Empirical Evidence of Wealth Effects on Consumption

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Abstract

The paper uses cointegration theory to study the interplay between consumption, income and housing wealth in 14 countries, observed quarterly from 1995 to 2013. Cointegration is found to be present in Canadian, Danish, German, Italian, Japanese and United States data, implying that the consistently estimable propensity to consume out of housing wealth is in the range of two cents per US dollar in Italy and five cents per US dollar in Canada. The housing wealth effect on consumption tends to be lower in countries where income elasticity of consumption, wealth volatility and income inequality are higher. The effect tends to be larger in countries where business conditions are superior and access to credit is easier. Examining the short-run relation between consumption, income and housing wealth highlights that transitory income moves do not Granger-cause consumption growth, and transitory housing wealth changes contain information useful for predicting consumption growth in each sample country.

Keywords: consumption; housing wealth; wealth effect; elasticity; cointegration
JEL classification: C22; C23; E21

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1 Introduction

Housing is a key sector of the economy and a major component of household wealth. Housing, finance, policy and the economy are entangled. The dynamic interactions between housing asset value and housing credit can be a powerful intertemporal multiplier, and the effect of a house price shock can raise the persistence and amplitude of financial and macroeconomic cycles. Australia, Belgium, Canada, Denmark, France, Italy, Sweden, the United Kingdom and the United States experienced a house price boom between 2000 and 2006, with a boom defined as a real house price index increase of at least 40 percent. Housing wealth per capita rose considerably in several Organisation for Economic Co-operation and Development (OECD) countries, and has grown by more than 30 percent since 2000 in countries including Australia, Belgium, Canada, Germany, Finland, France, Italy, Japan, Sweden, Switzerland, the Netherlands and the United Kingdom. The wealth effect on consumption is an important measure when assessing policy reform. Housing-related policy can have an impact on the interplay between consumption, income and housing wealth by influencing real estate prices, the value of housing assets, housing wealth distribution, and the cost of and access to housing credit. The idea that house price changes and associated housing wealth fluctuations have financial and macroeconomic implications typically gains special attention during episodes of house price correction.

Measuring the housing wealth effect is crucial in particular in economies where housing wealth is large relative to the gross domestic product (GDP), household income and consumption. The impact of an insufficient understanding of this effect on macroeconomic forecasting and policy setting can be serious. Various studies have investigated the wealth effect on consumption for one country or a limited number of countries, mostly focusing on the United States and asset or financial wealth. Altissimo et al. (2005) provide a literature review. Limited empirical evidence exists on the housing wealth effect on consumption. This study adds to the cross-country comparative literature and presents estimates of this effect in Australia, Belgium, Canada, Denmark, Finland, France, Germany, Italy, Japan, Sweden, Switzerland, the Netherlands, the United Kingdom and the United States. Estimating the housing wealth effect on consumption is challenging. A shock may affect consumption and housing wealth contemporaneously. There is a simultaneous causality between consumption and wealth. The time series of consumption and wealth typically have a random walk trend, are integrated of order one, denoted by $I(1)$, and are first difference stationary. Stationarity is denoted by $I(0)$ (Stock and Watson, 2011). The ordinary least squares (OLS) method is conventionally used to estimate the wealth effect on consumption, but the estimator is biased and inconsistent and regressions are spurious, if nonstationarity and simultaneous causality are present.

A promising approach is the study of the housing wealth effect on consumption in the context of a vector error correction model (VECM), given that the housing wealth effect on consumption is consistently estimable in a model with cointegrated measures of consumption, income and housing wealth. Empirical evidence in favor of cointegration among consumption and wealth components is ambiguous. Ludvigson and Steindel (1999), Lettau and Ludvigson (2001) and Hamburg et al. (2008) find evidence in favor of cointegration among consumption and wealth. Tan and Voss (2003) propose that cointegration among these variables is absent. In a critique of the procedure used by Lettau and Ludvigson (2001), Rudd and Whelan (2006) emphasize that consumption, income and asset wealth are not cointegrated as defined by Engle and Granger (1987) and the linear relationship between those variables predicted by Lettau and Ludvigson (2001) is questionable. This study is the first, to my knowledge, to examine whether consumption, income and housing wealth are cointegrated, as defined by Engle and Granger (1987), in the 14 sample countries. Relying on a new set of data sourced from the OECD, World Bank Group, statistical institutes and central banks, I add novel insights to the debate whether consumption, income and housing wealth have a common stochastic trend, i.e. are cointegrated, and whether the long-run propensity to consume out of housing wealth is consistently estimable. I also suggest factors influencing cross-country heterogeneity in the housing wealth effect on consumption.

This study finds that cointegration is present in Canadian, Danish, German, Italian, Japanese and United States data, implying that the consistently estimable propensity to consume out of housing wealth is in the range of five cents per US dollar in Canada and two cents per US dollar in Italy. Cross-country differences in the housing wealth effect on consumption tend to be associated with factors such as income elasticity of consumption, income and housing wealth volatility, income inequality and business conditions as well as households' access to credit. A comparison of the components that tend to contribute to the error correction mechanism reveals cross-country heterogeneity. The consequence of the absence of cointegration in Australian, Belgian, Dutch, Finnish, French, Swedish, Swiss and United Kingdom data is modeling the first differences in consumption, income and housing wealth using a vector autoregressive model (VARM). As a result, it is infeasible to verify the long-run housing wealth effect on consumption. An examination of the short-run relationship between consumption, income and housing wealth illustrates that transitory income changes do not Granger-cause consumption growth; this is in line with the permanent income hypothesis (Friedman, 1957). It also shows that transitory housing wealth moves tend to contain information useful for predicting consumption growth in each sample country; this is in line with Hall (1978).

The remainder of this study is structured as follows. First I highlight the linear relation between household consumption and wealth as suggested by economic theory, such as the life-cycle model (Modigliani and Brumberg, 1954) and the permanent income hypothesis (Friedman, 1957). Section 3 presents the econometric framework. Section 4 defines the data. Section 5 shows the empirical implementation of the VECMs and VARMs and presents the results of the estimation of the interplay between consumption, income and housing wealth. The final section concludes.

2 Literature and hypotheses

The wealth effect on consumption has a sound theoretical foundation and is a classic theme in macroeconomics. Economic theory (e.g., Keynes, 1936; Modigliani and Brumberg, 1954; Friedman, 1957; Blanchard, 1985; Deaton, 1992) identifies wealth as a key determinant of consumption. Econometric models contribute to the explanation of household consumption patterns and are based on the observation that consumers consider current and expected future wealth when they make spending decisions. Household total wealth consists of the present value of human and non-human capital wealth. Income determines human capital wealth, while financial and non-financial assets contribute to non-human capital wealth. Keynes (1936) postulates and Ando and Modigliani (1963) show that there is a linear relationship between consumption and income. Keynes (1936) suggests that the propensity to consume out of income is up to one. Modigliani and Brumberg (1954) and Friedman (1957) propose that consumers allocate resources over time in order to maximize lifetime utility subject to a budget constraint. Friedman (1957) stresses the importance of distinguishing between permanent income and transitory income. He suggests that consumption responds proportionally to changes in permanent income but does not respond to transitory income fluctuations.

Hall (1978) extends the model and assumes that consumers borrow and invest at a constant real interest rate to smooth consumption over time and have a discount rate equal to the real interest rate. For quadratic preferences, he finds that the marginal utility of consumption follows a random walk and that consumption evolves similarly. This implies that the best forecast for consumption in the next period is current consumption adjusted for drift. Hall (1978) proposes that consumption in the next period cannot be predicted by economic variables observed in the current period or earlier other than current consumption. He suggests that changes in consumption are unpredictable. He tests these hypotheses and confirms that income has no predictive power for consumption. Although there are formal rejections using stock prices, Hall (1978) concludes that the empirical evidence favors the permanent income hypothesis. The choice of the utility function influences the results of a macroeconomic model and interpretation of consumer behavior. The conclusion of Hall (1978) is based on linear marginal utility associated with consumers having quadratic utility. This typically is a relatively implausible representation of consumer preferences.

Although the Euler equation approach used by Hall (1978) is being challenged, models representing consumer preferences and consumption behavior as a function of wealth are popular and standard in the academic literature. The constraints imposed on consumer preferences by utility functions influence the estimates of consumer preference parameters, including the propensity to consume out of wealth. Pratt (1964) and Arrow (1964) propose formal indicators of absolute and relative risk aversion. Kimball (1990) proposes an indicator of absolute and relative prudence. Hall (1988) assesses the intertemporal elasticity of substitution in consumption. Kimball and Weil (2009) show that there is an identity linking prudence and risk aversion. Growing absolute and relative risk aversion and imprudence make quadratic utility an unrealistic representation of consumer preferences. Exponential utility implies constant absolute and falling relative risk aversion, which are unrealistic consumer preference assumptions. Isoelastic utility is a popular consumer preference specification because it exhibits falling absolute and constant relative risk aversion. Isoelastic utility is not without criticism, however, because the curvature parameter influences risk aversion, prudence and the intertemporal elasticity of substitution in consumption.

Campbell and Mankiw (1989) extend the Hall's model to the case of varying real interest rates. They propose distinguishing between permanent-income and current-income consumers. In contrast to Hall, they conclude that consumption is not a random walk. Campbell and Mankiw (1991) assume isoelastic preferences and find a linear relation between consumption and wealth. They discover that the consumption-to-wealth ratio is constant if the intertemporal elasticity of substitution in consumption (θ) is equal to one. Otherwise this ratio is a constant plus $(1-\theta)$ times the expected present value of future interest rates discounted by a parameter referring to the invested wealth-to-total wealth ratio. They conclude that high real interest rates lead to a falling consumption-to-wealth ratio if $\theta > 1$, and a rising consumption-to-wealth ratio if $0 < \theta < 1$. Blanchard (1985) finds that a fall in risk aversion reduces the propensity to consume out of wealth if $\theta > 1$. He also discovers that the propensity to consume out of wealth relies only partially on real interest rates if $0 < \theta < 1$, and may be negative if real interest rates exceed the subjective discount rate and $\theta > 1$. This is consistent with isoelastic preferences imposing an inverse re1ation between the coefficient of relative risk aversion and the intertemporal elasticity of substitution in consumption.

In addition to the model variations proposed by Campbell and Mankiw (1989), reasons for deviations from the hypothesis that consumption evolves as random walk are market frictions (e.g., Byrne and Davis, 2003; Catte et al., 2004; Muellbauer, 2007; Iacoviello and Neri, 2010), income uncertainty (e.g., Flavin, 1981; Zeldes, 1989; Carroll and Kimball, 1996), precautionary motives (e.g., Leland, 1968; Kimball, 1990; Kimball and Weil, 2009), bequest motives (Campbell and Viceira, 1999) and other behavioral aspects (e.g., Shefrin and Thaler, 1988; Sundaresan, 1989; Constantinides, 1990; Hoch and Loewenstein, 1991; Thaler, 1994). The literature on consumption under uncertainty emphasizes that the marginal propensity to consume out of wealth falls with wealth (e.g., Carroll and Kimball, 1996; Mian et al., 2013). Mian et al. (2013) stress that poorer and more levered households have a higher marginal propensity to consume out of housing wealth. However, many studies remain in the spirit of the permanent income hypothesis by positing efficient markets and forward looking representative agents without liquidity constraints. Some studies propose that the long-run propensity to consume out of wealth is relatively stable, and differs across wealth components, income classes and age groups (Altissimo et al., 2005). Ludvigson and Steindel (1999), Lettau and Ludvigson (2001), Corugedo et al. (2003) and Hamburg et al. (2008) study the effect of wealth on consumption in a VECM after finding evidence that consumption and wealth are cointegrated. Others including Tan and Voss (2003) find evidence against the hypothesis that consumption and wealth are cointegrated.

Altissimo et al. (2005) review the literature on the magnitude and determinants of the wealth effect on consumption and refer to Poterba (2000), who provides some guidance. Empirical evidence of the long-run wealth effect on consumption going back to Ando and Modigliani (1963) is inconclusive, and the size of this effect is controversial. The estimates of the long-run propensity to consume out of different asset wealth components presented in the literature, excluding negative estimates, are in the range of zero cents per US dollar to 15 cents per US dollar. The loadings of the estimates of the long-run wealth effect on consumption vary across wealth components and countries within single studies and across studies. Existing empirical research delivers a wide range of estimates of the propensity to consume out of wealth and the wealth elasticity of consumption across countries and over time. Only some of the differences are explained by variations in the methodology, the definitions of variables, data and sample periods. Lettau and Ludvigson (2001) find that most wealth changes are transitory and unrelated to consumption. Lettau and Ludvigson (2004) point out that studies that do not adjust for transitory wealth changes misstate the timing and overstate the magnitude of the long-run wealth effect on consumption.

The wealth effect on consumption in a single country is assessed by Poterba et al. (1995), Horioka (1996), Ogawa et al. (1996), Macklem (1997), Ludvigson and Steindel (1999), Poterba (2000), Mehra (2001), Davis and Palumbo (2001), Lettau and Ludvigson (2001), Corugedo et al. (2003), Tan and Voss (2003), Palumbo et al. (2006), Benito et al. (2006), Donihue and Avramenko (2006), Paiella (2007), Hamburg et al. (2008) and Aron and Muellbauer (2013). Cross-country comparisons of the wealth effect on consumption include Boone et al. (1998), Boone et al. (2001), Edison and Slok (2002), Bertaut (2002), Bayoumi and Edison (2003), Ludwig and Slok (2004), Catte et al. (2004), Case et al. (2005), Labhard et al. (2005), Norman et al. (2005), Barrell and Davis (2007), Cardarelli et al. (2008), Sousa (2009), Skudelny (2009) and Slacalek (2009). Maki and Palumbo (2001), Guiso et al. (2005), Campbell and Cocco (2007) and Grant and Peltonen (2008) find microdata evidence of the wealth effect on consumption. Most studies on the wealth effect on consumption are based on aggregate data, and investigate the asset wealth effect and notably the stock market wealth effect. The wealth effect on consumption tends to be influenced by the features of a wealth component; it may also matter whether wealth changes are permanent or transitory (e.g., Ludvigson and Steindel, 1999; Lettau and Ludvigson, 2001; Altissimo et al., 2005; Carroll et al., 2011).

Case et al. (2005) suggest that house price shocks have larger implications for consumption than stock price changes. Although household balance sheet and cash flow shocks associated with house price changes can increase the persistence and amplitude of business cycles more than those associated with stock price shocks (Claessens et al., 2012), the housing wealth effect on consumption is less explored in the literature. The objective of this study is to fill this gap and to add to the cross-country comparative work by examining this effect in 14 countries. Elliot (1980) suggests that the housing wealth effect is statistically insignificant. Bhatia (1987) challenges this finding. Catte et al. (2004), Ludwig and Slok (2004), Case et al. (2005), Muellbauer (2007), Cardarelli et al. (2008), Slacalek (2009) and Iacoviello (2011) study the housing wealth effect using a least squares method. The least squares estimator of the housing wealth effect can be subject to issues arising from nonstationarity and simultaneous causality, and the effect may be consistently estimable only if consumption, income and housing wealth have a common stochastic trend, i.e. are cointegrated. Given that there is no clear empirical evidence that consumption, income and housing wealth are cointegrated, I am, to my knowledge, the first to test the following hypothesis.

Hypothesis 1. *Consumption, income and housing wealth are cointegrated as defined by Engle and Granger (1987), and there is a consistently estimable long-run housing wealth effect on consumer spending.*

I study the housing wealth effect on consumption in VECMs and VARMs following the approach of other studies applying cointegration theory (e.g., Ludvigson and Steindel, 1999; Lettau and Ludvigson, 2001; Corugedo et al., 2003; Tan and Voss, 2003; Rudd and Whelan, 2006; Hamburg et al., 2008). If consumption, income and housing wealth are cointegrated as defined by Engle and Granger (1987), the least squares estimator of the long-run housing wealth effect on consumption is consistent, statistical inference on this effect based on heteroskedasticity and autocorrelation consistent (HAC) standard errors is valid, and comparing the consistently estimable long-run housing wealth effect on consumption across countries is viable. The consequence of an absence of cointegration is the inappropriateness of modeling trending consumption, income and housing wealth measures using a VECM and the appropriateness of modeling the stationary first differences in those variables using a VARM. A drawback of only using a VARM with first differences in consumption, income and housing wealth is that drawing a conclusion about the long-run housing wealth effect on consumption becomes infeasible. I also employ the VECMs and VARMs for performing Granger causality tests to verify the subsequent hypothesis in each sample country.

