Housing Bubbles and Interest Rates

Christian Hott and Terhi Jokipii

SCHWEIZERISCHE NATIONALBANK
BANQUE NATIONALE SUISSE
BANCA NAZIONALE SVIZZERA
BANCA NAZIUNALA SVIZRA
SWISS NATIONAL BANK

2012-7

Swiss National Bank Working Papers

ISSN 1660-7716 (printed version)
ISSN 1660-7724 (online version)

Housing Bubbles and Interest Rates*

Christian Hott and Terhi Jokipii†

Abstract

In this paper we assess whether persistently too low interest rates can cause housing bubbles. For a sample of 14 OECD countries, we calculate the deviations of house prices from their (theoretically implied) fundamental value and define them as bubbles. We then estimate the impact that a deviation of short term interest rates from the Taylor-implied interest rates have on house price bubbles. We additionally assess whether interest rates that have remained low for a longer period of time have a greater impact on house price overvaluation. Our results indicate that there is a strong link between low interest rates and housing bubbles. This impact is especially strong when interest rates are "too low for too long". We argue that, by ensuring that rates do not deviate too far from Taylor-implied rates, central banks could lean against house price fluctuations without considering house price developments directly. If this is not possible, e.g. because a single monetary policy is confronted with a very heterogenous economic development within the currency area, alternative counter cyclical measures have to be considered.

Keywords: House Prices, Bubbles, Interest Rates, Taylor Rule.

JEL-Classifications: E52, G12, R21.

June 12, 2012

*The opinions expressed herein are those of the authors and do not necessarily reflect the views of the Swiss National Bank.

†email: terhi.jokipii@snb.ch, Swiss National Bank, Bundesplatz 1, 3003 Bern.

1 Introduction

In the aftermath of the recent global financial crisis, central banks have been widely criticized for having kept interest rates too low for too long. As a consequence, an important strand of research has emerged focused on understanding whether exceptionally low interest rates spurred excessive risk taking in the banking sector, leading to the buildup of the crisis (Ciccarelli et al., 2011; Altumbas et al., 2010; Tabak et al., 2010; Dubecq et al., 2010). Estimating deviations of short term rates from Taylor-implied rates, one set of authors have argued that interest rate deviations were a primary cause in the build up of the financial crisis (see among others Taylor, 2010; Kahn, 2010; Nier and Merrouche, 2010). Others, however, have shown that direct linkages are weak at best and that financial market developments would have been only modestly different if monetary policy had followed a simple Taylor rule (Bernanke, 2010; Dokko et. al, 2009).

Literature has argued that property-price collapses have historically played an important role during episodes of financial instability (see among others Ahearne et al., 2005; Goodhart and Hofmann, 2007; Bank for International Settlements, 2004). There are at least two reasons why housing bubbles are particularly important compared to other asset bubbles. First, housing is a large fraction of national wealth, and residential investment is a significant and volatile part of GDP. Second, leveraged financial institutions hold a significant fraction of their portfolio in assets, such as mortgages or mortgage-backed securities, whose values depend greatly on movements in house prices. As a consequence, debate surrounding the role that asset prices should play in monetary policy has been ripe. Some authors have called for central banks to react to movements in asset prices (Borio and Lowe, 2002, Cecchetti et al., 2000) while others have shown that using monetary policy to lean against asset-price fluctuations may not be a sensible strategy (Assenmacher-Wesche and Gerlach, 2008).

A special case is the euro area, where a single policy interest rate is confronted with a very heterogenous development of house prices. While house prices increased very strongly between the end of the 1990s and 2007 in Ireland and Spain, prices remained rather stable in Germany. However, this heterogenous development of house prices was accompanied by a heterogenous development of economic growth and inflation. This might partly explain why in Ireland and Spain house price increases were stronger than in Germany. But it can also imply that the single policy interest rate was too low for Ireland and Spain and reasonable, or even too high, for Germany.

There are many possible explanations for the emergence of housing bubbles, including speculation (e.g. like Froot and Obstfeld, 1991), herding behavior (e.g. like Avery and Zemsky, 1998), and disaster myopia (e.g. Herring and Wachter, 1999) by investors as well as by lenders (e.g. Hott, 2011). In this paper, we focus solely on assessing whether persistently too low interest rates can lead to housing bubbles and do not aim to explain this link. Researchers assessing the role of monetary policy in the surge in house prices that preceded the recent financial turmoil have generally estimated vector auto-regressive (VAR) models with several macroeconomic variables. Our methodology differs from this as we adopt a theoretical house price model from which we calibrate fundamental house prices. As per Garber (2000), we define a housing bubble as the part of the house price movement that is unexplainable by fundamentals. Therefore, for each country in our sample, house price bubbles are identified as periods when observed prices deviate from those justified fundamentals. We then estimate the impact that a deviation of short term interest rates from the Taylor-implied interest rates ("too low...") have on house price overvaluation. In addition, we analyze the impact that the duration of an interest rate deviation from Taylor-implied rates can have on the creation of housing bubbles ("...for too long"). The two main innovationS of our paper are the consideration of house price deviations from their fundamental value and the evaluation of the impact of the duration of "too low" interest rates.

Our results for 14 OECD countries (including six euro area countries) indicate that there is a strong statistical link between interest rate deviations and housing bubbles and that deviations of observed rates from Taylor-implied rates Granger-cause house price bubbles. This impact is especially strong when interest rates are "too low", for "too long". In addition, the duration of interest rate deviations has a strong and significant impact on the emergence of housing bubbles. Our findings have important policy implications with regards to monetary policy and asset prices. In particular, we show that if interest rates are set at similar levels to those implied by the Taylor rule, housing overvaluation can be reduced. We therefore argue that in order to lean against house price fluctuations it is not necessary to consider house prices directly in monetary policy decisions. If the economic development within a currency area is very heterogenous, however, it is not possible to set the interest rate at a level that is optimal for all countries or regions within the currency area. In this case, additional measures have to be considered. These include macro prudential instruments like counter cyclical capital requirements for banks or a counter cyclical tax treatment of real estate holdings.

The rest of the paper is organized as follows. Section 2 describes our model for estimating housing overvaluation. Section 3 estimates interest rate deviations from Taylor-implied rates. Section 4 presents our estimations and discusses our findings. Section 5 briefly concludes.

2 Deviation of House Prices from their Fundamental Value

To estimate the impact that monetary policy stance has on the creation of housing bubbles, two steps are necessary: first, we need to define and identify bubble periods; and second, we need to estimate a proxy for monetary policy stance.

In this section we start with defining and identifying bubble periods. To do this, we compare actual and fundamentally justified house prices. The fundamental value is obtained by calibrating a theoretical house price model for each country in our sample. In what follows, deviations of house prices from their fundamental value are defined as housing bubbles, as per Garber (2000).

2.1 The Fundamental House Price Model

There are various possibilities to estimate the fundamental value of houses. One way is to look at indicators like the price-to-rent or price-to-(per capita) income. These indicators have some drawbacks. Firstly, they only consider a single factor (e.g. rent as an indicator for the return or income as an indicator for the affordability) and, secondly, the relationship between a fundamentally justified price and this single fundamental factor is not necessarily stable (e.g. because of changing interest rates). Another way is to estimate a general equilibrium model. Examples are Calza et al. (2009), Iacoviello (2005) and Kiyotaki and Moore (1997). These models are able to explain the interconnection between real estate prices, income and interest rates. Since we are only interested in the effect of fundamentals on prices, we can use a much simpler approach and can treat fundamentals as exogenous factors.

We estimate the fundamental value of houses in a similar fashion to Hott and Monnin (2008): The fundamental value of a house (P_t) is given as the sum of the future discounted fundamental imputed rents (H_t). Fundamental imputed rents are defined as the clearing price (i.e. rent) on a housing market.

To calculate the fundamental value of imputed rents, we assume that each household spends the fraction α of its income y_t per period on housing (Cobb-Douglas utility function). In period t the price for occupying a housing unit for one period (imputed rent) is H_t. Therefore, the demand for housing (d_t) is:[1]

$$d_t = \alpha \frac{y_t}{H_t}. \tag{1}$$

Further, we assume that in t there are N_t identical households. Hence, aggregated demand for housing (D_t) in period t is:

$$D_t = \alpha \frac{Y_t}{H_t}, \tag{2}$$

where $Y_t = y_t N_t$. Aggregated demand for housing, therefore, depends on the imputed rent and the aggregated income (or GDP).

[1]Like Hott and Monnin (2008), we assume that there are no savings.

To calculate the supply of housing units in t (S_t) we assume that it is given as the depreciated supply in $t-1$ plus the construction of new housing units in $t-1$ (B_{t-1}). Backward iteration leads to the following supply function:

$$S_t = (1-\delta)S_{t-1} + B_{t-1} = (1-\delta)^t S_0 + \sum_{j=1}^{t} (1-\delta)^{j-1} B_{t-j}, \tag{3}$$

where δ is the depreciation rate of housing units and S_0 is the initial housing stock.

The market clearing condition is:

$$D_t = \alpha \frac{Y_t}{H_t} = S_t. \tag{4}$$

By rearranging this equation we get the fundamental value of imputed rents as a function of aggregated income and housing supply:

$$H_t = \alpha \frac{Y_t}{S_t} = \alpha \frac{Y_t}{(1-\delta)^t S_0 + \sum_{j=1}^{t} (1-\delta)^{j-1} B_{t-j}}. \tag{5}$$

To derive the fundamental value of houses (P_t), we calculate the sum of the future discounted fundamental imputed rents (H_t). The discount factor is assumed to be the sum of the mortgage rate r_t in period t and the constant parameter ρ. This parameter ρ reflects a risk premium as well as maintenance costs (as a fraction of the house price).

$$P_t = E_t \left[\sum_{i=0}^{\infty} \frac{H_{t+i}}{\prod_{j=0}^{i} (1+\rho+r_{t+j})} \right]. \tag{6}$$

By replacing H_t by the fundamental values of imputed rents from equation (5), we get the following fundamental house price equation:

$$P_t^* = E_t \left[\sum_{i=0}^{\infty} \frac{\alpha Y_{t+i}}{(S_{t+i}) \prod_{j=0}^{i} (1+\rho+r_{t+j})} \right]. \tag{7}$$

Equation (7) implies that the fundamental value of houses is driven by present and future aggregated income, population and mortgage rates and by past, present and future construction activities.

2.2 Calibration Method

To calibrate the fundamental house price model we choose parameter values that lead to the best fit with actual house prices. In order to assure plausible results, we also take into account that the theoretically implied imputed rents are the fundamental value of actual rents. Therefore, we first choose parameter values of the imputed rent equation that lead to the best fit with actual rents. Then we take the resulting fundamental imputed rent to choose remaining parameter values of the fundamental house price equation by minimizing the deviation from actual house prices.

