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Monetary Policy Challenges From Falling Natural Interest Rates

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Monetary Policy Challenges from Falling Natural Interest Rates

By Klaus Adam[1]

Abstract

The real interest rates consistent with stable inflation (the natural rates of interest) has displayed a sustained downward trend in advanced economies over past decades. This has considerably complicated the conduct of monetary policy, which is increasingly constrained by the inability to lower nominal rates further. Over the same time period, the volatility of housing prices and stock prices has increased considerably, generating additional challenges for monetary policy. This paper summarizes recent academic research that analyses the monetary policy implications of lower natural rates and rising asset price volatility in a setting where policy is constrained by a lower bound on nominal rates. It focuses on the implications for (1) the optimal inflation target and (2) the question how monetary policy should respond to asset price movements.

1 Introduction

The natural rates of interest, i.e., the real interest rate on safe assets consistent with a stable inflation rate, has fallen significantly in advanced economies over recent decades. While the estimated levels of the natural rate vary across different estimation approaches, there is widespread agreement about the fact that their levels have declined over recent decades. Panel (a) in Chart 1 illustrates this trend using the estimates of Holston et al. (2017) and Fujiwara et al. (2016). The most recent estimates for the Euro Area suggest that the natural rate has fallen well below one percent and is perhaps even negative.[2]

A variety of structural economic forces have been identified as potential drivers of the general decline in safe real interest rates. One possible culprit is the observed decline in long-term growth rates, as illustrated in Panel (b) in Chart 1, but a range of additional factors might be at play (aging population, increased safe asset demand from less advanced economies, increased income and wealth inequality, etc).

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[2] Brand and Mazelis (2020), for instance, estimate the natural rate to be negative in the most recent quarters.

Whatever are the structural factors behind the observed decline in natural interest rates, the downward trend is posing important challenges to the existing monetary policy frameworks. To the extent that monetary policy is targeting a given time-invariant level of inflation, the fall in the natural rate implies that nominal rates must fall in tandem.

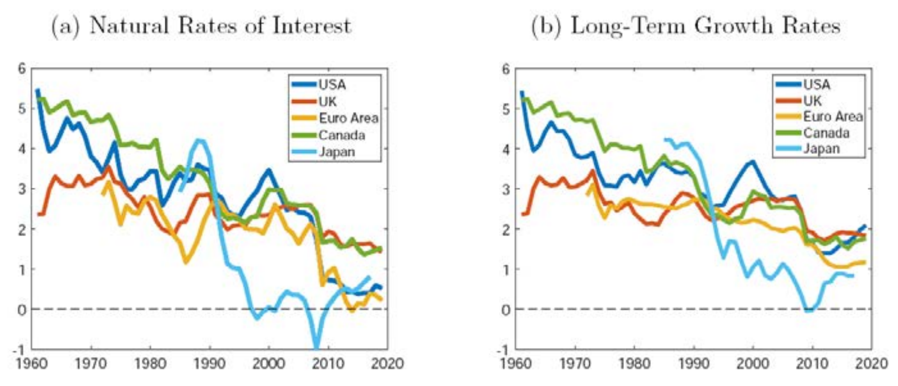
Lower average nominal rates mean, however, that the effective lower bound on nominal interest rates becomes an increasingly relevant constraint for the conduct of monetary policy.[3] Illustrating this trend, advanced economies have spent increasing amounts of time in a situation where policy rates are either close to zero or even negative.[4]

Recent experience in advanced economies furthermore illustrates that the inability to lower nominal rates further is associated with a considerable and rather persistent undershooting of the inflation target, despite all the newly instituted quantitative easing policies deployed by central banks. The persistent inflation shortfall risks unanchoring private-sector inflation expectations, which would have further adverse consequences for inflation outcomes.

Chart 1

Natural Rates and Long-Term Growth Rates in Advanced Economies

(growth rates and interest rates in percentage points)



Sources: Holston et al. (2017), Fujiwara et al. (2016).

Drawing on recent work with a number of co-authors and the monetary policy literature more generally, the present paper argues that the situation may actually be even more serious than indicated by the previous arguments. This is so because advanced economies experienced – in tandem with the decrease in natural rates of interest – a considerable increase in the volatility of housing prices (Adam, Pfaeuti and Reinelt (2020)) and equity prices.

[3] A lower bound exists because investors can always swap bank deposits into zero-interest bearing cash, which prevents interest rates on bank deposits from falling significantly below zero.

[4] In the Euro Area this has been since 2012; in the United States from the end of 2008 up until the end of 2015 and then again since the second quarter of 2020; in Japan nominal rates were zero since 1999, with only brief interruptions.

Increased asset price volatility further complicates monetary policy for a variety of reasons. Collateral constraints, for example, may become more easily binding, the risk of corporate and private defaults may periodically increase, and investment booms and busts may be triggered by the booms and busts in asset prices.

Furthermore, evidence on investor expectations obtained from investor surveys shows that the observed amounts of price volatility in housing and stock markets are unlikely efficient, instead are at least partly driven by systematic patterns of over-optimism and over-pessimism. (Vissing-Jorgensen (2003), Bacchetta, Mertens and Wincoop, (2009), Greenwood and Shleifer (2014), Adam, Marcet and Beutel (2017), Adam, Matveev and Nagel (2020), Adam, Pfaeuti and Reinelt (2020)). And perhaps, even more worryingly, it is perfectly conceivable that the observed fall in the average level of the natural rate actually triggered the increased instability in asset markets, as waves of investor optimism and pessimism become more likely when safe real interest rates are low (Adam and Merkel (2019)).

To the extent that the observed volatility increase in asset prices fails to be justified by fundamental factors, it will exacerbate the lower bound problem for monetary policy. Monetary policy is then not only confronted with lower average nominal rates, but it also has to vary nominal rates more actively in order to counteract the adverse effects of increased asset price volatility, e.g., the investment booms associated with asset price booms. The effective lower bound on nominal rates will thus become an even more stringent constraint.[5]

In light of these observations, the paper summarized recent academic research and discusses the implications of lower natural rates and increased asset price volatility for the conduct of optimal monetary policy when policy faces a lower-bound constraint on nominal interest rates. It focuses on the implications for (1) the optimal inflation target and (2) the desirability to ‘lean-against’ asset price movements. The paper also discusses mechanisms through which asset price volatility rises when (safe) real interest rates fall.

The quantitative and qualitative implications of lower natural rates and increased asset price volatility are a function of whether heightened asset price volatility is considered to be efficient or inefficient, e.g., driven by increased waves of investor optimism and pessimism.

If increased asset price volatility is judged to be efficient, then the observed fall in average natural rates justifies only a small increase in the inflation target (Adam, Pfaeuti and Reinelt (2020)): as the average natural rate falls from around 3% to a level close to zero, the inflation target optimally increases by less than 0.4%. In contrast, if the increase in asset price volatility is judged to be inefficient, then a corresponding fall in the average natural rate justifies a much stronger increase in the inflation target by around one 1%. This is illustrated in Chart 6 in section 4.1.

[5] Adam, Pfaeuti and Reinelt (2020) show how the volatility of the natural rate can increase as its average level falls and provide evidence that the volatility of natural rate has increased over time.