Hypothesis 2. *There is a statistically significant short-run housing wealth effect on consumption, and transitory housing wealth fluctuations contain information useful for predicting consumption growth.*

One objective of this study is to present new information about the housing wealth effect by testing the hypotheses above. Another is to shed light on potential sources of international differences in this effect. Critical ideas are that housing, finance and the economy are linked via the wealth effect (e.g., Keynes, 1936; Modigliani and Brumberg, 1954; Friedman, 1957; Modigliani, 1971; Blanchard, 1985; Deaton, 1992) and the financial accelerator (e.g., Bernanke and Gertler, 1989, 1995; Bernanke et al., 1996; Aoki et al., 2004; Iacoviello, 2005; Almeida et al., 2006). If the financial accelerator is operational, a housing asset value or cash flow shock can affect household spending by more than the conventional housing wealth effect, as borrowing conditions may be influenced by this shock. This idea has interesting implications that mainly remain unaddressed in this study. It suggests that housing credit features and housing wealth distribution across households[1] matter for aggregate household consumption (e.g., Davey, 2001; ECB, 2003). Lower net worth households presumably face a larger external finance premium and tend to have a greater marginal propensity to consume out of wealth than higher net worth ones. The effect on aggregate consumption of a given housing asset value or cash flow shock may be greater, the larger the fraction of lower net worth households in a given economy (e.g. Mian et al., 2013).

3 Methodology

3.1 Time series properties

I investigate the housing wealth effect in the VECMs (1) and (2) and the VARMs (7) and (8). The objective is to study the long-run and short-run effects on consumption

[1]Buiter (2010) stresses that, in a closed economy with representative agents, a change in the fundamental value of a housing unit may not affect aggregate consumption. He argues that aggregate consumption should change if the value of a housing unit deviates from its fundamental value or if wealth is redistributed among agents with different marginal propensities to consume out of wealth.

(C_{it}) of income (Y_{it}) and housing wealth (H_{it}) applying cointegration theory. E.g. the level of consumption in country i (with $1 \leq i \leq 14$) at period t (with $1 \leq t \leq 77$) is denoted by C_{it}. The respective log-level variable is denoted by c_{it}. Either level or log-level variables are used. The OLS and dynamic OLS (DOLS) methods are employed. Cointegration rests upon a long-run equilibrium relation between time series. To test whether consumption, income and housing wealth are cointegrated as defined by Engle and Granger (1987) in each sample country, I employ a two step procedure. I estimate the unknown parameters in Equations (3), (4), (5) and (6) using a least squares method and test the cointegration hypothesis. Pitfalls when estimating the relation between consumption, income and housing wealth include, amongst other factors, a failure to account for nonstationarity and simultaneous causality. A time series having d unit roots is integrated of order d, denoted by $I(d)$ (with $0 \leq d$), and has to be differenced d times to become stationary. Simultaneous causality implies a causal link from consumption to wealth and vice versa. If trending time series are not cointegrated and nonstationarity and simultaneous causality of the components of the $(3x1)$ vectors $\mathbf{X_{it}^H} = [C_{it}, Y_{it}, H_{it}]'$ and $\mathbf{x_{it}^h} = [c_{it}, y_{it}, h_{it}]'$ are not addressed, the least squares estimator of the long-run housing wealth effect on consumption is biased and inconsistent, the predicted long-run linear relation between consumption, income and housing wealth is spurious, and a high value of R-squared is not evidence of model adequateness.

The nonstationarity of the components of the $(3x1)$ vectors $\mathbf{X_{it}^H}$ and $\mathbf{x_{it}^h}$ tends to influence the application of estimation techniques and the interpretation of the housing wealth effect on consumption. Thus it is critical to determine whether the components of $\mathbf{X_{it}^H}$ and $\mathbf{x_{it}^h}$ are stationary prior to estimating the relationship between consumption, income and housing wealth. The components of $\mathbf{X_{it}^H}$ and $\mathbf{x_{it}^h}$ can have a stochastic trend if their plots have a trend and their first autocorrelation coefficient is close to one. A formal statistical procedure for testing whether a time series has a unit root is the augmented Dickey-Fuller Generalized Least Squares (ADF-GLS) test developed by Elliott et al. (1996). This test has higher power than previous Dickey-Fuller test versions (Dickey and Fuller, 1981) and is better able to distinguish between a unit root and a stochastic trend that is large but is less than one. The Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test for stationarity of a time series proposed by Kwiatkowski et al. (1992) is an alternative to the ADF-GLS test. Using both the ADF-GLS test and KPSS test I examine in each sample country whether the components of $\mathbf{X_{it}^H}$ and $\mathbf{x_{it}^h}$ follow a smoother stochastic trend than random walk. Time series with a stochastic trend can have a common stochastic trend, i.e. can be cointegrated. Prerequisites for cointegration are that cointegrated time series have the same order of integration, and the order of integration of the linear combination of those series is less than the order of integration of each individual time series. In this study I investigate whether the order of integration of the predicted linear cointegrating relationship between consumption, income and housing wealth is stationary. Engle and Granger (1987) show that cointegrated time series can be modeled using a VECM. To test whether consumption, income and housing wealth are cointegrated as defined by Engle and Granger (1987) in each sample country, I employ such model without using panel data specifications.

3.2 Vector error correction model

Long-run housing wealth effect on consumption

The VECMs (1) and (2) are formulated for country i and involve $N = 3$ variables, which are consumption, income and housing wealth. The $(3x1)$ vector $\mathbf{X^H_{it}}$ is used in the VECM (1), in which the first differences in C_{it}, Y_{it} and H_{it}, denoted by $\mathbf{\Delta X^H_{it}} = [\Delta C_{it}, \Delta Y_{it}, \Delta H_{it}]'$, are regressed on the value of the error correction term lagged one period ($\beta_{\mathbf{i}}^{\mathbf{H}\prime}\mathbf{X^H_{it-1}}$) and the lagged first differences in C_{it}, Y_{it} and H_{it}, denoted by $\mathbf{\Delta X^H_{it-j}}$. The $(3x1)$ vector $\mathbf{x^h_{it}}$ is used in the VECM (2), in which $\mathbf{\Delta x^h_{it}} = [\Delta c_{it}, \Delta y_{it}, \Delta h_{it}]'$ is regressed on $\beta_{\mathbf{i}}^{\mathbf{h}\prime}\mathbf{x^h_{it-1}}$ and $\mathbf{\Delta x^h_{it-j}}$. If $\mathbf{X^H_{it}}$ is a $(3x1)$ vector of $I\,(1)$ level variables and the components of $\mathbf{X^H_{it}}$ have a common stochastic trend, $\mathbf{\Delta X^H_{it}}$ is a $(3x1)$ vector of $I\,(0)$ variables. If $\mathbf{x^h_{it}}$ is a $(3x1)$ vector of $I\,(1)$ log-level variables and the components of $\mathbf{x^h_{it}}$ are cointegrated, $\mathbf{\Delta x^h_{it}}$ is a $(3x1)$ vector of $I\,(0)$ variables.

$$\Delta \mathbf{X^H_{it}} = \alpha_{\mathbf{i}}^{\mathbf{H}} \left[\beta_{\mathbf{i}}^{\mathbf{H}\prime}\mathbf{X^H_{it-1}}\right] + \sum_{j=1}^{k} \mathbf{\Gamma^H_{ij}} \Delta \mathbf{X^H_{it-j}} + \varepsilon^{\mathbf{H}}_{\mathbf{it}} \tag{1}$$

$$\Delta \mathbf{x^h_{it}} = \alpha_{\mathbf{i}}^{\mathbf{h}} \left[\beta_{\mathbf{i}}^{\mathbf{h}\prime}\mathbf{x^h_{it-1}}\right] + \sum_{j=1}^{k} \mathbf{\Gamma^h_{ij}} \Delta \mathbf{x^h_{it-j}} + \varepsilon^{\mathbf{h}}_{\mathbf{it}} \tag{2}$$

The parameter matrices $\mathbf{\Gamma^H_{ij}}, ..., \mathbf{\Gamma^H_{ik}}$ and $\mathbf{\Gamma^h_{ij}}, ..., \mathbf{\Gamma^h_{ik}}$ are of finite order, and $\varepsilon^{\mathbf{H}}_{\mathbf{it}}$ and $\varepsilon^{\mathbf{h}}_{\mathbf{it}}$ are $(3x1)$ residual vectors. The parameter matrices $\alpha_{\mathbf{i}}^{\mathbf{H}}$ and $\beta_{\mathbf{i}}^{\mathbf{H}}$ have rank r, if there are $0 \leq r < 3$ cointegrating equations in the VECM (1). The coefficient matrices $\alpha_{\mathbf{i}}^{\mathbf{h}}$ and $\beta_{\mathbf{i}}^{\mathbf{h}}$

have rank r, if there are $0 \leq r < 3$ cointegrating equations in the VECM (2). If there are $N = 3$ cointegrated variables, there can be more than one cointegrating equation. The number of cointegrating equations is r and the cointegration rank is $0 \leq r \leq 2$. If $r = 1$, $\alpha_{\mathbf{i}}^{\mathbf{H}} = \left(\alpha_i^C, \alpha_i^Y, \alpha_i^H\right)'$, $\alpha_{\mathbf{i}}^{\mathbf{h}} = \left(\alpha_i^c, \alpha_i^y, \alpha_i^h\right)'$, $\beta_{\mathbf{i}}^{\mathbf{H}} = \left(1, -\beta_i^Y, -\beta_i^H\right)'$ and $\beta_{\mathbf{i}}^{\mathbf{h}} = \left(1, -\beta_i^y, -\beta_i^h\right)'$ are $(3x1)$ coefficient vectors. Key coefficients are β_i^H and β_i^h, as β_i^H can be interpreted as long-run propensity to consume out of housing wealth and β_i^h can be interpreted as long-run housing wealth elasticity of consumption.

Engle and Granger (1987) propose cointegration tests. They recommend, and I use, the two step Engle-Granger augmented Dickey-Fuller (EG-ADF) test extending the unit root test procedures to test for cointegration among consumption, income and housing wealth. In the first step the unknown cointegrating vectors are estimated in each sample country. I use Models (3) and (4) and the OLS method for estimating the unknown cointegrating vectors. If the Models (3) and (4) contain trending time series, such as $I(1)$ time series, on both sides of the equation, the problem of spurious regression appears because the OLS estimator has nonstandard distribution and statistical inference on the parameter estimates can be misleading whether or not it is based on heteroskedasticity and autocorrelation consistent standard errors.

$$C_{it} = \beta_i^H H_{it} + \beta_i^Y Y_{it} + \varepsilon_{it}^H \tag{3}$$

$$c_{it} = \beta_i^h h_{it} + \beta_i^y y_{it} + \varepsilon_{it}^h \tag{4}$$

Due to drawbacks of the OLS estimator, Stock and Watson (1993) suggest, and I employ, the DOLS estimator as an asymptotically efficient estimator of the unknown cointegrating vectors. The DOLS estimator of $\beta_{\mathbf{i}}^{\mathbf{H}}$ and $\beta_{\mathbf{i}}^{\mathbf{h}}$ is the respective OLS estimator of the unknown cointegrating vectors in the regression of Equations (5) and (6). These equations involve past, present and future values of the first differences in the respective regressors (e.g., Granger and Newbold, 1974; Stock and Watson, 2011). In the second step the augmented Dickey-Fuller (ADF) test is applied to test for a unit root in the residuals $\widehat{\varepsilon_{it}^H}$ of Model (3) and the residuals $\widehat{\varepsilon_{it}^h}$ of Model (4) with the respective efficient estimates of $\beta_{\mathbf{i}}^{\mathbf{H}}$ and $\beta_{\mathbf{i}}^{\mathbf{h}}$ derived from the estimation of the cointegration vector using the DOLS method. Hats denote parameter estimates.

$$C_{it} \quad = \quad \beta_i^H H_{it} + \beta_i^Y Y_{it} + \sum_{j=-k}^{k} \delta_{ij}^H \Delta H_{it-j} + \sum_{j=-k}^{k} \delta_{ij}^Y \Delta Y_{it-j} + \varepsilon_{it}^H \tag{5}$$

$$c_{it} \quad = \quad \beta_i^h h_{it} + \beta_i^y y_{it} + \sum_{j=-k}^{k} \delta_{ij}^h \Delta h_{it-j} + \sum_{j=-k}^{k} \delta_{ij}^y \Delta y_{it-j} + \varepsilon_{it}^h \tag{6}$$

The insight on which the EG-ADF test related to the components of $\mathbf{X_{it}^H}$ and $\mathbf{x_{it}^h}$ is based is as follows. If the components of $\mathbf{X_{it}^H}$ are $I(1)$ and one vector $\beta_\mathbf{i}^\mathbf{H}$ exists, such that $\beta_\mathbf{i}^{\mathbf{H}\prime}\mathbf{X_{it}^H}$ is $I(0)$, the components of $\mathbf{X_{it}^H}$ are cointegrated of order $(1,1)$, denoted by $\mathbf{X_{it}^H} \sim CI(1,1)$, and the cointegrating vector is $\beta_\mathbf{i}^\mathbf{H}$. If the components of $\mathbf{x_{it}^h}$ are $I(1)$ and one vector $\beta_\mathbf{i}^\mathbf{h}$ exists, such that $\beta_\mathbf{i}^{\mathbf{h}\prime}\mathbf{x_{it}^h}$ is $I(0)$, $\mathbf{x_{it}^h} \sim CI(1,1)$ and the cointegrating vector is $\beta_\mathbf{i}^\mathbf{h}$. The null hypothesis of the EG-ADF test with respect to the components of $\mathbf{X_{it}^H}$ ($\mathbf{x_{it}^h}$) is tested by testing whether $\widehat{\beta_\mathbf{i}^\mathbf{H}}' \mathbf{X_{it}^H}$ ($\widehat{\beta_\mathbf{i}^\mathbf{h}}' \mathbf{x_{it}^h}$) has a unit root. The distribution of the EG-ADF test statistic is nonstandard (e.g., Stock, 1987; Hansen, 1992) and MacKinnon (2010) reports critical values. If the null hypothesis of the EG-ADF test is rejected, I conclude that consumption, income and housing wealth are cointegrated. The implication of $\mathbf{X_{it}^H} \sim CI(1,1)$ ($\mathbf{x_{it}^h} \sim CI(1,1)$) is that the components of $\mathbf{X_{it}^H}$ ($\mathbf{x_{it}^h}$) are drifting together, i.e. have a common stochastic trend. If $\mathbf{X_{it}^H} \sim CI(1,1)$ ($\mathbf{x_{it}^h} \sim CI(1,1)$) the DOLS estimator of $\beta_\mathbf{i}^\mathbf{H}$ ($\beta_\mathbf{i}^\mathbf{h}$) is efficient and consistent, its asymptotic distribution is χ^2 (Stock, 1987), and statistical inference on the parameters in the cointegrating equation based on HAC standard errors is valid (Stock and Watson, 2011). The use of the least squares estimator for estimating the unknown cointegrating vectors introduces sampling uncertainty, but if the components of $\mathbf{X_{it}^H}$ ($\mathbf{x_{it}^h}$) are cointegrated, the DOLS estimator of $\beta_\mathbf{i}^\mathbf{H}$ ($\beta_\mathbf{i}^\mathbf{h}$) is efficient and the components of $\widehat{\beta_\mathbf{i}^\mathbf{H}}$ ($\widehat{\beta_\mathbf{i}^\mathbf{h}}$) converge to the probability limit at a faster rate (Stock, 1987).

The EG-ADF test regarding the components of $\mathbf{X_{it}^H}$ and $\mathbf{x_{it}^h}$ does not allow the identification of the cointegration rank. Procedures to test for cointegration and to determine the number of cointegrating equations in the VECMs (1) and (2) are the likelihood ratio tests for inference on the cointegration rank proposed by Johansen (1988). Johansen (1996) suggests, and I apply, the trace statistic and the maximum eigenvalue statistic to determine the cointegration rank in the VECMs (1) and (2) for each sample country. The trace statistic compares the null hypothesis of r or less than r cointegrating equations with the alternative of more than r cointegrating equations. The maximum eigenvalue statistic compares the null hypothesis of r cointegrating equations with the alternative of $r + 1$ cointegrating equations. The distribution of the trace statistic and the maximum eigenvalue statistic are nonstandard and Osterwald-Lenum (1992) reports critical values. The power of cointegration tests is weak. The application of more than one cointegration test is recommended, as it allows more accurate testing of the hypothesis regarding whether consumption, income and housing wealth are cointegrated as defined by Engle and Granger (1987) in each sample country.

