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MASTER'S THESIS

THE WEALTH EFFECT – A PANEL DATA ANALYSIS

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INTRODUCTION

The rapid price movements in real estates and financial securities during the late 1990s and the early 2000s have sparked a growing interest in the wealth effect – the change in consumption behavior due to changes in wealth. Consumption is one of the main drivers of gross domestic product (hereinafter: GDP) – the aggregate market value of final goods and services produced within an economy over any given period. It is therefore important to build an understanding for its determinants. The relationship between wealth factors and consumption is essential for policy makers and the society as a whole. Modern consumption theory predicts that wealth and consumption are positively correlated but the casual effect of changes in consumption due to changes in wealth must be scrutinized because of the crucial implications it serves monetary and fiscal authorities.

The wealth effect originates from the life-cycle hypothesis of consumption, recognized by Franco Modigliani (Ando & Modigliani, 1963; Modigliani, 1986). The theory is based on the following three premises: (i) the utility of an agent is assumed to be a function of its own aggregate consumption over the expected remaining lifetime, (ii) the agent is maximizing its utility given the available resources, being the sum of future discounted earnings and the current net worth of assets and (iii) the agent wishes to distribute its consumption evenly across time. These premises suggest a positive long-run relationship between consumption and wealth.

Intuition may also predict a positive correlation between consumption and wealth. Apergis and Miller (2004, p. 2) argue that the value of stock holdings represents a significant indicator for household wealth. Changes in the asset value should therefore affect consumption behavior. Moreover, stock prices are correlated with GDP and thus remain stock wealth linked with consumption (Poterba & Samwick, 1995, p. 296; Starr-McCluer, 2002, p. 71). Case, Quagley and Shiller (2005, p. 1) argue for a positive relationship between housing wealth and consumption but this link has not been extensively studied. Increases in housing wealth may relax borrowing constraints, resulting in positive changes on consumption (Campbell & Cocco, 2007, p. 2). There may also be a motive for reduced "cautionary" savings, meaning that savings decrease during house price appreciations which also positively affect consumption (Carroll, 1992).

This thesis studies the relationship between housing wealth and stock wealth on consumption for countries that are members of the Organization for Economic Co-operation and Development (hereinafter: OECD) area – an international organization consisting of 34 countries that aims to stimulate economic activity and globalization. A panel of 14 countries, observed annually during the period 2000-2012 is used. The observed countries have unique institutional features and trading cultures which suggests that wealth effects may be heterogeneous between nations. This thesis postulates the fixed-effects estimator to control for unobservable differences between countries that are time-invariant and to control for unobservable differences that is time-variant with an equal effect for all countries. Additionally, an instrumental variables (IV) estimator combined with fixed-effects is proposed to observe whether there are any indications of endogeneity in the normal fixed-effects estimator.

Previous empirical studies in this topic are either outdated or inconclusive (Anderson & Kennedy, 1994; Ando & Modigliani, 1963; Apergis & Miller, 2004; Case et al., 2005; Chen, 2006; Dvornak & Kohler, 2007; Engelhardt, 1996; Girouard & Blöndal, 2001; Levin, 1998; Ludwig & Sløk, 2004; Skudelny, 2009; Starr-McCluer, 2002). This study accounts for the impact of the Great Recession and include control variables associated with wealth in the model specifications. Moreover, this thesis aims to discover whether there is any evidence of deleveraging effects – the contraction in aggregate private debt that occurs due to rapidly selling off assets. Deleveraging effects may be quantified by including interaction terms of crisis dummies and wealth variables into the estimation models. The interactions control for the potential differences in wealth effects during the crises periods and non-crisis periods. If deleveraging effects exists, the interaction coefficients should hold a significant negative sign as this may indicate that households sell off assets in order to finance debt which lowers the magnitude of the positive relationship between consumption and wealth.

The structure of the thesis is as follows: section 1 gives the background that includes a short introduction of the life-cycle hypothesis, deleveraging and a literature overview. Section 2 gives the estimation strategy. Section 3 provides information on the dataset and section 4 reveals the results.

1 BACKGROUND

1.1 Modigliani's Life-cycle Hypothesis

Modigliani's consumption theory is widely applied as a foundation for empirical studies that estimates consumption functions. Although this thesis is empirical, a short introduction to the theory is presented here. For further details see Ando and Modigliani (1963), chapter 16 in Mankiw (2003) and Modigliani, (1986).

The long-run relationship between consumption and wealth can first be expressed as an optimization problem

$$Max\ U = \sum_{t=1}^{T} \beta^t U_t(C_t) \tag{1}$$

$$s.t. \sum_{t=1}^{T} \frac{C_t}{(1+r)^T} \leq W_0 + \sum_{t=1}^{T} \frac{Y_t}{(1+r)^T}$$

An individual chooses a consumption path, C_t, that maximizes utility, U_t, which is weighted by a time discount, β^t, subject to a budget constraint that represents discounted flow of future income, $\sum_{t=1}^{T} \frac{Y_t}{(1+r)^T}$ and the initial wealth the individual currently possesses, W_0.

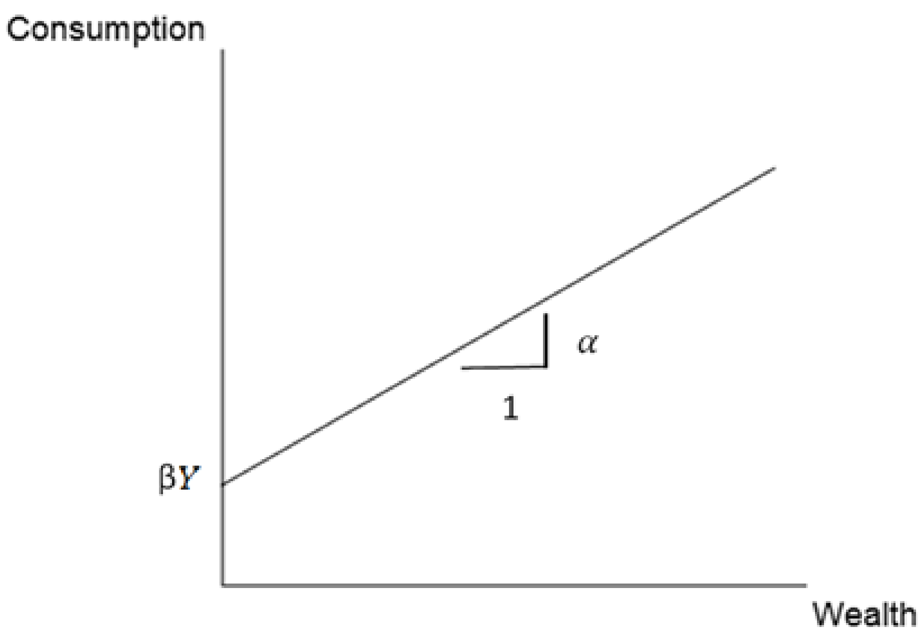
Ando and Modigliani (1963, p. 58) postulates the below consumption function to empirically test equation (1)

$$C_t = \alpha W_t + \beta Y_t \tag{2}$$

where α and β are slope coefficients on wealth and income respectively.

A graphical representation of equation (2) is given below

Figure 1. Graphic Representation of Equation (2)



There are two important implications of equation (2):

1. An agent will consume out of its wealth with rate α for any given income.
2. Wealth is defined as a single factor that controls for all types of asset classes.

The first implication sheds light on the topic of this thesis, the wealth effect – the change in consumption due to changes in wealth. The second implication assumes the same change in consumption for every unit of wealth, the marginal propensity to consume (hereinafter: MPC), for all types of asset classes. This is a strong assumption as consumption arguably reacts differently between changes in stock wealth and housing wealth (Greenspan, 2001, p. 4). Housing may be hard to liquidate relative to stocks due to high transaction costs, implying that the MPC out of housing wealth might be lower than the MPC out of stock wealth. Poterba (2000, p. 104) argues that house price appreciations raise the cost of living in houses which potentially cancels the housing wealth effects on non-housing goods, see Skinner (1996) for an analysis. Other reasons to why the two wealth components should be presented separately is that (i) some assets might be perceived riskier than others (ii) different tax regulations on realized capital gains should affect the consumption behavior differently and (iii) agents may separate various wealth components into mental accounts, meaning that some assets are more appropriate to use for current consumption while others are better used for future consumption. See for instance Case et al. (2005, p. 5), Dvornak and Kohler (2007, pp. 119-120) and Pissarides (1978) for a further discussion on why separate wealth effects should be presented and why the restriction in equation (2) that treats all assets equally potentially shadows important policy implications.

It would be more convenient to extend the consumption function in equation (2) to

$$C_t = \alpha H_t + \delta S_t + \beta Y_t \tag{3}$$

where H_t is housing wealth, S_t is stock wealth, Y_t is income with α, δ, and β as the respective slopes.

In the end, it is a matter of a quantitative empirical study to see which wealth component that has higher magnitude and best predicts consumption.

1.2 Deleveraging

Deleveraging is a topic frequently discussed during economic crises. There are many reasons for this phenomenon and some of these are discussed here.

Deleveraging is a key element in Irving Fisher's debt-deflation business cycle theory (Fisher, 1933). Assuming that there exists a state of so-called over-indebtedness, a schematic representation of Fisher's theory is as follows. (i) Investors would sell their investments which include stocks and real estates. This is because of the uncertainty of holding debt during crises. (ii) When investors have liquidated their assets, they begin paying off their financial debt, leading to contractions of the money supply which in turn leads to deflation. (iii) Bankruptcies follow the deflation and therefore also a further fall in investments. (iv) The bankruptcies lead to a general fall in profit and this fall in profit leads to lower employment. (v) Furthermore, pessimism and loss of confidence culminates within the economy. (vi) Consequently, agents hold on to their currency and stops spending. The final effect is complicated disturbances and signals on economic indicators which further contributes to uncertainty and makes the crisis even more severe than it once were.

Cuerpo, Drumond, Lendvai, Pontuch and Raciborski (2013, p. 2) argue that deleveraging pressures are taking place in both the private sector and the public sector since the occurrence of the Great Recession. This worries policy makers because of the economic recovery being potentially postponed. It would be of importance to try quantifying a relationship between wealth variables and consumption and to see whether the coefficients increase or decrease during periods of financial distress. A decrease in wealth effects during crises would indicate deleveraging effects while an increase may indicate higher uncertainty and therefore higher sensitivity of consumption on wealth factors.

Deleveraging effects may not always be predictable since it depends on what type of asset class that is emphasized and also what type of crisis that is referred to. It is expected that the estimated coefficients of housing wealth and stock wealth in equation (3) are positive. However, as previously noted, the coefficients may increase or decrease during crises. If the stock wealth effect increases during crises, it would suggest that stocks are not easily liquidated and therefore becomes consumption more sensitive to changes in the value of stocks. It may also imply that consumption is simply more sensitive to changes in wealth variables when general economic conditions worsen. If the stock wealth effect decreases during the crises, it may imply that the assets are able to be liquidated and therefore serves as a cushion for the decline in consumption. An increase in housing wealth effects during crises is plausible, especially when considering the Great Recession which was a significant real estate crisis. Since the housing bubbles in many countries burst, the mortgage debts needed to be deleveraged by selling the real estates, at a significant discount. This makes consumption more sensitive to changes in housing wealth during a real estate crisis. A decrease in the effect of housing wealth on consumption during crises may seem less plausible than an increase. This is due to the difficulty in liquidating houses when there are periods of financial distress.

The expectation is that stock wealth effects are decreasing during crises since stocks are generally more liquid and can therefore serve as a cushion for the drop in consumption. Housing wealth effects are on the other hand expected to increase due do its illiquid properties.

1.3 Literature Overview

Previous studies on the wealth effect goes far back into the 1960s where Ando and Modigliani (1963) aimed to test the life-cycle hypothesis using annual data for the United States (US) during the period 1929-1959. The dependent variable is aggregate consumption while the independent variables are net worth of assets and after-tax disposable income. The authors conclude that the data supports the life-cycle hypothesis since wealth is a significant determinant of consumption. However, the authors mainly emphasize financial wealth, not housing wealth in their definition for net worth of assets.

