EUROPEAN CENTRAL BANK
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WORKING PAPER SERIES
NO 1019 / MARCH 2009

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EVIDENCE FROM A DYNAMIC DIVIDEND-DISCOUNT MODEL

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In 2009 all ECB publications feature a motif taken from the €200 banknote.

1 The views expressed in this paper are those of the authors and do not necessarily reflect those of the European Central Bank (ECB). We would like to give a special thanks to Olli Castren, who provided ideas and input at an early stage essential to this work, as well as Chiara Osbat for valuable advice on econometric issues. All errors in this paper are, however, the sole responsibility of the authors.

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ISSN 1725-2806 (online)

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Abstract

We apply a dynamic dividend-discount model to analyse unexpected housing returns in a panel of eight euro area countries which together comprise 90% of euro area GDP. The application of this model allows for a decomposition of house price movements into movements in rent (cash-flow) and expected return news components. The empirical application of the model involves the estimation of a panel vector autoregressive model (VAR) for four variables –excess return to housing, rents, the real interest rate and real disposable per capita income– using quarterly data over the period 1985-2007. This empirical investigation yields two main findings. First, the bulk of the variability of house price movements in the panel of countries analysed can be attributed to movements in the rental yield. Indeed, perturbations to rents appear to result in a one-to-one analogous movement in house prices over the long term once controlling for changes in expected returns. Second, evidence from the dynamic profile of shocks along with the negative co-movement between changing rental yield expectations and changing expected returns on housing assets would suggest that euro area house prices overreact to news.

Keywords: House price, housing rental yield, return decomposition, panel VAR estimation, cash flow news.

JEL Classification: R21, C33, G12.

Non-technical summary

When housing is viewed as an asset, understanding the evolution of house prices is not unlike understanding that of financial assets, in that changes in valuation derive from news on fundamental determinants, or dividends, and expected returns. One methodology which is based on this notion and widely applied to understanding movements in financial asset prices (such as equities or bonds) is the dynamic dividend- discount model pioneered by Campbell and Shiller (1988a) and Campbell and Shiller (1988b). This model equates unexpected changes in the excess return of an asset over an alternative riskless asset to changes in the discounted flow of dividends it provides along with changes in expected returns.

Housing can, however, be characterised as both an asset and a consumption good. Nevertheless, from both perspectives, house prices would be expected to exhibit a long-run relationship with the conceptual analogue of dividends in the above model – in the form of rental yield. From the perspective of housing as an *asset*, house prices embed information about dividends in the form of the flow of future housing services (which can be proxied by the rental yield) in addition to expected returns. From the perspective of housing as a *consumption good*, house prices should co-move with rents in the long run given the substitutability between renting and owning a house on aggregate in the absence of frictions or borrowing constraints.

While such a long-run relationship between house prices and the rental yield may be expected, house prices in the euro area – similar to those in other developed economies – have exhibited considerably stronger growth than witnessed in housing rents over the last decade. The implied deterioration of the ratio of the observed house price to contemporaneous observed rent has been the subject of numerous studies. The literature, however, has tended to examine the relationship between house prices and rents in a static variant of the dividend-discount model, whereby expected returns are assumed to be constant through time. In the dynamic variant of the dividend-discount model, an alternative interpretation is that changes in expected returns as well as rents could have exerted influence on the evolution of euro area house prices.

This paper uses a dynamic dividend-discount model to decompose euro area house price developments into cash-flow fundamentals –in the form of rents– and expected returns. A vector autoregressive (VAR) model, following closely the methodology used by Vuolteenaho (2002) to analyse US equity prices, is run for a panel of eight euro area countries (Belgium, Germany, Ireland, Spain, France, Italy, the Netherlands and Finland) using quarterly data over the period 1985-2007. In this framework, real returns to housing (defined as real house price inflation less the real "risk free" return on a long-term government bond) are related to dividends from homeownership in the form of the real rental yield (proxied by observed real housing

rents), with controls for other important determinants of house prices, such as real long-term interest rates and real per capita disposable income. The parameters of the estimated model indicate, not surprisingly, that expected excess returns to housing are high when rents over the past period have generally been both significant and high, and real interest rates are low and significant. The empirical investigation, however, focuses on relating returns on housing in excess of the risk-free rate of return to two factors: a systematic news component (consisting of shocks to expected cash flows in the form of rents) and an idiosyncratic news component (consisting of shocks to expected return news). The results of a variance decomposition of changes in excess returns to housing, as well as a comparative analysis of impulse responses from shocks to rents and expected returns yields two main findings. First, the bulk of the variability of house price movements in the panel of countries analysed can be attributed to movements in the rental yield. Indeed, perturbations to rents appear to result in a one-to-one analogous movement in house prices over the long term once controlling for changes in expected returns. That said, while housing returns are driven mainly by news on country rents, there remains an important but less sizeable influence of market-wide (or expected-return) variations for house prices. Second, it appears that changes in rental yield expectations co-move negatively with changes in expected returns on housing assets, which would suggest in addition to information from the dynamic responses to shocks that house prices overreact to news. In the context of historically higher volatility in house prices compared with that of rents, stable low-frequency variation in expected returns could therefore have contributed to large and persistent swings in house prices.