2.2.1 Calibration of Fundamental Rents

In a first step to calibrate fundamental house prices we adjust the development of the fundamental imputed rents (H_t) to the development of the observed rents (M_t). According to equation (5), we need parameter values for α, δ and S_0 to calibrate the fundamental imputed rents. Literature provides some indication on the value of δ. In line with Harding et al. (2007), McCarthy and Peach (2004), Pain and Westaway (1997) and Poterba (1992) we assume that $\delta = 0.02$. Since actual rents are expressed as an indicator, we also need a conversion factor to compare their level with the right hand side of equation (5). Multiplying this positive conversion factor with the parameter $1 \geq \alpha \geq 0$ leads to the new parameter $\alpha_1 > 0$. For the initial housing stock we assume that $S_0 \geq 0$.

For α_1 and S_0 we have only assumed that they are positive. We now chose the actual country-specific values by solving the following minimization problem:

$$\min_{\alpha_1, S_0} \sum_{t=1}^{T} \left[m_t - h_t\right]^2, \qquad (8)$$

where T is the end of our data sample, $m_t = \ln(M_t)$ and $h_t = \ln(H_t)$ and subject to: $\alpha_1 \geq 0$ and $S_0 \geq 0$.

2.2.2 Calibration of Fundamental House Prices

To calibrate fundamental house prices we use the calibrated series for H_t and assume that agents are rational and have perfect foresight.[2] We can, therefore, replace the expected future fundamentals in price equation (7) by their actual values. This implies that for $t \leq T$ and $i \leq t$:

$$E_{t-i}(H_t) = H_t \qquad \text{and}$$

$$E_{t-i}(r_t) = r_t.$$

For $t > T$, however, we do not know the actual values of the fundamentals. For simplicity, we use a VAR model to forecast the values of the fundamentals after the end of our data sample ($t > T$). One problem is that H_t is not stationary. To deal with this problem, we calculate the annual growth rate of the imputed rents ($h_t - h_{t-4}$). Then we use this growth rate and the mortgage rate r_t for our VAR estimation. The number of lags included in the VAR is chosen by the Schwarz criterion, considering a maximum of four. In the next step we use the parameters of the VAR to calculate expected future interest rates and growth rates of the imputed rents.

To calibrate the fundamental house price, we need a value for the sum of maintenance costs and risk premium ρ and a conversion factor α_2 (rent index to property price index). In line with Himmelberg et. al (2005), Pain and Westaway (1997) and Porterba (1992), we assume that $\rho = 0.05$. For α_2, we chose country specific parameter values that lead to the best fit between the log of fundamental ($p_t^* = \ln(P_t^*)$) and the log of actual prices ($p_t^a = \ln(P_t^a)$). Hence, we have to solve the following minimization problem:

$$\min_{\alpha_2} \sum_{t=0}^{T} \left[p_t^a - p_t^*\right]^2, \qquad (9)$$

subject to: $\alpha_2 > 0$.

[2]This assumption is equivalent to the 'ex post rational prices' in Shiller's (1981) work on stock prices.

2.3 Housing Data

We calibrate the model for 14 OECD countries: Australia (AU), Canada (CA), Finland (FI), France (FR), Germany (DE), Ireland (IE), Japan (JP), the Netherlands (NL), Norway (NO), Spain (ES), Sweden (SE), Switzerland (CH), the UK and the US.

According to equation (5), (7), (8) and (9), we need data on GDP (Y_t), population (N_t), construction (B_t), rents (M_t), mortgage rates (r_t) and house prices (P_t^a). Since we consider only real data, we also need CPI data.

The main data sources are the BIS, Datastream, IMF (IFS) and the OECD (MEI). For most series we have quarterly data from 1981Q1 to 2010Q3. For some countries the time series are shorter. The annual population data is transformed into quarterly data through linear interpolation.

2.4 Calibration Results

Figure 1 shows the development of actual and fundamental house prices for the 14 OECD countries in our sample. It is evident that actual prices fluctuate much more than fundamental prices. According to Table 1, the standard deviations of the annual growth rates of actual house prices ($p_t^a - p_{t-4}^a$) are about three times higher than the standard deviations of fundamental house price growth rates ($p_t^* - p_{t-4}^*$).

Given the definition of the fundamental house price, average overvaluation is (close to) zero. However, the standard deviation of the overvaluation varies between 15% (CA) and 46% (IE). We observe several episodes of substantial deviations of actual house prices from their fundamental values (bubbles). Housing bubbles are observed in many countries around 1990. More recently, many countries experienced a significant surge in house prices between the late 1990s and 2007, leading to the biggest bubble in history (The Economist, 2004). These overvaluations were especially strong in Norway and two euro area countries, Ireland and Spain. By contrast, in Germany, Japan and Switzerland house prices have remained below their fundamental level since the mid-1990s.

The correlation between actual and fundamental house prices varies substantially between countries. For Japan, Spain, Switzerland and especially Germany and Canada, the correlation is even negative. However, Canada and Germany are also among the countries with the lowest standard deviation of actual from fundamental prices and with the lowest standard deviations of the annual growth rates of actual and fundamental prices. Hence, for these countries, the correlation can easily be affected by non-fundamental factors or simply noise. In Japan and Switzerland a reason for the negative correlation is that the housing bubbles around 1990 led to substantial price corrections in the 1990s while at the same time, fundamentals were increasing and hence, narrowing the gap to actual prices. In Spain the recent bubble was still building up when, due to excessive construction and the forthcoming economic weakening, fundamentals where already going down. This has negatively affected the correlation between actual and fundamental prices.

3 Interest Rates

In this section, we estimate a proxy for monetary policy stance. Determining whether monetary policy is "too loose", or "too tight" requires an assessment of whether observed rates deviate from some policy rule or economic model. Here, we adopt the Taylor rule (Taylor, 1993) as the benchmark rate from which to assess policy stance. For each country in our sample, we calculate interest rate deviations by comparing observed short-term interest rates with Taylor-implied rates. We acknowledge the fact that the Taylor rule is not a rule that should necessarily be followed systematically by a central bank taking policy decisions. However, we use the Taylor-implied rates since it is a benchmark rate that can be estimated for a broad sample of countries from which to determine whether monetary policy was generally too tight or too loose.

3.1 Deviations From Taylor-Rule Implied Rates

To address the issue of whether low interest rates contribute to the build up of the housing bubbles, we assess observed short term interest rates in 14 OECD countries relative to their Taylor-implied rates (Taylor, 1993). The Taylor rule is a benchmark policy tool that states that short-term interest rates should be a function of the following: (i) actual inflation relative to the targeted level; (ii) the deviation of economic activity from its full employment level and (iii) the level of short-term interest rates consistent with full employment. In general, interest rates should be higher when inflation is above target, $(\pi_t - \pi_t^*) > 0$, or when output is above its potential, $(y_t - y_t^*) > 0$. Taylor (1993) estimated the long-run real value of the federal funds rate to be about 2%. The equation for the Taylor rule accordingly shows that when inflation and output are equal to their targets, the policy rate should equal two plus the rate of inflation. Equivalently, when inflation and output equal their targets, the real value of the federal funds rate should equal 2%. The Taylor-implied rates are calculated in the following way:

$$i_t^T = \alpha^T + \pi_t + a(\pi_t - \pi^*) + b(y_t - y_t^*), \tag{10}$$

where α^T is the assumed equilibrium real interest rate. We assume a heterogeneous growth perspective such that we account for the impact of a country's equilibrium growth on its Taylor interest rate. Hence, each country is assumed to have a particular equilibrium real interest rate calculated as the trend growth of the HP-filtered real log GDP of the respective country. π_t denotes the inflation rate, π^* captures the desired rate of inflation, $y_t - y_t^*$ denotes the output gap: the difference between GDP (y_t) and its long-term potential non inflationary level (y_t^*). We estimate the output gap using a Hodrick-Prescott filter with λ=1,600 to estimate the trend. We set $a = b = 0.5$ and $\pi^* = 2\%$[3].

The deviation of observed rates from the Taylor-implied rates are then calculated as:

$$devTR = (i_{jt} - i_{jt}^T), \tag{11}$$

[3]The European Central Bank aims at inflation rates of below, but close to, 2% over the medium term, as stated on their website: http://www.ecb.int/mopo/html/index.en.html. The US Fed has informally said its goal is inflation of around 2%. But after years of internal debate on the subject, it hasn't adopted an official target.

for each country j in our sample. i_{jt} denotes the observed rate while i_{jt}^T captures the Taylor-implied rate.

3.2 Interest Rate Data

Taylor-implied rates are calculated for the 14 OECD countries listed in Section 2.3. Data is obtained at a quarterly frequency from Datastream. For most countries Taylor-implied rates start in 1981Q1. Table 3 presents the summary statistics of interest rate deviations for each country. The correlation matrix is presented in Table 4. Figure 2 plots the evolution of the observed interest rates together with the Taylor-implied rates.

3.3 Interest Rate Deviations From Taylor-Implied Rates

According to the Taylor-rule, of the 14 countries, five (Finland, Ireland, Spain, Switzerland and the US) have interest rates that have, on average, been lower than Taylor-implied rates over the sample period. In Finland, interest rates remained relatively low for much of the 1980s and early 1990s. Since the introduction of the Euro in 1999, rates have been consistently too low relative to those implied by the Taylor rule. In Ireland and Spain, observed rates were too low in the early 1980s and similarly to Finland, have remained consistently too low since 1999. In Switzerland and the US, rates were generally too low in the late 1980s and early 1990s and again from the late 1990s. However, compared to IE and ES, the deviations from the Taylor implied interest rates were rather moderate. Pairwise correlations of interest rate deviations are, on average, positive and significant while correlations between observed rates and Taylor-implied rates range between 0.55 (NL) and 0.86 (FR).

4 Empirical Estimations and Results

In this section we estimate the impact that deviations of short-term interest rates from the Taylor-implied rates have on housing bubbles. We subsequently assess whether the duration of the deviation has an additional impact. In both estimations, we do not control for further variables since our fundamental house price model as well as the Taylor-rule already include the most relevant variables (e.g. inflation, GDP and construction activities).

4.1 What Is The Impact of ***Too Low*** Interest Rates On Housing Bubbles?

Our baseline regression for analyzing the impact of low interest rates on housing bubbles can be written as:

$$(p^a_{jt} - p^*_{jt}) = \theta + \beta_1 devTR_{jt} + \epsilon_{jt}, \quad (12)$$

where θ is a constant term, $(p^a_{jt} - p^*_{jt})$ captures house price deviation and $devTR_{jt}$ denotes interest rate deviations from Taylor-implied rates for country j at time t. β_1 is our coefficient of interest. We test the independence of our equations using the Breusch-Pagan test of independence (Zellner, 1962; Breusch and Pagan, 1980; and Greene, 1997) and find that the test rejects independence. We therefore estimate using the Seemingly Unrelated Regression (SUR) methodology which assumes that the error terms across equations in a system are correlated.

