



**UNIVERSITY OF GOTHENBURG**  
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**Swedish Household Debt:  
Macroeconomic determinants of the household  
debt-to-income ratio**

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## Abstract

This paper describes how the rise in Swedish households' debt-to-income ratio (DTIR) over the last 30 years can be explained based on macroeconomic implications. In particular, cointegrating relations are analysed based on a specified vector autoregressive (VAR) model, due to spurious estimations from the general OLS-regression. The results explain both a long run relation as well as a short run. In the long run analysis the increase in DTIR is caused by an increase in house prices and a decrease in consumers' confidence and unemployment rate. In the short run model, comparatively, only consumers' confidence is shown to have a significant impact on the DTIR.

**Index Terms:** *Household debt-to-income, Life-cycle/permanent income hypothesis, Cointegration, Vector autoregressive model, Error correction model.*

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## Nomenclature

### Superscripts

$\alpha$	Adjustment speed vector
$\beta$	Cointegrating vector
$A_t$	Assets in period $t$
$c_t$	Consumption in period $t$
$\delta$	Discount rate
$\Delta$	First difference
$E_t$	Future expectation conditional on information available in period $t$
$e$	Error term
$h$	Degrees of freedom
$I(\cdot)$	Order of integration
$k$	Lag length
$n$	Sample size
$N$	Number of observations
$\hat{p}_k$	Sample autocorrelation
$P$	Number of regressors in the auxiliary regression
$r$	Rank order
$rr$	Real interest rate
$\Gamma$	Transitory effects measured by the lagged changes of the variables
$R'$	Vector used to test for restrictions on $\alpha$ and $\beta$
$R^2$	Power of the auxiliary regression
$T$	Length of economic life
$\theta$	Lagged coefficient
$u(\cdot)$	Utility function
$w_t$	Earnings in period $t$

$q$	Order of serial correlation
$y$	Vector space of variables
$\lambda$	Eigenvalues
$\mu$	Trend variable

### **Abbreviations**

ADF	Augmented Dickey-Fuller
ARCH	Autoregressive Conditional Heteroskedasticity
AIC	Akaike's Information Criterion
BIC	Bayesian Information Criterion
CCI	Consumers' Confidence Index
DTIR	Debt-To-Income Ratio
EC	Error Correction term
FATI	Financial Asset To Income
HPI	House Price Index
LCH	Life-Cycle Hypothesis
LM	Lagrange-Multiplier
OLS	Ordinary Least Squares
PIH	Permanent Income Hypothesis
RIR	Real Interest Rate
VAR	Vector Autoregressive
VECM	Vector Error Correction Model

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# 1 Introduction

Household debt levels have during the last decade been a contested and well-examined topic on a global level. Moody's recently published a study comparing countries with high household debt levels, where Sweden was most at risk. It believes the Riksbank will find it difficult to achieve its objective of significantly pushing up consumer price inflation in a deflationary global environment, while the sustained and strong growth in mortgage lending and house prices may lead to an (ultimately unsustainable) asset bubble (Moody's, 2016). In a press release, the Riksbank Governor Stefan Ingves pointed out the threats to both the real economy, financial stability and price stability associated with the housing market and household debt. "*A prerequisite for the long term success in the monetary policy strategy is that action is taken against the increasing debt ratios*". He states that the authorities have a responsibility to act when development threatens macroeconomic and financial stability (Ingves, 2015).

Following the US housing crash of 2008, Swedish household debt levels have been leading the drastic increases in the years since. Although Swedish households' debt levels were comparable to those in the US during the financial crisis, Sweden emerged from the downturn as a country with one of the lowest negative impacts on its economy (Molin, 2010). Since the crisis, however, Sweden has faced highly favorable borrowing conditions, resulting in speculations on unsustainably high debt levels and exorbitant prices of dwellings. Although, from a debt-to-income ratio (DTIR) perspective it started to increase already in the early 1990s from 90 per cent to a current level of 180 per cent, which is among the highest in the world (Wistrand & Ölcer, 2014).

Earlier research in the development of debt has been mostly theoretical in character and the few existing econometric studies available do not include the Nordic region. Although similar econometric studies have been done, differences between countries alter the results significantly, giving support for an analysis in a specific region (Kent et al, 2007). Consider for example residential mortgage default regulations, which vary across countries. In the US, a mortgage default may lead to repossession of dwellings or forced sales as a repayment of the mortgages, whilst in Sweden, debtors are still obligated to pay their mortgages even after a forced sale if the sale amount is not sufficient. Hence the results across countries may vary substantially and justify the need for a region-specific study.

In theory, debt can be justified from a standpoint of utility maximization, such as in Modigliani and Ando's (1957) life-cycle hypothesis (LCH), in which households take on debt to even consumption over a lifetime. This paper seeks to investigate the effects of macroeconomic determinants on the DTIR in Sweden, using a time series analysis, where the data is explained through the utilization of the life-cycle framework. Under the strict unit-root assumption, cointegrating relations of a vector autoregressive (VAR) model are determined using Johansen's framework. Furthermore, a long run cointegration analysis is per-



formed, followed by the development of a short run vector error correction model (VECM).

From the estimations, there are two main findings, one for the long run analysis and one for the short run analysis. In the long run analysis the increase in DTIR is caused by an increase in house prices and a decrease in the consumers' confidence and unemployment. In the short run model, comparatively, only the consumers' confidence is shown to have a significant impact on the DTIR.

## 2 Background

Household borrowing has increased considerably in a number of developed countries over the past two decades, including Sweden. The level of indebtedness in the household sector has resulted in a substantial increase in the country's DTIR since the recovery following the financial crash in the mid-1990s. In 2010, mortgage cap regulations were implemented which effectively lowered indebtedness for some time, before it eventually began to rise again in 2013 (See Figure 1 in Appendix). There are numerous ways to measure a country's indebtedness, not least by using DTIR. Since most households pay their loans with their current income, Wistrand and Ölcer (2014) suggests that DTIR is an appropriate measure of indebtedness.

The sharp escalation of DTIR in Sweden has raised concerns about the sustainability of household debt, and its implications for the stability of the financial system (Finansinspektionen, 2015). Regardless of whether the increase in household debt is sustainable, rising indebtedness has important macroeconomic implications. Some major risk factors associated with high DTIR are identified by Wistrand & Ölcer (2014). The authors point out that there is a relationship between increased borrowing in the household sector and the probability of a fall in housing prices. Considering that almost all household assets are held in real estate, this would eradicate the majority of a household's total assets. A steep fall in housing prices may then lead to repossession or forced sales of dwellings, and consequently a drop in consumption. Further, an unexpected rise in household expenses such as a shift in interest rates, or from new economic regulations, may lead to stressed mortgage repayments and thereafter a plunge in consumption. If the drop in consumer spending is severe enough, it may lead to a recession. Increased household DTIR is therefore closely linked to the likelihood of a country entering into a financial crisis, which has also been shown by a wide range of empirical research – evidently, households' individual borrowing decisions affect the domestic economy as a whole (Alfelt, Lagerwall & Ölcer, 2015). The authors further state that banks and households do not take this increased risk for a country's national economy into consideration in their decisions. Hence, the need for economic policies from the state, such as regulations of amortizations or DTIR limits, are often implemented as a tool to avoid a market failure.

Sweden is currently facing an increasing DTIR, rising house prices and falling real interest rates (See Figures 1 to 3 in Appendix), whereof the shift in real interest rates is caused by falling nominal interest rates and constantly low inflation. This market situation has intensified the discussion among politicians but also among economic institutions, such as; Finansinspektionen, Konjunktursinstitutet and the Riksbank, about how different policies ought to be introduced in order to bate lending. The mortgage cap, introduced in 2010, is one example of this push for regulation and it led to the loan-to-value limit being set at 85 per cent. Through inspection of Figure 1 in Appendix, it seems like this policy had a significant effect on the DTIR. In early 2015 Finansinspektionen (2015) proposed another regulation: an amortization plan for the repayment of loans, set to be introduced in June 2016. However, so as not to impede the building of new homes, newly built dwellings are exempted for five years. Also, this policy will only apply to new loans, in order not to jeopardize the market for existing mortgage takers. Further proposals include DTIR limits and deregulation of the interest rate deduction held for mortgage takers. According to Finansinspektionen, it would be appropriate for Swedish authorities to introduce a DTIR limit of 600 per cent (Svd, 2015a). As for interest rate deductions, the debate has continued to grow, since this would give highly favorable agreements for the households financing dwellings with debt (Svd, 2015b). Stress tests performed by the Riksbank (2015) on the Swedish households' sensitivity to macroeconomic volatility shows that dropping the interest rate deduction would result in around 35 per cent of all new mortgage borrowers taking on smaller debts. Not surprisingly, the interest rate deduction has important implications for the household indebtedness. Furthermore, how to implement DTIR limits or deregulations of interest rate deduction has not yet been settled, nor whether they will be introduced at all.

Stefan Ingves (2015), governor of the Riksbank, has proposed a dual repo rate policy, i.e. an extension of a second repo rate, which only applies to the housing market, while keeping the usual repo rate. By having a higher level on the additional repo rate, the demand for dwellings will slow as a result of the increased cost of borrowing. This also enables the Riksbank to more easily ensure the inflation target of two per cent with the usual policy rate (Ingves, 2015).

Among the most recent additions to the literature on the subject is an investigation by Moody's (2016) comparing three countries with negative interest rate: Sweden, Denmark and Switzerland. Although Denmark and Switzerland have lower interest rates, Sweden is still highlighted by the survey as the country with the highest risk of a setback. Moody's believe that the Swedish Riksbank will find it hard to boost the consumer price index in the current deflationary global environment. Simultaneously, if the strong growth in both mortgage borrowing and house prices is sustained, this may eventually lead to an unsustainable housing bubble. There is no doubt that the ongoing household debt situation in Sweden is an issue that deserves attention. Major parties and economic in-

stitutions seem to agree that regulations must be made in order to remedy the growing problem. By investigating the determinants of the DTIR, this paper contribute to valuable insight of where the decision making should be focused.

