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Abstract

This study analyzes the evolution of house prices in Ireland and investigates the question of whether Irish households are overexposed to certain economic risks rendering the decision to buy a house too risky and hence irrational. We use a simple theoretical framework to demonstrate the investment options of a typical household and derive the risk factors associated with the purchase of a house with respect to other types of investment.

Irish households hold the majority of their investments in property, specifically in their own houses. The empirical results illustrate that this wealth is exposed to inflation, interest rate changes and the business cycle. This exposure, while not problematic in times of low interest rates, moderate inflation and economic expansion, amplifies the risk to the value of households' investments if inflation increases, interest rates rise or the economy is in recession. We argue that the adoption of the euro has increased this risk because interest rates are exogenous to the Irish economy which could lead to a situation of deteriorating economic conditions and rising interest rates..

Our findings indicate that Irish households potentially underestimate the risk of buying a house. Viewing the purchase of a house as a risky investment could help reduce private debt in the future.

JEL classification: D14, E30, E44

Keywords: house prices, economic risk, household investment decisions

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Introduction

In 1999, Ireland, along with 10 other members of the European Union, adopted the new single European currency, the euro. Interest rates would now be set by the ECB, in accordance with conditions in the euro area as a whole. Of the original members, Ireland made up 1.4% of the euro area by GDP, and hence has very little influence over the level of official interest rates[3]. Prior to adoption of the euro, the Irish Central Bank was forced to cut official interest rates by 3% to bring Irish rates in line with those in Germany. However, this meant cutting rates aggressively in a booming economy[4] and gave rise to concerns about fuelling domestic inflation.

While consumer prices increased rapidly in the following 12 months, worries about domestic inflation receded as price levels moderated thereafter (see Figure 1). However, lower interest rates have come in tandem with an increase in personal debt. In 2005, Ireland had the second highest GNP per capita[5] in the OECD, but also the second highest level of mortgage debt per capita[6] (OECD 2006b). These debt levels mean Irish households are overly exposed to interest rates, at a time when a concerted tightening cycle by the ECB has left many Irish households with a sharply reduced disposable income and has put pressure on consumer spending, the property market and with it tax receipts and the government's fiscal situation.

From December 1999 to September 2007, private sector credit grew by 340% and household mortgage debt by 389%. Much of this additional borrowed money has been invested in housing. National Irish Bank (2008) showed Irish households have 67% of their investment portfolio in property, of which 49% is in their own homes. This has been a highly profitable strategy when house prices increased, but has exposure to interest rates, inflation and the business cycle at a time when all are moving in directions which are unfavourable to Irish households. While inflation and the business cycle have domestic drivers, interest rates are now an exogenous variable in the Irish economy. The current issues in the credit markets did not precede the downturn in the Irish housing market, but have brought into focus the unbalanced nature of Irish household investment.

[3] At December 2007, this figure was 2.1%
[4] Real GNP growth in the period 1995-1998 averaged 8.1% per annum (Reuters Ecowin)
[5] second to Luxembourg as of 2005
[6] second to New Zealand as of 2005

Literature Review

In the period 1995-2005, real Irish house prices increased by over 200%, the largest increase in the period in the OECD (OECD 2006a). Both the duration and the magnitude of real price increases are unprecedented for Ireland and have coincided with the longest sustained period of economic growth in Ireland's history, with GNP increasing from 47.0bn to 135.7bn euros in the same period (Reuters Ecowin), an average annual growth rate of 10.6%. However, in recent years, the drivers of Irish GNP growth have switched from exports and FDI to consumption and rising property valuations leaving Irish households' investment portfolios overexposed to property, primarily through their own homes. Private sector credit grew by 340% from December 1999 to September 2007. In the same period, household mortgage debt rose by 389%.

Stevenson (2008) suggested that Irish house prices were justified by economic fundamentals up to 2003, with the exception of the period 1999-2000 where prices were judged to have exceeded those warranted by fundamentals. He also highlighted Ireland's unique experience in having strong growth in the 1990s followed by a period of negative real interest rates as a key driver for the housing market in this period. Roche (2001) forecast that prices would continue to rise as long as interest rates were kept low in the euro area – and indeed the next tightening cycle in euro area interest rates did not commence until November 2005; 15 months before the Irish housing market reached its peak level in February 2007 (permanent tsb index).
McQuinn (2004) used quarterly data to develop a model of Irish house prices, decomposed into fundamental and non-fundamental. He found that in 2002 house prices were justified by fundamentals, similar to Stevenson's finding.

From September 2003, when the Stevenson study ended, until their peak in February 2007, Irish house prices increased by a further 38%. This time period was characterised by increasing competition and liberalization in the mortgage lending market, with several new entrants to the market, increasing mortgage terms and loan-to-value ratios combined with continuing low real interest rates to drive mortgage lending growth. From September 2003 to September 2007,

household mortgage finance grew from 50.5bn to 120.5bn euros, increasing at an average annual rate of 29.0%. (Reuters Ecowin[7]).

By 2007, studies were beginning to show Irish housing investment had the pattern of a speculative bubble. Kelly & Menton (2007) introduced figures on buy-to-let mortgages and found that they accounted for 25% of outstanding Irish mortgage lending – 3 times the proportion for the UK, which has a similar institutional structure to Ireland in its housing market. They also pointed to survey evidence that buy-to-let investors consist mostly of individual investors, who may be less able to weather a downturn in the market due to a smaller capital base. The Central Bank and Financial Services Authority of Ireland (2006) found capital gains are a large element of expected returns for property investors, and that returns would be negative for many investors if prices did not increase. Both these findings support the contention that Irish property investors were depending on further price appreciation to make profits on their investment, increasing the risk of the investment. This supports the findings of Case & Shiller (2003) that, during a bubble, homebuyers will buy a home which is normally too expensive in the expectation of future price increases, and will also save less, expecting their house to accumulate capital gains to compensate.

McQuinn & O'Reilly (2006) developed a model that determined Irish house prices in terms of the amount available for borrowing, and in a follow-up paper in 2007 found a direct relationship between credit availability and house prices, which was also found by Fitzpatrick and McQuinn (2007). Now it seemed as if Irish house prices were no longer driven by fundamentals but by cheap credit, and Irish property investors were not accounting for risk correctly, but behaving as if further price gains were guaranteed.

What are the risks involved in investing in Irish property? Quite apart from the degree of leverage taken on by Irish mortgage holders, housing as an investment class is risky in its own right, having exposure to several macroeconomic variables which may not be being accounted for by Irish investors.

Firstly, many studies have found a positive correlation between house prices and the business cycle. Ahearne et al. (2005) found real house prices are pro-cyclical and in addition that house price booms are typically preceded by periods of loose monetary policy. Co-movement of property prices and the business cycle also imply that banks' losses on mortgage lending are

[7] The figures are obtained from Domestic Finance – Deposits, Lending and Loans – Consumer Credit in Ecowin.

likely to be correlated with losses in other lines of business. These findings become particularly relevant for Ireland when we consider the interest rate path following the introduction of the euro in 1999 and the increasing importance of property to the Irish economy – in 2006 82% of new investment in the economy was property-related (CBFSAI 2007). Iacoviello & Minetti (2003) also found that not only does financial liberalisation directly spur house prices, but it can also increase the sensitivity of the housing market to monetary policy. The IMF (2008) found that, while real house prices lag the output gap in most countries, this position is reversed for Ireland with real house prices leading the output gap by 4-8 quarters, emphasising the risk to the Irish real economy of a sustained house price deflationary episode. The same study also found that the real residential investment comprised 12% of GDP in Ireland, the highest in the sample, compared to a long-run average for developed economies of 6.5%.

Borio & McGuire (2004) found high correlation between housing and share prices and that house price peaks tended to occur in the wake of economic upturn, and were exacerbated by credit shocks. Crucially, once the housing market peak had past, the relationship with equity markets was not strong, and the housing market downturn was driven solely by the dynamics of its previous expansion.