Stock and Watson (2011) argue that even if the least squares estimator is consistent, the estimated parameters in the cointegrating equation are not interpretable as long-run cumulative dynamic multipliers as long as the cointegrated variables are not strictly exogenous. In addition, in theory the propensity to consume out of wealth is constant only if the product of the wealth elasticity of consumption and the consumption-to-wealth ratio is constant over time. Campbell and Mankiw (1991) assume isoelastic preferences and show that the consumption-to-wealth ratio is constant only if the intertemporal elasticity of substitution in consumption is constant and equal to one. This implies that the degree of relative risk aversion is constant and equal to one. These assumptions impose relatively strong restrictions on consumer spending behavior. In reality, deriving a constant estimate of the long-run propensity to consume out of wealth from a model with log-level time series is problematic, because the consumption-to-wealth ratio typically evolves over time. Based on this observation, Altissimo et al. (2005) claim that it is appropriate to favor the estimation of the propensity to consume out of wealth based on a model with level variables over a model with log-level variables. I estimate the housing wealth effect on consumption based on models with either level or log-level variables and compare the respective results.

$$\Delta \mathbf{X}^{\mathbf{H}}_{\mathbf{it}} = \sum_{j=1}^{k} \mathbf{\Gamma}^{\mathbf{H}}_{\mathbf{ij}} \Delta \mathbf{X}^{\mathbf{H}}_{\mathbf{it-j}} + \varepsilon^{\mathbf{H}}_{\mathbf{it}} \tag{7}$$

$$\Delta \mathbf{x}^{\mathbf{h}}_{\mathbf{it}} = \sum_{j=1}^{k} \mathbf{\Gamma}^{\mathbf{h}}_{\mathbf{ij}} \Delta \mathbf{x}^{\mathbf{h}}_{\mathbf{it-j}} + \varepsilon^{\mathbf{h}}_{\mathbf{it}} \tag{8}$$

Vector error correction model stability

To confirm VECM stability if $\mathbf{X_{it}^H} \sim CI\,(1,1)$ ($\mathbf{x_{it}^h} \sim CI\,(1,1)$), I model $\mathbf{\Delta X_{it}^H}$ ($\mathbf{\Delta x_{it}^h}$) using the VECM (1) (VECM (2)) and test whether $\beta_{\mathbf{i}}^{\mathbf{H}\prime}\mathbf{X_{it-1}^H}$ ($\beta_{\mathbf{i}}^{\mathbf{h}\prime}\mathbf{x_{it-1}^h}$) helps predict the components of $\mathbf{\Delta X_{it}^H}$ ($\mathbf{\Delta x_{it}^h}$) (Engle and Granger, 1987). If $\mathbf{X_{it}^H} \sim CI\,(1,1)$ ($\mathbf{x_{it}^h} \sim CI\,(1,1)$), a component of $\mathbf{X_{it}^H}$ ($\mathbf{x_{it}^h}$) in the VECM (1) (VECM (2)) may adjust to the disequilibrium $\beta_{\mathbf{i}}^{\mathbf{H}\prime}\mathbf{X_{it}^H} \neq 0$ ($\beta_{\mathbf{i}}^{\mathbf{h}\prime}\mathbf{x_{it}^h} \neq 0$) to restore equilibrium $\beta_{\mathbf{i}}^{\mathbf{H}\prime}\mathbf{X_{it}^H} = 0$ ($\beta_{\mathbf{i}}^{\mathbf{h}\prime}\mathbf{x_{it}^h} = 0$). If $\mathbf{X_{it}^H} \sim CI\,(1,1)$ ($\mathbf{x_{it}^h} \sim CI\,(1,1)$), the components of $\widehat{\alpha_{\mathbf{i}}^{\mathbf{H}}}$ ($\widehat{\alpha_{\mathbf{i}}^{\mathbf{h}}}$) are interpreted as speed-of-adjustment parameters in the VECM (1) (VECM (2)), and measure the rate at which the components of $\mathbf{X_{it}^H}$ ($\mathbf{x_{it}^h}$) adjust to the disequilibrium $\beta_{\mathbf{i}}^{\mathbf{H}\prime}\mathbf{X_{it}^H} \neq 0$ ($\beta_{\mathbf{i}}^{\mathbf{h}\prime}\mathbf{x_{it}^h} \neq 0$). If $\widehat{\beta_{\mathbf{i}}^{\mathbf{H}}}'\mathbf{X_{it-1}^H}$ ($\widehat{\beta_{\mathbf{i}}^{\mathbf{h}}}'\mathbf{x_{it-1}^h}$) contributes to the prediction of a component of $\mathbf{\Delta X_{it}^H}$ ($\mathbf{\Delta x_{it}^h}$) in the VECM (1) (VECM (2)), the component of $\widehat{\alpha_{\mathbf{i}}^{\mathbf{H}}}$ ($\widehat{\alpha_{\mathbf{i}}^{\mathbf{h}}}$) in the respective equation in the model turns out statistically significant. At least one component of $\widehat{\alpha_{\mathbf{i}}^{\mathbf{H}}}$ ($\widehat{\alpha_{\mathbf{i}}^{\mathbf{h}}}$) in the VECM (1) (VECM (2)) is required to be statistically significant for model stability. There is an issue with VECM (1) (VECM (2)) stability, if all components of $\widehat{\alpha_{\mathbf{i}}^{\mathbf{H}}}$ ($\widehat{\alpha_{\mathbf{i}}^{\mathbf{h}}}$) are statistically insignificant. The implication of VECM (1) (VECM (2)) instability is that I model $\mathbf{\Delta X_{it}^H}$ ($\mathbf{\Delta x_{it}^h}$) using the VARM (7) (VARM (8)).

Short-run housing wealth effect on consumption

If I find no evidence in favor of the hypothesis that consumption, income and housing wealth are cointegrated in country i, I cannot verify the long-run relationship between the components of $\mathbf{X_{it}^H}$ ($\mathbf{x_{it}^h}$) in this country. The consequence of the absence of cointegration among consumption, income and housing wealth, denoted by $\mathbf{X_{it}^H} \nsim CI\,(1,1)$ ($\mathbf{x_{it}^h} \nsim CI\,(1,1)$), is the inappropriateness of modeling the trending components of $\mathbf{X_{it}^H}$ ($\mathbf{x_{it}^h}$) using the VECM (1) (VECM (2)) and the appropriateness of modeling their stationary first differences employing the VARM (7) (VARM (8)). If $\mathbf{X_{it}^H} \sim CI\,(1,1)$ ($\mathbf{x_{it}^h} \sim CI\,(1,1)$), I model $\mathbf{\Delta X_{it}^H}$ ($\mathbf{\Delta x_{it}^h}$) using the VECM (1) (VECM (2)). If $\mathbf{X_{it}^H} \nsim CI\,(1,1)$ ($\mathbf{x_{it}^h} \nsim CI\,(1,1)$), I model $\mathbf{\Delta X_{it}^H}$ ($\mathbf{\Delta x_{it}^h}$) employing the VARM (7) (VARM (8)). A drawback of only applying the VARM (7) and VARM (8) in country i is that drawing a conclusion about the long-run housing wealth effect on consumption is infeasible in this economy. I model $\mathbf{\Delta X_{it}^H}$ engaging the VECM (1) if $\mathbf{X_{it}^H} \sim CI\,(1,1)$, or the VARM (7) if $\mathbf{X_{it}^H} \nsim CI\,(1,1)$, to investigate the short-run relationship between consumption, income and housing wealth in each sample country. I test whether transitory income and housing wealth changes Granger cause consumption growth by performing a Granger causality test for the ΔC_{it} equation in the appropriate model.

4 Data

This study relies on an unbalanced panel of 14 countries observed quarterly from 1Q 1995 to 4Q 2013. Table (1) shows data availability. Table (2) exhibits summary statistics. The sample countries are Australia (AUS), Belgium (BEL), Canada (CAN), Denmark (DNK), Finland (FIN), France (FRA), Germany (DEU), Italy (ITA), Japan (JPN), Sweden (SWE), Switzerland (CHE), the Netherlands (NLD), the United Kingdom (GBR) and the United States (USA). Data sources are the OECD, World Bank Group, statistical institutes and central banks. The seasonally adjusted GDP measured in 2010 US dollars and at fixed Purchasing Power Parities (PPP) is sourced from OECD Quarterly National Accounts data files. Population and GINI index data are from the World Bank World Development Indicators. The basis for calculation of household debt per capita (D_{it}) is the household debt-to-gross disposable income ratio sourced from OECD Financial Indicators data files. C_{it}, Y_{it}, H_{it}, D_{it}, asset wealth (A_{it}) and financial wealth (F_{it}) are seasonally adjusted annualized per capita variables measured in 2010 US dollars and at fixed PPP. The end-of-period H_{it} is lagged one period to generate a start-of-period measure.

Table 1: Data availability

	AUS	BEL	CAN	CHE	DEU	DNK	FIN
C_{it}	95Q1-13Q4	95Q1-13Q4	95Q1-13Q4	95Q1-13Q4	95Q1-13Q4	95Q1-13Q4	95Q1-13Q4
Y_{it}	95Q1-13Q4	95Q1-13Q4	95Q1-13Q4	95Q1-12Q4	95Q1-13Q4	95Q1-13Q4	95Q1-13Q4
H_{it}	95Q1-13Q4	95Q1-13Q4	95Q1-13Q4	00Q1-12Q4	95Q1-12Q4	95Q1-12Q4	95Q1-13Q4

	FRA	GBR	ITA	JPN	NLD	SWE	USA
C_{it}	95Q1-13Q4	95Q1-13Q4	95Q1-13Q4	95Q1-13Q4	95Q1-13Q4	95Q1-13Q4	95Q1-13Q4
Y_{it}	95Q1-13Q4	99Q1-13Q4	95Q1-13Q4	95Q1-13Q4	95Q1-13Q4	95Q1-13Q4	95Q1-13Q4
H_{it}	95Q1-11Q4	99Q1-12Q4	95Q1-11Q4	95Q1-13Q4	96Q1-12Q4	95Q1-13Q4	95Q1-13Q4

Notes: The table exhibits data availability. Data sources are the OECD, World Bank Group, statistical institutes and central banks. C_{it} is household final consumption expenditure per capita in country i at period t. Y_{it} is gross household adjusted disposable income per capita in country i at period t. H_{it} is household housing wealth per capita in country i at period t.

- **Consumption**: The basis for calculation of C_{it} is a household final consumption expenditure-to-GDP ratio based on the World Bank household final consumption expenditure time series. This series shows the market value of all goods and services including consumer durables and payments and fees to governments to obtain permits and licenses. It includes expenditures of non-profit institutions serving

Table 2: Consumption, income and housing wealth summary statistics

	Statistics			Percentiles				Statistics			Percentiles		
	Obs.	Mean	Std.Dev.	25%	50%	75%		Obs.	Mean	Std.Dev.	25%	50%	75%
AUS							FRA						
C_{1t}	77	21271.0	1858.3	20012.7	22214.8	22741.4	C_{8t}	77	18990.4	1273.8	17945.6	19318.2	20217.8
Y_{1t}	77	28343.3	3136.0	25378.6	28997.6	30989.1	Y_{8t}	77	28078.3	1908.7	26179.6	29215.1	29461.3
H_{1t}	76	57821.1	9296.2	62216.8	62216.8	66506.5	H_{8t}	68	76787.8	11596.6	64870.1	78353.9	86255.8
BEL							GBR						
C_{2t}	77	19100.1	1092.5	18452.7	19252.6	20118.5	C_{9t}	77	21732.1	2280.4	20252.7	22896.1	23428.7
Y_{2t}	77	27707.7	1390.1	26430.1	28312.4	28641.4	Y_{9t}	60	27564.4	1426.0	27300.6	27875.1	28628.4
H_{2t}	76	75156.3	10602.8	66243.8	79496.8	83288.8	H_{9t}	56	127349.0	21305.6	115042.5	129905.9	145988.9
CAN							ITA						
C_{3t}	77	20970.0	1701.7	20006.0	21371.1	22253.7	C_{10t}	77	20746.8	980.2	20088.7	21157.6	21391.7
Y_{3t}	77	27319.0	1932.4	25532.4	27733.2	28775.1	Y_{10t}	77	27213.0	1321.9	26050.8	27147.6	28641.5
H_{3t}	76	54097.6	8245.1	46421.6	54579.0	60933.0	H_{10t}	68	119335.1	21572.2	94903.8	122837.0	139836.8
CHE							JPN						
C_{4t}	77	27216.3	1185.9	26592.4	27451.9	28186.7	C_{11t}	77	18836.9	1260.6	17756.9	18797.0	19841.9
Y_{4t}	73	32163.7	1583.0	30656.6	32977.0	33310.8	Y_{11t}	77	23850.2	1642.1	22251.2	23876.6	24883.0
H_{4t}	52	132430.1	7539.0	126684.6	132196.3	136215.5	H_{11t}	76	39034.7	7669.4	30023.5	41323.4	45059.9
DEU							NLD						
C_{5t}	77	21065.3	1427.6	19888.7	20977.9	22163.9	C_{12t}	77	19981.4	1250.7	19900.2	20371.2	20817.5
Y_{5t}	77	29591.3	1696.3	27725.1	29952.0	30743.3	Y_{12t}	77	28724.5	1895.0	27692.8	29449.2	30215.0
H_{5t}	72	72421.6	8803.9	64265.4	71792.4	78972.0	H_{12t}	68	87505.2	14670.6	74919.4	90860.7	100751.9
DNK							SWE						
C_{6t}	77	19709.2	858.6	19113.4	19797.9	20292.2	C_{13t}	77	17553.4	1789.9	16046.2	17950.7	19072.5
Y_{6t}	77	25814.8	941.8	24954.1	26303.2	26639.2	Y_{13t}	77	24770.3	3072.4	21282.8	25886.9	27256.4
H_{6t}	72	64177.9	5479.4	62211.1	64734.2	66858.3	H_{13t}	76	50003.2	12767.0	42473.7	53849.2	60984.7
FIN							USA						
C_{7t}	77	17726.7	2535.7	15394.8	18227.1	20230.4	C_{14t}	77	30946.6	2980.6	28731.4	32072.5	33397.8
Y_{7t}	77	23647.7	3468.0	20245.2	24581.2	26649.6	Y_{14t}	77	37420.3	3609.5	34477.9	38666.3	40397.9
H_{7t}	76	53682.5	10127.7	44637.4	53923.2	62681.5	H_{14t}	76	83537.7	16143.1	73582.6	81735.0	92798.1

Notes: The calculation of the statistics is based on data sourced from the OECD, World Bank Group, statistical institutes and central banks. C_{it} is household final consumption expenditure per capita in country i at period t. Y_{it} is gross household adjusted disposable income per capita in country i at period t. H_{it} is household housing wealth per capita in country i at period t. The same deflator is used to define the variables. E.g. the mean of $C_{1t} = 21271.0$ indicates that the average seasonally adjusted annualized household final consumption expenditure per capita measured in 2010 US dollars and at fixed PPP equals 21271.0.

households and excludes dwelling purchases. The World Bank raises concerns over some countries' approaches to determining the national expenditures components, as they have tended to focus on generating their primary assessment of GDP using the production approach, and to derive some of the main GDP aggregates based on the expenditure approach indirectly using GDP based on the production approach. This approach can hamper cross-country comparability of the World Bank household final consumption expenditure time series.

- **Income**: The basis for calculation of Y_{it} is a gross household adjusted disposable income-to-GDP ratio based on the OECD gross household adjusted disposable income per capita time series. This series refers to the maximum amount that a unit can afford to spend on consumption without reducing financial and non-financial assets and raising liabilities. It is calculated as wages plus salaries, mixed income, net property income, selected transfers including government provided education and health and social benefits net of taxes on income, wealth and social security contributions. The OECD national and disposable income time series differ. An important difference concerns the allocation of income across sectors. There is some double counting of the impact of non-financial assets income because of the inclusion of net property income into Y_{it}. This could bias the estimates of the wealth effect on consumption (Altissimo et al., 2005).

- **Asset wealth**: The calculation basis of A_{it} is a household total net worth-to-net disposable income ratio and is sourced from OECD National Accounts data files. Household total net worth is the value of financial and non-financial assets minus outstanding liabilities. A_{it} includes household financial net worth and the value of dwellings, excluding land. Expenditures on consumer durables are excluded. Internal consistency requires this exclusion, as C_{it} includes expenditures on consumer durables. The cross-country comparison of this OECD ratio is hampered by differences in the treatment of land in the recording of the value of dwellings. OECD highlights that the land value is included in the dwellings value in Switzerland, the United Kingdom and the United States. In addition, some countries provide dwelling data referring to households only, while others provide dwelling data referring to households and non-profit institutions serving households.

- **Financial wealth**: The basis for calculation of F_{it} is a household financial net worth-to-GDP ratio based on the OECD household financial net worth per capita time series. This series corresponds to the excess of financial assets such as deposits, shares and other equity, securities other than shares and net equity of households in life insurance reserves and pension funds over liabilities. Cross-country differences in the organization of pension systems, the relative importance of pension schemes included in or excluded from core financial accounts, and the holding of personal life insurance due to dissimilar availability of public and company pension schemes hamper international comparability of the OECD household financial net worth per capita time series. H_{it} is the difference between A_{it} and F_{it}.

Cross-study differences in the application of cointegration theory and data inconsistencies hamper the comparability of wealth effect estimates. Labhard et al. (2005) raise concerns over whether empirical measures of the household budget constraint components are sufficiently harmonized to permit an international comparison of wealth effect estimates. Reasons for differences in wealth recordings include dissimilar wealth concepts, measurement errors and data unavailability (e.g., Babeau and Sbano, 2003; Norman et al., 2005). Other studies on the wealth effect use different household consumption and wealth proxies. Ludwig and Slok (2004) use stock market and house price indexes. Boone et al. (1998) use stock market and non-stock market wealth. Slacalek (2009) builds a housing wealth approximation using house price indexes. Blinder et al. (1985), Ludvigson and Steindel (1999) and Labhard et al. (2005) relate non-durables and services consumption to wealth. Palumbo et al. (2006) suggest that relating non-durables and services consumption to wealth is appropriate only if non-durables and services consumption is a constant multiple of total consumption outlays.