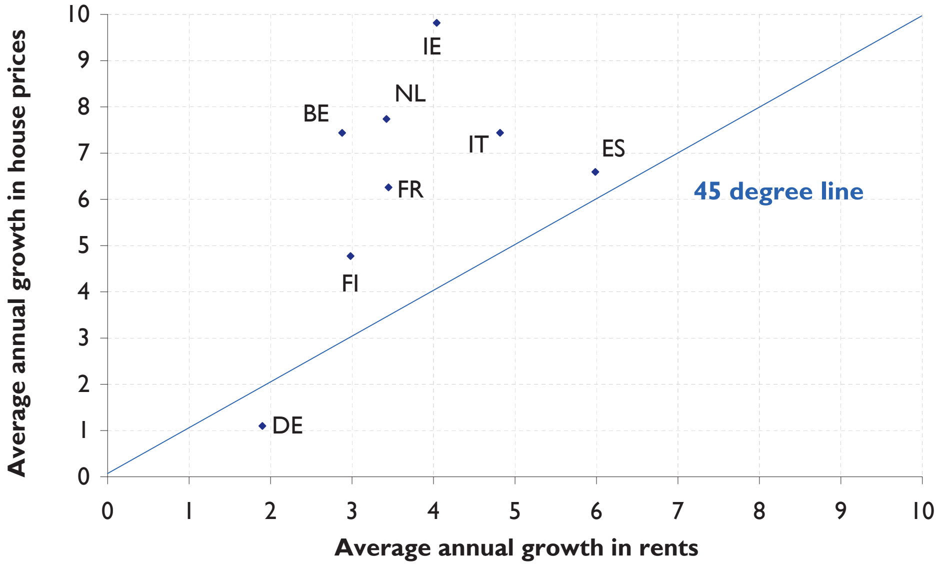
There are several caveats to the analysis, notably the role of country heterogeneity, the possibility that non-market forces influence the flexibility of house price and rents and their implied substitutability, along with the possibility of changing institutional factors, structural economic change and statistical issues that could imply some change in historical or equilibrium relationships. Nevertheless, the results can be considered as containing an illustrative assessment of the relationship between changing euro area house prices and changing fundamentals in a dynamic framework when allowing for changes in expected returns.

1 Introduction

The price of residential housing, which can be characterised as both a consumption good and as an asset (or investment good), should bear a close long-term resemblance to rental yields. In the role of housing as a consumption good, the rental yield provides a proxy of the flow of housing services accruing to a homeowner, and in this way is a key influence on the decision to acquire housing services on a month-by-month basis or as a flow through outright purchase. In the role of housing as an asset, house prices not only embed information about dividends in the form of the flow of future housing services, but also regarding expected returns. In this way, understanding the drivers of house price movements can be intrinsically related to movements in both rents and expected returns.

In the euro area, house prices have exhibited strong growth in many countries over the last decades. Such growth has been only partly related to movements in "dividends", in the form of housing rents as measured in consumer price statistics. As indicated in Figure 1, average annual growth in house prices has exceeded that of the rent component in consumer price indices over the past 25 years or so in many euro area countries. This could suggest that, in many euro area countries, changes in expected returns have exerted some influence on the evolution of house prices in addition to changes in the expected dividend yield in the form of rents.

Figure 1: **Evolution of house prices and rents in selected euro area countries** *(average percentage changes over 1985-2007)*



One methodology which has been widely applied to understanding movements in financial asset prices (such as equities or bonds) is a dividend-discount model. This model essentially postulates that the excess return of an asset over an alternative riskless asset can be related to the discounted flow of dividends it provides along with changes in expected returns. Most existing work analysing house prices using a dividend-discount approach is based on a static model which, *inter alia*, does not control for time-varying changes in expected returns. Using a static dividend-discount framework several studies have found that house price to rent ratios stand at elevated rates in many European countries – see, for instance, Girouard, Kennedy, van den Noord, and André (2006), Weeken (2004), and Ayuso, Blanco, and Restoy (2006). Several studies have also analysed the house price rent relationship for the United States, including Gallin (2008) and Himmelberg, Mayer, and Sinai (2006). Fewer studies have applied a dynamic application of the model, allowing for a dichotomy of house price movements driven by "fundamental' movements –or rents– and changes in expected returns. Campbell, Davis, Gallin, and Martin (2008) analyse the US regional house price-rent ratio in a dynamic framework, and find that housing premia account for a significant fraction of rent-price ratio volatility at the national and local levels, and that covariances between house prices, rents and housing risk premia damp fluctuations in rent-price ratios. Plazzi, Torous, and Valkanov (2006) find for commercial real estate prices in the US that variation in commercial real estate prices is largely due to movements in discount rates rather than cash flows, on the basis of a unique measure of rents accruing to owner occupiers.

We apply the dynamic variant of the dividend-discount model to analyse changes in the unexpected returns to euro area residential housing. Specifically, we investigate the relative contribution of rents and expected housing returns in driving excess returns on housing for a panel of eight large euro area countries (Belgium, Germany, Ireland, Spain, France, Italy, the Netherlands and Finland) over the period 1985-2007. Specifically, we implement the dynamic dividend-discount model as pioneered by Campbell and Shiller (1988a) and Campbell and Shiller (1988b), following closely the methodology used by Vuolteenaho (2002). The resulting empirical specification relates excess returns on house prices to rents, the real interest rate and real per capita disposable income. The empirical investigation, however, focuses on relating returns on housing in excess of the risk-free rate of return to two factors: a systematic news component (consisting of shocks to expected cash flows in the form of rents) and an idiosyncratic news component (consisting of shocks to expected return news). The results of a variance decomposition of changes in excess returns to housing, as well as a comparative analysis of impulse responses from shocks to rents and expected returns yields two main findings. First, the bulk of the variability of house price movements in the panel of countries analysed can be attributed to movements in the rental yield. Indeed, perturbations to rents appear to result in a one-to-one analogous movement in house prices over the long term once controlling for changes in expected returns. That said, while housing returns are driven mainly by news on country rents, there remains an important but less sizeable influence of market-wide (or expected-return) variations for house prices. Second, on the basis of both the dynamic profile of shocks along with negative co-movement between changes in rental yield expectations and changes in expected returns on housing assets, it would appear that house prices overreact to each type of independent news.

The rest of the paper is structured as follows. Section 2 outlines the dividend-discount model applied to house price analysis, both in the commonly applied static form and in the dynamic form used in this paper. Section 3 then outlines the VAR approach adopted to analyse house prices in this framework, based on the data outlined in Section 4. The results of the VAR analysis, including impulse response analysis and variance decomposition, are contained in Section 5. Lastly, concluding remarks are made in Section 6.

2 The dividend-discount model of asset pricing applied to house prices

The dividend-discount model of asset pricing has been widely applied to the analysis of various asset prices. The pioneering work of Campbell and Shiller (1988a) and Campbell and Shiller (1988b) involved the analysis of equities, where a firm's unexpected stock returns are driven by shocks to expected cash flows ("cash-flow news") and/or shocks to discount rates ("expected-return news"). In this setting, a firm's book-to-market ratio can be temporarily high if future cash flows are low and/or future excess stock returns are high.