When considering housing as an investment class, we should consider the possibility of an investment in housing being a hedge against inflation. Huang & Hudson-Wilson (2007), Bond & Seiler (1998) and Anari & Kolari (2002) found residential real estate a significant hedge against expected and unexpected inflation, However, Hoesli et al (1997) found stocks offer a better hedge against unexpected inflation than property in a study of the U.K., which has a similar mortgage market structure to Ireland.

In summary, the literature shows that Irish house prices are exhibiting the behaviour of a speculative bubble, with price increases being driven by credit growth and investors requiring high amounts of leverage and relying upon capital gains to get positive returns from their investment. In addition, the literature shows positive correlation between residential property and the business cycle, with the IMF study in particular suggesting residential property investment is a major driver of Irish GDP.

Let us highlight some distinctive aspects of the situation in Ireland. Firstly, there is the degree of the increase in house prices, and of private sector debt. Ireland since 1999 has been a member of the euro area and as such has no independent monetary policy and has fiscal policy constrained

by the Maastricht criteria. Maclennan et al. (2000) found that, of the euro area countries, Ireland, with Finland, has a markedly high response to monetary policy due to the institutional structure of its mortgage and corporate lending markets.

This paper aims to illustrate the evolution of Irish house prices, and to better understand and assess the risks a typical household faces from macroeconomic risk factors such as interest rates, inflation, the business cycle and the stock market. We contribute to the literature by showing the nature of the exposure that Irish house prices have to interest rates, inflation and the business cycle. In addition**,** we develop a theoretical model to demonstrate the investment options of Irish households. Finally, the empirical analysis uses monthly data in contrast to quarterly data used in other studies.

The paper is structured as follows: the first section uses a simple theoretical model to demonstrate the main determinants of a households' decision to buy a house or to rent a house. It also presents a formula for the optimal degree of leverage to finance a house. Section two introduces the econometric models employed to estimate the determinants of house prices in Ireland, section three presents the empirical results separated in a descriptive part and an econometric part. Finally, section four summarizes the main results and concludes.

I. Theoretical Framework

In this section we provide a theoretical framework that identifies the economic risks associated with the investment decisions of a typical household. The economic risks derived from the model will be used as ingredients in the econometric specification.

A. Capital Allocation

We start with a basic utility function determining the capital allocation between a risky asset (or portfolio) and a risk-free asset. The utility function U for a composite portfolio (denoted as c) comprising a risky portfolio (asset) and a risk-free asset is given as follows:

$$U = E(r_c) - \gamma \sigma_c^2 \qquad (1)$$

where $E(r_c)$ is the expected return of the composite portfolio C, γ is a risk aversion parameter and σ_c^2 is the risk of the composite portfolio. The expected return of portfolio C depends on the weight, m, assigned to the risky portfolio p and the risk-free asset f:

$$E(r_c)= m\, E(r_p) + (1-m)\, r_f \qquad (2)$$

Hence, the utility function can also be written as

$$U = m\, E(r_p) + (1-m)\, r_f - \gamma\, \sigma_p^2 \qquad (3)$$

The utility depends on the returns of portfolio p and f, the weights assigned to these portfolios (m and (1-m), respectively) and the risk (variance) of portfolio p and the risk aversion of the investor. The weight m allocated to the risky portfolio would normally be between zero and one for the representative investor. If the investor does not invest in a risky (optimally a well-diversified) portfolio but in a house, the utility function becomes

$$U = \underline{m}\, E(r_h) + (1-\underline{m})\, r_f - \gamma\, \underline{m}^2\, \sigma_h^2 \qquad (4)$$

where $\underline{m}$ and $(1-\underline{m})$ are the weights assigned to the house and the risk-free asset, respectively. The weights are denoted differently compared to equations 2 and 3 in order to stress that they are determined by factors such as the purchasing price of the house and the degree of leverage undertaken, and are thus not explicitly chosen by the household. The weight for the house is thus discrete (0 or $\underline{m}$) and not continuous as is m. The expected return of the house is denoted as $E(r_h)$, and σ_h^2 is the variation of the value of the house. Note that we assume that r_f is risk-free and thus uncorrelated with the variance (risk) of the house price. In the case that r_f is not risk-free which can be assumed to be the case if the household borrows money to finance the house purchase, the risk of buying a house is given by the sum of the house price variation, interest rate variation and the covariance of both variables.[8]

If the investor does not have sufficient capital, he will hold a leveraged position with $\underline{m}$ larger than one. For example, if an investor invests 50% of the purchase price and borrows the same, m=2. In the extreme case of a 100% mortgage, $\underline{m}$ is infinite[9].

[8] The variance is $\sigma_p^2 = \underline{m}^2\, \sigma_h^2 + (1-\underline{m})^2\, \sigma_f^2 + 2\, \underline{m}\, (1-\underline{m})\, \sigma_{h,f}$

[9] Although 100% mortgages were offered to Irish borrowers from June 2005 until recently, a 100% mortgage violates the assumption of rational behaviour as housing is a risky investment.

Equation 4 implicitly assumes that all variables are constant or represent average numbers over a given time period, e.g. 30 years. We relax this assumption and introduce a time-varying variance which is a function of a number of macro factors. Variations of the house price ($\sigma^2(r_h)$) are assumed to depend on the interest rate, inflation, the business cycle and alternative investments, e.g. the stock market. The interest rate will affect house prices by influencing the costs and the availability of mortgages, and the business cycle will affect house prices by increasing or decreasing the demand for houses. The role of inflation is less clear since it might increase the demand for houses as an inflation hedge or raise interest rates rendering the purchase of a house less profitable. Finally, alternative investment opportunities might change the relative profitability of real estate investments hence changing the prices of these investments. The variance of house prices can be written as follows:

$$\sigma^2(r_h) = f(i, \pi, g, r_a) \qquad (5)$$

where i is the interest rate, π the inflation rate, g the economy's growth rate and r_a the return of alternative investments. All variables could also be expressed with an expectations operator E( ) emphasizing their stochastic nature, that is, that their future values are uncertain.
The representative investor wants to maximize her utility by taking the derivative of equation 4 with respect to the weight invested in the risky asset. This maximization yields

$$m^* = [E(r_h)-r_f)]/ \gamma f(i, \pi, g, r_a) \qquad (6)$$

The optimal proportion of an investor's wealth m* depends on the differential between the expected return of the house price and the risk free rate, the risk aversion parameter and the risk of house price variations represented by the function f. This value can be compared with the purchasing price of the house, $\underline{m}$. If m* is larger than $\underline{m}$, the purchase is not optimal. In contrast, if m* is smaller or equal to $\underline{m}$, it is optimal to purchase the house for the price $\underline{m}$.
Interestingly, all variables except the risk aversion parameter γ are available on a historical basis. Therefore, we can compute m* over time by using a calibrated risk aversion parameter for average values of $\underline{m}$ or m*. This is done in section II.
Equation 5 can also be used for an econometric model which estimates the risk of house prices by regressing the variance of house prices (estimated with a GARCH model) on the variables specified in equation 5. Results are presented in section III.

B. The Risky Portfolio - Buying or Renting?

This section aims to introduce another utility function which emphasizes the choices of the investor or the potential house buyer. This section does not focus on capital allocation, that is, how much a rational investor should invest in real estate or how much money a rational investor should lend or borrow, but rather whether to invest in real estate or in other assets. In other words, this section focuses on the choice of the risky asset or portfolio, that is, stocks, bonds, commodities or a house.

