LUND UNIVERSITY
School of Economics and Management

Asymmetric Wealth Effects on Consumption: A Threshold Cointegration Approach on Swedish Households

Master's Thesis

by

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Lund, 16th of August 2017

in partial fulfilment of the requirements

for the degree of

Master of Science

Programme in Economics

Supervisor: **Emre Aylar**

Acknowledgements

Above all, I would like to express my gratitude to my supervisor Emre Aylar, who has been an encouraging motivator and valuable advisor. I am also indebted to Tillie Johansson and Eike Wülfers whose support and comments I highly appreciate. Last, but with no means least, I thank my family who made this thesis possible.

Abstract

Recognising the macroeconomic importance of private consumption, this thesis aims at examining possible forces that drive changes the level of households’ consumption. I do so by analysing the relationship of housing wealth, financial wealth, and consumption of households in Sweden in the short and long run. Using an M-TAR approach I find evidence for cointegration of these variables. Housing wealth and financial wealth appear to have positive effects on total consumption in the long run. Consumption is the error-correcting variable in the short run. However, without taking control variables into account, asymmetric disequilibrium adjustment cannot be verified significantly. Introducing broad money supply, to control for financial market conditions, results in weak evidence for the existence of asymmetric adjustment of total private consumption. Overall, housing wealth effects and financial wealth effects seem to play an important role in explaining changes in the level of consumption, and thus are of relevance for policymakers in the macroeconomy.

Keywords: wealth effects, private consumption, PIH, cointegration, M-TAR model

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1 Introduction

We live in a world where – especially in developed economies – private consumption vastly represents the largest part of aggregate demand, the economy's GDP. Consumption is observably less volatile than GDP but a huge drop in consumption is often connected to a recessive movement of economic output (Sorensen & Whitta-Jacobsen, 2010). Figure 1 captures the development of private consumption and the consumption-to-GDP ratio in Sweden over the past 47 years. It can be seen, that per-capita consumption almost monotonously increased during this period. Moreover, the graph reveals that a strong increase of the consumption-to-GDP ratio is connected to a decreasing or rigid level of consumption. Hence, the GDP dropped even more in these periods. This emphasises the importance of private consumption.

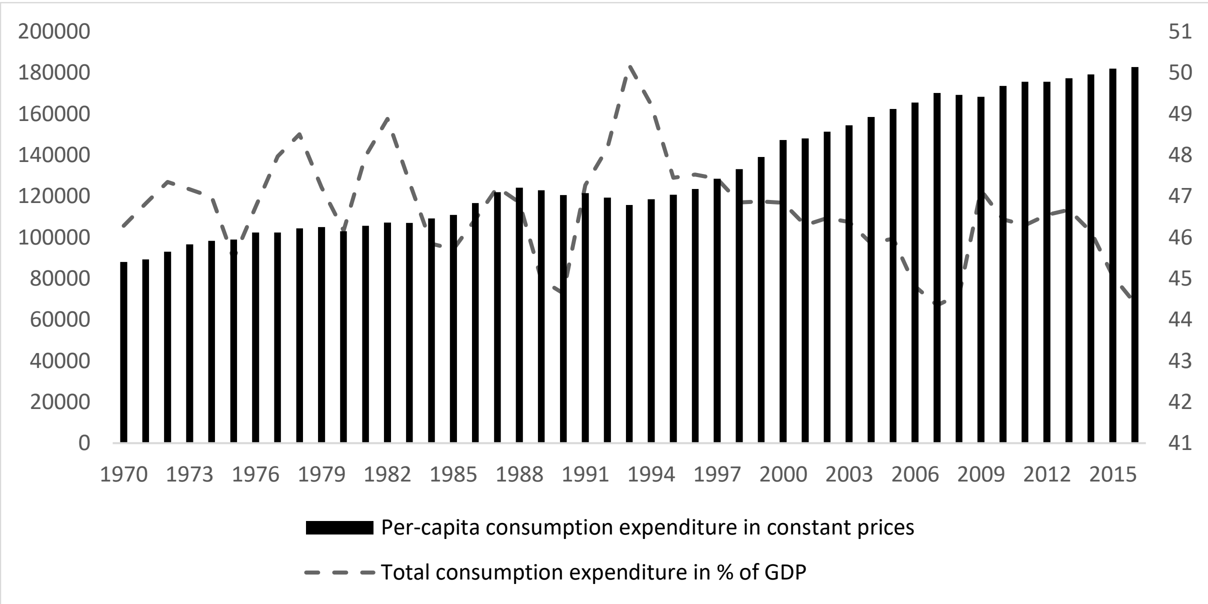

Figure 1: Swedish consumption figures from 1970 to 2016. Per-capita consumption on the left scale, consumption fraction of GDP on the right scale. Data source: worldbank.org *(2017)*

Figure 2 presents sources of funds to finance consumption. The data covers a shorter period of time, but it clearly points out that private net income has an upwards trend. However, more concerning is the upwards trend in the debt-to-income ratio, reaching more than 180% in 2016. Debt-financed consumption bears even more danger to cause a severe crisis if the level of consumption cannot be upheld (Cynamon & Fazzari, 2013).

According to Friedman's permanent income hypothesis, a household's consumption spending depends on the present value of expected lifetime income (Friedman, 1957). Having a relatively low volatility, disposable income is quite foreseeable and thus, according to Friedman's hypothesis, unlikely to explain changes in the level of consumption and debt. Hence, the increased consumption spending can be explained with Friedman's theory only if households expect higher future non-human wealth, which is the wealth that is not generated with human working power. Investigating the relationships between changes in non-human wealth and the level of private consumption represents the core issue of this thesis.

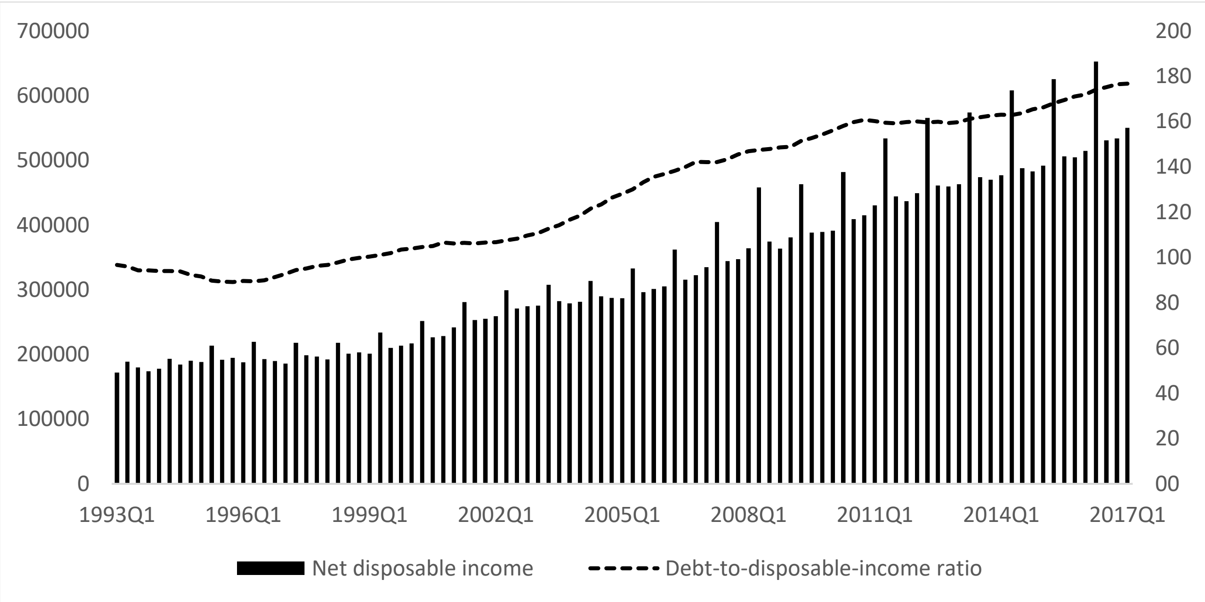

Figure 2: Net disposable income in million SEK (left scale) and debt-to-disposable-income ratio in % (right scale) for Swedish households from 1993Q1 to 2017Q1. Real values, not seasonally adjusted. Data source: Statistics Sweden *(2017)*

