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Are Stock and Housing Returns Complements or Substitutes? Evidence from OECD Countries

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Abstract

In this paper we use a representative consumer model to analyse the equilibrium relation between the transitory deviations from the common trend among consumption, aggregate wealth, and labour income, *cay*, and focus on the implications for both stock returns and housing returns. The evidence based on data for 15 OECD countries shows that when agents expect future stock returns to be higher, they will temporarily allow consumption to rise. Regarding housing returns, if housing assets are seen as complements to stocks, then investors react in the same way, but if they are instead treated as substitutes consumption will be temporarily reduced.

JEL classification: E21, E44, D12.
Keywords: consumption, wealth, stock returns, housing returns, OECD countries

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1. Introduction

The risk premium is generally interpreted as reflecting the ability of an asset to insure against consumption fluctuations. The empirical evidence has, however, shown that the covariance of returns across portfolios and contemporaneous consumption growth is not sufficient to justify the differences in expected returns. Possible reasons mentioned in the literature on asset pricing are market inefficiencies (Fama, 1998; Fama and French, 1996), the rational response of agents to time-varying investment opportunities that is driven by changes in risk aversion (Constantinides, 1990) and in the joint distribution of consumption and asset returns (Duffee, 2005), and different types of economic behaviour. Such factors might also explain why expected excess asset returns appear to vary with the business cycle.

Different variables have been considered to capture time-variation in expected returns and long-term predictability. Lettau and Ludvigson (2001) show that the transitory deviation from the common trend in consumption, aggregate wealth and labour income is a strong predictor of stock returns, as long as expected returns to human capital and consumption growth are not too volatile. Bansal and Yaron (2004) find that the long-run risk, that is, the exposure of assets' cash flows to consumption, is an important determinant of the risk premium. Lustig and Van Nieuwerburgh (2005) show that the housing collateral ratio can shift the conditional distribution of asset prices and consumption growth. Yogo (2006) and Piazzesi et al. (2007) stress the importance of non-separability of preferences in explaining the countercyclical variation in equity premium. Whelan (2008) highlights the role of the ratio of excess consumption (i.e. consumption in excess of labour income) to observable assets, and Sousa (2010) shows that the wealth composition risk is an important driver of the risk premium.

Only a few studies have instead tried to explain the factors behind housing premia. Sousa (2010) shows that financial wealth shocks are mainly transitory, whilst fluctuations in housing wealth are very persistent; therefore, the composition of wealth has implications for the predictability of asset returns. De Veirman and Dunstan (2008) and Fisher et al. (2010) apply the approach developed by Lettau and Ludvigson (2001) to New Zealand and Australia respectively, and find a higher elasticity of consumption to permanent housing wealth changes than to permanent financial wealth changes.

The current paper argues that wealth and macroeconomic data can be combined to address the issue of predictability of asset returns. More specifically, we follow Caporale and Sousa (2011) in focusing on the equilibrium relation between the transitory deviation from the common trend in consumption, aggregate wealth and labour income, labelled as *cay*, and stock returns as well as housing returns.

These common trends summarise agent's long-term expectations of stock returns, housing returns and/or consumption growth: when forward-looking investors expect future stock returns to be higher, they will allow consumption to rise above its common trend with aggregate wealth and labour income. In this way, as in Lettau and Ludvigson (2001) and Sousa (2010), investors insulate future consumption from fluctuations in stock returns. Concerning housing returns, if they are seen as complementary to financial assets, then investors increase consumption above its equilibrium relationship with aggregate wealth and labour income when they expect higher housing returns, whilst consumption is reduced below its equilibrium level if housing assets are considered substitutes for financial assets.

Using data for 15 OECD countries, we show that *cay* is statistically significant for a large number of countries and the point estimate of the coefficient is large in magnitude. Moreover, it predicts an important fraction of the variation in future real returns, especially at long horizons. In fact, cay_t explains 6% (Italy), 7% (Finland), 8% (Denmark), 11% (Australia), 14% (Japan), 23% (UK), 25% (Belgium), 49% (Canada) and 56% (Spain) of the real housing return over the next eight quarters. In contrast, its forecasting power is poor for countries such as France, Germany, Ireland and the US.

The empirical findings also suggest that in Belgium, Canada, Denmark, Finland, Ireland, Italy, Japan, Spain, Sweden, the UK and the US agents allow consumption to rise above its equilibrium relationship with asset wealth and labour income when they expect housing returns to increase in the future, that is, financial and housing assets are complements, whilst in France, Germany and the Netherlands they appear to be substitutes (Caporale and Sousa, 2011, also find mixed evidence in the case of emerging countries).

Finally, assessing the robustness of our results, we show that: (i) additional control variables do not change the predictive power of *cay*; and (ii) models that include *cay* perform better than other benchmark models. We also find that, in some countries, agents seem to have a myopic behaviour and suffer from money illusion, while in other countries they appear to use housing assets as a hedge against the inflation risk.

The paper is organised as follows. Section 2 describes the theoretical framework and presents the empirical methodology. Section 3 provides the estimation results of the forecasting regressions for real and excess housing returns. Section 4 focuses on the robustness analysis. Section 5 concludes.