Buying a house is an investment. This is true even though it might be seen as a necessity by households due to a long-rooted tradition in certain countries. Renting a house is a feasible alternative in many countries and is allowed.[10] The utility associated with the decision to buy a house instead of renting it can be represented by the following utility function:

$$U = p\,E(r_h) - [\lambda\, p\, E(i) - rent\,(1+E(\pi))] - (1-\lambda)\, p\, E(r_a) \qquad (7)$$

where p is the price of the house at the time of the purchase, λ is the degree of leverage[11] and rent denotes the average rent that would have to be paid for the house or a house resembling the essential features of the one purchased. The expected (average) change of the house price is given by $E(r_h)$, the expected (average) inflation is represented by $E(\pi)$ and the expected (average) return on an alternative in investment is denoted as $E(r_a)$. Equation 7 comprises three main terms. The first term represents the absolute return of the investment in the house, the second term represents the opportunity cost of not renting a house. If the rent is higher than the interest payments (excluding payments on the principal), the term is positive providing a marginal benefit to the house buyer. If, on the other hand, the rent is lower than the interest payments on the mortgage, the house buyer faces a marginal cost associated with the purchase of the house. The third term represents the opportunity cost of not investing in alternative assets such as stocks. The higher that return is, the lower is the utility level of the house buyer.

If the interest payments equal the potential future rent payments, the second term is zero.

Mortgage payments are not included in the utility function since they do not determine the decision to buy a house or, alternatively, to rent a house. If the interest payments on the mortgage

[10] The attractiveness of renting a house might well depend on the rights of tenants established in national laws. Tenants' laws vary significantly and might explain different preferences across countries.

[11] The degree of leverage is $\lambda=(m-1)/m$, i.e. the percentage of the purchase price which is borrowed.

are smaller than potential rental payments, the difference will yield a positive marginal utility and can be invested in payments on the principal or in alternative assets.
One could add an additional term to equation 7 representing the net utility of the benefit to live in your own house and the cost of being financially constrained due to mortgage payments. We assume that the two effects cancel each other out and therefore do not include such a term in equation 7.

Equation 7 shows that the utility of a house buyer is determined by several factors whose future values are uncertain. These factors are house price appreciation (r_h) , interest rates (i), inflation (π) and the return on a potential alternative investment (r_a). These determinants influence the decision of a typical household and are thus micro-founded. However, the obtained determinants are also variables that are available on a macro-level providing the opportunity to relate these variables to house price changes on a macroeconomic level.

II. Econometric Framework

This section describes the econometric framework that will be employed to assess whether Irish households were rational. The capital allocation decision outlined above demonstrated that the volatility of house prices as a risk measure is a variable of interest. However, both the capital allocation decision and the choice of the risky portfolio (decision in which asset class the investor should invest in) both stressed that the expected (average) return of the house price is a major component per se, not only the variation of the return. We therefore analyze both the returns and the volatility of house prices in order to determine which variables contribute to positive or negative returns and to lower or higher fluctuations (risk) of housing investments. The variables will be chosen based on the theoretical analysis described above and the availability of other, potentially important variables. Descriptive statistics and regression models will further reveal the correlation among the variables and thus demonstrate the total effect on house prices.

The basic model (implicitly derived from equation 7) is given as follows

$$r_{ht} = \alpha\, i_t + \beta\, \pi_t + \gamma\, r_{at} + \boldsymbol{\varphi}\mathbf{X_t} + \varepsilon_t \qquad (8)$$

where i denotes the interest rate, π the inflation rate, r_{at} the return on the alternative investment and **X** is a regressor matrix including additional variables such as GDP, household sentiment and expectations. The subscript t denotes the time and clarifies that we are interested in dynamic relationships. Equation 8 assumes that there is a contemporaneous relationship between the house price change (dependent variable) and the other variables, e.g. the inflation rate. Note that this is only the basic structure and that lagged effects will also be considered. It is well known that interest rate changes need time to transmit to the real sector or the housing sector in this case. Hence, analyzing the effects of lagged interest rate changes is an essential part of a sound econometric analysis. Since it is a priori not clear how many lags should be included in the model, we will employ a general to specific estimation methodology where a large number of lags is considered, e.g. 12 lags for monthly data. If the 12th lag is not significant, the model is re-estimated with 11 lags and so forth.[12]

The same structure can be used to model the risk of house prices. The risk is quantified as the volatility of house prices (see equation 5). To obtain a time-varying risk measure, we estimate an asymmetric GARCH (1,1) model with the variables used above and derived in equation 7 being part of the conditional volatility equation. The asymmetric GARCH(1,1) model can be written as follows:

$$r_{ht} = c + \varepsilon_t$$

$$h_{ht} = (a + b\,\varepsilon^2_{t-1} + c\,\varepsilon^2_{t-1}D_{neg} + d\,h_{ht-1}) \exp(\alpha\, i_{t-1} + \beta\, \pi_{t-1} + \gamma\, r_{at-1} + \boldsymbol{\varphi}\mathbf{X}_{t-1}) \qquad (9)$$

The variables of interest enter the conditional volatility equation as a multiplicative heteroscedasticity component. The term in the exponential function increases the conditional volatility if the value is positive and decreases it if the values are negative.

Finally, we analyze additional issues. First, it is possible that the focus on changes cannot capture a long-run equilibrium relationship between house prices and the variables studied. Therefore, we analyze whether there is a co-integration relationship between the variables. Moreover, we analyze whether the low interest rate regime caused by joining the euro is responsible for the strong evolution of the house prices in Ireland. To test this hypothesis a Granger causality test will be applied.

[12] E.g. Campos, Ericsson and Hendry (2005)

III. Empirical Analyses

This chapter first describes the data used for the study in section A and then presents the estimation results in section B.

A. Descriptive Statistics

We use aggregate monthly data of Irish macroeconomic variables and survey data obtained from Reuters Ecowin, Datastream and permanent tsb. The sample spans a time period of 12 years from April 1996 to December 2007 yielding 141 observations per time series. Table 1 displays the summary statistics for all variables in the data set starting with the nominal interest rate (3-month rate), the stock market (ISEQ20), production and three different house price indices (first time buyers, new houses and existing houses). The table also includes series based on survey data complied by the European Commission (DGECFIN), unemployment and employment, earnings and the consumer price index (CPI). The survey data is explained in more detail in table 1*.
Table 1 reports the mean, the standard deviation and the minimum and maximum values of the log-changes of the variables.[13] Some values are of particular interest in this study. For example, the average interest rate change is negative for the sample period which can be attributed to the adoption of the euro currency (see also figure 1). Moreover, while the stock market returns are positive on average with a value of 0.0074 and a standard deviation of 0.0526, it is important to note that the average returns of the house price indices are larger (between 0.0091 and 0.0097) with a standard deviation around 0.01. This implies that housing investment exhibited higher returns than stock markets at a lower risk. Finally, the average (monthly) inflation rate (cpi) is 0.0028 amounting to values around 3% per year.

Table 2 reports the unconditional correlations of the log-changes of five key macroeconomic variables, that is, house prices (existing), the interest rate, the stock market, production, earnings and cpi. The table shows the correlations for the full sample period and two sub-samples, a pre-Euro sample and a post-Euro (introduction) sample. The main findings are that house prices are negatively correlated with the other variables (except cpi) but with relatively low absolute numbers. This pattern changes significantly for the post-Euro period for which the unconditional correlation is positive for the interest rate, the stock market, earnings and cpi.

[13] We use logarithmic changes because since in this case the coefficient estimates can be interpreted as elasticities.

These results show that there is a positive co-movement between house prices and interest rates, the stock market, earnings and 12-month changes in cpi, which suggests that a house can serve as a hedge against rising interest rates and inflation. However, despite the relatively low correlations, it is important to stress that these results are based on unconditional correlations which implies that they represent the isolated effect on house prices. The regression results below will clarify that there are important differences if all variables are considered jointly and not separately. Such a joint consideration is also consistent with the main question addressed in this paper since a typical household is not exposed to just one economic risk but to several different risks simultaneously.

< Insert table 1 about here >

< Insert table 2 about here >

< Insert figure 1 about here >

B. Estimation Results

This section presents the estimation results of the regression models outlined in the econometric framework.