My objective is to deepen the research on the relationship of non-human wealth, expected non-human wealth, and consumption of households. To do this, I disaggregate household's finances into labour income, financial wealth, and housing wealth. I will test for cointegration between these variables, with a focus on housing wealth, financial wealth, and private consumption, and estimate long-term, as well as short-term behaviour. Asymmetries in the adjustments to equilibria are suspected to be existent since stock markets, labour markets, and housing markets are of different nature with respect to volatility and price rigidity (Tsai, Lee, & Chiang, 2012). Following the approach of Márquez et al. (2013) for the U.K.-case I aim to show that household consumption responds in different ways to wealth shocks of different kind and different direction. Márquez et al. find that positive housing wealth shocks have a positive effect on consumption, whereas negative housing wealth shocks have no effect. The Swedish economy has several features that make it a good candidate to investigate: First, Sweden has thorough, reliable, and available data, provided by Statistics Sweden. Besides that, Sweden is a developed economy with strong private consumption and financially sophisticated households, compared to other economies (Calvet, Campbell, & Sodini, 2006). Finally, housing wealth is an important wealth determinant in Sweden and is due to sharp price movements subject to research on a regular basis (see for example: Dermani et al. (2016)).

This thesis contributes to the research of macroeconomic consequences based on household financial decisions in existence of wealth shocks. For example, if households increase their consumption due to debt-financed increased housing wealth, this might bring them into an undesirable situation where their level of consumption possibly cannot be upheld if housing prices decline and the expected wealth never gets realized. If this happens to a high number of households, the macroeconomic effects can be critical for a whole economy. Besides the macroeconomic importance, the comparison of housing wealth shocks to financial wealth shocks gives information about different risk perception of labour income, financial assets, and real estate.

The remainder of this thesis is structured as follows. Section 2 states the motivation and hypothesis of my work and introduces the theoretical framework, before reviewing former literature. Section 3 first describes the methodology I will apply, and continues to discuss the choice of data. The results are presented and discussed in Section 4, where I will also debate open questions for future research. Section 5 concludes the findings.

2 Foundations

In this chapter, I reason the motivation that drives this work and state the hypothesis I try to verify with my research. In the following, I lead through the theoretical background as well as the former research that has been done on consumption and wealth effects.

2.1 Motivation and Hypothesis

The importance of consumption, mentioned before, raises attention to the determinants of consumption. Hence, enormous research has been done on private consumption theory within the past 80 years, starting with Keynes' *General Theory of Employment, Interest and Money*. Surely, since the consumption of goods contains personal decisions on the individual level, it has psychological determinants that influence the overall level of private consumption. This individual aspect complicates modelling consumption behaviour on an aggregate level.

This thesis aims at analysing, whether Swedish households respond differently in terms of the level of consumption to wealth shocks of different kind and direction. The main hypothesis is that household consumption is asymmetric in a way that positive wealth shocks increase the level of consumption, whereas negative shocks do *not* decrease the level of consumption. If this is the case, it implies that private households are either unlikely to give up a part of their consumption expenditure due to lower wealth in the short run, or assume positive wealth shocks to have increased their wealth permanently, whereas negative wealth shocks do not have decreased their wealth permanently. Figure 3 displays the development of the Swedish housing price index (HPI) and Swedish stock market index OMX30. HPI shows a clear upwards trend, whereas OMX30 has no clear trend in either direction. This can support the hypothesis that consumers react stronger to positive shocks at least for housing wealth. However, a major concern relates to the potential existence and bursts of bubbles. A bubble-driven increase of consumption bears the danger of a "consumption slump" as seen in the recent financial crisis (Mian, Rao, & Sufi, 2013). As I will focus on the wealth effects, regardless whether the wealth is debt- or equity-financed, the role of debt will not be investigated in my analysis.

The second hypothesis is that households respond differently to shocks in housing wealth than in financial wealth because shocks are interpreted in a different way. From Figure 3, it can also be seen that the price for financial wealth, approximated by the OMX30, has a higher volatility than HPI, representing the price of housing wealth. Thus, housing seems to be the less risky asset. By contrast, financial wealth is generally more liquid.

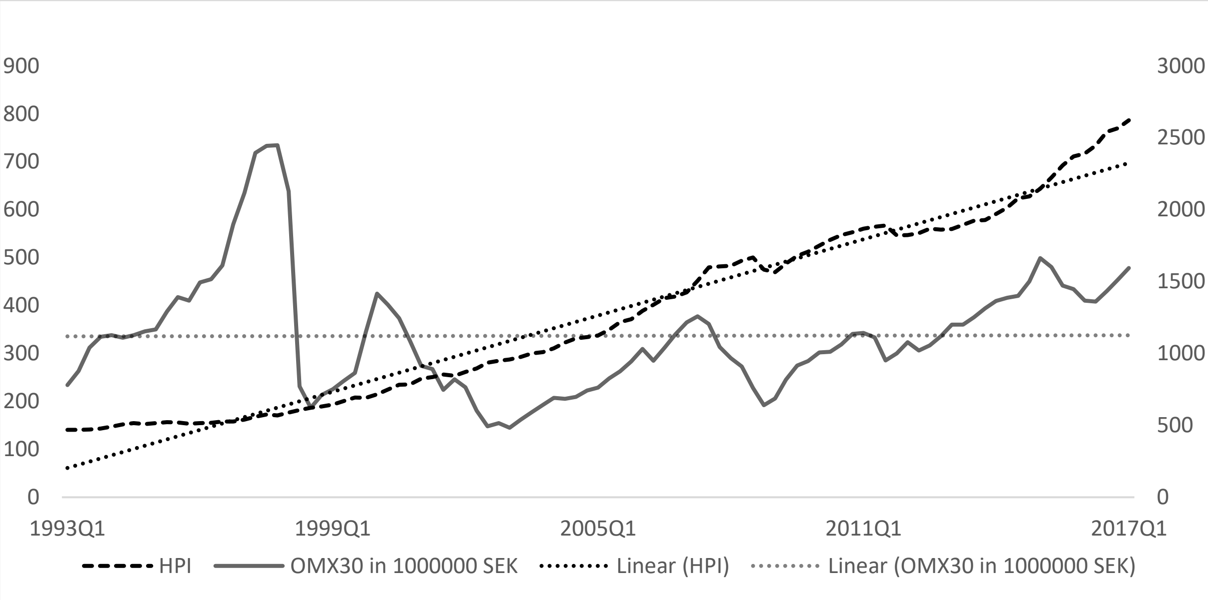

Figure 3: Swedish HPI (left scale) and OMX30 (right scale) in quarterly average from 1993Q1 to 2017Q1, and linear trendlines. Data source: Yahoo! Finance *(2017)*, Statistics Sweden *(2017)*

2.2 Theoretical Foundation

Most famous consumption theories suggest that private consumers smoothen their consumption expenditure over time. Hence, consumers include current wealth and income into their decision about current consumption, as well as expectations about future values of income and wealth (Sorensen & Whitta-Jacobsen, 2010). This behaviour was originally formalized by Friedman in the *permanent income hypothesis* (1957). Ando & Modigliani in their *life cycle hypothesis* (1963), and Hall with his *life cycle-permanent income hypothesis* (1978) expanded upon Friedman's work.