2. Theory and Empirics

2.1 Theoretical framework

Let us assume a representative consumer whose intertemporal budget constraint can be expressed as

$$W_{t+1} = (1 + R_{w,t+1})(W_t - C_t), \tag{1}$$

where W_t represents aggregate wealth, C_t denotes private consumption, and $R_{w,t+1}$ corresponds to the return on aggregate wealth between period *t* and *t+1.*

Under the assumption that the consumption-aggregate wealth ratio is stationary and that $\lim_{i\to\infty} \rho_w{}^i (c_{t+i} - w_{t+i}) = 0,$ Campbell and Mankiw (1989) use the following Taylor expansion approximation of equation (1)

$$c_t - w_t = \sum_{i=1}^{\infty} \rho_w^i r_{w,t+i} - \sum_{i=1}^{\infty} \rho_w^i \Delta c_{t+i} + k_w, \tag{2}$$

where $c \equiv logC$, $w \equiv logW$, and k_w is a constant. According to equation (2), deviations of consumption from its equilibrium relationship with aggregate wealth reflect changes in the returns on aggregate wealth or in consumption growth.

Similarly, the aggregate return on wealth can be decomposed as

$$R_{w,t+1} = \omega_t R_{a,t+1} + (1 - \omega_t) R_{h,t+1}, \tag{3}$$

where ω_t is a time varying coefficient and $R_{a,t+1}$ is the return on asset wealth, and Campbell (1996) uses the following approximation of equation (3)

$$r_{w,t} = \omega_t r_{a,t} + (1 - \omega_t) r_{h,t} + k_r, \tag{4}$$

where k_r is a constant, and $r_{w,t}$ is the log return on asset wealth. Following Campbell (1996) and assuming, as in Lettau and Ludvigson (2001) and Sousa (2010), that human wealth can be described well by labour income, y_t (i.e., $h_t = y_t + k_h$, where k_h is a constant), the log aggregate wealth can be approximated as

$$w_t = \omega a_t + (1 - \omega) h_t + k_a \approx \omega a_t + (1 - \omega) y_t + k_y, \tag{5}$$

where a_t is the log asset wealth, h_t is the log human wealth, ω is the mean of ω_t, and k_a and $k_y = (1 - \omega) k_h + k_a$ are constants.

Using equation (4) and (5) to substitute in (2), one obtains

$$c_t - \omega a_t - (1 - \omega) y_t = \sum_{i=1}^{\infty} \rho_w^i r_{a,t+i} - \sum_{i=1}^{\infty} \rho_w^i \Delta c_{t+i} + \eta_t + k, \tag{6}$$

where $\eta_t \equiv (1 - \omega) z_t$ is a stationary component, and *k* is a constant. If we take time *t* conditional expectation of both sides of equation (6), we obtain

$$\underbrace{c_t - \omega a_t - (1-\omega) y_t}_{cay_t} = E_t \sum_{i=1}^{\infty} \rho_w^i r_{\mathrm{a,t+i}} - E_t \sum_{i=1}^{\infty} \rho_w^i \Delta \mathrm{c}_{\mathrm{t+i}} + \eta_t + k. \qquad (7)$$

Therefore, agents will increase consumption if they expect higher future stock returns. The same holds for housing returns if the two types of assets are seen as complementary, whilst consumption is reduced if they are treated as substitutes. The crucial issue is the degree of separability between financial and housing assets: when they are separable, financial and housing assets are substitutes, and transitory movements in agents' asset wealth reflecting time variation in expected returns can be smoothed out; if instead they are non-separable, financial and housing assets are complements, and adjustments in response to exogenous shocks cannot be made. Consequently, the sign of the coefficients on *cay* in the forecasting regressions for stock and housing returns contains very useful information.

2.2. Empirical Methodology

We use quarterly data, post-1960, for 15 countries (Australia, Belgium, Canada, Denmark, Finland, France, Germany, Ireland, Italy, Japan, the Netherlands, Spain, Sweden, the UK, the US).

The consumption series are private consumption expenditure from the database of the NiGEM model of NIESR, the Main Economic Indicators of the OECD and DRI International. The labour income data correspond to the compensation series of the NIESR. In the case of the US, the labour income series was constructed following Lettau and Ludvigson (2001) and, for the UK, we follow Sousa (2010). The wealth data were taken from the national central banks or Eurostat. The housing return data were computed using the share price index and the price-rent ratio provided by the Bank for International Settlements (BIS). The population series were taken from the OECD's Main Economic Indicators and interpolated (from annual data), and all series were deflated with the GDP deflators and expressed in logs of per capita terms. The series were seasonally adjusted using the X-12 method where necessary.

As a preliminary step we test for unit roots in consumption, aggregate wealth and labour income using the Augmented Dickey-Fuller and the Phillips-Perron tests. These show that the three variables are integrated of order one. Then, we apply the Engle-Granger test for cointegration. Finally, following Stock and Watson (1993) we estimate the equation below with dynamic least squares (DOLS):

$$c_t = \mu + \beta_a a_t + \beta_y y_t + \sum_{i=-k}^{k} b_{a,i} \Delta a_{\mathrm{t-i}} + \sum_{i=-k}^{k} b_{y,i} \Delta y_{\mathrm{t-i}} + \varepsilon_t, \qquad (8)$$

where the parameters β_a and β_y represent the long-run elasticities of consumption with respect to asset wealth and labour income respectively, Δ denotes the first difference operator, μ is a constant, and ε_t is the error term.

