Abstract

Using the most recent data from 1996 to 2016, I examine the more current relationship between housing wealth and private consumption. I extend the Life-Cycle Hypothesis and separate wealth into housing wealth from financial wealth. The main method employed is the Engle-Granger two-step method. Combined with the use of quarterly data, the method allows investigation of the long-term and short-term effects in one methodological framework. Several modifications of a baseline model are tested and compared in search for the best model. The results reinforce the findings of previous studies, that housing wealth has a substantial effect on consumption. The exact estimates may vary depending on the choice of theory and methodology. Nevertheless a considerable effort was made on data selection to ensure that the estimates can provide a reliable update on the relationship, which could be useful for economists and politicians alike.

Key words: Life-Cycle Hypothesis, Engle-Granger, consumption, house prices, wealth
I would like to thank Associate Professor Klas Fregert for providing guidance and tips throughout the course of conducting this study.
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1 Introduction

Rising house prices has been one of the most talked about topics among economists and politicians in Sweden. In numbers, the average real price of owned small houses has more than doubled since 1990 (Dermani, Lindé & Walentin, 2016). This gain is despite an initial price drop of nearly 30 percent from 1990 to 1996. Comparing the development to the US, Swedish real house prices actually rose by about the same magnitude between 1990 and 2007, a 160 percent increase. Then came 2007. The literature on one of the worst property bubbles ever occurred is extensive, and to this day economists are still trying to understand all of the mechanisms behind the accumulation the burst of the bubble. Remarkably, the growth of the Swedish house prices only stagnated for a few years before picking up the pace once again, and just keeps rising to this day. See Dermani et al. (2016, p.8) for a graphical comparison.¹

The staggering increase in house prices is not unproblematic, even though any serious consequences are yet to happen in Sweden. One concern is the private debt level. Swedish government reports blame house prices as a central mechanism behind rising household debt (Finansinspektionen, Riksgälden & Riksbanken, 2015), a trend also illustrated in Dermani et al. (2016, p.8). That is of course only one of the many interactions of house prices on the economy. Since everyone needs a roof over head, the macroeconomic implications of house prices cannot be overstated.

This paper focuses on the wealth effect of housing on private consumption. The linkage between consumption and house prices has been studied for a long time, ever since the introduction of the famous Life-Cycle Hypothesis by Ando and Modigliani (1963) that connects consumption with both income and wealth. Most studies have been able to find a positive effect of housing wealth on consumption, although the magnitude varies. There are also a few studies based on Swedish data, but none of them are from more recent years to my knowledge. It is not unreasonable to believe that the relationship between housing wealth and consumption may have changed, along with large-scale structural changes of the Swedish economy (e.g. financial deregulation during the 1980s

¹ Article in Swedish. The graph to the left in Dermani et al. page 8 is the US data and the graph the right is Swedish data. In blue is the house prices and in red is the private debt-to-income ratio.
and pension reform during the 1990s) as well as behavioral changes of the households (e.g. increased urbanization, risk aversion). Having a thorough understanding of the current relationship is crucial for policy makers as they assess the side impacts of policies aimed to address the house price dilemma.

The primary aim of this paper is to examine the relationship between consumption and housing wealth in more recent times, from 1996-2016. To do this I apply conventional time-series techniques on the latest available data. The main model of this study is based on the Engel-Granger Two-Step Procedure, which along with the use of quarterly data allows me to study both the long-term effect and the short-term effect.

My estimation results are primarily able to support the findings of earlier studies. The main numerical results are also robust enough to offer an up-to-date overview of the relationship between housing and wealth.
2 Theories and Literature Review

2.1 Life-Cycle Hypothesis

The Life-Cycle Hypothesis (LCH) proposed by Ando and Modigliani (1963) assumes that an individual plans their consumption over their life cycle. The total resource available to this individual over their lifetime is their life income and bequest. To achieve an even consumption over the life cycle, the individual will save and accumulate wealth when their income is high and dissave when their income is low, for example after retirement. For an individual at age $T$ in year $t$, the consumption function can be written as:

$$c_t^T = \Omega t^T y_t^T + \Omega t^T (N - T) y^e_t + \Omega t^T a_{t-1}$$

where $\Omega$ is a proportionality factor depending on factors (e.g. rate of return, age, the form of the function) other than resources, $y$ represents for income, $y^e$ stands for “annual average expected income” (Ando & Modigliani, p.57), and $a$ denoting the carry-over wealth from the previous year.

By making the assumption that $\Omega$ is the same for all individuals within the same age group, and then summing over all age groups, Ando and Modigliani (1963) show that on the aggregate level equation (i) can be rewritten as:

$$C = \alpha Y^c + \beta Y^e + \gamma W$$

where $Y^c$ is the current non-property income, $Y^e$ is the “expected annual non-property income” (p.58) and $W$ is the current wealth stock. Furthermore, it is difficult for individuals to reliably predict their future income. To tackle this problem, Ando and Modigliani (1963) propose to make a general assumption that $Y^e$ is simply a multiplier of $Y^c$. This assumption is not unreasonable in reality, considering that real income typically grows at a relatively stable rate, reflecting the advancement of technology, capital stock and population. Now, with $Y^c$ carrying information about $Y^e$, it is possible to simplify equation (ii) to just:

$$C = \alpha Y + \gamma W$$
where $\alpha$ and $\gamma$ are the marginal propensities to consume (MPC) out of current income and wealth. Another implication of the LCH is that income and wealth shocks that are transitory should have no effect on consumption, at least in the long run (Ando & Modigliani, 1963).

One important thing to note about equation (iii) is that the MPC parameters can change over time with demographic changes and changes in the distribution of income and wealth (Ando & Modigliani, 1963). For example, if the population in the dissaving stages of their life cycle increases, it is likely that the MPC would increase.

Another reason to expect a change in MPC from reported figures in earlier Swedish studies is that the wealth-to-income ratio has grown substantially due to increased saving (see for example appendix 1). This is a global phenomenon really, but will probably lower the MPC ceteris paribus. Any estimate of MPC will only be representative of the average MPC observed during the entire testing period. This is of course unless the wealth-to-income ratio, or at least the growth of it has been stable.

### 2.2 Decomposing Wealth

Ando and Modigliani (1963) did not separate wealth into different components. Studies after Ando and Modigliani commonly differentiate wealth into housing wealth and non-housing wealth, alternatively housing wealth and financial wealth, or even housing wealth and stock market wealth. Distinguishing between the different types of wealth is interesting in many ways. First, gains in housing wealth are typically more stable than gains say from the stock market. Second, liquidity constrained households may be able to borrow more when their housing wealth increases and consume what otherwise may not be possible (Iacoviello, 2011). Furthermore, households may find it unevenly difficult to value different types of wealth (Case, Quigley & Schiller, 2006).