5 Results

5.1 Time series properties

Consumption, income and housing wealth are hypothesized to be cointegrated as defined by Engle and Granger (1987). The verification of the first autocorrelation coefficient and order of integration of C_{it}, Y_{it}, H_{it}, c_{it}, y_{it} and h_{it} are preliminary steps in testing whether a long-run housing wealth effect on consumption is consistently estimable in each sample country. The respective first autocorrelation coefficient of C_{it}, Y_{it}, H_{it}, c_{it}, y_{it} and h_{it} is close to one (Table (3)) and consequently the variables could have a stochastic trend. Table (4) summarizes the results of the ADF-GLS tests and the KPSS tests based on the full sample period. The test statistics are sensitive to the lag length selection and trend specification. Table (4) exhibits the optimal lag length chosen based on the Luetkepohl (2005) version of the Schwarz's Bayesian information criterion (SBIC) statistics. The ADF-GLS test alternative hypothesis is level stationarity. The KPSS test null hypothesis is level stationarity. These trend specifications imply that a deterministic time trend is excluded. Based on the ADF-GLS conventional critical values, the null hypothesis of a unit root in C_{it}, Y_{it}, H_{it}, c_{it}, y_{it} and h_{it} often cannot be rejected at all significance levels.

Table 3: First autocorrelation coefficient of consumption, income and housing wealth

Variable	AUS	BEL	CAN	CHE	DEU	DNK	FIN
C_{it}	0.958	0.960	0.961	0.948	0.954	0.957	0.970
c_{it}	0.957	0.959	0.961	0.947	0.954	0.956	0.969
Time range	95Q1-13Q4	95Q1-13Q4	95Q1-13Q4	95Q1-13Q4	95Q1-13Q4	95Q1-13Q4	95Q1-13Q4
Y_{it}	0.959	0.963	0.962	0.964	0.953	0.947	0.964
y_{it}	0.958	0.963	0.962	0.964	0.954	0.947	0.963
Time range	95Q1-13Q4	95Q1-13Q4	95Q1-13Q4	95Q1-12Q4	95Q1-13Q4	95Q1-13Q4	95Q1-13Q4
H_{it}	0.966	0.954	0.960	0.868	0.948	0.944	0.961
h_{it}	0.964	0.933	0.961	0.871	0.950	0.944	0.960
Time range	95Q1-13Q4	95Q1-13Q4	95Q1-13Q4	00Q1-12Q4	95Q1-12Q4	95Q1-12Q4	95Q1-13Q4

Variable	FRA	GBR	ITA	JPN	NLD	SWE	USA
C_{it}	0.967	0.965	0.947	0.940	0.949	0.966	0.960
c_{it}	0.966	0.964	0.946	0.940	0.947	0.966	0.959
Time range	95Q1-13Q4	95Q1-13Q4	95Q1-13Q4	95Q1-13Q4	95Q1-13Q4	95Q1-13Q4	95Q1-13Q4
Y_{it}	0.966	0.915	0.955	0.948	0.958	0.967	0.964
y_{it}	0.966	0.911	0.954	0.949	0.956	0.967	0.963
Time range	95Q1-13Q4	99Q1-13Q4	95Q1-13Q4	95Q1-13Q4	95Q1-13Q4	95Q1-13Q4	95Q1-13Q4
H_{it}	0.957	0.955	0.974	0.961	0.969	0.963	0.976
h_{it}	0.958	0.950	0.972	0.963	0.967	0.957	0.972
Time range	95Q1-11Q4	99Q1-12Q4	95Q1-11Q4	95Q1-13Q4	96Q1-12Q4	95Q1-13Q4	95Q1-13Q4

Notes: The table presents the first autocorrelation coefficient of C_{it}, c_{it}, Y_{it}, y_{it}, H_{it} and h_{it}. Uppercase letters denote level variables. Lowercase letters denote log-level variables. C_{it} is household final consumption expenditure per capita in country i at period t. Y_{it} is gross household adjusted disposable income per capita in country i at period t. H_{it} is household housing wealth per capita in country i at period t. The underlying data are sourced from the OECD, World Bank Group, statistical institutes and central banks.

The results of the KPSS tests confirm the ADF-GLS test results, but reveal that C_{it} and c_{it} in the Netherlands, Y_{it} and y_{it} in Italy, the Netherlands and the United Kingdom, and h_{it} in Sweden and the United Kingdom are trending but may not be $I(1)$. To summarize, the preliminary analysis shows that C_{it}, Y_{it}, H_{it}, c_{it}, y_{it} and h_{it} typically tend to be $I(1)$ and first difference stationary. These findings have consequences for the adequateness of using the least squares method when estimating the housing wealth effect because the least squares estimator is inconsistent, statistical inference is biased and the

Table 4: Order of integration of consumption, income and housing wealth

	AUS ($i=1$)	BEL ($i=2$)	CAN ($i=3$)	CHE ($i=4$)	DEU ($i=5$)	DNK ($i=6$)	FIN ($i=7$)	FRA ($i=8$)	GBR ($i=9$)	ITA ($i=10$)	JPN ($i=11$)	NLD ($i=12$)	SWE ($i=13$)	USA ($i=14$)
ADF-GLS test														
C_{it}	[2] $I(1)$***	[3] $I(1)$***	[2] $I(1)$***	[2] $I(1)$***	[2] $I(1)$***	[1] $I(1)$***	[1] $I(1)$***	[2] $I(1)$***	[2] $I(1)$***	[2] $I(1)$***	[1] $I(1)$***	[2] $I(1)$***	[1] $I(1)$***	[2] $I(1)$***
T statistic	0.7060	0.5520	0.8270	0.1590	0.8820	-0.3570	0.6680	0.1480	-0.0490	-0.9390	1.2030	-0.4510	0.5640	0.6360
ΔC_{it}	$I(0)$***	$I(0)$***	$I(0)$***	$I(0)$***	$I(0)$***	$I(0)$***	$I(0)$***	$I(0)$***	$I(0)$***	$I(0)$***	$I(0)$***	$I(0)$***	$I(0)$***	$I(0)$***
T statistic	-6.4610	-4.1760	-5.1060	-4.7650	-5.5690	-8.2540	-5.7320	-5.1860	-3.2750	-3.2920	-6.7630	-4.6160	-6.7430	-5.5450
Y_{it}	[3] $I(1)$***	[2] $I(1)$***	[3] $I(1)$***	[2] $I(1)$***	[2] $I(1)$***	[1] $I(1)$***	[1] $I(1)$***	[2] $I(1)$***	[2] $I(1)$***	[2] $I(1)$***	[2] $I(1)$***	[2] $I(1)$***	[2] $I(1)$***	[1] $I(1)$***
T statistic	0.8380	-0.3160	1.2750	-0.3950	0.3860	-0.6330	1.0880	-0.2330	-0.7410	-1.1500	1.5820	-0.6170	0.7830	0.8280
ΔY_{it}	$I(0)$***	$I(0)$***	$I(0)$***	$I(0)$***	$I(0)$***	$I(0)$***	$I(0)$***	$I(0)$***	$I(0)$***	$I(0)$***	$I(0)$***	$I(0)$***	$I(0)$***	$I(0)$***
T statistic	-5.5000	-4.5620	-5.0730	-3.6390	-5.5860	-8.0810	-7.2010	-4.3210	-3.0450	-3.0710	-6.2790	-4.4100	-5.8600	-6.1730
H_{it}	[3] $I(1)$***	[2] $I(1)$***	[2] $I(1)$***	[3] $I(1)$**	[2] $I(1)$***	[2] $I(1)$***	[2] $I(1)$***	[2] $I(1)$***	[2] $I(1)$**	[2] $I(1)$**	[2] $I(1)$***	[2] $I(1)$***	[2] $I(1)$***	[2] $I(1)$**
T statistic	0.0510	1.1380	1.0980	3.3000	1.6300	-0.6820	0.6480	0.7280	-0.9420	-0.5930	1.0420	0.1880	0.0070	-1.2030
ΔH_{it}	$I(0)$***	$I(0)$***	$I(0)$***	$I(0)$**	$I(0)$***	$I(0)$***	$I(0)$***	$I(0)$***	$I(0)$**	$I(0)$**	$I(0)$***	$I(0)$***	$I(0)$***	$I(0)$**
T statistic	-4.2590	-3.9980	-3.2990	-2.6120	-4.9920	-4.4710	-5.7140	-3.6410	-2.5310	-2.4650	-5.0860	-4.0080	-4.0840	-2.3640
c_{it}	[1] $I(1)$***	[2] $I(1)$***	[2] $I(1)$***	[2] $I(1)$***	[1] $I(1)$***	[1] $I(1)$***	[1] $I(1)$***	[2] $I(1)$***	[2] $I(1)$***	[2] $I(1)$***	[1] $I(1)$***	[2] $I(1)$***	[1] $I(1)$***	[2] $I(1)$***
y_{it}	[3] $I(1)$***	[2] $I(1)$***	[3] $I(1)$***	[2] $I(1)$***	[2] $I(1)$***	[1] $I(1)$***	[1] $I(1)$***	[2] $I(1)$***	[2] $I(1)$***	[2] $I(1)$***	[2] $I(1)$***	[2] $I(1)$***	[2] $I(1)$***	[1] $I(1)$***
h_{it}	[3] $I(1)$***	[2] $I(1)$***	[2] $I(1)$***	[4] $I(1)$***	[2] $I(1)$***	[2] $I(1)$***	[2] $I(1)$***	[2] $I(1)$***	[2] $I(1)$**	[2] $I(1)$***	[2] $I(1)$***	[2] $I(1)$***	[2] $I(1)$***	[2] $I(1)$**
KPSS test														
C_{it}	[2] $I(1)$**	[3] $I(1)$***	[2] $I(1)$***	[2] $I(1)$***	[2] $I(1)$***	[1] $I(1)$***	[1] $I(1)$***	[2] $I(1)$**	[2] $I(1)$*	[2] $I(1)$*	[1] $I(1)$***	[2] $I(2)$***	[1] $I(1)$***	[2] $I(1)$**
T statistic	1.8300	1.8600	2.8000	2.4200	2.7900	4.4200	5.9500	2.7700	2.5300	1.4600	2.8300	1.4800	2.8500	2.7400
ΔC_{it}	$I(0)$**	$I(0)$***	$I(0)$***	$I(0)$***	$I(0)$***	$I(0)$***	$I(0)$***	$I(0)$**	$I(0)$*	$I(0)$*	$I(0)$***	$I(1)$***	$I(0)$***	$I(0)$**
T statistic	0.4190	0.3210	0.1640	0.2440	0.0392	0.2050	0.1880	0.3650	0.5640	0.5680	0.0496	0.8840	0.0981	0.3620
Y_{it}	[3] $I(1)$***	[2] $I(1)$**	[3] $I(1)$***	[2] $I(1)$***	[2] $I(1)$***	[1] $I(1)$***	[1] $I(1)$***	[2] $I(1)$**	[2] $I(2)$***	[2] $I(2)$***	[2] $I(1)$***	[2] $I(2)$***	[2] $I(1)$***	[1] $I(1)$**
T statistic	1.9800	2.0600	1.9600	1.8900	2.6100	4.1700	5.9600	2.1900	0.9080	0.6990	1.4600	1.4800	2.8100	2.8600
ΔY_{it}	$I(0)$***	$I(0)$**	$I(0)$***	$I(0)$***	$I(0)$***	$I(0)$***	$I(0)$***	$I(0)$**	$I(1)$***	$I(1)$***	$I(0)$***	$I(1)$***	$I(0)$***	$I(0)$**
T statistic	0.0953	0.3890	0.0549	0.3330	0.0514	0.1400	0.1520	0.4440	0.9430	0.5490	0.0671	0.9180	0.1460	0.4230
H_{it}	[3] $I(1)$***	[2] $I(1)$***	[2] $I(1)$***	[3] $I(1)$***	[2] $I(1)$***	[2] $I(1)$***	[2] $I(1)$***	[2] $I(1)$***	[2] $I(1)$*	[2] $I(1)$***	[2] $I(1)$***	[2] $I(1)$***	[2] $I(1)$**	[2] $I(1)$***
T statistic	1.7200	1.4100	2.9100	1.2900	1.4100	1.7900	2.7800	2.5900	1.1400	2.5800	2.8500	2.5600	2.6000	1.3000
ΔH_{it}	$I(0)$***	$I(0)$***	$I(0)$***	$I(0)$***	$I(0)$***	$I(0)$***	$I(0)$***	$I(0)$***	$I(0)$*	$I(0)$***	$I(0)$***	$I(0)$***	$I(0)$**	$I(0)$***
T statistic	0.3130	0.1420	0.0602	0.2010	0.1020	0.0906	0.1530	0.0745	0.6320	0.3170	0.0740	0.2990	0.4600	0.2910
c_{it}	[1] $I(1)$*	[2] $I(1)$***	[2] $I(1)$***	[2] $I(1)$***	[1] $I(1)$***	[1] $I(1)$***	[1] $I(1)$***	[2] $I(1)$***	[2] $I(1)$*	[2] $I(1)$*	[1] $I(1)$***	[2] $I(2)$***	[1] $I(1)$***	[2] $I(1)$*
y_{it}	[3] $I(1)$***	[2] $I(1)$**	[3] $I(1)$***	[2] $I(1)$**	[2] $I(1)$***	[1] $I(1)$***	[1] $I(1)$***	[2] $I(1)$*	[2] $I(2)$***	[2] $I(1)$*	[2] $I(1)$***	[2] $I(2)$***	[2] $I(1)$***	[1] $I(1)$*
h_{it}	[3] $I(1)$*	[2] $I(1)$***	[2] $I(1)$***	[4] $I(1)$***	[2] $I(1)$***	[2] $I(1)$***	[2] $I(1)$***	[2] $I(1)$***	[2] $I(2)$***	[2] $I(1)$**	[2] $I(1)$***	[2] $I(1)$**	[2] $I(2)$***	[2] $I(1)$**

Notes: The table reports T statistics and reveals the order of integration of C_{it}, Y_{it}, H_{it} and their respective first differences based on the ADF-GLS and KPSS tests. C_{it} is household final consumption expenditure per capita in country i at period t. Y_{it} is gross household adjusted disposable income per capita in country i at period t. H_{it} is household housing wealth per capita in country i at period t. Uppercase letters denote level variables. The table also highlights the order of integration of c_{it}, y_{it} and h_{it} based on the ADF-GLS and KPSS tests. Lowercase letters denote log-level variables. T statistics of the log-level variables are not reported for parsimony reasons but are available upon request. The tests are based on the full sample period. The ADF-GLS test alternative hypothesis is level stationarity. The KPSS test null hypothesis is level stationarity. The optimal lag length is chosen based on the Luetkepohl (2005) version of the SBIC statistics and is shown in the squared parenthesis next to the estimated order of integration of C_{it}, Y_{it}, H_{it}, c_{it}, y_{it} and h_{it}. The respective conventional 1 percent (***), 5 percent (**) and 10 percent (*) critical values of the ADF-GLS test typically are -2.6100, -1.9500 and -1.6100, and those of the KPSS test are 0.7390, 0.4630 and 0.3470.

regression of consumption on income and housing wealth is spurious, if cointegration among the trending variables is absent.

5.2 Vector error correction model

Long-run housing wealth effect on consumption

To test the hypothesis whether the components of $\mathbf{X_{it}^H}$ or $\mathbf{x_{it}^h}$ are cointegrated as defined by Engle and Granger (1987) and to verify whether the respective cointegrating vector $\beta_\mathbf{i}^\mathbf{H}$ or $\beta_\mathbf{i}^\mathbf{h}$ is consistently estimable, the cointegration properties of the data are next studied in each sample country. The presence of cointegration is tested by using the two step EG-ADF test recommended by Engle and Granger (1987) as well as the likelihood ratio tests for inference on the cointegration rank suggested by Johansen (1996). The EG-ADF test involves the estimation of the components of $\beta_\mathbf{i}^\mathbf{H}$ and $\beta_\mathbf{i}^\mathbf{h}$ by employing a least squares method and testing for a unit root in the respective error correction terms in each sample country. Based on the full sample period, I estimate the unknown coefficients in the Models (3) and (4). I further estimate the unknown parameters in the Models (5) and (6). I check the robustness of the estimated coefficients based on the OLS method by comparing them with the estimated parameters based on the DOLS method. Tables (5) and (6) show the values of the estimated components of $\beta_\mathbf{i}^\mathbf{H}$ and $\beta_\mathbf{i}^\mathbf{h}$ based on the DOLS method; statistical inference is based on Newey-West standard errors robust to heteroskedasticity and first order autocorrelation (Newey and West, 1987). Tables (5) and (6) do not report the loadings and standard errors of the components of $\widehat{\beta_\mathbf{i}^\mathbf{H}}$ and $\widehat{\beta_\mathbf{i}^\mathbf{h}}$ based on the OLS method as the estimated parameters based on the DOLS method are the asymptotically efficient estimates of the components of $\beta_\mathbf{i}^\mathbf{H}$ and $\beta_\mathbf{i}^\mathbf{h}$ if consumption, income and housing wealth are cointegrated (Stock and Watson, 1993).