Table 5 presents the results of estimating equation (12). For most countries, interest rate deviations have a significantly negative impact on housing overvaluation. The finding provides evidence that interest rates that are too low relative to the Taylor rule are statistically linked to housing bubbles. The relationship is strongest for Ireland where interest rate deviations explain up to 50% of housing overvaluation. Here, a 1% deviation of interest rates from Taylor-implied rates results in a 7% overvaluation. Ireland is one of the countries that experienced significant variation in the growth of both actual and fundamental house prices (Table 1). Moreover, of all countries in the sample, mean observed interest rates relative to the Taylor-implied rates were lowest for Ireland over the sample period (Table 3). For the 14 countries in the sample, the average resulting overvaluation is around 2% following a deviation of around 1%. For Canada and Japan, the coefficient is positive but not statistically significant.

Granger causality: We assess the relationship between interest rate deviations and house price overvaluation further by conducting a set of Granger causality tests. Table 6 presents the results. In each case, when the null hypothesis of no causality is rejected, we report the level of statistical significance.

Our results indicate that in 10 of 14 cases, interest rate deviations Granger-cause bubbles. In each of these cases, Granger causality is observed at least at the 5% level of significance. The exceptions are Canada, Japan, Norway and Switzerland for which no significant degree of causality is detected between interest rates that are too low and house bubbles. As anticipated, we find no direct evidence of housing bubbles causing lower than implied interest rates.

4.2 What If Interest Rates Are Too Low For *Too Long*?

The results presented and discussed in the previous subsection provide evidence of a causal relationship between interest rates that are "too low" and house price overvaluation. For most countries in our sample, we find that when interest rates are set lower than those implied by the Taylor rule, house prices tend to be overvalued. To assess whether the duration of "too low" interest rates has an impact on house price deviations from their fundamental value, we create additional variables that capture the number of consecutive periods that observed short term rates are lower than those implied by the Taylor rule. We start by creating a duration variable, *duration*, that calculates the number of consecutive quarters that observed short term rates have been lower than those implied by the Taylor rule. Here, a larger number corresponds with a longer period of loose policy rates. The duration variable is included in the system of regressions as follows:

$$(p^a_{jt} - p^*_{jt}) = \theta + \beta_1 devTR_{jt} + \beta_2 duration_{jt} + \epsilon_{jt}. \quad (13)$$

As per equation (12), $(p^a_{jt} - p^*_{jt})$ captures house price overvaluation, θ is a constant term, $devTR$ denotes interest rate deviations from Taylor-implied rates for country j at time t and $duration$ is our newly created duration variable. β_1 and β_2 are our coefficients of interest denoting the impact of interest rate deviations and the duration of interest rate deviations on housing bubbles respectively. The results of estimating equation (13) are presented in panel *I* of Table 8.

For each of the 14 countries in the sample, β_2 is positive and statistically significant. This implies that the longer the rates deviate from the Taylor-implied rates, the higher the housing overvaluation. The *duration* coefficient is largest for Ireland, Spain, Finland and the US. These are the countries for which we observe the largest average deviation of interest rates from Taylor-implied rates over the sample period (Table 3). The average *R-squared* increases from around 20% to 35% when we account for the duration of the rate deviation. For Ireland, the length and the extent of the deviation from Taylor-implied rates together account for around 80% of housing overvaluation. For Finland and the Netherlands the corresponding amount is around 50% and around 20% for Switzerland, Germany and Norway.

In addition to assessing the impact of interest rates that are too low for too long using the duration variable as above, we create five additional dummy variables: $Q1$, $Q2$, $Q3$, $Q4$ and $> Q4$. We set $Q1$ equal to -1 when a negative deviation[4] lasts one quarter. $Q1$ equals 0 otherwise. Similarly, $Q2$, $Q3$ and $Q4$ are set equal to 1 when the deviation lasts two, three and four quarters respectively and 0 otherwise. The dummy $> Q4$ takes the value 1 when the deviation lasts longer than four quarters, and 0 otherwise. The resulting equation to be estimated can be written as follows:

$$(p_t^a - p_t^*) = \theta + \beta_1 devTR_{jt} + \beta_2 Q1_{jt} + \beta_3 Q2_{jt} + \beta_4 Q3_{jt} + \beta_5 Q4_{jt} + \beta_6 > Q4_{jt} + \epsilon_{jt}. \quad (14)$$

Again we estimate using SUR. β_1, β_2, β_3, β_4, β_5 and β_6 capture the impact that interest rates that are lower for longer have on housing bubbles. The results of estimating equation (14) are presented in panel *II* of Table 8. We see that for the majority of countries, the coefficient on the dummy variable gets larger the longer the duration of the deviation. In most cases, deviations lasting longer than four quarters, denoted by the coefficient on dummy $> Q4$, are negative and highly significant, suggesting

[4] A negative deviation is defined as a period when observed rates are lower than Taylor-implied rates.

that interest rates set lower than Taylor-implied rates for more than one year have, on average, the greatest impact on overvaluation.

Substantial variation in the relationship is observed across countries. In Canada and Germany for example, we find that the impact of the deviation dies out after three quarters. One explanation might be the relatively short periods during which interest rates were “too low” in these countries. Over the sample period, interest rates deviated from the Taylor-implied rates for a maximum duration of nine quarters in Canada and seven quarters in Germany (Table 3). For Finland and Spain, on the other hand, interest rate deviations only become significant if they last more than three quarters. After this time, the impact increases for each quarter that rates are set “too low”. For Ireland and the UK, a similar pattern is evident, however interest rate deviations become significant already after one quarter.

The analysis above shows that the duration of the deviation has a clear impact on overvaluation. In 12 of the 14 cases, durations lasting more than one year are highly statistically significant. Since deviations of one year can seem rather short lived, we create five additional dummy variables: $Y1$, $Y2$, $Y3$, $Y4$ and $> Y4$. We set $Y1$ equal to -1 when a negative deviation[5] lasts upto one year. $Y1$ equals 0 otherwise. Similarly, $Y2$, $Y3$ and $Y4$ are set equal to 1 when the deviation lasts up to two, three and four years respectively and 0 otherwise. The dummy $> Y4$ takes the value 1 when the deviation lasts longer than four years, and 0 otherwise.

The new dummy variables $Y1$, $Y2$, $Y3$, $Y4$ and $> Y4$ are substituted for $Q1$, $Q2$, $Q3$, $Q4$ and $> Y4$ in equation (14). The results are presented in panel *III* of Table 8. For 10 of the 14 countries in the sample, the coefficient on the interest rate deviation variable is negative and significant as per panel *I* of Table 5 confirming the previous findings that interest rate deviations have a significantly negative impact on housing overvaluation. The exceptions are the UK, Switzerland, Canada and Japan, for which the sign is correct, but the coefficients are not statistically significant. Turning to the coefficients on the duration dummy variables, we again find evidence in some

[5]A negative deviation is defined as a period when observed rates are lower than Taylor-implied rates

countries that the longer interest rates deviate from Taylor-implied rates, the greater the impact on overvaluation. In France and Ireland, after three years, the size of the dummy coefficient continues to increase steadily over time, while the degree of significance remains constant at the 1% level. The coefficient sizes are notably larger than those observed in panel *II* for shorter durations. We find a similar impact for the Netherlands and the UK, however for these countries, coefficients are also significant for shorter durations. Interestingly, for Switzerland, Spain and the US, the impact becomes significant only much later on (after around four years).

Overall, our analysis of interest rate deviation durations provide robust evidence that the longer interest rates are "too low", the greater the impact on overvaluation.

4.3 Robustness tests

In this section we split our sample into two subsections and re-estimate baseline equations (12) and (13) for each sub-sample separately. The separation is in part motivated by the fact that, as discussed in section 2.4, bubble periods are observed in most countries in the 1990s and again in 2007. Moreover, our sample is made up of 6 euro area countries, among which substantial heterogeneity with regard to both fundamental and actual house price developments is evident (Table 1). In some countries, house prices have increased strongly while in others, prices have remained relatively flat. These developments are accompanied by a heterogeneous evolution of economic growth and inflation. Despite these differences, euro area countries have shared a single monetary policy since 1999.

For the analysis that follows, we split the sample in 1999. *Sample 1* covers the period between 1980Q1 and 1989Q4. *Sample 2* covers the period between 1999Q1 and 2010Q4. Table 7 details the maximum number of consecutive quarters that interest rates were below the Taylor-implied rates for each sub-sample period, in each country. We see that on average, the maximum interest rate deviation over all countries in the sample increased from 2.5 years before 1999 to 6 years after 1999. For five of the six euro area countries in our sample, we see that the maximum number of quarters of "too low" interest rates increased substantially. The only exception is Germany, for who the maximum number of quarters remains stable over the sub-sample periods.

Table 9 presents the results of estimating equation (12) over the two sample periods separately. On average, the findings are not substantially different from those reported in table 5. For most countries, the negative relationship observed over the total sample period is also evident for both sub-sample periods. In Japan, the positive and insignificant relationship noted over the total sample is driven by the second half of the sample. Between 1980Q1 and 1998Q4 we are able to uncover a negative and significant relationship. For most euro area countries, a negative relationship between interest rate deviations and house price bubbles can be observed both before and after the introduction of the single currency. The impact is, however, slightly stronger after 1999.

Table 10 and Table 11 present the results of estimating equations (13) and (14) over *sample 1* and *sample 2* respectively. For most countries, the estimations with the duration variables are broadly unchanged when estimating sub-samples compared to the total sample. In the majority of cases, we note that the impact observed in table 11 is again slightly stronger than that observed in 10. This can in part be due to the increased number of interest rate deviations observed between 1990Q1 and 2010Q4 (Table 7).

The results presented in Tables 9, 10 and 11 provide robust evidence of the results reported in Table 8. We are able to show that interest rates that are set "too low" for "too long" have a significant impact on the creation of housing bubbles. Our results are robust over countries and between sample periods. For the euro area countries in our sample, we show that the impact of interest rate deviations on housing bubbles is greatest for Ireland, Finland and Spain, the three euro area countries with the lowest mean interest rate relative to Taylor-implied rates over the sample period. Moreover, as seen in Table 1, these countries experienced growth of both actual and fundamental house prices that were significantly above the sample average. Our results highlight the additional complexity of maintaining an appropriate policy interest rate for a group of countries that experience substantial heterogeneity in both the real estate markets as well as in the real economy. Our findings suggest that rates that are too low for too long can lead to housing bubbles. The strong link between deviations of short-term rates from Taylor-implied rates and housing bubbles suggest that in order to lean against house price fluctuations, it is not necessary to consider house prices directly in monetary policy decisions if policymakers set interest rates at levels close to those implied by the Taylor rule. However, as we have seen, Taylor-implied rates as well as the development of house prices differ substantially between some euro area countries. Since it is not possible to react to this with a single monetary policy, country specific measures should be taken to compensate for "too low" interest rates. This compensation could be achieved, for example, by introducing macro prudential instruments like counter cyclical capital requirements for banks or a counter cyclical tax treatment of real estate holdings.