Table 1 reports the quarterly nominal housing returns for each county. It shows that, over the sample period considered, they were largest in Ireland (6.85%), Spain (4.67%), UK (4.36%), Australia (4.08%) and Italy (4.00%). These figures are sizeable: they correspond to annual average nominal returns of 30.35%, 20.03%, 18.61%, 17.35% and 16.99%, respectively. As for Germany (1.39%) and Japan (1.64%), their quarterly nominal housing returns were the lowest of the sample, largely reflecting a much more stable pattern for housing prices in these countries.

Table 1 – Nominal housing returns.

	Mean	St. Dev.	Country	Mean	St. Dev.
Australia	4.08%	0.0227	Italy	4.00%	0.0463
Belgium	2.72%	0.0157	Japan	1.64%	0.0218
Canada	3.39%	0.0274	Netherlands	3.30%	0.0277
Denmark	2.91%	0.0263	Spain	4.67%	0.0266
Finland	3.08%	0.0306	Sweden	2.60%	0.0203
France	3.32%	0.0153	UK	4.36%	0.0268
Germany	1.39%	0.0094	US	2.80%	0.0090
Ireland	6.85%	0.0383			

Table 2 shows the estimates for the shared trend among consumption, asset wealth, and income, cay_t. It can be seen that, despite some heterogeneity, the long-run elasticities of consumption with respect to aggregate wealth and labour income imply roughly shares of one third and two thirds for asset wealth and human wealth, respectively. This is particularly true for Australia, Canada, Finland, France, Ireland, the UK and the US. Moreover, the disaggregation between asset wealth and labour income is statistically significant for all countries (with the exceptions of Finland and Italy).

Table 2 – The long-run relationship between consumption, aggregate wealth, and labour income, cay_t.

Australia	$cay_t := c_t - 0.35^{***}\, a_t - 0.54^{***} y_t$ (13.39) (8.03)	Italy	$cay_t := c_t + 0.02\, a_t - 1.49^{***}\, y_t$ (-0.20) (11.32)
Belgium	$cay_t := c_t - 0.16^{***}\, a_t - 0.56^{***}\, y_t$ (8.02) (13.01)	Japan	$cay_t := c_t - 0.08^{***}\, a_t - 0.89^{***}\, y_t$ (3.74) (25.99)
Canada	$cay_t := c_t - 0.36^{***}\, a_t - 0.56^{***}\, y_t$ (13.16) (10.82)	Netherlands	$cay_t := c_t - 0.17^{***}\, a_t - 0.53^{***}\, y_t$ (12.92) (10.30)
Denmark	$cay_t := c_t - 0.09^{***}\, a_t - 0.65^{***}\, y_t$ (6.12) (19.10)	Spain	$cay_t := c_t - 0.06^{*}\, a_t - 0.76^{***}\, y_t$ (1.67) (16.10)
Finland	$cay_t := c_t - 0.38^{***}\, a_t - 0.13\, y_t$ (6.88) (0.98)	Sweden	$cay_t := c_t + 0.13^{**}\, a_t - 1.12^{***}\, y_t$ (-2.45) (9.06)
France	$cay_t := c_t - 0.25^{***}\, a_t - 0.55^{***}\, y_t$ (16.95) (18.03)	UK	$cay_t := c_t - 0.32^{***}\, a_t - 0.66^{***}\, y_t$ (13.84) (12.84)
Germany	$cay_t := c_t - 0.13^{*}\, a_t - 1.16^{***}\, y_t$ (1.71) (35.01)	US	$cay_t := c_t - 0.28^{***}\, a_t - 0.79^{***}\, y_t$ (17.14) (35.75)
Ireland	$cay_t := c_t - 0.36^{***}\, a_t - 0.46^{***}\, y_t$ (9.17) (10.03)		

Notes: Newey-West (1987) corrected t-statistics appear in parenthesis. *, **, *** denote statistical significance at the 10, 5, and 1% level, respectively.

3. Results

3.1. Forecasting real housing returns

Equation (7) shows that transitory deviations from the long-run relationship among consumption, aggregate wealth and income, cay_t, mainly reflect agents' expectations of future changes in asset returns. We consider real housing returns (denoted by HR_t) for which quarterly data are available that should provide a good proxy for the non-human component of asset wealth.

Table 3 concerns the forecasting power of cay_t at different horizons. It reports estimates from OLS regressions of the H-period real housing return, $HR_{t+1} + \ldots + HR_{t+H}$, on the lag of cay_t.

Table 3 – Forecasting real housing returns.