The economic force triggering the previous finding is that – in the presence of subjective investor beliefs – a fall in the average *level* of the natural rate leads to higher *volatility* in the natural rate, in line with the empirical evidence available for advanced economies. The increased volatility of the natural rate reinforces the stringency of the lower bound constraint for monetary policy. The optimal policy reaction to these developments is to promise a somewhat higher average inflation rate.

The optimal response to housing price movements similarly depends on whether or not asset price volatility is considered to be efficient. With efficient asset prices, optimal monetary policy can be conducted without reference to housing prices and monetary policy can focus exclusively on the output gap and inflation (Adam and Woodford (2020)). Yet, if subjective belief dynamics amplify fundamentally justified housing price movements, as investor survey data suggests, then monetary policy should 'lean-against' housing price movements, i.e., undershoot its normal targets for inflation when housing prices rise and overshoot it usual targets when housing prices fall (Caines and Winkler (2018), Adam and Woodford (2020), Adam, Pfaeuti and Reinelt (2020)).

The remainder of the paper is structured, as follows: Section 2 summarizes the international evidence on the changing average level of natural rates and the changing volatility in housing and stock markets in advanced economies. It also shows how price fluctuations in housing and stock markets co-move with housing investment and business investment, which suggests that price fluctuations in these markets have implications for real allocations. Section 3 discusses key economic mechanisms that allow linking asset price volatility to the level of the safe real interest rate. It also summarizes evidence that shows that investors' asset price expectations are inconsistent with the rational expectations assumption, which strongly suggests that price fluctuations in these markets fail to be fully efficient. Section 4 discusses the implications of lower natural rates of interest for the optimal inflation target and the question whether policy should 'lean against' housing price movements.

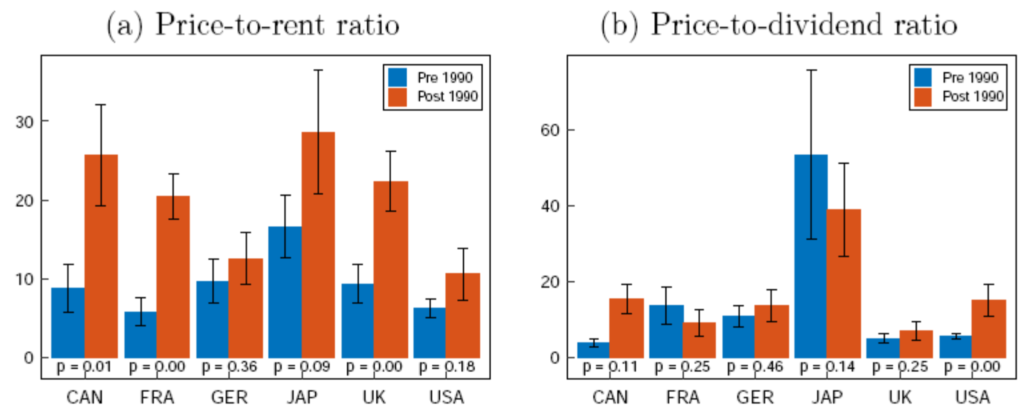
2 Natural Rates and Asset Price Volatility: Evidence

This section documents how the volatility of housing prices and stock prices has evolved over time in a number of advanced economies and how volatility changes correlate with changes in the average level of the natural rate of interest. The section summarizes results previously presented in Adam, Pfaeuti and Reinelt (2020) and adds new evidence on the evolution of price volatility in equity markets.

The fluctuations in basic valuation ratios, e.g., the price-to-rent (PR) ratio in housing markets or the price-to-dividend (PD) ratio in stock markets, are generally large and very persistent, which makes it difficult to estimate volatility and volatility changes precisely. To deal with this issue, one has to consider volatility changes across long periods of time, so as to increase the chances of detecting statistically significant volatility changes.

Chart 2

Standard Deviation of Valuation Ratios in Housing and Stock Markets



Notes: The figure reports the standard deviation of the two valuation ratios. Numbers reported at the bottom are robust p-values (Newey-West) for the null hypothesis that the standard deviations in the sub-samples are identical. Error bands indicate robust 90% confidence intervals for the estimated standard deviation. The reported numbers for the price-to-rent ratio differ from the ones in Adam, Pfaeuti and Reinelt (2020) because they compute the standard deviation in terms of percent deviation from sample mean. The latter leads to very similar conclusions.

Chart 2 depicts the standard deviation of the PR-ratio and of the PD-ratio, comparing the 30-year period 1960-1989 to the subsequent 30-year period 1990-2019.[6] Panel (a) shows that the point estimate for the standard deviation of the PR-ratio has increased in all considered economies. The increase in the point estimate is quantitatively large and statistically significant at the 10%-level in 4 of the 6 considered countries.[7]

Panel (b) in Chart 2 depicts the standard deviation of the PD ratio across the two sample periods. While the point estimate has increased in 4 of the 6 countries, the increase is statistically significant at the 10% level only in the United States, and marginally so for Canada. The volatility reductions in Japan and France are both insignificant.[8] The insignificant result for Japan is perhaps not too surprising, given that the sample split occurs close to peak of the Japanese stock market boom in the late 1980s, causing the run-up to be part of the pre-1990 sample and the subsequent bust to be part of the post-1990 sample.[9]

Overall, Chart 2 provides strong evidence in favour of an increase in the volatility of housing prices and somewhat weaker evidence in favour of an increase in stock price volatility.

[6] For housing markets, the PR-ratio is generally available only back to 1970. We take the series as far back as they are available.

[7] Importantly, this conclusion is not driven by the fact that PR-ratios were on average larger in the second half of the sample period. Considering instead the percent deviation of the PR-ratio from its period-specific mean leads to very similar results.

[8] The volatility of the Japanese stock market is so large because it experienced around 1990 one of advanced economies' largest stock price boom-bust episodes (in terms of the PD-ratio).

[9] Given that the natural rate declined significantly earlier in Japan, see Chart 1, one might argue that the Japanese sample should be split well before 1990 to be comparable with the other advanced economies.

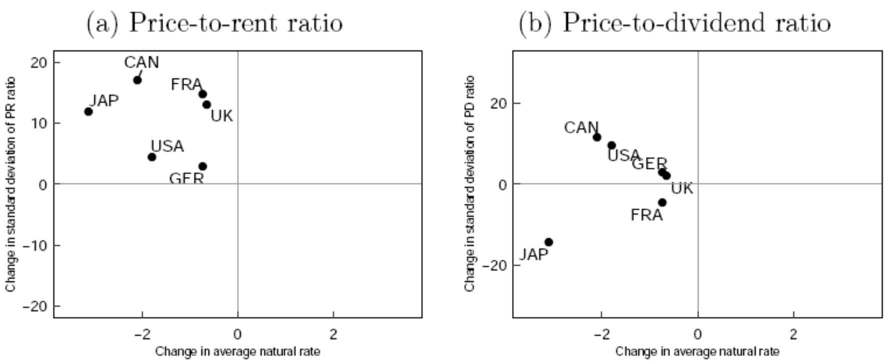
Chart 3 shows how the change in the average natural rate (pre- vs. post-1990, on the x-axis) compares with the change in asset price volatility (pre- vs. post-1990, on the y-axis). Panel (a) depicts the volatility change of the PR-ratio and Panel (b) the volatility change of the PD-ratio.