B1. House Price Determinants

Table 3 presents the estimation results of the regression model chosen with a general-to-specific estimation technique. The dependent variable is the log change of the house price (existing house price index) and the regressors are interest rates, inflation, stock market returns and production as a proxy for the business cycle.[14] The regression results show that the interest rate plays a significant role in the determination of the house prices. Rising interest rates decrease house prices and falling interest rates increase them. Note that there is a contemporaneous effect (-0.0356) and lagged effects (3-month lag (0.0489) and 6-month lag (-0.0455)). The aggregate effect is negative (-0.0322) and given by the sum of the contemporaneous effect and the lagged effects. An alternative estimation without any lagged effects of the interest rate yields a

[14] Production figures were used due to their availability on a monthly basis. GDP data is only available on a quarterly basis.

coefficient estimate of -0.02547. The coefficient estimate of the log-change in the consumer price index (cpi) is negative and the effect of the returns of the stock market (ISEQ20) is positive. However, both coefficient estimates are statistically insignificant. Finally, the effect of production representing the business cycle appears to be the most important variable since the coefficient estimates of the contemporaneous and lagged effects are all positive and significant. This implies that there is a strong co-movement of house prices and the business cycle. Other variables such as earnings or employment (see table 1 for details) were also considered but are not included in the final model due to economically and/ or statistically insignificant coefficient estimates.

< Insert table 3 about here >

It is possible that the relationships changed with the introduction of the Euro currency. Thus, we divide the full sample into two sub-samples. Table 4 shows the results for the period prior to the Euro introduction in 1999 and table 5 shows the results for the period after the introduction of the euro. Major differences for the pre-euro period are the contemporaneous negative effect of the interest rate (no significant lagged effect), the positive and relatively large coefficient above 1.3 for inflation (cpi) though statistically insignificant and the negative relation of house prices with the stock market (-0.1183). Finally, the coefficient estimates representing the influence of the business cycle (production) are considerably larger in the pre-Euro era compared to the full sample. The overall explanation of the variables, however, is similar (34% for the full period and 32% for the pre-Euro period). The results for the post-Euro period show that all variables have a smaller absolute influence on house prices than in the pre-Euro period. The estimates are insignificant for interest rates, inflation and the stock market and the business cycle effect is still significant but the coefficients are clearly smaller. These results indicate that the influence and thus exposure has changed over the years and is smaller in the post-Euro introduction era than in the pre-Euro era. Before concluding that the Irish housing market has decoupled from the real sector and was more driven by speculation or other factors, we further investigate the post-Euro episode by estimating a rolling windows regression with a 36-month window length. The results confirm the pre-Euro and post-Euro estimation results and additionally show that there is a strong downward trend for inflation (cpi), an upward trend for the stock market and large swings around zero for the interest rate and production. The coefficient estimates are larger than one for cpi in the beginning of the sample and become negative in the end of the sample with values around -0.3. The magnitude of the effects for the other variables is relatively small compared to the estimates for cpi and range between -0.05 and +0.05.

It is thus appropriate to conclude that the Irish housing market has temporarily decoupled from the business cycle and Euro zone interest rates. The negative impact of inflation on house prices implies that inflation hurts Irish households through lower house prices and higher prices for goods and services.

< Insert table 4 about here >

< Insert table 5 about here >

B2. House Price Volatility

This section presents estimation results that illustrate the relationship between macroeconomic variables and the risk (volatility) of the average house price in Ireland. The estimation results are based on equation 9 and are presented in table 6. In addition, figure 2 shows the relation of the house price index and the estimated risk (volatility) of this index through time.

Table 6 shows that all key macroeconomic variables (interest rate, the stock market, production and inflation (cpi)) influence the conditional volatility of the average house price. The interest rate exhibits a negative relation with the house price index while the other variables display a positive relation with the index. Thus, the interest rate tends to lower the conditional volatility while the other variables tend to increase the risk of investments in the housing market. The GARCH model estimates are significant (0.55 is the ARCH coefficient estimate and 0.53 is the GARCH estimate) in contrast to the asymmetric component (threshold ARCH) which negative and statistically insignificant. The relatively large coefficient estimate suggests, however, that there is some economically significant effect implying that negative shocks increase the risk more than positive shocks.

< Insert table 6 about here >

< Insert figure 2 about here >

B3. Calibration of Optimal Capital Allocation

This section presents the results of a calibration exercise with the objective to obtain time-varying estimates of the average percentage amount invested in the housing sector. This figure is obtained by using equation 6 ($m^* = [E(r_h)-r_f)]/ \gamma f(i, \pi, g, r_a)$) and calibrating gamma by assuming an

average value (through time) for m*. The other variables are part of the data set and can thus be used to compute a time-varying estimate for m* denoted as m_t* conditional the average value for m*. The main interest is thus not the level but the variation through time. Figures 3 and 4 present the estimates for average values of m* equal to 1 and 0.5, respectively.

< Insert figure 3 about here >

< Insert figure 4 about here >

The figures show that there is a significant degree of variation ranging from -4 to +4 for m*=1 on average and from -2 to +2 for m*=0.5. High values of m indicate a high degree of leverage. Not surprisingly, periods with a relatively high m coincide with increasing house prices. A negative value of m means an overinvestment of wealth in risk-free assets. The realizations of m can be used as an indicator that shows changes in the average degree of borrowing or lending.

B4. Alternative Determinants

This section goes beyond the theoretical models' variables and uses alternative variables in the regressions. Two different models are considered. The first model re-estimates the basic regression model but uses an alternative consumer price index comprising only alcoholic beverages, tobacco and narcotics. The second model only considers consumer survey data (all DGECFIN variables available) as potential regressors. The results are presented in table 7 and show that the alternative consumer price index is positive and significant which contrasts the findings for the commonly used CPI. Since the alternative index is only available for the last five years of the sample, the results are based on a sub-sample of the post-Euro period. The fact that production is not significant (contemporaneous and lags) is not counter to the findings obtained before but only due to the restricted sample period. Note that only the last 5 years of the sample are used in the estimation.

< Insert table 7 about here >

The second model uses all sixteen survey indicators in an initial regression and then applies the general to specific methodology by subsequently eliminating all variables that are insignificant. This procedure yields a specification with three variables, that is, a consumer survey based on the economic conditions over the last 12 months, a survey on major purchases over the next 12

months and a survey based on savings over the next 12 months. The first two variables' coefficient estimates are positive and the last one is negative. This means that positive economic conditions in the past and in the future positively affect the house price index while future savings decrease the index. These results are consistent with economic theory and might provide some evidence for the hypothesis that Irish households forecast future economic conditions reasonably well.

Another potential variable that influences house prices in Ireland is the change in the population. Ireland experienced a strong growth in its population. Quarterly data of the population aged 15 years or older (Reuters Ecowin) shows an increase from around 2.8 million in 1997 to 3.5 million in 2007. In addition, it is likely that the large numbers of immigrants (prominently from Eastern European countries)[15] contributed to the growth in house prices. Since most of these immigrants plan to return to their home country after a couple of years or as soon as economic conditions would be less favourable, the outflow of immigrants could worsen an already bad situation and amplify a crisis in the housing market. Due to the non-availability of monthly data on immigration or population, we are not able to estimate this effect.

B5. Co-integration

The final question we ask is whether there is a long-run equilibrium relationship between house prices and the interest rate. It is possible that the focus on log-changes of the variables eliminates or misses a (long-run) relation in levels. The first step for such an analysis is to assess whether the variables exhibit a common degree of integration. If there is a common degree of integration, the residuals of a regression of one variable on the other are analyzed. If these residuals are I(0), there is a co-integration relationship. The estimations show (results are not reported due to space considerations) that the variables are both integrated as I(2) but that there is no long-run equilibrium relationship between the two variables. The Dickey Fuller test for the residuals of a regression of the house price index on the interest rates illustrates that the null hypothesis that the residuals follow an I(1) process cannot be rejected.