Dvornak and Kohler (2007) analyze the wealth effect in Australia during the period 1984-2001 by using a quarterly panel. The dependent variable is consumption expenditures, aggregated over each state while the independent variables are net dwelling wealth, stock wealth, disposable income and other net wealth. The main estimators are the fixed-effects estimator and an IV estimator including fixed-effects. Moreover, since the data is cointegrated, the authors use an error-correction model (ECM) that aims to find the short-run equilibrium between consumption and wealth. Dvornak and Kohler (2007) find that stock wealth and housing wealth are two long-run determinants of consumption. The authors estimate an MPC of 6-9 cents for stock wealth and 3 cents for housing wealth for every 1 A$ using state level data. The MPC out of stock wealth were systematically larger than the MPC out of housing wealth which is in accordance with the theory that the two wealth components affect consumption differently.

Case et al. (2005) analyze the relationship between housing wealth and financial wealth on consumption using two datasets; (i) a panel of 14 developed countries that are observed annually during various years in 1975-1999 and (ii) a panel of quarterly data for the US during the period 1982-1999. The authors impute values for housing wealth, stock wealth and consumption in the US panel, whereas official data is used in the international panel. Case et al. (2005) estimate consumption functions in levels, first-differences and in error-correction form to see how robust and meaningful the estimates are to various model specifications. There seem to be weak evidence of stock wealth effects for the international data with an elasticity of 0.03. There are however strong evidence of housing wealth effects with an elasticity of around 0.11-0.17 which is both statistically and economically significant.

The literature goes beyond empirical papers. Starr-McCluer (2002) analyzes consumer behavior using the Michigan SRC Survey of Consumers in 1997 that asked questions about consuming and saving at times of significant stock price appreciations. The results show that 85 percent of the respondents did not increase their consumption during stock price appreciations. However, the respondents that represent the top 10 percent of the group with largest holdings did increase their consumption. The effect on aggregate consumption was significant and hence supports the life-cycle hypothesis.

Engelhardt (1996) examines the relationship between house price appreciations and savings using individual data during the period 1984-1989 for the US. The applied variables are savings, housing capital gains, income and a set of control variables that take into account different characteristics of the respondents. A housing wealth effect is observed with an MPC out of real housing capital gains of around 0.03 for every 1 US$. The results are however based on an asymmetry in the behavior of the respondents. Households who experienced capital gains did not alter their consumption significantly while the households who experienced capital losses did reduce their consumption.

Yet another study on micro-level is authored by Levin (1998) who uses data from the Longitudinal Retirement History Survey that includes 11 000 individuals between the ages 57-62 in year 1962. There are eight dependent variables and two sets of independent variables. The dependent variables represent private consumption in various sub-categories such as food, entertainment and vacations. The first set of independent variables are used as controls for household characteristics that vary over time such as marital status, number of people in the household and the like. The second set of independent variables is more relevant for this topic since it includes current income, housing wealth and liquid assets among other. Levin (1998) finds no indications of housing wealth effects but finds that liquid assets and income are significant determinants of consumption.

Ludwig and Sløk (2004) conduct a macro study using a quarterly panel of 16 OECD countries during the years 1960-2000. The applied variables are cointegrated and include price indices as proxies for stock wealth and housing wealth. The authors also include stock market capitalization to see how robust price indices are in measuring stock wealth effects. A long-run relationship is found between the two wealth components and consumption. Stock wealth elasticity is estimated to 0.08 while the elasticity for housing wealth is around 0.04.

Girouard and Blöndal (2001) analyze a panel of OECD countries between the years 1970-1999. The variables are cointegrated and include private consumption as the dependent variable while financial and non-financial wealth indicators together with various macroeconomic variables are treated as independent variables. There is evidence for financial and non-financial wealth effects but there are also inconsistencies. The estimated coefficients for some countries are not holding the expected sign nor are they statistically significant.

To summarize: previous literature on the wealth effect provides considerable differences regarding variables, sample properties, estimation strategies and results. In general, the literature is divided into two parts, micro-studies and macro-studies. Finally, there is mixed evidence when testing for the life-cycle hypothesis.

2 ESTIMATION STRATEGY

There are econometric problems involved when estimating parameters out of consumption functions. These include for instance: (i) unobserved differences between countries, (ii) simultaneous causality between consumption and wealth, (iii) residual autocorrelation due to model misspecification and (iv) errors in measuring wealth data. In order to conduct a proper empirical study, these problems should be taken into account.

The fixed-effects estimator may solve the problem of unobserved differences between countries while the IV estimator may potentially solve all four obstacles.

2.1 The Fixed-effects Estimator

The fixed-effects estimator traces out unobserved differences between countries by subtracting individual means from the data before estimation. An equivalent outcome is to include country specific dummy variables. This estimator should eliminate the contagion caused by the unobserved differences if these are time-invariant. The fixed-effects estimator allows for common slopes but country specific intercepts. An introduction to the fixed-effects estimator is given below, for more details see chapter 13 in Wooldridge (2003).

Consider a simple regression model that aims to estimate the MPC using a panel of countries

$$C_{i,t}=\beta_0+\beta_1 Y_{i,t}+\varepsilon_{i,t} \tag{4}$$

$$i=1,2,3\ldots N \qquad t=1,2,3\ldots T$$

where $C_{i,t}$ is consumption, β_0 is intercept, $Y_{i,t}$ is disposable income with slope β_1, and $\varepsilon_{i,t}$ is residual assumed to be independently identically distributed with mean 0 and variance σ^2, henceforth abbreviated $IID(0, \sigma^2)$.

Model (4) is a pooled estimator that potentially suffers from omitted variables bias since there are undoubtedly unobserved characteristics within each country that is correlated with disposable income and is also a determinant of consumption such as taxation, geography, and labor market conditions. This unobserved deviation can be captured from the residual component assuming that it is time-invariant

$$\varepsilon_{i,t}=\gamma_i+u_{i,t} \tag{5}$$

Where γ_i captures individual country deviations from the overall mean α.

By defining

$$\alpha_i = \gamma_i + \beta_0$$

one can rewrite model (4) as such

$$C_{i,t} = \alpha_i + \beta_1 Y_{i,t} + \varepsilon_{i,t} \tag{6}$$

Equation (6) is the fixed-effects estimator; $\alpha_1, \ldots, \alpha_N$ are treated as unknown intercepts to be estimated.

The threat of omitted variables bias is greatly reduced when viewing each country heterogeneously since variations within each state is controlled for via its specific intercept. One can extent model (6) by including time fixed-effects which captures variations over time that affects all states equally. Time fixed-effects may control for global economic conditions, education and innovations in technology. Equation (7) controls for fixed-effects and time fixed-effects

$$C_{i,t} = \alpha_i + \delta_t + \beta_1 Y_{i,t} + \varepsilon_{i,t} \tag{7}$$

where δ_t is time fixed-effects that controls for the time of the observation.

The fixed-effects estimator can be estimated with Ordinary Least Squares (OLS) – a standard regression estimator that aims to minimize the sum of squared residuals. $\hat{\alpha}_i$ is obtained by including a dummy variable for each entity while $\hat{\delta}_t$ is obtained by including dummy variables for each time period.

Below is the base-case model

$$C_{i,t}=\alpha_i+\beta_1 H_{i,t}+\beta_2 S_{i,t}+\beta_3 Y_{i,t}+\beta_4 O_{i,t}+\varepsilon_{i,t} \tag{8}$$

$$i=1,2,3 \ldots N \quad t=1,2,3 \ldots T$$

where $C_{i,t}$ is consumption, α_i is fixed-effects across countries, $H_{i,t}$ is a proxy for housing wealth with slope β_1, $S_{i,t}$ is a proxy for stock wealth with slope β_2, $Y_{i,t}$ is disposable income with slope β_3, $O_{i,t}$ are control variables treated as other wealth indicators with slope β_4, and $\varepsilon_{i,t} \sim IID(0, \sigma^2)$. All variables are transformed into natural logarithms.

Stock wealth has two proxies, household shares in investment funds and market capitalization of domestic listed firms. Both are used to check for sensitivity in the model specifications and to compare the estimates with previous studies that use stock market capitalization (Case et al., 2005; Ludwig & Sløk, 2004). The other wealth variables include net equity of households in pension funds reserves and net equity of households in life insurance reserves. These other wealth indicators are controlled for to check robustness and model sensitivity.

Several assumptions must be fulfilled in order to estimate a causal effect of (X) on (Y) in panel data context, see chapter 14 in Wooldridge (2003). One important assumption is that the residuals should not exhibit serial correlation. This thesis use clustered standard errors since these are robust to residual serial correlation.

2.2 Instrumental Variables Techniques

The fixed-effects estimator can be extended into an IV estimator to handle the possible endogeneity of the variables. IV techniques can potentially be powerful since these might solve problems related to omitted variables bias, measurement errors and simultaneous causality bias. An introduction to IV techniques is given below, for further details see chapter 15 in Wooldridge (2003).

Consider a simple regression model where one can think of the independent variable (X), having two parts; (i) the endogenous part which is to be avoided, and (ii) the exogenous part that is demanded. IV regressions are estimated using a two stage least squares (hereinafter: TSLS) estimator and the idea is to isolate the exogenous part of X on Y using the instrument, Z. TSLS in cross sectional setting follows the below two stages:

1. Run the first stage regression

$$X_i = \gamma_0 + \gamma_1 Z_i + u_i \tag{9}$$

Where γ_0 is intercept, γ_1 is the slope coefficient and $u_i \sim IID(0, \sigma^2)$.

Obtain $\hat{X}_i$.

2. Run the second stage regression

$$Y_i = \alpha + \beta_1 \hat{X}_i + \varepsilon_i \tag{10}$$

where α is intercept, β_1 is the slope coefficient and $\varepsilon_i \sim IID(0, \sigma^2)$.

The TSLS estimator relies on the following two assumptions:

1. Relevance - $E(X_i|Z_i) \neq 0$
2. Exogeneity - $E(\varepsilon_i|Z_i) = 0$

The relevance condition is required since the instrument would otherwise be a useless predictor in the first stage regression. The exogeneity condition is required since it will solve the original problem of endogeneity.

Testing for instrument relevancy is done in two steps. The first step observes whether the canonical correlations between the endogenous regressors and the instruments are different from zero. Rejection of the null implies identification, meaning that a significant correlation exists; while failing to reject the null implies that the equation is underidentified, meaning that the model is not proper and should be revised to avoid bias. Kleibergen and Paap (2006) have proposed the LM statistic to test for identification. This test is robust to serial correlated residuals.

The relevance criteria may however not hold even if there are significant canonical correlations (Bound, Jaeger & Baker, 1995, p. 443; Staiger & Stock, 1997, pp. 557-558). Bound et al. (1995, p. 449) suggest that the F-statistic and the R^2 in the first stage regression should be routinely reported in addition to the identification test. Instrument relevancy can be considered fulfilled if the partial F-statistic that jointly tests if all coefficients on the instruments are equal to zero in the first stage regression is larger than 10 (Staiger & Stock, 1997, p. 557).

The second step applies the Stock-Yogo weak instrument test (Stock & Yogo, 2005). The null hypothesis is a state of having weak instruments that is subject to bias in a proportion that the researcher decides unacceptably large. The bias comes in two forms: relative bias and size bias. A rejection of the null indicates that the instruments are not weak. The test statistic is a Wald F-statistic based on the Kleibergen-Paap LM test which is also robust to serial correlated errors.

The exogeneity assumption can be tested when having an overidentified model, that is, when the number of instruments is larger than the number of endogenous regressors. The standard test is based on obtaining residuals from the TSLS estimator and then modeling the residuals on all instruments and all control variables. The J-statistic is defined as the number of observations multiplied with the obtained R^2. This test can be extended by taking into account serial correlation in the error terms using General Method of Moments (hereinafter: GMM) estimators proposed by Hansen (1982). The problem with the exogeneity test is if the null is rejected, it will only tell us that something is wrong, not what.