Panel (a) shows that all countries are located in the upper-left quadrant, i.e., housing price volatility increased and natural rates fell in all countries. Moreover, there is a clear negative relationship between the changes in the average natural rate and the changes in housing price volatility, illustrating that countries that experienced larger drops in the natural rate also experienced larger increase in housing price volatility.

A similar pattern can be observed in Panel (b) of Chart 3, which considers changes in stock price volatility and average natural rates. Most countries lie in the upper-left quadrant. Moreover, abstracting from Japan, which is an outlier for reasons discussed before, there is also a near-perfect negative relationship between changes in the average natural rate and changes in the volatility of the PD-ratio.

Chart 3

Change in Average Natural Rates vs. Change in Std. Deviation of Valuation Ratios (Pre-1990 vs. Post-1990)



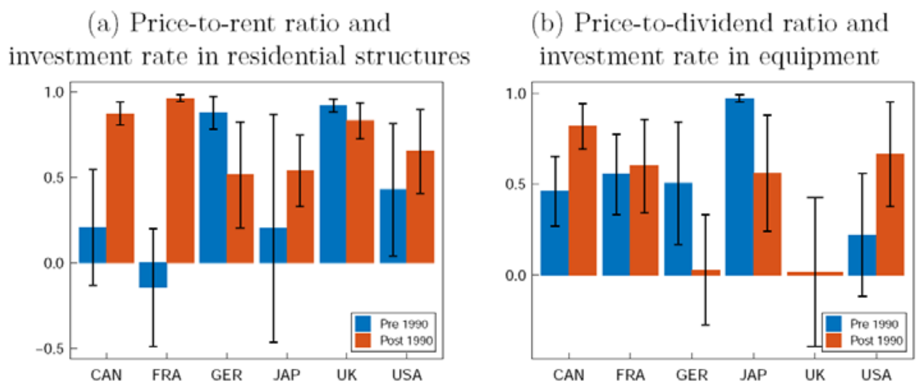
Notes: The change in the average natural rate is based on the natural rate estimates of Holston et al. (2017) and Fujiwara et al (2016). The change of the standard deviations of the PR-ratio and PD-ratio is from Chart 2.

The previous evidence is consistent with the notion that lower natural rates may have caused the observed volatility increase in housing and stock markets.[10] Yet, an important open question is to what extent increased asset price movements matter for real allocations. This question is particularly pressing because it has been argued in the past that the stock market, for instance, is a sideshow when it comes to business investment (Morck, Shleifer, Vishny (1990)). While more recent empirical evidence has been more supportive of the notion that investment at the firm level depends on the firm's stock market price, e.g., Baker, Stein and Wurgler (2003), Chart 4 presents evidence for the aggregate economy.

[10] This holds true despite the fact that the presented empirical evidence does not identify any causal relationship.

Chart 4

Correlation between Valuation Ratios and Investment Rates



Notes: The figure reports the correlation between the valuation ratios and the linearly detrended investment-to-GDP ratios. Error bands indicate robust 90% confidence intervals (Newey-West) and have been computed using the delta-method. Panel (a) is from Adam, Pfaeuti and Reinelt (2020).

Panel (a) in Chart 4 reports the correlation (pre- and post-1990) between the PR-ratio and the ratio of housing investment to GDP. It shows that all point estimates, except for one, are positive and that 9 out of the 12 reported correlations are significant at the 10% level. In many cases, the correlations are also pretty large. This suggests that high housing prices trigger high housing investment, so that housing price fluctuations matter for real allocations.[11]

Panel (b) in Chart 4 depicts the correlation (pre-/post-1990) between the PR-ratio and the ratio of investment into equipment to GDP.[12] The point estimates for all correlations turn out to be positive and most of them are quantitatively large. Of the reported 11 correlations, 8 are statistically significant at the 10% level. This again suggests that high stock prices trigger high business investment, so that stock price fluctuations matter for real allocations.

3 Economic Mechanisms Linking Growth Rates, Real Interest Rates and Asset Price Volatility

A number of economic mechanisms can explain why lower growth rates are associated with lower levels real interest rates and increased asset price volatility.

To make a sharp distinction, this section focuses on a frictionless efficient market model, which serves as a useful theoretical benchmark. It then considers pricing setups that allow for a role of speculative price expectations in asset pricing. The latter is motivated by survey evidence on investor expectations, which shows that

[11] Again, the evidence presented in Chart 4 does not identify a causal relationship.

[12] Since this investment series is not available for the U.K. prior to 1990, we report only post-1990 correlations for the U.K.

subjectively expected prices deviate in systematic ways from the behaviour of realized prices.[13]

While both setups provide mechanisms through which low safe interest rates increase asset price volatility, they differ with regard to the welfare implications of increased asset price volatility. Under the efficient market model, increased asset price volatility has per-se no welfare consequences. With speculative expectations, this fails to be true, which in turn will explain why the two setups give rise to rather different implications for the optimal inflation target and the desirability to lean-against asset price movements.

Clearly, the distinction between efficient and inefficient fluctuations in asset prices emphasized in this section does not exclude that an increase in the efficient fluctuations of asset prices alone can already have negative welfare implications. This can be the case in the presence of additional frictions, e.g., borrowing/collateral constraints or commitment problems that give rise to default incentives. For simplicity, the subsequent discussion abstracts from these additional frictions.

3.1 Average Growth Rates, Real Interest Rates and Natural Rates

Both considered setups rely on the same fundamental pricing equation for the safe real interest rate r_t. This equation will allow drawing a connection between the economy's average growth rate and the average safe real interest rate. The latter can furthermore be related to the average natural rate.

The fundamental asset pricing equation for a safe real short-term asset is

$$\delta(1 + r_t)E_t^S[g_{t,t+1}^m] = 1,$$

where $0 < \delta < 1$ denotes the time discount factor, which indicates how strongly agents discount the future (lower values indicated higher impatience) and $E_t^S[g_{t,t+1}^m]$ denotes the expected growth rate of the marginal utility of consumption, which is inversely related to economic growth, as higher growth means that the marginal unit of consumption tomorrow generates less additional utility. Expectations are based either on rational or subjective beliefs.[14]

Taking unconditional (rational) expectations of the previous equation, one obtains an expression characterizing the economy's average safe real interest rate r.[15]:

$$\delta(1 + \mathrm{r})\mathrm{E}[g_{t,t+1}^m] = 1$$

[13] Low real interest rates can affect asset price volatility through additional channels considered by neither of these setups. For instance, lower real rates provide investors with better financing conditions, which may make leveraged positions in asset market more attractive and thereby increase market instability.

[14] The expectation is formed in period t and is for the inverse of the growth rate of marginal utility between periods t and t+1.

[15] The expression holds independently of whether beliefs are rational or not, as long as subjective expectations are on average unbiased. To simplify notation, it uses the approximation $\frac{1}{\mathrm{E}\left[\frac{1}{g_{t,t+1}^m}\right]} \approx \mathrm{E}[g_{t,t+1}^m]$.

The average safe interest rate r is a function of the time discount factor δ and the objective average of the growth rate of marginal utility $E\left[g^m_{t,t+1}\right]$.

When investors become more patient, i.e., as the time discount factor δ moves closer to one, the safe interest rate r must fall for the previous equation to continue to hold. Likewise, as the average growth rate of the economy slows down, the average growth rate of marginal utility rises. With $E\left[g^m_{t,t+1}\right]$ rising, the real safe interest rate r must fall. The pricing equation is thus consistent with the empirical observation that lower average growth rates in advanced economies have been accompanied by a fall in average safe real interest rates.

