Asset Prices And Macroeconomic Uncertainty: The Role of Inflation and Monetary Policy Implications

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This Version: May 16, 2011

Abstract

This paper documents that uncertainty about future inflation and uncertainty about future consumption growth are channels of macroeconomic uncertainty and as such predict asset valuations. Roughly 50% of the variation in price-earnings ratios can be attributed to the variation in macroeconomic uncertainty. Inflation volatility is identified during long periods of time as the primary predictor of future valuation ratios rather than consumption growth volatility which is commonly used in the literature. Moreover, high valuation ratios sharply predict low subsequent macroeconomic uncertainty, in particular low uncertainty about future inflation. The paper highlights the importance of changes in the uncertainty proxies' time variability in different economic states for the impact of macroeconomic uncertainty on asset valuations. It provides evidence that shifts in the macroeconomy and monetary policy variables, help to explain the time-varying patterns in asset valuations during the last decades.

JEL-code: G10, G12, E44

Keywords: Consumption growth volatility; Inflation volatility; Long-run risk; Macroeconomic uncertainty; Monetary Policy; Price-earnings ratio; Great moderation.

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I would like to thank in particular Henrik Hasseltoft and Alexander Wagner for all encouragement and feedback and Marc Arnold, Kerstin Kehrle, Jochen Krause and seminar participants at the University of Zurich for helpful comments and discussions. All errors are mine.

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1 Introduction

This paper documents that uncertainty about future inflation and uncertainty about future consumption growth are channels of macroeconomic uncertainty and as such predict asset valuations. The variation in the macroeconomic uncertainty proxies explains roughly 50% of the variation in asset valuations. Importantly, the study shows that the high explanatory power during long periods of time primarily arises from the variation in inflation volatility. This suggests that uncertainty about future inflation is an important driver of expected returns. During certain periods of time it can be an even more important predictor of future asset valuations than consumption growth volatility, which is used in the previous literature as macroeconomic uncertainty proxy. High valuation ratios are found to sharply predict low subsequent macroeconomic uncertainty, in particular low uncertainty about future inflation. Another important insight is that heteroscedasticity of inflation and consumption (e.g. Engle, 1982 and Bollerslev, 1986 for inflation; Kandel and Stambaugh, 1990 for consumption) is a key ingredient of the relation between asset valuations and macroeconomic uncertainty in the sense that it implies shifts in economic uncertainty. Indeed, the results highlight that whenever macroeconomic uncertainty is high and strongly fluctuates, the macroeconomic uncertainty proxies highly significantly load on future asset valuations while when macroeconomic uncertainty is low and does not strongly vary over time, their predictive power on asset valuations vanishes. Moreover, the evidence suggests changes in the time variation and the relevance for return premia of the macroeconomic uncertainty proxies with shifts in the macroeconomic regimes over the last decades: The "Great Money Inflation" from the 1970s until the early 1980s, the "Great Moderation" in economic uncertainty from the early 1980s until the early 1990s, followed by the asset price inflation in the US during the late 1980s until the early 2000s and finally the "Great Contraction" with persistently decreasing valuations already since the early 2000s that culminated in the historical economic crises from end of 2007 until mid 2009. Changes in monetary policy variables turn out to further contribute to explaining the macroeconomic and asset valuation shifts.

The study follows the idea that if financial markets dislike economic uncertainty and volatilities are persistent this should be reflected in the expected risk premia on the market. An increase in macroeconomic uncertainty is perceived as "bad news" by the investors and induces a decline in asset prices while increasing asset prices indicate decreasing future macroeconomic uncertainty.

In this study, primarily volatilities of macroeconomic variables are used as channels of macroeconomic uncertainty. Using volatilities of macroeconomic variables as proxies for macroeconomic risk, derives its theoretical intuition from the "Long-Run Risk Model" by Bansal and Yaron (2004). Their model contributes to early works of e.g. Mehra and Prescott

(1985) or Weil (1989) as it can rationally explain several asset pricing puzzles such as the equity risk premium. The key ingredients of the model are a persistent expected consumption growth component, long-run time variation in consumption growth volatility, and through Epstein and Zin (1989) type investors' utility functions the possibility to model investors' preference of an early resolution of uncertainty. Within this specific model framework Bansal and Yaron (2004) show that if an agent's intertemporal elasticity of substitution is greater than one a decrease in consumption volatility drives up asset prices. Conversely, once the consumption growth volatility increases, asset prices fall.[2] However, Bansal and Yaron (2004) only briefly consider matters of correlations between squared consumption residuals and asset valuations. Furthermore, they neglect the uncertainty about future inflation as potential channel of macroeconomic uncertainty and the importance of changing macroeconomic regimes.

Why is it relevant to account for inflation and the uncertainty about future inflation once we try to rationally explain expected returns and shifts in expected returns in markets? If inflation uncertainty would not affect expectations about future consumption, the representative agent would not require risk premia for assets that are poor hedges against inflation such as equity or nominal bonds. Thus, agents try to avoid inflation shocks and demand a positive risk premium for equities and nominal bonds. It is important to note that the negative relationship between asset values and inflation is explained here with a rational risk premium type of argument; that is, agents dislike macroeconomic uncertainty and prefer its early resolution. This is in contrast to a broad field of previous literature that advocates an irrational investor based explanation for the empirically observed negative relationship between asset values, inflation and fluctuations in asset returns.[3]

This study posits that in an economy where aggregate (future) consumption is contemporaneously correlated with exogenous shocks resulting from inflation uncertainty, consumption risk premia increase during periods of high inflation uncertainty, coinciding with bad economic states. In good economic states with low inflation uncertainty the risk premia decrease. This

[2]In fact the "Long-Run Risk Model" is presently the basis for a large number of studies and thus can be considered as one of the most influential models in recent years in this field. For instance, some recent studies are Bansal, Kiku and Yaron (2009) who empirically evaluate the "Long-Run Risk Model" and compare it to backward looking habit models; Bansal, Kiku and Yaron (2010) who study the role of cyclical fluctuations and macroeconomic crises on asset prices and expected returns in the framework of the "Long-Run Risk Model"; Hasseltoft (2010) adds the term structure of interest rates to the "Long-Run Risk Model" and can explain deviations from the expectation hypothesis, an upward sloping of the yield curve and the correlation between real consumption growth and inflation. Bansal and Shaliastovich (2010) explain, based on the "Long-Run Risk Model", predictability puzzles in bond markets as well as the violation of the expectation hypothesis in currency markets. For further references see Bansal (2007) who provides a comprehensive review of the "Long-Run Risk Model" and summarizes recent literature that builds on the ideas of this model.

[3]Cf. Modigliani and Cohn (1979), Asness (2003), Basak and Yan (2010), Campbell and Vuoltaneeho (2004), Cohen, Polk and Vuoltaneeho (2005), or Schmeling and Schrimpf (2010) for the "inflation or money illusion" hypothesis and for distorted belief or time-varying risk-aversion explanations Campbell and Cochrane (1999) or Brandt and Wang (2003).

results in positive market prices of inflation risk.

The intuition for the inflation risk premium draws on the fact that assets are not simply denominated in fractions of consumption but consumption growth is a function of purchasing power. Thus, if asset valuations are a function of expected future consumption growth they also become a function of expected inflation. In addition, if agents continue to consume until the marginal utility of consumption today equals that of wealth, this rationalizes that investors dislike positive inflation shocks. Hence, they require risk premia for assets that are poor hedges against inflation such as equities or nominal bonds.

The main theoretical intuition of the relevance of inflation (uncertainty) for expected returns in changing macroeconomic environments in this study draws on a model with long-run risk properties by Hasseltoft (2009). He sets-up an equilibrium model with Epstein and Zin (1989) and Weil (1989) preferences that rationally explains the interrelations between US dividend yields and nominal interest rates (the so-called "FED-Model") and the comovement between stock and bond markets. He shows that within the framework of his model inflation volatility is the key driver of uncertainty and on account of this of risk premia in equity and bond markets. Importantly, he shows that the size of the equity risk premium is dominated by inflation volatility, however the strengths of the effect crucially depends on the state of the economy and the time variation of the volatility. In such a setting, a low level and low time variation of inflation volatility open up room for consumption growth volatility to dominate the equity premium that compensates for macroeconomic uncertainty.

The negative interdependence of uncertainty about future inflation and asset prices found in this study is also in line with for instance Koijen et al. (2010).[4]

The main empirical framework that is used here to show the importance of inflation volatility and consumption growth volatility as asset valuation predicting macroeconomic uncertainty channels draws on a study by Bansal, Khatchatrian and Yaron (2005). It directly maps the well-known present value relations into regressions that project (i.e. regress) future valuation ratios on inflation and consumption growth volatility and vice versa. Bansal et

[4]For further references of a variety of recent studies that investigate and support the role of inflation in different markets and settings see for instance: Piazzesi and Schneider (2006) show, using and extending the long-run risk model framework, that if increasing inflation acts as "bad news" for consumption growth, the yield curves slope up and thus also equity premia increase. Eraker (2008) also documents that inflation risk induces an upward sloping nominal yield curve. Ang, Bekaert and Wei (2008) provide evidence in a regime-switching model of nominal and real interest rates for the same upward sloping yield curve effect and identify variation in inflation risk premia as main determinant of variation in nominal and real interest rates. Bekaert and Engstrom (2010) and Pilotte (2003) corroborate with their findings that the relation between equity premia, dividend yields and economic uncertainty is dominated by inflation volatility as measure for macroeconomic uncertainty. Furthermore, the above authors detect a very high correlation between yields on stock and bond markets. Engstedt and Pedersen (2010) show that the empirical difference in the predicability of nominal and real asset returns and dividend growth results in inflation predictability by asset valuation ratios and vice versa.

al. (2005) find that consumption growth volatility is time-varying and a significant predictor of future asset valuations with a negative sign. Indeed, the evidence in this study corroborates this. Similarly, predictive regressions of macroeconomic risk on present asset valuations yield negative coefficients. However, this study highlights that during certain periods of time inflation volatility is an even more important macroeconomic risk channel than consumption growth volatility. The inflation volatility channel as potential driver of macroeconomic uncertainty is neglected in Bansal et al. (2005). Like this they miss an important source of macroeconomic uncertainty. In addition, they also do not go further and investigate the interdependencies and shifts of macroeconomic uncertainty, macroeconomic states, monetary policy variables and asset valuations.

The empirical study covers a post-worldwar sample period of 57 years of quarterly US data (1953:Q1 – 2009:Q4), including the recent financial crisis. Different measures of uncertainty – i.e. different types of volatilities and survey based measures – broadly support the findings of the main econometric specifications.

The evidence presented here, contributes in several ways to the literature. First, it documents the important role of time-varying inflation volatility as macroeconomic risk factor rather than consumption growth volatility. Periods of higher inflation and inflation uncertainty are also periods of higher aggregate uncertainty. The study shows that it is crucial to account for time-varying inflation uncertainty and its codependence with consumption growth uncertainty to explain risk premia in financial markets. The finding that during long periods of time variation of inflation volatility is the primary reason that explains the variation in asset valuations emphasizes that accounting for uncertainty about future inflation is important once macroeconomic uncertainty and asset prices are considered. The study also emphasizes that during certain periods of time it is an even more important predictor of future asset valuations than the hitherto applied proxies for uncertainty about future consumption growth.

Second, the study provides evidence that helps to explain the effects of changes in the degree of uncertainty for asset valuations, which materializes in substantial changes of the time variability and levels of the uncertainty proxies. It turns out that without a sufficient level of time variation, macroeconomic risk – no matter if it is proxied by inflation volatility or consumption growth volatility – does not significantly affect asset valuations anymore. Changes in the time variation of the macroeconomic risk proxies and their underlying macroeconomic fundamentals highly correlates with shifts in the overall macroeconomic state and with the probability of being in a state of counter- or procyclical effects of the macroeconomic uncertainty channels.

By the same token, the study provides insights that help to explain changes in the macroeconomic uncertainty, changes in the predictability and changes in the levels of asset valuations, by changes in the states of the economy from "bad" states (e.g. negative supply shocks), to "good" states (e.g. positive demand shocks) of the economy. It also links these shifts to changes in monetary policy variables. This helps to rationally explain, with a change in the time variation and the magnitudes of macroeconomic risk and with the potential impact of changes in monetary policy variables, long-run asset valuation shifts from depressed valuations during the 1970's "Great Money Inflation" to the "Great Moderation" from the early 1980s until the early 1990s and the "Great Asset Price Inflation" from the late 1980s until the early 2000s, preceded by the "Great Contraction", i.e. the persistent decline in valuations from the early 2000s until mid 2009.

The empirical findings also shed further light on the controversially discussed impact of monetary policy on the macroeconomy during the last decades. While the decline in macroeconomic risk is highly correlated with a money inflation targeting monetary policy (e.g. Bernanke, 2004, Bordo, Ducker and Wheelock, 2008, Bordo and Wheelock, 2007 and Clarida, Gali and Gertler, 1999 & 2000, Pilotte, 2003), a loose monetary policy with interest rates that were kept below the Taylor rule for a long time, was not effective at detecting and mitigating the risk from the inflation in asset prices (e.g. house prices) and an increasingly levered economy (Bean, 2010; Taylor, 2007; Taylor and Williams, 2009).[5] The results of the study provide supporting evidence to a strand of literature that argues in favor of modifying the standard Taylor rule by including asset price inflation – which is proxied here by the change in house prices – to improve the mitigating effects of monetary policy on economic exaggerations and downturns (e.g. Leamer, 2007, Bean, 2010). The empirical results detect an increase in macroeconomic uncertainty from the late 1990s that predicts slightly increasing short rates. Stock market valuations started to gradually decrease since the early 2000s while stock and asset prices remained high, coinciding with a persistent increase in macroeconomic uncertainty and increased probabilities of being in a state with high macroeconomic uncertainty. The results emphasize that the heavy adverse demand shocks due to the delevering financial system during the subprime crisis came along with a boost in macroeconomic uncertainty that could not be offset anymore with traditional monetary policy interventions such as a substantial down-cut of interest rates (Bean, 2010; Arouba and Diebold, 2010).

The remainder of the paper proceeds as follows. In Section 2 the data set is introduced, the descriptive properties of the time series are reported and discussed and the empirical framework of the analysis is set up. Section 3 provides the main results of the empirical study. In Section 3.2 the robustness of the results is tested using alternative measures of

[5]While low interest rates certainly also contributed to filling the credit market bubble, the empirical study will focus on asset prices only and leaves the simultaneous consideration of credit market frictions for future research.

macroeconomic uncertainty, i.e. other than volatilities. Section 4 provides evidence on the (long-run) variation of the macroeconomic uncertainty channels and asset valuation ratios and the consequences of these movements for the projections between asset valuation ratios and the macroeconomic uncertainty variables. Section 5 draws a link of the main empirical results with changes in monetary policy variables and housing markets. Section 6 concludes.

2 Data Description and Empirical Framework

The first part of this section discusses the data and the (auto)correlations of the economic uncertainty variables. The second subsection (2.2) introduces the volatility measures and the framework of the projections that are investigated later on.

2.1 Data Description

If not indicated differently, quarterly data in a sample period ranging from 1953:Q1 – 2009:Q4 is used.[6] A more detailed description of the data is provided in Appendix A.

The quarterly proxy for inflation denoted as "inf" is taken from NIPA and derived as deflator of non-durables consumption and services as described in Piazzesi and Schneider (2006). As an alternative proxy for uncertainty about future inflation and consumption the quarterly dispersion "$infdisp$" and "$cdisp$" of the annual projections for the current year individual inflation and consumption forecasts of the Survey of Professional Forecasters – measured as the log of the standard deviation of the individual forecasts in a quarter – is used.[7] There is a broad literature on professional survey forecasts, the dispersion of the forecasts, and its implications. Mankiw, Reis and Wolfers (2003) find that the dispersion of the forecasts comoves closely with the underlying forecasted variables. Thus, the dispersion of expectations is potentially significantly related to macroeconomic conditions and may serve as an instrument for inflation uncertainty, i.e. as an alternative proxy for macroeconomic uncertainty.