Dvornak and Kohler (2007, pp. 123-127) applies a TSLS estimator using lags of income, contemporaneous values of net housing wealth, net other financial wealth and stock market wealth as instruments. Skudelny (2009, p. 21) uses a similar strategy by instrumenting for total wealth and financial wealth using up to four lags for each of the two endogenous variables. Using lagged variables as instruments is common in time series and panel data context. The reason is because macroeconomic time series highly depends on previous realized data and that these data might not have any correlation with current shocks.

In this thesis, stock wealth and housing wealth are instrumented using the first lag of income, stock wealth and housing wealth as instruments. This setup seemed most appropriate as it fulfilled the underlying assumptions of IV techniques.

2.3 Alternative Models: Cointegration and Error-correction Models

An alternative to the fixed-effects estimator is the ECM that captures both short-run and long-run effects (Case et al., 2005; Dvornak & Kohler, 2007; Girouard & Blöndal, 2001; Ludwig & Sløk, 2004). This strategy only works with cointegrated variables.

The concept of cointegration and ECM was first introduced by Engle and Granger (1987). The idea is to find a stable long-run relationship between non-stationary variables. An introduction to the concept using a time-series setting is given below, for more information see chapter 4 in Pfaff (2008).

Assume a relationship between X_t and Y_t in the following way

$$X_t = X_{t-1} + \varepsilon_{xt}$$

$$Y_t = \alpha + \beta X_t + \varepsilon_{yt} \quad (11)$$

where ε_{xt} and $\varepsilon_{yt} \sim IID(0, \sigma^2)$.

Further assume that both variables have unit roots and are both random walks but now there is a factual relationship between them as shown above. The relationship can be characterized by the vector $[1, -\alpha\text{-}\beta]$ since $1 * Y_t - \alpha - \beta X_t = E(\varepsilon_{yt}) = 0$. This vector is called the cointegrating vector where α and β is the cointegrating parameter that defines the long-run equilibrium. The variables are said to be cointegrated since the below linear combination exists

$$Z_t = Y_t - \alpha - \beta X_t \quad (12)$$

The process in (12) is stationary since Z_t is equal to ε_{yt} which is stationary by construction. When two time series are cointegrated, the estimated parameters become “superconsistent” (Stock, 1987).

Engle and Granger (1987) suggest a two-step procedure when estimating an ECM on cointegrated variables.

Step 1. Test for a cointegrating relationship between variables by applying the Augmented Dickey Fuller unit root test on Z_t while using the critical values found in MacKinnon (1991, p. 275). Step 2 is initiated when the existence of a unit root is rejected.

Step 2. An ECM is estimated:

$$\Delta Y_t = \alpha + \beta_1 \Delta X_t + \beta_2 \Delta Z_{t-1} + \varepsilon_t \tag{13}$$

where

$$\Delta Z_{t-1} = Y_{t-1} - \alpha - \beta X_{t-1}$$

β_1 in (13) is the short-run effect and β_2 is an adjustment parameter that constantly adjusts the model towards its long-run equilibrium. β in (11) is the long-run effect.

Carroll, Otsuka and Slacalek (2011, p. 5) argue that a stable cointegrating vector between wealth components and consumption can never reliably be observed. Changes in long-run growth in GDP, technology innovation or interest rates should affect the relationship between consumption and wealth since these variables are interrelated. An agent might for instance deviate from its equilibrium MPC when the long-run growth in interest rates changes since expectations of mortgage repayments are altered.

2.4 Alternative Models: Dynamic Panel Data Models

Dynamic panel data models may improve the fit and the forecasting performance relative to the standard fixed-effects estimator discussed in sub-section 2.1. The perhaps most common estimator is the Arellano-Bond estimator that is mainly designed for panels following the characteristics: (i) small T large N panels, (ii) a linear functional relationship, (iii) the dependent variable has an autoregressive part, (iv) the independent variables are not strictly exogenous, (v) the panel contains unobserved fixed-effects. A short introduction to this technique is provided below, for more information; see Arellano and Bond (1991).

Consider equation (14) below that extends the standard fixed-effects estimator by including one lag of the dependent variable

$$Y_{i,t} = \alpha_i + \gamma_1 Y_{i,t-1} + \beta_1 X_{i,t} + \varepsilon_{i,t} \tag{14}$$

where $\alpha_1, \ldots, \alpha_N$ are treated as unknown intercepts to be estimated. γ_1 and β_1 are slopes and $\varepsilon_{i,t} \sim IID(0, \sigma^2)$.

Estimating equation (14) is not straightforward since there are reasons to believe that the lagged dependent variable is correlated with the residual. Nickell (1981) shows that the standard OLS estimator is inconsistent when applied to equation (14). An alternative approach would be to eliminate the fixed-effects by taking the first difference

$$\left(Y_{i,t}\text{-}Y_{i,t\text{-}1}\right)=\gamma_1\left(Y_{i,t\text{-}1}\text{-}Y_{i,t\text{-}2}\right)+\beta_1\left(X_{i,t}\text{-}X_{i,t\text{-}1}\right)+\left(\varepsilon_{i,t}\text{-}\varepsilon_{i,t\text{-}1}\right) \tag{15}$$

Equation (15) eliminated the contagion caused by unobserved differences that are time-invariant. However, by construction, it is evident that $\left(Y_{i,t-1}\text{-}Y_{i,t-2}\right)$ is correlated with $\left(\varepsilon_{i,t}\text{-}\varepsilon_{i,t-1}\right)$. But $Y_{i,t-2}$ is not necessarily correlated with $\left(\varepsilon_{i,t}\text{-}\varepsilon_{i,t-1}\right)$ since the innovations occur at different time periods. One can therefore use $Y_{i,t-2}$ as an instrument for $\left(Y_{i,t-1}\text{-}Y_{i,t-2}\right)$. Note that this technique is using lagged values of variables as instruments, similar to the TSLS estimator discussed in sub-section 2.2. Arellano and Bond find the GMM estimator significantly more efficient than the instrumental variables alternatives since it uses all of the information in the sample and provides robust standard errors, see Anderson and Hsiao (1981) and Holtz-Eakin, Newey and Rosen (1988) for more information on instrumental variable alternatives.

The Arellano-Bond GMM estimator uses a system of equations, one per time period where different numbers of instruments are used. When the lag length increases, the number of valid instruments grows as well and therefore the information is used more efficiently.

There are two important diagnostic tests required when estimating the Arellano-Bond dynamic panel data estimator. These are the Sargan test for overidentification and the autoregressive test for residual autocorrelation. The null hypothesis of the Sargan test is similar to what the J-statistic aims to reject, namely that the instruments as a group are exogenous. The null hypothesis for the autocorrelation test is no residual autocorrelation for the differenced residuals. Note that the null is likely to be rejected using the first lag since $\Delta\varepsilon_{i,t}=\varepsilon_{i,t}\text{-}\varepsilon_{i,t-1}$ and $\Delta\varepsilon_{i,t-1}=\varepsilon_{i,t-1}\text{-}\varepsilon_{i,t-2}$. Both of the differences have $\varepsilon_{i,t-1}$ included in the specification. The residual test of zero autocorrelation tests on the second lag should not be rejected. If however the null is rejected, it would indicate that the lagged endogenous variables are not appropriate instruments.

Although the Arellano-Bond estimator enables for dynamic panel data models that potentially increase the forecasting performance and explanatory power, it may not be recommended for narrow panels with low numbers of observations. The number of instruments quickly increases when the number of endogenous variables increases. Hence, the efficiency of the estimators may weaken and its precision fall. The applied panel in this thesis revealed weak results when using the Arellano-Bond dynamic panel data estimator, most likely due to the small number of observations and its narrowness.

2.5 Limitations in the Estimation Strategy

Previous empirical papers that jointly estimate housing and stock wealth effects usually find one of the two coefficients insignificant. Strong correlation between housing wealth and stock wealth might be the reason for this. To observe how sensitive the coefficients are, two different proxies for stock wealth are used.

The fixed-effects estimator controls for unobservable differences between countries that are time-invariant. However, many unobservable factors such as proportions of individuals owning shares or houses change if an economy runs into a recession. This is classified as a country specific time-variant effect which the model does not control for. The data spans for about 10 years and includes the dot-com crisis and the Great Recession which casts doubt on many unobservable time-invariant effects that the fixed-effects estimator assumingly controls for. One can include time fixed-effects so that the chance of omitted variables bias is reduced but the time coefficients assume the same effect for all countries.

The thesis focuses on quantifying the relationship between consumption and wealth for long-run horizons and not testing any particular consumption function. To test for specific functions one would include dynamics in equation (8) to enhance its short-run explanatory and forecasting performance.

3 DATA

3.1 Panel Data

The applied dataset is an unbalanced panel consisting of OECD countries that are studied annually during the period 2000-2011. Due to data limitations, this thesis is restricted to 14 countries.

The countries are geographically dispersed and cover the dot-com evolution and the Great Recession, providing the data important geographic and event variation. The total number of observations is 149.

Table 3.1 below gives an overview of the countries, periods studied and the number of observations.

Table 1. Panel Data Overview

Country	Period	Number of observations
AUSTRALIA	2000-2011	12
BELGIUM	2000-2011	12
CANADA	2000-2010	11
ESTONIA	2003-2010	8
FINLAND	2003-2010	8
FRANCE	2000-2010	11
GERMANY	2000-2011	12
HUNGARY	2000-2010	11
ITALY	2000-2008	9
LUXEMBOURG	2005-2011	7
NETHERLANDS	2000-2011	12
SWITZERLAND	2000-2011	12
UNITED KINGDOM	2000-2011	12
UNITED STATES	2000-2011	12
		Total: 149

The applied variables that were available for the 14 OECD countries include (i) private consumption (henceforth consumption), (ii) disposable income, (iii) household shares in investment funds (henceforth investment fund shares), (iv) market capitalization of domestic listed firms (henceforth stock market capitalization), (v) housing wealth, (vi) net equity of households in pension funds (henceforth pension funds reserves) and (vii) net equity of households in life insurance reserves (henceforth life insurance reserves).

The variables are neither deflated nor standardized with total population. Accordingly, each variable is adjusted to real per capita terms. The deflator for all variables except consumption is the country specific consumer price index (CPI) which measures the average change in prices of a basket of goods and services over a specific time with base 2000. The appropriate deflator for consumption is the PPP exchange rates. The data for the CPI, PPP and total population is obtained from OECD (OECD, 2013a; OECD, 2013b; OECD, 2013c). The mentioned variables are available for each country except for pension funds reserves, which is partial non-response for United Kingdom (UK).

3.2 Consumption

Consumption is defined as the final consumption expenditure of households (OECD, 2013d). This data is in accordance with System of National Accounts 1993 and is therefore comparable between countries.