Many economic models furthermore imply that the average safe real interest rate is equal to the average natural rate of interest, whenever the environment is characterized by stable inflation. To see why this is the case, assume – for the purpose of reaching a contradiction – that real interest rates were set permanently below (above) the average safe real rate, as determined by the previous equation. The demand stimulation (strangulation) associated with such real interest rate policies would cause the output gap to become ever more positive (negative). This, however, would be in consistent with stable inflation in the presence of a Phillips curve relationship. In a stationary environment without runaway inflation or deflation, the average natural rate is thus equal to the average real interest rate.

3.2 The Efficient Markets View

Under the efficient market model, the fundamental asset pricing equation for a risky asset (housing/equities) is given by

$$p_t = \xi_t + \frac{1}{1+r} E_t[p_{t+1}], \qquad (1)$$

where p_t denotes the asset price[16] and ξ_t the current-period payoff of the asset, which consist of dividends in the case of stocks and rents or rental utility in the case of housing.[17]

If investors hold rational expectations, one can iterate forward on the previous equation[18] and express the asset price as the expected discounted present value of future payoffs:

$$p_t = E_t\left[\sum_{j=0}^{\infty} \frac{\xi_{t+j}}{(1+r)^j}\right].$$

[16] To simplify notation and make the argument more transparent, the asset price is expressed here in marginal utility units, with marginal utility being detrended by the steady state growth rate of marginal utility.

[17] Rent payouts are equally expressed in marginal utility units.

[18] Adam and Marcet (2011) and Adam, Marcet and Beutel (2017) explain why such forward-iteration does generally not follow from individual rationality, instead provides agents with market-knowledge (rational expectations).

This shows how the asset price $\mathrm{p_t}$ will be more variable when the safe interest rate r is lower: since future payoffs get discounted less, the asset price $\mathrm{p_t}$ will move more in response to any given movement in the current payoff ξ_t, provided the movement in the current payoff signals a movement of future expected payoffs in the same direction. This is the case whenever the process for ξ_t is persistent.

While the asset price becomes more variable as the average safe average interest r falls, the resulting increase in asset price volatility is efficient and is thus not a source of concern for monetary policy. Clearly, this conclusion hinges on the assumption that investors' expectations about future asset prices are rational (and on the absence of other frictions in the economy). As discussed in the next section, there is mounting empirical evidence showing that rationality of expectations fails to hold.

3.3 Speculative Elements in Asset Price Expectations

A growing body of research in asset pricing has examined survey data on investor expectations. This literature finds that the time-series dynamics of investors' return/capital gain expectations are in conflict with the actual behaviour of returns/capital gains. In particular, expected returns/capital gains display (1) different cyclicality than actual return/capital gains, and (2) investor expectations about the future *level* of housing and stock prices display too much sluggishness in their adjustments. These two points are discussed in the following subsections.

3.3.1 Cyclicality of Actual versus Expected Returns/Capital Gains

While future stock returns and capital gains are counter-cyclical, i.e., tend to be low (high) when the price-dividend ratio is high (low), the survey evidence shows that investors' return and capital gain expectations are pro-cyclical: subjective expected returns/capital gains are high (low) in times of high (low) price-dividend ratios (Vissing-Jorgensen(2003), Bacchetta et al. (2009), Greenwood and Shleifer (2014), and Adam, Marcet and Beutel (2017), Adam, Matveev and Nagel (2020)).

The different cyclicality of realized and expected stock returns/capital gains is illustrated in table 1 using results from Adam, Marcet and Beutel (2017). The table reports the regression coefficients c and $\boldsymbol{c}$ of the following two regressions

$$R_{t,t+N} = \boldsymbol{a} + \boldsymbol{c} \cdot \frac{P_t}{D_t} + \boldsymbol{u_t} \qquad (2)$$

$$E_t^S[R_{t,t+N}] = a + c \cdot \frac{P_t}{D_t} + u_t, \qquad (3)$$

where $R_{t,t+N}$ denotes the realized stock return (or capital gain) between period t and $t+N$, $E_t^S[R_{t,t+N}]$ the survey expectation of the corresponding stock return (or capital gain) as of period t, and P_t/D_t the price-dividend (PD) ratio in period t.[19]

[19] The residuals $(u_t, \boldsymbol{u_t})$ are potentially serially correlated.

Table 1

The Different Cyclicality of Realized and Expected Returns/Capital Gains in Stock Markets

	Survey average				Survey median			
	$\hat{c} \cdot 10^3$	$\hat{\mathbf{c}} \cdot 10^3$	bias $\cdot 10^3$ $-E(\hat{\mathbf{c}} - \hat{c})$	p-value H_0: $c = \mathbf{c}$	$\hat{c} \cdot 10^3$	$\hat{\mathbf{c}} \cdot 10^3$	bias $\cdot 10^3$ $-E(\hat{\mathbf{c}} - \hat{c})$	p-value H_0: $c = \mathbf{c}$
Panel A. S&P 500, real returns								
UBS, >100k, 1 yr, SPF	0.58	−2.46	0.432	0.0000	0.48	−2.49	0.415	0.0000
UBS, >100k, 1 yr, Michigan	0.57	−2.46	0.452	0.0000	0.47	−2.49	0.413	0.0000
UBS, all, 1 yr, SPF	0.57	−2.46	0.424	0.0000	0.49	−2.49	0.401	0.0000
UBS, all, 1 yr, Michigan	0.56	−2.46	0.442	0.0000	0.48	−2.49	0.433	0.0000
CFO, 1 yr, SPF	0.20	−1.67	0.222	0.0011	0.25	−1.37	0.325	0.0471
CFO, 1 yr, Michigan	0.27	−1.67	0.200	0.0006	0.34	−1.37	0.313	0.0362
Panel B. Dow Jones, real price growth								
Shiller, 1 yr, SPF	0.26	−1.22	0.235	0.0011	0.24	−1.20	0.265	0.0015
Shiller, 1 yr, Michigan	0.33	−1.22	0.232	0.0006	0.31	−1.20	0.238	0.0007
Shiller, 10 yrs, SPF	4.73	−7.25	−1.367	0.0000	6.15	−7.24	−1.440	0.0000
Shiller, 10 yrs, Michigan	4.24	−7.25	−1.423	0.0000	5.65	−7.24	−1.462	0.0000

Source: Table 1A from Adam, Marcet and Beutel (2017).
Notes: The columns labelled $\hat{\mathbf{c}}$ report the estimate of the coefficient **c** in equation (2). The columns labelled $\hat{c}$ report the estimate of the coefficient c in equation (3). The columns labelled bias report the small sample bias correction and the columns labelled p-value report the small sample bias-corrected p-value for the null hypothesis that c=**c.**The leftmost column indicates the survey sources (UBS Survey, Chief Financial Officer Survey and Robert Shiller's investor survey), the horizon of the forecast (1 year, 10 years), the way real returns have been computed (inflation expectations from the Survey of Professional Forecasters (SPF), inflation expectations from the Michigan Survey), and various wealth categories (all: all investors in the survey, >100k: only investors with more than 100k USD in financial wealth).