The data for the price-earnings ratio "pe" and the earnings growth rates "g_e" is taken from Robert Shiller's web site. As quarterly consumption proxy the consumption of non-durables and services (in billions of dollars), as provided by NIPA, is used and its growth rate "g_c" which is calculated as in Piazzesi and Schneider (2006). Three-months risk free rates are extracted from the CRSP Fama Bliss monthly treasury file which is updated annually.

[6] The sample period is shortened if the available data does not cover the full sample length.

[7] Note, data for this survey is available only as of 1981:Q3 so the variables cannot be applied to the whole sample.

The variables are transformed to log-form and converted to real with the quarterly inflation measure.

House price changes are used towards the end of the study as proxy for asset price inflation and defined as the difference of the logarithmic values of the house price index as provided by Robert J. Shiller.

Table 1 reports summary statistics for the most important variables. The table provides means and standard deviations of the variables along with the one- and two-year (partial) autocorrelations.

INSERT TABLE 1 ABOUT HERE

Figure 1 plots in Panel A the time series of inflation and consumption growth. The lower panel (Panel B) depicts the volatilities of consumption growth and inflation together with the price-dividend and price-earnings ratios. Consumption growth and inflation both fluctuate over time whereas inflation fluctuates more heavily. This is also evident from the higher sample standard deviation of inflation in Table 1 and the more pronounced fluctuations in the volatility of inflation in Panel B of Figure 1. The unconditional standard deviation of the inflation volatility is 1.0004 compared to 0.3472 for the consumption growth volatility. This pattern is particularly pronounced during the mid-1970s, early 1980s and in the late 1980s – early 1990s. This indicates clearly that time variation is much more relevant to inflation volatility than to consumption growth uncertainty.

INSERT FIGURE 1 ABOUT HERE

During periods of relatively large shocks, consumption growth and inflation deviate largely and for some periods move completely into opposite directions. In the early part of the sample, shocks to consumption growth were relatively large but the magnitude of these shocks decreased over time. Only in the mid-1970s, the early 1980s and in the late 1980s – early 1990s shocks to consumption growth are of relatively large magnitude. Inflation has experienced relatively large shocks in the same time periods. In addition, Panel B provides a first indication that a high level of time variation in second moments tends to coincide with low asset valuations. Furthermore, the figure illustrates that decreasing and low levels of time variation in volatilities tend to come along with increasing and high levels of asset valuations.

Furthermore, the time variation of (auto)correlations of the first and second moments of the economic uncertainty channels are considered here as crucial for explaining the asset valuations. For instance, consider the relation between expected consumption and inflation as in Piazzesi and Schneider (2006). From there it follows that if asset valuation ratios are a function of expected consumption growth this immediately implies that they are a function of expected inflation. Thus, time variation in first and second moments of consumption growth and inflation as well as in their covariances matters to asset prices. In Table 2 unconditional correlations for the most important variables are reported.

INSERT TABLE 2 ABOUT HERE

Figure 2 depicts the 10-year ahead correlations of (i) inflation volatility with consumption growth volatility, (ii) the level of inflation with consumption growth volatility, (iii) the level of consumption growth with inflation volatility and (iv) the level of inflation with the level of consumption growth from the sample.

INSERT FIGURE 2 ABOUT HERE

The correlation between consumption growth and inflation decreased sharply in absolute terms from -0.6 in the early 1950s to a very low positive value in 1960, then decreased again and was large and negative until the 1970s. Thereafter it slightly but persistently decreased in absolute terms until the early 1990s where it jumped up and remained slightly negative for the rest of the sample period. Thus, the correlation between the level of consumption growth and the level of inflation changed over time. The correlation between the level of consumption growth and inflation volatility comoves relatively closely in the post 1960 periods for a long time with the correlation between inflation and consumption growth. However, from the early 1950s until the early 1960s it sharply declines from a relatively high positive level and becomes even negative. Also after the jump in the early 1990s it deviates from the movement patterns of the correlation between consumption growth and inflation as it sharply declines and becomes negative again immediately after the positive shock. Interestingly, while the correlation between consumption growth and inflation and the correlation between consumption growth with inflation volatility comove closely for long periods of time the other two correlations in the figure also exhibit a common pattern. However, it differs strongly from the other two correlations that are described above. The correlation between both volatilities and the correlation of inflation with consumption growth comove relatively closely most of the time. From the mid-1960s until the beginning of the 1980s both correlations remain at a relatively high positive level while before and after these years they sharply increase and decrease. After a sharp run up until the early 1990s they strongly decrease again. In particular, the correlation between both volatilities crashes down in the early 1990s and changes from relatively high positive values to remarkable negative values. Overall, Figure 2 reveals that time variation of consumption growth, of inflation, of their second moments and their correlations is highly relevant. Interestingly, in the early 1990s all plotted correlations sharply crash down or jump up. This is a first hint indicating that the asset valuation run-up in subsequent years is potentially related to changes in the structures of the times series as well as of the (auto)correlations. This is further examined and discussed in detail in Section 4. In addition, in the late 1990s and early 2000s the correlations sharply change again. After turning negative, the correlation between inflation and consumption growth sharply increases, jumps up and becomes positive again. The same but even more pronounced pattern can be detected for the correlation between the second moments of both variables. The correlations between the first moment of inflation or consumption growth with the second moment of consumption growth or inflation respectively sharply increase in absolute terms and become highly negative.

To sum up, the descriptive statistics already hint at time variation in the first and particularly the second moments of inflation and consumption growth and the correlations between them as potentially important in order to contribute to explaining the changes of asset valuations over the last decades.

2.2 Methods and Models

In this subsection the econometric methods and the main model formulations are introduced.

In Subsection 2.2.1 the empirical measure for volatility as source of economic uncertainty that is employed for the volatilities of consumption growth and inflation is introduced. The volatility formulation follows the notion of time-varying and as such predictable volatility. It also accounts for the conditional correlation between both volatilities. Thereafter, in Subsection 2.2.2, the main regression models are defined. Similar to Bansal at al. (2005) the empirical framework directly maps the well-known present value relations into regressions that project (i.e. regress) future valuation ratios on inflation volatility and consumption growth volatility and vice versa.

2.2.1 Measuring Volatility

The empirical measure for volatility that is used here is a GARCH(1,1)-type Baba-Engle-Kraft-Kroner-model (BEKK-model, Engle and Kroner, 1995) that accounts for the conditional correlation between both volatilities. Given previous evidence in the literature and already from the descriptive part of this work it is clear that there are (high) codependencies between both uncertainty measures.[8] Compared to other multivariate volatility models, the

[8]In unreported results three other measures (a realized volatility measure, a univariate AR(1)-GARCH(1,1) model and a ((V)AR-)DCC-model) are used that support qualitatively the results from the regressions. The multivariately estimated volatilities (i.e. the BEKK-model volatilities and the volatilities that are obtained

BEKK-model has – e.g. compared to a normal VEC model – the convenient property that the conditional covariance matrices are positive definite by construction which substantially improves the feasibility and it is still more general in terms of restrictions than for instance a DCC model. For the bivariate case it can be written as:

$$\Sigma_t = C_0'C_0 + \begin{pmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{pmatrix}' \begin{pmatrix} \epsilon^2_{1,t-1} & \epsilon_{1,t-1}\epsilon_{2,t-1} \\ \epsilon_{2,t-1}\epsilon_{1,t-1} & \epsilon^2_{2,t-1} \end{pmatrix} \begin{pmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{pmatrix} +$$

$$\begin{pmatrix} g_{11} & g_{12} \\ g_{21} & g_{22} \end{pmatrix}' \Sigma_{t-1} \begin{pmatrix} g_{11} & g_{12} \\ g_{21} & g_{22} \end{pmatrix}, \qquad (1)$$

with $\epsilon_t|\mathfrak{F}_{t-1} \sim N(0, \Sigma_t)$.

In the next subsection, the framework and models for the time series regressions are defined and briefly explained.

2.2.2 Motivation and Choice of the Main Econometric Specifications

From Campbell and Shiller's (1988) basic asset valuation approximation, it is known that

$$p_t - y_t = \nu_0 + E_t \sum_{j=1}^{\infty} \rho^{j-1}(g_{y,t+j} - r_{t+j}),$$

where p_t is the log price of the stock, y_t is the log-level of cash-flows, the growth rate of market cash-flows is denoted as $g_{y,t+j}$ and the return on the market portfolio is r_{t+j}. From here, the result follows that asset valuations can only vary if either expected growth rates in returns or the variation of expected asset returns change as

$$var(p_t - y_t) = \sum_{j=1}^{\infty} \rho^{j-1}(cov(g_{y,t+j}, p_t - y_t) - cov(r_{t+j}, p_t - y_t)).$$

A variety of studies in the consumption based asset pricing literature posit that expected returns are driven by the conditional volatility of consumption growth.[9] This study posits that (expected) inflation volatility plays an important role for investors' expectations of future asset returns. Accounting for the first and second moments of inflation, Hasseltoft (2009) shows that the equity risk premium is governed by the covariance between the real pricing kernel m_{t+1} and market returns $r_{m,t+1}$ which can be very large and dominated by inflation

by using a ((V)AR-)DCC-model), show that it is important to account for the codependence between both macroeconomic risk variables in order to obtain unbiased regression results.

[9]See for instance Kandel and Stambaugh (1990) or Bansal and Yaron (2004).

volatility $\sigma^2_{\text{inf},t}$ during certain periods of time. However, in other states of the economy the covariance term can also be very small or is governed by the volatility of consumption growth $\sigma^2_{c,t}$. Hasseltoft (2009) derives the following expression of the equity risk premium that also accounts for the heteroscedasticity of the inflation and consumption processes:

$$\begin{aligned} E_t(r_{m,t+1} - r_{f,t}) + 0.5Var_t(r_{m,t+1}) &= -Cov_t(m_{t+1}, r_{m,t+1}) \\ &= -(V_c\sigma^2_{c,t} + V_{inf}\sigma^2_{\text{inf},t} + C + F) \end{aligned}$$

While details on the derivation and the expressions for V_c, V_{inf}, C and F are given in Appendix B, the above expression for the equity risk premium already highlights those components of the covariance term which are most important for the theoretical intuition of this study, and which Hasseltoft (2009) also identifies as dominating forces in different economic states. Importantly, he finds for a similar sample period, as it is relevant for this study, that inflation volatility dominates the covariance term during long periods of time. The expression establishes the importance of inflation volatility on asset valuations and emphasizes the importance of time variation and changes in the strength of the impact of the macroeconomic uncertainty proxies in different states of the economy. Drawing on this interdependence of investors' expected equity returns with their uncertainty about future inflation and consumption growth, this study investigates the impact of changes in the time variability and the predictive power of the uncertainty variables for changing macroeconomic states, subsequent to examining the importance and relation of uncertainty about future inflation and consumption growth for the whole sample period, i.e. across economic states. In order to examine the relation between fundamental macroeconomic uncertainty and asset valuations the study employs as Bansal et al. (2005) a first set of regressions which directly project price-earnings ratios on their macroeconomic uncertainty proxy, i.e. consumption growth volatility and inflation volatility.[10] Based on Bansal and Yaron (2004) who introduce the important role of consumption growth volatility as macro risk proxy and Hasseltoft (2009) who shows that adding an inflation uncertainty channel is crucial, and in line with the empirical framework of Bansal et al. (2005), the first projections consider whether the lagged volatility of consumption growth and inflation predict asset valuations, i.e. $X_t = \{\log \sigma^2_{c,t}, \log \sigma^2_{inf,t}\}$, yielding:

$$p_t - e_t = b_0 + b_1 X_{t-1} + u_t. \tag{2}$$

[10]The same regressions are also run with price-dividend ratios. The results are nearly identical as both valuation ratios are nearly perfectly correlated so only the results for the price-earnings ratios are reported here.

If the coefficient b_1 is negative this indicates that markets dislike economic uncertainty for which the volatility measures are supposed to be relevant information channels. The coefficient is important for assessing the relevance of volatility as predictor of asset valuation ratios. For the regressions a two-step GMM procedure is employed. Robust t-stats and adjusted R^2s are reported.[11] As market risk premia can of course include future consumption growth or inflation, the first moments of consumption growth and inflation are not restricted here from driving expected returns and are also added as control variables in the subsequent empirical study.

In a second set of regressions, the volatilities are regressed on the price-earnings ratios. The intuition for this type of regression is that the better predictable consumption growth volatility and inflation volatility are, the more time variation matters to them and the more relevant channels for macroeconomic uncertainty and predictors of future asset valuations they are supposed to be.

The predictive regression model for the volatilities can be written as

$$\log \sigma_t^2 = \alpha_0 + \alpha_1 (p_{t-1} - e_{t-1}) + u_t. \tag{3}$$

In Subsection 3.1 the respective asset valuation ratios are regressed in uni- as well as multivariate regressions on inflation and consumption volatility. This may be interesting in order to investigate whether the predictive power of the regressions is significantly improved compared to the results from the univariate regressions and compared to results in the literature. It would imply that it is relevant to account for both channels of macroeconomic uncertainty in order to explain asset valuations. In addition, further multivariate regressions control for the first moments of the uncertainty proxies and for the risk-free rate. Adding the risk-free rate as predictor of asset valuations provides first hints at the role that monetary policy potentially plays.

3 Empirical Evidence – Main Regression Results

This section reports and discusses the results from the above introduced sets of regressions.

[11] Running the same regressions using an OLS or FGLS model yields almost exactly the same results, however, employing two-step OLS-like GMM allows for obtaining standard errors and R^2s that account for heteroscedasticity and autocorrelation.

3.1 Main Regression Results

To address the issue of the potentially high conditional correlation between both macro risk variables, the study uses a bivariate BEKK model volatility in the regressions as specified in equations (4) (Table 3, Panel A and B) and (5) (Table 3, Panel C). Weak-form tests of stationarity indicate that the volatilities are stationary.[12] Figure 3 plots the conditional correlation between both macro risk variables over time.

INSERT FIGURE 3 ABOUT HERE

Panel A of Table 3 reports results with both volatilities and either consumption growth or inflation together with both volatilities as regressors.

INSERT TABLE 3 ABOUT HERE

The results for A indicate that consumption growth volatility predicts asset valuations at a highly significant level with a negative coefficient and an R^2 yielding 28.52%. However, inflation volatility has a substantially stronger predictive power with an R^2 of 48.29% and a much higher t-statistic for the negative coefficients.

In sum, the results from the univariate regressions indicate that inflation uncertainty has a substantially stronger impact on asset valuation ratios than consumption growth volatilities.

In Panel B of Table 3 the results for the bivariate regression with both jointly estimated volatilities as regressors reveal interesting insights. Inflation volatility substantially drives out the predictive power of consumption growth volatility. In addition, the R^2 amounts to roughly the same value as for the univariate regression of price-earnings ratios on inflation volatility. Hence, the results from this first bivariate regression with jointly estimated volatilities strongly supports that exogenous shocks from inflation heavily impact asset valuations. Once both volatilities are used jointly in the same regression, it reveals that indeed the highly time-varying inflation volatility dominates.

Results from Granger causality tests (Granger, 1969) strongly confirm that even though the null that consumption growth volatility does not Granger cause inflation volatility can be rejected, the same hypothesis cannot be rejected for inflation volatility as Granger causing consumption growth volatility. This supports and emphasizes that it is not enough to consider consumption growth uncertainty and consumption based measures only as in most of the previous literature. Furthermore, it corroborates the view that inflation is bad news for consumption growth, in particular during times of high macroeconomic uncertainty.