I find a positive and statistically significant estimate of β_i^H in Belgium, Canada, Denmark, Germany, Italy, Switzerland and the United States, and a positive and statistically significant estimate of β_i^h in Belgium, Canada, Denmark, Germany, Italy, Japan, Switzerland and the United States. Statistical significance is often at the one percent significance level. The loadings of the positive and statistically significant $\widehat{\beta_i^H}$ are in the range of 0.019 in Italy and 0.116 in Switzerland. This refers to a propensity to consume out of housing wealth in the range of two cents per US dollar in Italy and twelve cents per US dollar in Switzerland. The values of the positive and statistically significant $\widehat{\beta_i^h}$ are in the range of 0.027 in Japan and 0.529 in Switzerland. The value of $\widehat{\beta_{11}^h} = 0.027$

Table 5: Estimated relationship between consumption, income and housing wealth based on level variables

	AUS	BEL	CAN	CHE	DEU	DNK	FIN	FRA	GBR	ITA	JPN	NLD	SWE	USA
Estimated long-run relationship between C_{it}, Y_{it} and H_{it} based on the DOLS estimator suggested by Stock et al. (1993)														
Dependent	C_{1t}	C_{2t}	C_{3t}	C_{4t}	C_{5t}	C_{6t}	C_{7t}	C_{8t}	C_{9t}	C_{10t}	C_{11t}	C_{12t}	C_{13t}	C_{14t}
Y_{it}	0.721***	0.574***	0.661***	0.385***	0.612***	0.540***	0.747***	0.575***	0.852***	0.696***	0.786***	0.677***	0.769***	0.769***
	(0.079)	(0.054)	(0.035)	(0.053)	(0.015)	(0.074)	(0.066)	(0.069)	(0.052)	(0.033)	(0.013)	(0.030)	(0.018)	(0.010)
H_{it}	0.011	0.042**	0.049***	0.116***	0.036***	0.090***	0.002	0.037	-0.006	0.019***	0.004	0.006	-0.033***	0.024***
	(0.036)	(0.019)	(0.016)	(0.014)	(0.006)	(0.027)	(0.028)	(0.024)	(0.011)	(0.008)	(0.008)	(0.010)	(0.008)	(0.004)
Leads/lags	3	3	3	3	3	3	3	3	2	3	3	3	2	2
Obs.	69	69	69	45	65	65	69	61	50	61	69	61	71	71
R-squared	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.999	1.000
$\beta_{\mathbf{i}}^{\mathbf{H}'}\mathbf{X}_{\mathbf{it-1}}^{\mathbf{H}}$ in the ΔC_{it} equation in the VECM (1)														
Dependent	ΔC_{1t}	ΔC_{2t}	ΔC_{3t}	ΔC_{4t}	ΔC_{5t}	ΔC_{6t}	ΔC_{7t}	ΔC_{8t}	ΔC_{9t}	ΔC_{10t}	ΔC_{11t}	ΔC_{12t}	ΔC_{13t}	ΔC_{14t}
$\beta_{\mathbf{i}}^{\mathbf{H}'}\mathbf{X}_{\mathbf{it-1}}^{\mathbf{H}}$	0.015	0.003	0.021	-0.029	-0.114**	-0.091**	-0.135**	0.002	0.036	0.021	-0.140**	-0.024	-0.025	0.085
	(0.019)	(0.019)	(0.032)	(0.056)	(0.049)	(0.040)	(0.056)	(0.016)	(0.032)	(0.022)	(0.061)	(0.036)	(0.025)	(0.087)
Lags	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Obs.	73	73	73	49	69	69	73	65	52	65	73	65	73	73
R-squared	0.671	0.686	0.730	0.510	0.752	0.634	0.815	0.736	0.757	0.814	0.789	0.625	0.751	0.596
$\beta_{\mathbf{i}}^{\mathbf{H}'}\mathbf{X}_{\mathbf{it-1}}^{\mathbf{H}}$ in the ΔY_{it} equation in the VECM (1)														
Dependent	ΔY_{1t}	ΔY_{2t}	ΔY_{3t}	ΔY_{4t}	ΔY_{5t}	ΔY_{6t}	ΔY_{7t}	ΔY_{8t}	ΔY_{9t}	ΔY_{10t}	ΔY_{11t}	ΔY_{12t}	ΔY_{13t}	ΔY_{14t}
$\beta_{\mathbf{i}}^{\mathbf{H}'}\mathbf{X}_{\mathbf{it-1}}^{\mathbf{H}}$	0.025	0.016	0.051	0.030	-0.131**	-0.077	-0.054	0.026	0.097**	0.054***	-0.066	0.115**	0.051	0.225**
	(0.025)	(0.025)	(0.036)	(0.047)	(0.052)	(0.053)	(0.059)	(0.022)	(0.041)	(0.0202)	(0.059)	(0.048)	(0.039)	(0.110)
Lags	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Obs.	73	73	73	49	69	69	73	65	52	65	73	65	73	73
R-squared	0.734	0.826	0.757	0.813	0.861	0.674	0.890	0.874	0.835	0.916	0.888	0.730	0.731	0.487
$\beta_{\mathbf{i}}^{\mathbf{H}'}\mathbf{X}_{\mathbf{it-1}}^{\mathbf{H}}$ in the ΔH_{it} equation in the VECM (1)														
Dependent	ΔH_{1t}	ΔH_{2t}	ΔH_{3t}	ΔH_{4t}	ΔH_{5t}	ΔH_{6t}	ΔH_{7t}	ΔH_{8t}	ΔH_{9t}	ΔH_{10t}	ΔH_{11t}	ΔH_{12t}	ΔH_{13t}	ΔH_{14t}
$\beta_{\mathbf{i}}^{\mathbf{H}'}\mathbf{X}_{\mathbf{it-1}}^{\mathbf{H}}$	0.032	0.240	0.350**	-0.370	0.943***	0.234	0.111	0.084	-1.362*	0.216	-0.236	0.406	0.071	0.453
	(0.102)	(0.198)	(0.141)	(0.486)	(0.313)	(0.327)	(0.410)	(0.150)	(0.715)	(0.300)	(0.328)	(0.302)	(0.209)	(0.574)
Lags	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Obs.	73	73	73	49	69	69	73	65	52	65	73	65	73	73
R-squared	0.525	0.580	0.683	0.579	0.519	0.355	0.327	0.664	0.667	0.641	0.431	0.485	0.511	0.759

Notes: The table exhibits the values of the estimates of the long-run propensity to consume out of housing wealth and income. C_{it} is household final consumption expenditure per capita in country i at period t. Y_{it} is gross household adjusted disposable income per capita in country i at period t. H_{it} is household housing wealth per capita in country i at period t. Uppercase letters denote level variables. The first difference in consumption, income and housing wealth is denoted by the respective component of $\Delta\mathbf{X}_{\mathbf{it}}^{\mathbf{H}}$. Standard errors are in parentheses. Statistical inference on the components of $\beta_{\mathbf{i}}^{\mathbf{H}}$ is based on Newey-West standard errors robust to heteroskedasticity and first order autocorrelation. The estimation of the components of $\beta_{\mathbf{i}}^{\mathbf{H}}$ is based on the full sample period. The optimal number of lags is chosen based on the Luetkepohl (2005) version of the SBIC statistics. Statistical inference on $\beta_{\mathbf{i}}^{\mathbf{H}'}\mathbf{X}_{\mathbf{it-1}}^{\mathbf{H}}$ in the VECM (1) is based on the asymptotic standard errors for impulse-response functions; a small sample degrees of freedom adjustment is employed when estimating the cross equation error variance covariance matrix. Shown is statistical significance with *** p<0.01, ** p<0.05, * p<0.1.

Table 6: Estimated relationship between consumption, income and housing wealth based on log-level variables

	AUS	BEL	CAN	CHE	DEU	DNK	FIN	FRA	GBR	ITA	JPN	NLD	SWE	USA
Estimated long-run relationship between c_{it}, y_{it} and h_{it} based on the DOLS estimator suggested by Stock et al. (1993)														
Dependent	c_{1t}	c_{2t}	c_{3t}	c_{4t}	c_{5t}	c_{6t}	c_{7t}	c_{8t}	c_{9t}	c_{10t}	c_{11t}	c_{12t}	c_{13t}	c_{14t}
y_{it}	0.916***	0.786***	0.787***	0.385***	0.768***	0.624***	0.929***	0.806***	1.032***	0.866***	0.948***	0.920***	1.018***	0.908***
	(0.087)	(0.077)	(0.045)	(0.071)	(0.023)	(0.097)	(0.086)	(0.096)	(0.097)	(0.045)	(0.015)	(0.051)	(0.033)	(0.010)
h_{it}	0.052	0.162**	0.174***	0.529***	0.182***	0.321***	0.040	0.142	-0.044	0.096**	0.027*	0.040	-0.050	0.069***
	(0.081)	(0.070)	(0.042)	(0.063)	(0.022)	(0.089)	(0.080)	(0.087)	(0.084)	(0.039)	(0.014)	(0.046)	(0.0304)	(0.009)
Leads/lags	3	3	3	3	3	3	3	3	3	3	3	3	2	2
Obs.	69	69	69	45	65	65	69	61	48	61	69	61	71	71
R-squared	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
$\beta_{\mathbf{i}}^{\mathbf{h}\prime}\mathbf{x}_{\mathbf{it-1}}^{\mathbf{h}}$ in the Δc_{it} equation in the VECM (2)														
Dependent	Δc_{1t}	Δc_{2t}	Δc_{3t}	Δc_{4t}	Δc_{5t}	Δc_{6t}	Δc_{7t}	Δc_{8t}	Δc_{9t}	Δc_{10t}	Δc_{11t}	Δc_{12t}	Δc_{13t}	Δc_{14t}
$\beta_{\mathbf{i}}^{\mathbf{h}\prime}\mathbf{x}_{\mathbf{it-1}}^{\mathbf{h}}$	0.011	0.001	0.020	-0.037	-0.155**	-0.095**	-0.147***	-0.003	0.022	0.008	-0.190***	-0.038	-0.033	-0.150
	(0.020)	(0.019)	(0.028)	(0.054)	(0.059)	(0.0402)	(0.049)	(0.018)	(0.032)	(0.021)	(0.063)	(0.037)	(0.026)	(0.104)
Lags	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Obs.	73	73	73	49	69	69	73	65	52	65	73	65	73	73
R-squared	0.724	0.703	0.738	0.506	0.766	0.650	0.824	0.736	0.753	0.836	0.788	0.641	0.721	0.646
$\beta_{\mathbf{i}}^{\mathbf{h}\prime}\mathbf{x}_{\mathbf{it-1}}^{\mathbf{h}}$ in the Δy_{it} equation in the VECM (2)														
Dependent	Δy_{1t}	Δy_{2t}	Δy_{3t}	Δy_{4t}	Δy_{5t}	Δy_{6t}	Δy_{7t}	Δy_{8t}	Δy_{9t}	Δy_{10t}	Δy_{11t}	Δy_{12t}	Δy_{13t}	Δy_{14t}
$\beta_{\mathbf{i}}^{\mathbf{h}\prime}\mathbf{x}_{\mathbf{it-1}}^{\mathbf{h}}$	0.019	0.013	0.030	0.017	-0.113**	-0.068*	-0.062	0.016	0.064*	0.036**	-0.093*	0.066*	0.033	-0.040
	(0.020)	(0.018)	(0.024)	(0.039)	(0.044)	(0.040)	(0.039)	(0.016)	(0.032)	(0.015)	(0.049)	(0.035)	(0.030)	(0.114)
Lags	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Obs.	73	73	73	49	69	69	73	65	52	65	73	65	73	73
R-squared	0.775	0.817	0.746	0.800	0.871	0.695	0.896	0.876	0.852	0.921	0.886	0.725	0.690	0.509
$\beta_{\mathbf{i}}^{\mathbf{h}\prime}\mathbf{x}_{\mathbf{it-1}}^{\mathbf{h}}$ in the Δh_{it} equation in the VECM (2)														
Dependent	Δh_{1t}	Δh_{2t}	Δh_{3t}	Δh_{4t}	Δh_{5t}	Δh_{6t}	Δh_{7t}	Δh_{8t}	Δh_{9t}	Δh_{10t}	Δh_{11t}	Δh_{12t}	Δh_{13t}	Δh_{14t}
$\beta_{\mathbf{i}}^{\mathbf{h}\prime}\mathbf{x}_{\mathbf{it-1}}^{\mathbf{h}}$	0.019	0.054	0.136***	-0.094	0.318***	0.080	-0.042	0.025	-0.262**	0.035	0.040	0.160**	0.062	0.140
	(0.041)	(0.053)	(0.045)	(0.099)	(0.110)	(0.100)	(0.117)	(0.039)	(0.123)	(0.052)	(0.162)	(0.067)	(0.071)	(0.259)
Lags	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Obs.	73	73	73	49	69	69	73	65	52	65	73	65	73	73
R-squared	0.535	0.595	0.707	0.550	0.498	0.353	0.391	0.678	0.680	0.638	0.443	0.573	0.638	0.739

Notes: The table exhibits the values of the estimates of the housing wealth and income elasticity of consumption. c_{it} is the log-level household final consumption expenditure per capita in country i at period t. y_{it} is the log-level gross household adjusted disposable income per capita in country i at period t. h_{it} is the log-level household housing wealth per capita in country i at period t. The first difference in log-level consumption, income and housing wealth is denoted by the respective component of $\Delta\mathbf{x}_{\mathbf{it}}^{\mathbf{h}}$. Standard errors are in parentheses. Statistical inference on the components of $\beta_{\mathbf{i}}^{\mathbf{h}}$ is based on Newey-West standard errors robust to heteroskedasticity and first order autocorrelation. The estimation of the components of $\beta_{\mathbf{i}}^{\mathbf{h}}$ is based on the full sample period. The optimal number of lags is chosen based on the Luetkepohl (2005) version of the SBIC statistics. Statistical inference on $\beta_{\mathbf{i}}^{\mathbf{h}\prime}\mathbf{x}_{\mathbf{it-1}}^{\mathbf{h}}$ in the VECM (2) is based on asymptotic standard errors for impulse-response functions; a small sample degrees of freedom adjustment is employed when estimating the cross equation error variance covariance matrix. Shown is statistical significance with *** p<0.01, ** p<0.05, * p<0.1.

indicates that consumption tends to grow by 0.027 percent, if housing wealth rises by one percent. The loadings of $\widehat{\beta_i^h}$ presented in Table (6) are less than one in each sample country. This suggests that consumption tends to be housing wealth inelastic. The housing wealth elasticity of consumption and median consumption-to-housing wealth ratio (Table (2)) differ across countries. The loading of $\widehat{\beta_i^h}$ in Italy is one-and-a-half times the one in the United States. The median consumption-to-housing wealth ratio in the United States is more than twice the one in Italy. Multiplying the loading of $\widehat{\beta_i^h}$ with the median consumption-to-housing wealth ratio in country i yields further estimates of the propensity to consume out of housing wealth, which are in the range of one cent per US dollar in Japan and eleven cents per US dollar in Switzerland. A comparison of the country-specific estimates of the propensity to consume out of housing wealth based on the Models (5) and (6) shows that those estimates are of similar size.

The loadings of $\widehat{\beta_i^H}$ and $\widehat{\beta_i^h}$ are positive but statistically insignificant in countries such as Australia, Finland, France and the Netherlands. I infer that housing wealth is unassociated with consumption in these countries. The value of $\widehat{\beta_i^h}$ is negative and statistically insignificant and that of $\widehat{\beta_i^H}$ is negative and statistically significant in Sweden. The values of $\widehat{\beta_i^H}$ and $\widehat{\beta_i^h}$ are negative and statistically insignificant in the United Kingdom. Negative loadings of $\widehat{\beta_i^H}$ and $\widehat{\beta_i^h}$ imply an adverse housing wealth effect on consumption. This finding is at odds with common sense. But an unfavorable wealth effect on consumption is not contradictory to economic theory if one assumes that real interest rates exceed the subjective discount rate and $\theta > 1$ (Blanchard, 1985). There are large cross-country differences in the loadings of the components of $\widehat{\beta_{\mathbf{i}}^{\mathbf{H}}}$ and $\widehat{\beta_{\mathbf{i}}^{\mathbf{h}}}$. Some parameter estimates are statistically insignificant. The predicted housing wealth effect on consumption is sometimes negative. Critical ideas are that variations in economic, financial, political, legal and structural conditions can give rise to cross-country differences in the housing wealth effect. Another important concept is that households own housing assets and consume housing services (ECB, 2003). An implication of this could be that the housing wealth distribution across households matters for aggregate consumption. These ideas have interesting implications for the housing wealth effect, but these are not the focus of this study. Caution is warranted in interpreting and comparing the values of the components of $\widehat{\beta_{\mathbf{i}}^{\mathbf{H}}}$ and $\widehat{\beta_{\mathbf{i}}^{\mathbf{h}}}$ across countries and studies. Jumping to conclusions is inadvisable because the predicted relation between consumption, income and housing wealth based on a least squares method is questionable as long as there is no evidence in favor of cointegration among those variables.