C. Specification Issues

This subsection briefly describes some specification issues and reports estimation results as a part of a robustness analysis (Results are not reported due to space considerations). Since we employed different models (house price returns and volatility) and also estimated the main

[15] http://www.cso.ie/releasespublications/documents/population/current/popmig.pdf

models for the full sample and two (pre- and post-Euro) sub-samples including an analysis of the last six years (table 7), the main estimation results already include basic robustness checks.

All results are based on a house price index for existing houses. If we re-estimate the model with two alternative house price indices (new houses and first-time buyer houses), the results are different. The major difference is in the coefficient estimates for inflation. While the coefficient is negative for the 'new house'-index, it is positive for the 'first-time buyer' house price index. The goodness of fit (R squared) falls from 27% for the original model to 18% for the first-time buyers and to 14% for the 'new house' index.

The model for the volatility of house prices (GARCH model) was also re-estimated for the two sub-samples and the results are consistent with the findings for the main model. Finally, including the variables also in the mean equation does not qualitatively change the results in the variance equation.

IV. Conclusions

This study analyzed the relation of house prices with key economic variables in order to assess the exposure of a typical Irish household to economic risks such as interest rate changes, inflation and the business cycle. The empirical analysis of a newly compiled data set, comprising monthly data over the last 12 years shows that investments in the Irish housing market have yielded high returns with a relatively low level of risk compared to the Irish stock market index. The regression results further show that house owners are negatively exposed to positive interest rate changes, higher inflation and lower or negative growth rates of the economy. The exposure is not problematic in times of low interest rates, moderate inflation and high economic growth but poses severe risks to households if inflation increases, interest rates go up and economic growth slows.

We further argue that the introduction of the Euro added to the total risk since interest rates and the business cycle can move simultaneously in unfavourable directions rendering the joint exposure larger. If Ireland is in a low-growth regime and the major EU countries are in a high-growth regime with increasing interest rates, Irish households might be affected by falling house prices, higher mortgage payments and the risk of becoming unemployed.

This paper aims to raise awareness that house buyers need to consider all relevant risks involved in the purchase of a house. It has been rational for a long time for Irish households to hold the majority of their assets in their houses, but this is unlikely to be the case going forward, as

macroeconomic risk factors to which households are exposed now begin to move in unfavourable directions.

The economic framework emphasizing the choices of rational households and the empirical results show that the purchase of a house is risky and should not be considered as a natural form of investment

References

Ahearne, A., J. Ammer, B. Doyle, L. Kole & R. Martin (2005), "House Prices and Monetary Policy: A Cross-Country Study", International Finance Discussion Paper 841, Board of Governors of the Federal Reserve System, September

Aksoy, Y., P. de Grauwe & H. Dewachter (2002), "Do asymmetries matter for European monetary policy?", *European Economic Review* 46

Anari, A. & J. Kolari (2002), "House Prices and Inflation", *Real Estate Economics*, Vol 30 No. 1

Bond, M. & M. Seiler (1998), "Real Estate Returns and Inflation: An Added Variable Approach", *Journal of Real Estate Research*, Vol 15 No. 3

Borio, C. & P. McGuire (2004), "Twin Peaks in Equity and Housing Prices?", *BIS Quarterly Review*, March

Case, K. & R. Schiller (2003), "Is there a bubble in the Housing Market?", *Brookings Papers on Economic Activity*, Vol 2003 No. 2

Campos, J., Ericsson, N. R. and D.F. Hendry, (2005), "General-to-Specific Modeling: An Overview and Selected Bibliography", *FRB International Finance Discussion Paper No. 838* Available at SSRN: http://ssrn.com/abstract=791684

Central Bank and Financial Services Authority of Ireland (2006), "Financial Stability Report", in Annual Report 2006

Central Bank and Financial Services Authority of Ireland (2007), "Sectoral Developments in Private-Sector Credit", December

Fitzpatrick, T. & K. McQuinn (2007), "House prices and mortgage credit: empirical evidence for Ireland", *The Manchester School*, Vol 75 No. 1

Hoesli, M., B. Macgregor, G. Matysiak & N. Nanthakumaran (1997), "The Short-term Inflation-hedging Characteristics of U.K. Real Estate", *Journal of Real Estate, Finance and Economics*, Vol 15 No. 1

Huang, H. & S. Hudson-Wilson (2007), "Private Commercial Real Estate Equity Returns and Inflation", *Journal of Portfolio Management,* Special Real Estate Issue

Iacoviello, M. & R. Minetti (2003), "Financial Liberalization and the Sensitivity of House Prices to Monetary Policy: Theory and Evidence", *The Manchester School*, Vol 71 No. 1

IMF (2008), "The changing housing cycle and the implications for monetary policy", World Economic Outlook, April

Kelly, J. & A. Menton (2007), "Residential Mortgages: Borrowing for Investment", Central Bank and Financial Services Authority of Ireland, Quarterly Bulletin 2

Maclennan, D., J. Muellbauer & M. Stephens (1998), "Asymmetries in housing and financial market institutions and EMU", *Oxford Review of Economic Policy*, Vol 14 No. 3. Updated July 2000

McQuinn, K. & G. O'Reilly (2006), "Assessing the Role of Income and Interest Rates in Determining Irish House Prices", Central Bank and Financial Services Authority of Ireland, Financial Stability Report

McQuinn, K. & G. O'Reilly (2007), "A Model of Cross-Country House Prices", Research Technical Paper, Central Bank and Financial Services Authority of Ireland, July

McQuinn, K. (2004), "A Model of the Irish Housing Sector", Research Technical Paper, Central Bank and Financial Services Authority of Ireland, April

National Irish Bank (2008), "The Emerald Isle: The Wealth of Modern Ireland", February

OECD (2006a), "Recent House Price Developments: The Role of Fundamentals", *OECD Economic Outlook No. 78*

OECD (2006b), "Has the Rise in Debt made Households more Vulnerable?", *OECD Economic Outlook No. 80*

Rae, D. & P. van den Noord (2006), "Ireland's housing boom: what has driven it and have priced overshot?", OECD, Working Paper, June

Roche, M. (2001), "The rise in house prices in Dublin: bubble, fad or just fundamentals", *Economic Modelling*, Vol 18 Issue 2

Stevenson, S. (2008), "Modelling Housing Market Fundamentals: Empirical Evidence of Extreme Market Conditions", *Real Estate Economics*, Vol 36 No. 1

Figure 1: Inflation rate and interest rate

This figure presents the evolution of interest rates (3-month DIBOR before January 1999, 3-month EURIBOR thereafter) and Irish inflation levels (change in CPI index in preceding 12 months)