Figure 2 gives the growths in consumption

Figure 2. Consumption Growth

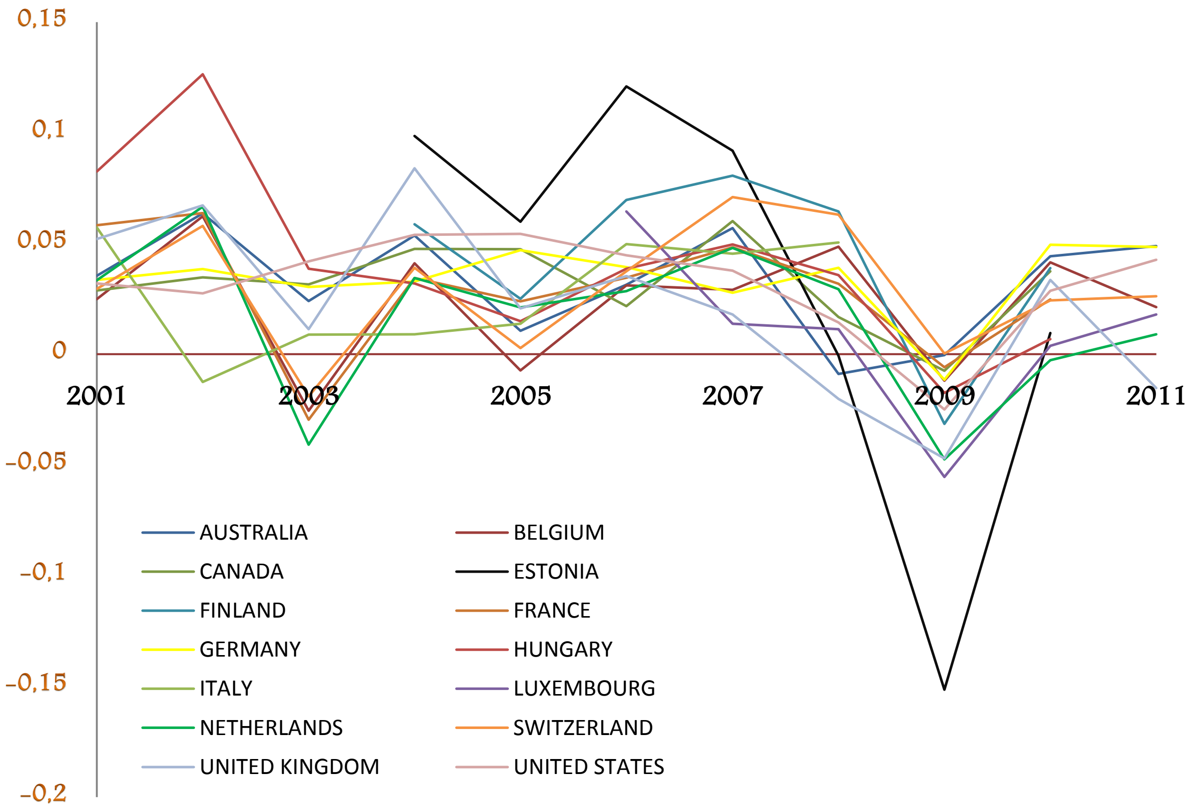
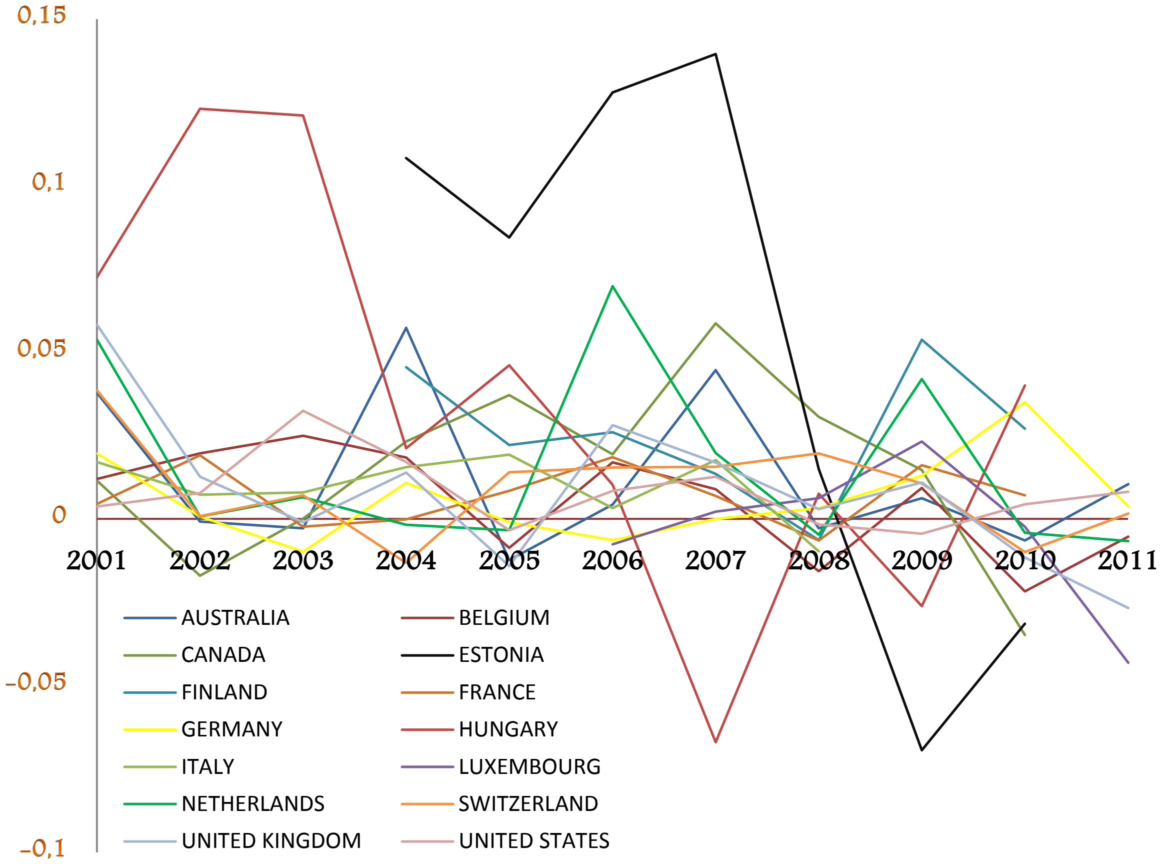


Figure 2 reveals that consumption dipped during 2003 for many countries. This may indicate that consumption was lagging the effect of the dot-com bust. Since 2003 it seems that the different series' move toward a more stationary pattern until the 2008 where the Great Recession culminated.

3.3 Disposable Income

Disposable income is defined as the average annual wages per full time employee, scaled down by the average tax wedge on earnings (OECD, 2013e; OECD, 2013f). The average tax wedge is defined as the average percentage tax on earnings for a family with two parents that earn 100% and 67% respectively of the average wage in the specific country conditional on having two children. Figure 3 gives the growth rates in disposable income

Figure 3. Disposable Income Growth



It is unclear on whether there is a common pattern in disposable income for the different countries. Hungary shows a massive growth in income during the period 2001-2003 while all other countries seem relatively stable. Moreover, Estonia shares similar volatile movements as Hungary.

3.4 Stock Wealth

Two proxies for stock wealth are used in this study. The first proxy is investment fund shares and is defined as shares issued by financial corporations who raise money from households and invest in specific assets (OECD, 2013g). The variable is valued in terms of market prices and is measured in aggregates for each country in each year. The second proxy is stock market capitalization and is defined as the number of shares outstanding multiplied with the share price for domestic listed firms (World Bank, 2013).

Figure 4 below gives the growths in stock wealth using investment fund shares.

Figure 4. Investment Fund Shares Growth

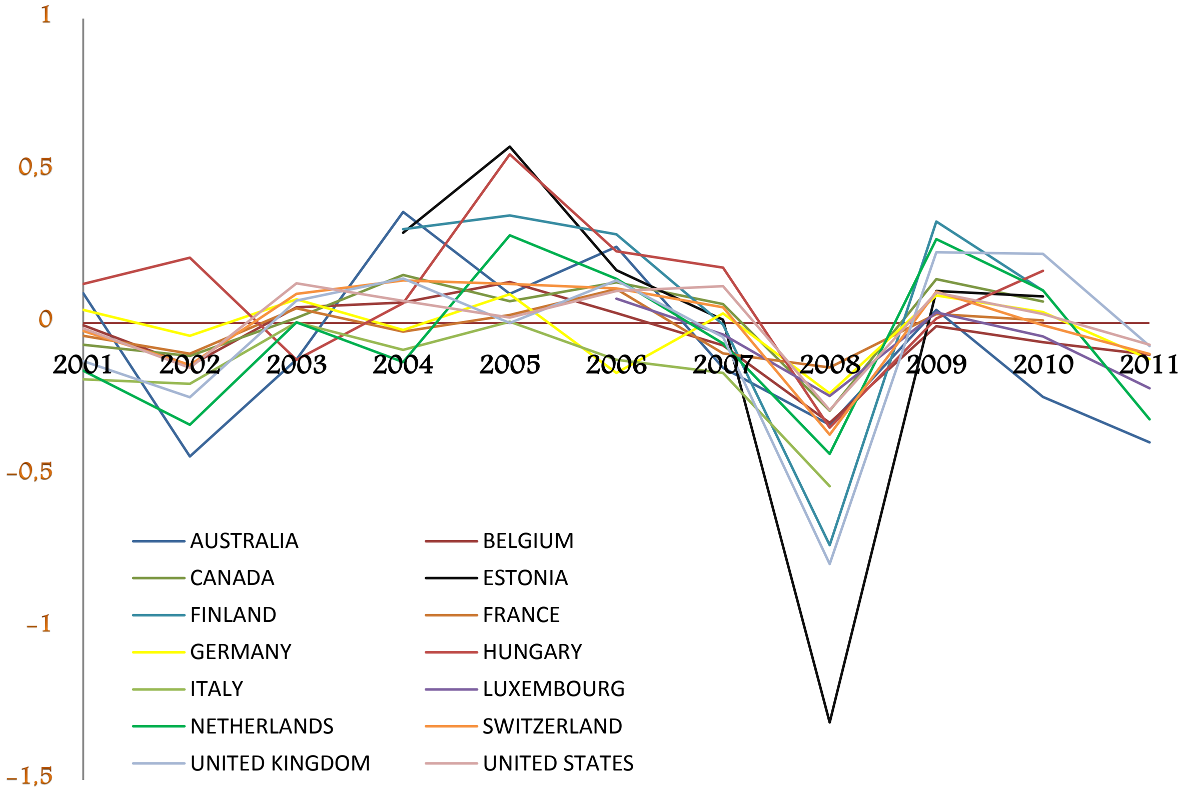
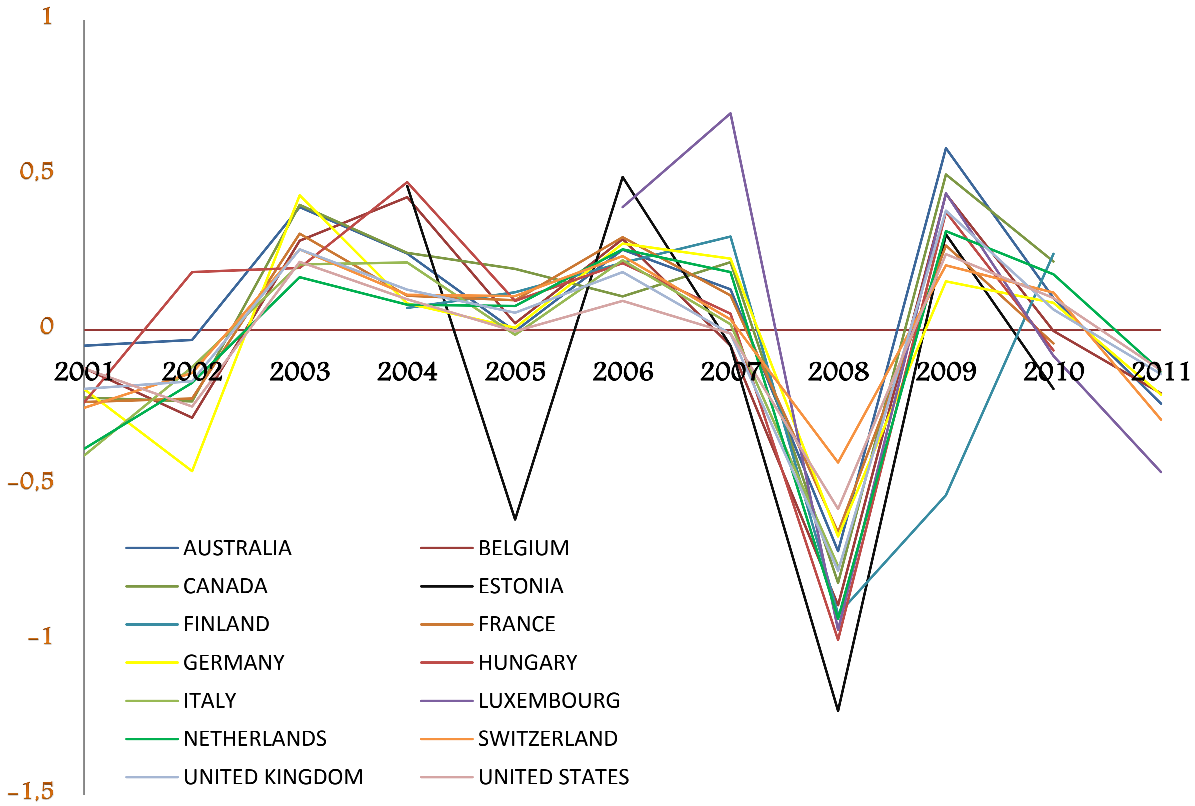