Table 1 reports the estimates of the coefficients c and $\boldsymbol{c}$ for various survey sources, various survey subsamples and various forecast horizons.[20] It performs the analysis once using the survey mean and once using the survey median, to account for potential outliers. It shows that the coefficient $\boldsymbol{c}$ for realized returns is always negative: future realized returns/capital gains are low (high) when the price-dividend ratio is high (low), i.e., actual returns/capital gains are counter-cyclical. In contrast, the estimated coefficient c for expected returns is always positive: expected returns/capital gains are high (low) when the PD is high (low), i.e., expected returns are pro-cyclical. The table also tests the hypothesis that both coefficients are equal. This test takes in to account potential small-sample bias corrections (also reported in Table 1) that may arise from the fact that the predictor variable (the PD-ratio) is serially correlated (Stambaugh(1999)). In all cases, equality of the regression coefficients is rejected at the 5% significance level and in the vast majority of cases the rejection is significant at the 1% level.

It turns out that the empirical findings for actual and expected capital gains in stock markets proves to be rather robust and can also be found for housing market expectations. Table 2 reports the regression coefficients c and $\boldsymbol{c}$ of the following two regressions

$$CG_{t,t+1} = \boldsymbol{a} + \boldsymbol{c} \cdot \frac{P_t}{R_t} + \boldsymbol{u_t} \qquad (4)$$

[20] See the explanatory notes below the table for a detailed description. Table 1 uses real returns and capital gains (realized and expected), but results are robust to using nominal returns/capital gains instead.

$$E_t^S[CG_{t,t+1}] = a + c \cdot \frac{P_t}{R_t} + u_t, \quad (5)$$

where $CG_{t,t+1}$ denotes the realized housing capital gain between period t and period $t+1$, $E_t^S[CG_{t,t+1}]$ the corresponding survey expectations of the capital gain from the Michigan survey, which covers the years 2007-2019, and P_t/R_t the price-to-rent (PR) ratio in period t.[21]

Table 2 shows that future capital gains in housing markets are negatively associated with the PR-ratio, i.e., are counter-cyclical. In contrast, survey expectations of future capital gains are positively associated with the PR-ratio, i.e., are pro-cyclical. This difference is highly statistically significant for the survey average and significant at approximately the 5%-level for the survey median, again accounting for potential small-sample biases in estimation.

Overall, table 2 suggests that expectations about capital gains in housing markets show the same puzzling property as survey expectations in stock markets.

Table 2

The Different Cyclicality of Realized and Expected Capital Gains in Housing Markets

Michigan survey, 1yr house price growth

Survey average				Survey median			
$\widehat{c}$	$\widehat{\mathbf{c}}$	bias $-E(\widehat{\mathbf{c}}-\widehat{c})$	p-value H_0:$c=\mathbf{c}$	$\widehat{c}$	$\widehat{\mathbf{c}}$	bias $-E(\widehat{\mathbf{c}}-\widehat{c})$	p-value H_0:$c=\mathbf{c}$
0.0607	-0.0462	0.0023	0.000	0.0187	-0.0462	0.0106	0.0571

Source: Adam, Pfaeuti and Reinelt (2020)
Notes: The columns labelled $\hat{\mathbf{c}}$ report the estimate of the coefficient **c** in equation (4) using the Case-Shiller home price index for the United States. The columns labelled $\hat{c}$ report the estimate of the coefficient c in equation (4) using the Michigan survey. The columns labelled bias report the small sample bias correction, performed as in Table1A in Adam, Marcet and Beutel (2017), and the columns labelled p-value report the small sample bias-corrected p-value for the null hypothesis that c=**c**.

3.3.2 Sluggish Adjustment of Housing and Stock Price Expectations

This section presents evidence for the fact that expectations about the *level* of future housing and stock prices adjust sluggishly. In particular, past upward revisions in investor expectations predict that future outcomes will on average exceed the upwardly-revised expectations. As a result, past forecast revisions predict future forecast errors in the same direction, which is inconsistent with forecasts being rational.

Following Coibion and Gorodnichenko (2015), one can consider regressions of the form

[21] The residuals $(u_t, \boldsymbol{u_t})$ are potentially serially correlated.

$$P_{t+j} - E_t^S[P_{t+j}] = a + b \cdot (E_t^S[P_{t+j}] - E_{t-1}^S[P_{t+j-1}]) + u_t, \quad (6)$$

where P_{t+j} denotes the housing or stock price in period $t+j$ and $E_t^S[P_{t+j}]$ the survey forecast of this price as of period t. The expression on the left-hand side of equation (6) is the forecast error about the level of the future housing/stock price. The right-hand side of the equation uses the belief revision about j-period ahead stock/housing prices between periods $t-1$ and t. Under the assumption of rational expectations, past forecast revisions should not predict future forecast errors at any forecast horizon j: past forecast are part of agents' information set and that information should be contained in any rational forecast. Under the hypothesis of rational expectations, one should thus find $b = 0$.

Table 3 shows, however, that one obtains $b > 0$ in all cases. [22] The evidence is highly statistically significant for housing price expectations, but less significant for stock markets. Overall, however, results all point in the same direction: past revisions of expectations in a certain direction predict further forecast errors in the same direction, i.e., the belief revisions are insufficiently strong. Expectations are thus adjusted sluggishly over time.

Table 3

Sluggish Adjustment of Expected Housing and Stock Prices (Levels)

	Survey Average		Survey Median	
	b	p-value	b	p-value
Housing Prices				
Michigan, 1yr	2.166	0.000	2.772	0.000
Stock Prices				
Shiller, 3m	0.219	0.131	0.189	0.204
Shiller, 6m	0.378	0.042	0.367	0.059
Shiller, 1yr	0.305	0.129	0.308	0.128

Source: Adam, Pfaeuti and Reinelt (2020).
Notes: The first column indicates the survey sources (Michigan, Shiller), the forecast horizons (3 months, 6 months, 1 year) and the predicted variable (housing price, stock price). The columns labelled b report the estimate of the coefficient b in equation (6). The reported p-values are robust (Newey-West with 4 lags).

3.4 Asset Price Volatility with Speculative Beliefs and the Effects of Low Real Interest Rates

This section explores the asset pricing implications of falling real interest rates when subjective capital gain expectations feature pro-cyclical fluctuations and sluggish updating, in line with the empirical evidence provided in the previous sections. This section is based on a strongly simplified setup of Adam and Merkel (2019), who

[22] Table 3 only uses surveys that ask for investors' capital gain expectations. Surveys that report return expectations require imputing expected dividends, to be able to compute a level forecast of the asset price.

consider a fully-fledged business cycle model. The goal here is to explain in simple terms how low real interest rates increase asset price fluctuations.

Let β_t denote investors' subjective capital expectations[23]

$$\beta_t = E_t^S[p_{t+1}/p_t].$$

Given these expectations, the fundamental asset pricing equation (1) delivers the equilibrium asset price

$$\mathrm{p_t} = \frac{\xi_t}{1-\beta_t/(1+r)}, \tag{7}$$

which depends positively on the current payoff ξ_t and positively on the subjective capital gain expectations β_t.[24]

Equation (7) shows how high (low) capital gain expectations give rise to a high (low) asset price and a high price-to-dividend or price-to-rent ratio ($\mathrm{p_t}/\xi_t$). In line with the evidence documented in the previous sections, subjective capital gain beliefs will thus necessarily be pro-cyclical, even if realized capital gains are counter-cyclical.