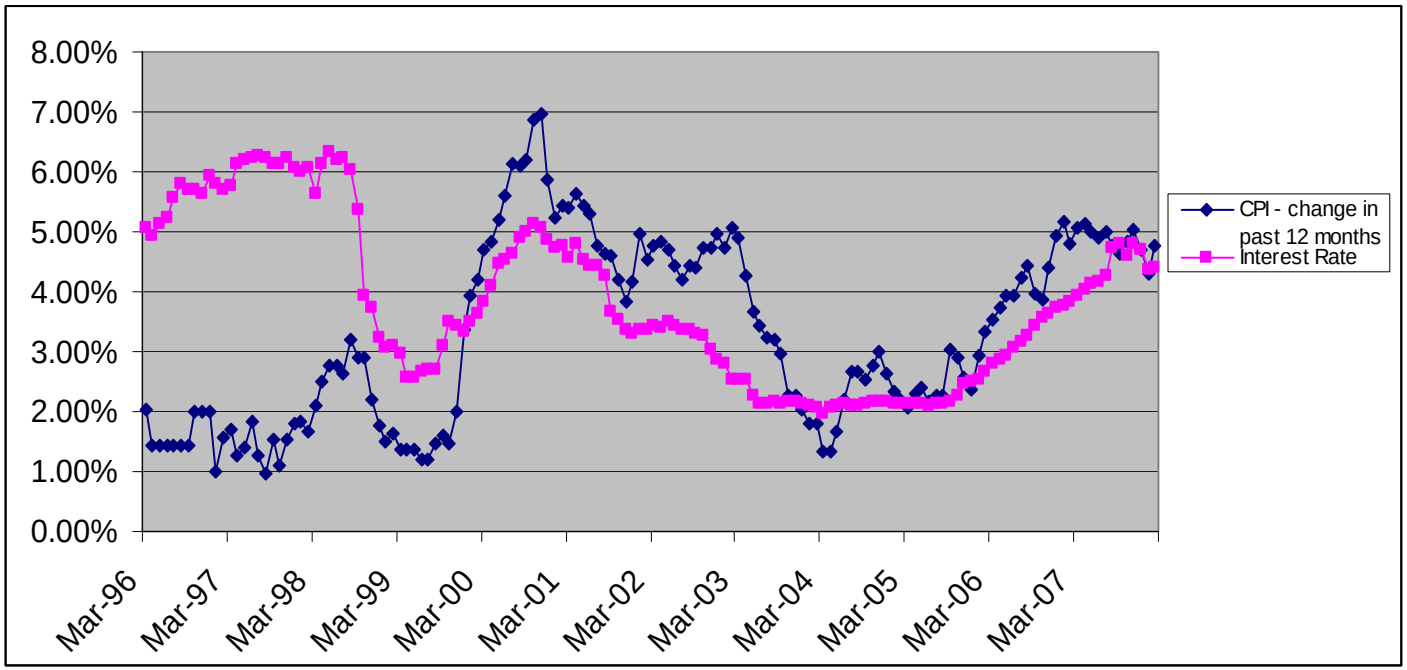

Figure 2: Variance (GARCH estimates) of house prices

The figure presents the evolution of the house price index and the estimated conditional volatility of that index.

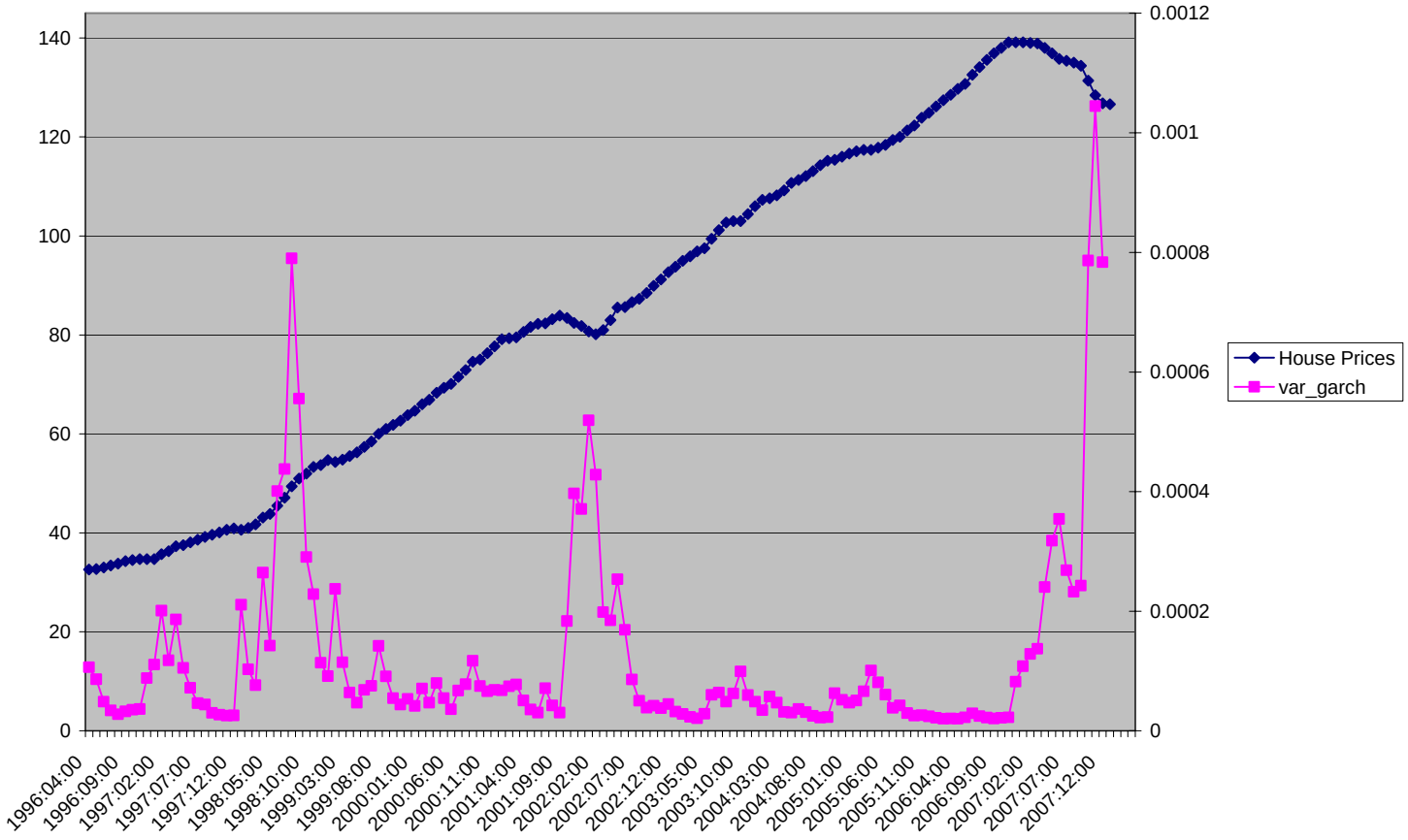

Figure 3: Optimal investment in real estate (m*)

The figure shows the time-variation of m calibrated to be one (m=1) on average based on $m^* = [E(r_h)-r_f)]/ \gamma f(i, \pi, g, r_a)$ with monthly data.