### 3 Prior research

The attention paid to household debt levels in Scandinavia has increased during the last decade, but among empirical studies the data remains poor. As a result, this paper must look at related works, such as Philbrick & Gustafsson's (2010) article which contains an empirical study of the macroeconomic determinants of DTIR in Australia. This research spans between 1980 and 2009 and the investigated variables include interest rate, house prices, the consumers' confidence index and inflation. Further, the study is divided into two parts, a long run analysis and a short run. For the long run analysis, interest rates and housing prices are shown to have an effect on the DTIR. The short run analysis further shows that DTIR is affected by house prices, the consumers' confidence index and inflation.

An additional empirical study regarding macroeconomic variables' effect on the DTIR is Kent et al's (2007) cross-correlation analysis of 18 different countries. Furthermore the cross-correlation analysis is divided in two parts, where the included macroeconomic variables are; house prices, mortgage rates, inflation rates and unemployment rates. In the first analysis, different "scores", which depend on the volatility of the macroeconomic variables, separate the countries from each other. If a country has higher average annual changes in its respective variables, it receives a higher score, and vice versa. Each country's score is then cross-correlated with their average annual growth rates of debt ratios. This examination results in a positive correlation between the scores and DTIR. The authors' second analysis is similar to the first but instead of using scores, each variable is analysed separately. Through this analysis the authors are able to identify a positive correlation between countries' real house price growth and negative correlation for changes in real mortgage rates, inflation rates and the unemployment rate.

Although the household debt level in Sweden has been highly debated lately, increases in household borrowing have been faced long before in a number of developed countries. In 2004, Debelle (2004) was among the first to do a comprehensive study of the situation. At the time, household DTIR had been increasing for approximately two decades in some countries, but without any major debates in academia or the political arena recognising the problem. Debelle's work is concerned with the macroeconomic implications of the rising household debt levels of 20 countries and its analysis is mainly formulated by the life-cycle and permanent-income models, of Modigliani (1986) and Friedman (1957), respectively. When comparing the countries, differences such as housing tenure, deregulation of the mortgage market, tax treatment of owner-occupied

dwellings and predominant type of interest rate, are considered and adjusted for. As a result, the effect on increased household debt is mainly explained by lowered interest rates and an easing of liquidity constraints, which further made the household sector more sensitive to changes in interest rates, income and asset prices. Debelle goes on to point out that societies with variable mortgage rates tend to be more sensitive to macroeconomic fluctuations whereas those with fixed rates are less sensitive. The study extends the discussion to housing prices and how increased indebtedness results in households that are more vulnerable to decreases in house prices. Consequently, such a fall might lower consumer confidence and lead to reduced household spending, while decreasing current mortgage holders' ability to finance consumption through their housing equity. Those facts therefore show a double effect between indebtedness and house prices, which has helped to maintain consumption through earlier global slowdowns. A vital influence on the future effects is if the increased borrowing is made by those households who are sensitive to economic changes. If they are, Debelle argues that it is highly likely to give rise to negative shocks in the economy.

One of the most recent studies that has contributed a great deal to the area is from Barbra and Pivetti (2009). The article analyses the rise in household indebtedness in the United States from the point of view of its causes and long run macroeconomic implications. Additionally, the authors look at the household debt level from a socio-economic perspective by including a class consumption function, which differs from many other studies, e.g. Debelle's (2004). By including the class consumption function, Barbra and Pivetti also complement the analysis by Debelle (2004) with which type of consumers who increase their borrowings. The main finding is that the supply of loans available for households makes it possible for low income households to increase a country's aggregate demand. This further leads to the fact that societies with high income inequalities have high household debt levels. The article considers the effects of high debt levels as well and concludes that the debt level itself is not the cause of negative shocks but the sensitivity to the variation in other macroeconomic variables.

## 4 Theory

There are many reasons why households may take on debt, but from a theoretical point of view there are primarily two: to smooth consumption over time or to finance acquisition of assets (Philbrick & Gustafsson, 2010). Taking on debt has a positive effect on a society by helping to sustain demand and activity, but as household debt levels increase it also contributes to a more sensitive market for negative shocks. It is not, however, the high debt level itself which would be the source of this sensitivity but rather variations in other macroeconomic variables (Barba & Pivetti, 2009). In this section a theoretical overview of what macroeconomic variables that may affect the household debt is presented.

Considering the classical Keynesian consumption theory, an issue that arises is the theory's inability to explain the apparent constancy in savings-rate under rising real incomes. From this uncertainty, a number of new theories in consumer behaviour emerged, among others, Friedman and Modigliani's models.

#### 4.1 Consumption theory

According to Friedman there are two motives for a household to spend more or less on consumption than its income: to smooth its consumption expenditures through an appropriate timing of borrowing and lending; or to realize interest earnings on deposits and borrowings. The behaviour of a household under the joint influence of these factors depends on its tastes and preferences. Building on these motives, Friedman developed the Permanent income hypothesis (PIH).

Friedman argues that the allocation of consumption across consecutive periods is the result of an optimizing method by which each household tries to maximize its utility and at the same time, to allocate consumption expenditures in every period. That is to say, households try to optimize not only across periods but also within each period.

In a paper on PIH by John Muth (1960), the author shows that the marginal propensities to consume outside of current and lagged income, depends on its stochastic properties. Income processes with large transitory components show that households have little propensity to consume outside of their current income. If the majority of the change in income is permanent, i.e. follows a random walk, the propensity to consume only slightly differs from permanent income. This result has important implications and has often been overlooked in empirical work (Hall 1978), e.g. in Mayer (1972a) when estimates of propensities to consume was interpreted as evidence against the PIH, without discussion of the stochastic process of income (Hall, 1978).

The evidence, however, is actually ambiguous because the PIH together with a plausible income process can well explain the degree of sensitivity found among households. Hall (1978) tackles some of these issues by deriving a model from a theory of the stochastic process of consumption, from both the LCH and PIH.

Furthermore, Hall (1978) shows how PIH is supported by current information criteria, e.g. that past income should not contain any additional explanatory power about current consumption above past consumption. Additional support from empirical studies of 2000 households by Hall and Mishkin (1980) shows positive responses in consumption to movements of income. The permanent movement of income was moreover much stronger than the transitory. This finding supports the idea of using consumers' confidence in the estimation of DTIR, since consumers' confidence is a good indicator of to what degree current income is transitional.

Aside from establishing support for how different sources of income have different responses in household consumption, Hall and Mishkin (1980) show how temporary income tax policies have smaller effects on consumption than other, more permanent changes in income of the same magnitude – casting doubt on the wisdom of temporary policy interventions to manipulate aggregate demand by changing disposable income. Lucas (1976) points out that if most households reacted only to the new information about their permanent incomes conveyed by an announced policy change, then policymakers would face the complex task of understanding the households' respective interpretations of the announcement. Lucas (1976) presents evidence of the obstacles to policy evaluation in these circumstances. Temporary changes in interest rate could evidently have minor effect in the smoothening of consumption across periods.

Hall and Mishkin (1980) also show that consumption is more sensitive to current income than it would be in an economy where every household borrowed and lent freely at the treasury bill rate, i.e. Hall and Mishkin suggests there is not a perfect capital market. Still, consumption is much less sensitive than in an economy where no household ever borrows or lends at all. Relatively few households behaved as if constraints on borrowing were important. This finding, however, was based on food consumption, and Hall and Mishkin argue that there is not necessarily the same amount of sensitivity on durable purchases, such as dwellings, in this case. In contrast, Friedman's theory argues that consumption is linked to the permanent income of households. Thus, when income is affected by transitory shocks, household consumption should not change, since savings or borrowing can be used to adjust. This implies that households are able to finance consumption with earnings that are not yet generated, and thus assume perfect capital markets.

Many of the rejections of the PIH emphasize the importance of liquidity constraints. This places a focus not on the PIH's behavioural assumptions, but rather on its ancillary assumption that households can easily borrow or lend. This insight has led to adjustments of the simplest PIH model to account for factors, for example, capital market imperfections.

As seen in the LCH developed by Modigliani and Ando (1957), households try to smooth their consumption over time to maximize their aggregate utility – just as in the PIH. Essentially, the two theories are closely related, but the LCH pays more attention to the motives for saving and argues in favour of including wealth, while the PIH focuses on the characteristics of the income process. In the LCH, present consumption is affected by total wealth – i.e., initial wealth plus current and expected future income. While on the other hand, the PIH relies on the assumption that consumption is affected by permanent income and transitory income. The LCH may be more useful in an econometric model, however, since it explicitly includes measures of current income and assets, which is more clearly interpretable than the characteristics of the income process.

In this paper a slightly modified maximization problem is analysed of the PIH and LCH theories, derived by Hall (1979). From his model the utility maximization problem is performed subject to a budget constraint. The mathematical formulations are represented as follows:

Maximize expected lifetime utility:

$$E_t \sum_{\tau=0}^{T-t} (1 + \delta)^{-\tau} u(c_{t+\tau}), \quad (1)$$

subject to budget constraint:

$$\sum_{\tau=0}^{T-t} (1 + rr)^{-\tau} u(c_{t+\tau} - w_{t+\tau}) = A_t, \quad (2)$$

where:

$E_t$  = future expectation conditional on all information available in  $t$ ,  
 $\delta$  = discount rate,  
 $rr$  = real interest rate,  
 $T$  = length of economic life,  
 $u()$  = utility function,  
 $c_t$  = consumption in period  $t$ ,  
 $w_t$  = earnings in period  $t$  and  
 $A_t$  = assets in period  $t$ .