To understand the dynamics of asset prices, one needs to take a stand on how subjective capital gain beliefs are adjusted over time. It makes sense to consider an empirically plausible belief specification that is consistent with the evidence on sluggish adjustment and that gives rise to countercyclical realized capital gains. Adam, Marcet and Nicolini (2016) show optimal (Bayesian) belief updating by investors can give rise to an updating equation of the form

$$\beta_{t+1} = \beta_t + \frac{1}{\alpha}(p_t/p_{t-1} - \beta_t), \tag{8}$$

where the parameter $1/\alpha$ (the Kalman gain) determines how strongly capital gain beliefs β_t get adjusted in light of the observed capital gain surprise $(p_t/p_{t-1} - \beta_t)$.[25]

Importantly, if $1/\alpha$ is sufficiently small, then these subjective beliefs will display sluggish adjustment in line with the empirical evidence (Adam, Pfaeuti and Reinelt (2020)). And as shown in the next section, realized capital gains will be counter-cyclical, in line with the data.

3.4.1 Belief-Driven Boom-Bust Dynamics in Asset Prices

Belief updating equation (8) and asset price equation (7) jointly imply that belief changes and price realizations can mutually reinforce each other in a way that generates persistent boom-bust cycles in asset prices (Adam, Marcet and Nicolini (2016)). These cycles will drive the counter-cyclicality of realized returns.

[23] Capital gain expectations should be interpreted again in marginal-utility adjusted terms.

[24] As explained in Adam and Marcet (2011), beliefs about the present value of dividends are irrelevant for asset pricing in the presence of subjective price beliefs, see also Adam, Marcet and Beutel (2017).

[25] One has to additionally impose an upper bound on the beliefs to ensure $\beta_t < 1 + r$, so that prices remain well-defined in equation (7).

To understand why this is the case, consider a situation in which the current payout ξ_t happens to be unusually large. From equation (7) follows that – for given capital gain expectations β_t - the realized asset price and thus the realized capital gain p_t/p_{t-1} will be unusually large. Given the belief updating equation (8) this implies that future capital beliefs β_{t+1} will be pushed upwards. The upward revision in beliefs produces –according to equation (7) – further capital gains in the next period. There is thus the possibility of a persistent asset price boom where prices and investor optimism rise together: upward revisions in beliefs produce capital gains and capital gains produce further upward belief revisions.

The boom will come to an end, once the realized capital gains start to fall short of investors' high capital expectations. At this point, there will be a Minsky moment: capital gain expectations are high but get revised downwards (equation (8)); the downward revision produces capital losses (equation (7)) and further downward revision in beliefs. Asset prices will then fall and can even persistently undershoot their efficient market value. The mean-reversion of asset prices implies that realized returns/capital gains will indeed be counter-cyclical, even though expected returns are pro-cyclical, in line with the empirical evidence.

Since these boom-bust like movements in asset prices will not be efficient, they will have the potential to distort the efficient investment decision, as suggested by the evidence in Chart 4, and thus have adverse welfare implications.

In the context of housing price dynamics, for example, a housing price boom that is fuelled by increased investor optimism is likely going to lead to an overaccumulation of the housing stock, in line with what has been observed in some countries during the run-up to the 2007 financial crisis (Adam, Marcet and Kuang (2012), Kaplan, Mitman and Violante (2020)). Likewise, a stock price boom, e.g., one created by the arrival of new optimistic narratives, has been shown to lead to investment booms, especially in equity-dependent firms (Baker, Stein and Wurgler (2003)), see also Gilchrist et al. (2005)).

Obviously, boom-bust cycles in asset prices can have adverse welfare implications via number of other economic channels, e.g., by redistributing wealth between different investors (Nagel and Greenwood (2009), Adam, Beutel, Marcet and Merkel (2015)).

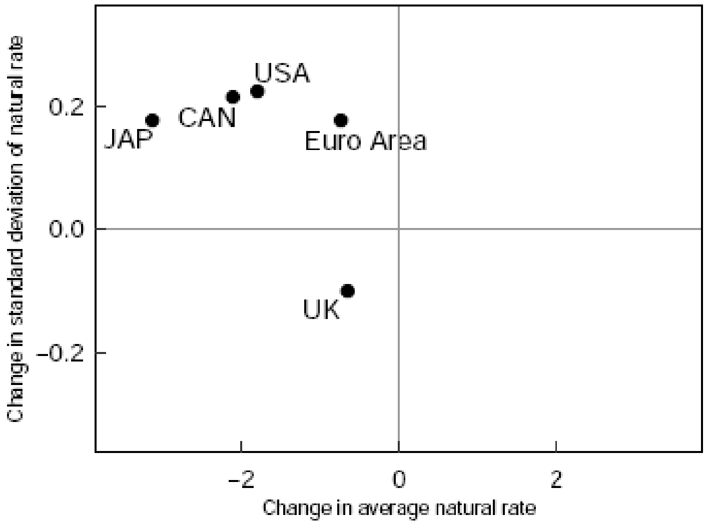
3.4.2 The Effect of Low Safe Real Rates on Boom-Bust Dynamics

This section explains how belief-driven boom-bust cycles, as described in the previous section, become more likely as the safe real interest rate r falls. The fact that this is the case suggests that the observed increase in asset price volatility is actually a by-product of the observed fall in the safe real interest rate.

As in the previous section, consider a fundamental impulse from an unusually high payout ξ_t. The capital gain produced by the positive fundamental will increase current capital gains and thereby the capital gain expectations β_{t+1} in the next period. Yet, for any given increase in capital gain expectations β_{t+1}, the capital gains in period t+1 will be larger the lower is the safe rate r, see equation (7). Asset prices thus become more sensitive to belief revisions when real interest rates are low.

Chart 5

Change in Average Natural Rate vs. Change in Std. Deviation of Natural Rate (Pre-1990 vs. Post-1990)



Source: Adam, Pfaeuti and Reinelt (2020).
Notes: The change in the average natural rate is based on the natural rate estimates of Holston et al. (2017) and Fujiwara et al (2016). The standard deviation of the natural rate has been computed by linearly detrending the natural rate to take into account its time trend.

Given this, the chances of any initial fundamental impulse to generate a self-sustaining increase in beliefs and asset prices become higher. Adam and Merkel (2019) illustrate this mechanism in detail, showing how – when real interest rates are low – smaller-sized shocks or a smaller number of shocks of any given size can generate self-sustaining boom-bust dynamics.

The prediction that boom-bust cycles become more frequent as interest rates fall is in line with the repeated housing and stock price cycles experienced in advanced economies since the 1990's.

3.4.3 Boom-Bust Dynamics and the Volatility of the Natural Rate

To the extent that the fall in the safe real interest rates generates an increase in (socially inefficient) asset price boom-bust cycles and to the extent that these price cycles are accompanied by corresponding cycles in investment (see Chart 4), lending, corporate and household defaults, etc., the increased occurrence of price cycles will have implications for the volatility of the natural rate.

The volatility of the natural rate is affected because stabilizing inflation in such an environment will require that monetary policy counteracts some of the covariates of boom-bust cycles, e.g., the associated investment cycles (Adam, Pfaeuti and Reinelt

(2020)). Interestingly, the empirical evidence suggests that the decrease in the average natural rate has in fact been accompanied by an increase in the volatility of natural rates.