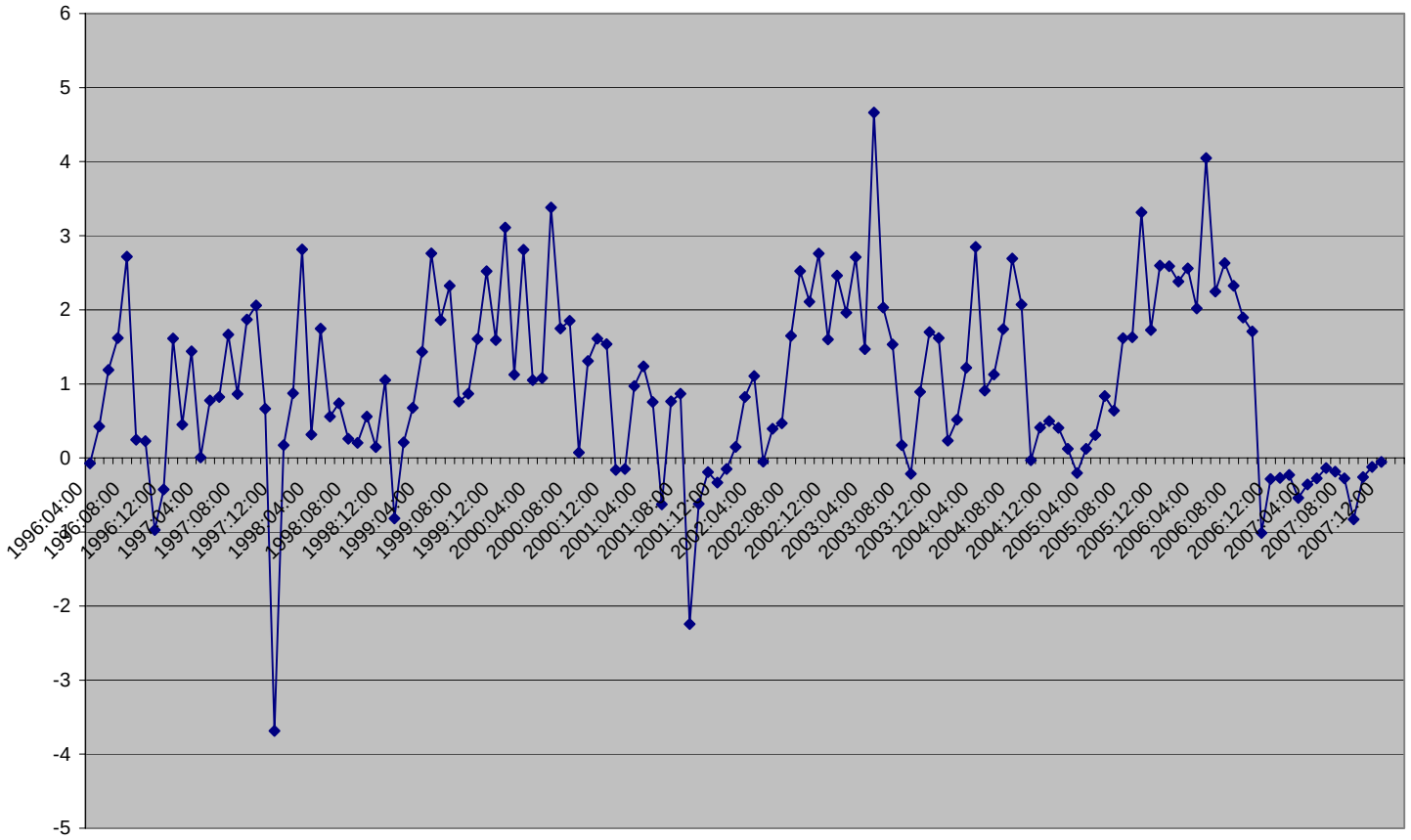

Figure 4: Optimal investment in real estate (m*)

The figure shows the time-variation of m calibrated to be 0.5(m=0.5) on average based on $m^* = [E(r_h)-r_f)]/ \gamma f(i, \pi, g, r_a)$ with monthly data:

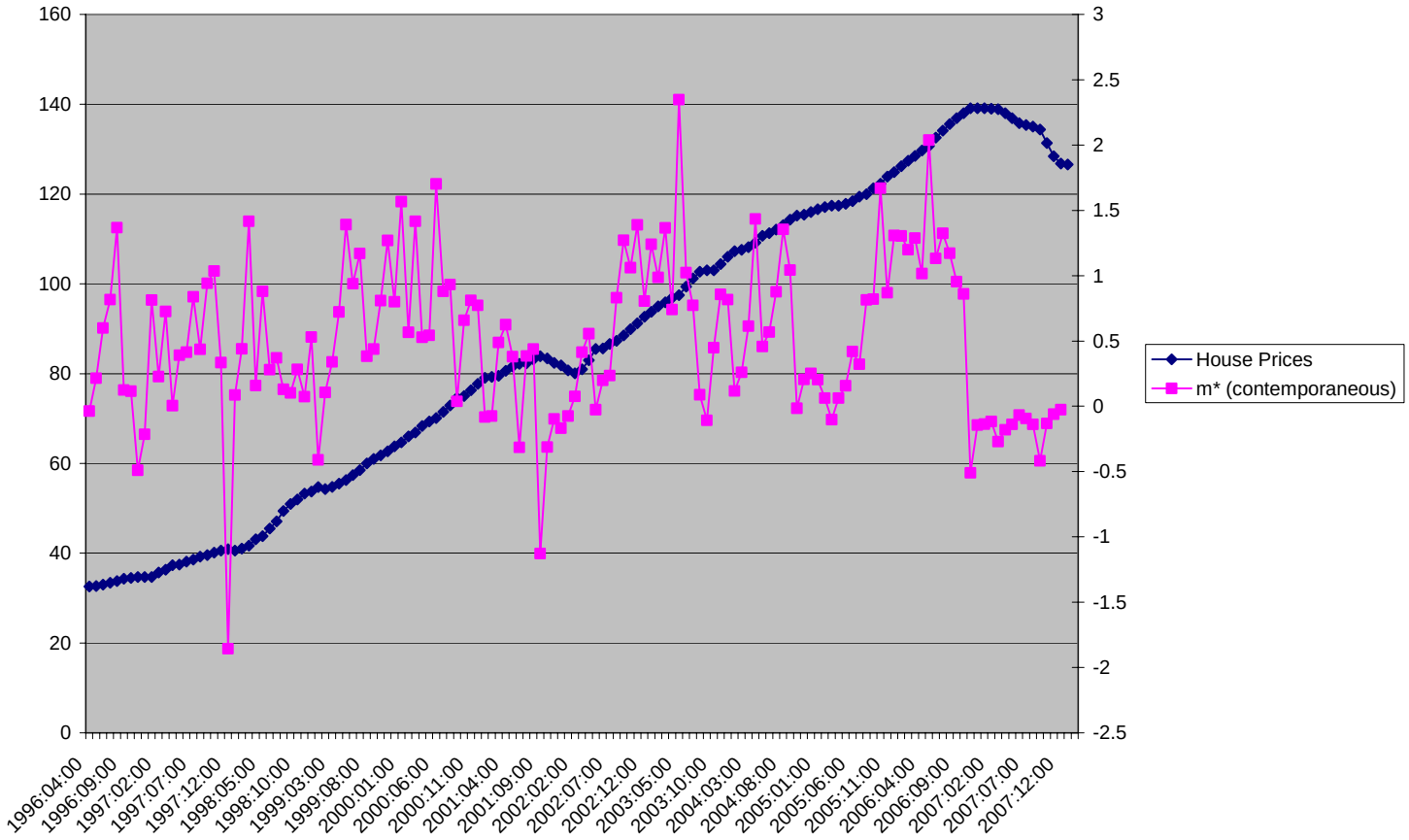

Table 1: Descriptive Statistics

The table displays the descriptive statistics of all variables in the sample. The columns contain the number of observations, the mean, the standard deviation, the minimum and the maximum value of the variable.

Variable (log-changes)	*Obs*	*Mean*	*Std. Dev.*	*Min*	*Max*
Interest rate	141	-0.0006	0.0519	-0.3112	0.1347
Stock market	141	0.0074	0.0526	-0.1710	0.1417
Production	141	0.0068	0.0885	-0.2674	0.2033
house price first	141	0.0097	0.0105	-0.0180	0.0441
House price new	141	0.0091	0.0098	-0.0151	0.0377
House price exist	141	0.0096	0.0107	-0.0231	0.0477
dgecfin1	141	-0.0014	0.0394	-0.1034	0.0866
dgecfin2	141	1.2610	10.4226	-22.1000	18.9000
Consumer Survey1	141	-0.0035	0.0514	-0.1405	0.1194
Consumer Survey2	141	-0.0019	0.0442	-0.0938	0.1666
Consumer Survey3	141	-0.0049	0.0765	-0.2367	0.2228
cars	141	-0.0166	0.6220	-0.7847	2.9655
Unemployment (male)	141	-0.0037	0.0256	-0.0613	0.0556
Unemployment (female)	141	-0.0033	0.0547	-0.1769	0.1280
Unemployment total	141	-0.0036	0.0357	-0.1076	0.0772
Employment total	141	0.0019	0.0314	-0.0754	0.0923
Earnings	135	0.0043	0.0061	-0.0086	0.0165
cpi	141	0.0028	0.0040	-0.0086	0.0118

Table 1*: Indicators

Indicator	*Description*		
DG ECFIN1	Economic Sentiment	Economic sentiment indicator	
DG ECFIN2	Consumer Surveys	Confidence indicator	
Consumer Surveys1	Consumer Sentiment Index (IIB Bank/ESRI)		
Consumer Surveys2	Current Economic Conditions Index (IIB Bank/ESRI)		
Consumer Surveys3	Consumers Expectations Index (IIB Bank/ESRI)		
DG ECFIN6	Consumer Surveys	Financial situation of households over last 12 months	
DG ECFIN7	Consumer Surveys	Financial situation of households over next 12 months	
DG ECFIN8	Consumer Surveys	General economic situation over last 12 months	
DG ECFIN9	Consumer Surveys	General economic situation over next 12 months	
DG ECFIN10	Consumer Surveys	Major purchases at present	
DG ECFIN11	Consumer Surveys	Major purchases over next 12 months	
DG ECFIN12	Consumer Surveys	Unemployment expectations over next 12 months	
DG ECFIN13	Consumer Surveys	Price trends over last 12 months	
DG ECFIN14	Consumer Surveys	Price trends over next 12 months	
DG ECFIN15	Consumer Surveys	Savings at present 12 months	
DG ECFIN16	Consumer Surveys	Savings over next 12 months	

Table 2: Unconditional correlations (full sample, pre-Euro and post-Euro)

The table shows the unconditional correlations between key macroeconomic variables: a house price index (existing houses), interest rate, the stock market, production, earnings and cpi.