I will start with a simplistic consumption function, following Davis and Palumbo (2001), to show the smoothening behaviour suggested by the theories above.

$$C_t = mpch_t H_t + mpcw_t W_{t-1} , \tag{1}$$

with

$$H_t = Y_t + E\left[\sum_{i=t+1}^{T} \frac{Y_i}{(1+r)^{i-t}}\right] , \; 0 < r < 1 , \tag{2}$$

and

$$W_t = W_{t-1} + (Y_t - C_t) + \Delta p_t W_{t-1} + E\left[\sum_{i=t+1}^{T} \frac{\Delta p_i W_t}{(1+r)^{i-t}}\right] . \tag{3}$$

C_t describes the aggregate consumption of an economy in period *t*. C_t is the weighted sum of human wealth H_t and non-human wealth at the end of the ladder period W_{t-1}. Human wealth is defined as disposable human income in period *t*, Y_t, plus the expected value of all future disposable income, discounted by factor *r*. This shows, that today's consumption is a function of future human income. Current non-human wealth W_t, here is defined as the sum of its last value, the savings of the current period, and the change of value of W_{t-1}, captured by price differences. In addition to the non-human wealth components considered by Davis and Palumbo, I include expectations about future states of the value W_t, to account for effects through anticipated changes in non-human wealth (However, for practical issues, the approximation of H_t and W_t requires observable variables, which are closely related to current human income and lagged non-human wealth. This will be discussed later.). Each of the wealth variables, H_t and W_t, is weighted with a factor respectively, the marginal *propensity to consume*, which describes the ratio of consumption to each wealth variable.

The focus of this thesis lies on the different wealth effects of housing and financial wealth. Hence, W_t needs to be classified in the following way.

$$W_t = D_t + F_t , \tag{4}$$

where D_t describes housing welath and financial wealth is defined as F_t. Since it is crucial for this work whether those variables exhibit different *marginal propensities to consume*, I use (3) and (4) to obtain:

$$D_t + F_t = D_{t-1} + F_{t-1} + (Y_t - C_t) + \Delta p_{dt} D_{t-1} + \Delta p_{ft} F_{t-1} + E\left[\sum_{i=t+1}^{T} \frac{\Delta p_{di} D_t + \Delta p_{fi} F_t}{(1+r)^{i-t}}\right] . \tag{5}$$

Applying the classification to (1) returns:

$$C_t = mpch_t H_t + mpcd_t D_{t-1} + mpcf_t F_{t-1} \,. \quad (6)$$

Equation (6) provides the long-term relationship between consumption and the different types of wealth. However, in the permanent income hypothesis, adjustment is expected to be symmetric (Christiano, Eichenbaum, & Marshall, 1987). The idea of asymmetric adjustment is based on a psychological phenomenon of individual decision making. The researchers Daniel Kahneman and Amos Tversky (1985) found that individuals tend to experience positive wealth shocks stronger than negative wealth shocks. I will investigate, whether this can be confirmed by Swedish households.

Before I introduce the methodology used to analyse the long-term relationship and short-term deviations, I provide an overview over former research on wealth effects on private consumption.

2.3 Previous Literature

Based on the fundamental work of Friedman, Ando and Modigliani, Hall, and others, the effects of changes in wealth on private consumption have been attracting the attention of policymakers and researchers. Interestingly, research results differ significantly with different data, methods, or time periods, and there is only little consensus about a general relationship between wealth effects on private consumption.

Ball and Drake (1964) ”*re-opened the question of the role of wealth in consumption theory”,* tested the ”*new consumption theories*” empirically, and found significant effects of wealth on consumption for the U.K. and U.S.A. The authors obtained stronger results when using non-durable consumption only. Shiller et al. (1984) emphasize on the psychological effects of stock price changes, whereas the wealth effect on consumption is of minor significance.

The relationship between wealth and consumption has often been examined using cointegration approaches. Lettau and Ludvigson (2001) find a shared trend between consumption, labour income and asset wealth; however, no significant error correction behaviour of consumption can be found on the U.S. market from 1952Q4–1998Q3. For almost the same sample, Mehra (2001) finds significant wealth effects on consumption with existing short-term responds of consumption to changes in wealth.

The general result of a cointegrated relationship between labour income, wealth, and consumption aroused the question, whether consumption reacts differently to different wealth incentives. In particular, researchers distinguished between housing wealth and stock market wealth, mainly due to divergence in three factors: Liquidity, volatility, and leverage (Tse, Man, & Choy, 2007). For Hong Kong, Tse et al. (2007) discovered a stronger effect of changes in housing wealth than financial wealth. Contrarily, Sousa (2009) suggests stronger effects of changes in financial wealth on consumption for the European Monetary Union with housing wealth effects being insignificant. Case, Quigley, and Shiller (2011) published several papers about the wealth effect in the U.S.A.. Their latest publication considers the sample period 1978–2009, which includes stock market and housing bubbles. The results presented support evidence for a strong effect of housing wealth variations, with no or little evidence of a financial wealth effect. A multi-country analysis by Slacalek (2006) confirms a sure heterogeneity of markets. Moreover, he points out that the housing wealth effect is commonly much stronger after 1988 due to eased access to credit.

Whether consumers react differently to positive wealth shocks than to negative ones, is subject to the works of Tsai et al. (2012), Aspergis and Miller (2004), and Márquez et al. (2013). While Apergis and Miller focus on asymmetric effects of financial wealth finding significantly higher negative than positive consumption corrections, Tsai et al. use a threshold cointegration model to investigate the wealth effect between housing and stock markets. The methodology of my thesis closely follows Márquez et al., who apply a threshold cointegration model on the U.K. market and find consumption responses to positive housing wealth shocks, but not to negative ones, and reversed reactions to financial wealth shocks.

The economy of Sweden has been in the focus of Chen (2006) particularly. Based on quarterly data from 1980 to 2004, Chen applies a symmetric vector error correction model (VECM) which suggests a strong and positive long-term relationship between housing wealth and private consumption. Moreover, housing wealth seems to be the only short-term disequilibrium-adjustment variable.

3 Methodology and Data

This chapter introduces the model and the dataset I use in my thesis. I start with a theoretical introduction to the econometric model before I connect it to the theoretical framework of the consumption model from the previous chapter. Afterwards, the choice of data and collection method will be presented.

3.1 Research Approach

Modelling asymmetric error correction in cointegrated variables requires a model that distinguishes between shocks in different directions. For this purpose, I will apply a *Momentum-Threshold Autoregressive (M-TAR)* model as proposed by Enders and Siklos (2001) and performed in wealth-effect analysis by Stevans (2004) and Márquez et al. (2013).

In *Cointegration and Threshold Adjustment* (2001), Enders and Siklos extend symmetric cointegration models to capture asymmetric behaviour, which was found in several univariate relations before, and generalise the M-TAR model. The general model can be written as

$$x_{1t} = \beta_0 + \beta_1 x_{2t} + \cdots + \beta_k x_{kt} + \mu_t \ , \tag{7}$$

and

$$\Delta\mu_t = I_t \rho_1 \mu_{t-1} + (1 - I_t)\rho_2 \mu_{t-1} + \varepsilon_t \ , \tag{8}$$

with the Heaviside indicator function

$$I_t = \begin{cases} 1 & if\ \Delta x_{i.t-1} \geq \ \tau \\ 0 & if\ \Delta x_{i.t-1} < \ \tau \end{cases}. \tag{9}$$

Equation (7) describes the long-term relationship between a dependent variable x_{1t} and k explanatory variables x, with $k > 0$. The residual of the long-term relationship, μ_t, is stationary if the adjustment parameters fulfil $\rho_1 < 0$, $\rho_2 < 0$, and $(1 + \rho_1)(1 + \rho_2) < 1$, independent of the threshold value τ. ρ_1 and ρ_2 are asymptotically normal distributed. The adjustment is symmetric if $\rho_1 = \rho_2$ (Enders & Siklos, 2001). Assuming a single cointegrating vector and asymmetric model specifications (i.e. $\rho_1 \neq \rho_2$) the error correction model takes the following form:

$$\Delta x_{it} = I_t \rho_{1.i} \mu_{t-1} + (1 - I_t) \rho_{2.i} \mu_{t-1} + \cdots + \nu_{it} \ . \tag{10}$$

$\rho_{1.i}$ and $\rho_{2.i}$ describe the speed of adjustment coefficients of Δx_{it}. Hence, their value determines, how fast the variable moves back to the long-term equilibrium after a shock generates a disequilibrium. The speed of adjustment parameters can differ for each Δx_{it} (Enders & Siklos, 2001).