The conceptual analogue of this framework applied to the housing market implies that unexpected changes in excess returns to housing –or the excess of the house price over the risk-free rate– is driven by shocks to expected future housing service flows (cash flows or, alternatively, dividends in the form of the housing rental yield) and/or shocks to expected future returns to housing assets. One important assumption underpinning the analysis is that the observable growth rate of rent paid by renters is equal to the unobservable growth rate of rents accruing to owner occupiers.[1] Taking this

[1]In this way, the applicability of rents as a proxy for housing dividends relates importantly to the national share of rental accommodation in total housing. Within the countries analysed, this varies considerably across the euro area – with a relatively high share of rental accommodation in countries such as Germany, France and the Netherlands in the range of 43-58% in 2006, contrasting with a relatively low share of rental accommodation in countries such as Ireland, Spain and Italy of below 20%.

assumption as given, a return decomposition applied to housing therefore involves breaking down unexpected changes in house prices into changes in the relevant fundamental (the rental yield) and expected returns (in the form, for instance, of capital gains or losses).

There are several caveats to this approach when applied to housing. First, the model is based on the assumption that households can either freely rent or own the housing stock, and therefore abstracts from non-market factors or liquidity constraints implying imperfect substitutability between the two options. Moreover, the dynamics of rent prices, in particular, might only sluggishly adjust to prevailing economic conditions given regulatory factors such as rent controls prevalent in several European countries. Second, many factors outside the purview of this model can also influence the user cost of home ownership, such as differences in risk, tax benefits, property taxes, depreciation and maintenance costs –see for instance Girouard, Kennedy, van den Noord, and André (2006). Third, data uncertainty is particularly high in measuring house prices given problems in coverage, quality control and representativeness. Notwithstanding these caveats, we analyse euro area house price movements in a dynamic dividend-discount framework closely aligned to the methodology of Vuolteenaho (2002) (examining stock markets), Castrén, Fitzpatrick, and Sydow (2006) (examining banking returns) and Castrén, Osbat, and Sydow (2006) (examining exchange rates). The methodology – first in terms of a static and then a dynamic dividend-discount model – is described below.

2.1 Static version

A static version of the dividend-discount asset pricing approach applied to housing involves relating house prices to contemporaneous rents, a risk-free rate of return, a housing risk premium over this latter rate and some error capturing expected capital gains or losses.

As a starting point, we use the standard identity for the one period gross return to an asset, R_{t+1},

$$R_{t+1} \equiv \frac{P_{t+1} + D_{t+1}}{P_t} \tag{1}$$

where P is the real price of housing and D is the flow of fundamental value (rents for the case of housing). Solving forward in a static framework, the house price in period t can be expressed as the present discounted value of the future stream of dividends or rents, discounted at a constant rate (R):

$$P_t = E_t \left[\sum_{i=1}^{\infty} \frac{D_{t+i}}{(1+R)^i} \right] \tag{2}$$

Assuming that payoffs grow at a constant real rate gives raise to the familiar Gordon growth model that is a workhorse model for static asset pricing exercises. Indeed, this approach has been applied in numerous studies applied to housing. Girouard, Kennedy, van den Noord, and André (2006) find that price-rent ratios stand above their their long-run value for most OECD countries. Weeken (2004) relates house prices to net rentals (a proxy for dividends) and estimated the model for UK data, and finds that lower real interest rates can account for part of the increase of the ratio of house prices to net rentals in the UK between 1996 and 2004, but to fully account for the observed increase the housing risk premium would need to have fallen as well. Using a quarterly empirical model based on an asset pricing approach applied to Spain, the UK and the US, Ayuso, Blanco, and Restoy (2006) find evidence that house prices are above their long-term equilibrium, though attribute part of this to other factors. Krainer and Wei (2004) finds for the US that most of the variance in the price-rent ratio has been due to changes in future returns and not to changes in rents. Also for the US, Himmelberg, Mayer, and Sinai (2006) calculate the imputed rent on housing based on a measure of user cost of housing, and in comparing it to actual rents available in the market find evidence of considerable heterogeneity across US cities.

2.2 Dynamic version

As outlined in Campbell, Davis, Gallin, and Martin (2008), a dynamic version of the model can provide additional information over and above the static version primarily in three ways. First, it yields a time-varying rather than fixed housing excess return over the risk-free rate. Second, it explicitly accounts for the dynamics of each component of excess returns to housing assets, rather than lumping all future considerations into expected future capital gains, as unlike a static analysis it can decompose whether asset price returns react to changes in agents' expectations of future dividends or changes in expectations on future returns. Third, as long as real interest rates and housing premia are stationary, it ties appreciation of house prices to growth in rents over the long-run in contrast to the static model.

The dynamic dividend-discount model, pioneered by Campbell and Shiller (1988a) and Campbell and Shiller (1988b), involves a log-linear approximation that is tractable even when unexpected returns vary through time, thereby allowing for an analysis of the relative importance of the cash-flow (or intrinsic value) and expected return components as drivers of asset price returns. We apply the version contained in Vuolteenaho (2002), who extends the Campbell-Shiller framework by incorporating accounting-based variables in a panel estimation framework.

As a starting point, we return to the one-period gross return to housing following the identity in equation (1). Taking the logarithm of this expression, and with lower-case letters denoting variables in logs, we get

$$r_{t+1} = \log(P_{t+1} + D_{t+1}) - p_t \tag{3}$$

While the exact implied relationship is non-linear, since it involves the log of the sum of the price and the dividend, Campbell and Shiller (1988a) note that R_t can be well approximated by applying a first-order Taylor expansion of equation (3), which replaces the above log sum of the price and the dividend with a weighted sum of the two components along with a constant as follows:

$$r_{t+1} \approx k + \rho p_{t+1} + (1 - \rho) d_t - p_t \tag{4}$$

where ρ is a parameter close to less than unity and k is a constant term and approximation error. Equation (4) now allows for the decomposition of the unexpected housing return into a cash-flow and expected return component. Taking the change in expectations of (4) from *t-1* to *t*, and solving forward yields

$$r_t - E_{t-1} r_t = \kappa + \triangle E_t \sum_{j=0}^{\infty} \rho^j (\Delta d_{t+j}) - \triangle E_t \sum_{j=0}^{\infty} \rho^j r_{t+j} \tag{5}$$

where $\triangle E_t$ denotes the change in expectations form $t - 1$ to t , κ is a constant term, and a standard transversality condition is imposed. Equation (5) implies that at any point in time, a surprise increase in house prices must be associated with an improvement in expected future dividends in the form of housing services (or rents) or a decrease in required future returns. An alternative interpretation is that of permanent (versus transitory) components to revisions in excess house price returns, whereby the current impact of a future change creates an equal or opposite movement in house prices.