	Forecast Horizon *H*						Forecast Horizon *H*				
	1	2	3	4	8		1	2	3	4	8
Australia	0.07	0.20*	0.33**	0.46***	0.85***	Italy	-0.01	-0.03	-0.01	0.07	0.68***
	(1.08)	(1.90)	(2.47)	(2.72)	(3.36)		(-0.24)	(-0.26)	(-0.04)	(0.36)	(3.17)
	[0.01]	[0.03]	[0.06]	[0.06]	[0.11]		[0.00]	[0.00]	[0.00]	[0.00]	[0.06]
Belgium	0.43***	0.90***	1.33***	1.85***	3.19***	Japan	0.50	0.91**	1.11***	1.22***	1.72***
	(2.97)	(4.50)	(4.83)	(5.60)	(6.13)		(1.43)	(2.14)	(2.63)	(5.55)	(4.43)
	[0.04]	[0.13]	[0.13]	[0.21]	[0.25]		[0.04]	[0.08]	[0.12]	[0.21]	[0.14]
Canada	0.35***	0.68***	1.01***	1.36***	2.69***	Netherlands	-0.28*	-0.49**	-0.59*	-0.66*	-0.39
	(4.06)	(4.94)	(6.08)	(7.17)	(10.38)		(-1.94)	(-2.07)	(-1.79)	(-1.64)	(-0.54)
	[0.14]	[0.20]	[0.26]	[0.32]	[0.49]		[0.04]	[0.04]	[0.03]	[0.02]	[0.00]
Denmark	0.16	0.41*	0.67**	0.91**	1.46***	Spain	0.80***	1.59***	2.39***	3.16***	5.32***
	(1.08)	(1.74)	(2.21)	(2.48)	(2.65)		(5.88)	(7.83)	(9.89)	(10.62)	(10.96)
	[0.02]	[0.05]	[0.07]	[0.08]	[0.08]		[0.33]	[0.46]	[0.54]	[0.58]	[0.56]
Finland	0.01	0.12	0.32	0.51**	1.28***	Sweden	0.31***	0.65***	0.86***	1.07***	2.08***
	(0.09)	(0.72)	(1.48)	(2.04)	(2.91)		(2.91)	(5.14)	(6.45)	(9.09)	(9.20)
	[0.00]	[0.01]	[0.02]	[0.03]	[0.07]		[0.07]	[0.20]	[0.23]	[0.30]	[0.37]
France	-0.05	-0.08	-0.10	-0.08	0.06	UK	0.26***	0.61***	1.00***	1.45***	2.93***
	(-0.81)	(-0.72)	(-0.63)	(-0.39)	(0.14)		(3.20)	(4.24)	(5.00)	(5.55)	(6.47)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]		[0.06]	[0.09]	[0.12]	[0.15]	[0.23]
Germany	-0.02	-0.03	-0.03	-0.05	-0.06	US	0.05	0.12	0.16	0.22	0.23
	(-0.97)	(-0.87)	(-0.64)	(-0.77)	(-0.64)		(0.90)	(1.17)	(1.16)	(1.26)	(0.74)
	[0.01]	[0.01]	[0.00]	[0.00]	[0.00]		[0.01]	[0.01]	[0.01]	[0.01]	[0.00]
Ireland	0.12	0.24	0.29	0.29	0.15						
	(0.68)	(0.74)	(0.63)	(0.51)	(0.16)						
	[0.00]	[0.01]	[0.01]	[0.00]	[0.00]						

Notes: Newey-West (1987) corrected t-statistics appear in parenthesis. Adjusted R-square is reported in square brackets. *, **, *** denote statistical significance at the 10, 5, and 1% level, respectively.

It can be seen that cay_t is statistically significant for a large number of countries and the point estimate of the coefficient is large in magnitude. Moreover, its sign is generally positive, suggesting that investors will temporarily allow consumption to rise above its equilibrium level in order to smooth it and insulate it from an increase in real housing returns. In addition, cay_t predicts a significant percentage of the variation in future real returns (as measured by the adjusted R-square), especially at long horizons. In fact, cay_t explains 6% (Italy), 7% (Finland), 8% (Denmark), 11% (Australia), 14% (Japan), 23% (UK), 25% (Belgium), 49% (Canada) and 56% (Spain) of the real housing return over the next eight quarters. In contrast, its forecasting power is poor for countries such as France, Germany, Ireland and the US.

The estimated sign of the coefficient of cay_t is positive for Australia, Belgium, Canada, Denmark, Finland, Ireland, Italy, Japan, Spain, Sweden, UK and US, and negative for France, Germany, and Netherlands. This piece of evidence supports the idea that, for the first set of countries, agents allow consumption to rise above its equilibrium relationship with asset wealth and labour income when they expect housing returns to increase in the future, that is, financial and housing assets are complements. As for the second set of countries, the evidence suggests that investors see financial and housing assets as substitutes.

3.2. Forecasting excess housing returns

Next we examine the forecasting power of cay_t in predicting excess housing returns (denoted by ER_t) for which quarterly data are available. As already explained, investors will increase/reduce their consumption depending on whether housing assets and stocks are treated as complements/substitutes. Therefore, in the former case the coefficient on cay_t in the forecasting regressions should be positive, whilst in the latter case it should be negative.