[12]The results for the BEKK-model coefficients and standard errors can be made available on request.

The results in Panel B further corroborate this view as the inclusion of the levels of both uncertainty variables does not substantially change the strength or significance of the results.

Turning now to the regressions in Panel B that include the risk-free rate as predictor of future asset valuations, significant coefficients for the risk-free rate and largely unchanged results for the macroeconomic risk variables could be expected if the impact of the interrelation between monetary policy variables and asset prices goes beyond what is already captured by the macroeconomic risk proxies.

Indeed, the inclusion of the risk free rate strengthens the results.[13] In particular, the regressions with inflation volatility and the risk-free rate as well as inflation volatility, consumption growth volatility and the risk-free rate as regressors reveal that the main predictors of future asset valuations are inflation volatility and the risk-free rate rather than consumption growth volatility. The coefficient of the risk-free rate is highly significant and has a negative sign. This is a first hint at the forces that are at work between inflation, macroeconomic uncertainty, monetary policy variables and asset prices. Supply shock governed high money inflation and high uncertain economic states come along with depressed asset prices and in case of money inflation targeting high risk-free rates. On the other hand, demand shock governed low inflation and low uncertainty macroeconomic states favor a loose monetary money inflation targeting policy, which however neglects potential risks from inflated asset prices in a levered-up economy. These results are interpretable in analogy with Mojon (2007). Using a Markov Switching VAR model his findings indicate that variation in monetary policy effectively impacted macroeconomic volatility in the time period which is coined here and in other studies the "Great Moderation", whereas the effect of monetary policy variation was negligible in the post-1990 time. A regime-switching monetary policy and its moderating impact on the economy in aggressively inflation targeting times and its growth supporting effect during times of an expansive policy is further corroborated in a continuous-time regime-switching model by Li, Li and Yu (2010).

In own unreported results from estimations of a multivariate regime switching VAR model of the volatilities of consumption growth and inflation, the smoothed probabilities of being in either a low or a high consumption and inflation uncertainty state are estimated. The results show that the probability of being in a state of "Great Moderation" in both variables sharply increases since the early 1980s and remains on average close to 1 until the mid 2000s when the subprime crisis was about to start evolving soon. Thus in the context of this work, it is interesting to account for correlations and relations that might change during different regimes. The dependence of expected returns, macroeconomic uncertainty and macroeconomic fundamental correlations and relations on different macroeconomic conditions is considered in more

[13]Note, that the risk-free rate and price-earnings ratios are correlated with the coefficient yielding -0.5138.

detail below in this section and in the last two sections.

Moreover, the results in Panel C show that consumption growth volatility is much harder to predict by the present valuation ratios with R^2s amounting to 25.07% compared to inflation volatility that is predicted by price-earnings ratios with an R^2 of 43.03%. This corroborates that time variation matters at least during certain periods of time much more to inflation volatility and is also a rational explanation for the strong impact of inflation volatility on asset valuations.

Summing up the general message from Table 3, the interrelation between uncertainty about future inflation and uncertainty about future consumption growth matters and has to be taken into account once both variables should be used as proxies for macroeconomic uncertainty. The results for the regressions with multivariately estimated volatilities and additional causality tests reveal that time-varying inflation volatility indeed is a dominant driver of asset valuations and during certain periods of time is an even more important predictor of future asset valuations than consumption growth volatility. In the joint regressions, consumption growth volatility is largely driven out by the much more heavily time-varying inflation volatility. Economically this means that in particular during times of highly time-varying inflation volatility, it is crucial to account for this macroeconomic risk factor. Furthermore, the results suggest an inverse relation between the risk-free rate and asset valuations which is a first hint at the interrelation of monetary policy and the asset price inflation in an increasingly leveraged economy since the early 1990s.

The results emphasize that macroeconomic variables are highly interrelated, time-varying in their (auto)correlations and differ in the strengths of their impact on asset prices in general and over time. It may be instructive to get an idea of the direction and strengths of the relations amongst the variables that are not yet explicitly reported or discussed. However, as they are not essential for the results of the study, they are reported and briefly discussed in Appendix C.

In the above, only volatilities of inflation and consumption growth were considered as proxies for uncertainty about future inflation and consumption growth and as such channels of macroeconomic uncertainty. In order to further validate the importance of uncertainty about future inflation and consumption growth as predictors of future asset valuations, it is instructive to use another type of uncertainty measure and rerun the main regressions using the alternative uncertainty proxy as asset valuation predictor. If uncertainty about future inflation and consumption growth matters to asset valuation ratios this can also be rephrased as inflation and consumption expectations mattering to asset valuation ratios. Previous studies find that the dispersion of inflation forecasts comoves closely with inflation and consumption growth. Thus, the dispersions of inflation and consumption growth forecasts can also serve as proxies of macroeconomic uncertainty with predictive power for asset valuation ratios. This would confirm the results for the volatilities as proxies of macroeconomic uncertainty. In addition, it is also interesting to investigate if the commonly used uncertainty proxy, consumption growth volatility, is still driven out as predictor of future asset prices, once an alternative inflation uncertainty proxy is used as regressor. Apart from that, if forecast dispersion significantly predicts asset valuation ratios this would corroborate the view that disagreement is a key to macroeconomic dynamics.

Thus, in the next subsection (Section 3.2), alternative proxies of uncertainty about future inflation and consumption growth from survey data are introduced and their interrelation as well as their predictive power for asset prices is tested in order to further validate the above results.

3.2 Forecast Dispersion and Asset Valuation Ratios

As a proxy for these expectations of inflation and consumption, data from the Survey of Professional Forecasters – i.e. the dispersion of the annual projections for the current year's individual inflation forecasts of the Survey of Professional Forecasters – is used here.[14] Note that the data for this survey only starts in 1981:Q3. Below Table 4 provides evidence that the annual projections for the current year inflation and consumption forecast dispersion help to predict asset valuation ratios. However, the predictive power is weaker than for inflation volatility and consumption growth volatility but it is still remarkable and highly significant.

INSERT TABLE 4 ABOUT HERE

The results for the univariate regressions (Panel A) as well as for the bivariate regressions (Panel B) with each of the consumption uncertainty proxies and the inflation forecast dispersion validate the above finding that the inflation uncertainty channel is a substantially more powerful predictor of asset valuations. Interestingly, also the results for the alternative inflation uncertainty measure confirm that once the estimation of the volatilities accounts for the conditional correlation between inflation and consumption growth volatilities, the coefficient of consumption growth volatility changes its sign in a joint regression. Here it even becomes insignificant. Almost all explanatory power of the regressions I.2 and II.2 in Panel A of Table 4 arises from the alternative inflation uncertainty measure. Panel B also further validates the

[14]There are of course other surveys, however these are usually either not publicly available or at lower frequencies. However, as for instance Mankiw et al. (2003) point out that the forecasts are very similar and thus without loss of generality interchangeably usable. Instead of the dispersion about consumption, forecast dispersion for real GDP growth is also used in unreported regressions. The results support what is reported below for the consumption forecast dispersion measure.

relevance of inflation uncertainty as macroeconomic risk factor that drives asset valuations. The coefficients are highly significant and negative even though the predictive power of this measure is only half as strong as the predictive power of inflation volatility.

From Panel C time variation of uncertainty about future inflation can also be validated as a robust pattern. The results indicate that uncertainty about future inflation amongst professionals is affected by present asset valuation ratios. This yields the same implication as above where future inflation volatility is highly predictable by present price-earnings ratios.

The results contribute further empirical support for the suggestion of Mankiw et al. (2003) that disagreement is a key to macroeconomic dynamics.

In sum, the results support that uncertainty about future inflation acts as important channel of macroeconomic uncertainty and as such is particularly important for predicting movements in asset markets. Uncertainty about future consumption growth also serves as proxy for macroeconomic risk but is largely driven out by the inflation uncertainty measures. Economically, this means that in times of high and highly time-varying uncertainty about future inflation it is crucial to incorporate inflation volatility for adequately predicting asset valuations. The results strongly suggest and validate that heteroscedasticity of the underlying processes and on account of this time variation of the uncertainty variables are highly relevant. In particular, this is relevant – considering the whole sample period – for inflation volatility.

As time variation seems to play a prominent role once macroeconomic uncertainty and asset prices are considered, in the next section, matters of time variation, changes in macroeconomic uncertainty and asset valuation patterns are investigated in detail. They are linked with shifts in the state of the economy in order to help explain the link between the macroeconomic states and asset prices.

4 Long-Run Shifts in Markets and Macroeconomic Uncertainty

A first intuitive approach for explaining the effects of asset price movements and time variation in macroeconomic uncertainty is to consider a potential link to the business cycle. Figure 4 depicts the time series of consumption growth and inflation (Panel A) and the respective volatilities (Panel B). The shaded regions emphasize the NBER recession periods. For several periods the sharp run-ups or decreases of the time series coincide with the recession intervals. This could be interpreted as indication for the business cycle as triggering time variation of macroeconomic uncertainty and expected returns. However, introducing a dummy to each of the above projections which is equal to 1 during NBER recession periods and 0 otherwise reveals that the impact of the business cycle variation on asset valuations is relatively small compared to macroeconomic uncertainty.

INSERT FIGURE 4 ABOUT HERE

The regression dummy is completely insignificant for all types of regressions in Table 5. The results of the recession dummy regressions show that the impact of the dummy and thus the short-term business cycle risk is not strong enough such that the dummy would contain information that can largely explain the variation of asset valuation ratios. It is driven out by the uncertainty arising from the long-run risk factors that capture the overall macroeconomic uncertainty.

INSERT TABLE 5 ABOUT HERE

Overall, the results for the macroeconomic uncertainty variables are validated. For the time variation of uncertainty about future consumption growth and inflation, unreported tests indicate that there is some correlation but no significant causal relation between the recession periods and the uncertainty variables detectable. This supports the view that due to the high persistence of asset valuation ratios and the macro variables it is unlikely to find a clear and significant linkage between them and short(er)-term factors. Instead and in line with the intuition from the "Long-Run Risk Model", changes in slow-moving (i.e. longer-term) factors are at work (cf. for instance Lettau and Nieuwerburgh, 2008; Engstedt and Pedersen, 2010).

The idea of linking long-run risk changes and shifts in the states of the macroeconomy builds on the observation that macroeconomic shocks can have a different nature and as a consequence, varying effects on investors' uncertainty and wealth. During the first part of the sample period, i.e. the period of "Great Money Inflation", mainly supply shocks were relevant for the economy. Then, during the "Great Moderation", i.e. from the early 1980s until the early 1990s, volatilities sharply declined in their levels and time-variation, strongly correlating with a change in the monetary policy towards a clearly money inflation oriented rule.[15] In the late 1970s and early 1980s, coinciding with Volcker's appointment as Chairman of the US Federal Reserve, the interest rates reached historically high levels which emphasizes the central bank's determination to fight the money inflation. In subsequent years, when macroeconomic volatilities and the level of inflation sharply decreased, interest rates were

[15] For a recent paper that investigates the sources of the "Great Moderation" and also shows its clear linkage with an overall decline in the second moments of US macroeconomic variables see Justiniano and Primiceri (2008).

also substantially lowered again. This was accompanied by persistently increasing growth rates (Stock and Watson, 2003; Clarida, Gali and Gertler, 2000).

Coinciding with the greater macroeconomic stability, demand shocks governed the macroeconomy. However, these favorable macroeconomic conditions also came along with a "Great Asset Price Inflation" in increasingly levered markets. The low levels of macroeconomic uncertainty, coupled with the decreasing short rates and persistently increasing growth rates help to explain these high levels of asset returns. Remembering the present value relations and the result in Section 2.2.2 that all variation in asset valuations either arises from changes in the expected growth rates or changes in expected returns, the sharp decrease in expected returns due to the decreased macroeconomic risk and the low interest rates, coupled with the persistently increasing growth rates, are a rational explanation to the high asset price inflation during the 1990s.

In a recent study, Lettau and Nieuwerburgh (2008) suggest a steady-state shift in asset valuation ratios (and other financial ratios) at about the beginning of the 1990s. One explanation for this steady state shift is that the persistent decline in expected returns and the persistent increase in growth rates, which came along with the shift of the macroeconomic state, on aggregate contributed to an increase in the steady state of asset valuation ratios.

A variety of recent studies advocates structural breaks in several macroeconomic time series between the late 1980s and the early 1990s (e.g. Lettau, Ludvigson and Wachter, (2008), for consumption volatility; Stock and Watson, 2003, for 22 macro time series). Evidence of other recent studies suggests that inflation has become harder to forecast over the last decades, resulting from a decline in time variation and thus a decreased level of macroeconomic risk. They investigate and discuss the "Great Moderation" of macroeconomic uncertainty and along with it changes in the structure of the inflation process and in the comovement between macroeconomic variables (for instance Stock and Watson, 2007 or Gali and Gambetti, 2009 or Giannone, Lenza and Reichlin, 2008). These aggregate effects can contribute to a rational explanation for the asset price run-up from the early 1990s until the early 2000s.

Using this evidence together with the results from Lettau and Nieuwerburgh (2008) and the intuition from this study, yields the following reformulation of the basic asset valuation approximation:

$$(p_t - y_t)_{steady,new} = (p - y)_{steady,old} + \left[\sum_{j=1}^{\infty} \rho^{j-1} (E_t(\Delta g^s_{y,t+1}) - (E_t(\Delta r^s_{t+1}))) \right]_{excess} , \qquad (4)$$

where $(p-y)_{steady,old}$ is the steady state asset valuation ratio defined as in Equation (6) and denotes a constant average logarithmic asset valuation ratio across time in the old steady state. $(\ldots)_{excess}$ is the expected future deviation from (i) the previous steady state's growth $(\Delta g^s_{y,t} = g^s_{y,t+1} - \bar{g}_y)$ and (ii) the deviation from the previous steady state's expected returns $(\Delta r^s_{t+1} = r^s_{t+1} - \bar{r})$, where s denotes the state of the economy which for reasons of simplicity is assumed to be either a "good" (e.g. positive demand shocks) or a "bad" (e.g. negative supply shocks) economic state. The intuition is that depending on the state of the economy, growth rates and returns might deviate from the previous steady state value – denoted here with an upper bar – which on aggregate and over several periods of time might result in $E_t((\ldots)_{excess}) \neq 0$, i.e. a shift in the steady state.

A structural change in the asset valuation ratios (as detected by Lettau and Nieuwerburgh (2008)) driven by regime dependent changes in the expected return, implies then that the regime dependent shifts in the covariance term between the real pricing kernel and market returns – due to the different strengths of the impact of the particular macroeconomic uncertainty proxies during different economic regimes – on aggregate and for several periods of time contributed to a steady state shift in asset valuations. The persistently increasing growth rates, which came along with the "good" economic state, further contributed to this shift in asset valuations.

OLS-regression based supF-tests – as originally proposed by Chow (1960) – for the price-earnings projections serve here as tests for the relation of the structural break in the valuation ratios (as identified by Lettau and Nieuwerburgh, 2008) and structural breaks in the single time series of expected returns and thus indeed subject to different regimes. Single time series of the variables are assumed to follow AR(1)-processes. For reasons of brevity the results are not reported here but can be made available.

Briefly summarized, the structural break analysis reveals that in a reasonable confidence interval around the asset valuation ratio break date, the existence of potential breaks in the correlation between the volatilities of inflation and consumption growth, the autocorrelations of the volatilities themselves and the level of inflation cannot be rejected.

Investigating whether the fundamental change in the macroeconomic uncertainty variables and their correlations, coupled with low risk-free rates and persistently increasing growth rates, changed the predictive relation between the valuation ratio projections, helps to rationalize the steady state shift in asset valuations and provides a framework to explain other shifts in asset prices and correlations. This is further corroborated by the estimated smoothed probabilities of being in either a high or a low consumption growth and inflation uncertainty state from a multivariate Markov switching VAR model. Changes in the probabilities come along with changes in signs and strengths of the correlations and relations of the macroeconomic variables that are rleevant here.