5 Conclusions

In this paper, we assess whether interest rates that deviate from Taylor-implied rates can cause housing bubbles. Based on a sample of 14 OECD countries, we estimate the impact that interest rates that are "too low" for "too long" can have on housing bubbles. We start by estimate fundamental house prices for each country in our sample by calibrating a theoretical house price model and define the deviation from fundamental values as bubbles. We then assess the extent to which housing bubbles are explained by interest rate deviations from their Taylor-implied levels ("too low..."). As an additional analysis, we create a set of variables that capture the duration that observed rates remained below the Taylor-implied rates ("...for too long").

Our results indicate that there is a strong link between short-term rates that are below the Taylor-implied rates and housing bubbles. Moreover, we are able to show that for 10 of 14 countries in our sample interest rate deviations Granger-cause housing bubbles. The impact of short-term interest rates on housing bubbles is especially strong when they are "too low" for "too long". We further assess whether the relationship holds by splitting our sample and assessing two periods of of observed house price overvaluation separately. We are able to provide robust evidence that interest rates that are set “too low” for “too long” have a significant impact on the creation of housing bubbles.

Our findings have important implications with regards to monetary policy and house prices. We show that in countries that experienced strong growth in house prices, interest rates have been kept low relative to Taylor-implied rates. We show that the relationship between low interest rates and housing bubbles are strongest for those countries in which the observed rate was lower than the rate implied by the Taylor-rule since the introduction of the single policy rate. Our estimations provide evidence suggesting that if interest rates are set at similar levels to those implied by the Taylor rule, deviations of house prices from their fundamental value can be reduced. We therefore argue that in order to lean against house price fluctuations it is not necessary to consider house prices directly in monetary policy decisions. If a heterogenous economic development within a currency area makes it impossible to set a single optimal policy rate, alternative counter cyclical measures have to be considered.

References

Ahearne, A., J. Ammer, B. Doyle, L. Kole and R. Martin (2005). 'House Prices and Monetary Policy: A Cross-Country Study', *Board of Governors of the Federal Reserve System, International Finance Discussion Papers No. 841.*

Altunbas, Y., L. Gambacorta, and D. Marques-Ibanez (2010). 'Does Monetary Policy Affect Bank Risk-Taking?' *ECB working paper, No. 1166.*

Assenmacher-Wesche, K. and S. Gerlach (2008). 'Financial Structure and the Impact of Monetary Policy on Asset Prices', *Swiss National Bank Working Paper 2008-16.*

Avery, C. and P. Zemsky (1998). 'Multidimensional Uncertainty and Herd Behavior in Financial Markets', *The American Economic Review, vol. 88, pp. 724-748.*

Bernanke, B. (2010). 'Monetary Policy and the Housing Bubble', *Speech at the Annual Meeting of the American Economic Association, Atlanta Georgia.*

Bank for International Settlements (2004). 'Bank Failures in Mature Economies', *BCBS Publications: Bank for International Settlements Working Paper No. 13.*

Borio, C. and P. Lowe (2002). 'Asset Prices, Financial and Monetary Stability: Exploring the Nexus', *BIS Working Paper No 114.*

Breusch, T. and A. Pagan (1980). 'The LM Test and Its Application to Model Specification in Econometrics', *Review of Economic Studies, 1980, 47, pp. 239-54.*

Ciccarelli, M., A. Maddaloni and J-L. Peydró (2010). 'Trusting the Bankers: A New Look at the Credit Channel of Monetary Policy', *ECB Working Paper No 1228.*

Calza, A., T. Monacelli and L. Stracca (2009). 'Housing Finance and Monetary Policy', *ECB Working Paper Series, No. 1069.*

Cecchetti, M., H. Genberg, J. Lipsky and S. Wadhwani (2000). 'Asset Prices and Central Bank Policy', *Geneva Report on the World Economy 2, CEPR and ICMB.*

Dokko, J., B. Doyle, M. Kiley, J. Kim, S. Sherlund, J. Sim, and S. Van den Heuvel (2009). 'Monetary Policy and the Housing Bubble', *Finance and Economics Discussion Series 2009-49. Washington: Board of Governors of the Federal System, December.*

Dubecq, S., B. Mojon, and X. Ragot (2009). 'Fuzzy Capital Requirements, Risk-Shifting and the Risk Taking Channel of Monetary Policy', *Banque de France Working Paper No. 254.*

Froot, K. A. and M. Obstfeld (1991). 'Intrinsic Bubbles: The Case of Stock Prices', *The American Economic Review, vol. 81 (5), pp. 1189-1214.*

Garber, P. (2004). 'Famous First Bubbles', *MIT Press, 2000.*

Goodhart, C. and B. Hofmann (2007). 'House Prices and the Macroeconomy: Implications for Banking and Price Stability', *Oxford University Press, Oxford.*

Greene, W. (1997). 'Econometric Analysis', *3 edition. rd Upper Saddle River, NJ: Prentice-Hall, 1997.*

Harding, J., S. Rosenthal and C. Sirmans (2007). 'Depreciation of Housing Capital, Maintenance, and House Price Inflation: Estimates from a Repeat Sales Model', *Journal of Urban Economics, Vol. 61 (2), pp. 193-217.*

Herring, R. and S. Wachter (1999). 'Real estate booms and banking busts: An international perspective', *Wharton Financial Institutions Center Working Paper 99-27.*

Himmelberg, Charles, Christoph Mayer and Todd Sinai (2005). 'Assessing High House Prices: Bubbles, Fundamentals, and Misperceptions', *Journal of Economic Perspectives, Vol. 19 (4), pp. 67-92.*

Hott, C. (2011). 'Lending Behavior and Real Estate Prices', *Journal of Banking and Finance, doi:10.1016/j.jbankfin.2011.02.001.*

Hott, C. and P. Monnin (2008). 'Fundamental Real Estate Prices: An Empirical Estimation with International Data', *Journal of Real Estate Finance and Economics, Vol. 36, No. 4, 427-450.*

Iacoviello, M. (2005). 'House Prices, Borrowing Constraints, and Monetary Policy in the Business Cycle', *The American Economic Review, Vol. 95, No. 3, 739-764.*

Kahn, G. (2010). 'Taylor Rule Deviations and Financial Imbalances', *Economic Review, 2010, issue Q II, pages 63-99.*

Kiyotaki, N. and J. Moore (1997). 'Credit Cycles', *The Journal of Political Economy, Vol. 105, No. 2, 211-248.*

McCarthy, J. and R. Peach (2004). 'Are Home Prices the Next 'Bubble'?', *FRBNY Economic Policy Review, December.*

Nier, E. and O. Merrouche (2010). 'What Caused the Global Financial Crisis - Evidence on the Drivers of Financial Imbalances 1999 - 2007?', *IMF Working Papers No. 10/265.*

Pain, N. and P. Westaway (1997). 'Modelling Structural Change in the UK Housing Market: A Comparison of Alternative House Price Models', *Economic Modelling, Vol. 14, pp. 587-610.*

Poterba, J. (1992). 'Taxation and Housing: Old Questions, New Answers', *The American Economic Review, Vol. 82 (2), pp. 237-242.*

Tabak, B., M. Laiz, and B. Cajueiro (2010). 'Financial Stability and Monetary Policy-The Case of Brazil', *Banco Central Do Brazil Working Paper Series No. 217.*

Taylor, J. (2010). 'The Fed and the Crisis: A Reply to Ben Bernanke', *The Wall Street Journal, p. A19.*

Taylor, J. (2009). 'The Financial Crisis and the Policy Responses: An Empirical Analysis of What Went Wrong', *NBER Working Paper No. 14631.*

Taylor, J. (2007). 'Housing and Monetary Policy', *in Housing, Housing Finance, and Monetary Policy Federal Reserve Bank of Kansas City.*

Taylor, J. (1993). 'Discretion versus Policy Rules in Practice', *Carnegie-Rochester Conference Series on Public Policy, 39, pp. 195-214.*

The Economist (2005). 'In Come the Waves: The Worldwide Rise in House Prices is the Biggest Bubble in History. Prepare for the Economic Pain When it Pops', *The Economist, 2005-06-16.*

Zellner, A. (1962). 'An efficient method of estimating seemingly unrelated regression equations and tests for aggregation bias', *Journal of the American Statistical Association 57: 348368.*

Table 1: House Price Overvaluations

		(p_t^a	-	p_{t-4}^a)		(p_t^*	-	p_{t-4}^*)		(p_t^a	-	p_t^*)		*correl*
	Observ.	*Mean*	*St dev*	*Min*	*Max*	*Mean*	*St dev*	*Min*	*Max*	*Mean*	*St dev*	*Min*	*Max*	($p_t^a; p_t^*$)
AU	98	0.04	0.07	-0.08	0.26	0.01	0.02	-0.03	0.07	0	0.25	-0.32	0.5	0.59
CA	120	0	0.05	-0.16	0.1	0	0.02	-0.03	0.04	0	0.15	-0.19	0.29	-0.75
FI	132	0.02	0.1	-0.24	0.29	0.01	0.03	-0.05	0.09	0	0.23	-0.44	0.59	0.5
FR	122	0.03	0.08	-0.13	0.2	0.01	0.02	-0.04	0.04	0	0.26	-0.32	0.48	0.71
DE	113	0	0.02	-0.07	0.05	0.01	0.01	-0.01	0.04	0	0.18	-0.27	0.25	-0.63
IRL	92	0.04	0.09	-0.17	0.22	0.01	0.04	-0.04	0.08	0	0.46	-0.6	0.75	0.21
JAP	141	-0.01	0.04	-0.07	0.11	0.01	0.04	-0.1	0.07	0	0.34	-0.53	0.45	-0.02
NL	104	0.04	0.05	-0.06	0.16	0.02	0.02	-0.01	0.07	0	0.26	-0.34	0.36	0.89
NO	121	0.04	0.08	-0.19	0.18	0	0.02	-0.04	0.04	0	0.29	-0.46	0.56	0.62
ES	96	0.04	0.07	-0.13	0.2	0	0.03	-0.04	0.06	0	0.34	-0.45	0.61	-0.23
SE	100	0.04	0.07	-0.21	0.13	0.02	0.02	-0.02	0.07	0	0.21	-0.33	0.34	0.72
CH	144	0	0.05	-0.12	0.18	0.01	0.01	-0.03	0.04	0	0.18	-0.23	0.43	-0.29
UK	98	0.03	0.1	-0.22	0.23	0.02	0.02	-0.02	0.08	0	0.25	-0.37	0.41	0.62
US	96	0	0.07	-0.23	0.12	0.01	0.01	-0.02	0.02	0	0.17	-0.21	0.38	0.45
average	113	0.02	0.07	-0.15	0.17	0.01	0.02	-0.04	0.06	0	0.26	-0.36	0.46	0.24

Note: Descriptive statistics for the annual growth rate of actual ($p_t^a - p_{t-4}^a$) and fundamental ($p_t^* - p_{t-4}^*$) house prices and for the difference between the log of actual and fundamental house prices.

Table 2: House Price Overvaluation: correlation matrix.