3 Empirical implementation of the dynamic model using a VAR approach

In order to empirically assess the drivers of excess returns on housing, we obtain quantitative results from a vector autoregressive (VAR) estimation in a panel setting. The exposition below and resulting empirical investigation follows closely that of Castrén, Fitzpatrick, and Sydow (2006), Castrén, Osbat, and Sydow (2006), and Vuolteenaho (2002). Below, we outline the panel VAR used for subsequent analysis.[2] A VAR system, in combination

[2]The decomposition is the same for an estimated single-country VAR or panel VAR provided that homogeneity restrictions on the coefficients of interest hold in the panel setting. In relation to the latter assumption, we report some country results to illustrate the importance of heterogeneity across euro area countries in Section 5.

with the log-linear asset pricing framework, can be used to calculate the impact that an innovation in the expected return will have on the house prices, holding the expected future housing services flow variable constant. This impact is the expected return news component of the unexpected return on housing. The housing services flow is therefore obtained as a residual.

Defining z_{it} as a k-dimensional vector of variables for each country, ordered so that the first variable in the system reflects excess returns on housing. A panel VAR can then be represented –exemplified in what follows with a lag length of one for illustrative purposes– in the following way:

$$z_{it+1} = \Gamma z_{it} + u_{it+1} \tag{6}$$

where u_{it} is serially uncorrelated, with mean 0 and variance Σ, imposing no restrictions on contemporaneous correlation in Σ. For the panel estimation, the standard assumption that the coefficient matrix Γ, is constant both over time and across cross-sectional units is assumed to hold.[3] Given a selection vector e_1 of appropriate dimensions, the forecast of excess returns on housing (h_t) is then:

$$h_{it+1+j} = e_1 \Gamma^{j+1} z_{it} \tag{7}$$

where j represents the length of the forecast horizon. Introducing an expectations operator, one-step forward forecasts over two consecutive periods can be denoted as follows:

$$E_t \left[h_{it+1+j}\right] = e_1{}' \Gamma^{j+1} z_{it}$$

$$E_{t+1} \left[h_{it+1+j}\right] = e_1{}' \Gamma^{j} z_{it+1}$$

The expectation error from the above two consecutive one-period ahead forecasts can be represented as:

$$E_{t+1} \left[h_{it+1+j}\right] - E_t \left[h_{it+1+j}\right] = e_1{}' \Gamma^{j} z_{it+1} - e_1' \left(\Gamma^j \Gamma\right) z_{it} \equiv e_1' \Gamma^j u_{it+1} \tag{8}$$

Generalising this two-period framework to a multi-period framework, i.e. a discounted sum of forecast revisions of returns, assuming a discount factor equal to one, is then given by:

[3] Given that the panel estimation imposes the usual homogeneity restrictions on the resulting estimates, we also tackle the issue of heterogeneity by examining estimates for an alternative specification excluding Germany, where housing market developments have differed considerably from the other countries in the panel over the last decade. These estimates do not strongly differ from the results of the complete eight country panel. Moreover, results for selected euro area countries with markedly different house price profiles are presented in Section 5 to illustrate the potential role of heterogeneity.

$$(E_{t+1} - E_t) \sum_{j=1}^{\infty} [h_{it+1+j}] = e_1' \sum_{j=1}^{\infty} \Gamma^j u_{it+1} \tag{9}$$

If the eigenvalues of the companion matrix Γ are inside the unit circle, then the (discounted) sum of revisions in forecast returns is given by:

$$N_{r,t} = (E_{t+1} - E_t) \sum_{j=1}^{\infty} [h_{it+1+j}]$$

$$= e_1' \Gamma (I - \Gamma)^{-1} u_{it+1} = \lambda' u_{it+1} \tag{10}$$

where $\lambda = e_1' \Gamma (I - \Gamma)^{-1}$.

The unexpected return can be decomposed as the difference between cash-flow news ($N_{rents,t}$) and expected return news ($N_{return,t}$). In terms of the VAR parameterisation we then get:

$$e_1' u_{it} = N_{rents,t} - N_{returns,t} \tag{11}$$

The housing services component can be written compactly as:

$$N_{rents,t} = e_1' u_{it} + N_{returns,t}$$

$$e_1' (I + \Gamma (I - \Gamma)^{-1}) u_{it} \tag{12}$$

In order to construct *impulse response functions*, we define the innovation in cumulative expected changes in future returns on housing investment $k > 1$ periods forward as:

$$e_1' \Phi (k) \, u_{it} = e_1' \left(\Gamma - \Gamma^{k+1} \right) (I - \Gamma)^{-1} u_{it} \tag{13}$$

and the total impulse response as the shock itself plus the cumulative sum above:

$$e_1' \Psi (k) \, u_{it} = e_1' \left(I + \Phi (k) \right) u_{it}$$

$$= e_1' \left(I + \left(\Gamma - \Gamma^{k+1} \right) (I - \Gamma)^{-1} \right) u_{it} \tag{14}$$

The return decomposition stipulates that the infinite-horizon total impulse response is equal to the news on housing services. Indeed, as noted in Vuolteenaho (2002), if returns (on housing) are unpredictable, then expected return news are identically zero and the entire return is due to cash-flow news. In this way, expected return news can be first computed directly and then cash flow news can be backed out as the sum of unexpected return and expected return news. In this way, we calculate the impulse response of returns to an unexpected return, u_{1t}, by setting the return shock arbitrarily to be equal to 50 basis points while the other elements of the error vector are set equal to their conditional value given that $u_{1t} = 0.50$. To calculate the impulse response of returns to a 50 basis points cash-flow shock the normalised sum of squared errors from the VAR is minimised, subject to the constraint that $e_1' \left(I + \Gamma \left(I - \Gamma \right)^{-1} \right) u_{it} = 0.50$. Impulse responses of the other variables included in the VAR to shocks in expected return news and cash-flow news can be derived similarly, using different selection vectors.