The resulting expectation is that housing wealth and non-housing wealth may have different effects on consumption. This has been proven by many studies, some of which I briefly describe in the following section.
2.3 Previous Studies and Results

There are two main types of studies, one based on aggregate-level time-series data and one based on micro-level panel data. Nevertheless, the results are similar in general, with micro-level studies finding a perhaps slightly larger wealth effect. See for example Poterba (2000) for a more comprehensive review of studies.

The most common way of presenting the estimation results is through (unit to unit) marginal propensity to consume (MPC). The interpretation of MPC is that a one-dollar increase in income or wealth leads to a X-dollar (or cents) increase in consumption. This easy interpretation is the advantage of using MPC. It also allows results from different countries and time periods to be compared. Another way of presenting is through elasticity, which is obtained directly from the commonly used log-log models. More often than not elasticity is converted into MPC using the wealth to income ratio. The mathematical conversion used in this paper is described in section 4.3.

Previous studies on Swedish data include Johnsson and Kaplan (1999) who estimate the long-run MPC out of net housing wealth\(^2\) to be 0.04. Chen (2006) quantifies the MPC out of permanent housing wealth shocks to be 0.056.

Internationally, Carroll, Otsuka and Slacalek (2006) find the US MPC to be 0.02 the next quarter, and up to between 0.04 to 0.10 in the longer run. Catte, Girouard, Price and André (2004) use data for 10 OECD countries and estimate the MPC to be above zero for most countries, from up to 0.03 in the short term and up to 0.08 in the long term, and slightly higher than the MPC for financial wealth on average. Although they also find the housing wealth effect insignificant for a few of the countries. Brayton and Tinsley (1996) estimate the US MPC out of net tangible assets to be 0.075. Case et al. (2006) focus on the stock wealth but also compare it to housing wealth. Their results for US data differs significantly from international data, but they do conclude that housing wealth has a much stronger effect in both regions than stock wealth.

\(^{2}\)Their differentiation of wealth is financial assets and value of housing stock less liabilities. They emphasize that it is not the conventional approach. Also note that they use the term “housing stock” which typically means the number of dwellings, not wealth. In this paper “housing stock” is also referred to the number of dwellings.
The time periods and countries in the above studies all vary. Yet the consensus seems to be that there is a statistically significant wealth effect from housing in general. There are also several different methodologies used in the studies. Studies based on the LCH typically rely on variations of a cointegration model as the basic model. Studies using other theories naturally adopt other appropriate methods (some studies referenced in this paper that use an alternate theory are for example Chen, 2006 and Iacoviello, 2001).

The main method used in this paper is the Engle-Granger two-step procedure. The approach most closely resembles these used in Johnsson and Kaplan (1999), Catte et al. (2004) and Case et al. (2006), whose approach are also mainly based on the LCH. A brief walkthrough of the Engle-Granger two-step procedure is provided in section 4.1.
3 Data

3.1 Data source and range

Almost all data used is official data from the government agency Statistics Sweden with only two exceptions. Historical values of the Swedish official bank rate, along with the dates of adjustments, are obtained from the Swedish central bank, Riksbanken. The total private holding of assets, used as one of the variables in estimating housing wealth, is obtained from Waldenström (2015a). To best accomplish the purpose of this paper I use quarterly data ranging from 1996Q1 to 2016Q4. It is also convenient that all National Accounts and Financial Accounts data from 1996 are presented in accordance to the ESA2010 standard. This ensures that my data should have high reliability. It also allows good comparability across studies, specifically European ones. Using quarterly data creates a large number of observations and thereby allows me to investigate the short-term effects.

3.2 General treatment of data

All price data are converted to real prices using CPI\(^3\) as deflator. This eliminates the effects of inflation and makes the results easier to interpret. Many of the data series also contain seasonal variation. To determine which series need seasonal adjustment, the ESS guidelines (European Statistical System, n.d.) are followed. I found that all the flow variables (e.g. consumption) and index series need seasonal adjustment. The stock variables (e.g. assets) do not\(^4\) qualify for seasonal adjustment because 1) there is no clear and consistent seasonality when inspecting the data\(^5\); 2) there is no theoretical ground\(^6\); 3) in the case of financial assets, even if there is seasonality, it is near impossible to separate it from random walk behaviors of financial instruments; 4) there is significant residual seasonality after testing with an adjustment. Seasonal adjustments were made

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\(^3\) Statistics Sweden publishes CPI data monthly. The data is converted from monthly to quarterly by taking the arithmetic mean. Ideally calendar adjustments can be made but the difference is negligible.

\(^4\) For financial wealth and liabilities, seasonally adjusted CPI is used when deflating. This is because the seasonal variations in CPI can be considered transitory and the clear seasonal patterns in quarterly CPI are unwanted.

\(^5\) Visually and with seasonal dummies.

\(^6\) One could argue that assets and liability are connected with income and consumption, but such relationship is difficult to define and quantify.
using Eview’s Census X-13 Seasonal Adjustment Program developed by the US Census
Bureau.

3.3 Description of variables

In this section a detailed description of the variables is given. Unit root tests of the vari-
ables were also conducted using Augmented Dicky-Fuller test. The procedure of the
tests is documented in section 4.2.1, and the test results are presented in appendix 2.
Section 3.4 provides a basic summary of all variables used in the models. Appendix 1
provides descriptive statistics of the main variables.

3.3.1 Consumption and Income

Consumption ($C$) is measured using total household consumption expenditures\(^7\). This
is the most common choice of consumption measure in previous studies. The main ar-
argument against is that the total household consumption expenditure figure does not dis-
tinguish between consumption of durable goods and nondurable goods, as both are
treated as if they are consumed immediately. Johnsson and Kaplan (1999) however note
that the difference may not be very large at the aggregate level since purchases of dura-
able goods are spread out over time and tend to follow GDP. Most Swedish studies have
also used total consumption expenditures (Chen, 2006). Figure 1 depicts the growth of
real consumption, which has been quite consistent, just slightly more in the early years
of the testing period.