Table 4 provides a summary of the OLS regressions of the *H*-period excess housing return, $ER_{t+1} + \ldots + ER_{t+H}$, on the lag of cay_t. It shows that cay_t is a strong predictor of future excess housing returns. At the eight quarter horizon, cay_t forecasts 5% (Australia), 7% (Italy), 9% (UK), 10% (France and Netherlands), 12% (Denmark), 14% (Finland), 24% (Sweden), 29% (Belgium), 35% (Spain), 36% (Japan) and 46% (Canada) of the excess housing risk premium in the coming eight quarters. As for Germany, Ireland and the US, the predictive ability of cay_t is virtually nil.

Table 4 – Forecasting excess housing returns.

	Forecast Horizon *H*						Forecast Horizon *H*				
	1	2	3	4	8		1	2	3	4	8
Australia	-0.13**	-0.21*	-0.28*	-0.35*	-0.75***	Italy	0.08	0.15	0.24	0.40	1.10***
	(-2.03)	(-1.861)	(-1.76)	(-1.70)	(-2.53)		(1.13)	(1.16)	(1.30)	(1.61)	(2.91)
	[0.03]	[0.02]	[0.02]	[0.02]	[0.05]		[0.01]	[0.01]	[0.01]	[0.02]	[0.07]
Belgium	0.50***	0.98***	1.49***	2.02***	3.49***	Japan	0.51***	0.99***	1.44***	1.85***	2.95***
	(4.10)	(4.42)	(4.71)	(4.93)	(5.09)		(5.94)	(5.95)	(6.07)	(6.20)	(6.05)
	[0.17]	[0.22]	[0.25]	[0.28]	[0.29]		[0.38]	[0.39]	[0.39]	[0.39]	[0.36]
Canada	0.45***	0.88***	1.33***	1.80***	3.54***	Netherlands	-0.64***	-1.22***	-1.73***	-2.20***	-3.06***
	(4.74)	(5.76)	(6.89)	(7.85)	(10.83)		(-4.45)	(-4.61)	(-4.37)	(-4.14)	(-3.14)
	[0.17]	[0.23]	[0.29]	[0.33]	[0.46]		[0.17]	[0.17]	[0.16]	[0.16]	[0.10]
Denmark	0.24	0.55**	0.89***	1.25***	1.98***	Spain	0.81***	1.62***	2.42***	3.20***	5.42***
	(1.60)	(2.35)	(2.65)	(2.98)	(2.95)		(6.09)	(7.48)	(8.21)	(8.17)	(7.58)
	[0.05]	[0.08]	[0.10]	[0.13]	[0.12]		[0.30]	[0.37]	[0.41]	[0.42]	[0.35]
Finland	0.08	0.26	0.54**	0.85***	2.21***	Sweden	0.24***	0.49***	0.73***	0.98***	2.09***
	(0.81)	(1.52)	(2.31)	(3.01)	(4.27)		(4.62)	(5.85)	(6.18)	(6.01)	(5.77)
	[0.01]	[0.02]	[0.04]	[0.06]	[0.14]		[0.13]	[0.15]	[0.16]	[0.16]	[0.24]
France	-0.32***	-0.63***	-0.94***	-1.19***	-2.19***	UK	0.18***	0.44***	0.71**	1.01***	1.79***
	(-4.88)	(-4.92)	(-4.89)	(-4.60)	(-4.23)		(2.48)	(3.25)	(3.74)	(4.13)	(4.25)
	[0.11]	[0.12]	[0.12]	[0.11]	[0.10]		[0.03]	[0.05]	[0.06]	[0.08]	[0.09]
Germany	-0.02	-0.04	-0.06	-0.08	-0.12	US	0.12	0.24*	0.33*	0.42	0.29
	(-1.23)	(-1.25)	(-1.41)	(-1.55)	(-1.57)		(1.58)	(1.72)	(1.66)	(1.61)	(0.61)
	[0.03]	[0.03]	[0.03]	[0.04]	[0.04]		[0.02]	[0.03]	[0.02]	[0.02]	[0.00]
Ireland	0.21	0.35	0.21	-0.06	-1.26						
	(1.05)	(1.04)	(0.40)	(-0.08)	(-1.03)						
	[0.02]	[0.03]	[0.00]	[0.00]	[0.03]						

Notes: Newey-West (1987) corrected t-statistics appear in parenthesis. Adjusted R-square is reported in square brackets. *, **, *** denote statistical significance at the 10, 5, and 1% level, respectively.

The coefficient on cay_t is positive for Belgium, Canada, Denmark, Finland, Ireland, Italy, Japan, Spain, Sweden, UK and US, and negative for Australia, France, Germany, and Netherlands. As a result, in the first group of countries, financial and housing assets are best described as complementary assets, while, in the second group, investors perceive them as substitutes.

4. Robustness analysis

4.1. Potential bias

We also analyse the potential bias in the coefficient of *cay*. More specifically, Stambaugh (1999) suggest that when the regressor of the forecasting equations (i.e. *cay*) is autocorrelated and the shocks to regressors are correlated with shocks to returns, the dependent variable is not independent of all leads and lags of the error terms. Therefore, the estimates are biased upwards.