As for the *variance decomposition* analysis, the two return components of equation (5) can be re-defined as news on dividends in the form of housing services, or rents (N_{rent}), and news on expected returns ($N_{returns}$):

$$N_{rent,t} \equiv \triangle E_t \sum_{j=0}^{\infty} \rho^j (d_{t+j}) + \kappa, \qquad N_{returns,t} \equiv \triangle E_t \sum_{j=0}^{\infty} \rho^j r_{t+j} \tag{15}$$

Since r_t-$E_{t-1} r_t = N_{rents,t}$-$N_{returns,t}$, the unexpected excess return on housing can be high if either expected future excess returns on housing decrease and/or expected future housing service flows increase. The unexpected return variance can be similarly decomposed into three components:

$$var(r_t - E_{t-1} r_t) = var(N_{returns,t}) + var(N_{rents,t}) - 2cov(N_{returns,t}, N_{rents,t}) \tag{16}$$

The variance decomposition in equation (16) can be used to assess empirically the relative importance of expected returns and changes in housing services as drivers of excess returns on housing.

4 Data

We estimate a VAR system on the basis of the empirical framework presented in the preceding Section using four basic variables: (1) excess returns on real house prices, defined as real house prices less the risk-free rate, (2) real housing rents, (3) the risk-free real interest rate and (4) real disposable income.[4] Beyond the three basic variables of house prices, rents and the interest rate implied by a dynamic dividend-discount approach, the income variable is used to augment the regression with a control for housing demand fundamentals. This can be motivated both on the basis of housing's role as a consumption good (as well as an asset), where income is a key variable in determining consumption of housing, along with income as a proxy for leverage as a conceptual analogue to the stock-market analysis of Vuolteenaho (2002). Indeed, it can be argued on economic grounds that, over the long

[4] More detailed information on the data can be found in Appendix A.

term (i.e. a period over which permanent income considerations outweigh the per-period importance of financing conditions), house prices and household disposable income should be closely linked. Beyond such an economic relationship, income may also have a statistical relationship with rents insofar as rental income constitutes an important contributor to disposable income.

The VAR estimation is based on an equally-weighted balanced panel of eight euro area countries with a weight of over 90% in euro area GDP (Belgium, Germany, Ireland, Spain, France, Italy, the Netherlands and Finland). The data are quarterly (and interpolated quarterly), spanning the period 1985-2007. The adopted lag length is 4 lags (or one year) and chosen on the basis of the results of Akaike statistical information criteria tests.

Various transformations are made to the data.The house price and risk free rate data are continuously compounded, and the excess return on housing is computed as the difference between the two series. To construct an appropriate panel for estimation, the excess return series is then cross-sectionally demeaned and normalised by division with its standard deviation.

Descriptive statistics on the above basic four variables, contained in Table 1 below, indicate that in the euro area, house prices have generally exhibited strong growth and relatively high volatility with few exceptions. Such a development has contrasted with a lower growth rate and volatility of housing rents as observed in consumer price statistics, consistent with the picture presented in Figure 1. A similar picture to house prices in relation to rents is evident when examining income, whereby growth and volatility of house prices have been higher than per capita disposable income. This implies that unexpected movements in the excess return to housing assets could play an important role for changes in expected returns to housing assets as well as changes in expected cash flows from rents. In assessing the relationship between housing, rents and income, changes in the interest rate are important given their role in the discounting of expectations embedded in house prices (as asset prices) concerning future income and rent developments.

Table 1. Descriptive statistics for variables included in the VAR analysis
%, calculated over the period 1985-2007 based on quarterly data

	Mean	*Std. dev.*	*Min*	*Max*
Real house price growth				
Belgium	5.00	4.22	-6.03	15.07
Germany	-0.58	2.23	-3.55	5.55
Ireland	6.47	6.81	-8.90	26.06
Spain	2.97	9.08	-15.63	24.86
France	3.93	4.96	-4.98	13.40
Italy	3.21	6.78	-9.43	17.84
Netherlands	5.44	4.39	-3.88	16.17
Finland	2.77	11.34	-21.73	34.89
Unweighted country average	*3.65*	*6.23*	*-9.27*	*19.23*
Real rental yield growth				
Belgium	0.84	1.33	-1.66	3.73
Germany	0.34	2.67	-8.95	7.40
Ireland	1.19	4.80	-12.98	10.89
Spain	1.44	1.87	-5.25	5.07
France	1.23	1.26	-2.09	3.66
Italy	1.08	2.31	-3.82	14.90
Netherlands	1.48	1.73	-2.72	7.74
Finland	0.51	3.36	-7.52	10.42
Unweighted country average	*1.01*	*2.42*	*-5.62*	*7.98*
Real interest rate				
Belgium	4.44	1.91	0.33	7.49
Germany	4.09	1.49	1.07	7.21
Ireland	4.14	2.90	-0.79	10.27
Spain	3.96	2.61	-0.57	9.43
France	4.39	1.73	1.18	7.33
Italy	4.58	2.23	1.16	9.19
Netherlands	4.00	1.98	-0.23	7.47
Finland	4.89	2.11	2.12	9.66
Unweighted country average	*4.31*	*2.12*	*0.53*	*8.51*
Real per capita disposable income growth				
Belgium	1.68	2.41	-2.95	9.76
Germany	2.25	2.61	-1.41	9.21
Ireland	4.92	3.07	-0.54	13.76
Spain	2.51	1.82	-2.34	5.85
France	1.63	1.30	-1.40	3.62
Italy	1.85	3.15	-7.04	8.64
Netherlands	1.42	2.08	-3.94	5.58
Finland	2.06	3.30	-6.82	9.26
Unweighted country average	*2.29*	*2.47*	*-3.30*	*8.21*

Note: See Appendix A for more information on data definitions and sources.

5 Results from the VAR analysis

Results are presented for the complete panel of eight euro area countries. The parameter estimates of the four-variable panel estimation are reported in Table 2.