Figure 5. Stock Market Capitalization Growth



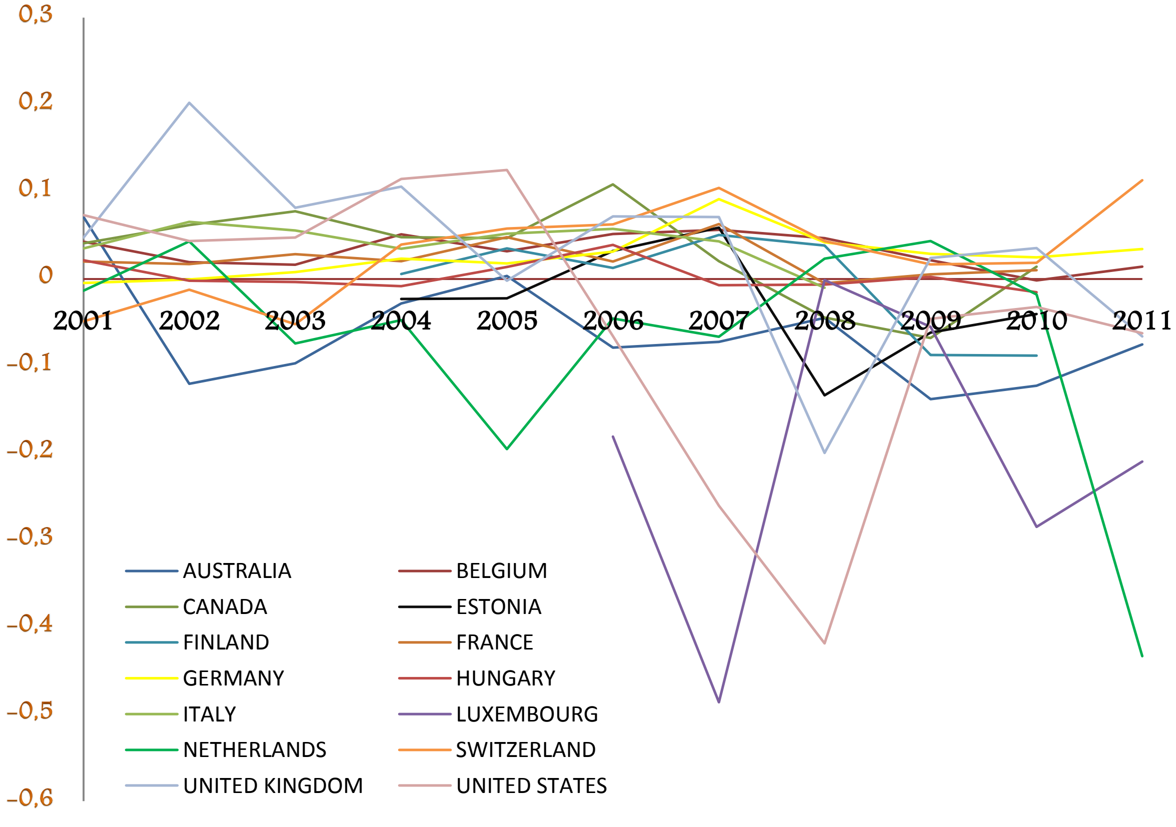
The various time series show similar patterns which hints on the significance of the interrelationship between different economies. The dips due to the dot-com crisis and the Great Recession in 2002 and 2008 are evident in figure 4. Figure 5 below gives the growths in stock wealth using stock market capitalization

As in figure 4, it is clear that the countries generally follow the same pattern over time. The negative growth during 2008 is heavier in figure 5 compared to figure 4. In the end, it will be evident which proxy that can best describe variations in consumption.

3.5 Housing Wealth

The proxy for housing wealth is defined as the market value of dwellings aggregated over households, netted out with the lending for house purchase (OECD, 2013g). Figure 6 gives the growths in housing wealth.

Figure 6. Housing Wealth Growth



The above time series' seems to fluctuate slightly above zero for most countries. Moreover, the real estate bust that developed in late 2007 is evident for some of the observed countries.

3.6 Other Wealth

Pension funds reserves and life insurance reserves are two control variables.

Pension funds reserves are defined as the net equity of households in reserves held by insurance enterprises to provide pensions for employees after retirement (OECD, 2013g). Life insurance reserves is defined as the net equity of reserves against extraordinary risks and reserves that add to the value on existing assets with a certain maturity (OECD, 2013g). Both variables are aggregated over households and valued at market prices.

3.7 Limitations in the Data

The CPI is not an appropriate deflator for real estates and stocks. It would be ideal to have a deflator that consistently adjusts for price fluctuations between countries such as PPP data for each variable. Moreover, the CPI may hold different weightings on different items between countries (OECD, 2013h). This gives even more uncertainty regarding comparability and the risk of measurement errors heightens.

Consumption does not distinguish between durable and non-durable goods. Durable goods can be seen as capital stock expenditures and is therefore not representing "pure" consumption. Durable goods such as housing services are included in the consumption variable which may be seen as a drawback since this allows for a clear channel between housing wealth and consumption (Poterba, 2000, p. 104). Some studies however suggest that total consumption should be emphasized when examining the link between consumption and wealth since the research question is how actual consumption changes due to changes in wealth (Mehra, 2001, pp. 52-53).

The data are mainly obtained from official national accounts and thus follow a risk for measurement errors because of institutional differences between countries.

The time series are short. A longer time series is desired to test for long-run equilibrium models such as cointegration and ECM. Moreover, the panel is narrow and the numbers of observations are low making dynamic panel data models not an appropriate candidate estimator.

4 RESULTS

Figures 7-9 below introduces this section by giving some pictures of the data.

Figure 7 gives the variables in pooled average terms using investment fund shares as the proxy for stock wealth. The data is aggregated across countries by year and then divided by the number of observations per year. Both wealth components seem to roughly lead and granger-cause consumption. This is expected since consumption does not react immediately to asset prices but serve as indications for future growth in macroeconomic outputs (Duca, 2007). The 2008 meltdown is clearly detected in the figure. There might also be a significant relationship between the wealth components since they seem to follow each other. This confounding relationship may render one of the coefficients insignificant during estimations.

Figure 8 is a pooled scatter plot with investment fund shares as the proxy for stock wealth on the horizontal axis and consumption on the vertical axis expressed in growths. There seems to be no positive significant relationship between consumption and wealth when eyeballing the data. In fact, it appears that there is an inverse relationship which gives no economic sense. However, the potential outlier at (0.1, -0.15) is weighting the slope in the negative direction.

Figure 9 is a scatter plot similar to figure 8 except that housing wealth is now on the horizontal axis. The correlation is positive as expected.

Figure 7. Average Annual Growth in Stock Wealth, Housing Wealth and Consumption

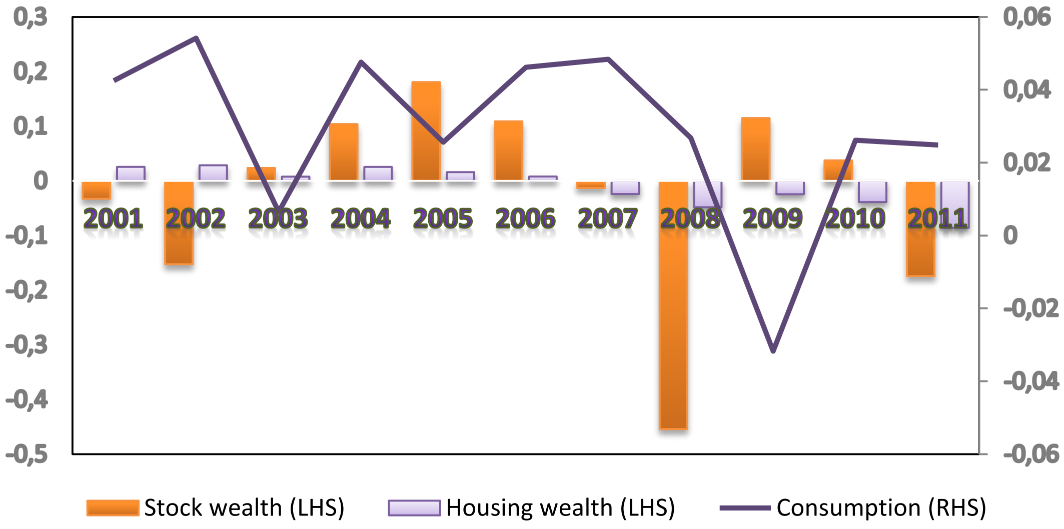


Figure 8. Stock Wealth Effect

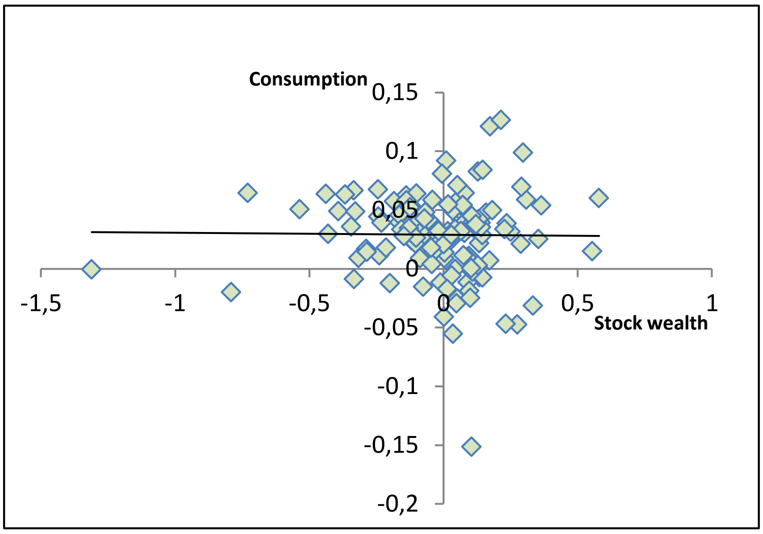
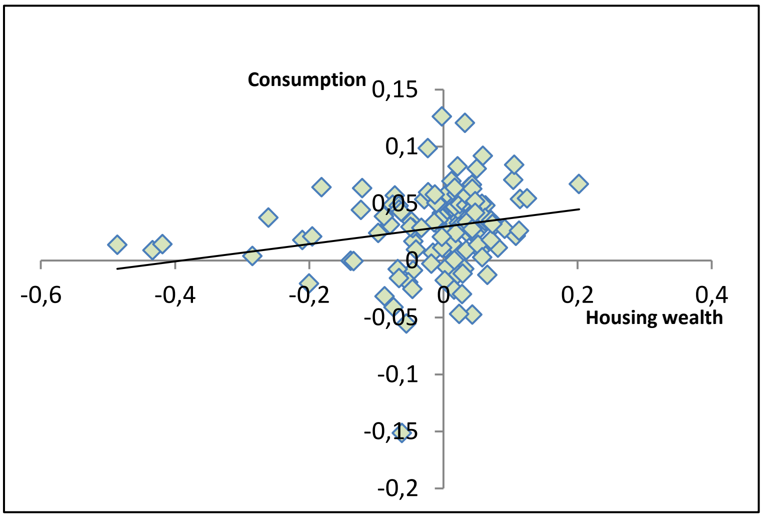


Figure 9. Housing Wealth Effect



The empirical study goes beyond these figures by including various control variables and appropriate regression models.