In order to test whether there is such a fundamental change in the predictive relation, firstly, using the estimated break date for price-earnings ratios from Lettau and Nieuwerburgh (2008), the sample is divided in two subsamples, where the first subsample dates back to 1953:Q1 until 1989:Q4 and the second subsample covers the rest of the sample period, i.e. 1990:Q1 until 2009:Q4.[16] The unconditional correlation between inflation and consumption growth is -0.4245 at the left side of the structural break and slightly weaker but still negative for the more recent subsample (-0.0524). This fundamental change in the unconditional correlation as well as in the correlations between other variables were already obvious from Figure 2. In addition, the other correlations also exhibit sharp changes at the beginning of the 1990s. Table 6 reports the results from the regressions of the non-overlapping subsamples which are divided at the structural break point.

INSERT TABLE 6 ABOUT HERE

Panel A contains the results for the univariate regression models for both volatilities respectively and for their first moments. The results for the first subsample correspond to a large extent with the results from the regressions of the whole sample in Table 3, i.e. time-varying inflation volatility is the dominating driving force for asset valuation predictions while all other variables are either much weaker or even insignificant in their impact. More importantly, after the structural break point date, inflation volatility becomes a much weaker predictor of future asset valuations. However, consumption growth volatility becomes a stronger predictor of future asset valuations even though its explanatory power is still substantially lower than that of inflation volatility in the first subsample. The same pattern occurs for the first moments. While consumption growth becomes a more powerful predictor of future asset valuations in the second subsample, inflation becomes even completely insignificant. These findings strongly suggests that a decline in macroeconomic risk indeed has had a substantial impact on asset valuations in the sense that the decreased uncertainty did not substantially affect expected returns and did not significantly depress asset prices anymore. In the positive demand shock driven macroeconomy, growth rates became more relevant predictors.

These findings are corroborated in Panel B where the results for the different sets of joint regressions are reported. The results further emphasize how important heteroscedasticity, time variation and regime shifts are in the relation between macroeconomic uncertainty and asset prices. In the first subsample inflation volatility as well as inflation volatility and the risk-free rate completely drive out consumption growth volatility as predictor of future asset

[16] As the structural breakpoint estimates are usually only made on a certain confidence interval, other ranges for the break date are tested. However, this does not substantially change the results.

valuations such that its coefficients becomes even insignificant. The same pattern occurs for the first moment of consumption growth. However, in the second subsample period, this pattern completely changes again. While the first and in particular the second moment of consumption growth become substantially stronger predictors of future asset valuations, the first and second moment of inflation become much weaker predictors or even completely insignificant. Also the risk-free rate completely looses its predictive power. This further hints at the role of monetary policy. While in the first subsample the strict monetary policy interventions contributed to the decrease in macroeconomic uncertainty and the increase in asset prices, the relatively loose policy in the low inflation risk in these periods, substantially weakened the link between asset prices and the monetary policy variable.

Panel C confirms that the time-variation in the volatilities of inflation has come down so much that it is hard to predict this variable. On the other hand the better predictability of consumption growth volatility in the second subsample reveals that obviously time-variation during this period plays a more important role for consumption growth volatility. This helps to understand why consumption growth volatility becomes a more important predictor of future asset valuations in the second subsample. It also highlights that it is important to account for both macroeconomic risk channels and for their time-varying behavior.

In sum, Table 6 highlights that the decline of macroeconomic risk coupled with the persistently increasing growth rates, help to explain a macroeconomic condition dependent change in asset valuation ratios and could contribute to explaining the asset valuation run-up in the 1990s and early 2000s. The change in the correlation between the volatilities of inflation and consumption growth as well as the sharp decrease in levels and volatilities of inflation and consumption growth also indicate that the structural break in asset valuations – and thus in expected returns – is likely to be accompanied by structural breaks in the (auto)correlations of the macroeconomic risk variables.

Previous literature associates the decreased macroeconomic risk and the subsequent asset price inflation with a change in monetary policy towards money inflation targeting since the early 1980s (Bordo, Dueker and Wheelock, 2008, Bordo and Wheelock, 2007 and Clarida et al., 1999 & 2000). This policy shift potentially contributed to diminishing the aggregate level of macroeconomic uncertainty such that expected returns and thus market risk premia substantially decreased and remained at a low level for long periods of time. Several studies (e.g. Clarida et al., 1999 & 2000) also draw a strong link between an inflation-targeting oriented FED-policy which (pro-)actively used short-term rate adjustments as an important monetary policy instrument since the early 1980s and the overall attenuation of macroeconomic uncertainty. The findings from the subsample regression indicate that there are different regimes of macroeconomic uncertainty and monetary policy which are closely related to expected returns in markets. These empirical findings corroborate the predictions made by the model of Li et al. (2010). Their model predicts that for the first subsample that is used here, an aggressively money inflation targeting monetary policy is relevant which is also highly related to the "Great Moderation" in macroeconomic uncertainty. At about the structural break point that is used here, they find a regime-switch in monetary policy and a change towards an expansive FED policy.

It is also still an open question whether the increased macroeconomic stability has contributed to more liquid and more levered asset markets that are generally less vulnerable to crises or, as Gai et al. (2010) show, if this comes at the price that once a crises inevitably hits the macroeconomy, its potential impact will be much more severe. Opponents of this view claim that from at least from an ex ante point of view, the loose monetary policy due to the low money inflation was reasonable (e.g. Svensson, 2010).[17] This study documents that the money inflation oriented FED policy, which was quite expansionary during times of low macroeconomic uncertainty and low risk premia in financial market, did neither effectively act on the asset price inflation nor was it a useful predictor of the asset market bust.

Thus, finding explanations for the asset price inflation in the 1990s, is not the only interesting insight from the second part of the sample. Looking at the data that is used here, valuations started to persistently decrease since the early 2000s. This coincided with an increasing macroeconomic uncertainty and a FED that tried to act on the resurgent inflation risk by increasing the interest rate. During the last two years of the subsample, i.e. the subprime crises, asset valuations dramatically decreased and finally ended up at about the same level as in 1990. The coinciding sharp cut down of interest rates to mitigate the fall in asset prices in the delevering markets, was no more a sufficient manoeuvre to offset the effects of the adverse demand shocks in a strongly delevering economy.

To further investigate the link between the results of this study and the change in monetary policy variables, section 5 considers whether these observations can also be linked with fundamental shifts in the present-value relations. In addition links between monetary policy, stock market returns and asset price inflation – proxied by the change in house prices – are investigated. The next section also helps to further understand the fundamental macroeconomic changes preceding the subprime crises and during the crisis which was blatantly more than a simple moment of historical bad luck for the US and several other economies.

[17] This study does not take the stance of saying that monetary policy was the main systematic trigger of the boom and bust in the asset market. Distorted incentives, excessive risk taking, a high market complexity and a hugely underestimated systemic risk certainly played a much more substantial role.

5 Expected Returns, Monetary Policy and Asset Price Inflation

To better capture the effects of changes is monetary policy variables, the second subsample is divided again in the subsample of the "Great Asset Price Inflation" and the third subsample of the "Great Contraction". The results for the different sets of regressions are reported in Table 7.[18]

INSERT TABLE 7 ABOUT HERE

In sum, the results indicate that depending on the state of the economy, macroeconomic uncertainty has a different impact on future asset valuations with regard to the strengths of the predictive power and the channel of macroeconomic risk that has the largest impact on future asset valuations. In close connection with this, the same type of monetary policy rule might be more or less related to the change in future asset valuations.

The above subsample analysis already provides first links to a strictly money inflation-targeting oriented policy since the Volcker-era that contributed to the "Great Moderation" in macroeconomic risk, but did not substantially contribute to mitigating the "Great Asset Price Inflation" (Borio and Lowe, 2002, Borio and Zhu, 2008) and was not effective in acting on the effects of the adverse demand shocks during the "Great Contraction". Indeed this is also consistent with the smoothed probabilities of being in a low consumption growth and inflation state that are close to one since the Volcker-era and dropped down to values close to zero since the mid 2000s where the economy was increasingly levered up and asset price were high.

The results indicate that different economic regimes come along with different monetary policies and changes in the interdependencies of expected returns, macroeconomic uncertainty proxies and their correlations. To further empirically investigate the link to changes in monetary policy variables and the macroeconomy – as indicated in the subsample regressions – , a simple monetary policy rule with growth variables and inflation uncertainty as regressors is considered. At this, the study builds on a recent long-run risk type model by Gallmeyer et al. (2007). The authors develop a dynamic model of arbitrage-free bond pricing that captures the relation between Taylor rule driven monetary policy, nominal bond prices and an endogenous equilibrium inflation process. It highlights the impact of monetary policy on nominal bond pricing, linking short rate feedback rules, inflation and the nominal pricing kernel. Their model suggests that long-run inflation risk premia can explain historical yield curve structures

[18]Note that the results from this subsample analysis are to be interpreted rather as indications or correlations than clear-cut relations as the subsample size is now relatively small.

and the term structure of yield volatilities. As a simple monetary policy rule, the authors propose a linear combination of growth, inflation and some monetary policy shock as main determinants of the risk-free rate.

Thus, it is interesting to test whether a link with such a relatively parsimonious and intuitive monetary policy rule is already helpful for finding empirical support for the interdependence of changes in monetary policy variables with the changing patterns in macroeconomic uncertainty and asset prices during the last decades. If this is the case, the insights would encourage to dig deeper with future research into this direction. In addition, the impact of asset prices which are proxied by house prices is considered in order to investigate whether despite a substantial asset price inflation during times of low money inflation, the FED did not act on the potential market overheating in house and stock prices and kept interest rates low.[19] Figure 5 plots the time series of the house price index that is used in Robert Shiller's book "Irrational Exuberance". House prices experienced a historical run-up during those periods where money inflation and interest rates were low, growth rates persistently increased and the economy levered up. The sharp drop in prices once the overheated markets started to enter a sudden ice age is also obvious.

INSERT FIGURE 5 ABOUT HERE

Why could it be relevant for a central bank to consider the change in house prices in addition to the change in money prices and add asset prices to the Taylor rule? Over the sample period, eight out of ten periods of recessions were predicted by persistent and significant downturns in housing markets. In addition to that, housing market strengths predicted economic boom times during the last decades. Consistent with this relation of hot high housing markets coinciding with economic peaks and housing market ice ages at times when the economy is particularly weak, the unconditional correlations between consumption growth and house price changes are negative and positive respectively. Figure 6 plots 5-year rolling unconditional correlations between consumption growth and changes in the house price index. Times of weak economic conditions coincide with sharply increasing and high positive correlations while times of strong economic conditions come along with sharply decreasing and very low valued correlations.[20]

INSERT FIGURE 6 ABOUT HERE

[19]Usually housing investments are highly levered which implies that housing markets are very sensitive to changes in interest rates even if rental markets are strong.

[20]See also Leamer (2007) for an extensive discussion of the relevance of housing markets for the business cycle and why monetary authorities should also consider housing markets in their policy.

In order to investigate the impact of changes in monetary policy variables, the last part of the empirical study runs regressions for simple monetary policy rules for the full sample as well as for the subsamples that use the 3-months risk free rate as dependent variable and lagged consumption growth and inflation as regressors.[21] To investigate whether asset price inflation at least partly explains the variation in the monetary policy variable it is also added. For robustness, further relations with the second moments of inflation and consumption growth are also considered. Table 8 reports the results.

INSERT TABLE 8 ABOUT HERE

The results for the full sample highlight the strong relationship between inflation, inflation volatility and short rates. However, during the period of low inflation, the regression results become insignificant. This supports the view that during the period of low inflation and low macroeconomic uncertainty, monetary policy had no significant reason to act on its main target variable. However, as the second regression in Table 8 reveals, monetary policy variables did not significantly change in times of low macroeconomic uncertainty but increasing asset price inflation. This is reflected in the result that the variation in price-earnings ratios is insignificant for the variation of future risk-free rates in the second subsample. The results for the bivariate regression of the risk-free rate on both macroeconomic risk proxies lend support to a FED-policy similar to Gallmeyer et al. (2007) for the full sample, however, it also becomes clear that the rule finds less support during the second subsample where the FED became relatively loose in its policy. This emphasizes also that it is important to account for different regimes of the economy and the targets of monetary policy.[22] The last regression corroborates the above interpretations and emphasizes that the variation in asset price inflation was not a significant determinant of changes in the monetary policy variable. This supports the view that the FED did not act in the exploding asset prices such that the favorable conditions for further increasing leverage persisted. Plotting the fitted value of regressing the risk-free rate on consumption growth and money inflation against the realized time series in Figure 7 corroborates this view as the time series is relatively well fitted through this simple regression and adding house price changes would not improve the fit.

INSERT FIGURE 7 ABOUT HERE

[21] As risk-free rate, the Fama-Bliss treasury file as provided by CRSP is used. Using short and longer maturity treasury bills does not substantially change the results. FED-fundrates and treasury bills are unconditionally correlated at more than 99%. In addition, using US GDP growth or industrial production growth instead of consumption growth does not significantly change the results. All variables are at a quarterly basis.

[22] Intuitively, it is also insightful to test the same rule with yields instead of short-rates, following the notion that usually nominal yields are decomposed into their real part and inflation (uncertainty) components. In unreported regressions, similar results as for the short rates are found.

As a further test of the role of the change in monetary policy variables, the endogenous inflation process as proposed by Gallmeyer et al. (2007) is tested in different sets of regressions. The results are reported in Table 9.

INSERT TABLE 9 ABOUT HERE

The results corroborate the strong link between the variation in the risk-free rate and the variation in inflation. Including inflation volatility, which also loads strongly on inflation and on the risk-free rate, does not drive out this effect. The results from the multivariate regressions corroborate the endogenous inflation process similar to Gallmeyer et al. (2007) and thus a link between changes in monetary policy variables and macroeconomic uncertainty.

To sum up and interpret the indications from this section: Due to the supply shock induced money inflation in the 1970s and early 1980s, the FED changed its policy. The new FED-policy agitated vividly against inflation and made heavy use of interest rate governance, which importantly contributed to diminishing the macroeconomic volatility. In addition, growth rates persistently increased. Eventually the sharp decrease in macroeconomic uncertainty coupled with persistently increasing growth rates resulted in a steady state shift of asset valuation ratios. The money inflation oriented FED-policy did effectively keep money inflation at a low level but did not react strongly to the asset price inflation in increasingly levered markets. Accordingly, inflation, stock market valuations and macroeconomic volatility predict at a highly significant level future short rates during the time period before 1990 but this link becomes very weak during the 1990s. In addition, house price variation does not help to explain changes in the monetary policy variable, suggesting that asset prices were not relevant for the FED's policy. Finally, the "Great Contraction" and the coinciding increasing macroeconomic uncertainty in a delevering economy was not successfully stimulated by changes in monetary policy variables. Greater macroeconomic stability implied a mean-preserving reduction in volatility which decreased the likelihood of a crisis. However, it also implied an increased impact of a crisis once it inevitably occurs. The results corroborate the view that due to time-variation and shifts in the macroeconomic conditions, it is important to account for both, inflation volatility and consumption growth volatility as macroeconomic risk channel and that it is important to account for changes in their time-variation during different states of the economy, once asset prices, macroeconomic uncertainty and their codependencies should be explained over time. In addition, modifying the Taylor rule by including house price changes is advocated here to improve measures of monetary policy in mitigating exaggerations and depressions in the economy.