Table 2. Estimated VAR

Variables included are excess returns on housing (r_t), rents ($RENT_t$), the real long-term interest rate (RIR_t), and real disposable income per capita ($YDPC_t$). Parameter estimates are presented with 4 lags. Significance at 10% level or higher denoted with an asterisk. Sample period: 1985-2007 (quarterly data).

		$dlog(r_t)$	$dlog(RENT_t)$	$d(RIR_t)$	$dlog(YDPC_t)$
$dlog(r_{t-i})$	i=1	-0.076*	-0.035	0.057	0.017
	i=2	0.015	0.027	-0.068*	0.020
	i=3	-0.091*	0.010	-0.060	0.068
	i=4	-0.269*	-0.055	-0.079*	0.022
$dlog(RENT_{t-i})$	i=1	0.097*	0.320*	-0.070*	0.022
	i=2	-0.014	0.094*	0.054	-0.050
	i=3	-0.066	0.154*	0.042	-0.033
	i=4	0.120*	-0.026	-0.168*	0.018
$d(RIR_{t-i})$	i=1	-0.134*	-0.105*	0.177*	0.060
	i=2	0.019	0.053	-0.083*	0.017
	i=3	0.038	-0.030	-0.058	0.088*
	i=4	-0.018	0.035	-0.340*	-0.044
$dlog(YDPC_{t-i})$	i=1	0.012	0.061*	-0.031	0.139*
	i=2	-0.040	0.010	0.041	0.226*
	i=3	0.012	-0.044	-0.019	0.056
	i=4	0.011	-0.006	-0.016	-0.043
Adjusted R^2		*0.1231*	*0.1839*	*0.1811*	*0.0881*

The estimates indicate that expected excess returns to housing are high when they have been low in the past, rents over the past period have generally been both significant and high, real interest rates are low and significant. Interestingly, expected excess returns appear to have an autoregressive component, which would prima facie suggest the notion that excess returns on housing are, to some extent forecastable and that the market is not completely efficient. As for expected rents, they appear to be high when they have been high in the past, income is significant and high, and real interest rates both significant and low, though the relation with excess returns is not significant. Real interest rates appear to be a negative function of past excess returns on housing, past rents and past real interest rates. Real per capita disposable income exhibits a pattern whereby a high and significant relation with itself and the real interest rate contrasts with an insignificant relation with the real interest rate and rents.

In the following subsections, we present the main VAR output in the form of first, the impulse responses to excess housing returns and second, a variance decomposition analysis.

5.1 Impulse Responses

The impulse responses in Figure 2 indicate similar dynamics in the response of returns to cash flows (rent) and expected returns, but a stronger impact of the latter in magnitude. The cumulative responses of returns for the 20 quarters (or 5 years) following each of the 50 basis point shocks appear to show a similar profile of a peak immediately following the shocks, and a subsequent decline over the following years with slight overshooting, followed by a stabilisation at a long-run rate after roughly 2.5 years. For both shocks, the magnitude of the transitory movements is roughly equivalent, at around 20-25 basis points.

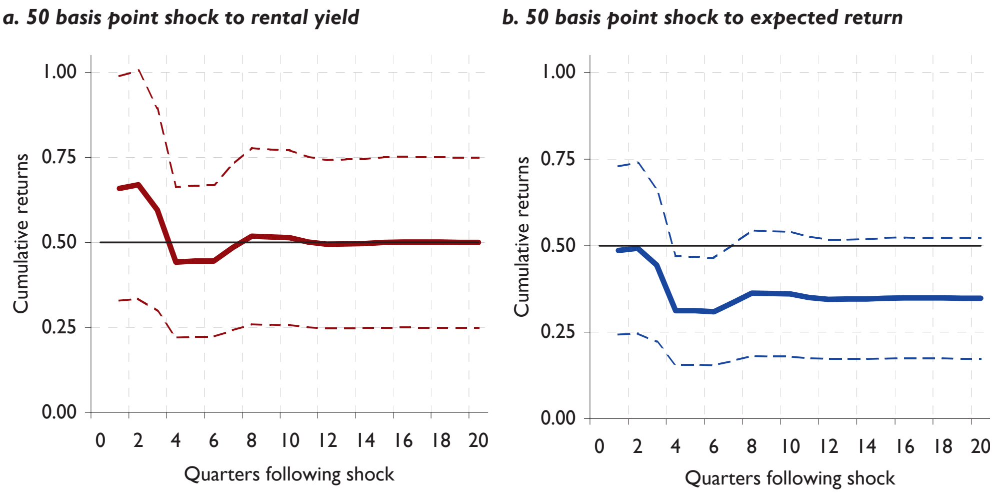
For the shock to rents (or cash flow), while the initial impact exceeds the size of the shock, cumulated returns are ultimately *exactly* equivalent to the shock to cash flow news, at 50 basis points, keeping the expected return constant. One interpretation of this finding is that house prices overreact initially –consistent with the relatively higher volatility of house prices compared with rents noted in Table 1– but then converge back to equilibrium in the medium term.[5] Information scarcity and relative risk could play a role as well in shaping these dynamics.

For expected return news, the initial impact on cumulative returns initially deviates little from the size of the shock, then converges downward (with minor overshooting) to an eventual permanent impact of around 35 basis points. In the end, this indicates that roughly 70% of the shock is permanent. This suggests some price-momentum and price-reversal patterns not unlike those exhibited for unexpected returns of stock prices.

To illustrate the possible role of heterogeneity underlying these aggregate results, an alternative specification excluding Germany, where housing market developments have differed considerably from the other countries in the panel over the last decade, do not strongly differ from the results of the complete eight country panel. Moreover, to illustrate country heterogeneity, country-specific impulse response functions are presented in Appendix B for two large countries from the panel where house price developments have differed considerably over the last years: Germany and Spain. For Germany (where house prices have been relatively stagnant in recent times) and Spain (where house prices have been relatively buoyant in recent times), the salient finding of an exact correspondence of cumulated returns to a shock to cash flow news remains, despite some divergences in the dynamic profile. The shock to expected returns, however, appears to differ across the two countries, with a strong correspondence of expected return shocks to cumulated

[5]This appears to broadly confirm the finding of Gallin (2008) for the US, who finds using an error-correction model of house prices and rents that the rent-price ratio is an indicator of valuation in the housing market.