4.1 Consumption Functions

The models below are estimated using the fixed-effects estimator and TSLS

$$C_{i,t}=\alpha_i+\delta_t+\beta_1 H_{i,t}+\beta_2 S_{i,t}+\beta_3 Y_{i,t}+\varepsilon_{i,t} \quad (16)$$

$$C_{i,t}=\alpha_i+\delta_t+\beta_1 H_{i,t}+\beta_2 S_{i,t}+\beta_3 Y_{i,t}+\beta_4 PF_{i,t}+\varepsilon_{i,t} \quad (17)$$

$$C_{i,t}=\alpha_i+\delta_t+\beta_1 H_{i,t}+\beta_2 S_{i,t}+\beta_3 Y_{i,t}+\beta_4 PF_{i,t}+\beta_5 LI_{i,t}+\varepsilon_{i,t} \quad (18)$$

where $C_{i,t}$ is consumption, α_i is fixed-effects across countries, δ_t is time fixed-effects, $H_{i,t}$ is housing wealth with slope β_1, $S_{i,t}$ is a proxy for stock wealth which comes in two forms, investment fund shares and stock market capitalization with slope β_2, $Y_{i,t}$ is disposable income with slope β_3, $PF_{i,t}$ is pension funds reserves with slope β_4, $LI_{i,t}$ is life insurance reserves with slope β_5 and $\varepsilon_{i,t}\sim IID(0, \sigma^2)$. All variables are transformed into natural logarithms.

In order to observe any deleveraging effects that may have occurred during the great recession, an extension of models (16)-(18) are estimated that include two interaction terms. The dummy variable in which the interaction is built upon is coded

$$GR=\begin{cases}1, if\ 2007 < year < 2010 \\ 0, \quad otherwise\end{cases} \quad (19)$$

Interactions on the dot-com crisis did not show any significant results and therefore it is omitted in this analysis.

4.2 Fixed-effects Estimation

Tables 2 and 3 below give the regression outputs for the fixed-effects estimator.

Table 2. Results for the Fixed-effects Estimator

Dependent Variable: Consumption	Investment Fund Shares			Stock Market Capitalization		
	(16)	(17)	(18)	(16)	(17)	(18)
Disposable Income	0.319** (0.06)	0.31** (0.13)	0.31** (0.111)	0.39** (0.062)	0.346** (0.13)	0.345** (0.11)
Stock Wealth	0.054** (0.018)	0.05** (0.02)	0.05** (0.015)	0.023 (0.027)	0.022 (0.029)	0.008 (0.025)
Housing Wealth	0.051* (0.03)	0.055* (0.03)	0.07** (0.02)	0.053 (0.03)	0.057* (0.033)	0.067** (0.026)
Pension Funds Reserves		0.00 (0.03)	0.044* (0.022)		0.01 (0.03)	0.05* (0.028)
Life Insurance Reserves			-0.1** (0.02)			-0.1** (0.023)

Summary Statistics

R^2 within	0.92	0.93	0.95	0.91	0.92	0.94
No. of observations	149	137	137	149	137	137
No. of groups	14	13	13	14	13	13
F-test (time-effects)	529**	5856**	204**	280**	2064**	2707**
F-test (fixed-effects)	406**	260**	311**	190**	172**	236**

Note: All variables are in real per capita terms expressed in natural logarithms. All models include country specific fixed-effects and time fixed-effects. The F-tests tells whether the data indicates heterogeneity between the observed countries (fixed-effects) and if the year dummy variables are jointly equal to zero (time-effects). Standard errors are in parenthesis, clustered by country and are robust to serial correlated error terms. * denotes p-values below 10 percent and ** denotes p-values below 5 percent.

Table 3. Results for the Fixed-effects Estimator, Evidence of Deleveraging

Dependent Variable: Consumption	Investment Fund Shares			Stock Market Capitalization		
	(16)	(17)	(18)	(16)	(17)	(18)
Disposable Income	0.32**	0.31**	0.33**	0.41**	0.38**	0.39**
	(0.07)	(0.13)	(0.12)	(0.07)	(0.15)	(0.128)
Stock Wealth	0.055**	0.054*	0.046**	0.02	0.016	0.00
	(0.026)	(0.03)	(0.017)	(0.03)	(0.03)	(0.023)
Housing Wealth	0.05	0.052*	0.06**	0.05	0.053	0.062**
	(0.03)	(0.03)	(0.02)	(0.03)	(0.033)	(0.025)
Stock Wealth*GR	0.00	-0.004	0.00	0.002	0.005	0.008*
	(0.00)	(0.005)	(0.004)	(0.005)	(0.003)	(0.004)
Housing Wealth*GR	0.00	0.01**	0.005	0.01**	0.01**	0.012**
	(0.00)	(0.003)	(0.003)	(0.002)	(0.002)	(0.004)
Pension Funds Reserves		-0.004	0.04*		0.005	0.047*
		(0.027)	(0.02)		(0.031)	(0.026)
Life Insurance Reserves			-0.1**			-0.1**
			(0.015)			(0.022)

Summary Statistics

R^2 within	0.92	0.93	0.95	0.91	0.92	0.95
No. of observations	149	137	137	149	137	137
No. of groups	14	13	13	14	13	13
F-test (time-effects)	550**	2203**	936**	395**	-17687**	5365**
F-test (fixed-effects)	400**	256**	306**	190**	173**	247**

Note: All variables are in real per capita terms expressed in natural logarithms. All models include country specific fixed-effects and time fixed-effects. The F-tests tells whether the data indicates heterogeneity between the observed countries (fixed-effects) and if the year dummy variables are jointly equal to zero (time-effects). Standard errors are in parenthesis, clustered by country and are robust to serial correlated error terms. * denotes p-values below 10 percent and ** denotes p-values below 5 percent.

Tables 2 and 3 are divided into two parts; the first part uses investment fund shares as the proxy for stock wealth while the second part uses stock market capitalization. The number of fixed-effects is either 13 or 14. This is because UK has partial non-response for pension funds reserves. All the coefficients should be interpreted as the long-run elasticity since the models are estimated in logarithmic levels. The interpretation is how many percent consumption changes if the independent variable changes with one percent.

The fixed-effects controls for unobservable time-invariant factors for each country together with time-variant factors that affects all countries equally. Both F-tests in the tables are highly significant which indicates that there are heterogeneities between the countries which are time-invariant and time-variant factors that affect all countries equally. These findings come as no surprise since there are obvious differences between the observed countries. Tables 2 and 3 reveal the explained variance within each country to be around 93 percent on average, suggesting good fit.

The elasticity coefficients of investment fund shares are significant around 0.05 for both tables, meaning that a 1 percent increase in stock wealth increases consumption on average by 0.05 percent. Stock market capitalization shows no significant elasticity coefficient in any model specification. This implies that the definition of stock wealth is important and the results are not robust towards different proxies. This finding contradicts the results brought by Case et al. (2005) and Ludwig and Sløk (2004) since they apply stock market capitalization as a proxy for stock wealth and find the results significant and insensitive towards different model specifications. The coefficient of investment fund shares is similar to Ludwig and Sløk (2004, p. 13) who study various OECD countries and find an estimate of 0.08 using price indices and stock market capitalization as proxies for stock wealth. Case et al. (2005, p. 17) find an elasticity of around 0.02 for their international data using stock market capitalization as a proxy which is at about half of the magnitude compared to the estimate found in tables 2 and 3. Comparing the estimated elasticity with Girouard and Blöndal (2001, p. 27) who also studies OECD countries gives different estimates. The authors find the elasticity between 0.13-0.23. This deviation may have occurred due to different definitions of stock wealth since they define it as financial wealth netted out with financial liabilities. Chen (2006, p. 13) shows the exact same elasticity estimates of 0.05 using Swedish data.

Table 3 includes the interaction term of stock wealth and the Great Recession. The coefficient is significant in model (18) using stock market capitalization as the proxy for stock wealth. Although significant, the parameter is not holding the expected sign. The elasticity is expected to decrease during the crisis due to deleveraging effects. Stocks are liquid, therefore should agents be able to sell off the assets in order to finance debt and promote consumption.

Tables 2 and 3 reveals that the elasticity estimates of housing wealth are significant around 0.05-0.07 meaning that a 1 percent increase in housing wealth increases consumption on average by 0.05-0.07 percent. These estimates are consistent across model specifications. Case et al. (2005, p. 17) find the elasticity to be around 0.11-0.17 when applying the fixed-effects estimator on their international data. The authors however use imputed data for housing wealth. Girouard and Blöndal (2001, p. 27) find a housing wealth elasticity of 0.02-0.11 for various countries which seem to be in accordance with tables 2 and 3. The elasticity coefficient of housing wealth is close to the estimates by Ludwig and Sløk. They find an elasticity of 0.04 when using price indices as a proxy for housing wealth (Ludwig & Sløk, 2004, p. 13). Chen (2006, p. 21), using Swedish data, finds a long-run elasticity of about 0.11 which is about the double magnitude compared to the findings in tables 2 and 3.

The interaction of housing wealth and the Great Recession in table 3 show positive significant coefficients of around 0.01. The results have strong economic meaning; during a real estate crisis, agents may find it difficult to liquidate their houses which lead to more sensitive consumption behavior due to changes in housing wealth.

Disposable income has an elasticity coefficient that ranges between 0.31-0.33 using investment fund shares and 0.35-0.41 when using stock market capitalization. This variable is therefore not robust when specifying alternative model specifications. It is however highly significant in every model specification. Pension funds reserves are significant with coefficients between 0.04-0.05 when life insurance reserves are controlled for. Life insurance reserves are significant but the estimated elasticity does not hold the expected sign. An increase in reserves against "extraordinary" negative event should promote consumption.

To conclude table 2 and 3, one can witness both housing and stock wealth effects. The coefficients seem to be robust towards various model specifications when using investment fund shares as the proxy for stock wealth. The estimated elasticity for the different wealth components is similar in magnitudes. Moreover, there was no significant evidence of deleveraging with respect to stock wealth during the Great Recession. The housing wealth interaction however showed an increase in elasticity during the real estate crisis. This finding has a strong theoretical relevancy; houses are difficult to liquidate during the burst of a housing bubble which implies that consumption is more sensitive to changes in housing wealth.

Although the results in tables 2 and 3 generally seem both statistically and economically significant, they may be biased due to measurement errors, simultaneous causality and omitted variables bias. In order to see whether the results in tables 2 and 3 are unbiased, the TSLS estimator is used below and compared with the standard fixed-effects estimator.