If this maximization problem is solved, the following expression is achieved:

$$E_t u'(c_{t+1}) = \frac{1 + \delta}{1 + rr} u'(c_t). \quad (3)$$

The model derived by Hall (1979) relies on the assumption of perfect capital markets. However, as it was later shown by Hall and Mishkin (1980), the consumption sensitivity was evidence that the market was not entirely efficient. Hence, the use of Treasury bill rates is being replaced by real mortgage rates, partially capturing the inefficiency effect, although not at the individual level. Aggregate household debt depends on demographic factors, expected path of future income, and rate of time preference. In the LCH framework the demographic factor is reliant on the fact that most households experience a rising income through their working life, hence debt will be substantial relative to income early in life and decline gradually with age. Also, the future income is assumed to cover both wage earning but also income from assets, which is in line with the LCH.

Furthermore, in both theories the time preference households exhibit at any given moment is determined solely by their personal preferences. For example, individuals with a high rate of time preference places more emphasis on their wellbeing today rather than tomorrow, and vice versa. In the model this variation is captured by the discount factor.

From the Hall model, it is clear that if the discount rate ( $\delta$ ) and interest rate ( $rr$ ) are equivalent, the consumption in period  $t$  would be exactly the same as the expected consumption for all future periods. Yet the ability to achieve this hinges on consumers not facing credit constraints. As mentioned earlier, the LCH and PIH theories emphasise on the importance of no liquidity constraints. However, this critique is focused not on the LCH and PIH's behavioural assumptions, but rather on its ancillary assumption that households can easily borrow or lend. Still, they may be restricted by income and their ability to post collateral (Rinaldi & Sanchis-Arellano, 2006). In most countries, including Sweden, financial institutions do not lend the full value of a dwelling, requiring the household to invest some of its own money to be able to take on the mortgage. Hence younger households have to save money in order to be able to pay for the down payment. Despite these kinds of regulations, financial institutions also have additional limits, which are contingent on the household's disposable income, in order to be able to serve the loans. When household income and savings grow, the credit constraints are eased (Debelle, 2004).

Another point made evident by Barbra and Pivetti (2009) in their study of the US market is that through household debt, low wages appear to have been brought to coexist with relatively high levels of aggregate demand. This means that income inequalities tend to give a rise of the DTIR and that households are influenced by the behavior of the surroundings and not only to smooth their consumption over time, as in the LCH and PIH. If a household's income is decreased or the surrounding households' incomes are increased, this states that inferior income households will sustain consumption through increased debt, *ceteris paribus*. This behaviour is possible until credit constraints are faced.

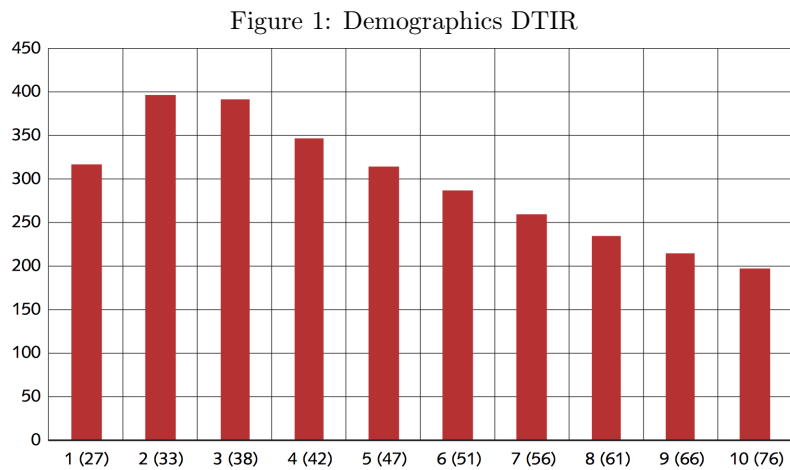
## 5 Discussion of economic determinants

Based on the above theory and suggested extensions mentioned, the macroeconomic variables for this study are thereby chosen. Below it is discussed how each variable from the existing theory could affect the DTIR. The variables to be discussed are, in order, demographics, house prices and dwelling ownership levels, interest rates, inflation, unemployment rate, consumers' confidence and household assets.



## 5.1 Demographics

As described above, consumption theory states that age affects household debt level because income is assumed to increase over time. This means that societies with a younger population would have higher household debt levels.



Source: Wistrand, Ölcer (2014)

Figure 1, illustrates the average DTIR in each age decile for Swedish households, where age is based on the age of the primary borrower. This concludes that individuals with an average age of 33 have the highest DTIR, which can be explained by the fact that many people at this age begin to start families and move to larger homes (Wistrand & Ölcer, 2014). This finding confirms the LCH in that younger households have higher DTIR than senior households, at least from ages around 33 and above. Still, it is not clear if the debt across ages differs because of income differences over a lifetime or because of changes of generation's attitude to debt. Wistrand and Ölcer (2014) also remark that it would be interesting to include information on educational level in these kind of studies since it generally affects salary growth as well. Due to a lack of available data on this topic, however, this paper will not include such an analysis.

Two other demographic factors that may affect the DTIR, both mentioned by Riksgälden (2015), are urbanization and population growth. If the population increases, it means that more people are competing within the housing market. Furthermore, it takes some time to build new dwellings in order to match demand. Thus, a rapidly changing population has effect on the house prices if supply does not shift along with the demand. In recent decades, Sweden's population has largely grown through immigration. This entails greater need for housing in the near future while an increasing birth surplus will further increase the demand for houses, but with a lag. Therefore, it can be stated that

Sweden's demand for housing will increase in the near future. At the same time the need for new housing is greatest in urban areas and growth regions (Riksgälden, 2015). Urbanization, a growing trend where households move to built up areas with more expensive dwellings, causes those with no savings to face an increased indebtedness, presumably pushing up the overall indebtedness of the population.

## 5.2 House prices and dwelling ownership levels

Swedish house prices have made a significant increase over the last few years and the majority of households' total assets are reflected in dwellings. Since few households can afford their home through savings, typically they are financed partially through debt. For those households which have purchased their dwellings early on, the dwellings contribute to an increase in their wealth. Correspondingly, for those who have not yet entered the market, the increased prices of dwellings could contribute to increased debt levels. For those that were able to enter the housing market early, their assets and collateral increase, meaning that their credit constraints will likely have eased according to theory. House prices therefore have a positive effect on debt levels in two ways. Firstly, households that have not yet entered the market must take on debt according to the present house price levels. Secondly, households that have already entered the market can use their dwellings as collateral, and as such increase their debt levels accordingly to price shifts in house prices.

Through tenancies, households get accommodation without having to take on mortgages, hence the distribution between owned and rented dwellings has an impact on the DTIR. In Sweden, an increasing number of households purchase their homes instead of renting them, driving up the number of households facing mortgages. One reason for this is that the market for rental units is damped by policy price and environmental regulations, making it less profitable for property developers to provide tenancies (Riksgälden, 2015).

## 5.3 Interest rate

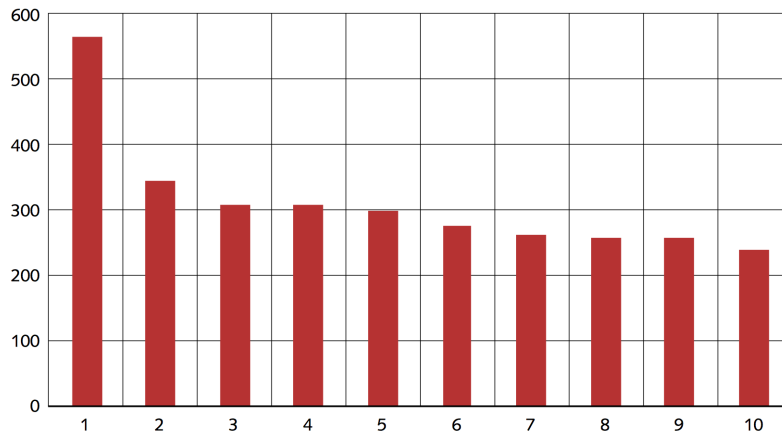
Our discussion of the existing theory shows that the consumption distribution is affected by real interest rate – i.e., nominal interest rate minus inflation. The Riksbank can adjust inflation with the use of nominal interest rate (repo rate) changes. Given that mortgage rates depend on the repo rate, they are assumed to be positively correlated, albeit with some delay. Furthermore, the tax system may vary with the rate of inflation according to Debelle, (2004), which has an effect on household indebtedness. In Sweden this can be seen for example in instances where mortgage interest payments on owner-occupied dwellings are tax-deductible. In the first half of the 1980s Sweden had negative after-tax real interest rates, which contributed to rapid growth in the borrowing for dwellings (Debelle, 2004).

From Equation 3 it can be seen that the real interest rate has a direct effect on the consumption distribution according to theory. Debelle (2004) remarks that changes in real interest rates first of all affect the real cost of borrowing, but it can also have implications beyond that. Given a household's income, a decline in nominal interest rates may lead to an increased threshold of the amount a financial institution is willing to lend a household. As mentioned earlier, greater indebtedness makes the household sector more sensitive to changes in macroeconomic variables and thus real interest rates. This sensitivity is furthermore found to be higher where households have variable instead of fixed rate mortgages (Debelle, 2004).