Figure 2: **Impulse responses from selected shocks** *(%, average response along with jackknife standard error bands)*



housing returns in Germany but not in Spain, as well as relatively stronger transitory dynamics in Spain. This could partly relate to the less volatile underlying house price movements in Germany relative to Spain reported in Table 1.

5.2 Variance Decomposition

The variance decomposition implied by the model is contained in Table 3, and indicates that movements in cash flows, or rents, are the main driver of movements in housing market returns. While the unadjusted variance of cash-flow news, in the form of rents, is over four times that of expected returns, the cash-flow-news standard deviation, at 68% (variance of 0.466, with standard error of 0.028) is roughly double that of expected-return news of around 35% (variance of 0.120). The correlation between the two news series is negative and sizeable, at −0.296. This negative correlation suggests that house prices overreact to each piece of independent news. The ratio of cash flow variance to total unexpected return variance is over 50%. Overall, the results indicate that housing returns are mainly driven by news on rents (or cash flows), though with an important but less sizeable influence of expected-return variation for house prices. Consistent with the high volatility of house prices outlined in Table 1, there may be stable low-frequency variation in expected returns that have little effects on one-period unexpected returns but cause large and persistent swings in house prices.

Table 3. Variance decomposition of unexpected excess return to housing
percentage points

	Variance	Jackknife standard error
Expected return news	0.120	(0.008)
Cash-flow news	0.466	(0.028)
Correlation between expected return and cash-flow news	-0.296	(0.025)
Ratio of expected return news variance to total unexpected-return variance	0.136	(0.149)
Ratio of cash flow news variance to total unexpected-return variance	0.529	(0.527)

Note: See Table 2 for further details on the estimation.

For robustness, alternative estimations are also run both using population rather than real per capita disposable income as a control variable (given the potential importance of demographic movements in the context of the inelasticity of housing in the short term), as well as the sample excluding Germany. The variance decomposition in both cases is almost unchanged with respect to results in the baseline specification. Additionally, country-specific return decompositions are presented in Appendix B for Germany and Spain to illustrate the possible role of heterogeneity underlying these aggregate results. Results indicate a much stronger role for cash-flow news in explaining movements in housing returns in Germany, and a strong role of expected returns in driving developments in housing returns in Spain. Interestingly, however, the correlation between the two news series is positive, suggesting that house prices underreact to each piece of independent news in contrast to the aggregate results.

6 Conclusions

The application of a standard present-value formula to housing market analysis implies that house price volatility originates from some combination of cash-flow or expected-return news. This paper investigated this relationship for a panel of eight euro area countries using quarterly data over the period 1985-2007. Taking rental yields to reflect cash-flow news, and running a vector autoregressive (VAR) model together with the variables excess return on housing, the real interest rate and real per capita disposable income, the empirical investigation yields two main findings. First, the bulk of the variability of house price movements in the panel of countries analysed can be attributed to movements in the rental yield. Indeed, perturbations to rents appear to result in a one-to-one analogous movement in house prices over the long term once controlling for changes in expected returns. That said, while housing returns are driven mainly by news on country rents, there remains an important but less sizeable influence of market-wide (or expected-return) variations for house prices. Second, it appears that changes in rental yield expectations co-move negatively with changes in expected returns on housing assets, which would suggest in addition to information from the dynamic responses to shocks that house prices overreact to news. In the context of historically higher volatility in house prices compared with that of rents, stable low-frequency variation in expected returns could therefore have contributed to large and persistent swings in house prices.

There are several caveats to the analysis, notably the role of country heterogeneity, the possibility that non-market forces influence both the flexibility of house price and rents and their implied substitutability, along with the possibility of changing institutional factors, structural economic change and statistical issues that could imply some change in historical or equilibrium relationships. Nevertheless, the results can be considered as containing an illustrative assessment of the relationship between changing euro area house prices and changing fundamentals in a dynamic framework when allowing for changes in expected returns.

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Appendices

A Data sources

CONSUMER PRICE INFLATION

Definition: Overall Harmonised Index of Consumer Prices (HICP) index (used to deflate nominal variables). Seasonally adjusted using an x11 filter.

Units: Index, 2005=100.

Source: Eurostat and national sources. Series extended back using overall consumer price inflation data using national sources for Belgium (pre-1991), Germany (pre-1994), Ireland (pre-1988), Spain (pre-1992), France (pre-1990), Italy (pre-1987), Netherlands (pre-1988) and Finland (pre-1987).

HOUSE PRICE

Definition: Residential property price data deflated using consumer price inflation; existing dwellings (houses and flats, whole country) for Belgium, France, the Netherlands and Finland; all dwellings (new and existing houses and flats, whole country) for Germany, Ireland, Spain and Italy. Data interpolated to quarterly for Germany and Italy on the basis of a local quadratic procedure. Level calibrated to price per square metre in capital city in December 2007 and extended back using index. Seasonally adjusted using an x11 filter.

Units: Real price per square metre.

Source: Calculations based on ECB database of national sources (Central Bank of Belgium/STADIM, Deutsche Bundesbank/BulwienGesa AG, Permanent TSB, Ministerio de Vivienda, Notaires/INSEE, Banca d'Italia, Kadaster, Statistics Finland) and Global Property Guide (price per square metre in capital city in December 2007). ECB database extended back using data from the Bank for International Settlements (BIS) for Belgium (pre-1988), Ireland (pre-1988), Spain (pre-1995) and the Netherlands (pre-1993). Series extended back using data from Gros (2006) for Germany and France (bot pre-1995).

RENTAL YIELD

Definition: HICP component "Actual rentals paid by tenants including other actual rentals" deflated using the overall HICP index. Level calibrated to price per square metre in capital city in December 2007 and extended back using index. Seasonally adjusted using an x11 filter.

Units: Real price per square metre.