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\(^7\) I chose to include the contribution from Non-Profit Institutions Serving Households (NPISH) for con-
sumption and income but not for assets and liabilities. The reason for exclusion of assets and liabilities
controlled by NPISHs is obvious. It is more debatable whether NPISH consumption and income should
have been included. It is unclear how closely NPISH consumption and income relates to the households’.
Nevertheless the decision here is trivial since NPISHs only represent a very small part of the private sec-
tor.
Income ($Y$) is represented by the net disposable income. In the Financial Accounts database, disposable income consists of labor income, income from transfers and net capital income. One potential risk of using disposable income is double counting the interest returns from deposits and the coupons from bond holdings. Therefore some studies use labor income to represent income (for example Catte et al, 2004). However dividends also correspond to a major if not the biggest part of capital income. On the day of the dividend the value of the stock drops and the shareholders receive the dividend to their bank accounts. Since the price of the stock recovers over time, there is no change in the asset column of the households’ balance sheet in the long run ceteris paribus and not accounting for tax. Therefore dividends are in essence an income and should be treated so in the LCH. Unfortunately there is no easy way to separate dividends from interest income. Furthermore, in my data consumption exceeds labor income. That would not make much sense in a model based on the LCH since it would imply that on the aggregate level people spend more than they earn and wealth should decline instead of accumulate. Nevertheless, figure 2 shows the stable growth of income over the testing period.
3.3.2 Assets and Liabilities

Financial assets (FA) is the total value of financial assets held by the households. The series is based on National Accounts data with one adjustment. “Tenancy right shares of condominiums” (in Swedish *bostadsrätter*)\(^8\) and foreign properties are subtracted from financial assets and added onto housing assets. The reasoning for the latter is apparent, it is only considered a financial asset in National Accounts because of taxing. As for the former, 1) in the sense of a place to live, they serve the same purpose as owned homes; 2) they are fully tradable just like owned homes barring from minor restrictions; 3) their values can be expected to move in the same direction as owned homes. Figure 3 provides a visual of how financial assets have grown. It is by far the most volatile of the series.

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\(^{8}\) "Tenancy right shares of condominiums" is a popular form of housing solution, which you purchase a membership in the association to have the right to use the apartment indefinitely against only a yearly fee. The membership can be then sold (through the association) to get back whatever value the membership has. In essence it is not too different from owning a house.
**Figure 3.** Seasonally smoothed\(^9\) financial assets series

**Housing assets** \((HA)\) generally needs to be proxied or constructed using other data. The simplest solution is proxying using house prices as Bover (2005) and others have done. This is not ideal especially in Sweden where the housing situation is complicated by the existence of tenancy right shares of condominiums.

With some new and better data, I attempted at constructing \(HA\) using “backward induction”, starting with the latest data, which I assume are the most accurate, and working back in time.

I estimated the value of housing assets in 2016Q4, \(HA_{t=2016Q4}\), based on the annual estimates of Waldenström (2016a).\(^{10,11,12}\) To project the quarterly movements, I began by

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\(^{9}\) Indicates that the series is not seasonally adjusted but only somewhat smoothed by using seasonally adjusted CPI series as deflator.

\(^{10}\) Waldenström (2016a) is a new database which I used for an estimated of the households’ total assets and housing assets. The latest data point from the database is 2014. For 2015 and 2016 I assume a growth of 9 percent based on house prices and financial assets data. The value of tenancy right shares of condominiums grew over 28 percent between 2014Q4 and 2016Q4. During the same period house prices for one- and two-dwelling homes grew 19 percent, and financial assets grew almost 16 percent. 9 percent per year overall seems like a reasonable approximation. My estimate of housing assets for 2016Q4 is 11 090 493 MSEK.

\(^{11}\) I treated all non-financial assets as housing assets. Housing assets were the main component at just under 90 percent and remained consistent during the entire data range. Thus the risk of oversimplifying is small.

\(^{12}\) One often-cited estimates in news articles is the report series *Sparbarometer* (Saving Barometer) from a major Swedish bank. I deem the reported total asset figures to be unreliable for the earlier years (e.g. assets nearly doubled from 2012 to 2016 which seems highly implausible, and it is more likely caused by changes in methodology). Nevertheless I use the reported figure for 2016Q4 (SEB, 2017) as a rough check for a plausibility of the numbers.
constructing two deflating series, the house price ratio, $HPR$, and the housing stock ratio, $HSR$, the former accounting for changes in average house price and the latter accounting for changes in housing stock. The two ratios can be expressed as:

$$HPR_t = \frac{HPI_t}{HPI_{t=2016Q4}} \quad (iv)$$
$$HSR_t = \frac{HS_t}{HS_{t=2016Q4}} \quad (v)$$

In equation (iv), $HPI$ is the price index of small houses (approximated by the Statistics Sweden price index series for “one- and two-dwelling houses for permanent living”). The equation compares the average house price at a certain historical in time to the that of 2016Q4. In equation (v), $HS$ is the total housing stock at a certain historical period compared to that of 2016Q4. The historical housing stock is derived from construction data of small houses. Simply explained, the logic behind these two equations is that if the total value of small houses (almost all “one- and two-dwelling houses for permanent living” are privately owned) is X krona today, and in period $t$ the average price of small house was 50 percent of what it is today and there existed 90 percent as many small houses as today, then the total value of all small houses in period $t$ is 45 percent of the sum today.

One more adjustment needed to be made, and that is subtracting the 2016Q4 value of “tenancy rights shares of condominiums” plus foreign properties to get 2016Q4’s total value of small houses, which (iv) and (v) then can be applied on. This is because the exact historical development of their value is already reflected in the data obtained from Financial Accounts. The final equation is shown as equation (vi):

$$HA_t = (HA_{t=2016Q4} - \theta_{t=2016Q4}) \times HPR_t \times HSR_t + \theta_t$$
$$= (HA_{t=2016Q4} - \theta_{t=2016Q4}) \times \frac{HPI_t}{HPI_{t=2016Q4}} \times \frac{HS_t}{HS_{t=2016Q4}} + \theta_t \quad (vi)$$

where $\theta$ is the “tenancy rights shares of condominiums” plus foreign properties. The content of the parenthesis gives us the value of small houses in 2016, then the two ratios $HPR$ and $HSR$ introduced in (iv) and (v) are applied. Finally, the $\theta$ in each period is tagged on at the end. The final result is visible in figure 4.
As another quality check, I compared the numbers to Waldenström's (2016a) annual estimates from 1996 to 2016 and found any disparity to be no more than 7 percent.

**Liabilities** ($L$) is the total liabilities held by the households. Liabilities include all forms of debt and not limited to mortgage loans and other bank loans. Figure 5 depicts the growth of liabilities, expectedly the most smooth of the variables. There is a small inconsistency impacting the first quarter of 2001, which I believe is caused by some of the pension reform changes that first came into effect that year.

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13 Indicates that the series is not seasonally adjusted but only somewhat smoothed by using seasonally adjusted CPI series as deflator.
3.3.3 Wealth

(Net) wealth is uncontroversially assets less liabilities. Although there seems to be no consensus among previous studies on how liabilities should be included in the model. One possibility is to let liabilities be a variable on its own, but its estimates appear to be insignificant when tested\textsuperscript{15}.