Full sample (N=135)	***House prices***	***Interest rate***	***Stock market***	***Production***	***earnings***
House prices	1				
Interest rate	-0.0573	1			
Stock market	-0.0514	0.0345	1		
Production	-0.0085	0.0153	0.0351	1	
Earnings	-0.0752	-0.0498	-0.0141	-0.0608	1
Cpi	0.0121	0.0918	-0.0578	0.2804	0.0329
Pre Euro sample (N=35)	**House prices**	**Interest rate**	**Stock market**	**Production**	**earnings**
House prices	1				
Interest rate	-0.1542	1			
Stock market	-0.303	-0.0785	1		
Production	0.0791	-0.2675	0.0633	1	
Earnings	-0.3863	-0.0593	0.0418	-0.069	1
Cpi	0.1151	0.1231	-0.1281	0.0341	0.099
Post Euro sample (N=100)	**House prices**	**Interest rate**	**Stock market**	**Production**	**earnings**
House prices	1				
Interest rate	0.0876	1			
Stock market	0.0102	0.1389	1		
Production	-0.0557	0.1451	0.0226	1	
Earnings	0.1361	-0.0663	-0.0176	-0.0566	1
cpi	0.0528	0.0404	0.0067	0.3539	-0.0116

Table 3: Regression results

The table presents the estimation results of a regression of the house price changes on interest rates, inflation, stock market returns and the business cycle. In order to determine the number of lags a general-to-specific estimation methodology is chosen.

	Coef.	*Std. Err*	*t-stat.*	
interest	-0.0356	0.0171	-2.08	**
L3.	0.0489	0.0186	2.63	***
L6.	-0.0455	0.0172	-2.65	***
cpi	-0.0955	0.2528	-0.38	
stockm	0.0050	0.0162	0.31	
prod	0.0231	0.0125	1.85	*
L1.	0.0359	0.0132	2.72	***
L2.	0.0530	0.0150	3.52	***
L3.	0.0480	0.0156	3.07	***
L4.	0.0856	0.0162	5.3	***
L5.	0.0935	0.0165	5.67	***
L6.	0.0958	0.0166	5.79	***
L7.	0.0613	0.0154	3.98	***
L8.	0.0569	0.0145	3.92	***
L9.	0.0393	0.0133	2.96	**
L10.	0.0244	0.0119	2.05	**
const.	0.0052	0.0013	3.9	***
F (16,114)	3.60	***		
R squared	0.3358			

Table 4: Regression results (pre-Euro)

The table presents the estimation results of a regression of the house price changes on interest rates, inflation, stock market returns and the business cycle for the period prior to the Euro introduction (pre-Euro). In order to determine the number of lags a general-to-specific estimation methodology is chosen.

	Coef.	*Std. Err.*	*t-stat*	
interest	-0.0799	0.0407	-1.96	**
cpi	1.2684	1.1227	1.13	
stock market	-0.1183	0.0535	-2.21	*
prod	0.0191	0.0490	0.39	
L1.	0.0642	0.0662	0.97	
L2.	0.1125	0.0674	1.67	
L3.	0.1550	0.0896	1.73	
L4.	0.2468	0.0825	2.99	**
L5.	0.2262	0.0872	2.59	**
L6.	0.2045	0.0790	2.59	**
L7.	0.1399	0.0626	2.23	**
L8.	0.1435	0.0538	2.67	**
L9.	0.0775	0.0416	1.86	*
const.	-0.0057	0.0088	-0.66	
Number of obs.	25			
F(14,10)	1.81			
R squared	0.3197			

Table 5: Regression results (post-Euro)

The table presents the estimation results of a regression of the house price changes on interest rates, inflation, stock market returns and the business cycle for the period after the Euro introduction (post-Euro). In order to determine the number of lags a general-to-specific estimation methodology is chosen.

	Coef.	*Std. Err.*	*t-stat*	
Interest	-0.0066	0.0211	-0.31	
Cpi	-0.0511	0.2710	-0.19	
Stock market	0.0217	0.0183	1.19	
Production	0.0130	0.0135	0.96	
L1.	0.0333	0.0142	2.35	**
L2.	0.0443	0.0162	2.74	***
L3.	0.0458	0.0169	2.7	***
L4.	0.0637	0.0180	3.53	***
L5.	0.0731	0.0185	3.95	***
L6.	0.0731	0.0186	3.93	***
L7.	0.0487	0.0166	2.94	***
L8.	0.0422	0.0157	2.68	***
L9.	0.0331	0.0141	2.35	**
L10.	0.0212	0.0127	1.67	*
const.	0.0052	0.0013	3.86	***
Number of obs.	106			
F(14,91)	1.65	*		
R squared	0.2024			

Table 6: Estimation Results Asymmetric GARCH Model

The table presents the estimation results of an asymmetric GARCH(1,1,1) model with a multiplicative heteroscedasticity component (HET) including the interest rate, the stock market, production and cpi. The results show that all variables influence the conditional volatility of the house price index. Interest rates exhibit a negative influence on volatility (lower volatility) while the other variables are positively related to the house price index.

		Coeff.	*Std. Err.*	*z-stat.*	*P>|z|*
HET	**Const.**	0.01	0.00	16.36	0.00
	Interest (t-1)	-15.27	7.98	-1.91	0.06
	Stock market (t-1)	41.68	14.43	2.89	0.00
	Production (t-1)	22.28	7.19	3.10	0.00
	CPI (t-1)	172.02	195.01	0.88	0.38
	Const.	-15.48	1.73	-8.97	0.00
ARCH					
	ARCH	0.55	0.24	2.28	0.02
	TARCH	-0.25	0.22	-1.13	0.26
	GARCH	0.53	0.12	4.30	0.00

Table 7: Alternative determinants

The table presents estimation results for two models with alternative variables. Model 1 shows the regression results for an alternative consumer price index only comprising alcoholic beverages, tobacco and narcotics. Model 2 shows the regression results for consumer survey indicators. The three indicators reported are selected with a general-to-specific estimation strategy starting with 16 indices (see descriptive statistics).

Model 1	***Coef.***	***Std. Err.***	***t-stat***	
Interest rate	-0.0656	0.0293	-2.24	**
cpi (alcoholic beverages, drugs etc.)	0.3813	0.1895	2.01	**
Stock market return	0.0398	0.0207	1.92	*
Production change	0.0036	0.0112	0.32	
const.	0.0052	0.0012	4.40	***
F(4,67)	3.06	**		
R squared	0.1545			
Model 2	**Coef.**	**Std. Err.**	**t-stat**	
Consumer survey (economic condition over last 12 months)	0.0579	0.0346	1.68	*
Consumer survey (major purchases next over 12 months)	1.0387	0.2405	4.32	***
Consumer survey (savings over next 12 months)	-0.4790	0.1165	-4.11	***
const.	22.2353	2.6675	8.34	***
F(3,137)	15.56	***		
R squared	0.2542			

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