	AU	CA	FI	FR	DE	IE	JP	NL	NO	ES	SE	CH	UK	US
AU	1													
CA	0.59*	1												
FI	0.40*	0.63*	1											
FR	0.84*	0.64*	0.56*	1										
DE	-0.72*	-0.06	-0.05	-0.47*	1									
IE	0.87*	0.35*	0.26*	0.65*	-0.87*	1								
JP	-0.63*	0.25*	0.09	-0.43*	0.92*	-0.77*	1							
NL	0.78*	0.11	0.05	0.47*	-0.94*	0.93*	-0.90*	1						
NO	0.89*	0.33*	0.38*	0.75*	-0.87*	0.91*	-0.77*	0.86*	1					
ES	0.95*	0.62*	0.36*	0.89*	-0.68*	0.89*	-0.60*	0.74*	0.88*	1				
SE	0.70*	0.89*	0.84*	0.88*	-0.27*	0.55*	0.02	0.33*	0.64*	0.72*	1			
CH	-0.31*	0.42*	0.54*	-0.03	0.75*	-0.52*	0.79*	-0.72*	-0.48*	-0.31*	0.31*	1		
UK	0.77*	0.85*	0.78*	0.86*	-0.36*	0.68*	-0.11	0.44*	0.68*	0.78*	0.89*	0.22*	1	
US	0.78*	0.45*	0.40*	0.68*	-0.67*	0.90*	-0.54*	0.75*	0.77*	0.81*	0.58*	-0.26*	0.80*	1

Note: * denotes significance at the five percent level of significance.

Table 3: Interest Rate Deviations

Variables	*Observations*	*Mean*	*Std dev*	*Min*	*Max*	*IR corr*	*Max duration*
AU	120	.916	2.771	-7.438	7.716	0.82	8
CA	120	.680	2.579	-5.607	6.116	0.82	9
FI	119	-.874	3.407	-11.399	6.4258	0.70	23
FR	119	1.115	2.629	-7.814	8.510	0.86	17
DE	120	.838	1.885	-3.572	6.514	0.80	7
IE	120	-.961	5.876	-18.946	9.454	0.56	41
JP	108	.497	1.826	-4.270	5.272	0.75	12
NL	121	.370	2.386	-5.505	7.033	0.55	42
NO	120	1.108	3.825	-14.219	7.391	0.58	15
ES	90	-.865	3.260	-5.872	7.456	0.76	42
SE	116	.660	3.147	-7.470	12.501	0.80	13
CH	88	-.924	1.409	-4.351	2.532	0.82	49
UK	121	.189	2.476	-8.476	5.545	0.81	20
US	125	-.649	2.628	-10.362	5.926	0.75	30

Note: IR corr refers to the correlation between the observed short term interest rate and the deviation from Taylor-implied rates. Max duration denotes the maximum duration in quarters of a negative deviation of observed rates from Taylor-implied rates.

Table 4: Interest Rate Deviation: correlation matrix.

	AU	CA	FI	FR	DE	IE	IT	JP	NL	NO	ES	SE	CH	UK	US
AU	1														
CA	0.57*	1													
FI	0.38*	0.45*	1												
FR	0.41*	0.55*	0.38*	1											
DE	0.01	0.32*	-0.22*	0.22*	1										
IE	0.56*	0.64*	0.64*	0.63*	0.20*	1									
JP	0.08	0.38*	0.19	0.50*	0.43*	0.38*	1								
NL	0.37*	0.45*	0.19*	0.62*	0.38*	0.62*	0.46*	1							
NO	0.40*	0.50*	0.59*	0.36*	0.03	0.47*	0.12	0.07	1						
ES	0.60*	0.67*	0.25*	0.83*	0.34*	0.85*	0.34*	0.69*	0.31*	1					
SE	0.18*	0.41*	0.64*	0.35*	0.01	0.38*	0.21*	0.19*	0.22*	0.23*	1				
CH	0.39*	0.73*	0.45*	0.58*	0.18	0.55*	0.35*	0.29*	0.34*	0.59*	0.65*	1			
UK	0.38*	0.51*	0.54*	0.60*	-0.01	0.55*	0.50*	0.33*	0.47*	0.45*	0.35*	0.44*	1		
US	0.09	0.33*	-0.14	0.33*	0.24*	0.014	0.35*	0.24*	-0.28*	0.56*	0.13	0.64*	0.36*	1	

Note: * denotes significance at the one percent level of significance.

Table 5: Seeming unrelated regressions

	AU	CA	FI	FR	DE	IE	JP	NL	NO	ES	SE	CH	UK	US
Estimating equation (12)														
devTR	-0.013**	0.012	-0.055***	-0.003	-0.006**	-0.060***	0.004	-0.062***	-0.028***	-0.052***	-0.022***	-0.027***	-0.049***	-0.031***
obs	85	85	85	85	85	85	85	85	85	85	85	85	85	85
R-sq	0.09	0.04	0.46	0.02	0.03	0.55	0.19	0.37	0.19	0.21	0.33	0.04	0.34	0.28

Note: *, ** and *** denote significance at the ten, five and one percent level respectively.

Table 6: Granger causality tests

Variables	*devTR Granger causes overvaluation*	*overvaluation Granger causes devTR*
AU	0.01	no causality
CA	no causality	no causality
FI	0.00	no causality
FR	0.00	no causality
DE	0.00	no causality
IE	0.00	no causality
JP	no causality	no causality
NL	0.01	no causality
NO	no causality	no causality
ES	0.05	no causality
SE	0.05	no causality
CH	no causality	no causality
UK	0.02	no causality
US	0.01	no causality

Table 7: Maximum duration interest rate deviation

Variables	*1980Q1 to 1989Q4*	*1999Q1 to 2010Q4*
AU	8	6
CA	9	9
FI	18	23
FR	3	17
DE	7	7
IE	14	41
JP	10	12
NL	11	42
NO	15	6
ES	1	42
SE	8	13
CH	10	49
UK	7	20
US	11	30
avg	9	23

Table 8: Seeming unrelated regressions with duration

	AU	CA	FI	FR	DE	IE	JP	NL	NO	ES	SE	CH	UK	US
Panel I: estimating equation (13)														
devTR	-0.022***	0.005	-0.053***	-0.005**	-0.011**	-0.032***	0.008	-0.038***	-0.021***	-0.015***	-0.086***	-0.038***	-0.035***	-0.055***
duration	0.008***	0.005**	0.086**	0.019***	0.021***	0.099***	0.012***	0.063***	0.039***	0.088***	0.019***	0.067***	0.017***	0.093***
obs	85	85	85	85	85	85	85	85	85	85	85	85	85	85
R-sq	0.08	0.09	0.50	0.13	0.19	0.78	0.36	0.52	0.20	0.67	0.35	0.23	0.37	0.33
Panel II: estimating equation (14) with Q														
devTR	-0.017***	-0.004***	-0.049***	0.029***	-0.013***	-0.004	-0.009	-0.041***	-0.018***	-0.0411***	-0.010***	-0.011	-0.065	-0.053***
Q1	0.022	-0.033**	-0.038*	0.054	-0.003	-0.021***	-0.011	0.062	0.075	-0.058**	-0.073	-0.038	-0.012***	-0.022
Q2	0.010	-0.036**	-0.011	-0.051**	-0.029*	-0.025***	-0.053	0.030	0.012	-0.077	-0.071	-0.057*	-0.021***	-0.041
Q3	-0.015**	-0.049**	-0.035**	-0.017***	-0.037*	-0.028***	-0.065	0.063	0.044	-0.072*	-0.060	-0.033**	-0.024**	-0.049
Q4	-0.033**	-0.032	-0.053*	-0.019***	-0.032	-0.031***	-0.040	0.075	-0.035*	-0.091**	-0.074	-0.012*	-0.025**	-0.067*
>Q4	-0.039**	-0.015	-0.079***	-0.023***	-0.021	-0.069***	-0.0177***	-0.015***	-0.023***	-0.094***	-0.013***	-0.052***	-0.032***	-0.080***
obs	85	85	85	85	85	85	85	85	85	85	85	85	85	85
R-sq	0.09	0.04	0.52	0.11	0.05	0.72	0.06	0.43	0.18	0.65	0.25	0.14	0.42	0.45
Panel III: estimating equation (14) with Y														
devTR	-0.018***	0.005	-0.054***	-0.015**	-0.013***	-0.028***	-0.004	-0.021***	-0.015**	-0.008*	-0.007**	-0.007	-0.065	-0.005***
Y1	-0.004	-0.036**	0.001	0.013	-0.001	-0.069	-0.012	-0.089***	-0.104**	-0.007	-0.068***	-0.038	-0.162***	-0.056**
Y2	-0.040	-0.017	0.042	0.047	-0.004	0.081	-0.054	-0.121**	-0.223***	-0.223	-0.169***	-0.015	-0.336***	-0.013
Y3		-0.049	-0.025	-0.160***		-0.225***	-0.032	-0.134***		-0.204	-0.204***	-0.051	-0.272***	-0.016
Y4			-0.003	-0.256***		-0.261***		-0.234***		-0.122	-0.121**	-0.121**	0.161***	-0.052
>Y4			0.007	-0.182***		-0.529***		-0.309***		-0.361***		-0.163***		-0.286***
obs	85	85	85	85	85	85	85	85	85	85	85	85	85	85
R-sq	0.007	0.06	0.53	0.12	0.03	0.74	0.03	0.51	0.18	0.65	0.36	0.29	0.50	0.47

Note: *, ** and *** denote significance at the ten, five and one percent level respectively. In panel *I*: *Duration* captures the number of consecutive quarters that interest rates are below the Taylor-implied rates. A longer duration denotes interest rates that were too loose too long. In panel *II*: Q1, Q2, Q3 and Q4 are dummy variables that are set equal to 1 when observed interest rates are lower than the Taylor-implied rates for one quarter, two quarters, three quarters and four quarters respectively. The dummy >Q4 is set equal to one when the duration of lower than implied rates is greater than four quarters. In panel *III*: Y1, Y2, Y3 and Y4 are dummy variables that are set equal to 1 when observed interest rates are lower than the Taylor-implied rates for one year, two years, three years and four years respectively. The dummy >Y4 is set equal to one when the duration of lower than implied rates is greater than four years.

Table 9: Seeming unrelated regressions

	AU	CA	FI	FR	DE	IE	JP	NL	NO	ES	SE	CH	UK	US
Panel I: estimating equation (12): $1980Q1 - 1998Q4$														
devTR	-0.012**	0.005	-0.081***	-0.049***	-0.069***	-0.012***	-0.053***	-0.016***	-0.013***	-0.029***	-0.021***	-0.011***	-0.017***	-0.015***
obs	40	40	40	40	40	40	40	40	40	40	40	40	40	40
R-sq	0.08	0.02	0.43	0.24	0.03	0.29	0.27	0.15	0.07	0.37	0.07	0.02	0.04	0.29
Panel II: estimating equation (12): $1999Q1 - 2010Q4$														
devTR	-0.039***	-0.005***	-0.016***	-0.042***	-0.014***	-0.004**	0.005	-0.006***	-0.041***	-0.021***	-0.035***	-0.003***	-0.113***	-0.038***
obs	45	45	45	45	45	45	45	45	45	45	45	45	45	45
R-sq	0.08	0.01	0.55	0.27	0.17	0.51	0.05	0.03	0.33	0.42	0.21	0.03	0.59	0.11

Note: *, ** and *** denote significance at the ten, five and one percent level respectively.