#### 5.4 Unemployment rate

The most significant and probably the largest negative shock to a household's income is unemployment. In societies with large indebtedness, sensitivity will increase with a rise in unemployment, and high unemployment may also amplify the effect of a negative shock. According to Barba and Pivetti (2009), an increased rate of unemployment may result in affected households increasing their debt to keep up consumption. However, this is only sustainable until the credit constraints are met. If reached, unemployment has the potential to increase the number of distressed sales and push up the likelihood of a downward spiral in house prices (Debelle, 2004). As described in the theory above, consumption is dependent on future expectations of a household's economy – decreasing if affected by unemployment. Hence, the LCH and PIH theories contradict Barba and Pivetti (2009) and the theoretical effect from unemployment on DTIR is twofold.

Figure 2: DTIR for different income deciles



Source: Wistrand, Ölcer (2014)

Through inspection of the DTIR at different income deciles in Sweden (Figure 2), the theory from Barba and Pivetti (2009) seems to be supported considering households with lower incomes have higher DTIR. In particular, individuals in the income decile 1 stand out with significantly larger DTIR than the other decile groups. The other groups seem to have a relatively stable linear negative relationship. However, by including unemployment the objective is to capture the effects suggested by the theory about these income inequalities.

### 5.5 Consumer confidence

Both PIH and LCH suggests that consumption is related to a household's future expectation  $E_t$ , which is reflected by the current economic situation. Hence, expectations of the future may be affected by many of the other macroeconomic variables, as for example unemployment. A variable reflecting the consumers' confidence may consequently be a reasonable factor to include in the model.

### 5.6 Household assets

A household's assets can primarily be divided into gross and net terms. The LCH, but not the PIH, includes the net assets, which are the gross assets minus debt. According to the LCH, net assets have two effects on the DTIR. Firstly, income is affected by the assets in terms of returns and dividends on the equity. Secondly, the credit constraints are eased with increased net assets, which makes it possible for households to take on more debt (Debelle, 2004). Since a high proportion of the assets are from owner occupied dwellings, some of the assets' effect on DTIR may be captured from the house prices. One option is therefore to divide the assets into real and financial assets, where dwellings represents the real assets. The financial assets would then capture effects on DTIR from assets such as shares, bank deposits, mutual funds, bonds and insurance savings.

## 6 Method and empirical specification

Based on the previous theoretical discussion, this chapter focuses on the chosen variables, followed by the methods and empirical specifications used in order to complete the estimations.

### 6.1 Choice of variables

Through the assessment of existing theory, numerous variables are suggested to have an impact on the DTIR. In order to reduce the observed number of variables and avoid spurious results, as well as a lack of certain historical data, not all variables discussed in the theory section are considered. For instance, inflation and nominal interest rate are merged to the real effect. As discussed by Modigliani (1957), consumption shall be even over a lifetime in order to maximize utility, which results in individuals taking on more debt earlier in their

lifetime. However, there is not sufficient amount of historical age distribution data to test this from an econometric point of view, even though the DTIR distribution among ages still supports the hypothesis. The two other demographic variables mentioned, population growth and urbanization, will not be considered either. To get a realistic impact of changes in population, the market for dwellings needs to be considered, an area where there is not a sufficient amount data available. The same problem applies to dwelling ownership levels, and likewise is the reason why these two variables also are left out from the model.

As mentioned in the theory, financial assets are extracted from total assets to avoid capturing the effects from dwellings twice. Additionally, some variables are log transformed to consistently span all variables and get comparable scales. Despite these adjustments the variables are in line with the theoretical framework. The main model is represented as:

$$l\_DTIR = f(l\_HPI(+), RIR(-), Unemp(?), l\_CCI(+), l\_FATI(+)) \quad (4)$$

where,  $l\_HPI$  is the log transform of the house price index,  $RIR$  real interest rate,  $Unemp$  the unemployment rate,  $l\_CCI$  log transform of consumer confidence index and  $l\_FATI$  the log transform of financial assets to income ratio. The expected impact on DTIR suggested from the theory is denoted by signs (+, -) in the specification. It is know from the theory that the unemployment effects are twofold, and are denoted by a question mark, since the net effect is unknown.

## 6.2 Diagnostic tests on OLS

A standard ordinary least square (OLS) estimation is run for comprehensive purposes. Furthermore, diagnostic tests of autocorrelation, normality and heteroskedasticity are completed to check the representability of the estimate, i.e. if it fulfills the Gauss-Markov conditions. The initial regression has the following representation:

$$l\_DTIR_t = \beta_0 + \beta_1 l\_HPI_t + \beta_2 RIR_t + \beta_3 Unemp_t + \beta_4 l\_CCI_t + \beta_5 l\_FATI_t + e_t \quad (5)$$

Autocorrelation implies that the distribution of error terms is not independent and identical, and also that the covariance matrix is non-diagonal, such that correlation exists between different error terms. In case of autocorrelation, this may lead to the OLS being biased and even if it remains unbiased, the routinely computed variance and standard errors are based on the wrong expression. Thus standard t- and F-tests will no longer be valid and interferences will be misleading (Verbeek, 2012).

Autocorrelation is tested by a Breusch-Godfrey Lagrange-Multiplier (LM) test, mathematically represented below.

$$LM = (N - q)R^2 \sim \chi_q^2 \quad (6)$$

Here,  $N$  is the number of observations,  $q$  the order of serial correlation and  $R^2$  the power of the auxiliary regression. Under the null hypothesis of no serial correlation, the test has a chi-square distribution with  $q$  degrees of freedom.

Heteroskedasticity arises if different error terms do not have identical variance, so that the diagonal elements of the covariance matrix are not the same. This is a common problem with time series data (Verbeek, 2012). In the case where the covariance matrix is diagonal, but not equal to the variance times the identity matrix, it is referred to as heteroskedastic. Furthermore, the error terms are mutually uncorrelated, while the variance in the error term may vary over the observations.

Heteroskedasticity is tested using the White's test. To execute the test,  $NR^2$  is obtained in the regression of  $e_t^2$  on a constant and all (unique) first moments, second moments and cross-products of the original regressors. The test statistic has the asymptotic distribution of Chi-square with  $P$  degrees of freedom, where  $P$  is the number of regressors in the auxiliary regression, excluding the intercept. In comparison to the Breusch-Pagan test, the White's test excludes any higher-order terms. Consequently, the White's test may detect more general forms of heteroskedasticity than the Breusch-Pagan test. Although this is a virtue, it is at the same time a potentially serious shortcoming. The test may reveal heteroskedasticity, but it may also instead identify some other specification error, such as an incorrect functional form (Verbeek, 2012).

In financial time series, volatility clustering is in practise a behaviour often seen. A big shock in the residuals is often followed by another big shock in either direction, and a small shock tends to follow small shocks, i.e. the variance of the error term at time  $t$  depends upon the squared error terms from previous periods. A way to model these patterns is to allow the variance of  $e_t$  to depend on its history. This concept of autoregressive conditional heteroskedasticity (ARCH) was proposed in a paper by Engle (1982). The presence of ARCH errors in a regression or an autoregressive model does not necessarily invalidate the OLS estimation. However, it does imply that a more efficient (nonlinear) estimator may exist. When testing for the presence of ARCH effects it is sufficient to run an auxiliary regression of squared OLS residuals  $e_t^2$  with lagged squares  $e_{t-1}^2, \dots, e_{t-p}^2$  and a constant and compute  $T$  times the  $R^2$ . The test follows an asymptotic chi-square distribution under the null of homoscedasticity, against the alternative that the errors follow an ARCH process (Verbeek, 2012).

### 6.3 Unit root tests

Cointegration methods have been very popular tools in applied econometric work since their introduction about 35 years ago. However, these methods rely on the strict unit-root assumption (Österholm and Hjalmarsson, 2007). To examine the properties of the data, or how the data is affected by time, a unit-root test can be performed.

A variable is said to be strictly stationary if its properties are unaffected by a change of time origin, i.e. the joint probability distribution for any time set is not under the influence of an arbitrary shift along the time axis (Verbeek, 2012). This implies that the variable has the same distribution and that the covariance between  $Y_t$  and  $Y_{t-k}$  for any  $k$  does not depend upon  $t$ . The opposite, a so-called non-stationary variable, can arise from different sources. However, an important case of non-stationarity is the presence of a unit root.

An auto-regressive process with one lag (AR(1)) is considered to be a unit root if the lagged coefficient,  $\theta = 1$ . This also implies that the intercept term is zero. Stationarity can further be achieved with a non-zero intercept term by differencing the AR(1) process, i.e. by integration of order one (Verbeek, 2012).

The order of integration, denoted  $I(\cdot)$ , specifies the number of differences to reach stationarity, e.g. first order,  $I(1)$  is called a random walk with drift and reflects a deterministic trend in  $Y_t$  and is difference stationary. This is vital because in the long run it makes a considerable difference whether the series has an exact unit root or whether it is slightly larger than one, i.e. being  $I(0)$  or  $I(1)$  (Hjalmarsson & Österholm, 2007). A stochastic process of order zero fluctuates around its mean with a finite variance and does not depend on time. In the long run it has a mean-reverting characteristic with limited memory, implying that the effects of a particular random innovation are only transitory. However, processes integrated of order one have a tendency to wander widely, suggesting that an innovation will permanently affect the process (Verbeek, 2012).

In a model with unit roots, a shock has persistent effects that last forever, while shocks are only temporary in case of a stationary model. Of course, the long run effect of a shock is not necessarily in the same magnitude as the short run effect. Testing the presence of a unit-root was proposed in a paper by Dickey and Fuller (1979) and will be considered in the Estimation chapter.