Table 5 – Stambaugh (1999) bias?

	Forecast Horizon *H*						Forecast Horizon *H*				
Real housing returns	1	2	3	4	8	Excess housing returns	1	2	3	4	8
Australia	-0.01	-0.02	-0.02	-0.02	-0.01	Australia	-0.02	-0.03	-0.03	-0.03	-0.02
Belgium	-0.01	-0.02	-0.02	-0.02	-0.01	Belgium	-0.01	-0.01	-0.02	-0.02	-0.01
Canada	-0.00	0.01	0.01	0.01	0.03	Canada	-0.01	0.00	0.01	0.01	0.04
Denmark	0.01	0.00	0.00	0.01	0.05	Denmark	0.01	0.00	0.01	0.01	0.04
Finland	-0.04	-0.08	-0.11	-0.10	-0.08	Finland	-0.05	-0.09	-0.12	-0.13	-0.11
France	-0.00	-0.01	-0.01	-0.02	-0.01	France	-0.01	-0.02	-0.02	-0.03	-0.04
Germany	-0.00	-0.01	-0.01	-0.01	-0.01	Germany	-0.00	-0.01	-0.01	-0.01	-0.01
Ireland	0.02	0.02	0.03	0.04	0.06	Ireland	-0.01	-0.01	-0.01	-0.01	-0.16
Italy	0.01	0.03	0.04	0.03	-0.02	Italy	0.01	0.01	-0.00	-0.03	-0.03
Japan	0.01	0.02	0.03	0.03	0.05	Japan	0.01	0.01	0.02	0.03	0.06
Netherlands	-0.01	-0.01	-0.02	-0.02	-0.04	Netherlands	-0.01	-0.03	-0.04	-0.05	-0.08
Spain	0.00	-0.00	-0.00	0.03	0.15	Spain	0.01	0.02	0.03	0.07	0.20
Sweden	-0.02	-0.03	0.01	0.02	0.02	Sweden	-0.01	0.00	0.00	0.00	0.00
UK	-0.01	-0.02	-0.02	-0.02	0.03	UK	-0.01	-0.02	-0.02	-0.02	0.02
US	-0.00	-0.00	0.00	-0.00	0.01	US	-0.00	0.00	0.01	0.01	0.02

Notes: the magnitude of the bias is, approximately, equal to $\gamma/(1+3\rho)/T$, under the normality assumption; γ is the coefficient from regressing the residual in the returns regression on the residual from an AR(1) regression for the forecasting variable (*cay*); ρ is the AR coefficient for the forecasting variable (*cay*); *T* is the sample size. (Stambaugh, 1999).

In Table 5, we report the size of the bias in the forecasting regressions at different horizons. It can be seen that the bias does not affect the predictive power of *cay* as it is very small (in general, it does not represent more than 10% of the coefficient of *cay*). Consequently, *cay* is confirmed as an important predictor of real and excess housing returns. This is also in line with the findings of Lettau and Ludvigson (2001), Whelan (2008) and Sousa (2010).

4.2. Additional variables

In the literature on stock return predictability, Campbell and Shiller (1988), Fama and French (1988) and Lamont (1998) find that valuation ratios (such as the price-to-dividend ratio or the price-to-earnings ratio) display forecasting power for stock returns.

In the same spirit, Table 6 reports the estimates from forecasting regressions for real housing returns that include the lag of the rent yield ratio ($RentYld_{t-1}$). In addition, Davis and Kutan (2003) highlight the fact that inflation is a predictor of asset returns. As a result, we consider the lag of the inflation rate ($Inflation_{t-1}$) as a potential explanatory variable for housing returns. We also add the lag of real housing returns (HR_{t-1}) as a control variable. Table 7 displays the results for the forecasting regressions for excess housing returns. In both Table 6 and 7, we present the forecasting regressions at the eight-quarter horizon for which the predictability power of *cay* was found to be largest.

Table 6 – Forecasting real housing returns: additional control variables.