Source: Eurostat, Global Insight and national sources (index) and Global Property Guide (price per square metre in capital city in December 2007). HICP rents data extended back using consumer price inflation data of rents from national sources for Belgium (pre-1995), Germany (pre-1995), Ireland (pre-1995), Spain (pre-1995), France (pre-1996), Italy (pre-1995), Netherlands (pre-1995), and Finland (pre-1995).

INTEREST RATE

Definition: Interest rate on long-term government bonds less annual consumer price inflation.

Units: Percent.

Source: OECD Economic Outlook Database and national sources. Series extended back using national sources for Belgium (pre-1992), Germany (pre-1991), Ireland (pre-1989), Spain (pre-1993), France (pre-1991), Italy (pre-1988), Netherlands (pre-1989) and Finland (pre-1988).

POPULATION

Definition: Total population.

Units: Thousands of persons.

Source: Eurostat, Global Insight and national data. Data interpolated to quarterly on the basis of a local quadratic procedure. Eurostat series extended back using national sources for Belgium (pre-1995), Germany (pre-1991), Spain (pre-1991) and Portugal (pre-1991). Population data for Germany adjusted for unification by imposing the average growth rate observed over the period 1986Q1-1988Q4 on growth rates over the period 1989Q4-1991Q4.

PER CAPITA DISPOSABLE INCOME

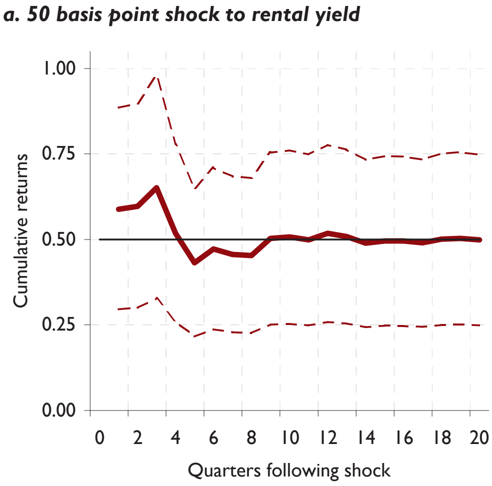
Definition: Real disposable income divided by population data. Seasonally adjusted using an x11 filter.

Units: 2005 euro.

Source: Calculations based on Eurostat, Global Insight and national data, and the Area-Wide Model database of Fagan, Henry, and Mestre (2005). Disposable income extended back using national sources the case of Belgium (pre-1995), Germany (pre-1995), Spain (pre-1995), France (pre-1995), Italy (pre-1995), the Netherlands (pre-1997) and Finland (pre-1995). Real disposable income data interpolated to quarterly for Ireland on the basis of a local quadratic procedure.

B Results of country VARs for Germany and Spain

Figure 3: **Impulse responses from selected shocks (Germany)** *(%, average response along with jackknife standard error bands)*



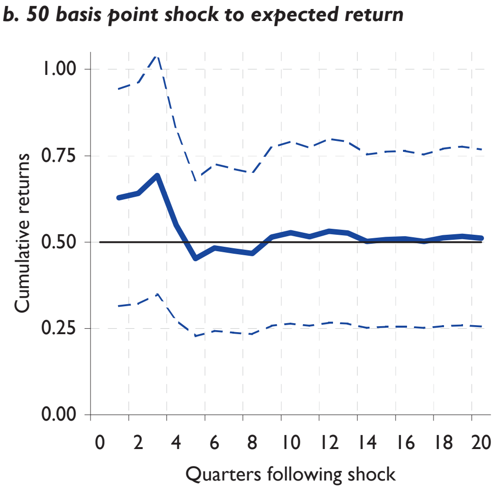


Table B1. Variance decomposition of unexpected excess return to housing
percentage points, German data

	Variance	Jackknife standard error
Expected return news	0.031	(0.005)
Cash-flow news	0.614	(0.104)
Correlation between expected return and cash-flow news	0.089	(0.030)
Ratio of expected return news variance to total unexpected-return variance	0.056	(0.058)
Ratio of cash flow news variance to total unexpected-return variance	1.104	(1.140)

Note: See Table 2 for further details on the estimation.

Figure 4: **Impulse responses from selected shocks (Spain)** *(%, average response along with jackknife standard error bands)*

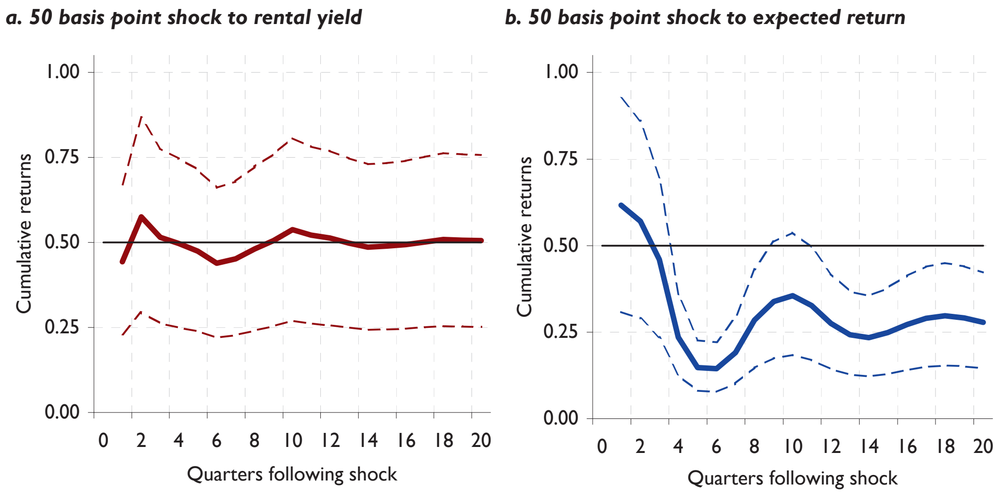


Table B2. Variance decomposition of unexpected excess return to housing
percentage points, Spanish data

	Variance	Jackknife standard error
Expected return news	0.359	(0.096)
Cash-flow news	0.409	(0.065)
Correlation between expected return and cash-flow news	0.277	(0.096)
Ratio of expected return news variance to total unexpected-return variance	0.732	(1.212)
Ratio of cash flow news variance to total unexpected-return variance	0.834	(0.825)

Note: See Table 2 for further details on the estimation.

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