Table 10: Seeming unrelated regressions with duration: $1980Q1 - 1998Q4$

	AU	CA	FI	FR	DE	IE	JP	NL	NO	ES	SE	CH	UK	US
Panel I: estimating equation (13)														
devTR	0.011***	0.004*	-0.067***	-0.049***	-0.007**	-0.009***	-0.029***	-0.013	-0.016***	-0.016***	-0.009***	-0.015***	-0.018	-0.017***
duration	0.003	0.003	0.017***	0.031	0.021***	0.117***	0.018***	0.017***	0.016***	0.014***	0.034***	0.008***	0.103***	0.018***
obs	40	40	40	40	40	40	40	40	40	40	40	40	40	40
R-sq	0.08	0.03	0.78	0.24	0.20	0.30	0.32	0.84	0.08	0.20	0.37	0.02	0.31	0.22
Panel II: estimating equation (14) with Q														
devTR	-0.010***	-0.009	-0.0244***	-0.040***	-0.025	-0.010***	-0.038***	-0.001	-0.011**	-0.074**	-0.010	-0.071***	-0.038***	-0.017
Q1	0.001	-0.022**	-0.028	-0.037	-0.053***	-0.126***	-0.003	0.057***	0.008	-0.027	-0.238***	-0.185***	-0.309***	-0.024*
Q2		-0.648	-0.37	-0.092**		-0.072	0.125***			-0.277***	-0.212***		-0.001	
Q3		-0.462***				-0.108***	-0.169***						-0.006	
Q4			-0.231*											
>Q4			-0.797***			-0.069***								
obs	40	40	40	40	40	40	40	40	40	40	40	40	40	40
R-sq	0.09	0.04	0.52	0.11	0.05	0.32	0.06	0.43	0.18	0.65	0.25	0.14	0.42	0.45
Panel III: estimating equation (14) with Y														
devTR	-0.010***	0.001	-0.022***	-0.039***	0.002	-0.008***	-0.039**	0.011	-0.011***	-0.007**	-0.001	-0.071***	-0.039**	-0.008
Y1	-0.001	-0.022**	-0.020	-0.039	-0.053***	-0.126***	-0.001	-0.057***	-0.010	-0.028	-0.241***	-0.185***	-0.309***	-0.024
Y2			-0.017*		-0.092***		-0.069	-0.126***			-0.285***	-0.213***		-0.017
Y3			-0.043*				-0.106*	-0.168***				-0.074		-0.007
Y4			-0.047*											
>Y4														
obs	40	40	40	40	40	40	40	40	40	40	40	40	40	40
R-sq	0.09	0.02	0.89	0.21	0.18	0.59	0.29	0.83	0.07	0.61	0.43	0.15	0.38	0.12

Note: *, ** and *** denote significance at the ten, five and one percent level respectively. In panel *I*: *Duration* captures the number of consecutive quarters that interest rates are below the Taylor-implied rates. A longer duration denotes interest rates that were too loose too long. In panel *II*: Q1, Q2, Q3 and Q4 are dummy variables that are set equal to 1 when observed interest rates are lower than the Taylor-implied rates for one quarter, two quarters, three quarters and four quarters respectively. The dummy >Q4 is set equal to one when the duration of lower than implied rates is greater than four quarters. In panel *III*: Y1, Y2, Y3 and Y4 are dummy variables that are set equal to 1 when observed interest rates are lower than the Taylor-implied rates for one year, two years, three years and four years respectively. The dummy >Y4 is set equal to one when the duration of lower than implied rates is greater than four years.

Table 11: Seeming unrelated regressions with duration: $1999Q1 - 2010Q4$

	AU	CA	FI	FR	DE	IE	JP	NL	NO	ES	SE	CH	UK	US
Panel I: estimating equation (13)														
devTR	-0.029***	0.011	-0.015***	-0.013	-0.011***	-0.031***	0.006**	-0.002	-0.026***	-0.042***	-0.008	-0.007***	0.097***	-0.009
duration	0.001	0.003*	0.026***	0.013***	0.003	0.019***	0.006***	0.004	0.022*	0.018***	0.001***	0.004***	0.009***	
obs	45	45	45	45	45	45	45	45	45	45	45	45	45	45
R-sq	0.08	0.03	0.78	0.24	0.20	0.60	0.32	0.44	0.08	0.76	0.37	0.02	0.31	0.28
Panel II: estimating equation (14) with Q														
devTR	-0.021**	-0.0038***	-0.013***	0.002*	-0.009***	-0.024**	-0.009**	-0.014***	-0.011*	-0.049***	-0.006	-0.006**	-0.047***	-0.048***
Q1	0.026	-0.0128**	-0.034*	0.006	-0.001		-0.06	0.006	0.249***	-0.256*	-0.022	-0.001	-0.041	-0.076
Q2	0.001	-0.020**	-0.054	-0.036	-0.019*	-0.063	-0.041*	0.014	0.331***	-0.398***	-0.023		-0.123**	-0.127*
Q3	-0.022	-0.020**	-0.029	-0.093*	-0.023*	-0.110	-0.045**	0.013	0.171*	-0.581***	-0.019		-0.157**	-0.114
Q4	-0.054	-0.002	-0.005	-0.106*	-0.020	-0.027	-0.056***	0.006	-0.031	-0.540***	-0.002		-0.113*	-0.247***
>Q4	-0.0219	-0.009	-0.002	-0.107**	-0.009	-0.384***	-0.056***	-0.061**	-0.197***	-0.324**	-0.148***	-0.052***	-0.187***	-0.218***
obs	45	45	45	45	45	45	45	45	45	45	45	45	45	45
R-sq	0.07	0.03	0.45	0.08	0.05	0.61	0.25	0.26	0.03	0.56	0.34	0.41	0.62	0.18
Panel III: estimating equation (14) with Y														
devTR	-0.010***	0.001	-0.022***	-0.039***	0.002	-0.008***	-0.039**	0.011	-0.011***	-0.007**	-0.001	-0.071***	-0.039**	-0.008
Y1	-0.026	-0.022	-0.022**	-0.072*	-0.003	-0.495***	-0.011	-0.016	-0.278***	-0.320***	-0.038	-0.00	-0.094**	-0.048
Y2	-0.025	-0.015	-0.317**	-0.103*	-0.003	-0.337***	-0.026	-0.035	-0.021**	-0.464***	-0.179***			-0.071
Y3		-0.001	-0.443***	-0.026		-0.187**	-0.044**	-0.348***		-0.434***	-0.229***	-0.076***	-0.155***	-0.157***
Y4			-0.447***	-0.113**		-0.164*		-0.270***		-0.254**	-0.094	-0.084***	-0.105**	-0.081*
>Y4			-0.638*	-0.142***		-0.215**		-0.035***		-0.175***		-0.061***		-0.096***
obs	45	45	45	45	45	45	45	45	45	45	45	45	45	45
R-sq	0.07	0.03	0.65	0.15	0.16	0.74	0.13	0.77	0.37	0.60	0.33	0.56	0.66	0.39

Note: *, ** and *** denote significance at the ten, five and one percent level respectively. In panel *I*: *Duration* captures the number of consecutive quarters that interest rates are below the Taylor-implied rates. A longer duration denotes interest rates that were too loose too long. In panel *II*: Q1, Q2, Q3 and Q4 are dummy variables that are set equal to 1 when observed interest rates are lower than the Taylor-implied rates for one quarter, two quarters, three quarters and four quarters respectively. The dummy >Q4 is set equal to one when the duration of lower than implied rates is greater than four quarters. In panel *III*: Y1, Y2, Y3 and Y4 are dummy variables that are set equal to 1 when observed interest rates are lower than the Taylor-implied rates for one year, two years, three years and four years respectively. The dummy >Y4 is set equal to one when the duration of lower than implied rates is greater than four years.