	HR_{t-1}	cay_{t-1}	$RentYld_{t-1}$	Adj. R-square	HR_{t-1}	cay_{t-1}	$Inflation_{t-1}$	Adj. R-square
Australia	-0.61**	0.82***	6.63**	[0.16]	-0.57*	0.83***	-0.00	[0.14]
	(-1.95)	(3.49)	(1.90)		(-1.91)	(2.87)	(-0.83)	
Belgium	0.66**	2.63***	7.59**	[0.33]	2.15***	2.43***	0.02***	[0.36]
	(2.27)	(5.35)	(2.40)		(2.86)	(5.22)	(2.54)	
Canada	0.15	2.19***	12.16***	[0.62]	0.40	2.98***	0.02***	[0.54]
	(0.60)	(9.22)	(6.48)		(1.57)	(10.84)	(3.70)	
Denmark	0.30	1.19***	40.04***	[0.47]	0.72	1.28**	0.00	[0.10]
	(0.79)	(2.98)	(8.86)		(1.29)	(2.24)	(0.02)	
Finland	0.98***	1.16***	31.74***	[0.39]	2.50***	2.27***	0.03***	[0.26]
	(2.65)	(3.38)	(8.37)		(4.20)	(4.65)	(4.16)	
France	1.93***	-0.07	28.78***	[0.35]	1.98***	-0.16	-0.01	[0.16]
	(3.94)	(-0.20)	(6.90)		(3.59)	(-0.35)	(-1.52)	
Germany	0.95**	-0.16	8.74*	[0.07]	1.64***	0.09	0.01***	[0.10]
	(2.13)	(-1.42)	(1.89)		(4.16)	(0.85)	(2.50)	
Ireland	0.09	-0.12	1.69**	[0.13]				
	(0.95)	(-0.62)	(2.42)					
Italy	0.56	-0.80***	69.86***	[0.71]	1.21***	0.48**	-0.03**	[0.22]
	(1.61)	(-3.74)	(9.72)		(2.86)	(2.25)	(-2.46)	
Japan	0.05	0.78*	47.32***	[0.24]	-0.15	1.77***	-0.00	[0.15]
	(0.25)	(1.71)	(4.58)		(-0.20)	(3.93)	(-0..26)	
Netherlands	2.38***	0.26	19.93***	[0.53]	3.19***	1.46*	-0.01	[0.28]
	(4.30)	(0.48)	(6.90)		(3.46)	(1.85)	(-0.35)	
Spain	1.18***	3.96***	6.31	[0.60]	1.02**	4.30***	-0.01	[0.60]
	(3.08)	(5.42)	(0.87)		(2.49)	(5.94)	(-0.94)	
Sweden	0.44*	0.45	24.57***	[0.46]	1.43**	1.76***	0.01*	[0.40]
	(1.84)	(1.03)	(4.54)		(2.42)	(7.12)	(1.74)	
UK	0.78*	-0.23	49.65***	[0.45]	0.69	2.52***	-0.02*	[0.29]
	(1.64)	(-0.32)	(5.72)		(1.27)	(4.67)	(-1.88)	
US	1.77***	-0.06	23.91***	[0.25]	0.66	-0.24	-0.04***	[0.29]
	(4.01)	(-0.24)	(4.54)		(1.34)	(-1.01)	(-5.05)	

Notes: Newey-West (1987) corrected t-statistics appear in parenthesis. Adjusted R-square is reported in square brackets. *, **, *** denote statistical significance at the 10, 5, and 1% level, respectively.

The results show that the point estimates of the coefficient of *cay* and their statistical significance do not change with respect to the findings of Tables 3 and 4 where only *cay* was included as the explanatory variable. Moreover, the lag of the dependent variable is, in general, statistically significant, a feature that can be explained by the high autocorrelation of housing returns (Case and Shiller, 1989).

The rent yield ratio ($RentYld_t$) also seems to provide relevant information about future asset returns given that it is statistically significant in the vast majority of regressions and it improves the adjusted R-square.

Finally, the coefficient associated with the inflation rate ($Inflation_{t-1}$) is small in magnitude. However, it tends to be statistically significant, in particular in the forecasting regressions for real housing returns. Moreover, it is: 1) positive for Belgium, Canada, Finland, Germany and Sweden, which suggests that agents have a myopic behaviour and suffer from money illusion; and 2) negative for Italy, the UK and the US, where investors seem to use housing assets to hedge against the risk of inflation.

Table 7 – Forecasting excess housing returns: additional control variables.

	ER_{t-1}	cay_{t-1}	$RentYld_{t-1}$	Adj. R-square	ER_{t-1}	cay_{t-1}	$Inflation_{t-1}$	Adj. R-square
Australia	-0.84*	-1.08***	25.16***	[0.21]	-0.09	-0.53*	0.01	[0.05]
	(-1.65)	(-4.30)	(4.89)		(-0.16)	(-1.64)	(1.60)	
Belgium	2.99***	1.97***	0.66	[0.60]	2.95***	2.02***	-0.00	[0.60]
	(7.74)	(4.20)	(0.20)		(7.51)	(4.72)	(-0.61)	
Canada	0.48*	2.67***	19.62***	[0.67]	0.72***	3.98***	0.04***	[0.57]
	(1.98)	(10.00)	(6.81)		(2.78)	(11.73)	(4.27)	
Denmark	1.00**	1.43***	31.59***	[0.36]	1.18**	1.26*	-0.01	[0.16]
	(2.28)	(2.52)	(5.18)		(2.15)	(1.82)	(-0.49)	
Finland	2.35***	2.41***	32.89***	[0.50]	2.84***	2.93***	0.01	[0.34]
	(5.17)	(6.35)	(7.61)		(4.73)	(5.63)	(0.86)	
France	3.33***	-1.40***	39.32***	[0.61]	4.15***	-0.98*	-0.01	[0.40]
	(8.28)	(-3.33)	(8.24)		(8.97)	(-1.72)	(-1.07)	
Germany	-0.70	-0.01	-7.23	[0.07]	-0.51	-0.08	0.01***	[0.14]
	(-1.14)	(-0.10)	(-1.31)		(-0.81)	(-0.96)	(2.67)	
Ireland	2.04***	-1.23	-9.31*	[0.30]				
	(3.13)	(-1.26)	(-1.77)					
Italy	0.00	-1.05***	61.91***	[0.62]	1.60***	0.82***	-0.03***	[0.32]
	(0.01)	(-3.73)	(11.40)		(3.82)	(3.73)	(-2.53)	
Japan	-0.33	1.92***	59.48***	[0.49]	-0.18	3.03***	-0.00	[0.36]
	(0.53)	(3.53)	(7.86)		(-0.26)	(5.04)	(-0.03)	
Netherlands	3.02***	-1.43	18.14***	[0.44]	3.61***	1.29	-0.03*	[0.36]
	(4.84)	(-1.40)	(5.23)		(4.52)	(1.55)	(-1.68)	
Spain	2.43***	2.41**	20.16**	[0.47]	2.23***	3.16***	-0.05**	[0.50]
	(3.04)	(2.19)	(1.97)		(2.82)	(2.61)	(-2.01)	
Sweden	2.90***	-0.60	34.10***	[0.46]	2.31***	1.48***	-0.00	[0.34]
	(5.07)	(-1.04)	(5.60)		(3.62)	(3.32)	(-0.64)	
UK	1.19***	-1.52**	53.29***	[0.40]	1.60***	1.67***	-0.01	[0.18]
	(2.53)	(-2.21)	(5.51)		(3.04)	(3.49)	(-0.84)	
US	3.87***	-0.11	23.91***	[0.34]	3.12***	-0.23	-0.04***	[0.36]
	(7.96)	(-0.29)	(2.86)		(6.28)	(-0.71)	(-2.92)	