6 Conclusion

This study documents the important role of time-varying inflation volatility as a macroeconomic risk factor. Consumption growth volatility, which is employed as macroeconomic risk proxy in the previous literature, is driven out during long periods of time by inflation volatility as a macroeconomic uncertainty proxy that sharply predicts and is predicted by asset valuations. Roughly 50% of the variation in asset valuations is explained by the variation in macroeconomic uncertainty, and most of this variation is attributed to the variation in the inflation uncertainty proxy.

The paper also provides clear evidence that macroeconomic risk affects asset valuations only if the level of time variation is sufficiently high, no matter which macro risk proxy is used. Heteroscedasticity of inflation and consumption, resulting in strong fluctuations of their second moments, are a key ingredient for time variation in investors' expected returns and as a consequence in asset valuations.

The evidence highlights that not only time variation per se but also different states of the macroeconomy play a role for the predictive relations between macroeconomic risk channels and asset valuation ratios. During times of "good" economic states (e.g. positive demand shocks) with low uncertainty about future economic fundamentals, asset markets require a smaller risk premium than during times of "bad" economic states (e.g. a supply shock driven macroeconomy) with high levels and heavy fluctuations in the macroeconomic uncertainty proxies. This contributes to explaining asset valuation puzzles with a change in the time variation and the magnitudes of macroeconomic risk such as the run-up of asset valuation ratios in the late 20^{th} century, subsequent to the empirically documented "Great Moderation" of macroeconomic risk since the early 1980s.

The results lend support to the suggestion that the "Great Moderation" of macroeconomic volatility in the US, subsequent to times of a "Great Money Inflation", is closely correlated with an inflation-targeting FED-policy. As a result, a permanent shift in expected returns became relevant. In addition, growth rates persistently increased. While the money inflation oriented FED-policy kept money inflation risk low, it did not strongly affect the demand shock driven "Great Asset Price Inflation" in an increasingly levered economy in the 1990s. Asset valuations started to gradually decrease since the early 2000s, coinciding with a persistent increase in macroeconomic uncertainty and asset prices. Heavy adverse demand shocks due to the delevering financial system during the subprime crisis came along with a boost in macroeconomic uncertainty while a complete down-cut of interest rates did not have a remarkable effect that would have mitigated the "Great Contraction".

In sum, the central contribution of the paper is to highlight the relevance of the time-variation in uncertainty about both, future inflation and consumption, for asset valuations. Moreover, drawing on the well-known present-value relations, time variation in macroeconomic uncertainty, different macroeconomic states and changes in monetary policy variables in a long-run risk framework, the paper contributes to the present literature as it can help to rationally explain shifts in asset valuations in a changing macroeconomic environment, subject to the changing effects of monetary policy variables.

Investigating the findings with regard to potential consequences for and the interdependencies with monetary policy variables is subject to ongoing research. In particular it is also interesting to incorporate matters of the impact of liquidity on the macroeconomy.

As a natural extension and a further test of robustness, the empirical study could also consider data from international markets such as the UK, Sweden, Denmark, Germany or Japan that went through partly different macroeconomic regimes and were subject to other monetary policy regimes.

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Appendix A Data in Detail

If not indicated differently, quarterly data in a sample period ranging from 1953:Q1 – 2009:Q4 is used.[23]

- Quarterly inflation proxy inf: Deflator of non-durables consumption and services. Source: NIPA Tables 2.3.3 and 2.3.4 lines 2 and 13. The deflator is computed as for instance described in Piazzesi and Schneider (2006) Appendix C which is available online.

- $infdisp$, $cdisp$: Survey of Professional Forecasters' annual projections for the current year individual inflation and consumption forecasts: As provided by Federal Reserve Bank of Philadelphia. Note, data for this survey is available only as of 1981:Q3 so the variables cannot be applied to the whole sample. For the regressions the dispersions –measured as the log of the standard deviation of the individual forecasts in a quarter – of the individual forecasts as an alternative measures of economic uncertainty is used.

- Quarterly consumption proxy C: Consumption of non-durables and services (in billions of dollars). Source: NIPA Tables 2.3.3 and 2.3.4 lines 2 and 13. The consumption growth g_c is computed as in Piazzesi and Schneider (2006) Appendix C.

- P_{indx}: Monthly stock price index on NYSE/AMEX. For each month, the price index is calculated as $P_{indx,t} = (VWRETX_t + 1) \cdot P_{indx,t-1}$ (where t is in months). The price index for a quarter is the price index for the last month of the quarter. $VWRETX$ is the value weighted return on NYSE/AMEX excluding dividends, Source: CRSP.

- D_{indx}: Monthly dividend index on NYSE/AMEX. The dividend for each month t is calculated as $D_{inx,j} = \left(\frac{1+VWRETD_t}{1+VWRETX_t} - 1\right) \cdot P_{indx,t}$, where $VWRETD$ and $VWRETX$ are, correspondingly, the value weighted return in the NYSE/AMEX including and excluding dividends. Source: CRSP.

- $\bar{D}_{indx,t} = \frac{1}{4}\sum_{t=0}^{3} D_{indx,t-j}$, where t is in quarters. This means that after constructing quarterly levels of dividends by summing the level of dividends D_{indx} within a quarter a trailing four quarter average of the quarterly dividends is employed to construct the deseasonalized quarterly dividend series $\bar{D}_{indx,t}$. As the first quarterly dividend series which is obtained for the sample of this study is in 1953:Q1 this means that data starting in 1952:Q2 is used in order to construct this index. These series are converted to real by the personal consumption deflator yielding $D_t = \frac{\bar{D}_{indx,t}}{P_{c},t}$. Log growth rates are constructed by taking the log first difference of the quarterly deseasonalized series, yielding: $g_{D,t} = \log\left(\frac{D_t}{D_{t-1}}\right)$. This method is consistent with Heaton (1993) or Hodrick (1992) and used as dividend filter in several works that use the same index data as it is used here.

- Price-earnings ratio pe: Data for the price-earnings ratio is taken from Robert Shiller's web site: http://aida.econ.yale.edu/ shiller/data.htm

[23]The sample period is shortened if the available data does not cover the full sample length.

- Earnings growth g_e: Trailing moving average calculated as for the quarterly dividend index. Data for the price-earnings ratio is taken from Robert Shiller's web site: http://aida.econ.yale.edu/ shiller/data.htm

- R_m: Net return on NYSE/AMEX: $R_{m,t} = (D_{indx,t} + P_{indx,t}/P_{indx,t-1}) - 1$, where t is in quarters. It is also possible to obtain the series by compounding monthly value weighted returns (including dividends).

- Risk-free rate Data for the 3-months risk-free rate is taken from the Fama-Bliss monthly treasury file as provided by CRSP.

- Housing price index: From Robert J. Shiller, "Irrational Exuberance", 2nd. Edition, Princeton University Press,2005, 2009, Broadway Books 2006, online available on Robert J. Shiller's webpage.

- The variables are transformed in log-form and converted to real with the respective quarterly inflation measure.

Appendix B Model Derivation

The following model derivations are as in Hasseltoft (2009) for the case with heteroscedastic state variables.

Dynamics

The state variables of the model, consumption, inflation and dividend process are used in log-form and modeled in state-space form $z_{t+1} = [\Delta c_{t+1}, inf_{t+1}, \Delta d_{t+1}]'$. Let the vector $v_t = [v_c, v_{inf}, v_d]'$ be the time-varying part of the conditional means. The processes for the state variables are given by

$$z_{t+1} = \mu + v_t + \eta_{t+1}, \tag{5}$$

$$v_{t+1} = \beta v_t + \delta\eta_{t+1}, \tag{6}$$

$$\begin{aligned} \eta_{t+1} &\sim \mathcal{N}\ i.i.d\ (0, \Omega), \\ \mu &= [\mu_c, \mu_{inf}, \mu_d]', \\ \eta &= [\eta_c, \eta_{inf}, \eta_d]'. \end{aligned}$$

The macro shocks η_{t+1} are normally distributed with mean zero and with the conditional covariance matrix

$$\Omega_t = \begin{pmatrix} \sigma^2_{c,t} & \sigma_{c\ inf,t} & \sigma_{cd,t} \\ \sigma_{c\ inf,t} & \sigma^2_{inf,t} & \sigma_{inf\ d,t} \\ \sigma_{cd,t} & \sigma_{inf\ d,t} & \sigma^2_{d,t}. \end{pmatrix}$$

The dynamics of the variances and covariances take the form:

$$\sigma^2_{c,t+1} = \alpha_c + \phi_c(\sigma^2_{c,t} - \alpha_c) + \tau_c\epsilon_{c,t+1}, \tag{7}$$

$$\sigma^2_{inf,t+1} = \alpha_i nf + \phi_{inf}(\sigma^2_{inf,t} - \alpha_i nf) + \tau_{inf}\epsilon_{inf,t+1}, \tag{8}$$

$$\sigma^2_{d,t+1} = \alpha_d + \phi_d(\sigma^2_{d,t} - \alpha_d) + \tau_d\epsilon_{d,t+1}, \tag{9}$$

$$\sigma_{c\ inf,t+1} = \alpha_{c\ inf} + \phi_{c\ inf}(\sigma_{c\ inf,t} - \alpha_{c\ inf}) + \tau_{c\ inf}\epsilon_{c\ inf,t+1}, \tag{10}$$

$$\sigma_{cd,t+1} = \alpha_{cd} + \phi_{cd}(\sigma_{cd,t} - \alpha_{cd}) + \tau_{cd}\epsilon_{cd,t+1}, \tag{11}$$

$$\sigma_{inf\ d,t+1} = \alpha_{inf\ d} + \phi_{inf\ d}(\sigma_{inf\ d,t} - \alpha_{inf\ d}) + \tau_{inf\ d}\epsilon_{inf\ d,t+1}, \tag{12}$$

with α as the unconditional mean of each process, ϕ the shock persistence of the second moments, and τ the parameter of the volatility of the second moments.

Preferences

Agents in this economy have Epstein and Zin (1989) and Weil (1989) recursive preferences

$$U_t = \{(1-\delta)C_t^{\frac{1-\gamma}{\theta}} + \delta(E_t[U_{t+1}^{1-\gamma}])^{\frac{1}{\theta}}\}^{\frac{\theta}{1-\gamma}}, \tag{13}$$

with δ as discount factor, $\theta = \frac{1-\gamma}{1-\frac{1}{\psi}}, \gamma > 0$ is the risk aversion coefficient and $\psi \geq 0$ is the elasticity of intertemporal substitution (EIS) and is > 1.

In this economy the Euler condition according to Epstein and Zin (1989) is for any asset i with log return $r_{i,t+1}$ and $r_{c,t+1}$ the logarithmic return on the aggregate wealth portfolio:

$$E_t[exp(\theta \log\delta - \frac{\theta}{\psi}\Delta c_{t+1} + (\theta-1)r_{c,t+1} + r_{i,t+1}] = 1. \tag{14}$$

The logarithmic intertemporal marginal rate of substitution contained in the Euler equation is

$$m_{t+1} = \theta\log\delta - \frac{\theta}{\psi}\Delta c_{t+1} - (1-\theta)r_{c,t+1}. \tag{15}$$

Model Solution

Campell and Shiller (1988) show that the aggregate wealth and the aggregate market portfolio can be approximated as:

$$r_{c,t+1} = k_{c,0} + k_{c,1}pc_{t+1} - pc_t + \Delta c_{t+1}, \tag{16}$$

$$r_{m,t+1} = k_{d,0} + k_{d,1}pd_{t+1} - pd_t + \Delta d_{t+1}, \tag{17}$$

where pc and pd are the price-consumption and the price-dividend ratio and the coefficients k_c, k_d are functions of the average level of pc_t and pd_t, denoted as $\bar{pc}, \bar{pd}$. Then the coefficients can be written as

$$k_{c,1} = \frac{exp(\bar{pc})}{1+exp(\bar{pc})}, \tag{18}$$

$$k_{c,0} = \log(1+exp(\bar{pc})) - k_{c,1}\bar{pc}, \tag{19}$$

and similarly for the k_d coefficients.

Hasseltoft (2009) derives the log price-consumption and the log price-dividend ratio as linear functions of the expected values of the state variables. The price-consumption ratio takes the form:

$$pc_t = A_{c,0}+A_{c,1}v_{c,t}+A_{c,2}v_{inf,t}+A_{c,3}v_{d,t}+A_{c,4}\sigma^2_{c,t}+A_{c,5}\sigma^2_{inf,t}+A_{c,6}\sigma^2_{d,t}+A_{c,7}\sigma_{c\ inf,t}+A_{c,8}\sigma_{cd,t}+A_{c,9}\sigma_{inf\ d,t}. \tag{20}$$

The expressions and detailed derivations for the A_c-coefficients are in Appendix A.1 in Hasseltoft (2009). Note that coefficients $A_{c,4}$ and $A_{c,5}$ have a negative sign, implying that increasing consumption growth and inflation volatilities depress the log price-consumption ratio.

With the vector λ denoting the market price of risk, the real pricing kernel takes the following form:

$$m_{t+1} - E_t(m_{t+1}) = \lambda_{\eta_c}\eta_{c,t+1} + \lambda_{\eta_c}\eta_{inf,t+1}, \tag{21}$$

with

$$\begin{aligned}\lambda_{\eta_c} &= -\frac{\theta}{\psi} + (\theta - 1)(k_{c,1}A_{c,1}\delta_1 + k_{c,1}A_{c,2}\delta_3 + k_{c,1}A_{c,3}\delta_5 + 1),\\ \lambda_{\eta_{inf}} &= (\theta - 1)(k_{c,1}A_{c,a}\delta_2 + k_{c,1}A_{c,2}\delta_4).\end{aligned}$$

Defining the real pricing kernel in this way, allows for pricing the risk of shocks to both consumption growth and inflation. For instance, if $\lambda_{\eta_{inf}} > 0$ this means that investors require a positive price for taking inflation risk and thus dislike positive inflation shocks.

Similarly the price-dividend ratio is derived as:

$$pd_t = A_{d,0}+A_{d,1}v_{c,t}+A_{d,2}v_{inf,t}+A_{d,3}v_{d,t}+A_{d,4}\sigma^2_{d,t}+A_{d,5}\sigma^2_{inf,t}+A_{d,6}\sigma^2_{d,t}+A_{d,7}\sigma_{c\ inf,t}+A_{d,8}\sigma_{cd,t}+A_{d,9}\sigma_{inf\ d,t}. \tag{22}$$

For the A_d-coefficients see Appendix A.2 in Hasseltoft (2009).

The Equity Risk Premium

The equity risk premium in the economy is given by:

$$\begin{aligned}E_t(r_{m,t+1} - r_{f,t}) + 0.5Var_t(r_{m,t+1}) &= -Cov_t(m_{t+1}, r_{m,t+1})\\ &= -(AC\sigma^2_{c,t} + BC\sigma^2_{inf,t} + (AD + BC)\sigma_{c\ inf,t}\\ &+ AE\sigma_{cd,t} + BE\sigma_{inf\ d,t} + F]\\ &= -(V_c\sigma^2_{c,t} + V_{inf}\sigma^2_{\mathrm{inf},t} + C + F),\end{aligned}$$

with

$$
\begin{aligned}
A &= \lambda_{\eta_c}, \\
B &= \lambda_{\eta_{inf}}, \\
C &= k_{d,1}A_{d,1}\delta_1 + k_{d,1}A_{d,2}\delta_3 + k_{d,1}A_{d,3}\delta_5, \\
D &= k_{d,1}A_{d,1}\delta_2 + k_{d,1}A_{d,2}\delta_4, \\
E &= k_{d,1}A_{d,3}\delta_6 + 1 \\
F &= (\theta - 1)k_{c,1}k_{d,1}(A_{c,4}A_{d,4}\tau_c^2 + A_{c,5}A_{d,5}\tau_{inf}^2 + A_{c,6}A_{d,6}\tau_d^2 + A_{c,7}A_{d,7}\tau_{c\ inf}^2 A_{c,8}A_{d,8}\tau_{cd}^2 + A_{c,9}A_{d,9}\tau_{inf\ d}^2).
\end{aligned}
$$

Appendix C Further Relations between Macroeconomic Variables and Asset Valuation Ratios

From the above it is obvious that macroeconomic variables, are highly interrelated, time-varying in their (auto)correlations and differ in the strengths of their impact on asset valuations in general and over time. It may be instructive to get an idea of the direction and strengths of the relations amongst the variables that are not explicitly reported or discussed in other sections. To shed some light on these relations in a compact but still insightful way, Figure 8 provides a "map" of the "topology" of these relations. Note that for keeping the map arranged in a reasonably clear way, only those relations are provided which are not yet reported and discussed in other sections. They are also required to have significant coefficients as predictive variables in a univariate predictive two-step GMM regression. For instance, regressing earnings growth on inflation volatility does not yield significant results and thus it does not appear in the figure. The relations between the volatilities of consumption and inflation with the price-earnings ratio are also not in the figure as they are broadly discussed above. The variable towards which the arrow points is the respective regressand.