### 6.4 Cointegration

Cointegration arises when a particular linear combination of two or more variables integrated of order one exists. Formally, this happens if there is some value such that  $Y_t - \beta X_t$  is  $I(0)$ , although  $Y_t$  and  $X_t$  are  $I(1)$ . In such a case, it is said that  $Y_t$  and  $X_t$  are cointegrated. This can also be thought of as a long run relationship between the two variables and that the non-stationary series

shares the same stochastic trend. However, cointegration has implications for the short run behaviours as well, since mechanisms must exist that can drive the variables to their long run equilibrium. The mechanism behind this is driven by an error correction mechanism, where the short run dynamics also are driven by the ‘equilibrium error’ (Verbeek, 2012). The cointegration analysis is although more complex since the cointegrating vector generalizes to a cointegrating space, where the dimension of which is not known a priori. That is to say, when a set of  $k$   $I(1)$  variables are included, there may be up to  $k - 1$  independent linear relationships that are  $I(0)$ , while any linear combination of these relationships are by construction also  $I(0)$ . This implies that individual cointegrating vectors are no longer statistically identified, only the space spanned by these vectors is. Ideally, vectors in the cointegrating space can be found to have an economic interpretation and be interpreted as representing long run equilibria (Verbeek, 2012). To identify and analyse cointegrating relations, the Johansen framework is used, which is based on a VAR-model. The first part in this section therefore shows how the VAR-model is specified.

#### 6.4.1 Vector autoregressive (VAR) model specification

In order to specify the VAR-model, an appropriate number of lags needs to be determined. From lag-selection theory the two most common criteria are the Akaike’s information criterion (AIC) (Akaike, 1973):

$$AIC = \log(\hat{\sigma}^2) + 2\frac{k + n + 1}{T}, \quad (7)$$

or the alternative Bayesian information criterion (BIC) proposed by Schwarz (1978):

$$BIC = \log(\hat{\sigma}^2) + \frac{k + n + 1}{T} \log(T). \quad (8)$$

Here,  $\hat{\sigma}^2$  is the residual sum of squares divided by the sample size,  $k$  the lag order,  $n$  the sample size and  $T$  the time variable. Usually the AIC tends to result asymptotically in over-parameterized models, but is widely used in common practise. Others argue that the model with the smallest AIC or BIC value is preferred although one can choose to deviate from this if the differences in criterion values are small for a subset of the models (Verbeek, 2012).

To determine an appropriate number of lags, the AIC and BIC are used, but potential problems with autocorrelation, ARCH and normality are also considered. The general VAR-model looks as follows:

$$\begin{bmatrix} y_{1,t} \\ \vdots \\ y_{i,t} \end{bmatrix} = \begin{bmatrix} c_1 \\ \vdots \\ c_i \end{bmatrix} + \begin{bmatrix} \beta_{1,1} & \cdots & \beta_{1,j} \\ \vdots & \ddots & \vdots \\ \beta_{i,1} & \cdots & \beta_{i,j} \end{bmatrix} \begin{bmatrix} y_{1,t-k} & \cdots & y_{i,t-k} \\ \vdots & \ddots & \vdots \\ y_{1,t-k} & \cdots & y_{i,t-k} \end{bmatrix} + \begin{bmatrix} e_{1,t} \\ \vdots \\ e_{i,t} \end{bmatrix} \quad (9)$$



In order to check for autocorrelation a Portmanteau test for autocorrelation in the residuals is made. Instead of testing randomness at each distinct lag, Ljung-Box tests the overall randomness based on a number of lags and whether the autocorrelation is different from zero. This is mathematically described below.

$$Q = n(n + 2) \sum_{k=1}^h \frac{\hat{p}_k^2}{n - k} \log(T), \quad (10)$$

where,  $n$  is the sample size,  $\hat{p}_k$  the sample autocorrelation at lag  $k$ , and  $h$  is the number of lags being tested. Under the null the statistic follows a chi-square distribution with  $h$  degrees of freedom.

To diagnose the model for normality, a Doornik-Hansen multivariate normality test is performed, where the multivariate observations are transformed. This is followed by a computation of the univariate skewness and kurtosis for each transformed variable, which are then combined into an approximate chi-square statistic (Doornik and Hansen, 2008).

Since quarterly data is used, seasonality tests are performed using a Wald's test. Under the null, this test statistic approximately follows a chi-square distribution.

#### 6.4.2 Vector error correction model (VECM)

The Vector Error Correction Model (VECM) is a convenient reformulation of the unrestricted VAR-model in terms of differences, lagged differences, and levels of the process, where the likelihood function is unchanged. The reproduced VAR-model can be formulated as a VECM:

$$\Delta y_t = \Gamma_1 \Delta y_{t-1} + \dots + \Gamma_{k-1} \Delta y_{t-k+1} + \alpha \beta' y_{t-1} + \mu + e_t, \quad (11)$$

where,  $\Gamma_1 \Delta y_{t-1} + \dots + \Gamma_{k-1} \Delta y_{t-k+1}$  are some lagged stationary variables and  $\beta' y_{t-1}$  is a vector of stationary cointegrating relations (Juselius, 2005).

There are four advantages with the VECM formulation; firstly, it significantly reduces the problem with multicollinearity which is strongly presented in time series data. Secondly, the determination of long run effects is summarized in the levels matrix  $\alpha \beta'$ , which can be analysed when solving the cointegrating relations. That is to say, if  $\alpha \beta' > 0$  there is no cointegration between the analysed variables. Thirdly, coefficients can be naturally classified into long run and short run effects because the interpretation of the estimates is more intuitive. Finally, the model gives the direct answer to why a variable may change from the previous period to the present (Juselius, 2005).

### 6.4.3 Johansen framework

In order to analyse the cointegrating relations within the VAR-system the number of cointegrating vectors need to be determined as well as testing for exclusion of variables and weak exogeneity.

**6.4.3.1 Rank test** To analyse the number of cointegrating relations ( $r$ ) in a model, Johansen and Juselius (1990) has developed a rank test. More formally, the VAR-model and its presence of stochastic trends leads to a reduced rank condition on a long run matrix  $\Pi = \alpha\beta'$ , where  $\alpha$  is an adjustment vector and  $\beta$  a cointegrating vector. Within the VAR-model, the cointegration hypothesis can be formulated as a reduced rank restriction on the  $\Pi$  matrix. In the Johansen framework the VAR-model is generally reproduced in the VECM form under the  $I(1)$  assumption as: (same as equation 11):

$$\Delta y_t = \Gamma_1 \Delta y_{t-1} + \dots + \Gamma_{k-1} \Delta y_{t-k+1} + \alpha\beta' y_{t-1} + \mu + e_t, \quad (12)$$

where,  $\Gamma_1 \Delta y_{t-1} + \dots + \Gamma_{k-1} \Delta y_{t-k+1}$  are some lagged stationary variables,  $\beta' y_{t-1}$  is an  $r \times 1$  vector of stationary cointegrating relations and  $\alpha\beta'$  is the matrix where the rank test is performed (Juselius, 2005).

When the rank test of  $\alpha\beta'$  is performed, Johansen uses two different analyses regarding its eigenvalues  $\lambda$ . The estimated eigenvalues can be tested for the null  $r \leq r_0$  versus the alternative  $H_1 : r_0 < r \leq k$ . This is tested using the statistic:

$$\lambda_{trace}(r_0) = -T \sum_{j=r_0+1}^k \log(1 - \hat{\lambda}_j), \quad (13)$$

which is called a trace test and checks whether the smallest  $k - r_0$  eigenvalues are significantly different from zero. Furthermore, the null of  $r \leq r_0$  versus the more restrictive  $H_1 : r = r_0 + 1$  can be tested using:

$$\lambda_{max}(r_0) = -T \log(1 - \hat{\lambda}_{r_0+1}), \quad (14)$$

which is called the maximum eigenvalue test (Vebeek, 2012).

**6.4.3.2 Weak exogeneity** To test for common driving forces in the system, weak exogeneity analyses are performed, i.e. tests for zero rows in the adjustment coefficient vector  $\alpha$ . Consequently, defining specific variables that have influenced the long run stochastic path of the other variables in the system, while at the same time has not been influenced by them. If certain variables can be regarded as weakly exogenous this can be regarded as a conditioning variable in the model, and a partial model is generated. The main reason of conditional weakly exogenous variables instead of including the full system is

that one often can achieve more stable parameters (Juselius, 2005). A variable that has a zero row in  $\alpha$  does not adjust to the long run relations and, hence, can be considered a common driving trend in the system (weakly exogenous). The test is performed as:

$$R'\alpha = 0, \tag{15}$$

where  $R' = [0\ 1\ 0\ 0\ 0]$  if the second variable should be tested for weak exogeneity. Another indicator of weakly exogenous variables is whether the error correction term in the VECM is significant or not. If it is not significant, the dependent variable included can be assumed to be weakly exogenous (Juselius, 2005).

**6.4.3.3 Exclusion restrictions on cointegrating vector** Discussed above are restrictions on  $\alpha$ . Most common trend models are, however, identified based on exclusion restrictions on  $\beta$ . For example, one can do a test of long run exclusion of a linear trend in the cointegrating vector. The test is formulated as:

$$R'\beta = 0, \tag{16}$$

where  $R' = [0\ 1\ 0\ 0\ 0]$ , if exclusion of the second variable is tested. By comparing the results before and after the restriction and investigating the test acceptance, it is possible to determine whether the variable can be excluded or not (Juselius, 2005).

## 7 Data

In the model quarterly data is used between Q4 1985 and Q4 2015, i.e. a sample set of 120 observations. Since no earlier or later data is found for all variables, the span is simply chosen because of this reason. The variables included, motivated from theory, are described below.

### 7.1 Debt to income ratio

The DTIR is obtained from the Riksbank (Riksbanken, 2015). This data refers to the aggregate household DTIR, including tax liabilities and student debts, and is calculated as the total debt as a percentage of total disposable income in Sweden.

### 7.2 House price index

The HPI are included in real terms and are collected from Statistics Sweden (SCB, 2016). This data refers to one- and two-family houses and terraced

houses. The index takes into account that it is not necessarily fully comparable properties sold at each measurement by dividing the properties sold after tax assessment and geographic location.