4.3 Instrumental Variables Estimation

Table 4. Results for the TSLS Estimator

Dependent Variable: Consumption	Investment Fund Shares			Stock Market Capitalization		
	(16)	(17)	(18)	(16)	(17)	(18)
Disposable Income	0.25**	0.287*	0.29**	0.33**	0.32**	0.32**
	(0.09)	(0.15)	(0.12)	(0.09)	(0.12)	(0.01)
Stock Wealth	0.1**	0.09**	0.08**	0.045	0.028	0.01
	(0.03)	(0.02)	(0.02)	(0.046)	(0.048)	(0.035)
Housing Wealth	0.07**	0.07**	0.08**	0.06*	0.07**	0.08**
	(0.03)	(0.03)	(0.014)	(0.03)	(0.03)	(0.022)
Pension Funds Reserves		-0.023	0.027		-0.004	0.039
		(0.03)	(0.021)		(0.03)	(0.027)
Life Insurance Reserves			-.1**			-.11**
			(0.02)			(0.02)

Summary Statistics

R^2 within	0.14	0.17	0.48	0.18	0.22	0.46
No. of observations	135	124	124	135	124	124
No. of groups	14	13	13	14	13	13
Kleibergen-Paap LM statistic	4.94*	4.95*	4.93*	8**	7.8**	8.27**
Kleibergen-Paap F-statistic	66.47†	65.31†	60.49†	31.64†	33.85†	55.02†
Hansen J-statistic	0.88	0.92	0.33	1.40	1.88	0.75

Note: All variables are in real per capita terms expressed in natural logarithms. All models include country specific fixed-effects and time fixed-effects. Stock wealth and housing wealth are instrumented using the first lag of stock wealth, housing wealth and income as instruments. Kleibergen-Paap LM statistic test whether the specified model is underidentified, meaning zero canonical correlations in the first stage regression, Kleibergen-Paap F-statistic tests whether there are any indications of weak identification, meaning relative or size bias occurring due to weak instruments using critical values from Stock and Yogo (2005) and Hansen J-statistic tests for overidentification, meaning exogeneneity in the instruments. The partial F-statistic that jointly tests if all coefficients on the instruments is equal to zero in the first stage regression is substantially larger than 10 for all model specifications, indicating relevant instruments. Standard errors are in parenthesis, clustered by country and are robust to serial correlated error terms. * denotes p-values below 10 percent and ** denotes p-values below 5 percent.

† The null of a relative bias and/or size bias is rejected whenever critical values from Stock and Yogo (2005) are available.

Table 5. Results for the TSLS Estimator, Evidence of Deleveraging

Dependent Variable: Consumption	Investment Fund Shares			Stock Market Capitalization		
	(16)	(17)	(18)	(16)	(17)	(18)
Disposable Income	0.19** (0.09)	0.25* (0.15)	0.29** (0.127)	0.35** (0.088)	0.36** (0.13)	0.38** (0.115)
Stock Wealth	0.12** (0.04)	0.11** (0.035)	0.08** (0.028)	0.039 (0.05)	0.018 (0.049)	-0.001 (0.03)
Housing Wealth	0.06** (0.032)	0.068** (0.03)	0.07** (0.015)	0.058* (0.032)	0.066** (0.03)	0.07** (0.021)
Stock Wealth*GR	-0.013* (0.007)	-0.01** (0.006)	-0.008* (0.005)	0.00 (0.007)	0.004 (0.006)	0.006 (0.004)
Housing Wealth*GR	0.007* (0.004)	0.01** (0.003)	0.01** (0.003)	0.01** (0.002)	0.01** (0.003)	0.01** (0.004)
Pension Funds Reserves		-0.031 (0.03)	0.018 (0.019)		-0.01 (0.032)	0.035 (0.023)
Life Insurance Reserves			-.11** (0.01)			-.12** (0.02)

Summary statistics

R^2 within	0.14	0.18	0.49	0.2	0.25	0.51
No. of observations	135	124	124	135	124	124
No. of groups	14	13	13	14	13	13
Kleibergen-Paap LM statistic	5.5*	5.55*	5.651*	7.93**	7.64**	8.43**
Kleibergen-Paap F-statistic	27.37†	34.93†	32.3†	22.27†	23.81†	35.05†
Hansen J-statistic	2.316	2.678	1.12	1.946	1.82	0.79

Note: All variables are in real per capita terms expressed in natural logarithms. All models include country specific fixed-effects and time fixed-effects. Stock wealth and housing wealth are instrumented using the first lag of stock wealth, housing wealth and income as instruments. Kleibergen-Paap LM statistic test whether the specified model is underidentified, meaning zero canonical correlations in the first stage regression, Kleibergen-Paap F-statistic tests whether there are any indications of weak identification, meaning relative or size bias occurring due to weak instruments using critical values from Stock and Yogo (2005) and Hansen J-statistic tests for overidentification, meaning exogeneneity in the instruments. The partial F-statistic that jointly tests if all coefficients on the instruments is equal to zero in the first stage regression is substantially larger than 10 for all model specifications, indicating relevant instruments. Standard errors are in parenthesis, clustered by country and are robust to serial correlated error terms. * denotes p-values below 10 percent and ** denotes p-values below 5 percent.

† The null of a relative bias and/or size bias is rejected whenever critical values from Stock and Yogo (2005) are available.

Tables 4 and 5 are divided into two parts; the first part uses investment fund shares as the proxy for stock wealth while the second part uses stock market capitalization. The number of fixed-effects is either 13 or 14. This is because UK has partial non-response for pension funds reserves. All the coefficients should be interpreted as the long-run elasticity since the models are estimated in logarithmic levels. The interpretation is how many percent consumption changes if the independent variable changes with one percent.

The applied estimator is the TSLS combined with fixed-effects estimator. The TSLS results should reveal whether the fixed-effects estimation in tables 2 and 3 are endogenous.

The explained variance is between 14-25 percent for models (16)-(18) in both tables and then it jumps to 46-51 percent when controlling for all potential consumption drivers. The number of effective observations has been reduced since the models include lags of variables as instruments. The models seem to fulfill the relevance and exogeneity criteria since the Kleibergen-Paap LM statistic gives no indication of an underidentified model, Kleibergen-Paap F-statistic shows no evidence of weak identification and the Hansen J-statistic is not significant in any model specification.

The results in tables 4 and 5 compared to tables 2 and 3 are slightly different when comparing the coefficients of investment fund shares. Although the coefficients are statistically significant, the magnitudes have nearly doubled to around 0.08-0.12, indicating that the elasticity coefficients in tables 2 and 3 are biased. Moreover, the coefficients are not robust to different model specifications since the elasticity decreases when controlling for additional variables. The parameters of stock market capitalization are insignificant which again contradicts previous studies (Case et al., 2005; Ludwig & Sløk, 2004).

Table 5 reveals the interaction terms of stock wealth and the Great Recession. The coefficients are significant around -0.01 when using investment fund shares as proxy for stock wealth. Moreover, the coefficients are holding the expected negative sign; during a financial crisis, agents deleverage by liquidating their assets in order to finance debt. Additionally, equity is known to be relatively more volatile than real estates which imply that stock wealth recovers more quickly. Hence, elasticity should decrease during a financial crisis.

The estimates of housing wealth are significant and relatively robust compared to stock wealth. The coefficients are between 0.06-0.08 which is close to the elasticity of around 0.06 found in tables 2 and 3.

The interaction in table 5 of housing wealth and the Great Recession show positive significant coefficients of around 0.01. The results are in accordance with table 3 and have strong economic meaning; during a real estate crisis, agents may find it difficult to liquidate their houses which lead to more sensitive consumption behavior due to changes in housing wealth.

Disposable income has a significant elasticity that ranges between 0.19-0.38 using various model specifications. Pension funds reserves are insignificant in all model specifications which are not in accordance with table 2 and 3. Life insurance reserves are significant with an elasticity coefficient of around -0.12 but the estimate is again not holding the expected sign.

To conclude tables 4 and 5, stock wealth effects are not robust to model specifications. Moreover, the coefficients are substantially different than the estimates found in table 2. The interpretation of a stock wealth effect should thus be tentative. Housing wealth effects seem relatively consistent since the coefficients are similar when applying the fixed-effects estimator and the TSLS estimator in all model specifications. As in table 2 and 3, the estimated housing wealth elasticity is almost identical for both wealth indicators. There is significant evidence of deleveraging with respect to stock wealth during the Great Recession. The housing wealth interaction however showed an increase in elasticity during the crisis. This finding has a strong economic meaning; houses are difficult to liquidate during the burst of a housing bubble which implies that consumption is more sensitive to changes in housing wealth.

The preferred model is model (18) in table 4 when running the TSLS estimator using investment fund shares as the proxy for stock wealth. This is because elasticity of investment fund shares changes considerably when comparing the two estimators. Additionally, the standard errors of housing wealth drastically diminish when controlling for additional wealth factors while holding the elasticity coefficient relatively stable.

4.4 Rolling Fixed-effects Estimation

Estimating models based on a sample collected over time assumes that the obtained estimates are constant. The assumption that coefficients are constant over time is however difficult to accept since the economic environment can change quite quickly and considerably. Financial deregulations and of course the Great Recession may have caused structural breaks in the time series'.

A rolling regression is used in order to assess the stability of the coefficients over time. It is based on computing the coefficients over a rolling window that is fixed through the sample. The estimated coefficients over rolling windows should approximately be the same in order to conclude that the coefficients are constant.

The rolling regression applied here consists of an estimation window of five years using the preferred model. This means that there are four overlapping years in each step. Table 6 below gives the rolling periods, the years covered and the number of observations in the regression model.

Table 6. Rolling Regression Specification

Rolling Period	Years Covered	Number of Observations
1	2000-2004	40
2	2001-2005	44
3	2002-2006	46
4	2003-2007	50
5	2004-2008	51
6	2005-2009	51
7	2006-2010	50
8	2007-2011	43

The number of observations in each rolling period is very small and this will most likely lead to large standard errors. Moreover, the standard errors are clustered by country which is also a contributing factor for imprecise estimates. The degrees of freedom quickly diminishes since the fixed-effects estimator includes dummy variables for each country and each time unit, leading to larger critical values and ultimately to more difficulty in finding significant estimates. Figure 10 and 11 below gives graphical representations of the rolling regressions.

Figure 10. Fixed-effects Rolling Regression, Stock Wealth

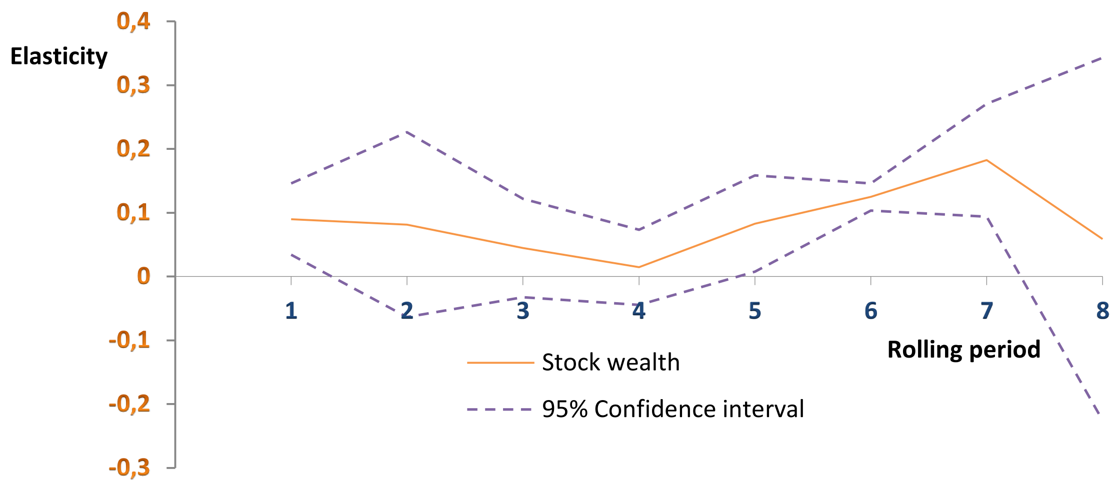
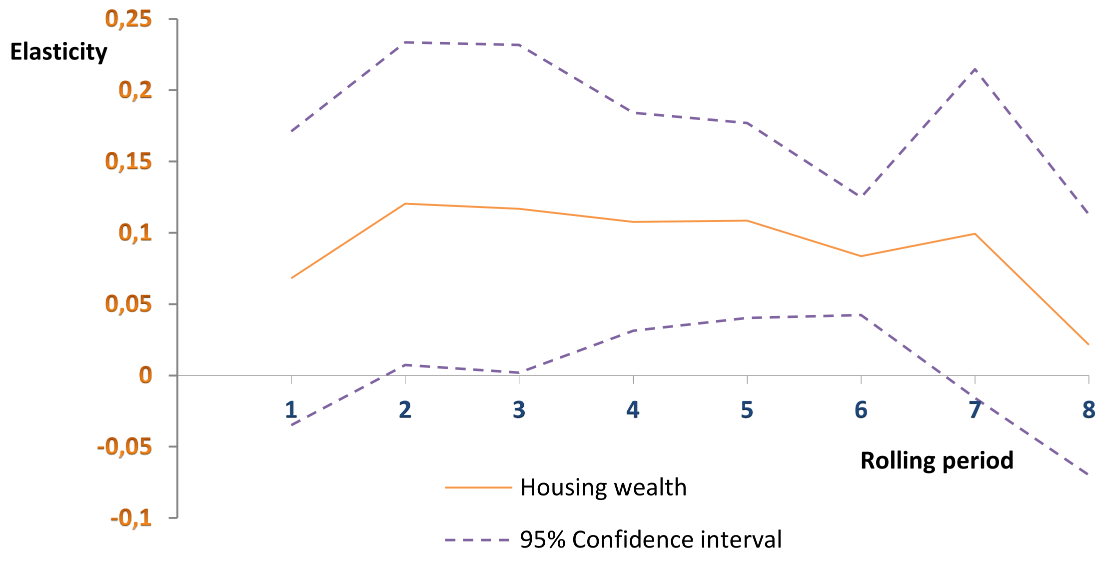


Figure 11. Fixed-effects Rolling Regression, Housing Wealth



The estimated parameters are generally insignificant. Figure 10 reveals that stock wealth elasticity is not stable. The fourth period gives an estimate close to zero but then it moves upwards towards 0.2. The magnitudes shift rapidly depending on which period the wealth effect is estimated, indicating that the stock wealth effect is time-variant. Figure 11 shows that the elasticity coefficients of housing wealth are relatively stable. The difference in magnitudes have a maximum of about 0.05 and the interval of the estimates are somewhere between 0.05-0.1 which is close to the estimates found in table 4. The housing wealth effect seems consistent and time-invariant given the small sample sizes.