In addition, Granger causality tests are carried out in order to verify whether the regression results can be considered as hinting at a causal relation or whether the results are better to be interpreted as pure correlations. For those variables where the null is rejected that they do not Granger cause the other variable, the arrow is in bold and the sign of the regression coefficient together with the adjusted R^2 are reported. For the other predictive relations that are significant in the regressions but for which it is not possible to reject the null that the regressor does not Granger cause the regressand, the arrow is dashed and only the sign of the coefficient is reported. This should emphasize that these relations are not to be considered as potential causal relations. They are to be interpreted more cautiously as correlations only. Note that the results presented here are fully supported by corresponding VAR models. However, as the two-way simple regression approach already delivers the same results but in a more parsimonious and easily accessible way, only these results are reported here.

INSERT FIGURE 8 ABOUT HERE

The level of inflation predicts price-earnings ratios with a fairly high R^2 (roughly 30%) and highly significant t-statistics (-10.52). Similar to inflation volatility, the level of inflation is also predicted by past price-earnings ratios at a highly significant level (t-stat of roughly -6). This implies that time variation also matters for the level of inflation. This is in line with Engstedt and Pedersen (2010) who also find high predictability of future inflation by present valuation ratios. Furthermore, inflation significantly predicts the level of consumption growth while the reverse is not true. This is in line with the results from e.g. Bekaert and Engstrom (2010), Hasseltoft (2009), Piazzesi and Schneider (2006), and Pilotte (2003). It supports the view that accounting for the high codependence of consumption growth and inflation as well as the relation between the conditional volatility of inflation and asset valuation ratios, immediately leads back to positing a negative effect of inflation on consumption growth. Finally, this implies positive risk premia on asset prices and yields. It also supports the notion that including uncertainty about future inflation, once asset valuations and macroeconomic uncertainty are considered, rather than relying merely on consumption growth uncertainty, is highly relevant.

This is further supported by the finding that the level of consumption growth only allows for a cautious statement with regard to future asset valuation ratios yielding a very low R^2 and a t-stat of roughly 2. This is in line with Boguth and Kuehn (2009). Also the relation between inflation volatility and the level of consumption growth hints at time-varying inflation as relevant driver of consumption growth. These findings further support the results from the above regressions and the conclusion that time-varying uncertainty about future inflation significantly impacts asset valuations ratios. Thus, it has to be taken into account once returns in asset markets should be modeled or investigated. In addition, the results corroborate that heteroscedasticity of inflation and consumption and thus the time variation of macroeconomic uncertainty (i.e. its proxies) plays a key role to its impact in asset valuations.[24]

[24]Further and more detailed results of the relationships between all variables can be made available on request.

Appendix D Tables & Figures

Table 1: Summary Statistics

	$E(\cdot)$	$\sigma(\cdot)$	$AC(4)$	$AC(8)$	$PAC(4)$	$PAC(8)$
g_c	0.0077	0.0048	0.1214	-0.1328	-0.0800	-0.1561
inf	0.0092	0.0064	0.6203	0.4648	-0.0445	0.0054
g_e	0.0013	0.0557	-0.1530	-0.1049	0.1494	-0.0849
r_m	0.0155	0.0815	-0.0078	-0.0148	0.0012	0.0087
pe	2.8594	0.4091	0.9043	0.8183	-0.0014	0.0951

Note: This table reports summary statistics for the quarterly data. g_c and g_e denote real consumption and earnings growth. inf denotes inflation, r_m is the real market return and pe is the log price-earnings ratio respectively. $E(\cdot)$ and $\sigma(\cdot)$ denote the mean and the standard deviation, and $(P)AC(4)$, $(P)AC(8)$ are the 4 quarter and 8 quarter (partial) autocorrelation.

Table 2: Correlations

	g_c	inf	g_e	r_m	pe
g_c	1				
inf	-0.3056	1			
g_e	0.1251	0.0955	1		
r_m	0.2209	-0.1640	0.1547	1	
pe	0.1444	-0.5154	0.0811	0.0796	1

Note: This table reports correlations for the quarterly data. g_c and g_e denote real consumption and earnings growth. inf denotes inflation, r_m is the real market return and pe is the log price-earnings ratio respectively.

Table 3: Regression Results Using Volatilities from Bivariate BEKK-Estimations

Panel A: univariate regressions					
$p_t - e_t = b_0 + b_c \log \sigma^2_{c,t-1} + u_t$	b_{c2}	–	–	–	R^2
	-0.3718	–	–	–	0.2852
	(-7.89)	–	–	–	
$p_t - e_t = b_0 + b_{inf2} \log \sigma^2_{inf,t-1} + u_t$	b_{inf2}	–	–	–	R^2
	-0.2845	–	–	–	0.4829
	(-12.73)	–	–	–	
Panel B: multivariate regressions					
$p_t - e_t = b_0 + b_{c2} \log \sigma^2_{c,t-1} + b_{1,2} \log \sigma^2_{inf2,t-1} + u_t$	b_{c2}	b_{inf2}	–	–	R^2
	-0.107	-0.2447	–	–	0.4949
	(-2.479)	(-10.18)	–	–	
$p_t - e_t = b_0 + b_{c2} \log \sigma^2_{c,t-1} + b_{rf} r_{f,t-1} + u_t$	b_{c2}	b_{rf}	–	–	R^2
	-0.303	-0.2576	–	–	0.4826
	(-7.52)	(-8.499)	–	–	
$p_t - e_t = b_0 + b_{inf2} \log \sigma^2_{inf,t-1} + b_{rf} r_{f,t-1} + u_t$	b_{inf2}	b_{rf}	–	–	R^2
	-0.2291	-0.1421	–	–	0.5271
	(-8.096)	(-3.313)	–	–	
$p_t - e_t = b_0 + b_{c2} \log \sigma^2_{c,t-1} + b_{inf2} \log \sigma^2_{inf,t-1} + b_c g_{c,t-1} + u_t$	b_{c2}	b_{inf2}	b_c	–	R^2
	-0.1071	-0.2473	-2.218	–	0.4932
	(-2.483)	(-10.22)	(-0.505)	–	
$p_t - e_t = b_0 + b_{c2} \log \sigma^2_{c,t-1} + b_{inf2} \log \sigma^2_{inf,t-1} + b_{inf} inf_{t-1} + u_t$	b_{c2}	b_{inf2}	b_{inf}	–	R^2
	-0.1219	-0.1869	-11.58	–	0.5108
	(-2.899)	(-5.68)	(-2.701)	–	
$p_t - e_t = b_0 + b_{c2} \log \sigma^2_{c,t-1} + b_{inf2} \log \sigma^2_{inf,t-1} + b_{rf} r_{f,t-1} + u_t$	b_{c2}	b_{inf2}	b_{rf}	–	R^2
	-0.1493	-0.1654	-0.1631	–	0.5518
	(-3.399)	(-4.968)	(-3.891)	–	
$p_t - e_t = b_0 + b_{c2} \log \sigma^2_{c,t-1} + b_{inf2} \log \sigma^2_{inf,t-1} + b_c g_{c,t-1} + b_{rf} r_{f,t-1} + u_t$	b_{c2}	b_{inf2}	b_c	b_{rf}	R^2
	-0.1493	-0.1652	-0.1132	-0.1631	0.5498
	(-3.393)	(-4.977)	(0.02707)	(-3.988)	
$p_t - e_t = b_0 + b_{c2} \log \sigma^2_{c,t-1} + b_{inf2} \log \sigma^2_{inf,t-1} + b_{inf} inf_{t-1} + b_{rf} r_{f,t-1} + u_t$	b_{c2}	b_{inf2}	b_{inf}	b_{rf}	R^2
	-0.1516	-0.1576	-2.395	-0.1544	0.5504
	(-3.386)	(-4.619)	(-0.5602)	(-3.274)	
Panel C: predicting second moments					
$\log \sigma^2_{c,t} = b_0 + b_1(p_{t-1} - e_{t-1}) + u_t$	b_1	–	–	–	R^2
	-0.7261	–	–	–	0.2507
	(-6.887)	–	–	–	
$\log \sigma^2_{inf,t} = b_0 + b_1(p_{t-1} - e_{t-1}) + u_t$	b_1	–	–	–	R^2
	-1.609	–	–	–	0.4303
	(-8.329)	–	–	–	

Note: This table reports the results for two-step GMM regressions as specified in equations $Y_t = b_0 + b_1 X_{t-1} + u_t$ (Panels A, B) and $\log \sigma^2_t = \alpha_0 + \alpha_1 X_{t-1} + u_t$ (Panel C) using quarterly data of consumption growth and inflation. The regression coefficients are b_{inf} for inflation, b_c for consumption growth, b_{rf} for the Fama-Bliss 3-month risk-free rate, b_{inf2} for inflation volatility and b_{c2} for consumption growth volatility. Volatilities are estimated in using a bivariate BEKK-model. In addition, adjusted R^2s and (in parentheses) robust t-statistics are reported.

Table 4: Regression Results Using Inflation and Consumption Forecast Dispersion as Proxy for Macroeconomic Uncertainty

Panel A: univariate regressions			
$p_t - e_t = b_0 + b_{inf}\ infdisp_{t-1} + u_t$	b_{inf}	–	R^2
	-0.3584	–	0.2620
	(-5.349)	–	
$p_t - e_t = b_0 + b_c\ cdisp_{t-1} + u_t$	b_c	–	R^2
	-14.83	–	0.07142
	(-2.807)	–	
Panel B: multivariate regressions			
$p_t - e_t = b_0 + b_{c2} \log \sigma^2_{c,t-1} + b_{inf}\ infdisp_{t-1} + u_t$	b_{c2}	b_{inf}	R^2
	-0.3026	-0.2517	0.3569
	(-3.716)	(-4.531)	
$p_t - e_t = b_0 + b_{inf}\ infdisp_{t-1} + b_c\ cdisp_{t-1} + u_t$	b_{inf}	b_c	R^2
	-0.3419	-8.375	0.2709
	(-5.203)	(-1.525)	
$p_t - e_t = b_0 + b_{inf2} \log \sigma^2_{inf,t-1} + b_c\ cdisp_{t-1} + u_t$	b_{inf2}	b_c	R^2
	-0.3448	-13.23	0.3634
	(-5.379)	(-2.615)	
Panel C: predicting uncertainty			
	b_1	–	R^2
$infdisp_t = b_0 + b_1(p_t - e_t) + u_t$	-0.6249	–	0.1913
	(-4.58)	–	
	b_1	–	R^2
$cdisp_t = b_0 + b_1(p_t - e_t) + u_t$	-0.003813	–	0.05808
	(-2.824)	–	

Note: This table reports the results for two-step GMM regressions as specified in equations $Y_t = b_0 + b_1 X_{t-1} + u_t$ (Panels A, B) and $\log \sigma^2_t = \alpha_0 + \alpha_1 X_{t-1} + u_t$ (Panel C). The consumption growth volatility is estimated using a bivariate BEKK-model. b_{disp} denotes the regression coefficient for inflation forecast dispersion $infdisp$, b_c for consumption forecast dispersion $cdisp$ and b_{c2} for consumption growth volatility estimates. In addition, adjusted R^2 and (in parentheses) robust t-statistics are reported.

Table 5: Asset Valuation Ratios, Macroeconomic Uncertainty and NBER Recessions

	b_{c2}	b_{NBER}	R^2	
$p_t - e_t = b_0 + b_{c2} \log \sigma^2_{c,t-1} + b_{NBER}\ dummy_{NBER} + u_t$	-0.3492	-0.095	0.2868	
	(-7.159)	(-1.325)		
	b_{inf2}	b_{NBER}	R^2	
$p_t - e_t = b_0 + b_{inf2} \log \sigma^2_{inf,t-1} + b_{NBER}\ dummy_{NBER} + u_t$	-0.2785	-0.04608	0.4826	
	(-12.34)	(-0.6899)		
	b_{c2}	b_{inf2}	b_{NBER}	R^2
$p_t - e_t = b_0 + b_{c2} \log \sigma^2_{c,t-1} + b_{inf} \log \sigma^2_{inf,t-1} + b_{NBER}\ dummy_{NBER} + u_t$	-0.1032	-0.243	-0.02332	0.4931
	(-2.531)	(-9.764)	(-0.3608)	

Note: This table reports the results for two-step GMM regressions $Y_t = b_0 + b_1 X_{t-1} + u_t$ with two regressors for price-earnings ratios using quarterly data of consumption growth and inflation as well as a dummy variable that is equal to 1 during NBER recession periods and 0 otherwise. b_{inf2} denotes the regression coefficient for inflation, b_{NBER} for the recession dummy and b_{c2} for consumption growth. In addition, adjusted R^2s and in parentheses robust t-statistics are reported. The volatilities are estimated in a bivariate BEKK-model.