The most reasonable approach is to deduct mortgage loans from housing assets and other liabilities from financial assets. The ratio of mortgage loans to other loans has not been consistent, but due to lack of data all the way back to 1996 I assumed a historical average 70-30 ratio.\textsuperscript{16} The main housing wealth (HW) and financial wealth (FW) definitions used in the models are:

\[ HW = HA - 0.7L \]  
\[ FW = FA - 0.3L \]

Due to the uncertainty though I also compare the main results to another common approach, which is to consider liabilities as entirely financial. The rationale is that the sum of already existing liabilities is permanent while the value of housing assets changes constantly. This also isolates the effect of housing wealth, but it makes estimates of financial wealth less interpretable. This alternative definition will thus estimate models using the variable pair of housing assets (HA) and financial balance (FB) in place of HW and FW. Financial balance is defined as:

\[ FB = FA - L \]

Make also note that in this paper the term “wealth” always implies net values, and the term “assets” is the corresponding for gross or pre-liability values. In some previous studies, the terms may be used in other ways.

\textsuperscript{14}Indicates that the series is not seasonally adjusted but only somewhat smoothed by using seasonally adjusted CPI series as deflator.
\textsuperscript{15}Johnsson and Kaplan (1999) also report this problem.
\textsuperscript{16}From 2006 to now the ratio has been slowly growing, but it is improbable that this will continue on for a long time.
3.3.4 Additional variables

**Real interest rate** ($R$) is estimated according to the Fisher equation, using the average Swedish repo rate during each quarter and the ex-post inflation rate. More specifically, this is the ex-post real interest rate. The series is in percent.

**Unemployment rate** ($U$) is the relative rate of unemployment, i.e. unemployed divided by population in the labor force. The series is in percent.

3.4 Summary of variables

Table 1 provides a summary of all variables to be used in models.

<table>
<thead>
<tr>
<th>Level</th>
<th>Log</th>
<th>Name</th>
<th>Unit</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>c</td>
<td>Consumption</td>
<td>MSEK</td>
<td>Real, SA</td>
</tr>
<tr>
<td>Y</td>
<td>y</td>
<td>Income</td>
<td>MSEK</td>
<td>Real, SA</td>
</tr>
<tr>
<td>HW</td>
<td>hw</td>
<td>Housing wealth</td>
<td>MSEK</td>
<td>Real, SS</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>HA–0.7L</td>
</tr>
<tr>
<td>FW</td>
<td>fw</td>
<td>Financial wealth</td>
<td>MSEK</td>
<td>Real, SS</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>FA–0.3L</td>
</tr>
<tr>
<td>HA</td>
<td>ha</td>
<td>Housing assets</td>
<td>MSEK</td>
<td>Real, SS</td>
</tr>
<tr>
<td>FB</td>
<td>fb</td>
<td>Financial balance</td>
<td>MSEK</td>
<td>Real, SS</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>FA–L</td>
</tr>
<tr>
<td>R</td>
<td></td>
<td>Real interest rate</td>
<td>Percent</td>
<td>Ex-post, SA</td>
</tr>
<tr>
<td>U</td>
<td></td>
<td>Unemployment rate</td>
<td>Percent</td>
<td>Relative</td>
</tr>
</tbody>
</table>

SA indicates seasonal adjustment.
SS indicates seasonal smoothing by deflating using seasonally adjusted CPI.
4 Methodology

4.1 The Engle-Granger Two-Step Method

4.1.1 Order of Integration

Most economic variables are non-stationary. These variables along with their variances can start at zero and still grow towards infinity as time progresses. A time series with these characteristics are said to be integrated of order 1, if stationarity is achievable by differencing the series once (Engle & Granger, 1987). The common denotation of such series is I(1).

The main problem of working with series that are I(1) is that an conventional regression estimated with Ordinary Least Squares (OLS) can be spurious. The regression may appear to be robust and the estimates significant, even though there is no underlying relationship between the variables.

A common workaround is using the differenced series of I(1) series. The differenced series are of course I(0). However the models using only I(0) series typically have low explanatory power and are only able to shed light on possible short-term dynamics (Dougherty, 2011).

4.1.2 Cointegration

The problem of spurious regressions will not be a factor under one condition, cointegration. Two variables are cointegrated if there exists an equilibrium relationship that holds them together in the long run (Engle & Granger, 1987). In other words their difference is a I(0) series. The two cointegrated variables will not drift too far away from each other, and the error term from the equilibrium relationship is expected to at least occasionally cross its mean (which is often zero).

According to Engle and Granger (1987), the same applies to a dependent variable and its vector of explanatory variables. A regression representing a cointegrated relationship will have stationary residuals. The residual represents a temporary disequilibrium that is expected to be corrected in the not too distant future.
4.1.3 The Two-Step Procedure

The Engle-Granger two-step procedure is a cointegration model taking advantage of the properties of cointegration relationships described in the previous section.

The first step is to estimate the long run regression. As explained in the previous section, if the residuals series from the regression is stationary, or I(0), the regression is cointegrated. The regression is estimated using OLS. According to Stock (1987), the OLS-estimates for a cointegrated relationship will not only be non-spurious, but very efficient.

In the second step, the lagged residuals are used as an error correction term. The lagged residual series is inserted into the short run model with first differences. The rationale is that in the short run, any disequilibrium will have an impact on the changes in other variables. Since for the long run equilibrium to hold, there must be a mechanism that prevents the two series (in this case, the actual dependent variable and the predicted dependent variable from a vector of explanatory variables) from drifting apart indefinitely (Dougherty, 2011). The short run regression will then consist of first differences of I(1) variables and the lagged residuals, both of which will be I(0). Once again, OLS-estimation will be effective. The interpretation of the coefficient in front of the lagged residual series is the speed of adjustment to equilibrium and should always be negative. For example, a coefficient of -0.2 means that on average 20 percent of the disequilibrium can be expected to disappear after the first period. The speed of adjustment is often put in terms of half life. In the example it takes about three periods before the disequilibrium is halved.

4.2 Augmented Dickey-Fuller Unit Root Test

4.2.1 Testing Series for Stationarity

To test each series’ order of integration, I use the Augmented Dickey-Fuller Unit Root Test (ADF-test). The ADF-test is one of the most widely used tests for stationarity. The null hypothesis is that the time series has a unit root and is nonstationary. When rejected, the time series is integrated of order 0.
The results of the ADF-tests are reported in appendix X. The variables are tested in logarithmic form using lag structures identified by the Schwarz Info Criterions, which according to Koehler and Murphree (1988) is in general the more effective of the two most popular information criterions Akaike and Schwarz.