4.5 Marginal Propensities to Consume

The estimates in tables 2, 3, 4 and 5 are elasticity coefficients and are therefore not interpretable as the MPC out of wealth components. The elasticity coefficients are adjusted in order to obtain the MPC in absolute monetary units.

The below formula is used to obtain the MPC for each country

$$MPC \approx \underbrace{\left(\frac{\Delta C/C}{\Delta W/W}\right)}_{\beta}\left(\frac{\sum_{t=1}^{T} C_t}{\sum_{t=1}^{T} W_t}\right) = (\Delta C/\Delta W)(W/C)\left(\sum_{t=1}^{T} C_t \Big/ \sum_{t=1}^{T} W_t\right) \approx \frac{\Delta C}{\Delta W} \qquad (20)$$

where β is the estimated elasticity, C is the CPI deflated consumption which maintains consistent currency units between the numerator and the denominator. W is an observed wealth component which is either stock wealth or housing wealth.

This approximation should only be taken as an indicative picture of the “true” MPC. The aim is to see whether the magnitudes are consistently different. These types of approximations have been widely applied in previous research (Chen, 2006; Dvornak & Kohler, 2007; Girouard & Blöndal, 2001; Ludwig & Sløk, 2004).

The MPC out of stock wealth is expected to be different to the MPC out of housing wealth due to the fact that these two assets are fundamentally different: (i) some assets might be perceived riskier than others (ii) different tax regulations on realized capital gains should affect the consumption behavior and (iii) agents may separate various wealth components into mental accounts, indicating that some assets are more appropriate to use for current consumption while other assets are better used for future consumption, see for instance Case et al. (2005, p. 5), Dvornak and Kohler (2007, p. 119-120) and Pissarides (1978) for a further discussion. Table 7 gives the MPC out of wealth for the different countries.

Table 7. Marginal Propensities to Consume

Country	Stock wealth	Housing wealth
AUSTRALIA	0.84	0.15
BELGIUM	0.11	0.03
CANADA	0.20	0.12
ESTONIA	4.82	0.05
FINLAND	0.55	0.07
FRANCE	0.30	0.04
GERMANY	0.24	0.05
HUNGARY	0.71	0.04
ITALY	0.20	0.02
LUXEMBOURG	0.17	0.34
NETHERLANDS	0.42	0.17
SWITZERLAND	0.14	0.04
UNITED KINGDOM	0.48	0.03
UNITED STATES	0.15	0.07

Note: The MPC is obtained by applying equation (20) for each country. All variables are CPI deflated and expressed in per capita monetary unit terms. The elasticity coefficient of investment fund shares and the elasticity coefficient of housing wealth have been applied using model (18) in table 4.

The MPC out of stock wealth is generally higher than the MPC out of housing wealth which is in accordance with the theory that stocks are more liquid than housing and that these assets classes are fundamentally different. Note however that these estimates are only indicative.

Australia shows an MPC out of stock wealth of 0.84 cents for every 1A$ while the MPC out of housing wealth is 0.15 cents. These estimates are quite high compared with Dvornak and Kohler (2007, p. 117) who find an MPC of 6-9 cents for stock wealth and an MPC of 3 cents for housing wealth using state level data.

Girouard and Blöndal (2001, p. 27) find an MPC out of financial wealth for US, Canada, UK, France and Italy to 0.04, 0.083, 0.037, 0.079 and 0.05 respectively. Table 7 finds the MPC out of stock wealth to 0.15, 0.20, 0.48, 0.30 and 0.20 for the same countries. The estimates are not consistent and one possible reason for this is because Girouard and Blöndal (2001) use financial wealth less financial liabilities as the proxy for financial wealth while this thesis use investment fund shares as the proxy for stock wealth, or financial wealth. The authors find an MPC out of housing wealth for US, Canada, UK, France and Italy to 0.02, 0.18, 0.027, 0.037 and -0.03 respectively (Girouard & Blöndal, 2001, p. 27). Comparing these estimates with table 7 for the same countries give 0.07, 0.12, 0.03, 0.04 and 0.02 which are quite similar. This is likely due to a comparable definition of the wealth component.

Ludwig and Sløk (2004, p. 17) find MPC out of stock wealth for Australia, Canada, UK, US, France and Germany to 0.023, 0.023, 0.013, 0.018, 0.014 and 0.019 respectively. These results differ to the estimates found in table 7 since they read 0.84, 0.20, 0.48, 0.15, 0.30 and 0.24 for the respective countries. The authors however use a different estimation strategy together with a different definition of stock wealth.

The general finding is that the MPC out of stock wealth is substantially higher than the MPC out of housing wealth which is consistent with expectations. The estimated MPC out of the wealth components are thus different while the elasticity is quite close as seen in table 4. A brief comparison showed inconsistencies between studies, but this is likely due to different model specifications and variable definitions.

4.6 Policy Implications

Some policy implications to the findings of this thesis are given below.

The significant positive relationship between the wealth components and consumption implies that fiscal and monetary authorities should monitor the evolutions in the financial and non-financial markets. Comprehensive data should be available in order to measure and monitor wealth effects in a consistent and comparable manner for both academics and authorities. Today there are difficulties when collecting data across countries since information are generally not comparable and hard to find.

Policy makers should monitor the housing and equity market separately since the MPC differs between assets. Authorities should monitor changes in agents' housing wealth to decide whether or not the agent may borrow money against the real value of the house. This step may be regarded as crucial for short-term growth in aggregate demand.

Policy makers should expect an increase in consumption sensitivity on housing wealth during a real estate crisis due to difficulties in liquidating real estates. Stock wealth effects are however expected to decrease during crises as stock wealth is volatile and liquid.

CONCLUSION

The wealth effect has been frequently discussed since the boom and bust periods of the dot-com crisis in the late 1990s and the early 2000s Consumption is one of the main drivers of GDP and therefore it is important to build an understanding for the various factors that affect it. The relationship between wealth factors and consumption are crucial both for policy makers and the society as a whole. Consumption theory predicts that wealth and consumption moves together with each other but the casual effect of changes in consumption due to changes in wealth must be scrutinized because of the essential implications it serves monetary and fiscal authorities.

This thesis aimed to quantify the relationship between housing wealth and stock wealth on consumption using a panel of 14 OECD countries that are studied annually during the years 2000-2011. Previous empirical studies in this topic are either outdated or inconclusive (Anderson & Kennedy, 1994; Ando & Modigliani, 1963; Apergis & Miller, 2004; Case et al., 2005; Chen, 2006; Dvornak & Kohler, 2007; Engelhardt, 1996; Girouard & Blöndal, 2001; Levin, 1998; Ludwig & Sløk, 2004; Skudelny, 2009; Starr-McCluer, 2002). This study accounted for the impact of the Great Recession and included control variables associated with wealth in the model specifications. Moreover, attempts were made to discover whether there was any evidence of deleveraging effects.

Three consumption models were postulated with two different estimators, the fixed-effects estimator and the TSLS estimator combined with the fixed-effects estimator to handle the possible endogeneity of the wealth components. The first model included disposable income as a control variable for stock wealth and housing wealth. The second model added pension funds reserves a control and the third model included life insurance reserves. The preferred model included all control variables with investment fund shares as the proxy for stock wealth while running the TSLS estimator. Stock market capitalization showed no reliable estimates in any model specification and estimator. This implies that the definition of stock wealth is important and that the results are not robust across different proxies. This finding also contradicts the results brought by Case et al. (2005) and Ludwig and Sløk (2004) since they apply stock market capitalization as a proxy for stock wealth and find the results significant and insensitive.

The impact of housing wealth and stock wealth on consumption were statistically significant and economically meaningful in all model specifications. In fact, the estimated coefficients did not vary considerably between models within the two estimators. There is however a substantial difference in the stock wealth elasticity when comparing the fixed-effects estimator to the TSLS estimator. This suggests that stock wealth is endogenous in the normal fixed-effects estimator. The estimated long-run elasticity for both housing wealth and stock wealth on consumption is approximately 0.08 for the preferred model. These results are rather different compared to Case et al. (2005, p. 17) since they find the elasticity between 0.11-0.17 for housing wealth and around 0.02 for stock wealth using their international data. Chen (2006, p. 13) uses Swedish data and estimates the stock wealth elasticity to around 0.05, which is very close to the elasticity estimates found here while the estimates for housing wealth obtained here is substantially lower. The results also seem consistent with Girouard and Blöndal (2001, p. 27) who studies specific OECD countries, with regards to housing wealth but not stock wealth. Finally, the results for both wealth components found here are similar to Ludwig and Sløk (2004, p. 13) who also studies OECD countries.

Significant deleveraging effects were discovered when using the TSLS estimator. It seems that the elasticity of housing wealth on consumption increased during the Great Recession. The elasticity of stock wealth however decreased during the crisis. The intuition behind these results is that stock wealth is relatively more liquid than housing wealth. The sensitivity of consumption on stock wealth may therefore be reduced due to the possibility of liquidating the assets. The housing wealth interaction coefficient was positive perhaps because of the liquidity issues of this asset class. Real estates are hard to liquidate after a burst in the housing bubble. Moreover, if liquidation is possible, the asset would most likely sell at a significant discount which makes consumption more sensitive towards fluctuation in the housing wealth.

The stability of the elasticity coefficients were tested using a rolling regression with an estimation window of five years. The results revealed that the coefficients quickly become insignificant relative to the preferred model, most likely due to small sample sizes and low degrees of freedom. The stock wealth elasticity was not stable over time while the housing wealth elasticity was.

The estimated elasticity for both wealth components was almost identical in the preferred model while the MPC differed widely. The MPC out of stock wealth is substantially larger than the MPC out of housing wealth which is consistent with expectations and previous studies.

A positive relationship seems to exist between wealth and consumption. Fiscal and monetary authorities may find it useful to monitor the evolutions in the financial and non-financial markets as these give implications for aggregate consumption. Since the MPC differs between assets, policy makers should monitor the housing and equity market separately. Authorities should monitor changes in agents' housing wealth to decide whether or not the agent may borrow money against the real value of the house. This step may be regarded as crucial for short-term growth in aggregate demand.

Policy makers should expect an increase in consumption sensitivity on housing wealth during a real estate crisis. Stock wealth effects are however expected to decrease during crises.

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