Table (7) shows the cointegration test results. Using interpolated critical values based on the tables in Fuller (1996), the EG-ADF test null hypothesis can be rejected at least at the ten percent significance level in Canada, Denmark, Italy and the United States; this provides evidence in favor of $\mathbf{X_{it}^H} \sim CI\,(1,1)$ and $\mathbf{x_{it}^h} \sim CI\,(1,1)$ in such countries. Based on this test, I also find evidence in favor of $\mathbf{x_{it}^h} \sim CI\,(1,1)$ in Germany and Japan. The EG-ADF test null hypothesis cannot be rejected in Australia, Belgium and Switzerland providing evidence against $\mathbf{X_{it}^H} \sim CI\,(1,1)$ and $\mathbf{x_{it}^h} \sim CI\,(1,1)$ in those countries. I check the robustness of the results by testing for cointegration using the EG-ADF test with interpolated critical values based on the tables in MacKinnon (2010). The results of the revised EG-ADF test shown in Table (7) confirm and are supportive of the robustness of the results of the initial EG-ADF test with interpolated critical values based on the tables in Fuller (1996). I check the robustness of the results of both EG-ADF tests by applying the likelihood ratio tests proposed by Johansen (1988). Based on the trace statistic related to the components of $\mathbf{X_{it}^H}$ and $\mathbf{x_{it}^h}$, I reject the null hypothesis that there are zero cointegrating equations, but fail to reject the null hypothesis of at most one cointegrating equation at least at the five percent significance level in Canada, Denmark and Japan. Based on the trace statistic, I further find evidence in favor of $\mathbf{x_{it}^h} \sim CI\,(1,1)$ in Germany and $\mathbf{X_{it}^H} \sim CI\,(1,1)$ in Italy and the United States. Based on the maximum eigenvalue statistic, I accept the null hypothesis that there is one cointegrating equation (at least at the five percent significance level) in the Models 1 and 2 in Canada and the United States. Based on the maximum eigenvalue statistic, I also find evidence in favor of $\mathbf{X_{it}^H} \sim CI\,(1,1)$ in Denmark and Italy.

Based on the cointegration test results, I conclude that $\mathbf{X_{it}^H} \sim CI\,(1,1)$ in Canada, Denmark, Italy and the United States, and $\mathbf{x_{it}^h} \sim CI\,(1,1)$ in Canada, Denmark, Germany, Italy, Japan and the United States. This implies that the long-run housing wealth effect on consumption is not consistently estimable in Australia, Belgium, Finland, France, Sweden, Switzerland, the Netherlands and the United Kingdom, as the components of neither $\mathbf{X_{it}^H}$ nor $\mathbf{x_{it}^h}$ are cointegrated as defined by Engle and Granger (1987). Given evidence in favor of $\mathbf{X_{it}^H} \sim CI\,(1,1)$, I reason that the magnitude of the consistently estimable long-run propensity to consume out of housing wealth is five cents per US dollar in Canada, nine cents per US dollar in Denmark and two cents per US dollar in Italy and the United States. The results shown in Table (7) further allow the conclusion that the consistently estimable housing wealth elasticity of consumption is 0.174 in

Table 7: Cointegration properties of consumption, income and housing wealth based on the EG-ADF and likelihood ratio tests

	AUS ($i=1$)	BEL ($i=2$)	CAN ($i=3$)	CHE ($i=4$)	DEU ($i=5$)	DNK ($i=6$)	FIN ($i=7$)	FRA ($i=8$)	GBR ($i=9$)	ITA ($i=10$)	JPN ($i=11$)	NLD ($i=12$)	SWE ($i=13$)	USA ($i=14$)
Two step EG-ADF test with interpolated critical values based on the tables in MacKinnon (2010)														
$\widehat{\beta_i^{\mathbf{H}}}' \mathbf{X}_{\mathbf{it}}^{\mathbf{H}}$	[2] $I(1)^{***}$	[3] $I(1)^{***}$	[2] $I(0)^{**}$	[2] $I(1)^{***}$	[2] $I(1)^{***}$	[2] $I(0)^{**}$	[2] $I(0)^{***}$	[2] $I(0)^{*}$	[2] $I(0)^{*}$	[2] $I(0)^{*}$	[2] $I(0)^{***}$	[2] $I(0)^{***}$	[2] $I(0)^{***}$	[2] $I(0)^{**}$
T statistic	-1.310	-1.434	-2.371	0.598	-1.287	-2.332	-2.628	-1.773	-1.923	-1.813	-3.058	-2.935	-3.189	-2.418
$\widehat{\beta_i^{\mathbf{h}}}' \mathbf{x}_{\mathbf{it}}^{\mathbf{h}}$	[2] $I(1)^{***}$	[3] $I(1)^{***}$	[2] $I(0)^{**}$	[2] $I(1)^{***}$	[2] $I(0)^{*}$	[3] $I(0)^{**}$	[2] $I(0)^{**}$	[2] $I(0)^{*}$	[2] $I(0)^{*}$	[2] $I(0)^{*}$	[2] $I(0)^{***}$	[2] $I(0)^{***}$	[2] $I(0)^{***}$	[2] $I(0)^{***}$
T statistic	-1.385	-1.445	-2.137	0.432	-1.812	-2.113	-2.248	-1.794	-1.725	-2.057	-3.155	-2.788	-2.736	-4.067
Trace statistic suggested by Johansen (1996)														
$\mathbf{X}_{\mathbf{it}}^{\mathbf{H}}$	[2] $r=0^{***}$	[3] $r=0^{***}$	[2] $r=0^{***}$	[3] $r=0^{***}$	[3] $r=0^{***}$	[2] $r=0^{***}$	[3] $r=0^{***}$	[2] $r=0$	[2] $r=0$	[2] $r=0$	[3] $r=0^{***}$	[2] $r=0$	[2] $r=0$	[2] $r=0$
T statistic	19.0282	19.4874	28.4466	18.1038	23.1906	25.7052	25.6848	35.0981	41.8748	73.0970	25.4496	40.7392	32.6139	44.6905
$\mathbf{X}_{\mathbf{it}}^{\mathbf{H}}$	[2] $r\leq 1$	[3] $r\leq 1$	[2] $r\leq 1^{**}$	[3] $r\leq 1$	[3] $r\leq 1$	[2] $r\leq 1^{**}$	[3] $r\leq 1^{**}$	[2] $r\leq 1^{***}$	[2] $r\leq 1^{***}$	[2] $r\leq 1^{***}$	[3] $r\leq 1^{**}$	[2] $r\leq 1^{***}$	[2] $r\leq 1^{***}$	[2] $r\leq 1^{***}$
T statistic	3.7455	3.6900	9.5368	5.3973	8.5304	7.5562	11.8666	9.8048	10.6716	7.6425	9.4839	14.0496	14.1982	16.1469
$\mathbf{x}_{\mathbf{it}}^{\mathbf{h}}$	[2] $r=0^{***}$	[3] $r=0^{***}$	[2] $r=0$	[3] $r=0^{***}$	[3] $r=0^{***}$	[2] $r=0^{***}$	[3] $r=0^{***}$	[2] $r=0$	[2] $r=0$	[3] $r=0^{***}$	[3] $r=0^{***}$	[2] $r=0$	[2] $r=0$	[2] $r=0$
T statistic	20.7296	19.9756	30.5784	17.1698	24.6577	25.8855	29.6830	30.2396	44.7508	22.1477	26.0682	39.1833	45.6901	48.0712
$\mathbf{x}_{\mathbf{it}}^{\mathbf{h}}$	[2] $r\leq 1$	[3] $r\leq 1$	[2] $r\leq 1^{***}$	[3] $r\leq 1$	[3] $r\leq 1^{**}$	[2] $r\leq 1^{**}$	[3] $r\leq 1$	[2] $r\leq 1^{***}$	[2] $r\leq 1^{***}$	[3] $r\leq 1$	[3] $r\leq 1^{**}$	[2] $r\leq 1^{***}$	[2] $r\leq 1$	[2] $r\leq 1$
T statistic	3.6037	3.5828	10.5664	5.2088	9.9882	8.0949	15.0659	9.5949	10.8720	9.8171	10.4651	14.6328	23.8228	17.9538
Maximum eigenvalue statistic suggested by Johansen (1996)														
$\mathbf{X}_{\mathbf{it}}^{\mathbf{H}}$	[2] $r=0^{***}$	[3] $r=0^{***}$	[2] $r=0^{***}$	[3] $r=0^{***}$	[3] $r=0^{***}$	[2] $r=0^{***}$	[3] $r=0^{***}$	[2] $r=0$	[2] $r=0$	[2] $r=0$	[3] $r=0^{***}$	[2] $r=0$	[2] $r=0^{***}$	[2] $r=0$
T statistic	15.2827	15.7918	18.9098	12.7064	14.6602	18.1490	13.8182	25.2933	31.2032	65.4546	15.9657	26.6896	18.4158	28.5435
$\mathbf{X}_{\mathbf{it}}^{\mathbf{H}}$	[2] $r=1$	[3] $r=1$	[2] $r=1^{**}$	[3] $r=1$	[3] $r=1$	[2] $r=1^{**}$	[3] $r=1$	[2] $r=1^{***}$	[2] $r=1^{***}$	[2] $r=1^{***}$	[3] $r=1$	[2] $r=1^{***}$	[2] $r=1^{**}$	[2] $r=1^{***}$
T statistic	3.5294	2.7992	8.7893	5.2348	8.4576	7.3329	8.6190	8.0437	9.7877	6.2391	6.9224	10.3156	9.5495	13.0444
$\mathbf{x}_{\mathbf{it}}^{\mathbf{h}}$	[2] $r=0^{***}$	[3] $r=0^{***}$	[2] $r=0^{***}$	[3] $r=0^{***}$	[3] $r=0^{***}$	[2] $r=0^{***}$	[3] $r=0^{***}$	[2] $r=0^{***}$	[2] $r=0$	[3] $r=0^{***}$	[3] $r=0^{***}$	[2] $r=0$	[2] $r=0$	[2] $r=0$
T statistic	17.1260	16.3928	20.0119	11.9610	14.6695	17.7906	14.6172	20.6447	33.8789	12.3306	15.6031	24.5506	21.8673	30.1175
$\mathbf{x}_{\mathbf{it}}^{\mathbf{h}}$	[2] $r=1$	[3] $r=1$	[2] $r=1^{**}$	[3] $r=1$	[3] $r=1$	[2] $r=1$	[3] $r=1$	[2] $r=1^{**}$	[2] $r=1^{***}$	[3] $r=1$	[3] $r=1$	[2] $r=1^{***}$	[2] $r=1$	[2] $r=1^{***}$
T statistic	3.3255	3.0429	10.4123	5.1556	9.9819	7.8035	10.4303	7.9532	10.1305	8.8138	6.8219	10.1266	19.2397	14.9665

Notes: The table reports T statistics and the cointegration properties of the components of $\mathbf{X}_{\mathbf{it}}^{\mathbf{H}}$ and $\mathbf{x}_{\mathbf{it}}^{\mathbf{h}}$ based on the full sample period. The respective one percent (***), five percent (**) and ten percent (*) conventional critical values of the EG-ADF test typically are -2.611, -1.950 and -1.610, and those based on the tables in MacKinnon (2010) are -2.597, -1.945 and -1.614. The respective one and five percent critical values related to the trace statistic of r=0 are 29.75 and 24.31. The respective one and five percent critical values related to the trace statistic of r=1 are 16.31 and 12.53. The respective one and five percent critical values related to the maximum eigenvalue statistic of r=0 are 22.99 and 17.89. The respective one and five percent critical values related to the maximum eigenvalue statistic of r=1 are 15.69 and 11.44. The cointegrating equations are assumed to be without a trend or constant. The optimal lag length is chosen based on the Luetkepohl (2005) version of the SBIC statistics and is shown in the squared parenthesis.

Canada, 0.321 in Denmark, 0.182 in Germany, 0.096 in Italy, 0.027 in Japan and 0.069 in the United States. This means consumption tends to be housing wealth inelastic in these countries. There are large cross-country differences in the housing wealth effect. Consumption is more responsive to housing wealth fluctuations in Denmark than in Canada, Germany, Italy, Japan and the United States. The value of $\widehat{\beta_i^h}$ is highest in Denmark at more than eleven times the value of $\widehat{\beta_i^h}$ in Japan where it is lowest. The loadings of $\widehat{\beta_i^H}$ are relatively small, but looking at hundreds or thousands of billion US dollar aggregate housing wealth, a one cent rise in consumption per US dollar housing wealth growth adds up. The estimated impact of an increase in aggregate housing wealth in 2011 by one percent on 2012 consumption is 326 million US dollars in Denmark or 0.14 percent of the 2012 Danish GDP, and is 1,561 million US dollars in Italy or 0.08 percent of the 2012 Italian GDP. These estimates are based on seasonally adjusted variables measured in 2010 US dollars and at fixed PPP.

The magnitude of the product of the value of $\widehat{\beta_i^h}$ and the median consumption-to-housing wealth ratio in Germany is similar to Hamburg et al. (2008) reporting a propensity to consume out of asset wealth of four cents to five cents per euro. The $\widehat{\beta_i^H}$ loading in the United States is close to the one predicted by Ludvigson and Steindel (1999) but lower than that estimated by Mian et al. (2013). I find that consumption, income and housing wealth are not cointegrated as defined by Engle and Granger (1987) in Australia, Belgium, Finland, France, Sweden, Switzerland, the Netherlands and the United Kingdom. Hence I challenge Tan and Voss (2003) and Corugedo et al. (2003), who propose cointegration among consumption and wealth in Australia and the United Kingdom, respectively. The absence of cointegration among consumption, income and housing wealth does not run counter to economic theory, but is serious inasmuch as it casts doubt on the general fit of Models 1 and 2. Rudd and Whelan (2006) suggest that structural breaks tend to cause cointegration to be rejected in data. Labhard et al. (2005) claim that the wealth effect might differ during episodes of rising and falling household wealth. Hendry (1986) argues that the absence of cointegration may be caused by the omission of a trending time series in the cointegrating equation. Errors associated with the compilation of data could hamper the validity of the predicted wealth effect. Using disaggregated data to study consumer behavior (Deaton, 1992) and in particular the housing wealth effect is desirable, but data limitations typically impede such analysis. Either explanation raises concerns regarding the design of the models capturing the housing wealth effect on consumption based on averaged household data.

Vector error correction model stability

Based on $\mathbf{X_{it}^H} \sim CI\,(1,1)$, I model $\mathbf{\Delta X_{it}^H}$ in Canada, Denmark, Italy and the United States using the VECM (1). Based on $\mathbf{x_{it}^h} \sim CI\,(1,1)$, I model $\mathbf{\Delta x_{it}^h}$ in Canada, Denmark, Germany, Italy, Japan and the United States engaging the VECM (2). I study VECM (1) (VECM (2)) stability and test whether the error correction term helps predict a component of $\mathbf{\Delta X_{it}^H}$ ($\mathbf{\Delta x_{it}^h}$). The results (Table (5)) suggest VECM (1) stability in Canada, Denmark, Italy and the United States as at least one component of $\widehat{\alpha_{\mathbf{i}}^{\mathbf{H}}}$ is statistically significant in the respective model. Statistical significance of at least one component of $\widehat{\alpha_{\mathbf{i}}^{\mathbf{h}}}$ (Table (6)) implies VECM (2) stability in Canada, Denmark, Germany, Italy and Japan. I check which components of $\mathbf{X_{it}^H}$ ($\mathbf{x_{it}^h}$) adjust to disequilibrium $\beta_{\mathbf{i}}^{\mathbf{H}'}\mathbf{X_{it}^H} \neq 0$ ($\beta_{\mathbf{i}}^{\mathbf{h}'}\mathbf{x_{it}^h} \neq 0$). Dissimilar speed-of-adjustment parameters in the country-specific VECM (1) (VECM (2)) are statistically significant. A comparison reveals cross-country heterogeneity in the components contributing to the error correction mechanisms.