### 7.3 Unemployment

The unemployment rate is collected from the database of EUROSTAT (2015) and is adjusted for seasonal variation.

### 7.4 Real interest rate

The RIR is calculated as Swedbank's five year mortgage rate for dwellings minus Sweden's inflation. The interest rate is collected from Swedbank (2015) and the inflation is calculated from the consumer price index as the quarterly average of monthly data. This is collected from SCB (2016).

### 7.5 Consumers' confidence index

The CCI is collected from Konjunktursinstitutet (2016). This data is a combination of two surveys, one between 1985 to 1992 and a similar from 1993 to 2016. In the first survey the candidates are asked about their expectations of their own and Sweden's economy in twelve months. The second survey is performed in the same way except an extension about expectations of capital goods future prices. Both surveys indicators are standardized with a mean of 100 and standard deviation 10.

### 7.6 Financial assets to income

The FATI data is collected from SCB (2016) and regards the aggregate households financial assets divided by the total household's income in Sweden.

## 8 Estimation

This chapter deals with the estimates made based on the above method and empirical specification. First, the OLS estimation is shown where diagnostic tests are made. Further estimations are made to correct for possible problems and to get meaningful results for both the long run and short run analysis.

### 8.1 Diagnostic tests on OLS

In order to get a better understanding of the data, it is visually inspected. By running an OLS estimation based on the regression model;

$$l\_DTIR_t = \beta_0 + \beta_1 l\_HPI_t + \beta_2 RIR_t + \beta_3 Unemp_t + \beta_4 l\_CCI_t + \beta_5 l\_FATI_t + e_t \quad (17)$$

the results illustrated in the table below are generated.

Table 1: OLS, using observations 1985:4-2015:4 ( $T = 120$ ), Dependent variable: DTIR

	Coefficient	Std. Error	$t$ -ratio	p-value
const	2,21501	0,266493	8,3117	0,0000
$l\_HPI$	0,453428	0,0324974	13,9528	0,0000
$RIR$	-0,00201690	0,00513219	-0,3930	0,6951
Unemp	-0,0314271	0,00392422	-8,0085	0,0000
$l\_CCI$	0,100189	0,0693882	1,4439	0,1515
$l\_FATI$	-0,0365003	0,0623402	-0,5855	0,5594
Mean dependent var	4,831392	S.D. dependent var	0,219100	
Sum squared resid	0,583387	S.E. of regression	0,071225	
$R^2$	0,898728	Adjusted $R^2$	0,894325	
$F(5, 115)$	204,1105	P-value( $F$ )	1,89e-55	

In order for an OLS to be the best linear unbiased estimator (BLUE), it needs to fulfill the Gauss-Markov conditions (A1)-(A4) (Verbeek, 2012). To test for autocorrelation, a Breusch-Godfrey Lagrange-Multiplier (LM) test is used. This shows a p-value close to zero, which means that the null of no autocorrelation is rejected at a one per cent significance level, indicating that problems with autocorrelation may exist.

Testing for heteroskedasticity, using the White's test, also gives a p-value close to zero, i.e. the null of homoskedasticity is rejected at a one per cent significance level. Even the ARCH test resulted in a p-value close to zero, indicating that also ARCH effects may exist in the data.

From the diagnostic tests it is concluded that the OLS does not satisfy all the necessary Gauss-Markov conditions to be BLUE, since all three tests are rejected at very low p-values. This means that the  $t$ - and  $F$ -statistics are unreliable and overestimated, but the OLS parameters may however still be unbiased.

Looking at the coefficients and p-values in the OLS estimate, it can be seen that the variables  $l\_FATI$  and  $RIR$  does not seem to have any impact in the model. From this observation, enough motives are not found to keep these variables for further testing, since they are probably not good estimators of the DTIR. Hence, these variables are dropped from the model. However, even the p-value for  $l\_CCI$  is not significant. As will be seen further down it though seem to contribute in the cointegrating relation, and is therefore kept.

## 8.2 Unit root tests

Before the cointegration analysis, each variable has been tested for order of integration, i.e. stationarity conditions. This is performed with an augmented Dickey-Fuller (ADF) test and the results are shown in Table 2. Since quarterly data is used, seasonal dummy's are also included. Time series plots for all variables can be found in Figures 1 to 6 in Appendix.

Table 2: Unit root test using ADF

Variable	Method	Lags	Model	p-value	Order of integration
$l\_DTIR$	Level	4	$\beta_0 + \beta_1 t$	0.3361	$I(1)$
	First Diff	3	-	0.00434	
$l\_HPI$	Level	2	$\beta_0 + \beta_1 t$	0.2593	$I(1)$
	First Diff	4	-	0.01931	
$Unemp$	Level	1	$\beta_0 + \beta_1 t$	0.595	$I(1)$
	First Diff	0	-	6.399e-06	
$RIR$	Level	4	$\beta_0 + \beta_1 t$	0.09633	$I(1)$
	First Diff	3	-	4.004e-14	
$l\_CCI$	Level	0	$\beta_0 + \beta_1 t$	0.1122	$I(1)$
	First Diff	0	-	6.531e-85	
$l\_FATI$	Level	3	$\beta_0 + \beta_1 t$	0.2645	$I(1)$
	First Diff	0	-	1.861e-32	

### 8.2.1 Variable analysis

Based on the ADF test all variables are integrated of order one. However, as mentioned earlier the variables  $l\_FATI$  and  $RIR$  are dropped based on the OLS results. Henceforth, the new model has the following structure:

$$l\_DTIR = \beta_0 + \beta_1 l\_HPI_t + \beta_2 Unemp_t + \beta_3 l\_CCI_t + e_t \quad (18)$$

## 8.3 Cointegration analysis

This section starts out with the VAR-model specification followed by the cointegration analysis.

### 8.3.1 Specifying the VAR-model

In order to determine an appropriate number of lags, a lag order selection, based on the information criteria is done.

Table 3: VAR-system, lag order selection

Lags	loglik	p(LR)	AIC	BIC
1	759,48969		-12,805127	-11,936225
2	808,99426	0,00000	-13,398129	-12,143047*
3	833,66273	0,00003	-13,551553	-11,910293
4	845,07078	0,11874	-13,470279	-11,442840
5	861,93286	0,00592	-13,485537	-11,071920
6	883,86198	0,00021	-13,590477*	-10,790681
7	895,55098	0,10400	-13,514177	-10,328201
8	910,00858	0,02451	-13,486877	-9,914723

\* = Optimal lag order selection

From the lag criteria tests, shown in Table 3, AIC results in six lags, while BIC results in two. Since the AIC sometimes overrate the result, starting out with two lags seems reasonable. Based on the lag order selection the following VAR-model is specified:

$$\begin{bmatrix} l\_DTIR_t \\ l\_HPI_t \\ Unemp_t \\ l\_CCI_t \end{bmatrix} = \begin{bmatrix} c_1 \\ c_2 \\ c_3 \\ c_4 \end{bmatrix} + \begin{bmatrix} \beta_{1,1} & \beta_{1,2} \\ \beta_{2,1} & \beta_{2,2} \\ \beta_{3,1} & \beta_{3,2} \\ \beta_{4,1} & \beta_{4,2} \end{bmatrix} \begin{bmatrix} l\_DTIR_{t-1} & l\_HPI_{t-1} & Unemp_{t-1} & l\_CCI_{t-1} \\ l\_DTIR_{t-2} & l\_HPI_{t-2} & Unemp_{t-2} & l\_CCI_{t-2} \end{bmatrix} + \begin{bmatrix} e_{1,t} \\ e_{2,t} \\ e_{3,t} \\ e_{4,t} \end{bmatrix} \quad (19)$$

However, further tests are necessary for problems with autocorrelation, ARCH and normality. Running a Ljung-Box Q' Portmanteau test for autocorrelation in the residuals, given two lags, results in p-values above 10 per cent in all four equations, i.e. no indication of autocorrelation problems. The results from the ARCH tests are also comforting, with similar results and all p-values above 10 per cent. In the Doornik-Hansen test the null of normality is rejected at all levels. However, as discussed in (Juselius, 2005) non-normality is not a severe concern in the Johansen framework. Based on these discussions, inclusion of outlier dummies or more lags are not used in order to adjust for normality problems. Finally, the model is tested for seasonality. The result from the Wald's test shows that the null of seasonality could not reject at any significance level. As a result, inclusion of seasonality dummy's are made.

### 8.3.2 Johansen framework

Within the Johansen framework subsection the system is tested for rank, weak exogeneity and exclusion of variables.

**8.3.2.1 Rank test** To determine the number of cointegrating relations ( $r$ ), the Johansen rank test is performed, which is presented below.

Table 4: Johansen rank test

Number of equations: 4					
Lag order: 2					
Estimation period: 1986:2-2015:4 (T=119)					
Case: Unrestricted constant					
Tests: Trace and maximum eigenvalue					
Log-Likelihood: 1175.8 (including constant term): 837.788					
Cointegration tests					
Rank	Eigenvalue	Trace test	p-value	Lmax test	p-value
0	0.36230	81.806	0.0000	53.537	0.0000
1	0.15656	28.269	0.0754	20.262	0.0650
2	0.062933	8.0069	0.4719	7.7351	0.4150
3	0.0022812	0.27177	0.6021	0.27177	0.6022

Here,  $r$  is determined by identifying the lowest non-rejected rank. At a five per cent significance level neither the trace test nor the maximum eigenvalue test can be rejected for rank one and at a 10 per cent level for rank two. Hence, the rank test suggests there exist one or two cointegrating vectors. Hence, solely using the rank test in the determination of the number of cointegrating relations may be insufficient and requires further analyses. In Tables 5 and 6 the renormalized vectors of  $\beta$  and  $\alpha$  are presented.