Figure 1: *House prices.*

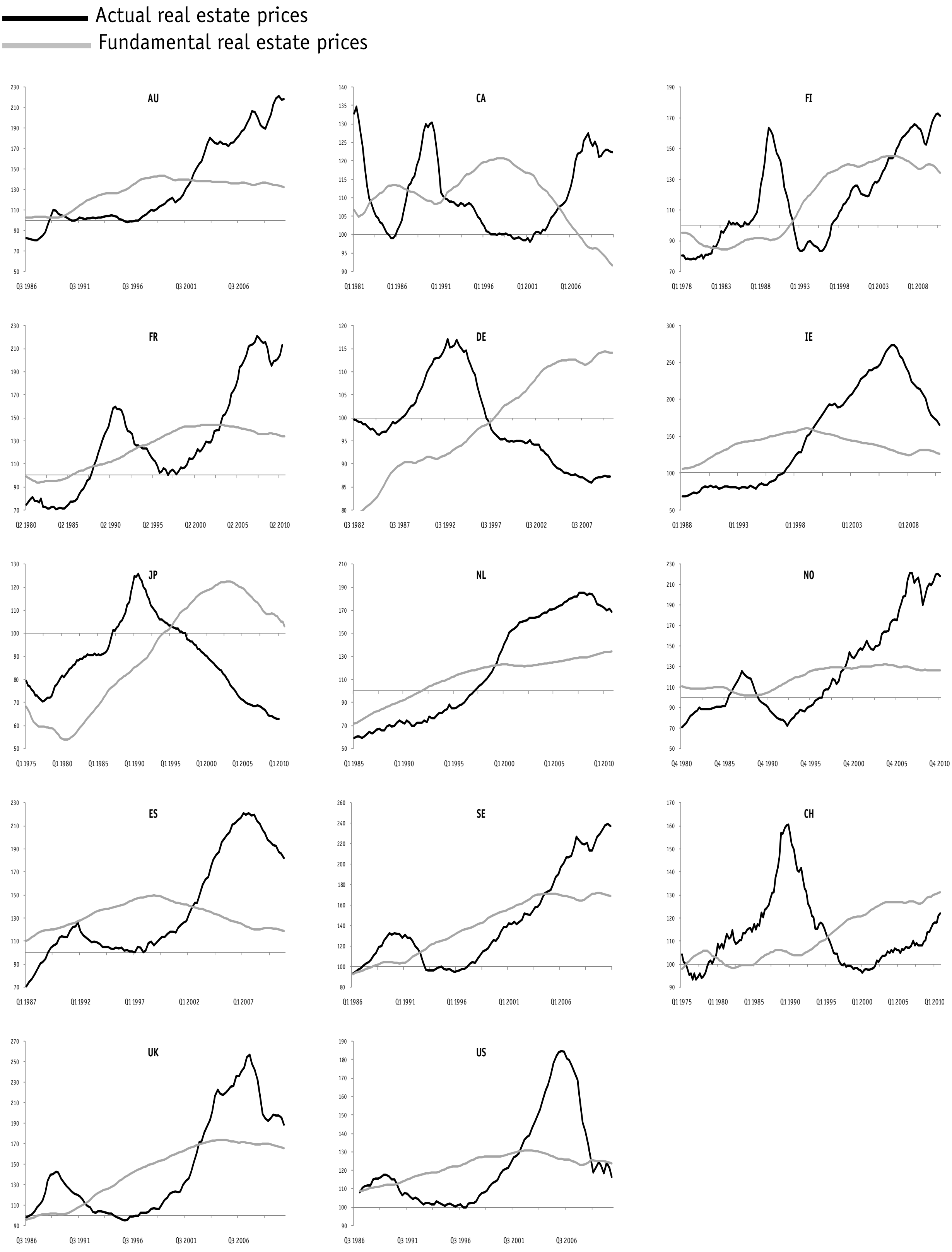


Figure 2: *Interest rates.*

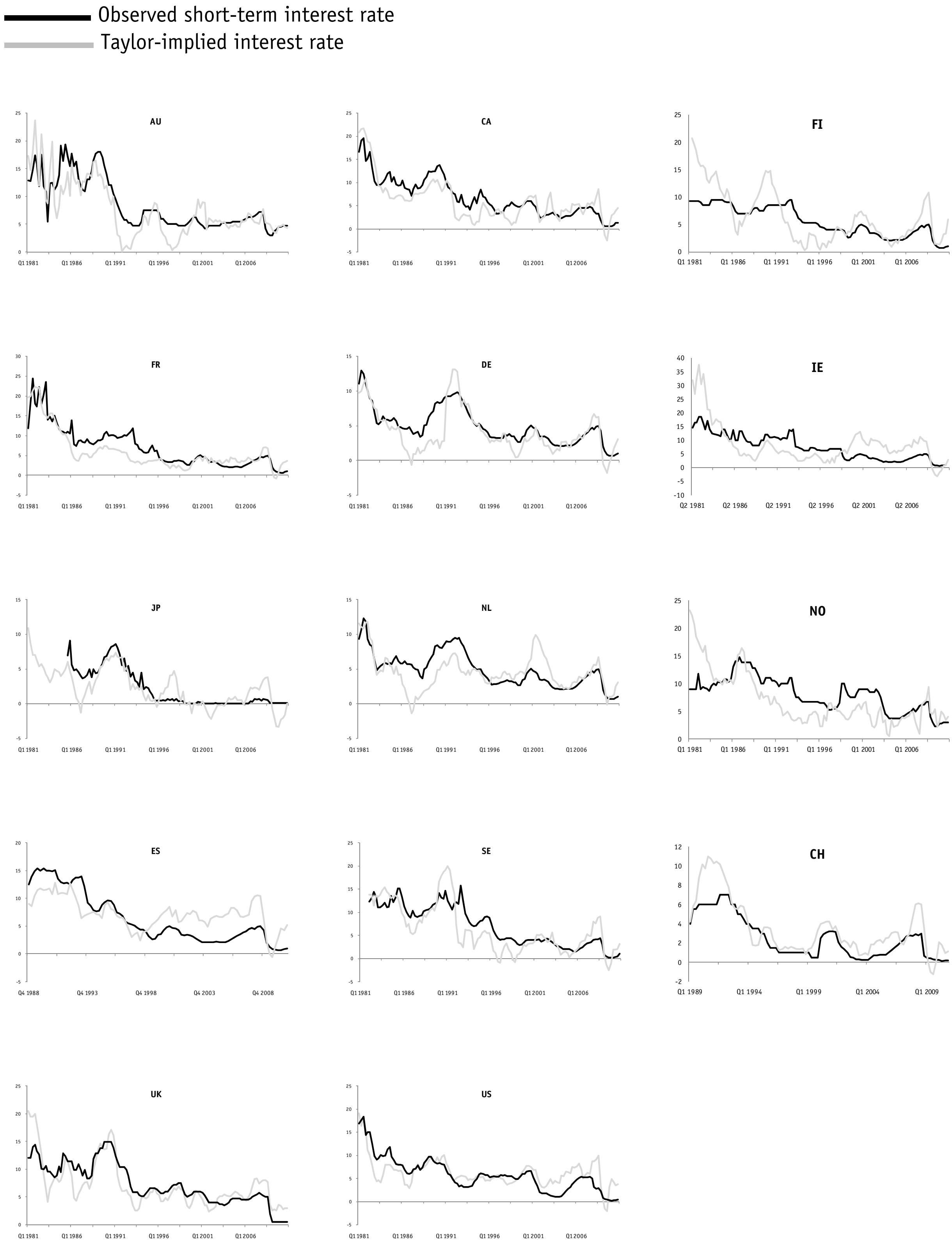
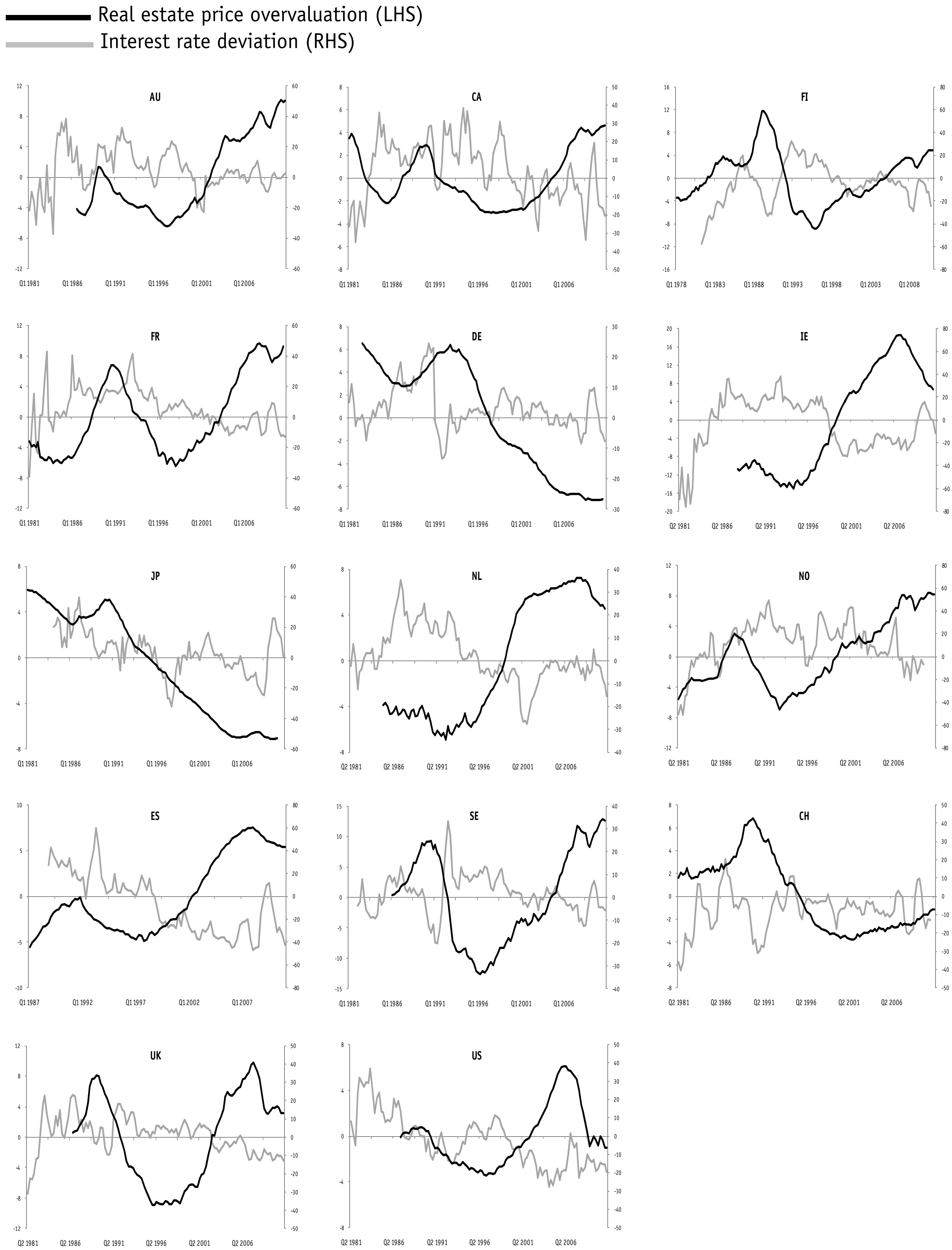


Figure 3: *Housing overvaluation and interest rate deviations.*



Swiss National Bank Working Papers published since 2004:

2004-1 Samuel Reynard: Financial Market Participation and the Apparent Instability of Money Demand

2004-2 Urs W. Birchler and Diana Hancock: What Does the Yield on Subordinated Bank Debt Measure?

2005-1 Hasan Bakhshi, Hashmat Khan and Barbara Rudolf: The Phillips curve under state-dependent pricing

2005-2 Andreas M. Fischer: On the Inadequacy of Newswire Reports for Empirical Research on Foreign Exchange Interventions

2006-1 Andreas M. Fischer: Measuring Income Elasticity for Swiss Money Demand: What do the Cantons say about Financial Innovation?

2006-2 Charlotte Christiansen and Angelo Ranaldo: Realized Bond-Stock Correlation: Macroeconomic Announcement Effects

2006-3 Martin Brown and Christian Zehnder: Credit Reporting, Relationship Banking, and Loan Repayment

2006-4 Hansjörg Lehmann and Michael Manz: The Exposure of Swiss Banks to Macroeconomic Shocks – an Empirical Investigation

2006-5 Katrin Assenmacher-Wesche and Stefan Gerlach: Money Growth, Output Gaps and Inflation at Low and High Frequency: Spectral Estimates for Switzerland

2006-6 Marlene Amstad and Andreas M. Fischer: Time-Varying Pass-Through from Import Prices to Consumer Prices: Evidence from an Event Study with Real-Time Data

2006-7 Samuel Reynard: Money and the Great Disinflation

2006-8 Urs W. Birchler and Matteo Facchinetti: Can bank supervisors rely on market data? A critical assessment from a Swiss perspective

2006-9 Petra Gerlach-Kristen: A Two-Pillar Phillips Curve for Switzerland

2006-10 Kevin J. Fox and Mathias Zurlinden: On Understanding Sources of Growth and Output Gaps for Switzerland

2006-11 Angelo Ranaldo: Intraday Market Dynamics Around Public Information Arrivals

2007-1 Andreas M. Fischer, Gulzina Isakova and Ulan Termechikov: Do FX traders in Bishkek have similar perceptions to their London colleagues? Survey evidence of market practitioners' views

2007-2 Ibrahim Chowdhury and Andreas Schabert: Federal Reserve Policy viewed through a Money Supply Lens

2007-3 Angelo Ranaldo: Segmentation and Time-of-Day Patterns in Foreign Exchange Markets

