',"Case-Shiller", "CPI", "PB"),
fill=c('blue',"black", "red", "green"), inset=0.04)


#Corr-matrix
library("corrplot")
d <- data.frame(GDP=SWE_GDP,HOX= SWE_HOX, CPI=SWE_CPI)
names(d) <- c("GPD","HOX","CPI")
corrplot(cor(d),method ="number")

d <- data.frame(GDP=SWE_GDP_2009,HOX= SWE_HOX_2009,
CPI=SWE_CPI_2009)
names(d) <- c("GPD","HOX","CPI")
corrplot(cor(d),method ="number")

d <- data.frame(GDP=US_GDP_real[1:133],CS=US_CaseShiller[1:133],
CPI=US_CPI[1:133], PB=US_PB[1:133])
names(d) <- c("GPD","HOX","CPI","PB")
corrplot(cor(d),method ="number")

d <- data.frame(GDP=US_GDP_real_2009[1:85],CS=US_CaseShiller_2009[1:85],
CPI=US_CPI_2009[1:85], PB=US_PB_2009[1:85])
names(d) <- c("GPD","HOX","CPI","PB")
corrplot(cor(d),method ="number")


#Regression
SWE_GDP_real <- (100+SWE_GDP-SWE_CPI)
summary(lm(SWE_HOX ~ SWE_REPO +SWE_GDP_real))
SWE_GDP_real_2009 <- (100+SWE_GDP_2009-SWE_CPI_2009)
summary(lm(SWE_HOX_2009 ~ SWE_REPO_2009 + SWE_GDP_real_2009))

summary(lm(US_CaseShiller ~ US_FED[1:133] + US_GDP_real[1:133] + US_PB[1:133]))
summary(lm(US_CaseShiller_2009 ~ US_FED_2009[1:85] +
US_GDP_real_2009[1:85] + US_PB_2009[1:85]))

summary(lm(US_PB[1:133] ~ US_FED[1:133] + US_GDP_real[1:133] + US_CaseShiller[1:133]))
summary(lm(US_PB_2009[1:85] ~ US_FED_2009[1:85] + US_GDP_real_2009[1:85] +
US_CaseShiller_2009[1:85]))


vif(lm(SWE_HOX ~ SWE_REPO +SWE_GDP_real))
```

References

[1] D. K. Berman. Investing in 2016: 'the only winning movie is not to play the game'. *The Wall Street Journal*, 2016.

[2] International Monetary Fund. World economic outlook update, 2016.

[3] N. Irwin. Why china won't keep growing fast forever. *The NEw York Times*, 2014.

[4] V. Yuzhakov. Challange the 5 biggest misconceptions about china's economy. *SumZero*, 2016.

[5] H. J. Wright. What does Monetary Policy do to Long-term Interest Rates at the Zero Lower Bound? *The Economic Journal*, 122(564):447–466, 2012.

[6] J. B. Taylor. Discretion versus policy rules in practice. *Carnegie-Rochester Conference Series on Public Policy*, 39:195–214, 1994.

[7] G. Coenen. Zero lower bound: Is it a problem in the Euro Area? *European Central Bank*, Working Paper(269), 2003.

[8] Schmitt-Grohé and Uribe. Optimal inflation stabilization in a Medium-Scale Macroeconomic model. *National Bureau of Economic Research*, Working Paper(11854), 2005.

[9] Reifschneider and Williams. Three Lessons for Monetary Policy in a Low-Inflation Era. *The Ohio State Press*, 32(4):936–966, 2000.

[10] Effective federal funds rate. `https://research.stlouisfed.org/fred2/series/FEDFUNDS`. Accessed: 2016-05-11.

[11] LaForte J. Reifschneider D. Chung, H. and J. C. Williams. Have We Underestimated the Likelihood and Severity of Zero Lower Bound Events? *Journal of Money, Credit and Banking*, 44(1):47–82, 2012.

[12] Malliaris A. G. Malliaris M. Bhar, R. The impact of large-scale asset purchases on the SP 500 index, long-term interest rates and unemployment. *Applied Economics*, 47(55):6010–6018, 2012.

[13] M. T. Kiley. The Response of Equity Price to Movements in Long-Term Interest Rates Associated with Monetary Policy Statements: Before and After the Zero Lower Bound. *Journal of Money, Credit and Banking*, 46(5):1057–1071, 2014.

[14] C. K. Y. Leung. Economic Growth and Increasing House Prices. *Pacific Economic Review*, 8(2):183–190, 2003.

[15] C. A. Claussen. Are Swedish houses overpriced? *International Journal of Housing Markets and Analysis*, 6(2):180–196, 2013.

[16] B. D. Nissim. Predicting housing prices according to expected future interest rate. *Applied Economics*, 45:3044–3048, 2012.

[17] Ayhan K. M. Otrok C. Terrones M. E. Hirata, H. Global House Price Fluctuations: Synchronization and Determinants. *National Bureau of Economic Research*, Working Paper(18362), 2012.

[18] Z. Yang. Co-integration of housing prices and property stock prices: evidence from the Swedish market. *Journal of Property Research*, 22(1):1–17, 2005.

[19] Jou J. B. Tripe D. Shi, S. Can interest rates really control house prices? Effectiveness and implications for macroprudential policy. *Journal of Banking Finance*, 45:15–28, 2014.

[20] P. Fraser. US share prices and real supply and demand shocks. *The Quarterly Review of Economics and Finance*, 46(1):149–167, 2006.

[21] E. Ngare. Stock market development and economic growth in Africa. *Journal of Economics and Business*, 74:24–39, 2014.

[22] M. Poterba, J. Stock market Wealth and Consumption. *Journal of Economic Perspectives*, 14(2):99–18, 2000.

[23] A. Ciarlone. Housing Wealth Effect in Emerging Economics. *Emerging Markets Review 12*, 12(4):399–417, 2011.

[24] B. Singh. How Important Is the Stock Market Wealth Effect on Consumption in India? *Empirical Economics*, 42(3):915–927, 2012.

[25] D. G. McMillan. Consumption and Stock Prices: Evidence from a Small International Panel. *Journal of Macroeconomics*, 36:76–88, 2013.

[26] Časni A.Č. Vizek M. Šonje, A. The Effect of Housing and Stock Market Wealth on Consumption in Emerging and Developed Countries. *Economic Systems*, 38(3):433–450, 2014.

[27] M. S. Gibler K. Zhou, X. Chang. The Asymmetric wealth effects of housing market and stock market on consumption in China. *Asia Pacific Economy*, 21(2):196–216, 2016.

[28] David Miles, Andrew Scott, and Francis Breedon. *Macroeconomics Understanding The Global Economy*. John WIley Sons, Ltd, West Wessex, United Kingdom, 2012.