Table 5: Renormalized  $\beta$ 

	$\beta_1$	$\beta_2$	$\beta_3$	$\beta_4$
$l\_DTIR$	1.0000	-11.683	37.754	-3.7443
$l\_HPI$	-0.6855	1.0000	-18.140	-0.4243
$Unemp$	0.1243	-12,631	1.0000	0.0074
$l\_CCI$	1.8894	297.76	-5.2100	1.0000

Table 6: Renormalized  $\alpha$ 

	$\alpha_1$	$\alpha_2$	$\alpha_3$	$\alpha_4$
$l\_DTIR$	0,0241	4,0257e-06	-0,0002	0,0007
$l\_HPI$	-0,0003	2,3463e-05	0,0013	0,0002
$Unemp$	-0,6548	9,5513e-05	-0,0047	0,0040
$l\_CCI$	-0,0420	-0,0005	0,0026	0,0011

From the first adjustment coefficient vector ( $\alpha_1$ ),  $Unemp$  seem to have the most significant impact adjusting to the long run equilibrium and this vector seem to contribute to a cointegrating relation. In the vectors  $\alpha_2 - \alpha_4$  all coefficients are close to zero, indicating that they have low impact in the adjustment to the long run equilibrium. Consequently, indication of a single cointegrating vector, ( $\beta_1$ ) rather than two is assumed.



**8.3.2.2 Weak exogeneity test** A weak exogeneity test is performed on each variable. The program used is Matlab and the built in *jctest* function with restrictions on the adjustment coefficient  $\alpha$ . When performing the test, one cointegrating relation is assumed, since this is suggested from the tests above.

Table 7: Weak exogeneity test

Test for null: $\alpha R' = 0$				
Rank: 1				
Restriction $R'$ -vector	[1 0 0 0]	[0 1 0 0]	[0 0 1 0]	[0 0 0 1]
Including: $l\_DTIR, l\_HPI, Unemp, l\_CCI$				
$H_0$ :	1	1	1	0
p-value	0.0076	0.027	0.0000	0.8660

From the results in Table 7, the variable  $l\_CCI$  is accepted to be weakly exogenous, with a p-value of 0.87. Then a valid inference can be obtained by the three dimensional system, describing;  $l\_DTIR, l\_HPI$  and  $Unemp$  conditional on  $l\_CCI$  (Juselius, 2005). Re-performing the diagnostic tests on the new model gives similar results, but slightly reduces all three problems. Hence, proceeding with this model seems reasonable. As in the diagnostic tests, re-performing the rank and lag length selection tests give similar results and assumptions of one cointegrating relation followed by two lag lengths are kept.

**8.3.2.3 Exclusion restrictions on cointegrating vector** With the assumption of only one cointegrating vector, it is investigated if any of the variables;  $l\_DTIR, l\_HPI, Unemp$ , or  $l\_CCI$ , is accepted to be excluded. When performing tests on each variable separately, none of them is accepted being dropped on a 10 per cent significance level.

Table 8: Restrictions on cointegrating vector  $\beta$

Test for null: $\beta R' = 0$				
Restriction $R'$ -vector	[1 0 0 0]	[0 1 0 0]	[0 0 1 0]	[0 0 0 1]
Including exogenous variable				
$H_0$ :	1	1	1	1
p-value	0.0976	0.0163	0.000	0.0026

Because the exclusion of any variable is not accepted at a 10 per cent level, as can be seen in Table 8, the inclusion of all variables seems reasonable.

### 8.3.3 Vector error correction model (VECM)

When test statistics of the VECM is performed on the restricted model including  $l\_DTIR$ ,  $l\_HPI$  and  $Unemp$  conditional on  $l\_CCI$  with two lags and rank one, the results shown in Table 9 is generated.

Table 9: VECM system, lag order 2  
Maximum likelihood estimates, observations 1986:2–2015:4 ( $T = 119$ )  
Cointegration rank = 1  
Case 3: Unrestricted constant

Equation 1:  $\Delta l\_DTIR_t$

	Coefficient	Std. Error	<i>t</i> -ratio	p-value
const	-0,233706	0,0753551	-3,1014	0,0024
$\Delta l\_DTIR_{t-1}$	0,104263	0,0960455	1,0856	0,2800
$\Delta l\_HPI_{t-1}$	0,0794524	0,0948461	0,8377	0,4040
$\Delta Unemp_{t-1}$	-0,000701501	0,00503579	-0,1393	0,8895
$\Delta l\_CCI_t$	0,0409035	0,0147103	2,7806	0,0064
S1	-0,0165753	0,00485948	-3,4109	0,0009
S2	-0,00686371	0,00451162	-1,5213	0,1310
S3	-0,00719387	0,00434913	-1,6541	0,1010
EC	0,0242546	0,0108491	2,2356	0,0274
Mean dependent var	0,004750	S.D. dependent var	0,019240	
Sum squared resid	0,030933	S.E. of regression	0,016769	
$R^2$	0,291860	Adjusted $R^2$	0,240359	

Equation 2:  $\Delta l\_HPI_t$

	Coefficient	Std. Error	<i>t</i> -ratio	p-value
const	-0,147320	0,0697973	-2,1107	0,0371
$\Delta l\_DTIR_{t-1}$	0,275936	0,0889617	3,1017	0,0024
$\Delta l\_HPI_{t-1}$	0,401263	0,0878507	4,5676	0,0000
$\Delta Unemp_{t-1}$	-0,000657926	0,00466437	-0,1411	0,8881
$\Delta l\_CCI_t$	0,0300497	0,0136253	2,2054	0,0295
S1	0,0205634	0,00450107	4,5686	0,0000
S2	0,0285493	0,00417887	6,8318	0,0000
S3	0,0182343	0,00402836	4,5265	0,0000
EC	0,00875339	0,0100489	0,8711	0,3856
Mean dependent var	0,015269	S.D. dependent var	0,022429	
Sum squared resid	0,026539	S.E. of regression	0,015533	
$R^2$	0,552932	Adjusted $R^2$	0,520418	

Equation 3:  $\Delta Unemp_t$ 

	Coefficient	Std. Error	t-ratio	p-value
const	4,32122	0,993060	4,3514	0,0000
$\Delta l\_DTIR_{t-1}$	3,50216	1,26573	2,7669	0,0066
$\Delta l\_HPI_{t-1}$	-3,22709	1,24992	-2,5818	0,0111
$\Delta Unemp_{t-1}$	0,558075	0,0663637	8,4093	0,0000
$\Delta l\_CCI_t$	-0,624649	0,193858	-3,2222	0,0017
S1	-0,0442549	0,0640403	-0,6910	0,4910
S2	0,119629	0,0594560	2,0121	0,0467
S3	0,0898678	0,0573146	1,5680	0,1198
EC	-0,691092	0,142973	-4,8337	0,0000
Mean dependent var	0,037815	S.D. dependent var	0,347440	
Sum squared resid	5,372232	S.E. of regression	0,220994	
$R^2$	0,622850	Adjusted $R^2$	0,595421	

From these results it can be concluded that the equation for  $\Delta l\_DTIR_t$  is significant at a five per cent level in the long run analysis (p-value on the error correction term,  $EC$ , is 0,03). The high p-value for  $l\_CCI$  from the OLS indicated that it was not significant, however, when performing the VECM without  $l\_CCI$ , the  $EC$  is not significant. Hence, the variable is assumed to contribute to the long run cointegrating relation and was not dropped together with  $l\_FATI$  and  $RIR$ , as mentioned before. In the short run only  $\Delta l\_CCI_t$  and one of the seasonality variables are significant. The magnitude of the coefficient for  $\Delta l\_CCI_t$  is although small and since quarterly samples are used, as in these contexts are short ranges, the short run results may be representing noise. From analysing the other systems it can be seen that the equation for  $\Delta Unemp_t$  gives the lowest p-value for the error correction term. This indicates that the other variables seem to have high impact on the unemployment rate in the long run. However, the equation for  $\Delta l\_HPI_t$  gives reason to suspect this variable to be weakly exogenous (insignificant error correction term). Although, these two findings will not be investigated further, the equation for  $\Delta l\_DTIR_t$  is still significant at a five per cent level in the long run analysis. Based on the estimation the adjustment vector  $\alpha$  and the cointegrating vector  $\beta$  is generated, including  $l\_CCI$  as a restricted weakly exogenous variable.

$$\alpha' = [0.024120 \quad -0.000296 \quad -0.654770 \quad -0.041971] \quad (20)$$

$$\beta' = [-6.5942 \quad 3.9297 \quad -0.5685 \quad -7.0532], \quad (21)$$

What can be concluded from the  $\alpha$ -coefficients is that  $Unemp$  has the highest impact adjusting the model towards equilibrium. However, the cointegrating

vector gives a better meaning when it is normalized, thus it has been transformed as:

$$\beta' = [1.0000 \quad -0.5959 \quad 0.0862 \quad 1.0696], \quad (22)$$

which leads to the equation:

$$EC = \beta_0 - l\_DTIR_t + 0.5959l\_HPI_t - 0.0862Unemp_t - 1.0696l\_CCI_t. \quad (23)$$

Here  $l\_CCI_t$  has the largest impact in the model, followed by the  $l\_DTIR_t$ ,  $l\_HPI_t$  and  $Unemp_t$ , respectively.

## 9 Conclusion

Supported by econometric relationships this paper investigates the macroeconomic determinants of Sweden's DTIR. The long run increase in DTIR is explained by increasing house prices and decreasing consumers' confidence and unemployment rate through the properties of cointegration. The coefficients magnitude states that an increase of one unit in the log of house prices will contribute to a 0.60 unit increase in the log of DTIR. Similarly, the log of consumers' confidence index and the unemployment rate have an impact of -1.07 and -0.09, respectively.