2007-4 Jürg M. Blum: Why 'Basel II' May Need a Leverage Ratio Restriction

2007-5 Samuel Reynard: Maintaining Low Inflation: Money, Interest Rates, and Policy Stance

2007-6 Rina Rosenblatt-Wisch: Loss Aversion in Aggregate Macroeconomic Time Series

2007-7 Martin Brown, Maria Rueda Maurer, Tamara Pak and Nurlanbek Tynaev: Banking Sector Reform and Interest Rates in Transition Economies: Bank-Level Evidence from Kyrgyzstan

2007-8 Hans-Jürg Büttler: An Orthogonal Polynomial Approach to Estimate the Term Structure of Interest Rates

2007-9 Raphael Auer: The Colonial Origins Of Comparative Development: Comment. A Solution to the Settler Mortality Debate

2007-10 Franziska Bignasca and Enzo Rossi: Applying the Hirose-Kamada filter to Swiss data: Output gap and exchange rate pass-through estimates

2007-11 Angelo Ranaldo and Enzo Rossi: The reaction of asset markets to Swiss National Bank communication

2007-12 Lukas Burkhard and Andreas M. Fischer: Communicating Policy Options at the Zero Bound

2007-13 Katrin Assenmacher-Wesche, Stefan Gerlach, and Toshitaka Sekine: Monetary Factors and Inflation in Japan

2007-14 Jean-Marc Natal and Nicolas Stoffels: Globalization, markups and the natural rate of interest

2007-15 Martin Brown, Tullio Jappelli and Marco Pagano: Information Sharing and Credit: Firm-Level Evidence from Transition Countries

2007-16 Andreas M. Fischer, Matthias Lutz and Manuel Wälti: Who Prices Locally? Survey Evidence of Swiss Exporters

2007-17 Angelo Ranaldo and Paul Söderlind: Safe Haven Currencies

2008-1 Martin Brown and Christian Zehnder: The Emergence of Information Sharing in Credit Markets

2008-2 Yvan Lengwiler and Carlos Lenz: Intelligible Factors for the Yield Curve

2008-3 Katrin Assenmacher-Wesche and M. Hashem Pesaran: Forecasting the Swiss Economy Using VECX* Models: An Exercise in Forecast Combination Across Models and Observation Windows

2008-4 Maria Clara Rueda Maurer: Foreign bank entry, institutional development and credit access: firm-level evidence from 22 transition countries

2008-5 Marlene Amstad and Andreas M. Fischer: Are Weekly Inflation Forecasts Informative?

2008-6 Raphael Auer and Thomas Chaney: Cost Pass Through in a Competitive Model of Pricing-to-Market

2008-7 Martin Brown, Armin Falk and Ernst Fehr: Competition and Relational Contracts: The Role of Unemployment as a Disciplinary Device

2008-8 Raphael Auer: The Colonial and Geographic Origins of Comparative Development

2008-9 Andreas M. Fischer and Angelo Ranaldo: Does FOMC News Increase Global FX Trading?

2008-10 Charlotte Christiansen and Angelo Ranaldo: Extreme Coexceedances in New EU Member States' Stock Markets

2008-11 Barbara Rudolf and Mathias Zurlinden: Measuring capital stocks and capital services in Switzerland

2008-12 Philip Sauré: How to Use Industrial Policy to Sustain Trade Agreements

2008-13 Thomas Bolli and Mathias Zurlinden: Measuring growth of labour quality and the quality-adjusted unemployment rate in Switzerland

2008-14 Samuel Reynard: What Drives the Swiss Franc?

2008-15 Daniel Kaufmann: Price-Setting Behaviour in Switzerland – Evidence from CPI Micro Data

2008-16 Katrin Assenmacher-Wesche and Stefan Gerlach: Financial Structure and the Impact of Monetary Policy on Asset Prices

2008-17 Ernst Fehr, Martin Brown and Christian Zehnder: On Reputation: A Microfoundation of Contract Enforcement and Price Rigidity

2008-18 Raphael Auer and Andreas M. Fischer: The Effect of Low-Wage Import Competition on U.S. Inflationary Pressure

2008-19 Christian Beer, Steven Ongena and Marcel Peter: Borrowing in Foreign Currency: Austrian Households as Carry Traders

2009-1 Thomas Bolli and Mathias Zurlinden: Measurement of labor quality growth caused by unobservable characteristics

2009-2 Martin Brown, Steven Ongena and Pinar Yeşin: Foreign Currency Borrowing by Small Firms

2009-3 Matteo Bonato, Massimiliano Caporin and Angelo Ranaldo: Forecasting realized (co)variances with a block structure Wishart autoregressive model

2009-4 Paul Söderlind: Inflation Risk Premia and Survey Evidence on Macroeconomic Uncertainty

2009-5 Christian Hott: Explaining House Price Fluctuations

2009-6 Sarah M. Lein and Eva Köberl: Capacity Utilisation, Constraints and Price Adjustments under the Microscope

2009-7 Philipp Haene and Andy Sturm: Optimal Central Counterparty Risk Management

2009-8 Christian Hott: Banks and Real Estate Prices

2009-9 Terhi Jokipii and Alistair Milne: Bank Capital Buffer and Risk Adjustment Decisions

2009-10 Philip Sauré: Bounded Love of Variety and Patterns of Trade

2009-11 Nicole Allenspach: Banking and Transparency: Is More Information Always Better?

2009-12 Philip Sauré and Hosny Zoabi: Effects of Trade on Female Labor Force Participation

2009-13 Barbara Rudolf and Mathias Zurlinden: Productivity and economic growth in Switzerland 1991-2005

2009-14 Sébastien Kraenzlin and Martin Schlegel: Bidding Behavior in the SNB's Repo Auctions

2009-15 Martin Schlegel and Sébastien Kraenzlin: Demand for Reserves and the Central Bank's Management of Interest Rates

2009-16 Carlos Lenz and Marcel Savioz: Monetary determinants of the Swiss franc

2010-1 Charlotte Christiansen, Angelo Ranaldo and Paul Söderlind: The Time-Varying Systematic Risk of Carry Trade Strategies

2010-2 Daniel Kaufmann: The Timing of Price Changes and the Role of Heterogeneity

2010-3 Loriano Mancini, Angelo Ranaldo and Jan Wrampelmeyer: Liquidity in the Foreign Exchange Market: Measurement, Commonality, and Risk Premiums

2010-4 Samuel Reynard and Andreas Schabert: Modeling Monetary Policy

2010-5 Pierre Monnin and Terhi Jokipii: The Impact of Banking Sector Stability on the Real Economy

2010-6 Sébastien Kraenzlin and Thomas Nellen: Daytime is money

2010-7 Philip Sauré: Overreporting Oil Reserves

2010-8 Elizabeth Steiner: Estimating a stock-flow model for the Swiss housing market

2010-9 Martin Brown, Steven Ongena, Alexander Popov, and Pinar Yeşin: Who Needs Credit and Who Gets Credit in Eastern Europe?

2010-10 Jean-Pierre Danthine and André Kurmann: The Business Cycle Implications of Reciprocity in Labor Relations

2010-11 Thomas Nitschka: Momentum in stock market returns: Implications for risk premia on foreign currencies

2010-12 Petra Gerlach-Kristen and Barbara Rudolf: Macroeconomic and interest rate volatility under alternative monetary operating procedures

2010-13 Raphael Auer: Consumer Heterogeneity and the Impact of Trade Liberalization: How Representative is the Representative Agent Framework?

2010-14 Tommaso Mancini Griffoli and Angelo Ranaldo: Limits to arbitrage during the crisis: funding liquidity constraints and covered interest parity

2010-15 Jean-Marc Natal: Monetary Policy Response to Oil Price Shocks

2010-16 Kathrin Degen and Andreas M. Fischer: Immigration and Swiss House Prices

2010-17 Andreas M. Fischer: Immigration and large banknotes

2010-18 Raphael Auer: Are Imports from Rich Nations Deskilling Emerging Economies? Human Capital and the Dynamic Effects of Trade

2010-19 Jean-Pierre Danthine and John B. Donaldson: Executive Compensation: A General Equilibrium Perspective

2011-1 Thorsten Beck and Martin Brown: Which Households Use Banks? Evidence from the Transition Economies

2011-2 Martin Brown, Karolin Kirschenmann and Steven Ongena: Foreign Currency Loans – Demand or Supply Driven?

2011-3 Victoria Galsband and Thomas Nitschka: Foreign currency returns and systematic risks

2011-4 Francis Breedon and Angelo Ranaldo: Intraday patterns in FX returns and order flow

2011-5 Basil Guggenheim, Sébastien Kraenzlin and Silvio Schumacher: Exploring an uncharted market: Evidence on the unsecured Swiss franc money market

2011-6 Pamela Hall: Is there any evidence of a Greenspan put?

2011-7 Daniel Kaufmann and Sarah Lein: Sectoral Inflation Dynamics, Idiosyncratic Shocks and Monetary Policy

2011-8 Iva Cecchin: Mortgage Rate Pass-Through in Switzerland

2011-9 Raphael A. Auer, Kathrin Degen and Andreas M. Fischer: Low-Wage Import Competition, Inflationary Pressure, and Industry Dynamics in Europe

2011-10 Raphael A. Auer and Philip Sauré: Spatial Competition in Quality, Demand-Induced Innovation, and Schumpeterian Growth

2011-11 Massimiliano Caporin , Angelo Ranaldo and Paolo Santucci de Magistris: On the Predictability of Stock Prices: a Case for High and Low Prices

2011-12 Jürg Mägerle and Thomas Nellen: Interoperability between central counterparties

2011-13 Sylvia Kaufmann: K-state switching models with endogenous transition distributions

2011-14 Sébastien Kraenzlin and Benedikt von Scarpatetti: Bargaining Power in the Repo Market

2012-01 Raphael A. Auer: Exchange Rate Pass-Through, Domestic Competition, and Inflation: Evidence from the 2005/08 Revaluation of the Renminbi

2012-02 Signe Krogstrup, Samuel Reynard and Barbara Sutter: Liquidity Effects of Quantitative Easing on Long-Term Interest Rates

2012-03 Matteo Bonato, Massimiliano Caporin and Angelo Ranaldo: Risk spillovers in international equity portfolios

2012-04 Thomas Nitschka: Banking sectors' international interconnectedness: Implications for consumption risk sharing in Europe

2012-05 Martin Brown, Steven Ongena and Pinar Yeşin: Information Asymmetry and Foreign Currency Borrowing by Small Firms

2012-06 Philip Sauré and Hosny Zoabi: Retirement Age across Countries: The Role of Occupations

2012-07 Christian Hott and Terhi Jokipii: Housing Bubbles and Interest Rates

Swiss National Bank Working Papers are also available at www.snb.ch, section Publications/Research
Subscriptions or individual issues can be ordered at Swiss National Bank, Fraumünsterstrasse 8, CH-8022 Zurich,
fax +41 44 631 81 14, E-mail library@snb.ch