Statistical significance of $\widehat{\alpha_i^C}$ ($\widehat{\alpha_i^c}$) reveals whether $\beta_{\mathbf{i}}^{\mathbf{H}'}\mathbf{X_{it}^H} \neq 0$ ($\beta_{\mathbf{i}}^{\mathbf{h}'}\mathbf{x_{it}^h} \neq 0$) can have an economic impact via amplified household consumption correction. Consumption contributes to the error correction mechanism in Denmark, Germany and Japan. The values of $\widehat{\alpha_i^C}$ ($\widehat{\alpha_i^c}$) have a negative sign. The absolute values of $\widehat{\alpha_i^C}$ ($\widehat{\alpha_i^c}$) are in the range of 0.091 in Denmark and 0.190 in Japan, implying that the respective adjustment to disequilibrium via this channel takes about eleven and five quarters. Housing wealth contributes to the error correction mechanism in Canada and Germany. The values of $\widehat{\alpha_i^H}$ ($\widehat{\alpha_i^h}$) have a positive sign. The adjustment to disequilibrium via this channel tends to take up to eight quarters. Income contributes to the error correction mechanism in Italy and the United States. The values $\widehat{\alpha_{10}^Y} = 0.054$ and $\widehat{\alpha_{14}^Y} = 0.225$ suggest that the respective adjustment to disequilibrium via this channel takes 19 and five quarters.

The findings above are in line with Lettau and Ludvigson (2001) inasmuch as consumption does not contribute to the error correction mechanism in the United States. The results are in contrast to Ludvigson and Steindel (1999) and Lettau and Ludvigson (2001) in showing that asset wealth contributes to the error correction mechanism in the United States. Hamburg et al. (2008) report that income mainly contributes to the error correction mechanism in Germany. Due to differences in the application of cointegration theory and data inconsistencies, the comparability of the findings regarding the components contributing to the error correction mechanisms may be limited.

Short-run housing wealth effect on consumption

I next assess the short-run interplay between consumption, income and housing wealth using level variables. If $\mathbf{X_{it}^H} \sim CI\,(1,1)$, I model $\mathbf{\Delta X_{it}^H}$ using the VECM (1). If $\mathbf{X_{it}^H} \nsim CI\,(1,1)$, I model $\mathbf{\Delta X_{it}^H}$ employing the VARM (7). To check whether transitory housing wealth and income changes Granger cause consumption growth, I perform a Granger causality test for the ΔC_{it} equation in the respective model. Table (8) displays the loadings of the components of $\widehat{\mathbf{\Gamma_{ij}^H}}, ..., \widehat{\mathbf{\Gamma_{ik}^H}}$ in the ΔC_{it} equation in the VECM (1) or VARM (7). I infer from the statistical insignificance of the estimated parameters on the lagged values of ΔY_{it} that transitory income changes tend not to be associated with consumption growth. Based on the statistical significance of the estimated coefficients on the lagged values of ΔH_{it}, I claim that transitory housing wealth changes tend to have useful predictive content above and beyond lagged values of ΔC_{it} and ΔY_{it} in the respective model. The joint effect on ΔC_{it} of lagged values of ΔH_{it} tends to be positive, and typically is statistically significant at the one percent significance level.

I perform Granger causality tests to verify whether lagged values of ΔH_{it} and ΔY_{it} contain information useful for predicting ΔC_{it} in each sample country. The test results are presented in Table (8). The F statistic testing the null hypothesis that the estimated coefficients on lagged values of ΔY_{it} are jointly zero has a p-value of more than 0.050 in each sample country. Thus the null hypothesis cannot be rejected at the five percent significance level. The result that transitory income changes tend to have no predictive power for consumption growth is in line with the permanent income hypothesis. The F statistic testing the null hypothesis that the estimated parameters on lagged values of ΔH_{it} are jointly zero has a p-value of less than 0.010 in each sample country; I conclude at the one percent significance level that lagged values of ΔH_{it} Granger cause ΔC_{it}. This means that past values of ΔH_{it} tend to contain information useful for predicting ΔC_{it} beyond that contained in lagged values of ΔC_{it} and ΔY_{it}.

Existing intertemporal consumption theory does not explain why transitory housing wealth changes affect consumption growth differently than transitory income changes. However, the findings in this study are in line with Tan and Voss (2003) in observing sensitivity of consumption to household net wealth components, and with Hall (1978) in showing that income has no predictive power for consumption, while stock price changes contain information useful for predicting consumption growth.

Table 8: Estimated short-run relationship between consumption, income and housing wealth

	AUS	BEL	CAN	CHE	DEU	DNK	FIN	FRA	GBR	ITA	JPN	NLD	SWE	USA
ΔC_{it} equation in the VARM (7) or the VECM (1)														
Dependent	ΔC_{1t}	ΔC_{2t}	ΔC_{3t}	ΔC_{4t}	ΔC_{5t}	ΔC_{6t}	ΔC_{7t}	ΔC_{8t}	ΔC_{9t}	ΔC_{10t}	ΔC_{11t}	ΔC_{12t}	ΔC_{13t}	ΔC_{14t}
$\beta_{\mathbf{i}}^{\mathbf{H}'}\mathbf{X}_{\mathbf{it-1}}^{\mathbf{H}}$			0.003			-0.096**				0.021				0.085
			(0.036)			(0.044)				(0.022)				(0.087)
ΔC_{it-1}	0.550***	1.078***	0.754***	0.592**	0.810***	0.544**	0.727***	0.316*	0.762***	1.009***	0.478*	0.558***	0.127	0.385
	(0.176)	(0.217)	(0.185)	(0.257)	(0.277)	(0.248)	(0.186)	(0.163)	(0.173)	(0.183)	(0.276)	(0.202)	(0.221)	(0.361)
ΔC_{it-2}	0.047	-0.444*	0.113	-0.114	-0.505*	-0.203	-0.275	0.213	-0.319*	-0.162	-0.010	0.240	0.545*	0.506
	(0.205)	(0.264)	(0.232)	(0.238)	(0.277)	(0.311)	(0.185)	(0.183)	(0.170)	(0.187)	(0.325)	(0.248)	(0.277)	(0.339)
ΔC_{it-3}	0.004	0.033	-0.078			0.035		-0.162			0.142	0.058	-0.080	
	(0.211)	(0.185)	(0.183)			(0.250)		(0.186)			(0.319)	(0.247)	(0.280)	
ΔC_{it-4}	-0.132							-0.190			-0.437	-0.144	-0.172	
	(0.166)							(0.151)			(0.266)	(0.200)	(0.210)	
ΔY_{it-1}	-0.050	-0.378**	-0.136	-0.003	-0.250	-0.192	-0.009	0.081	-0.164	-0.304*	0.228	0.084	0.236*	0.0452
	(0.137)	(0.168)	(0.166)	(0.228)	(0.234)	(0.193)	(0.155)	(0.116)	(0.130)	(0.169)	(0.280)	(0.136)	(0.129)	(0.280)
ΔY_{it-2}	0.050	0.258	-0.267	-0.011	0.370*	0.088	0.221*	-0.161	0.135	0.144	0.020	-0.092	-0.335*	-0.327
	(0.171)	(0.194)	(0.204)	(0.193)	(0.203)	(0.236)	(0.132)	(0.150)	(0.112)	(0.138)	(0.342)	(0.174)	(0.174)	(0.278)
ΔY_{it-3}	-0.166	-0.053	0.165			-0.042		-0.081			-0.147	-0.076	-0.053	
	(0.170)	(0.104)	(0.150)			(0.179)		(0.147)			(0.299)	(0.170)	(0.184)	
ΔY_{it-4}	0.125							0.127			0.278	0.053	0.103	
	(0.133)							(0.081)			(0.200)	(0.126)	(0.141)	
ΔH_{it-1}	0.209***	0.077***	0.210***	0.068***	0.223***	0.147***	0.258***	0.112***	0.014**	0.105***	0.351***	0.101***	0.168***	0.093***
	(0.025)	(0.0123)	(0.029)	(0.017)	(0.0207)	(0.018)	(0.017)	(0.015)	(0.006)	(0.010)	(0.027)	(0.019)	(0.017)	(0.020)
ΔH_{it-2}	-0.167***	-0.019	-0.176***	-0.049**	-0.124***	-0.098***	-0.216***	-0.060*	0.014	-0.072***	-0.295***	-0.071**	-0.103***	-0.055**
	(0.043)	(0.029)	(0.052)	(0.022)	(0.0390)	(0.033)	(0.031)	(0.035)	(0.008)	(0.022)	(0.079)	(0.031)	(0.034)	(0.025)
ΔH_{it-3}	-0.020	-0.016	0.033			0.028		0.001			-0.013	-0.025	-0.022	
	(0.049)	(0.027)	(0.043)			(0.029)		(0.041)			(0.094)	(0.033)	(0.037)	
ΔH_{it-4}	0.078**							0.047			0.067	0.024	0.055*	
	(0.038)							(0.037)			(0.069)	(0.024)	(0.029)	
Lags	4	3	3	2	2	3	2	4	2	2	4	4	4	2
Obs.	71	72	72	49	69	68	73	63	52	65	71	63	71	73
R-squared	0.697	0.689	0.741	0.507	0.730	0.640	0.798	0.776	0.750	0.814	0.801	0.618	0.772	0.596
Granger causality test														
Equation	ΔC_{1t}	ΔC_{2t}	ΔC_{3t}	ΔC_{4t}	ΔC_{5t}	ΔC_{6t}	ΔC_{7t}	ΔC_{8t}	ΔC_{9t}	ΔC_{10t}	ΔC_{11t}	ΔC_{12t}	ΔC_{13t}	ΔC_{14t}
ΔY_{it-j}	0.424	2.262*	2.121	0.005	1.688	0.480	2.051	1.126	0.921	1.728	0.835	0.270	1.592	0.957
ΔH_{it-j}	20.239***	17.039***	18.752***	8.268***	69.640***	23.714***	112.180***	17.723***	10.865***	63.530***	48.499***	7.874***	29.972***	16.041***

Notes: The table shows the estimated short-run relationship between consumption, income and housing wealth. Depending on the presence of cointegration, the table shows the values of the estimated coefficients on the components of $\Delta\mathbf{X}_{\mathbf{it-j}}^{\mathbf{H}}$ and the loading of the estimated coefficient on $\beta_{\mathbf{i}}^{\mathbf{H}'}\mathbf{X}_{\mathbf{it-1}}^{\mathbf{H}}$ in the ΔC_{it} equation in the VECM (1) or the values of the estimated coefficients on the components of $\Delta\mathbf{X}_{\mathbf{it-j}}^{\mathbf{H}}$ in the ΔC_{it} equation in the VARM (7). Small sample T statistics and F statistics are reported. Standard errors are in parentheses. A small sample degrees of freedom adjustment is used when estimating the cross equation error variance covariance matrix. Shown is statistical significance with *** $p<0.01$, ** $p<0.05$, * $p<0.1$. The Granger causality test results highlight the F statistic testing the null hypothesis that the estimated coefficients on lagged values related to income or housing wealth are jointly zero in the ΔC_{it} equation in the VARM (7) or the VECM (1). The results of the estimation of the unknown coefficients in the ΔY_{it} and ΔH_{it} equation in the VARM (7) or the VECM (1) are not of primary interest and are not reported for parsimony reasons but are available upon request.

Potential reasons for cross-country heterogeneity

To identify reasons for cross-country heterogeneity in the housing wealth effect on consumption, I calculate Bravais-Pearson correlation coefficients between data sets. The first set refers to the predicted housing wealth effect on consumption. The second set refers to factors associated with the housing market and the economy. Table (9) exhibits the key findings. Correlation between the values of $\widehat{\beta_i^H}$ and $\widehat{\beta_i^h}$ is positive and is almost equal to one. This is unsurprising given that the propensity to consume out of housing wealth is the product of the housing wealth elasticity of consumption and the consumption-to-housing wealth ratio. The housing wealth effect on consumption is negatively correlated with housing wealth volatility and income volatility. This implies that the housing wealth effect on consumption tends to be higher in countries where housing wealth volatility and income volatility are lower. These findings are in line with Zeldes (1989), Carroll and Kimball (1996) and ECB (2003).

Table 9: Bravais-Pearson correlation analysis

Measure		Bravais-Pearson correlation coefficient (1)	(2)	(3)
(1)	Long-run propensity to consume out of housing wealth	1.000		
(2)	Long-run housing wealth elasticity of consumption	0.973	1.000	
(3)	Short-run housing wealth effect on consumption	0.014	0.106	1.000
(4)	Long-run propensity to consume out of income	-0.524	-0.697	-0.393
(5)	Long-run income elasticity of consumption	-0.969	-0.991	-0.183
(6)	Housing wealth volatility	-0.505	-0.506	-0.810
(7)	Income volatility	-0.384	-0.507	-0.389
(8)	Income inequality	-0.521	-0.635	-0.648
(9)	Doing Business DTF score	0.684	0.600	0.237
(10)	Household indebtedness	0.797	0.719	0.325

Notes: The table presents Bravais-Pearson correlation coefficients. The correlation calculations only consider the countries with a consistently estimable long-run housing wealth effect on consumption. Housing wealth and income volatility are measured as the respective standard deviation of H_{it} and Y_{it}. The data underlying the calculations are sourced from the OECD, World Bank Group, statistical institutes and central banks.

A negative correlation between the GINI index level and the housing wealth effect on consumption implies that as income inequality rises, the housing wealth effect on consumption tends to fall. The correlation between the values of $\widehat{\beta_i^H}$ and $\widehat{\beta_i^y}$ is negative. This suggests that the housing wealth effect on consumption tends to be lower in countries where income elasticity of consumption is higher. The consumption function is concave in wealth (Carroll and Kimball, 1996). Mian et al. (2013) show heterogeneity in the propensity to consume out of housing wealth by household income and leverage. Compared with higher-income households, lower-income households tend to spend a larger portion of their income (Dynan et al., 2004). Knowledge about these concepts is critical when assessing the effect of a housing wealth shock on the economy, as the effect may depend not only on the magnitude of the shock, but also on the dispersion of the shock across households with different propensities to consume out of wealth.

Housing wealth fluctuations can affect household consumption by more than the conventional housing wealth effect if the financial accelerator is operational (e.g., Bernanke and Gertler, 1989, 1995; Bernanke et al., 1996). Davey (2001) assumes that the ability to withdraw housing equity promotes household consumption. ECB (2003) supposes that financial deregulation and innovation strengthen the housing wealth effect on consumption. Mian et al. (2013) presume that higher indebted households have a larger marginal propensity to consume out of housing wealth. King (1994) highlights that the marginal propensity to consume out of wealth may be higher for credit-constrained households. Understanding of the implications of heterogeneity in finance and business conditions for the housing wealth effect, and thus for aggregate consumption and the economy, is important. Consequently I next analyze the correlation between the housing wealth effect and finance conditions as well as business conditions.

I investigate the correlation between the housing wealth effect and household indebtedness, which is measured as the median D_{it}-to-Y_{it} ratio. I also study the Bravais-Pearson correlation coefficient between the housing wealth effect and business conditions, which are measured by the World Bank Doing Business distance to frontier (DTF) score. This correlation analysis reveals that the long-run housing wealth effect on consumption tends to be higher in countries with the following characteristics: (i) fewer steps, time and costs are involved in registering property; (ii) more standardized property purchase processes are in place; (iii) the existing insolvency law is stronger and there are fewer procedural and administrative bottlenecks in the insolvency process; and (iv) lending activities are facilitated by superior credit reporting systems and efficient collateral and bankruptcy laws. The findings above indicate points of action aimed at controlling the housing wealth effect on consumption.

6 Conclusion

In this study I investigate the long-run and short-run interplay between consumption, income and housing wealth by applying VECMs and VARMs and employing OLS and

DOLS methods. By using level and log-level variables, it becomes feasible to draw conclusions about the propensity to consume out of housing wealth and the housing wealth elasticity of consumption. I show that level measures of consumption, income and housing wealth are cointegrated as defined by Engle and Granger (1987) in Canada, Denmark, Italy and the United States. I find a consistently estimable long-run propensity to consume out of housing wealth in the range of nine cents per US dollar in Denmark and two cents per US dollar in Italy. Cointegration among the log-level measures of consumption, income and housing wealth is present in Canada, Denmark, Germany, Italy, Japan and the United States. I conclude that the consistently estimable housing wealth elasticity of consumption is in the range of 0.027 in Japan and 0.321 in Denmark. A correlation analysis allows a tentative identification of factors associated with cross-country differences in the housing wealth effect on consumption: heterogeneity tends to be related to factors such as income elasticity of consumption, income and housing wealth volatility, access to credit, income inequality and business conditions. The correlation analysis indicates points of action aimed at controlling the housing wealth effect on consumption.

Cointegration among consumption, income and housing wealth is absent in Australian, Belgian, Dutch, Finnish, French, Swedish, Swiss and United Kingdom data. This implies that the long-run housing wealth effect on consumption is not consistently estimable in such countries. The absence of cointegration among consumption, income and housing wealth does not run counter to economic theory, but is serious as it casts doubt on the general fit of the applied VECMs. Structural breaks and the omission of a trending time series in the cointegrating equation tend to cause cointegration to be rejected in data. If cointegration is present, I check VECM stability and test whether deviations of consumption, income and housing wealth from the common stochastic trend have macroeconomic implications via amplified consumption correction. A comparison of the components contributing to the error correction mechanism reveals cross-country heterogeneity. I find that consumption contributes to the error correction mechanism in Denmark, Germany and Japan. The adjustment to disequilibrium through this channel can take up to eleven quarters. If cointegration is present I use the VECM, and if cointegration is absent I employ the VARM, to examine the short-run interplay between consumption, income and housing wealth. I discover that transitory income moves do not Granger cause consumption growth, while transitory housing wealth changes contain information useful for predicting consumption growth in each sample country.