The following section will combine the econometric model with the theoretical foundation of consumption theory, as defined in chapter 2.

3.2 Research Design

The long-term relationship of consumption, human wealth, housing wealth, and financial wealth follows the definition in Equation (6), but variables are transformed to logarithmic per-capita values, and the equation includes an intercept and error term, such that

$$c_t = \beta_0 + \beta_1 h_t + \beta_2 d_{t-1} + \beta_3 f_{t-1} + \mu_t \ . \tag{11}$$

Small-letter variables describe the logarithmic value of *per-capita* variables, β_0 is the intercept and μ_t is the error term. With applying logarithms, the marginal propensities to consume are now interpreted as elasticities and are captured with β_1, β_2, and β_3 respectively. The M-TAR process is specified as

$$\Delta \hat{\mu}_t = \sum_{i=1}^{k} \Delta \hat{\mu}_{t-i} + \alpha + I_t \rho_1 \hat{\mu}_{t-1} + (1 - I_t) \rho_2 \hat{\mu}_{t-1} + \varepsilon_t \tag{12}$$

and

$$I_t = \begin{cases} 1 & if \ \Delta d_{t-1}, \Delta f_{t-1} \geq 0 \\ 0 & if \ \Delta d_{t-1}, \Delta f_{t-1} < 0 \end{cases} . \tag{13}$$

$\hat{\mu}_t$ is defined as the residual from OLS-estimation of Equation (11). Lags of $\Delta \hat{\mu}_t$ can be included. α is a constant. The Heaviside indicator function I_t depends on the change of value in d_{t-1} or f_{t-1} respectively. The threshold value τ can be estimated consistently, as shown by

Enders and Siklos (2001), however, here it is determined to the natural value of zero, so it distinguishes between positive (or no) changes of wealth and negative changes of wealth.

Hereafter, the methodology is divided into three steps.

Step 1: Testing for (asymmetric) cointegration

The M-TAR model specification requires the variables to be cointegrated of rank 1 (Enders & Siklos, 2001). Hence, to test for cointegration and determine the rank, I apply the same methodology as Márquez et al (2013). This includes augmented Dickey-Fuller (ADF) tests to check for stationarity within the series and the Johansen methodology to determine the cointegration rank. Additionally, since the power of unit root tests and rank determination is of low power in case of asymmetric cointegration, I apply Enders' and Siklos' three-steps method for threshold models. This test is following the Engle-Granger method, which can be used to test for symmetric cointegration. The first step covers the creation of a linear combination of the variables in the model. The obtained residual series will be written as an M-TAR model, following (16). The parameters ρ_i are tested to be significantly different from zero using the F-statistics. The second step tests the asymmetric behaviour. Thus, the null hypothesis $\rho_1 = \rho_2$ will be tested. This can be done by using classic t-intervals as shown by Enders and Falk (1999). The lag length of the model will be determined by the Schwarz Bayesian Information Criterion (BIC) (Enders & Siklos, 2001).

Step 2: Estimating the long-term relationship

Márquez et al. (2013) suggest Phillips' and Hansen's *Fully Modified Ordinary Least Squares* (FMOLS) method to estimate the long-term relationship. This method differs from simple OLS, as it corrects for effects due to possible collinearity of variables. Collinearity leads to unreliable regression estimators and occurs if explanatory variables can be written as linear combinations of each other, or are close to this (Verbeek, 2004). Using FMOLS to perform the first step of the Enders-Siklos method, mentioned above will result in parameter-estimators for the long-term relationship.

Step 3: Computing the VECM parameters

Finally, based on the estimated residuals from *Step 2*, the short-run behaviour is measured by estimating the VECM, specified in Equation (10), with $\Delta x_{1t} = \Delta c_t$, $\Delta x_{2t} = \Delta h_t$, $\Delta x_{3t} = \Delta d_t$, and $\Delta x_{4t} = \Delta f_t$. This allows me to analyse, whether households respond asymmetrically to positive and negative wealth shocks in the short run, and whether the responses differ depending on the type of wealth shock.

3.3 Data

This section provides an overview and rationale for the choice of variables. The data collection method and sources can be found in the Data Appendix. All variables are per-capita values in Swedish crowns (SEK), deflated by CPI (year 2010, price = 100).

Consumption

It is often discussed, whether the consumption of durable goods should be included into the analysis or whether consumption of only non-durable goods provides more meaningful results. Chen (2006) argues, that the utility flows from durable goods are hard to measure. Thus, the smoothing of life-cycle consumption can be observed easier by considering non-durable goods only. On the contrary, he argues that total consumption represents a better choice if one is interested in macroeconomic effects, rather than microeconomic behaviour. Due to this and comparability issues, Chen uses total consumption data. Lettau and Ludvigson (2001) use non-durable consumption only; however, their approach is criticised to make incorrect assumptions about the relationship of total consumption and non-durable consumption, so that their results are inconsistent with the underlying theory (Rudd & Whelan, 2002).

The %-changes in total and non-durable consumption for Sweden over the sample period are presented in Figure 4. Non-durable consumption appears to be more volatile than total consumption. This can be the result of wealth effects. Since no consensus over the correct choice of variable is reached, and the variables show different volatility behaviour, I apply the methodology to both, total consumption, and non-durable consumption, in two separated models, and compare the results.

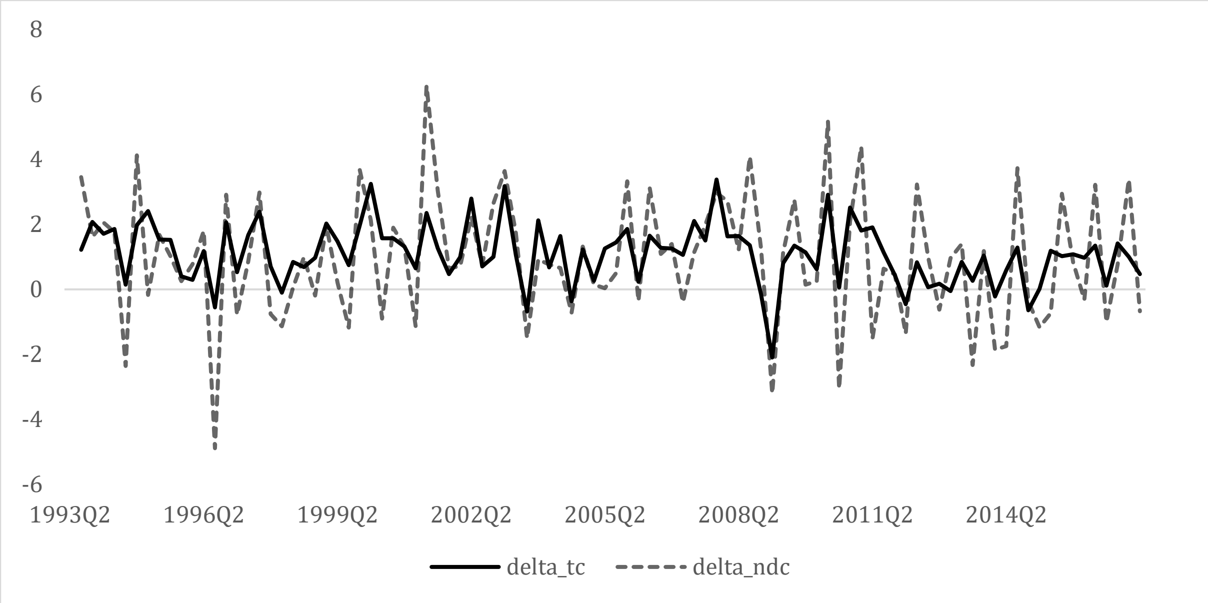

Figure 4: %-change of total consumption and non-durable consumption to the previous period from 1993Q2 to 2017Q1. Data Source: Statistics Sweden *(2017)*