I use a standard testing procedure starting by including both a trend and a constant in the test, eliminating the trend if it is insignificant, and finally the constant if insignificant. It can be argued whether it is reasonable to remove the constant altogether even if it is insignificant. I note though that the test results do not change by much, at least far from enough to affect the decision to reject or accept the null hypothesis.

4.2.2 Testing Regression Residuals for Stationarity

As discussed previously, testing for stationarity of the regression residual series is essential in the Engle-Granger approach to cointegration (Engle & Granger, 1987). In the case of a multivariate regression, the test is performed between the value of the dependent variable predicted by the regression and the actual turnout. If the residual series is stationary, then cointegration is proven.

It is widely suggested that the ADF-test performed on regression residuals should not use the normal Dicker-Fuller t-statistic critical values, but instead the asymptotic critical values suggested by MacKinnon (2010)\(^\text{17}\). The asymptotic critical values, often referred to as \(\tau\)-values, are more stringent than the ordinary critical t-values used for testing stationarity of a series. The reason to be more careful with the regression residuals is to take into account the fact that the OLS procedure used to estimate the equilibrium equation inherently tends to minimize the residual sum of squares by forcing a zero mean on the residuals (Dougherty, 2010).

4.3 Conversion from Elasticity to MPC

The coefficient(s) in front of the explanatory variable(s) in a typical log-linear regression is interpreted as elasticity. It represents the percentage change in the dependent variable if the explanatory variable changes by one percent. The mathematical definition of \(\beta\) is:

\(^{17}\)Update of the original work from MacKinnon in 1996.
\[ \beta = \frac{\Delta y}{\Delta x} \frac{x}{y} \]  

MPC can then be easily derived from equation (viii) since MPC is essentially the ratio of change in level.

\[ MPC = \frac{\Delta y}{\Delta x} = \frac{\beta y}{x} \]  

(xi)

In the case of consumption and wealth, equation (ix) becomes:

\[ MPC = \frac{\Delta C}{\Delta W} = \frac{\beta C}{W} \]  

(xii)

where the right hand side should be the average of the ratio between annual consumption in housing. Since this paper deals with quarterly data, consumption is multiplied by 4 to obtain the final outcome:

\[ MPC = \beta \times \frac{\sum_{i=1}^{n} \left( \frac{W_i}{4C_i} \right)}{N} \]  

(xiii)
5 Results

5.1 Models and Estimates

I begin with estimating the long-run equilibrium equation, in model (1a):

$$c_t = \alpha + \beta_1(y_t) + \beta_2(hw_t) + \beta_3(fw_t) + \varepsilon_t \quad (1a)$$

In the model, lower case letters denote that the variables are in (natural) logarithmic form. $c$ is real consumption, $y$ is real income, $hw$ and $fw$ represent the households’ real housing wealth and real financial wealth as defined in section 3.3.3 respectively, and $\varepsilon$ is an error term. A constant $\alpha$ is include to avoid forcing the regression through the origin.

A second equation (1b) is estimated with a set of differently defined variables for wealth. As discussed earlier, this is to investigate whether the different ways of deducting liabilities from assets will have any impact on the estimates.

$$c_t = \alpha + \beta_1(y_t) + \beta_2(ha_t) + \beta_3(fb_t) + \varepsilon_t \quad (1b)$$

In model (1b), the entirety of household liabilities are treated as financial and thereby deducted from financial assets. $ha$ represents housing assets and $fb$ represents financial balance.

Under the assumption that the LCH holds, consumption, income and wealth will be cointegrated, and OLS-estimates of the models (1a) and (1b) will be super efficient (Stock, 1987). The estimation results are presented in Table 2.

---

18 Housing wealth is housing assets less mortgage-related liabilities, assumed to be 70 percent of all liabilities. Financial wealth is financial assets less the remaining thirty percent of liabilities.
From table 2 we can see that the estimated elasticities of the same wealth type appear to be significantly different depending on the definition. However this is mainly because the wealth-to-income ratio in each case changes when liabilities are distributed differently. Applying the elasticity-to-MPC conversion process described in section 4.3, the

<table>
<thead>
<tr>
<th>Model</th>
<th>(1a)</th>
<th>(1b)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Income</td>
<td>0.368**</td>
<td>0.370**</td>
</tr>
<tr>
<td></td>
<td>(15.06)</td>
<td>(13.14)</td>
</tr>
<tr>
<td>Housing wealth</td>
<td>0.094**</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(5.99)</td>
<td></td>
</tr>
<tr>
<td>Financial wealth</td>
<td>0.124**</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(8.74)</td>
<td></td>
</tr>
<tr>
<td>Housing assets</td>
<td></td>
<td>0.135**</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(8.76)</td>
</tr>
<tr>
<td>Financial balance</td>
<td></td>
<td>0.081**</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(9.28)</td>
</tr>
<tr>
<td>Constant</td>
<td>4.785**</td>
<td>4.786**</td>
</tr>
<tr>
<td></td>
<td>(31.04)</td>
<td>(27.75)</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.997</td>
<td>0.996</td>
</tr>
<tr>
<td>S.E. of regression</td>
<td>0.009</td>
<td>0.009</td>
</tr>
<tr>
<td>Schwarz criterion</td>
<td>6.362</td>
<td>6.335</td>
</tr>
<tr>
<td>Durbin-Watson</td>
<td>0.621</td>
<td>0.599</td>
</tr>
</tbody>
</table>

*t-statistics in parentheses
* *p < 0.05, **p < 0.01
MPC implied in model (1a) is 0.033 for housing wealth and 0.041 for financial wealth.\(^{19}\) In model (2a) the implied MPC is 0.035 for housing wealth and 0.039 for financial wealth. These are the long-term MPC. From table 2 we can also see that the common variables are also estimated to have near-identical elasticities between the two models. At least in the long run, it can be concluded based on these results that the difference between the models is small. Model (1a) seems to be slightly more robust than model (1b), with a higher R-squared, Schwarz and Durbin-Watson statistics, but only marginally.

What is slightly surprising is that the long-term MPC out of financial wealth is estimated to be higher than the long-term MPC out of housing wealth. While this is not completely unique, it is uncommon for Western countries according to the results from Catte et al. (2004). It is difficult to determine the validity of this observation at this stage, as Johnsson and Kaplan (1999) stress that the financial wealth effect could be ambiguous if the increase in financial wealth is caused by increased saving.