This is illustrated in Chart 5, which compares the change in the average natural rate (pre-/post-1990) on the x-axis to the change in the volatility of natural rate (pre-/post-1990) on the y-axis. For all considered currency areas, except for the U.K, the decrease in the average natural rates was associated with an increase in the volatility of the natural rate. This suggests that lower average natural rates may in fact have contributed to an increase in the volatility of the natural rate.

4 Monetary Policy Implications of Lower Natural Rates

This section discusses the implications of lower average natural rates and increased housing price volatility have for (1) the level of the optimal inflation target and for (2) the conduct of monetary policy in response to housing sector disturbances. As will become clear, the monetary policy conclusions depend in crucial ways on the economic drivers of increased asset price volatility (Adam and Woodford (2020), Adam, Pfaeuti and Reinelt (2020)).

4.1 Implications for the Optimal Inflation Target

We start by considering the case in which the empirically observed increase in asset price volatility is judged to be efficient, as would be the case under the conditions outlined in section 3.2. While the empirical evidence provided in section 3.3 does not support the interpretation that asset price fluctuations are efficient, the efficient market setting nevertheless provides an important reference point that allows for a better understanding of the additional implications generated by inefficient fluctuations in asset prices.

With efficient asset price fluctuations, lower average natural interest rates will depress the average nominal interest rates (taking the inflation target as given). Lower nominal rates, however, cause the effective lower bound constraint on nominal rates to become increasingly binding. One can thus ask the question whether and to what extent the presence of a lower bound constraint justifies increasing the inflation target and to what extent this increase depends on the average level of the natural rate.

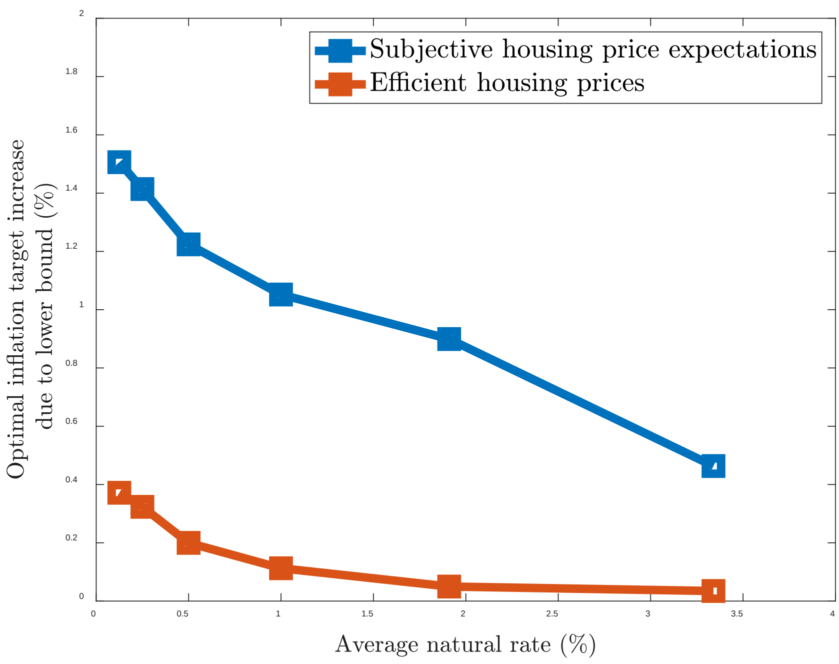
The intuition for why the inflation target optimally increases when policy is constrained by the lower bound on nominal rates is rather simple: since real interest rates cannot be lowered further via a reduction in nominal rates, the only other tool available for lowering real interest rates is a promise to achieve higher future inflation in the future.[26] Such promises of higher future inflation, which are part of the optimal

[26] This is so because the real rate is the nominal rate minus the expected inflation rate. The argument implicitly assumes that the promises, to the extent that they are feasible, are correctly anticipated by the private sector.

conduct of monetary policy when policy is constrained by the lower bound, increase the average inflation rate.

Chart 6

Optimal Increase of the Inflation Target Due to the Effective Lower Bound on Nominal Rates



Source: Adam, Pfaeuti and Reinelt (2020).

Chart 6 reports the optimal inflation target, i.e., the average inflation outcome under optimal conduct of monetary policy. For each considered level of the average natural rate (on the x-axis), the chart reports the optimal inflation target (on the y-axis) in an economy with an effective lower bound constraint, relative to the target that would be optimal in the absence of a lower-bound constraint.[27]

Chart 6 illustrates that the presence of the lower bound constraint justifies targeting higher average inflation and that this effect is stronger, the lower the average natural interest rate. The quantitative effect of the lower-bound constraint on the inflation target is, however, relatively muted when asset prices are efficient. Even with average natural rates dropping permanently from a level of 3.3% to a level of 0.125% per year, the inflation target increases by less than 0.4%.

[27] Chart 6 is based on a calibrated workhorse New Keynesian sticky price model featuring also a housing sector, see Adam, Pfaeuti, Reinelt (2020) for details. In the absence of a lower bound constraint, the optimal inflation target is zero, because the model abstracts from other forces that make targeting positive average rates of inflation optimal, e.g., the ones considered in Adam and Weber (2019,2020).

This result differs strongly from the findings reported in Andrade et al. (2019), who find a near one-to-one relationship between drops in the average natural rate and the optimal inflation target. The source of this difference is that Chart 6 considers fully optimal monetary stabilization policy while Andrade et al. consider Taylor-type monetary policies and optimize only with respect to the intercept term in the Taylor rule.

Chart 6 also reports the optimal increase in the inflation target for the case where housing prices are driven – at least partly – by fluctuations in subjective housing price expectations, in line with the empirical evidence from section 3.3. The reported inflation target increase now comprises the combined effect of a lower bound and of fluctuations of subjective housing price expectations.

Two findings are remarkable. First, the combined effect of subjective beliefs and a lower bound constraint is always larger than the effect of the lower bound constraint alone, i.e., both effects work in the same direction. Second, as the average natural rate falls, the optimal inflation target increases much more strongly in the setting with subjective housing beliefs.

The reason for the latter finding is that lower natural real rates of interest not only put downward pressure on nominal rates, but also increase the likelihood of boom-bust cycles in asset prices, as discussed in section 3.4.3. These boom-bust cycles make the natural rate more volatile, in line with the evidence shown in Chart 5, and thereby increase the likelihood of hitting the lower bound, unless policy adjusts by increasing the inflation target.

The combined effect of a lower average level of the natural rate and of increased natural rate volatility justifies a stronger increase in the optimal inflation target as the natural rates fall: instead of increasing by less than 0.4% when the natural rate falls from 3.3% to 0.125%, as was the case with efficient asset prices, the inflation target now increases by a full 1%. This shows how the fall in average natural rates can rationalize a significant increase in the optimal inflation target.

4.2 Implications for the Policy Response to Asset Price Booms/Busts

This section discusses some of the factors affecting the optimal monetary policy response to increased asset price movements. As with the inflation target, the optimal policy response turns out to depend crucially on the economic forces driving the increase in asset price volatility.