Human Wealth

The human-wealth variable includes expectations about future income, and it is beyond my resources to collect this data. Hence, I will introduce the current value of total disposable income as an approximation. This is in accordance with other papers, for example Chen (2006) and Stevans (2004). The aggregate disposable income covers income of all age groups. Thus, the per-capita disposable income displays an average income which might be interpreted as a fraction of human wealth. A possible bias can occur through major demographic changes. Over the sample period the average age in Sweden rose from 39.41 in 1992 to 41.20 in 2016 (Statistics Sweden, 2017a), which I disregard.

Housing Wealth

Housing wealth is the variable in my model, that is most difficult to measure. The abolition of the Swedish wealth tax in 2007 makes it impossible to use tax assessment to value gross housing wealth, as it is done by Chen (2006) in his main model. For that reason, I will use the housing prices instead of housing wealth. This makes it more difficult to compare housing wealth effects to financial wealth effects. However, according to Chen (2006), who compares models with housing wealth and housing price proxies, core results should be unaffected. I approximate the housing prices with the real estate price index for one- or two-dwelling buildings for permanent living from Statistics Sweden. I choose this over building price indices since it considers older buildings as well.

Financial Wealth

Thorough financial wealth data is provided by Statistics Sweden. To approximate private financial wealth, I deduct total household financial liabilities from total household financial assets to obtain net financial wealth.

4 Results and Discussion

Following the methodology presented in the previous chapter, the consequent results are obtained.

4.1 Unit-Root Tests

	(1) Constant	(2) Constant and trend	(3) No constant and no trend	lag length
5 % critical value	-2.891871	-3.457301	-1.944211	
tc	-2.431582*	-0.563121	11.37991	0
ndc	-0.455542	-1.630347	3.612617	3
h	-0.299082	-2.410563	-3.116316	4
d	-0.071484	-1.852359	3.057592	5
f	-2.525986*	-2.269102	5.715718	0
*** p<0.01, ** p<0.05, * p<0.1				

Table 1: Reports the results of Augmented Dickey-Fuller (ADF) tests to determine whether the variables show existence of a unit root. The tests are performed for each variable including a constant, constant and trend, or neither constant nor trend. The lag length is determined automatically using the model with the lowest Bayesian-Schwarz Information Criterion (BIC). Critical values are following MacKinnon *(1996)*.

The unit-root tests fail to reject the null hypothesis of a unit root in any case at the 5%-significance level. Hence, I conclude that each variable that was tested is a non-stationary process with a unit root. This is a necessary condition for cointegration of variables.

4.2 Johansen's Cointegration Test

	Trace Test	Maximum Eigenvalue
Model 1: Total consumption	Single cointegration relationship	Single cointegration relationship
Model 2: Non-durable consumption	Two cointegration relationships	Single cointegration relationship

Table 2: Suggested cointegration rank based on Johansen's Trace test and Maximum Eigenvalue test.

Johansen's cointegration test is used to determine the rank of cointegrated variables. Detailed results can be found in Appendix B. As the results presented in Table 2 propose, both, total and non-durable consumption models are integrated of rank one. However, the trace test of the non-durable consumption analysis proposes two integration relationships. Using Swedish data, Chen (2006) finds a single cointegration relationship between the variables. However, he points out that the conclusions of the Johansen methodology can lead to spurious conclusions. Furthermore, for asymmetric cointegration models, standard cointegration tests bear the danger of misspecification (Márquez, Martínez-Cañete, & Pérez-Soba, 2013). Given that, I apply the three-step method proposed by Enders and Siklos (2001).

4.3 Long-Run Relationship

As mentioned before, the first step starts with estimating the long-term relationship between consumption and the income and wealth variables. Using FMOLS on logarithmic variables, the parameter estimators can be interpreted as the consumption elasticity with respect to the corresponding variable. The estimation results for the two different model specifications are as follows:

Model 1: Total consumption

$$tc_t = \underset{(0.29834^{***})}{5.438891} + \underset{(0.039885^{***})}{0.15807}\, h_t + \underset{(0.036753^{***})}{0.348313}\, d_{t-1} + \underset{(0.019098^{***})}{0.103498}\, f_{t-1}$$

Model 2: Non-durable consumption

$$ndc_t = \underset{(0.347251^{***})}{5.156802} + \underset{(0.046424^{***})}{0.194455}\, h_t + \underset{(0.042779^{***})}{0.475788}\, d_{t-1} - \underset{(0.022229^{**})}{0.057955}\, f_{t-1}$$

The results are followed by standard errors in parentheses below (with *** p < 0.01, ** p < 0.05, * p < 0.1). In the first model, where the log of total consumtion expenditure is the dependent variable, all explanatory variables have positive and significant effects, which is similar to the findings of Chen (2006) and Márquez et al. (2013), for example. However, it stands out that in this model, the housing-wealth parameter is higher than the human wealth parameter. This is contrary to other research. The explanation for that is related to the choice of variable approximation: Using the HPI, which appears to be a lower number than aggregate housing wealth, results in numerical differences in the estimators. This makes it difficult to compare the intensity of the effect of housing wealth to the effect of financial wealth. Nonetheless, the direction of the effect is not affected.

Model 2 on the other hand shows an interesting feature: While all other estimators are highly similar to the first model, the parameter estimator for the logarithmic financial wealth variable is negative. That means that the consumption of non-durable goods decreases if financial wealth increases. Connecting this to the positive parameter estimator from the first model, one can conclude that increasing financial wealth leads to increased consumption of durable goods, while having a decreasing effect on the consumption of non-durable goods. Housing wealth, as well as human wealth, has a positive effect on consumption in both models, yet the consumption elasticity of non-durable goods is higher with respect to h_t and d_{t-1}.

4.4 M-TAR Analysis

The asymmetric Momentum-Threshold AR models are presented below. Both models include one lag. The model selection is based on the BIC (values can be found in Appendix B).