References

Almeida, H., Campello, M., and Liu, C. (2006). The financial accelerator: evidence from international housing markets. *Review of Finance*, 10(3):321–352.

Altissimo, F., Georgiou, E., Sastre, T., Valderrama, M. T., Sterne, G., Stocker, M., Weth, M. A., Whelan, K., and Willman, A. (2005). Wealth and asset price effects on economic activity. Occasional Paper 29, European Central Bank.

Ando, A. and Modigliani, F. (1963). The life cycle hypothesis of saving: aggregate implications and tests. *American Economic Review*, 53(1):55–84.

Aoki, K., Proudman, J., and Vlieghe, G. (2004). House prices, consumption, and monetary policy: a financial accelerator approach. *Journal of Financial Intermediation*, 13(4):414–435.

Aron, J. and Muellbauer, J. (2013). Wealth, credit conditions, and consumption: evidence from South Africa. *Review of Income and Wealth*, 59(S1):S161–S196.

Arrow, K. J. (1964). The role of securities in the optimal allocation of risk-bearing. *Review of Economic Studies*, 31(2):91–96.

Babeau, A. and Sbano, T. (2003). Household wealth in the national accounts of Europe, the United States and Japan. Statistics Working Paper 2003/02, Organisation for Economic Co-operation and Development.

Barrell, R. and Davis, E. P. (2007). Financial liberalisation, consumption and wealth effects in seven OECD countries. *Scottish Journal of Political Economy*, 54(2):254–267.

Bayoumi, T. and Edison, H. (2003). Is wealth increasingly driving consumption? Staff Reports 101, De Nederlandsche Bank.

Benito, A., Thompson, J. N. R., Waldron, M., and Wood, R. (2006). House prices and consumer spending. Quarterly Bulletin Summer 2006, Bank of England.

Bernanke, B. and Gertler, M. (1989). Agency costs, net worth, and business fluctuations. *American Economic Review*, 79(1):14–31.

Bernanke, B. and Gertler, M. (1995). Inside the black box: the credit channel of monetary policy transmission. *Journal of Economic Perspectives*, 9(4):27–48.

Bernanke, B., Gertler, M., and Gilchrist, S. (1996). The financial accelerator and the flight to quality. *Review of Economics and Statistics*, 78(1):1–15.

Bertaut, C. C. (2002). Equity prices, household wealth, and consumption growth in foreign industrial countries: wealth effects in the 1990s. International Finance Discussion Paper 724, Board of Governors of the Federal Reserve System.

Bhatia, K. B. (1987). Real estate assets and consumer spending. *Quarterly Journal of Economics*, 102(2):437–444.

Blanchard, O. J. (1985). Debt, deficits, and finite horizons. *Journal of Political Economy*, 93(2):223–247.

Blinder, A. S., Deaton, A., Hall, R. E., and Hubbard, R. G. (1985). The time series consumption function revisited. *Brookings Papers on Economic Activity*, 1985(2):465–521.

Boone, L., Giorno, C., and Richardson, P. (1998). Stock market fluctuations and consumption behaviour: some recent evidence. Economics Department Working Paper 208, Organisation for Economic Co-operation and Development.

Boone, L., Girouard, N., and Wanner, I. (2001). Financial market liberalisation, wealth and consumption. Economics Department Working Paper 308, Organisation for Economic Co-operation and Development.

Buiter, W. H. (2010). Housing wealth isnt wealth. *Economics: The Open-Access, Open-Assessment E-Journal*, 4(2010-22).

Byrne, J. P. and Davis, E. P. (2003). Disaggregate wealth and aggregate consumption: an investigation of empirical relationships for the G7. *Oxford Bulletin of Economics and Statistics*, 65(2):197–220.

Campbell, J. Y. and Cocco, J. F. (2007). How do house prices affect consumption? Evidence from micro data. *Journal of Monetary Economics*, 54(3):591–621.

Campbell, J. Y. and Mankiw, N. G. (1989). Consumption, income and interest rates: reinterpreting the time series evidence. In Blanchard, O. J. and Fischer, S., editors, *NBER Macroeconomics Annual*, volume 4, pages 185–246. MIT Press.

Campbell, J. Y. and Mankiw, N. G. (1991). The response of consumption to income: a cross-country investigation. *European Economic Review*, 35(4):723–756.

Campbell, J. Y. and Viceira, L. M. (1999). Consumption and portfolio decisions when expected returns are time varying. *Quarterly Journal of Economics*, 114(2):433–495.

Cardarelli, R., Monacelli, T., Rebucci, A., and Sala, L. (2008). The changing housing cycle and the implications for monetary policy. World Economic Outlook, Chapter 3, International Monetary Fund.

Carroll, C. D. and Kimball, M. S. (1996). On the concavity of the consumption function. *Econometrica*, 64(4):981–992.

Carroll, C. D., Otsuka, M., and Slacalek, J. (2011). How large are housing and financial wealth effects? A new approach. *Journal of Money, Credit and Banking*, 43(1):55–79.

Case, K. E., Quigley, J. M., and Shiller, R. J. (2005). Comparing wealth effects: the stock market versus the housing market. *Advances in Macroeconomics*, 5(1):1–32.

Catte, P., Girouard, N., Price, R. W., and Andre, C. (2004). Housing markets, wealth and the business cycle. Economics Department Working Paper 394, Organisation for Economic Co-operation and Development.

Claessens, S., Kose, M. A., and Terrones, M. E. (2012). How do business and financial cycles interact? *Journal of International Economics*, 87(1):178–190.

Constantinides, G. M. (1990). Habit formation: a resolution of the equity premium puzzle. *Journal of Political Economy*, 98(3):519–543.

Corugedo, E. F., Price, S., and Blake, A. P. (2003). The dynamics of consumers expenditure: the UK consumption ECM redux. Working Paper 204, Bank of England.

Davey, M. (2001). Mortgage equity withdrawal and consumption. Quarterly Bulletin Spring 2001, Bank of England.

Davis, M. A. and Palumbo, M. G. (2001). A primer on the economics and time series econometrics of wealth effects. Finance and Economics Discussion Serie 9, Board of Governors of the Federal Reserve System.

Deaton, A. (1992). *Understanding consumption*. Oxford University Press, Oxford.

Dickey, D. A. and Fuller, W. A. (1981). Likelihood ratio statistics for autoregressive time series with a unit root. *Econometrica*, 49(4):1057–1072.

Donihue, M. and Avramenko, A. (2006). Decomposing consumer wealth effects: evidence on the role of real estate assets following the wealth cycle of 1990-2002. Working Paper 06-15, Federal Reserve Bank of Boston.

Dynan, K. E., Skinner, J., and Zeldes, S. P. (2004). Do the rich save more? *Journal of Political Economy*, 112(2):397–444.

ECB (2003). Structural factors in the EU housing markets. Report, Task Force on Housing of the Monetary Policy Committee of the European System of Central Banks, European Central Bank.

Edison, H. and Slok, T. (2002). Stock market wealth effects and the new economy: a cross-country study. *International Finance*, 5(1):1–22.

Elliot, J. W. (1980). Wealth and wealth proxies in a permanent income model. *Quarterly Journal of Economics*, 95(3):509–535.

Elliott, G., Rothenberg, T. J., and Stock, J. H. (1996). Efficient tests for an autoregressive unit root. *Econometrica*, 64(4):813–836.

Engle, R. F. and Granger, C. W. J. (1987). Co-integration and error correction: representation, estimation, and testing. *Econometrica*, 55(2):251–276.

Flavin, M. A. (1981). The adjustment of consumption to changing expectations about future income. *Journal of Political Economy*, 89(5):974–1009.

Friedman, M. (1957). The permanent income hypothesis. In *A theory of the consumption function*, pages 20–37. Princeton University Press.

Fuller, W. A. (1996). *Introduction to statistical time series*. Wiley-Interscience Publication, 2 edition.

Granger, C. W. J. and Newbold, P. (1974). Spurious regressions in econometrics. *Journal of Econometrics*, 2(2):111–120.

Grant, C. and Peltonen, T. A. (2008). Housing and equity wealth effects of Italian households. Working Paper 857, European Central Bank.

Guiso, L., Paiella, M., and Visco, I. (2005). Do capital gains affect consumption? Estimates of wealth effects from Italian households behavior. Temi di discussione 555, Bank of Italy.

Hall, R. E. (1978). Stochastic implications of the life cycle-permanent income hypothesis: theory and evidence. *Journal of Political Economy*, 86(6):971–987.

Hall, R. E. (1988). Intertemporal substitution in consumption. *Journal of Political Economy*, 96(2):339–357.

Hamburg, B., Hoffmann, M., and Keller, J. (2008). Consumption, wealth and business cycles in Germany. *Empirical Economics*, 34(3):451–476.

Hansen, B. E. (1992). Efficient estimation and testing of cointegrating vectors in the presence of deterministic trends. *Journal of Econometrics*, 53(1-3):87–121.

Hendry, D. F. (1986). Econometric modelling with cointegrated variables: an overview. *Oxford Bulletin of Economics and Statistics*, 48(3):201–212.

Hoch, S. J. and Loewenstein, G. F. (1991). Time-inconsistent preferences and consumer self-control. *Journal of Consumer Research*, 17(4):492–507.

Horioka, C. Y. (1996). Capital gains in Japan: their magnitude and impact on consumption. *Economic Journal*, 106(436):560–577.

Iacoviello, M. (2005). House prices, borrowing constraints, and monetary policy in the business cycle. *American Economic Review*, 95(3):739–764.

Iacoviello, M. (2011). Housing wealth and consumption. International Finance Discussion Paper 1027, Board of Governors of the Federal Reserve System.

Iacoviello, M. and Neri, S. (2010). Housing market spillovers: evidence from an estimated DSGE model. *American Economic Journal. Macroeconomics*, 2(2):125–164.

Johansen, S. (1988). Statistical analysis of cointegration vectors. *Journal of Economic Dynamics and Control*, 12(2-3):231–254.

Johansen, S. (1996). *Likelihood-based inference in cointegrated vector autoregressive models*. Oxford University Press, Oxford, 2 edition.

Keynes, J. M. (1936). *The general theory of employment, interest, and money*. Macmillan, London.

Kimball, M. S. (1990). Precautionary saving in the small and in the large. *Econometrica*, 58(1):53–74.

Kimball, M. S. and Weil, P. (2009). Precautionary saving and consumption smoothing across time and possibilities. *Journal of Money, Credit and Banking*, 41(2/3):245–284.

King, M. (1994). Debt deflation: Theory and evidence. *European Economic Review*, 38(3-4):419–445.

Kwiatkowski, D., Phillips, P. C. B., Schmidt, P., and Shin, Y. (1992). Testing the null hypothesis of stationarity against the alternative of a unit root: how sure are we that economic time series have a unit root? *Journal of Econometrics*, 54(1-3):159–178.

Labhard, V., Sterne, G., and Young, C. (2005). Wealth and consumption: an assessment of the international evidence. Working Paper 275, Bank of England.

Leland, H. E. (1968). Saving and uncertainty: the precautionary demand for saving. *Quarterly Journal of Economics*, 82(3):465–473.

Lettau, M. and Ludvigson, S. C. (2001). Consumption, aggregate wealth, and expected stock returns. *Journal of Finance*, 56(3):815–849.

Lettau, M. and Ludvigson, S. C. (2004). Understanding trend and cycle in asset values: reevaluating the wealth effect on consumption. *American Economic Review*, 94(1):276–299.

Ludvigson, S. C. and Steindel, C. (1999). How important is the stock market effect on consumption? Economic Policy Review 07-99, Federal Reserve Bank of New York.

Ludwig, A. and Slok, T. (2004). The relationship between stock prices, house prices and consumption in OECD countries. *Topics in Macroeconomics*, 4(1):1–26.

Luetkepohl, H. (2005). *New introduction to multiple time series analysis*. Springer Science and Business Media.

MacKinnon, J. G. (2010). Critical values for cointegration tests. Working Paper 1227, Queen's University, Department of Economics.

Macklem, R. T. (1997). Aggregate wealth in Canada. *Canadian Journal of Economics*, 30(1):152–168.

Maki, D. M. and Palumbo, M. G. (2001). Disentangling the wealth effect: a cohort analysis of household saving in the 1990s. Finance and Economics Discussion Serie 21, Board of Governors of the Federal Reserve System.

Mehra, Y. P. (2001). The wealth effect in empirical life-cycle aggregate consumption equations. Economic Quarterly 87(2), Federal Reserve Bank of Richmond.

Mian, A., Rao, K., and Sufi, A. (2013). Household balance sheets, consumption, and the economic slump. *Quarterly Journal of Economics*, 128(4):1687–1726.

Modigliani, F. (1971). Monetary policy and consumption: linkages via interest rate and wealth effects in the FMP model. In *Consumer spending and monetary policy: the linkages*, volume 5, pages 9–84, Nantucket Island, MA. Federal Reserve Bank of Boston.

Modigliani, F. and Brumberg, R. (1954). Utility analysis and the consumption function. In Kurihara, K. K., editor, *Post-Kenesian economics*, pages 388–436. Rutgers University Press, New Brunswick, NJ.

Muellbauer, J. (2007). Housing, credit, and consumer expenditure. Jackson Hole Symposium, Housing, Housing Finance and Monetary Policy, Federal Reserve Bank of Kansas City.

Newey, W. K. and West, K. D. (1987). A simple, positive semi-definite, heteroskedasticity and autocorrelation consistent covariance matrix. *Econometrica*, 55(3):703–708.

Norman, B., Barriel, M., and Weeken, O. (2005). Equity wealth and consumption - the experience of Germany, France and Italy in an international context. Quarterly Bulletin Spring 2002, Bank of England.

Ogawa, K., Kitasaka, S.-i., Yamaoka, H., and Iwata, Y. (1996). An empirical re-evaluation of wealth effect in Japanese household behavior. *Japan and the World Economy*, 8(4):423–442.

Osterwald-Lenum, M. (1992). A note with quantiles of the asymptotic distribution of the maximum likelihood cointegration rank test statistics. *Oxford Bulletin of Economics and Statistics*, 54(3):461–472.

Paiella, M. (2007). Does wealth affect consumption? Evidence for Italy. *Journal of Macroeconomics*, 29(1):189–205.

Palumbo, M., Rudd, J., and Whelan, K. (2006). On the relationships between real consumption, income, and wealth. *Journal of Business and Economic Statistics*, 24(1):1–11.

Poterba, J. M. (2000). Stock market wealth and consumption. *Journal of Economic Perspectives*, 14(2):99–118.

Poterba, J. M., Samwick, A. A., Shleifer, A., and Shiller, R. J. (1995). Stock ownership patterns, stock market fluctuations, and consumption. *Brookings Papers on Economic Activity*, 1995(2):295–372.

Pratt, J. W. (1964). Risk aversion in the small and in the large. *Econometrica*, 32(1/2):122–136.

Rudd, J. and Whelan, K. (2006). Empirical proxies for the consumption-wealth ratio. *Review of Economic Dynamics*, 9(1):34–51.

Shefrin, H. M. and Thaler, R. H. (1988). The behavioral life-cycle hypothesis. *Economic Inquiry*, 26(4):609–643.

Skudelny, F. (2009). Euro area private consumption: is there a role for housing wealth effects? Working Paper 1057, European Central Bank.

Slacalek, J. (2009). What drives personal consumption? The role of housing and financial wealth. *B.E. Journal of Macroeconomics*, 9(1):1–35.

Sousa, R. M. (2009). Wealth effects on consumption - evidence from the euro area. Working Paper 1050, European Central Bank.

Stock, J. H. (1987). Asymptotic properties of least squares estimators of cointegrating vectors. *Econometrica*, 55(5):1035–1056.

Stock, J. H. and Watson, M. W. (1993). A simple estimator of cointegrating vectors in higher order integrated systems. *Econometrica*, 61(4):783–820.

Stock, J. H. and Watson, M. W. (2011). *Introduction to econometrics*. Addison-Wesley Longman, Amsterdam, 3rd international edition.

Sundaresan, S. M. (1989). Intertemporally dependent preferences and the volatility of consumption and wealth. *Review of Financial Studies*, 2(1):73–89.

Tan, A. and Voss, G. (2003). Consumption and wealth in Australia. *Economic Record*, 79(244):39–56.

Thaler, R. H. (1994). Psychology and savings policies. *American Economic Review*, 84(2):186–192.

Zeldes, S. P. (1989). Optimal consumption with stochastic income: deviations from certainty equivalence. *Quarterly Journal of Economics*, 104(2):275–298.