If the observed increase in asset price volatility is judged to be efficient, e.g., reflects only the decrease in the safe real interest rate, as discussed in section 3.2, then in the absence of other frictions (besides pricing frictions), increased asset price volatility will not be relevant for the stabilization goals of welfare-oriented monetary policy. In particular, there is no need for monetary policy to respond to asset price movements (Adam and Woodford (2020)).[28]

In light of the empirical evidence discussed in section 3.3, however, it is unlikely that asset price fluctuations are entirely efficient, as investors' asset price expectations fail to be fully rational. In fact, the dynamics of the empirically observed subjective capital gain expectations suggests that movements in subjective capital gain expectations amplify fundamentally justified asset movements and thereby generate excessive asset price volatility (Adam, Marcet, Beutel (2017)). And as discussed in section 3.4, inefficient asset price volatility increases as the average natural interest falls (Adam and Merkel (2019)).

To the extent that excessive price volatility has welfare costs, it becomes optimal for policy to counteract these and the urgency to do so rises as the misalignments increase in size or frequency. Generally, it would be desirable to have additional (non-monetary) policy tools at disposal to deal with excessive asset price movements. While such tools may be deployed in practice, e.g., via time-varying borrowing restrictions or capital requirements, their effects are likely going to be imperfect, especially given the fact that the macro-prudential framework in the Euro Area is still quite imperfect (e.g., covers only banks).

In light of this situation, monetary policy will have to take a decision on how to respond to any residual asset price movements not addressed by macro-prudential policies or other policy tools. This is particularly true because monetary policy as a financial stability tool has the advantage that it "gets in all of the cracks" of the financial system (Stein (2013)).

The literature has shown that in the presence of subjective belief fluctuations, it can become optimal for monetary policy to "lean-against" asset price movements. This holds true for a range of alternative subjective belief specifications (Caines and Winkler (2018), Adam and Woodford (2020), Adam, Pfaeuti and Reinelt (2020)). Counteracting asset price movements does thereby *not* require that monetary policy properly diagnoses any misalignments in asset prices. Instead, it can be sufficient to simply react to asset price surprises (Adam and Woodford (2020)) or it can be approximately optimal to respond to observed capital gains (Caines and Winkler (2018).

Chart 7, which is based on Adam, Pfaeuti and Reinelt (2020), illustrates the optimal policy response following a persistent housing demand shock in a setting where investors extrapolate past housing price increases.

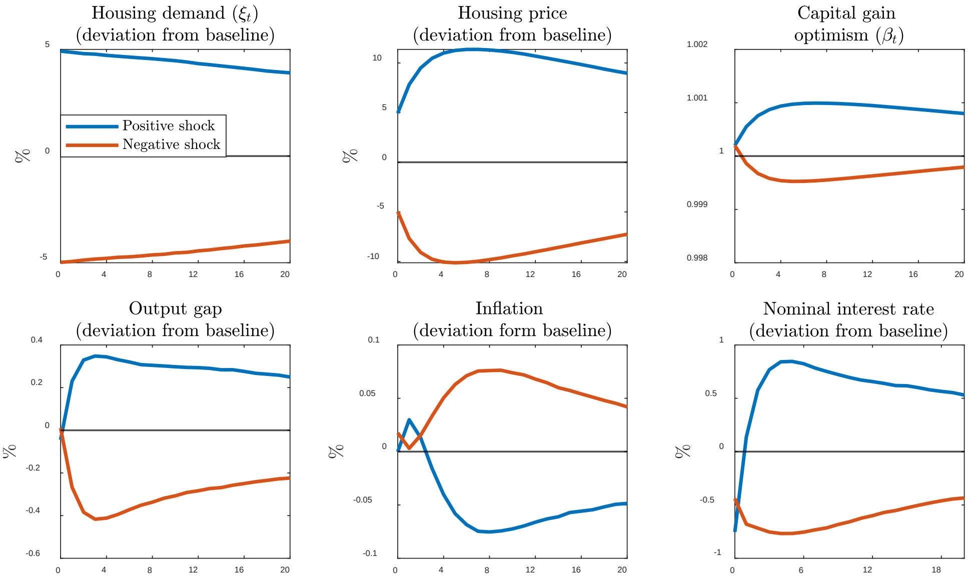
The responses to a positive housing demand shock are shown in blue in Chart 7. The housing demand shock itself is thereby shown in the upper left panel: housing demand increases on impact and gradually reverts over time. Following the initial demand shock, housing prices rise, because housing supply is fixed in the short-term. The fundamentally justified initial increase in housing prices, however, gets

[28] As discussed before, the presence of other frictions, e.g., collateral or borrowing constraints, would overturn this result.

amplified over time (upper middle panel in Chart 7): in light of the initial capital gains, investors become somewhat more optimistic about future capital gains (upper right panel in Chart 7), which drives up housing price further and generates further increases in optimism. As a result, housing prices increase for a number of periods, before slowly reverting direction. This belief-based amplification of housing price movements illustrates how housing prices can persistently overshoot their efficient level, which sets in motion an inefficient housing investment boom (and likely a number of additional distortions). The overinvestment in housing explains the positive output gap in the lower left panel of Chart 7. To counteract the housing boom, it becomes optimal for monetary policy to lean against the housing price increase (lower right panel in Chart 7). This causes inflation to temporarily undershoots it usual target (lower middle panel in Chart 7).

Chart 7

Optimal Monetary Policy Leans Against Housing Prices when Housing Prices are Partly Driven by Subjective Capital Gain Optimism



Source: Adam, Pfaeuti and Reinelt (2020).

Chart 7 also highlights that the opposite policy response is optimal when faced instead with a negative housing demand shock (red coloured lines in the chart). Policy then persistently lowers nominal interest rates and inflation persistently overshoots its usual targets by a small amount. The policy response to positive and negative shocks fails to be entirely symmetric because the presence of a lower bound constraint on nominal rates has implications for stabilization policy well before the lower bound constraint is reached (Adam and Billi (2006)).

The results discussed above differ from the conclusions reached in an earlier literature, which focused on rational asset price bubbles. Bernanke and Gertler (1999, 2001), for example, argue that asset prices do not merit any special role in determining monetary policy, whenever the central bank takes demand pressures into account. While this may be true for a setting in which asset prices have demand effects only, e.g., where asset prices relax collateral constraints, it fails to hold in a setting where asset price misalignments also give rise to supply distortions (Adam and Woodford (2020)).

Galì (2014) also considers rational asset price bubbles and argues that monetary policy may increase the growth rate of (rational) bubbles by raising interest rates in response to a bubble. Miao, Shen and Wang (2019) show, however, that the conclusions in Gali (2014) are sensitive to what is assumed about the nature of the rational bubble process. Moreover, the notion of a rational bubble is not consistent with survey evidence presented in section 3.3.

5 Conclusions

Falling natural rates and rising asset price volatility pose important challenges for monetary policymakers in advanced economies, which are increasingly constrained by the effective lower bound on monetary policy.

The paper argues that the fall in natural rates justifies an increase in the optimal inflation target. The extent of the increase depends on how one interprets the observed increase in asset price volatility. If the increase is not due to efficient forces, then the increase in the inflation target should be more pronounced and monetary should lean against asset price movements.

What if falling long-term growth rates have caused the fall in natural rates and the increase in asset price volatility, as many economic models suggest? Then an even better policy response – albeit one beyond the realm of monetary policy – consists of enacting structural policies that contribute to raising advanced economies' growth potential. Such policies would also simplify the task of monetary policy.

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