The constants in both (1a) and (1b) are significant. However they are still quite small in relationship to the other variables in level terms, so it should not be a problem. The Durbin-Watson statistics suggest serial correlation, which is normal if there exists a cointegrating relationship. In fact, a Durbin-Watson statistically significant from zero is actually a welcoming sign when it comes to proving cointegration (Engle & Granger, 1987).

Before moving on to the second stage of the Engle-Granger two-step procedure, it must be assured that the residual series from models (1a) and (1b) are I(0). The \(t\) statistics from the ADF-test are 3.88 and 3.80 respectively, both passing the required asymptotic critical \(\tau\)-value of 3.74 suggested by MacKinnon (2010). It is possible from the ADF-test to conclude that the regressions represent a cointegrated relationship (Engle & Granger, 1987).

\(^{19}\)The average of the ratio HW/4C each quarter during the testing period is 2.8373. For FW/4C, HA/4C and FB/4C it is 3.0480, 3.8295 and 2.0557 respectively.
Proceeding with the Engle-Granger two-step procedure, I estimate the short-term relationship using differenced terms and the lagged residual series obtained from estimating models (1a) and (1b):

\[
\begin{align*}
    c_t &= \alpha + \beta_1(y_t) + \beta_2(hw_t) + \beta_3(fw_t) + e_{ct} \quad (1a^*) \\
    \Delta(c_t) &= \alpha + \beta_1(e_{ct_{t-1}}) + \beta_2(\Delta(y_t)) + \beta_3(\Delta(hw_t)) + \beta_4(\Delta(fw_t)) + \varepsilon_t \quad (2a)
\end{align*}
\]

\[
\begin{align*}
    c_t &= \alpha + \beta_1(y_t) + \beta_2(ha_t) + \beta_3(fb_t) + e_{ct} \quad (1b^*) \\
    \Delta(c_t) &= \alpha + \beta_1(e_{ct_{t-1}}) + \beta_2(\Delta(y_t)) + \beta_3(\Delta(ha_t)) + \beta_4(\Delta(fb_t)) + \varepsilon_t \quad (2b)
\end{align*}
\]

(1a*) and (1b*) are essentially the same equations as (1a) and (1b), only that the error terms are rewritten to \(e_{ct}\), denoting that they are the error correction terms inserted into models (2a) and (2b) after lagging them by one period. Models (2a) and (2b) are the short-term models with differenced variables and an error correction mechanism. The estimation results are summarized in table 3.
Table 3. **Detailed estimation results of models (2a) and (2b)**

Short-run relationship
Estimation method: OLS

<table>
<thead>
<tr>
<th>Model</th>
<th>(2a)</th>
<th>(2b)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Δ Income</td>
<td>0.160**</td>
<td>0.158**</td>
</tr>
<tr>
<td></td>
<td>(3.06)</td>
<td>(13.14)</td>
</tr>
<tr>
<td>Δ Housing wealth</td>
<td>0.099**</td>
<td>0.139**</td>
</tr>
<tr>
<td></td>
<td>(2.97)</td>
<td>(3.24)</td>
</tr>
<tr>
<td>Δ Financial wealth</td>
<td>0.076**</td>
<td>0.051**</td>
</tr>
<tr>
<td></td>
<td>(4.43)</td>
<td>(4.34)</td>
</tr>
<tr>
<td>Δ Housing assets</td>
<td></td>
<td>0.002**</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(2.35)</td>
</tr>
<tr>
<td>Δ Financial balance</td>
<td></td>
<td>0.002</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(1.98)</td>
</tr>
<tr>
<td>Error correction term (-1)</td>
<td>-0.251**</td>
<td>-0.241**</td>
</tr>
<tr>
<td></td>
<td>(-3.33)</td>
<td>(-3.24)</td>
</tr>
<tr>
<td>Constant</td>
<td>0.002*</td>
<td>0.002</td>
</tr>
<tr>
<td></td>
<td>(2.35)</td>
<td>(1.98)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>(2a)</th>
<th>(2b)</th>
</tr>
</thead>
<tbody>
<tr>
<td>R-squared</td>
<td>0.398</td>
<td>0.393</td>
</tr>
<tr>
<td>S.E. of regression</td>
<td>0.006</td>
<td>0.006</td>
</tr>
<tr>
<td>Schwarz criterion</td>
<td>7.177</td>
<td>7.170</td>
</tr>
<tr>
<td>Durbin-Watson</td>
<td>1.939</td>
<td>1.940</td>
</tr>
</tbody>
</table>

*Statistical significance
* $p < 0.05$, ** $p < 0.01$
The results are once again similar between the two variants. A ten percent increase in housing wealth is estimated to have an immediate effect of 10 to 14 percent on consumption. Again, in terms of elasticity the difference is large, but in terms of MPC it is almost the same, at around 0.036.

Both models predict an adjustment speed towards equilibrium of around 25 percent per quarter, or 2.4 quarters in disequilibrium half-life. If the short run is defined as one year, i.e. four periods, the corresponding short-term MPC out of a housing wealth shock is then 0.011, absent of a second shock. If the short run is defined shorter as two quarters, the new short-term MPC is 0.020.

Do note that the models assume the same speed of adjustment for shocks in income, housing wealth and financial wealth. This may or may not be true in reality. As it is difficult to theorize around why there would be any disparity, the assumption stands for the purpose of this study.

Unfortunately, it is unclear to me how Catte et al. (2004) derived short-term MPC from their estimation results. The description of the conversion process provided is too general and unhelpful. Several hypotheses have been tested mathematically but all unsuccessful. The short-term MPC between Catte et al. (2004) and this paper may be incommensurate if the time horizon of short run is defined differently.

As for financial wealth, models (2a) and (2b) predict an immediate elasticity between 5 percent and 8 percent, both around 0.025 converted to MPC. The issue brought up by Johnson and Kaplan (1999) is not as prominent in the short run, as saving behavior can be expected to change relatively slowly. If true, any short-term shocks in financial assets can be mostly attributed to the relatively volatile stock market. Thereby it can be concluded that the financial wealth effect is smaller than the housing wealth effect in the short run. This is more in line with the general consensus of previous studies. It implies that households regard gains from the financial market as more transitory. Indeed, this is in agreement with the visual evidence back in chapter 3. The disparity estimated in this study is relatively small, especially compared to Johnsson and Kaplan (1999) who use older Swedish data. It might be a hint at a growing fear of housing bubble.
From the results of all four models investigated so far, it can be decisively concluded that how liability is distributed in the models has a very small impact on the final MPC estimate. This is consistent with the suggestions from Catte et al. (2004). The households seem to regard mortgage-related liabilities indifferently from other liabilities. This could be why liabilities would not be significant when both Johnsson and Kaplan (1999) and I attempted inserting liabilities into the regression as a standalone variable.