Table 6: Structural Break Subsample Regression Results with Two Subsamples

Panel A: univariate regressions				
$p_t - e_t = b_0 + b_{c2} \log \sigma^2_{c,t-1} + u_t$	b_{c2}	–	–	R^2
(1953:Q1 – 1989:Q4)	-0.2042	–	–	0.125
	(-4.261)	–	–	
(1990:Q1 – 2009:Q4)	-0.3391	–	–	0.3334
	(-7.99)	–	–	
$p_t - e_t = b_0 + b_{inf2} \log \sigma^2_{inf,t-1} + u_t$	b_{inf2}	–	–	R^2
(1953:Q1 – 1989:Q4)	-0.2218	–	–	0.5132
	(-11.63)	–	–	
(1990:Q1 – 2009:Q4)	-0.2127	–	–	0.2452
	(-5.161)			
$p_t - e_t = b_0 + b_c g_{c,t-1} + u_t$	b_c	–	–	R^2
(1953:Q1 – 1989:Q4)	21.33	–	–	0.1001
	(4.089)	–	–	
(1990:Q1 – 2009:Q4)	37.35	–	–	0.281
	(4.901)			
$p_t - e_t = b_0 + b_{inf} inf_{t-1} + u_t$	b_{inf}	–	–	R^2
(1953:Q1 – 1989:Q4)	-29.66	–	–	0.407
	(-9.875)	–	–	
(1990:Q1 – 2009:Q4)	-3.807	–	–	-0.009551
	(-0.2636)			
Panel B: multivariate regressions				
$p_t - e_t = b_0 + b_{c2} \log \sigma^2_{c,t-1} + b_{inf2} \log \sigma^2_{inf,t-1} + u_t$	b_{c2}	b_{inf2}	–	R^2
(1953:Q1 – 1989:Q4)	0.05222	-0.2387	–	0.5148
	(1.404)	(-12.21)	–	
(1990:Q1 – 2009:Q4)	-0.2782	-0.0893	–	0.3847
	(-5.064)	(-1.72)	–	
$p_t - e_t = b_0 + b_{c2} \log \sigma^2_{c,t-1} + b_{inf2} \log \sigma^2_{inf,t-1} + b_c g_{c,t-1} + u_t$	b_{c2}	b_{inf2}	b_c	R^2
(1953:Q1 – 1989:Q4)	0.05715	-0.2294	7.445	0.5251
	(1.539)	(-11.87)	(1.952)	
(1990:Q1 – 2009:Q4)	-0.2061	-0.06811	20.33	0.4255
	(-3.212)	(-1.133)	(2.488)	
$p_t - e_t = b_0 + b_{c2} \log \sigma^2_{c,t-1} + b_{inf2} \log \sigma^2_{inf,t-1} + b_{inf} inf_{t-1} + u_t$	b_{c2}	b_{inf2}	b_{inf}	R^2
(1953:Q1 – 1989:Q4)	0.04122	-0.1865	-9.561	0.5309
	(1.065)	(-5.505)	(-2.081)	
(1990:Q1 – 2009:Q4)	-0.28	-0.1005	-10.97	0.3886
	(-4.904)	(-2.187)	(-1.582)	
$p_t - e_t = b_0 + b_{c2} \log \sigma^2_{c,t-1} + b_{inf2} \log \sigma^2_{inf,t-1} + b_{rf} r_{f,t-1} + u_t$	b_{c2}	b_{inf2}	b_{rf}	R^2
(1953:Q1 – 1989:Q4)	0.6087	-0.1518	-0.1649	0.6087
	(0.3417)	(-4.921)	(-4.014)	
(1990:Q1 – 2009:Q4)	-0.2549	-0.1079	0.0006856	0.3621
	(-4.889)	(-2.023)	(0.009834)	
Panel C: predicting second moments				
$\log \sigma^2_{c,t} = b_0 + b_1(p_{t-1} - e_{t-1}) + u_t$	b_1	–	–	R^2
(1953:Q1 – 1989:Q4)	-0.578	–	–	0.09896
	(-3.181)	–	–	
(1990:Q1 – 2009:Q4)	-1.018	–	–	0.324
	(-4.386)	–	–	
$\log \sigma^2_{inf,t} = b_0 + b_1(p_{t-1} - e_{t-1}) + u_t$	b_1	–	–	R^2
(1953:Q1 – 1989:Q4)	-2.104	–	–	0.4168
	(-7.426)	–	–	
(1990:Q1 – 2009:Q4)	-1.204	–	–	0.2497
	(-3.112)	–	–	

Note: This table reports the results for two-step GMM regressions $Y_t = b_0 + b_1 X_{t-1} + u_t$ (Panels A, B) and $\log \sigma^2_t = \alpha_0 + \alpha_1 X_{t-1} + u_t$ (Panel C) for the structural-break subsamples 1953:Q1 – 1989:Q4 and 1990:Q1 – 2009:Q4 using quarterly data of consumption growth and inflation. Volatilities are estimated in using a bivariate BEKK-model. $\log \sigma^2_{inf,t}$ is the log-volatility of inflation and $\log \sigma^2_{c,t}$ the log-volatility of consumption growth. g_c denotes the level of consumption growth, inf the level of inflation and r_f the 3-months Fama-Bliss risk-free rate. The regression coefficients are b_{inf} for inflation, b_c for consumption growth, b_{rf} for the risk-free rate, b_{inf2} for inflation volatility and b_{c2} for consumption growth volatility. In addition, adjusted R^2 and (in parentheses) robust t-statistics are reported.

Table 7: Structural Break Subsample Regression Results with 3 Subsamples

Panel A: univariate regressions				
$p_t - e_t = b_0 + b_{c2} \log \sigma^2_{c,t-1} + u_t$	b_{c2}	–	–	R^2
(1953:Q1 – 1989:Q4)	-0.2042	–	–	0.125
	(-4.261)	–	–	
(1990:Q1 – 2000:Q4)	-0.3975	–	–	0.2716
	(-5.94)	–	–	
(2001:Q1 – 2009:Q4)	-0.288	–	–	0.5741
	(-5.175)	–	–	
$p_t - e_t = b_0 + b_{inf2} \log \sigma^2_{inf,t-1} + u_t$	b_{inf2}	–	–	R^2
(1953:Q1 – 1989:Q4)	-0.2218	–	–	0.5132
	(-11.63)	–	–	
(1990:Q1 – 2000:Q4)	-0.2963	–	–	0.2147
	(-5.221)			
(2001:Q1 – 2009:Q4)	-0.1669	–	–	0.3937
	(-5.702)	–	–	
$p_t - e_t = b_0 + b_{rf} r_{f,t-1} + u_t$	b_{rf}	–	–	R^2
(1953:Q1 – 1989:Q4)	-0.2822	–	–	0.4547
	(-9.918)	–	–	
(1990:Q1 – 2000:Q4)	0.3942	–	–	0.07839
	(1.868)			
(2001:Q1 – 2009:Q4)	0.2929	–	–	0.3954
	(3.56)	–	–	
Panel B: multivariate regression				
$p_t - e_t = b_0 + b_{c2} \log \sigma^2_{c,t-1} + b_{inf2} \log \sigma^2_{inf,t-1} + u_t$	b_{c2}	b_{inf2}	–	R^2
(1953:Q1 – 1989:Q4)	0.05222	-0.2387	–	0.5148
	(1.404)	(-12.21)	–	
(1990:Q1 – 2000:Q4)	-0.3011	-0.1925	–	0.3391
	(-3.266)	(-2.232)	–	
(2001:Q1 – 2009:Q4)	-0.2375	-0.0486	–	0.579
	(-2.58)	(-1.009)	–	
Panel C: predicting second moments				
$\log \sigma^2_{c,t} = b_0 + b_1(p_{t-1} - e_{t-1}) + u_t$	b_1	–	–	R^2
(1953:Q1 – 1989:Q4)	-0.578	–	–	0.09896
	(-3.181)	–	–	
(1990:Q1 – 2000:Q4)	-0.7575	–	–	0.3007
	(-3.539)	–	–	
(2001:Q1 – 2009:Q4)	-1.84	–	–	0.4518
	(-4.462)	–	–	
$\log \sigma^2_{inf,t} = b_0 + b_1(p_{t-1} - e_{t-1}) + u_t$	b_1	–	–	R^2
(1953:Q1 – 1989:Q4)	-2.104	–	–	0.4168
	(-7.426)	–	–	
(1990:Q1 – 2000:Q4)	-0.6924	–	–	0.1706
	(-2.091)	–	–	
(2001:Q1 – 2009:Q4)	-2.766	–	–	0.5584
	(-5.224)	–	–	

Note: This table reports the results for two-step GMM regressions $Y_t = b_0 + b_1 X_{t-1} + u_t$ (Panels A, B) and $\log \sigma^2_t = \alpha_0 + \alpha_1 X_{t-1} + u_t$ (Panel C) for the subsamples 1953:Q1 – 1989:Q4, 1990:Q1 – 2000:Q4 and 2001:Q1 – 2009:Q4, using quarterly data of consumption growth and inflation. Volatilities are estimated in using a bivariate BEKK-model. $\log \sigma^2_{inf,t}$ is the log-volatility of inflation and $\log \sigma^2_{c,t}$ the log-volatility of consumption growth. g_c denotes the level of consumption growth and inf the level of inflation. The regression coefficients are b_{inf} for inflation, b_c for consumption growth, b_{inf2} for inflation volatility and b_{c2} for consumption growth volatility. In addition, adjusted R^2 and (in parentheses) robust t-statistics are reported.

Table 8: Monetary Policy and Asset Valuation Determinants

$r_{f,t} = b_0 + b_{inf} inf_{t-1} + u_t$	b_{inf}	–	–	–	R^2
	74.7	–	–	–	0.4279
	(8.586)	–	–	–	
(1953:Q1 – 1989:Q4)	77.43	–	–	–	0.4892
	(7.725)	–	–		
(1990:Q1 – 2009:Q4)	28.52	–	–	–	0.04507
	(1.758)	–	–		
$r_{f,t} = b_0 + b_{pe} pe_{t-1} + u_t$	b_{pe}	–	–	–	R^2
	-0.9422	–	–	–	0.2732
	(-5.563)	–	–	–	
(1953:Q1 – 1989:Q4)	-1.297	–	–	–	0.2904
	(-5.727)	–	–		
(1990:Q1 – 2009:Q4)	0.3911	–	–	–	0.0386
	(1.391)	–	–		
$r_{f,t} = b_0 + b_{inf2} \log \sigma^2_{inf,t-1} + u_t$	b_{inf2}	–	–	–	R^2
	0.3982	–	–	–	0.2922
	(5.447)	–	–	–	
(1953:Q1 – 1989:Q4)	0.4623	–	–	–	0.3907
	(6.139)	–	–		
(1990:Q1 – 2009:Q4)	-0.1467	–	–	–	0.02588
	(-1.066)	–	–		
$r_{f,t} = b_0 + b_{c2} \log \sigma^2_{c,t-1} + u_t$	b_{c2}	–	–	–	R^2
	0.2748	–	–	–	0.04418
	(1.962)	–	–	–	
(1953:Q1 – 1989:Q4)	0.3429	–	–	–	0.05851
	(2.069)	–	–		
(1990:Q1 – 2009:Q4)	-0.3927	–	–	–	0.1336
	(-2.631)	–	–		
$r_{f,t} = b_0 + b_c g_{c,t-1} + u_t$	b_c	–	–	–	R^2
	19.43	–	–	–	-0.004283
	(0.138)	–	–	–	
(1953:Q1 – 1989:Q4)	-28.44	–	–	–	0.02657
	(-1.764)	–	–		
(1990:Q1 – 2009:Q4)	51.49	–	–	–	0.1633
	(2.991)	–	–		
$r_{f,t} = b_0 + b_{c2} \log \sigma^2_{c,t-1} + b_{inf2} \log \sigma^2_{inf,t-1} + u_t$	b_{c2}	b_{inf2}	–		R^2
	-0.2617	0.4957	–	–	0.3154
	(-2.627)	(7.502)	–		
(1953:Q1 – 1989:Q4)	-0.2469	0.5426	–	–	0.4085
	(-2.023)	(8.285)	–		
(1990:Q1 – 2009:Q4)	-0.4095	0.02166	–	–	0.123
	(-2.856)	(0.1693)	–		
$r_{f,t} = b_0 + b_c g_{c,t-1} + b_{inf} inf_{t-1} + b_h g_{h,t-1} + u_t$	b_c	b_{inf}	b_h		R^2
	3.332	8.1280	-1.1470	–	0.4648
	(3.8210)	(9.8500)	(-0.3334)		
(1953:Q1 – 1989:Q4)	2.1570	8.4400	1.8380	–	0.4993
	(1.8888)	(8.909)	(0.3936)		
(1990:Q1 – 2009:Q4)	6.8550	3.1120	-5.1240	–	0.2572
	(4.2970)	(2.2320)	(-1.4830)		

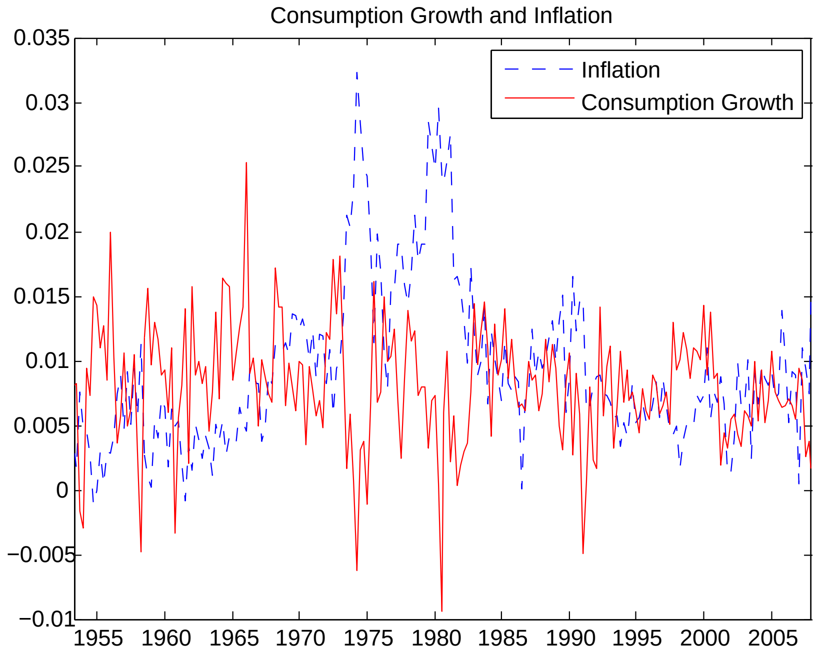
Note: This table reports the results for two-step GMM regressions $Y_t = b_0 + b_1 X_{t-1} + u_t$ as univariate (Panels A) and multivariate (Panel B) projections using the Fama-Bliss 3-months risk-free rates r_f, as regressand and inflation inf, inflation volatility $\log \sigma^2_{inf,t}$, consumption growth volatility $\log \sigma^2_{c,t}$, log price-earnings ratios pe, consumption growth g_c as well as asset price inflation proxied by house price growth g_h as the respective regressors. The regression coefficients are b_{inf} for inflation, b_c for consumption growth, b_{pe} for log price-earnings ratios, b_{inf2} for inflation volatility, b_{c2} for consumption growth volatility and b_h for house price inflation. In addition, adjusted R^2 and (in parentheses) robust t-statistics are reported.

Table 9: Inflation and Monetary Policy

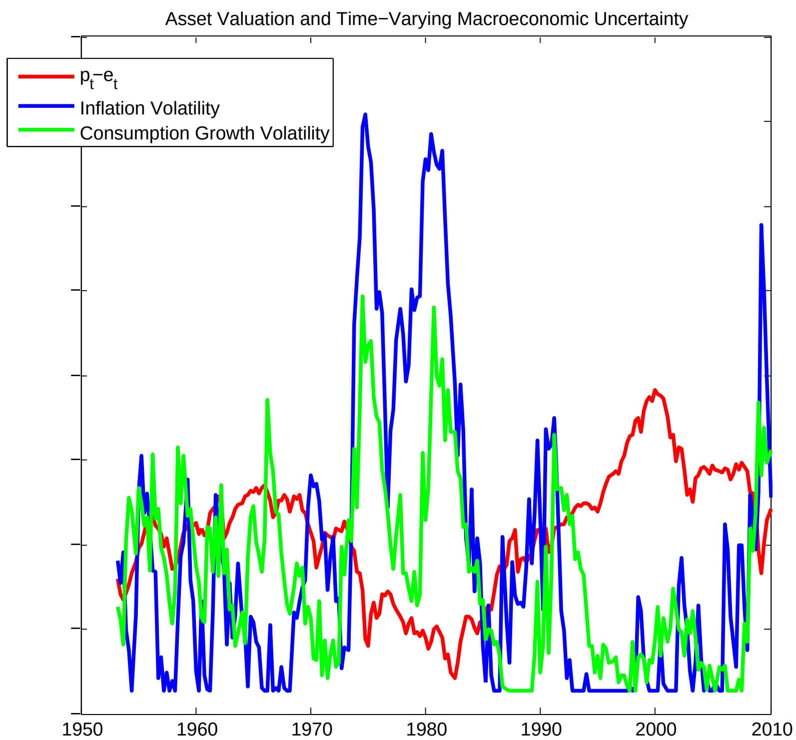
Panel A: bivariate regressions				
$inf_t = b_0 + b_{rf} r_{f,t-1} + b_c g_{c,t-1} + u_t$	b_{rf}	b_c	–	R^2
	0.00562	-0.1152	–	0.4151
	(7.91)	(-1.117)	–	
$inf_t = b_0 + b_{rf} r_{f,t-1} + b_{c2} \log \sigma^2_{c,t-1} + u_t$	b_{rf}	b_{c2}	–	R^2
	0.005377	0.001616	–	0.4287
	(7.509)	(2.100)	–	
$inf_t = b_0 + b_{rf} r_{f,t-1} + b_{inf2} \log \sigma^2_{inf,t-1} + u_t$	b_{rf}	b_{inf2}	–	R^2
	0.003592	0.002819	–	0.5467
	(4.885)	(5.772)	–	
$inf_t = b_0 + b_{c2} \log \sigma^2_{c,t-1} + b_{inf2} \log \sigma^2_{inf,t-1} + u_t$	b_{c2}	b_{inf2}	–	R^2
	-0.002532	0.005163	–	0.459
	(-3.054)	(9.235)	–	
$inf_t = b_0 + b_c g_{c,t-1} + b_{c2} \log \sigma^2_{c,t-1} + u_t$	b_c	b_{c2}	–	R^2
	-0.09499	0.002929	–	0.07455
	(-0.7179)	(3.074)	–	
Panel B: multivariate regression				
$inf_t = b_0 + b_{rf} r_{f,t-1} + b_{c2} \log \sigma^2_{c,t-1} + b_{inf2} \log \sigma^2_{inf,t-1} + u_t$	b_{rf}	b_{c2}	b_{inf2}	R^2
	0.003362	-0.001659	0.003526	0.5581
	(4.716)	(-2.339)	(6.282)	

Note: This table reports the results for two-step GMM regressions $Y_t = b_0 + b_1 X_{t-1} + u_t$ as bivariate (Panels A) and multivariate (Panel B) projections using inflation inf, as regressand and the Fama-Bliss 3-months risk-free rates r_f, consumption growth volatility $\log \sigma^2_{c,t}$ as well as consumption growth g_c as the respective regressors. The regression coefficients are b_{rf} for the risk-free rate, b_c for consumption growth and b_{c2} for consumption growth volatility. In addition, adjusted R^2 and (in parentheses) robust t-statistics are reported.