Notes: Newey-West (1987) corrected t-statistics appear in parenthesis. Adjusted R-square is reported in square brackets. *, **, *** denote statistical significance at the 10, 5, and 1% level, respectively.

4.3. Nested forecast comparisons

We also consider nested forecast comparisons, in which we compare the mean-squared forecasting error from a series of one-quarter-ahead out-of-sample forecasts obtained from a prediction equation that includes *cay* as the only forecasting variable, to a variety of forecasting equations that do not include it.

We look at two benchmark models: the *autoregressive benchmark*, where we compare the mean-squared forecasting error from a regression that includes just the lagged housing return as a predictive variable to that from regressions also including *cay*; and the *constant expected returns benchmark*, where we compare the mean-squared forecasting error from a regression that includes a constant to that from regressions that also include *cay*.

Table 8 summarises the nested forecast comparisons for the equations of the real and excess housing returns using *cay*. It shows that the inclusion of *cay* improves the forecasting performance of the model vis-a-vis the benchmark specifications, particularly in the case of the *constant expected returns benchmark*, which provides evidence of time-variation in expected housing returns.

Table 8 – One-quarter ahead forecasts of returns: *cay* model vs. constant/AR models.

	Real housing returns		Excess housing returns	
	$MSE_{cay}/MSE_{constant}$	MSE_{cay}/MSE_{AR}	$MSE_{cay}/MSE_{constant}$	MSE_{cay}/MSE_{AR}
Australia	0.999	1.002	0.991	1.005
Belgium	0.985	0.990	0.918	0.973
Canada	0.930	0.940	0.912	0.915
Denmark	0.995	1.003	0.982	0.999
Finland	1.005	1.003	1.002	0.951
France	1.002	1.001	0.945	0.999
Germany	1.001	1.004	0.997	0.996
Ireland	1.004	0.998	0.998	0.988
Italy	1.006	1.004	1.000	1.004
Japan	0.984	0.960	0.789	0.910
Netherlands	0.986	0.987	0.917	1.003
Spain	0.823	0.969	0.844	0.955
Sweden	0.971	0.979	0.939	0.985
UK	0.974	0.980	0.988	0.972
US	1.000	1.002	0.992	1.000

Note: MSE represents the mean-squared forecasting error.

5. Conclusions

In this paper we follow Caporale and Sousa (2011) and focus, in the context of a representative consumer model, on the equilibrium relation between the trend deviations among consumption, aggregate wealth and labour income (summarised by the variable *cay*) and expected future housing returns. The rationale is that *cay* provides information on agent's expectations about future returns. Specifically, forward-looking investors allow consumption to rise above its equilibrium level if they expect higher stock returns. Concerning housing returns, investors behave in a similar way if the two types of assets are seen as complements. By contrast, they allow consumption to fall below its equilibrium relationship with wealth and labour income if they are seen as substitutes.

Using data for 15 OECD countries, we show that *cay* forecasts more than 10% of the variation in real housing returns in countries such as Australia, Japan, the UK, Belgium, Canada and Spain at the eight-quarter horizon. In the case of France, Germany, Ireland and US, the forecasting power of *cay* is instead rather poor.

We also find that in the forecasting regressions the sign of the coefficient on cay_t is positive for Belgium, Canada, Denmark, Finland, Ireland, Italy, Japan, Spain, Sweden, the UK and the US, which supports the idea that financial and housing assets are complements in these countries. In contrast, it is negative for France, Germany and the Netherlands, suggesting that investors see financial and housing assets as substitutes. Overall, the evidence is mixed as also found in the case of emerging markets by Caporale and Sousa (2011).

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