For the sake of simplicity I will only estimate using the definition pair housing wealth and financial wealth from this point on. This is the definition pair used in models (1a) and (2a), the models which are slightly more robust than their counterparts based on R-squared and Schwarz statistics.

Inspired by Case et al. (2006) and Iacoviello et al. (2010), I make some dynamic modifications to the short-term model (2a) and estimate the following model:

$$\Delta(c_t) = \alpha + \beta_1(ec\ t_{t-1}) + \beta_2\Delta(c_{t-1}) + \beta_3\Delta(y_t)$$

$$+ \beta_4\Delta(hw_t) + \beta_5\Delta(hw_{t-1}) + \beta_6\Delta(fw_t) + \beta_7\Delta(fw_{t-1}) + \epsilon_t \quad (3)$$

where three new lagged terms are included. The lagged change in income could account for any sluggishness in adjustments to a new consumption level (Case et al., 2006). The lagged changes in the two wealth variables could be reasonable to include since the asset and liabilities data used to compute housing wealth and financial wealth are end-of-quarter stock data while consumption and income are flow data during a period. Lagged income is left out deliberately for fitting none of the mentioned motives. Table 4 showcases the results.
Table 4. **Detailed estimation results of model (3)**

Short-run relationship, dynamic modifications  
Estimation method: OLS

<table>
<thead>
<tr>
<th>Model</th>
<th>(3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Δ Consumption (-1)</td>
<td>-0.036 (-0.35)</td>
</tr>
<tr>
<td>Δ Income</td>
<td>0.179** (3.62)</td>
</tr>
<tr>
<td>Δ Housing wealth</td>
<td>0.068 (1.82)</td>
</tr>
<tr>
<td>Δ Housing wealth (-1)</td>
<td>0.045 (1.26)</td>
</tr>
<tr>
<td>Δ Financial wealth</td>
<td>0.080** (4.96)</td>
</tr>
<tr>
<td>Δ Financial wealth (-1)</td>
<td>0.017 (0.93)</td>
</tr>
<tr>
<td>Error correction term (-1)</td>
<td>-0.258** (-3.41)</td>
</tr>
<tr>
<td>Constant</td>
<td>0.002 (1.93)</td>
</tr>
</tbody>
</table>

R-squared 0.476  
S.E. of regression 0.006  
Schwarz criterion 7.198  
Durbin-Watson 1.575

* t-statistics in parentheses  
* * p < 0.05, ** p < 0.01
All of the lagged variables are insignificant, but this is to be expected because of the complicated autocorrelation relationships. Housing wealth change in the current period is barely insignificant. Comparing the coefficients with the results from model (2a), some sluggishness of the wealth effects can be observed.

Moving on, I follow both Kaplan and Johnson (1999) and Catte et al. (2004) and estimate models (4) and (5) which rerun the Engle-Granger two-step procedure, this time including two new variables, unemployment and interest rate. The two variables are widely considered to affect consumption, at least in theory (see any conventional macroeconomic textbook). Unemployment will proxy all uncertainty and real interest rate measures the alternative cost of consuming now versus saving. The *ect* term in model (5) is from model (4), not to be confused with previous models. The results are presented in table 5.

\[
c_t = \alpha + \beta_1(y_t) + \beta_2(hw_t) + \beta_3(fw_t) + \beta_4(U_t) + \beta_5(R_t) + e_{ct} \quad (4)
\]
\[
\Delta(c_t) = \alpha + \beta_1(ect_{t-1}) + \beta_2(\Delta y_t) + \beta_3(\Delta hw_t) + \beta_4(\Delta fw_t) + \beta_5(\Delta U_t) + \beta_5(\Delta R_t) + \varepsilon_t \quad (5)
\]

---

20 Ideally one would use the ex-ante real interest rate instead of the ex-post real rate computed in this paper. However computing the ex-ante real interest rate is much more difficult.
Table 5. **Detailed estimation results of models (4) and (5)**

Extended models
Estimation method: OLS

<table>
<thead>
<tr>
<th>Model</th>
<th>(4)</th>
<th>(5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Income</td>
<td>0.386**</td>
<td>0.180**</td>
</tr>
<tr>
<td></td>
<td>(16.88)</td>
<td>(3.61)</td>
</tr>
<tr>
<td>Δ Income</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Housing wealth</td>
<td>0.092**</td>
<td>0.089**</td>
</tr>
<tr>
<td></td>
<td>(6.62)</td>
<td>(0.032)</td>
</tr>
<tr>
<td>Δ Housing wealth</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Financial wealth</td>
<td>0.087**</td>
<td>0.07**</td>
</tr>
<tr>
<td></td>
<td>(5.95)</td>
<td>(4.40)</td>
</tr>
<tr>
<td>Δ Financial wealth</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unemployment</td>
<td>-0.002**</td>
<td>0.001</td>
</tr>
<tr>
<td></td>
<td>(-3.07)</td>
<td>(0.53)</td>
</tr>
<tr>
<td>Δ Unemployment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Real interest rate</td>
<td>-0.006**</td>
<td>-0.003*</td>
</tr>
<tr>
<td></td>
<td>(-4.96)</td>
<td>(-2.18)</td>
</tr>
<tr>
<td>Δ Real interest rate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Error correction term (-1)</td>
<td></td>
<td>-0.318**</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(-3.73)</td>
</tr>
<tr>
<td>Constant</td>
<td>5.181**</td>
<td>0.003**</td>
</tr>
<tr>
<td></td>
<td>(32.25)</td>
<td>(2.75)</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.997</td>
<td>0.478</td>
</tr>
<tr>
<td>S.E. of regression</td>
<td>0.008</td>
<td>0.006</td>
</tr>
<tr>
<td>Schwarz criterion</td>
<td>6.542</td>
<td>7.257</td>
</tr>
<tr>
<td>Durbin-Watson</td>
<td>0.830</td>
<td>1.639</td>
</tr>
</tbody>
</table>

* $t$-statistics in parentheses
* $p < 0.05$, ** $p < 0.01$
Stringently speaking, as both $U$ and $R$ are I(0), it can be inappropriate to include them in the equilibrium equation. However, only including them in the dynamic short-term equation makes them far from being significant. This could be because of the immediate effect of any smaller fluctuations in unemployment and real interest rate are small, as households tend to wait for a clear trend first. By including the variables in model (4), at least real interest rate becomes significant in the corresponding dynamic model, model (5).