Model 1: $\Delta\hat{\mu}_{t,tc} = \gamma\Delta\hat{\mu}_{t-1,tc} + \alpha + I_t\rho_1\hat{\mu}_{t-1,tc} + (1 - I_t)\rho_2\hat{\mu}_{t-1,tc} + \varepsilon_t$					
	Coefficient	Coefficient	Standard Error	t-Statistic	p-value
Δd_{t-1}	γ	-0.4289474	0.0965073	-4.44	0.000
	α	-0.0009332	0.0017958	-0.52	0.605
	ρ_1	-0.2830836	0.1008719	-2.81	0.006
	ρ_2	-0.6905942	0.4098807	-1.68	0.096
	F-Statistic ($\rho_1 = \rho_2 = 0$)	21.07***			0.000
	F-Statistic ($\rho_1 = \rho_2$)	1.00			0.317
Δf_{t-1}	γ	-0.4408396	0.0975663	-4.52	0.000
	α	-0.0008014	0.0018064	-0.44	0.658
	ρ_1	-0.3071409	0.1214667	-2.53	0.013
	ρ_2	-0.2667329	0.160086	-1.67	0.099
	F-Statistic ($\rho_1 = \rho_2 = 0$)	20.53***			0.000
	F-Statistic ($\rho_1 = \rho_2$)	0.04			0.968
Model 2: $\Delta\hat{\mu}_{t,ndc} = \gamma\Delta\hat{\mu}_{t-1,ndc} + \alpha + I_t\rho_1\hat{\mu}_{t-1,ndc} + (1 - I_t)\rho_2\hat{\mu}_{t-1,ndc} + \varepsilon_t$					
	Coefficient	Coefficient	Standard Error	t-Statistic	p-value
Δd_{t-1}	γ	-0.4431072	0.0940291	-4.71	0.000
	α	-0.0006992	0.0023567	-0.30	0.767
	ρ_1	-0.2811109	0.1059684	-2.65	0.009
	ρ_2	-0.6680461	0.2763162	-2.42	0.018
	F-Statistic ($\rho_1 = \rho_2 = 0$)	23.72***			0.000
	F-Statistic ($\rho_1 = \rho_2$)	1.87*			0.061
Δf_{t-1}	γ	-0.441558	0.0951901	-4.64	0.000
	α	-0.0009557	0.0023669	-0.40	0.687
	ρ_1	-0.3614369	0.1174791	-3.08	0.003
	ρ_2	-02017355	0.1797501	-1.12	0.265
	F-Statistic ($\rho_1 = \rho_2 = 0$)	22.99***			0.000
	F-Statistic ($\rho_1 = \rho_2$)	0.62			0.503

Table 3: M-TAR estimations for total consumption (Model 1) and non-durable consumption (Model 2). The Heaviside indicator functions depend on either Δd_{t-1} or Δf_{t-1}. Both models include one lag according to BIC.

The results display several important features. First, all coefficients are negative. This is a necessary condition for stationarity as mentioned in Chapter 2. Moreover, the parameters ρ_1 and ρ_2 are significant in every case, except for $(1 - I_t)\rho_2\mu_{t-1}$ with Δf_{t-1} determining the Heaviside function, which is only significant at the 10%-level in the first model, and unsignificant in the second model. Critical values for the F-statistics are taken from Enders and

Siklos (2001) for models with threshold value equal to zero. From this we can reject the null hypothesis of no cointegration.

If adjustment is asymmetric, then $\rho_1 \neq \rho_2$. The corresponding F-statistics are insignificant using classic t-intervals. Hence, the hypothesis of asymmetric cointegrated variables cannot be proven for both models with the presented specifications. In the reference paper of Márquez et al. (2013), the authors are able to obtain higher F-statistics with strong significance, and thus, prove asymmetric wealth effects for the U.K. economy. A possible reason for the results above can be insufficient model specification. In the above-mentioned paper, Márquez et al., for example, include control variables into the model to account for credit conditions and outlier periods (credit boom in 2005 and credit crunch in 2008). In chapter 4.7, I will modify the model by introducing a control variable and compare the results.

Nonetheless, the symmetric behaviour found above supports the general theory of the permanent income hypothesis.

4.5 Short-Run Behaviour

Since the tests conclude symmetrically cointegrated variables, the short-run behaviour will be observed by applying a VEC model. The coefficient estimates are presented below, first for total consumption and afterwards for non-durable consumption behaviour in the short run.

	$\Delta x_{it} = I_t \rho_{1.i} \mu_{t-1,tc} + (1 - I_t) \rho_{2.i} \mu_{t-1,tc} + \nu_{it}$
Δd_{t-1}	$\Delta \mathrm{tc}_t = 0.0107043 - 0.1229021 * I_t \mu_{t-1} - 0.173518 * (1 - I_t) \mu_{t-1} + \nu_{1t}$ (0.00094***) (0.0459166***) (0.2068464) $\Delta \mathrm{h}_t = 0.0105082 + 0.137627 * I_t \mu_{t-1} + 1.352071 * (1 - I_t) \mu_{t-1} + \nu_{2t}$ (0.0123585) (0.60085) (2.706729) $\Delta \mathrm{d}_t = 0.0175691 - 0.3410247 * I_t \mu_{t-1} - 0.4546624 * (1 - I_t) \mu_{t-1} + \nu_{3t}$ (0.00178***) (0.0863728***) (0.3890951) $\Delta \mathrm{f}_t = 0.0278696 - 0.2575729 * I_t \mu_{t-1} + 0.388901 * (1 - I_t) \mu_{t-1} + \nu_{4t}$ (0.00494***) (0.2401825) (1.081982)
Δf_{t-1}	$\Delta \mathrm{tc}_t = 0.0106041 - 0.1668298 * I_t \mu_{t-1} - 0.0267643 * (1 - I_t) \mu_{t-1} + \nu_{1t}$ (0.000934***) (0.053***) (0.081678) $\Delta \mathrm{h}_t = 0.0122449 + 0.9592418 * I_t \mu_{t-1} - 1.619171 * (1 - I_t) \mu_{t-1} + \nu_{2t}$ (0.012099) (0.9592418) (1.057578) $\Delta \mathrm{d}_t = 0.0175974 - 0.3515446 * I_t \mu_{t-1} - 0.3336774 * (1 - I_t) \mu_{t-1} + \nu_{3t}$ (0.001778***) (0.1008534***) (0.1554049**) $\Delta \mathrm{f}_t = 0.0271618 - 0.387938 * I_t \mu_{t-1} + 0.1507604 * (1 - I_t) \mu_{t-1} + \nu_{4t}$ (0.004921***) (0.2791672) (0.4301688)

Table 4: VEC model for total consumption. Standard errors in parentheses.

The interpretation of the coefficients is as follows for the first equation: Total consumption growth decreases with 0.1229% if the lagged consumption error is +1% and the change in housing wealth in the latter period was positive. If the change in housing wealth was negative, a +1%-change in lagged consumption error is followed by a 0.1735%-decrease in total consumption growth. But due to the insignificance of the last coefficient, the error correction of total consumption is stronger when housing wealth was increasing in the latter period. Considering the change in financial wealth in the Heaviside function, the coefficients are smaller, so that a +1%-change in lagged consumption error causes a -0.106%-change in total consumption growth if $\Delta f_{t-1} < 0$, which is also insignificant, and a 0.0268%-decrease in the case of $\Delta f_{t-1} \geq 0$. After all, the standard errors indicate that the error correction of total consumption is significant only if housing wealth or financial wealth were increasing. If the Heaviside indicator equals zero, meaning negative wealth changes, no significant correction of total consumption can be found as $\rho_{2.i}$ is not significant in either case.

For the U.K., Márquez et al. find a similiar reaction for housing wealth changes, which they explain with an increasing housing equity withdrawal (HEW) in case of low price uncertainty. According to the authors, HEW is a financial tool with which homeowners can transform housing equity to more liquid assets which can be used for consumption. This leads to an indirect wealth effect through increased borrowing capacities additionally to the direct wealth effect (of being or feeling wealthier). As shown in Figure 3, housing prices have been rising remarkably stable in Sweden over the sample period; hence, the explanation might be valid here, too. Contrarily to my results, the authors conclude a reversed reaction to financial wealth shocks, so that consumption reacts significantly only to negative changes in financial wealth. It is to mention that they use a threshold value of 0.0013 instead of the natural level zero, as they were able to improve their results with respect to information criteria. Another possible explanation is the introduction of control variables in their work. However, the included controls unemployment, credit conditions index, and dummy variables for the years 2005 and 2008 are mostly insignificant (Márquez, Martínez-Cañete, & Pérez-Soba, 2013).