As anticipated and in accordance with theory, the rise in house prices has been a large contributor to the increase in DTIR. Noteworthy is that apartments, whose prices have increased more than other dwellings, are not included in the house price data (SCB, 2016). Nor that DTIR, compared to house prices, is adjusted for the significant difference between urban and rural areas. Considering these facts the model may suffer from heterogeneity effects, despite only one country is analysed. Simultaneously, such effects cannot be reduced completely, and is seen more as delimitation in this research. Considering the twofold theory of unemployment, results support a negative impact on the DTIR, which is in accordance with the LCH and PIH, but not with Barba and Pivetti.

Although the interpretation of house prices and unemployment may seem straightforward, others are slightly more complex. E.g. theory suggests that consumers' confidence has a positive impact on DTIR as opposed to our results for the long run model. Konjunktursinstitutet conduct the consumers' confidence through surveys in which consumers' future expectations of capital goods prices as well as their personal and Sweden's economy are collected. Consequently, a fall in consumers' confidence does not necessarily imply lowered expectations of house prices. Further investigations show that the similarity between the consumers' confidence and the Swedish business cycle is inevitably large. This belief that the expected future economy is a reflection of the present may rather indicate that the population has poor foresight. Since coherent data over the business cycle is unavailable, deeper analyses of the link are problematic. Yet, if the assumption is true, the link between DTIR and the consumers' confidence can be explained by that DTIR increases in recessions.

From theory, real interest rate and financial assets to income are suggested to influence DTIR, but do not show any impact in the estimation. Mortgages are by far the most significant portion of a household's total debt and the result that real interest rate do not have any effect on DTIR is unexpected. However, nor do financial assets to income show any effect on DTIR, which is less surprising since dwellings stand out as a household's major asset. Furthermore, dwellings are primarily debt financed, which is not the case for financial assets. The result does anyhow contribute to the conclusion that households does not seem to be affected by the credit constraints from the banks. An explanation

to the insignificance in the real interest rate may, in the long run, be due to a change in households' attitude towards debt. Furthermore, household's demand of borrowing may have grown faster than the interest rates' falling trend, while the interest rate fluctuations have been too small to undermine the demand for borrowing. Additional support can be found in Lucas (1976) who argues that temporary changes in interest rate could evidently have minor effect in the smoothening of consumption across periods. Hall and Mishkin (1980) also show how temporary income tax policies have smaller effects on consumption than other, more permanent changes in income of the same magnitude. With this conclusion, it is doubtful whether the Riksbank's proposition of a dual repo rate policy is relevant, when it appears that the real interest rate does not have an effect on the DTIR.

The results of the error correction analysis gives some insight into the deviations from the long run relationship described above, and in the short run, the effects seem to be small. In the VECM, there is a significant short term effect from the consumers' confidence, but the coefficient's magnitude is close to zero and may be representing noise, as previously mentioned. In the equation for  $\Delta Unemp_t$  an interesting observation is that DTIR, house prices and consumers' confidence seem to have a long run effect on unemployment (highly significant error correction term), suggesting that they may be good estimators of the unemployment rate. However, this fact is not investigated further but opens up for deeper causality analyses.

## 10 Further research

A drawback from the econometric testing of cointegrating relations in household data are especially that there is not much research available to compare with our findings. Even though there have been a few panel data studies of household behaviours and a recent study for the Australian private debt market, profound studies in the causality of interest rates among countries in the European union would be an interesting addition to current research. Furthermore, how come economic institutions, such as the Riksbank, focuses many of their analyses on interest rate fluctuations if, as suggested by Lucas (1976), households are insensitive to temporal monetary changes? Based on the results in this research an appropriate question could be if there exist an over-reliance on how interest rates affect the households' decisions in Sweden? Finally the relationship between urban dwellings and the household debt levels or the evident relation between unemployment and the housing market achieved from the VECM may be interesting subjects for further academic research.

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## Appendix

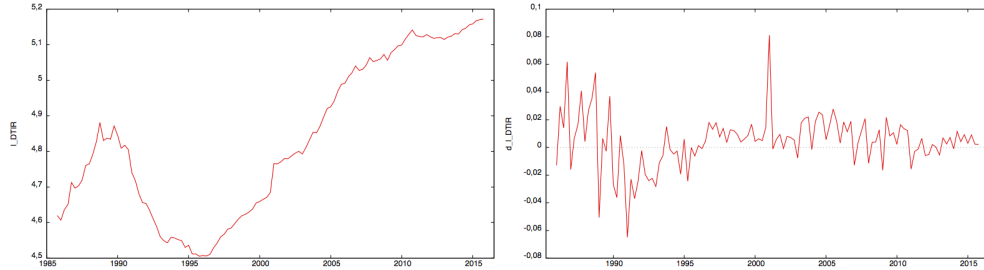


Figure 1: Logged DTIR and first difference of logged DTIR

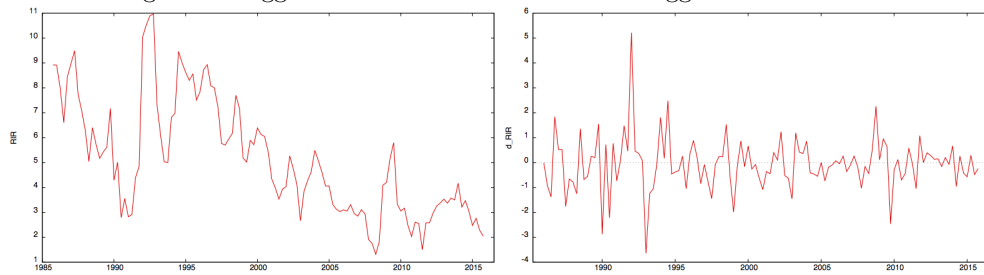


Figure 2: RIR and first difference of RIR

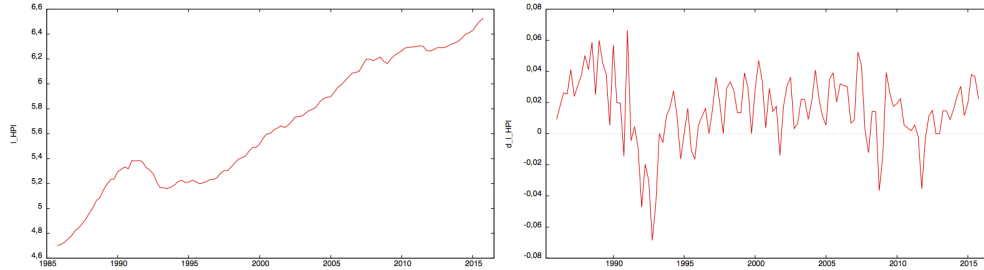


Figure 3: Logged HPI and first difference of logged HPI

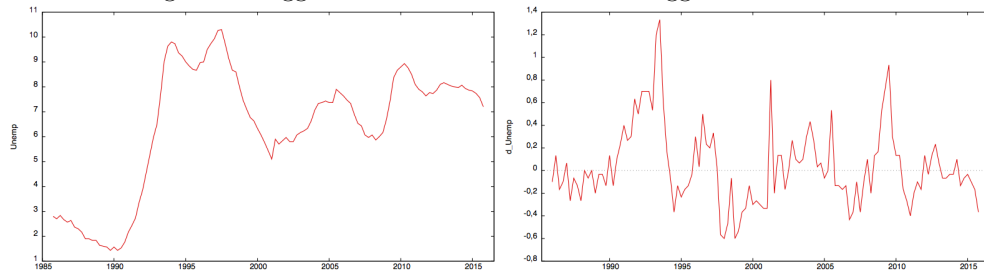


Figure 4: Unemp and first difference of Unemp

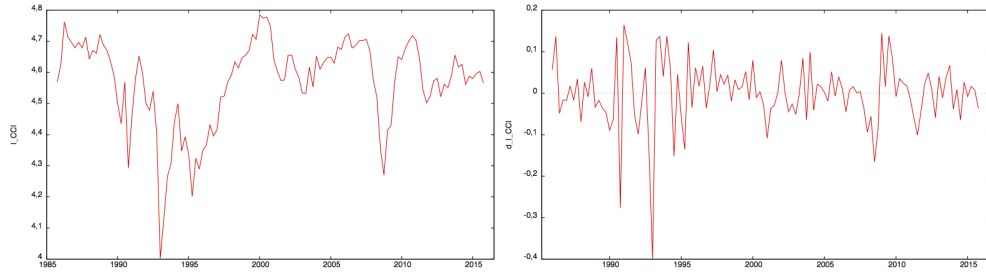


Figure 5: Logged CCI and first difference of logged CCI

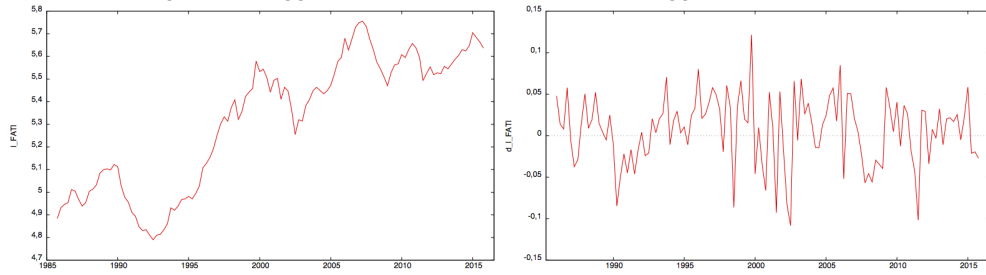


Figure 6: Logged FATI and first difference of logged FATI

## **Software**

MATLAB Release 2012b

Gretl 2016a