Nevertheless the error correction term from model (4) passes the ADF-test (see appendix X), so the results may still be somewhat reliable. In the long run, unemployment and real interest rate both have the expected signs, and are highly significant. Compared to model (1a), the housing wealth effect is only slightly lower while the financial wealth effect is expected to be much lower. The inclusion of real interest rate perhaps addresses some of the ambiguity of any financial wealth effect discussed earlier. In the short run, both the housing and financial wealth effect and are lower by almost 10 percent, compared to the results of model (2).

Interestingly, when another an additional lag term each for unemployment and real interest rate are included in model (5), the consumption elasticity of housing and financial wealth then estimates to 0.098 and 0.072 respectively. The most of the wealth effect loss of housing wealth is recovered while the opposite is true for financial wealth.

It was intended that two more models were to be estimated, using a smaller range, 1996Q1 to 2008Q4 and 2004Q1 to 2016Q4. The aim of the models was to investigate whether the MPC has been trending up or down. Perhaps restrained by the still relatively small sample size, the residuals from the equilibrium model were found to be non-stationary. The $\tau$ test values on the residual series were 3.12 and 3.42, far from enough to pass the recommended 3.74.

Overall, results from all the models suggest a slightly smaller wealth effect than Johnsson and Kaplan (1999) and Chen (2006). While Chen took a completely different approach, my results should offer some reasonable comparability with Johnsson and
Kaplan's estimate. Primarily, it reinforces the finding of long-term MPC out of housing wealth to be around 0.04 as Johnsson and Kaplan suggested. Whether the 0.006 points of difference between our findings can indicate a decline in the wealth effect of housing perhaps needs further testing. After all, it can also come down to any errors on data selection and model execution that this paper or another paper has committed.

5.2 Limitations

The limitations of this study are twofold. For one, the choice of theory, the LCH, relies on a few assumptions. While proven, the theory is somewhat inflexible, at least when used with macro-level data. As discussed earlier, studies based on micro-level panel data tend to provide higher estimates. Iacoviello (2011) hints that the unequal distribution of wealth and income may be a big factor. Wealthy individuals or households perhaps plan their consumption less carefully, while the poor sometimes cannot execute their plans when faced with borrowing constraints. This study may have been able to shed some light on the current wealth effect of housing, but cannot help to understand the underlying changes.

The Engle-Granger approach also has its limitations. The model assumes that one variable is the dependent one and all others are the explanatory ones. In reality, this is seldom so clear-cut. Once again consider the problem Johnsson and Kaplan (1999) brought up, if there is a negative shock in consumption behavior forced by a third factor, for example a new revolutionary type of asset, then the decreased spending results in saving, which results accumulation of wealth in the LCH. Another mode, perhaps a Vector Error Correction Model that assumes endogeneity for all variables may be able to investigate from that perspective.


6 Conclusion

The findings of this study reinforce the general consensus that there exists a substantial wealth effect of housing on private consumption. The main model of this study finds the long-term marginal propensity to consume (MPC) out of housing wealth in Sweden during the past 21 years to be 0.034. This means that a permanent increase of one krona in housing wealth leads to a 3.4 cents in consumption. In the short run, the immediate MPC out of housing wealth in 0.036, which declines to 0.011 if measured after one year. The results also suggest that housing wealth has a larger consumption effect than financial wealth in the short run. The long-term comparison cannot be conclusively be made however due to how the data is set up to focus on housing wealth.

While the numeric results from this study seem to be robust overall, what this paper does not explain is the dynamics behind why the wealth effect is at the magnitude it is and why it could possibly be changing. Through testing several different models the study discovers potential evidence of side findings but even more so raises more questions. Restricted by the choice of model and method, these questions shall be left for more advanced studies to answer.

Nevertheless the primary purpose of this study has been achieved. The estimates presented should provide policymakers with a reliable estimate of the housing wealth effect that is more up-to-date.
References


Appendix 1 Descriptive statistics of main variables

Appendix Table A1. **Descriptive statistics of main variables**

Household sector, MSEK, real prices with reference 2016Q4, seasonally adjusted
For details see chapter 3

<table>
<thead>
<tr>
<th>Series</th>
<th>Consumption</th>
<th>Income</th>
<th>Housing assets</th>
<th>Financial assets</th>
<th>Liabilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>386 784</td>
<td>398 545</td>
<td>6 145 044</td>
<td>5 536 754</td>
<td>2 271 992</td>
</tr>
<tr>
<td>Median</td>
<td>388 483</td>
<td>385 709</td>
<td>6 453 567</td>
<td>5 657 532</td>
<td>2 273 405</td>
</tr>
<tr>
<td>Maximum</td>
<td>493 474</td>
<td>543 428</td>
<td>11 090 493</td>
<td>9 647 444</td>
<td>3 865 795</td>
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<tr>
<td>Minimum</td>
<td>280 088</td>
<td>286 002</td>
<td>2 586 674</td>
<td>2 237 620</td>
<td>1 037 989</td>
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</tbody>
</table>

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<td>Observations</td>
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</tbody>
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## Appendix 2 ADF-test Results on Variables and Error Correction Terms

### Appendix Table A2. Augmented Dickey-Fuller Test Results

Lag structure: As determined by Schwarz Criterion  
Estimation method: OLS

<table>
<thead>
<tr>
<th>Variable or residual</th>
<th>Level</th>
<th>First difference</th>
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<tr>
<td>Consumption (C)</td>
<td>-3.2550**</td>
<td>-8.6447**</td>
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<tr>
<td>Disposable income (Y)</td>
<td>-4.0505*</td>
<td>-7.7870**</td>
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<tr>
<td>Housing assets (HA)</td>
<td>-2.2166</td>
<td>-3.4831*</td>
</tr>
<tr>
<td>Financial assets (FA)</td>
<td>-3.0343</td>
<td>-8.2619**</td>
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<tr>
<td>Housing wealth (HW)</td>
<td>-1.8292</td>
<td>-3.6708**</td>
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<tr>
<td>Financial wealth (FW)</td>
<td>-3.0936</td>
<td>-8.2666**</td>
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<tr>
<td>Financial balance (FB)</td>
<td>-3.1423</td>
<td>-8.2787**</td>
</tr>
<tr>
<td>Unemployment rate (U)</td>
<td>-3.0771*</td>
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</tr>
<tr>
<td>Real interest rate (R)</td>
<td>-2.6702**</td>
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<tr>
<td>Ect from model (1a)</td>
<td>-3.8993*</td>
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<tr>
<td>Ect from model (1b)</td>
<td>-3.7989*</td>
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<tr>
<td>Ect from model (4)</td>
<td>-5.0277**</td>
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</tr>
</tbody>
</table>

Tests performed on error correction terms use MacKinnon (2010) critical τ-values.  
* $p < 0.05$, ** $p < 0.01$