Another implication presented in Table 4 concerns the error correction of housing wealth. Housing wealth is significantly error-correcting with -0.341% if the change in housing wealth was positive and the lagged consumption error is +1%. It also responds significantly negative to positive consumption errors with a positive change in financial wealth. The other variables appear to be not error-correcting and thus are weakly exogenous.

	$\Delta x_{it} = I_t \rho_{1.i} \mu_{t-1,ndc} + (1 - I_t) \rho_{2.i} \mu_{t-1,ndc} + \nu_{it}$
Δd_{t-1}	$\Delta ndc_t = 0.0085811 - 0.1278194 * I_t \mu_{t-1} + 0.0849132 * (1 - I_t) \mu_{t-1} + \nu_{1t}$ (0.0019735***) (0.0762843*) (0.2239854) $\Delta h_t = 0.0102956 + 0.3250544 * I_t \mu_{t-1} + 0.3821654 * (1 - I_t) \mu_{t-1} + \nu_{2t}$ (0.0123224) (0.4763076) (1.398531) $\Delta d_t = 0.0178165 - 0.21835 * I_t \mu_{t-1} - 0.3140462 * (1 - I_t) \mu_{t-1} + \nu_{3t}$ (0.00182***) (0.0701734***) (0.2060426) $\Delta f_t = 0.0276945 + 0.0730907 * I_t \mu_{t-1} + 1.048116 * (1 - I_t) \mu_{t-1} + \nu_{4t}$ (0.00487***) (0.1881197) (0.552356*)
Δf_{t-1}	$\Delta ndc_t = 0.0087069 - 0.1315087 * I_t \mu_{t-1} - 0.024339 * (1 - I_t) \mu_{t-1} + \nu_{1t}$ (0.0019723***) (0.0830196) (0.1464513) $\Delta h_t = 0.0104481 + 0.7181038 * I_t \mu_{t-1} - 0.875828 * (1 - I_t) \mu_{t-1} + \nu_{2t}$ (0.01213) (0.5105327) (0.90061) $\Delta d_t = 0.0177588 - 0.2205619 * I_t \mu_{t-1} - 0.2528279 * (1 - I_t) \mu_{t-1} + \nu_{3t}$ (0.001812***) (0.0762637***) (0.1345335*) $\Delta f_t = 0.0282635 + 0.0312016 * I_t \mu_{t-1} + 0.6252668 * (1 - I_t) \mu_{t-1} + \nu_{4t}$ (0.004873***) (0.2050985) (0.3618055*)

Table 5: VEC model for consumption of non-durable goods. Standard errors in parentheses.

Comparing the error correction of non-durable consumption to total consumption displays many similarities, but also some differences. So does non-durable consumption growth respond positively to lagged consumption errors with a negative change in housing wealth (yet, the coefficient is insignificant). Generally, the significance of error-correcting non-durable consumption coefficients is lower, compared to total consumption coefficients. Hence, I conclude that in the the short run, total consumption responds stronger to a disequilibrium than non-durable consumption. This is somewhat surprising since Figure 4 shows that the consumption of non-durable goods is more volatile than total consumption. However, this volatility is apparently not driven by error correction due to changes in financial or housing wealth.

4.6 Model Variation

Including Money Supply

Since the results of the M-TAR specification above do not support the hypothesis of asymmetric adjustment, I will modify the model to account for financial market conditions, which are surely important to consider when observing consumption behaviour. The availability of money will affect financial wealth, housing wealth, and thus, consumption. To capture financial market conditions, I include the broad money supply (M3) into my analysis. This idea is following Tse et al. (2007), who find that money supply has a strong impact on consumption and is more significant than the interest rate. Therefore, I give preference to include the money supply variable over interest rate variables. It follows the extention of the model to:

$$c_t = \beta_0 + \beta_1 h_t + \beta_2 d_{t-1} + \beta_3 f_{t-1} + \beta_4 m_t + \mu_t \,, \tag{14}$$

with m_t as logarithmic value of M3 index. For total and non-durable consumption, I obtain the below long-term relationships.

Model 1: Total consumption

$$\underset{(0.2271544^{***})}{tc_t = 5.792989} + \underset{(0.0302562^{***})}{0.108565 h_t} + \underset{(0.0356829^{***})}{0.3527 d_{t-1}} + \underset{(0.0135073^{***})}{0.097889 f_{t-1}} + \underset{(0.0345913)}{0.0460241 \mathrm{m}_t}$$

Model 2: Non-durable consumption

$$\underset{(0.2952965^{***})}{ndc_t = 5.64068} + \underset{(0.0393325^{***})}{0.121832 h_t} + \underset{(0.04673871^{***})}{0.409455 d_{t-1}} - \underset{(0.0175592^{***})}{0.0524274 f_{t-1}} + \underset{(0.044968^{***})}{0.13568 \mathrm{m}_t}$$

In the model of total consumption, the changes to the original model are neglectible with only slight changes in the coefficients and an insignificant role of money supply. Also for the second model, no strong change in coefficient estimates is occuring. However, money supply appears to be significant with a positive long-term effect, when it comes to consumption of non-durable goods.

The M-TAR specifications presented below provide stronger evidence for the possibile existence of asymmetric behaviour compared to the original models.

Model 1: $\Delta\hat{\mu}_{t,tc} = \gamma\Delta\hat{\mu}_{t-1,tc} + \alpha + I_t\rho_1\hat{\mu}_{t-1,tc} + (1 - I_t)\rho_2\hat{\mu}_{t-1,tc} + \varepsilon_t$					
	Variable	Coefficient	Standard Error	t-Statistic	p-value
Δd_{t-1}	α	0.0002799	0.0015993	0.17	0.861
	ρ_1	-0.2936608	0.0764918	-3.84	0.000
	ρ_2	-0.1400732	0.1884282	-0.74	0.459
	F-Statistic ($\rho_1 = \rho_2 = 0$)	7.65**			0.018
	F-Statistic ($\rho_1 = \rho_2$)	0.57			
Δf_{t-1}	α	0.0005611	0.0015682	0.36	0.721
	ρ_1	-0.3160293	0.0778781	-4.06	0.000
	ρ_2	-0.0745381	0.1647717	-0.45	0.652
	F-Statistic ($\rho_1 = \rho_2 = 0$)	8.34**			0.01
	F-Statistic ($\rho_1 = \rho_2$)	1.75*			
Model 2: $\Delta\hat{\mu}_{t,ndc} = \gamma\Delta\hat{\mu}_{t-1,ndc} + \alpha + I_t\rho_1\hat{\mu}_{t-1,ndc} + (1 - I_t)\rho_2\hat{\mu}_{t-1,ndc} + \varepsilon_t$					
	Variable	Coefficient	Standard Error	t-Statistic	p-value
Δd_{t-1}	α	-0.000221	0.0022624	-0.10	0.922
	ρ_1	-0.4122664	0.0826712	-4.99	0.000
	ρ_2	0.1593732	0.2402138	0.79	0.433
	F-Statistic ($\rho_1 = \rho_2 = 0$)	12.75***			0.002
	F-Statistic ($\rho_1 = \rho_2$)	5.62***			
Δf_{t-1}	α	0.001513	0.0023783	0.64	0.526
	ρ_1	-0.4008013	0.083369	-4.54	0.000
	ρ_2	-0.0909243	0.2044528	-0.44	0.658
	F-Statistic ($\rho_1 = \rho_2 = 0$)	10.50***			0.005
	F-Statistic ($\rho_1 = \rho_2$)	1.88*			

Table 6: M-TAR estimations for total consumption (Model 1) and non-durable consumption (Model 2) The consumption error is calculated from the modified model including the money supply variable. The Heaviside indicator functions depend on either Δd_{t-1} or Δf_{t-1}. Both models include zero lags according to BIC.

Introducing money supply causes the coefficient ρ_1 to become more significant, independently of the chosen Heaviside indicator with a simultaneous drop of significance of ρ_2. The F-statistics for $\rho_1 = \rho_2 = 0$ decrease, but are still strongly significant and the F-statistics for $\rho_1 = \rho_2$ increase, mostly above 10%-significance levels. However, the second model does not fulfil the stationarity condition of $\rho_2 < 0$. Hence, the residual series is not stationary and cointegration cannot be concluded for the model of non-durable consumption. This result is robust for including lags. After all, the model modification allows me to find evidence for asymmetric cointegration of financial wealth and consumption.

As the M-TAR model fails to prove cointegration for non-durable consumption, I will present the short-run behaviour in the VECM framework for the model of total consumption only.

Δd_{t-1}	$\Delta tc_t = 0.0110019 - 0.1850479 * \mathrm{I_t}\mu_{t-1} - 0.0640184 * (1 - \mathrm{I_t})\mu_{t-1} + \nu_{1t}$ (0.0009045***) (0.0432594***) (0.1065642) $\Delta h_t = 0.009087 + 1.960974 * \mathrm{I_t}\mu_{t-1} + 0.5674333 * (1 - \mathrm{I_t})\mu_{t-1} + \nu_{2t}$ (0.0117116) (0.560133) (1.379819) $\Delta d_t = 0.0184124 - 0.3043085 * \mathrm{I_t}\mu_{t-1} - 0.1826741 * (1 - \mathrm{I_t})\mu_{t-1} + \nu_{3t}$ (0.001828***) (0.0874345***) (0.2153844) $\Delta f_t = 0.0267366 + 0.1212784 * \mathrm{I_t}\mu_{t-1} + 0.8428997 * (1 - \mathrm{I_t})\mu_{t-1} + \nu_{4t}$ (0.0049573***) (0.2370927) (0.5840491)
Δf_{t-1}	$\Delta tc_t = 0.0111915 - 0.1852575 * \mathrm{I_t}\mu_{t-1} - 0.0902631 * (1 - \mathrm{I_t})\mu_{t-1} + \nu_{1t}$ (0.000894***) (0.0443967***) (0.0939329) $\Delta h_t = 0.0069568 + 1.934534 * \mathrm{I_t}\mu_{t-1} + 0.9986416 * (1 - \mathrm{I_t})\mu_{t-1} + \nu_{2t}$ (0.0115834) (0.5752453***) (1.217083) $\Delta d_t = 0.0185046 - 0.2509318 * \mathrm{I_t}\mu_{t-1} - 0.4486859 * (1 - \mathrm{I_t})\mu_{t-1} + \nu_{3t}$ (0.001798***) (0.0892928***) (0.1889223**) $\Delta f_t = 0.0277406 + 0.1889345 * \mathrm{I_t}\mu_{t-1} + 0.3782821 * (1 - \mathrm{I_t})\mu_{t-1} + \nu_{4t}$ (0.004925***) (0.2445767) (0.5174662)

Table 7: VEC model for total consumption in the modified model. Standard errors in parentheses.

The error correction results are quite similar to the original model. Positive changes in financial or housing wealth lead to a negative adjustment of consumption growth. Including the money supply variable, however, causes the error correction to be slightly stronger and independent of the type of wealth change.

4.7 Shortcomings and Suggestions for Future Research

No Proxy of Housing Wealth

Due to the unavailability of data, I can neither approximate gross nor net aggregate household wealth in housing. Although the cointegration tests show that the HPI and consumption are cointegrated in the original model, numerical differences occur, which impede clear interpretations. Chen (2006) mentions that key findings are unaffected by using housing prices instead of housing wealth. Another feature of observing prices is that it includes the reaction of renters. Since increasing housing prices cause increasing rents, it might increase the wealth of homeowners; however, it might also lower the wealth of renters. So, in order to investigate the wealth effect more precisely, it seems to be important to approximate housing wealth meaningful and consider rents.

Micro Data

Even more informative would be the analysis on the microeconomic level. This would allow to draw more particular conclusions, if the individual household's circumstances were considered. Surely, this is out of my scope due to extraordinary data collection effort.

Estimation of a Consistent Threshold Value

As mentioned before, it is possible to estimate the threshold value τ constistently. I was interested in the consumption response distiguishing between positive and negative shocks, however, using a consistent threshold value, might lead to different results (if it is different from zero).

Permanent and Transitory Distinction

My work does not consider the persistence of shocks. It would be interesting to investigate the consumption reaction to transitory shocks compared to permanent shocks. Lettau and Ludvigson (2001), as well as Stevans (2004) find proof for significant differences. Chen (2006) confirms these findings for the Swedish economy, using a PT variance decomposition. Applying this method to a model of asymmetric cointegration is an interesting starting point for future research.

Debt

With regard to macroeconomic consequences of consumption behaviour, the role of debt cannot be left out. Debt-fueled consumption booms have been connected to the greatest economic crises in the past 100 years (Cynamon & Fazzari, 2013). Especially housing wealth, which is often debt-financed, can endanger financial and economic stability as seen in the recent crisis. Several factors, like deregulated and globalised financial markets, as well as low interest rates, ease the access to credit, even for financing consumption. So, from the macroeconomic perspective, research has to be done on the connection of debt and wealth effects on consumption.

5 Conclusion

Using an M-TAR model approach, I was able to prove cointegration between housing wealth and private consumption, as well as financial wealth and private consumption for the Swedish economy. This result is in accordance with former findings of Chen (2006). In the long run, both housing and financial wealth have a positive impact on total consumption. Non-durable consumption, however, is positively affected by housing wealth, while the long-term effect of financial wealth is negative. In the short run, total consumption appears to be error-correcting, whereas significance can only be found if the wealth shock in the latter period was positive. This indicates asymmetric behaviour; however, significance tests reject the hypothesis of asymmetric adjustment for both of the original models with no control variables.

The introduction of money supply as a control variable to account for financial market conditions does not affect the long-term relationships between the wealth variables and consumption. The M-TAR analysis fails to reject the null hypothesis of no cointegration when considering consumption of non-durable goods. Contrarily, total consumption is cointegrated with both types of wealth in the modified model and weak evidence for asymmetric adjustment can be found, which supports the original hypothesis that responses of households to positive wealth shocks are different from negative wealth shocks.

My results show that private consumption is cointegrated with housing wealth and financial wealth and thus, that these variables can cause a ”consumption slump” with potentially strong macoeconomic consequences. Future research in this field should aim at investigating the role of debt and analysing microeconomic data to obtain a better comprehension of individual consumption decisions.

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Appendix A: Data Appendix

The sample investigated in this paper covers quarterly observations from 1993Q1 to 2017Q1. The data is deflated by the Swedish consumer price index (CPI) with base 2010Q1 and divided by the Swedish total population. The CPI is obtained from the Economic Research database of the Federal Reserve Bank of St. Louis. The Swedish population data is taken from Eurostat.

Data on total household consumption is obtained from Statistics Sweden. The same source offers data on household consumption of non-durable goods. Both series are seasonally adjusted but deflated manually in the above-mentioned way.

Statistics Sweden also provides the datasets for net disposable income, financial net wealth, and the housing price index as the proxy for housing wealth. The money-supply (M3) series was taken from the OECD database.

Appendix B: Model Selection

Lags	Model 1		Model 2	
	Δd_{t-1}	Δf_{t-1}	Δd_{t-1}	Δf_{t-1}
Zero	-463.9218	-462.3648	-410.814	-410.1053
One	-478.0325	-477.0382	-426.9979	-425.7107
Two	-467.7803	-467.0194	-418.3464	-417.4182

Table 8: BIC model selection for M-TAR models