Figure 1: Inflation, Consumption Growth and their Volatilities



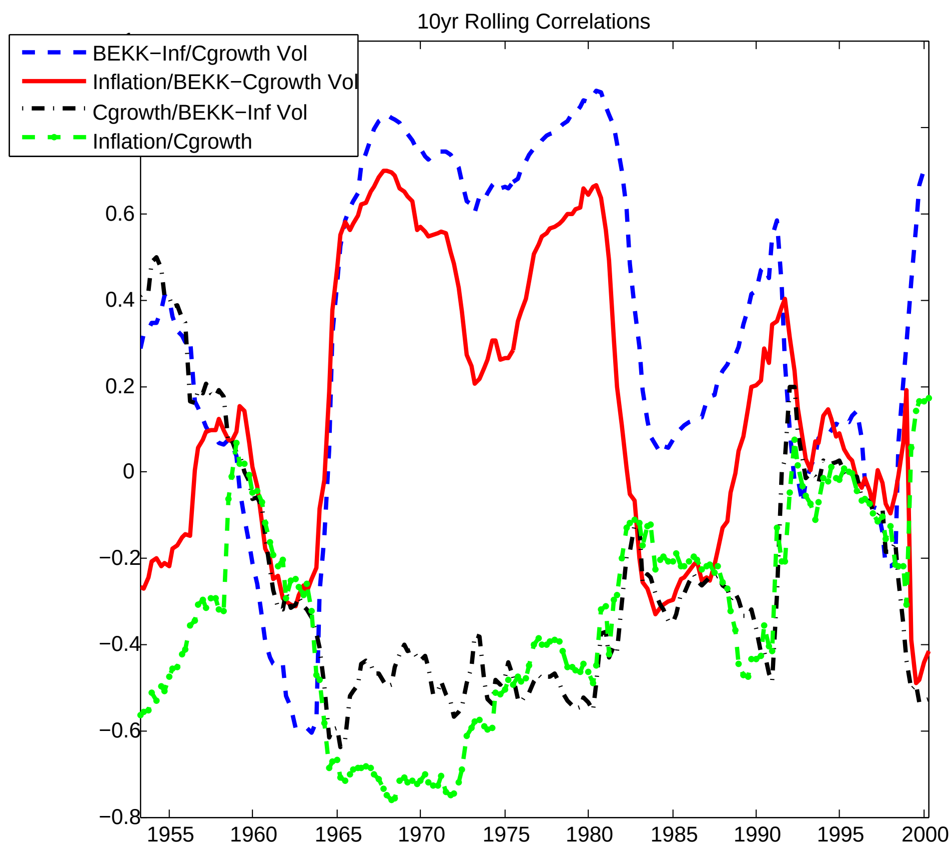
A.



B.

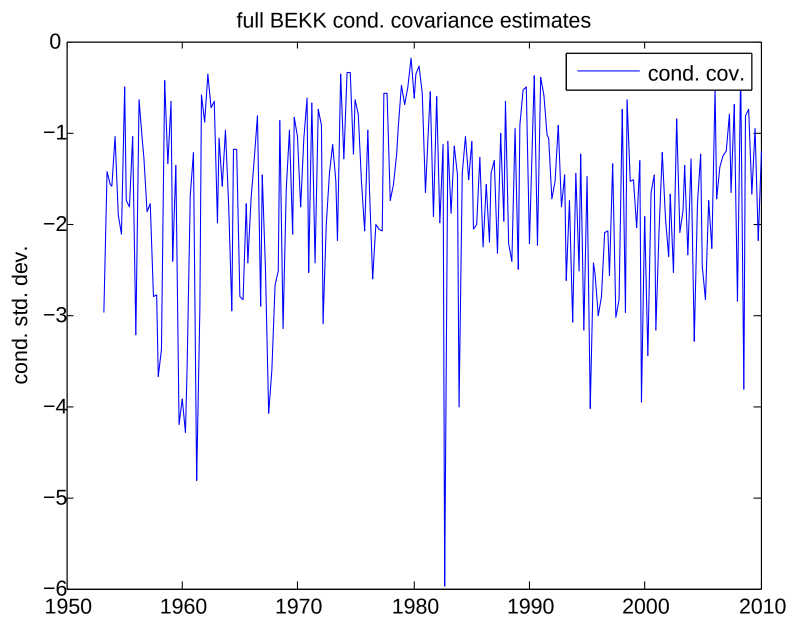
Note: Figure A plots levels of inflation and consumption growth over the whole sample period. Figure B plots the volatilities of both variables together with the log price-dividend and the log price-earnings ratio over the whole sample period. For the estimation of the volatilities a bivariate BEKK-model is used as described in Section 2.2.1. Note that there is no unit scaling provided for Panel B as the scales of the variables had to be changed in order to make the time-series comparable in such a way.

Figure 2: Historical 10-Year Rolling Correlations of Consumption Growth (Volatility) and Inflation (Volatility)



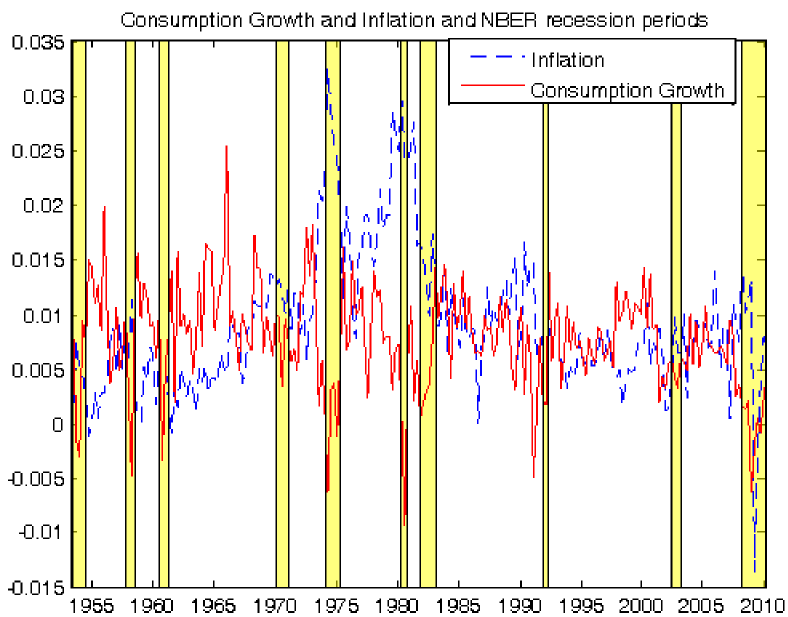
Note: In this figure the 10-year ahead correlations of (i) inflation volatility with consumption growth volatility, (ii) the level of inflation with consumption growth volatility, (iii) the level of consumption growth with inflation volatility and (iv) the level of inflation with the level of consumption growth from the sample are plotted. For the estimation of the volatilities a bivariate BEKK-model is used as described in Section 2.2.1.

Figure 3: Conditional Covariance of Consumption Growth and Inflation

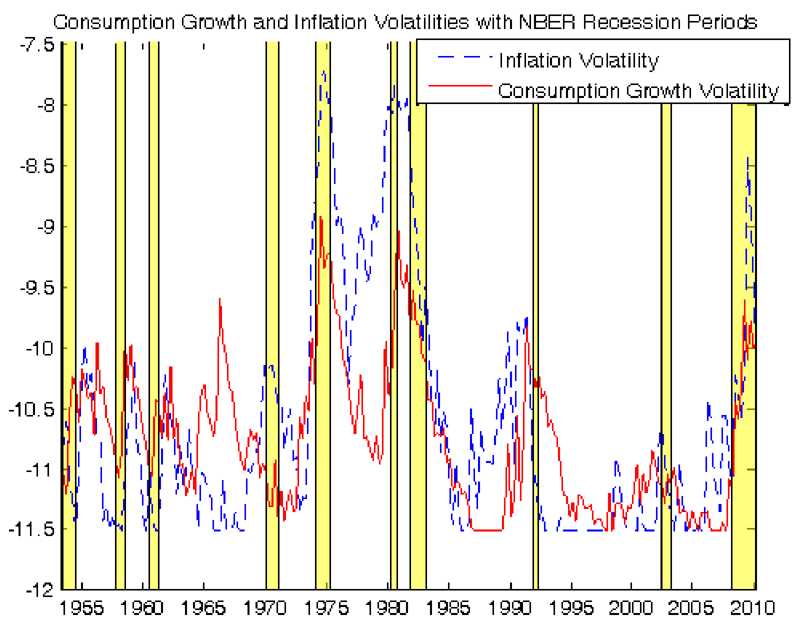


Note: The Figure plots the conditional covariance of the bivariately estimated BEKK-volatilities of consumption growth and inflation over the whole sample period.

Figure 4: Inflation, Consumption Growth, Macro Uncertainty and NBER Recession Periods



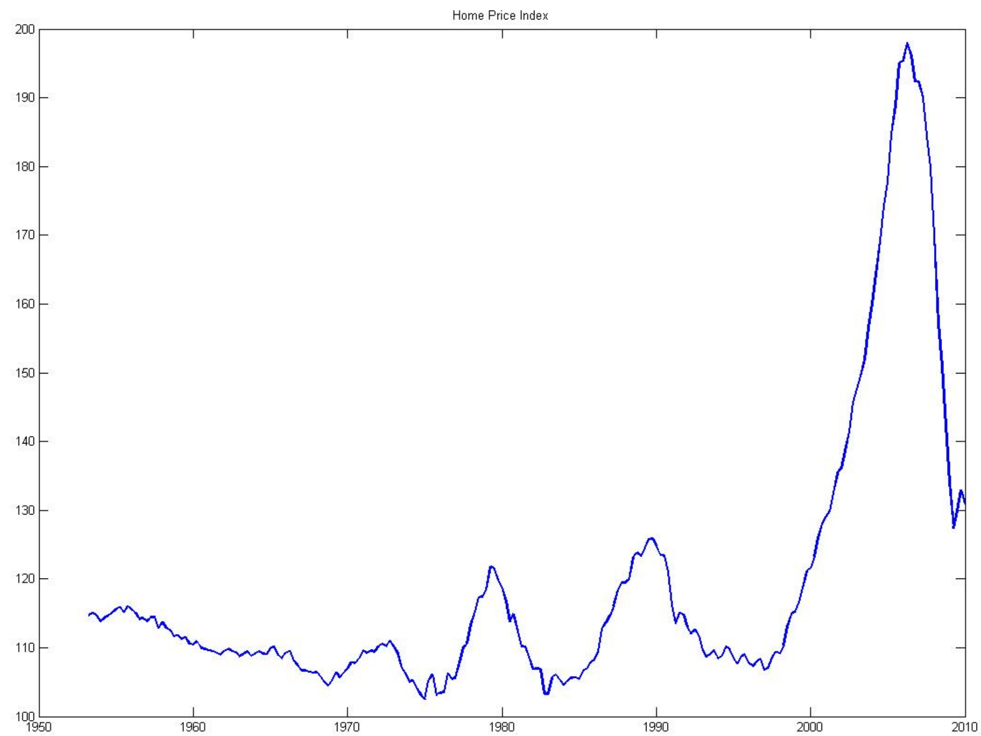
A.



B.

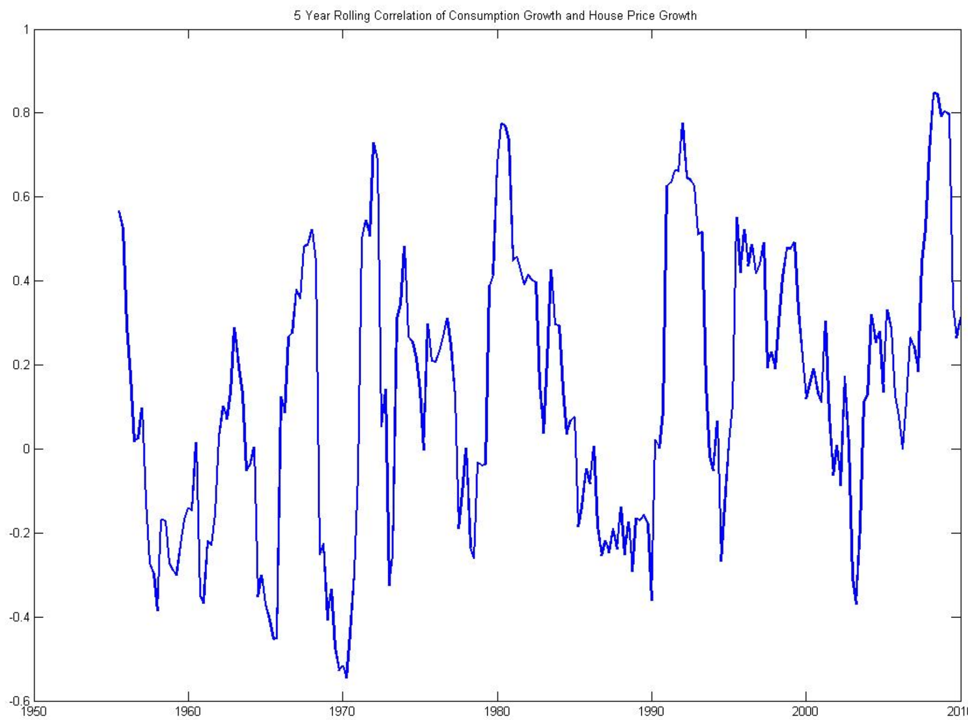
Note: Figure A plots levels of inflation and consumption growth over the whole sample period. NBER recession periods are denoted as shaded regions. On the right hand side B plots the bivariately estimated BEKK-volatilities over the whole sample period. NBER recession periods are denoted as shaded regions.

Figure 5: Robert J. Shiller's House Price Index.



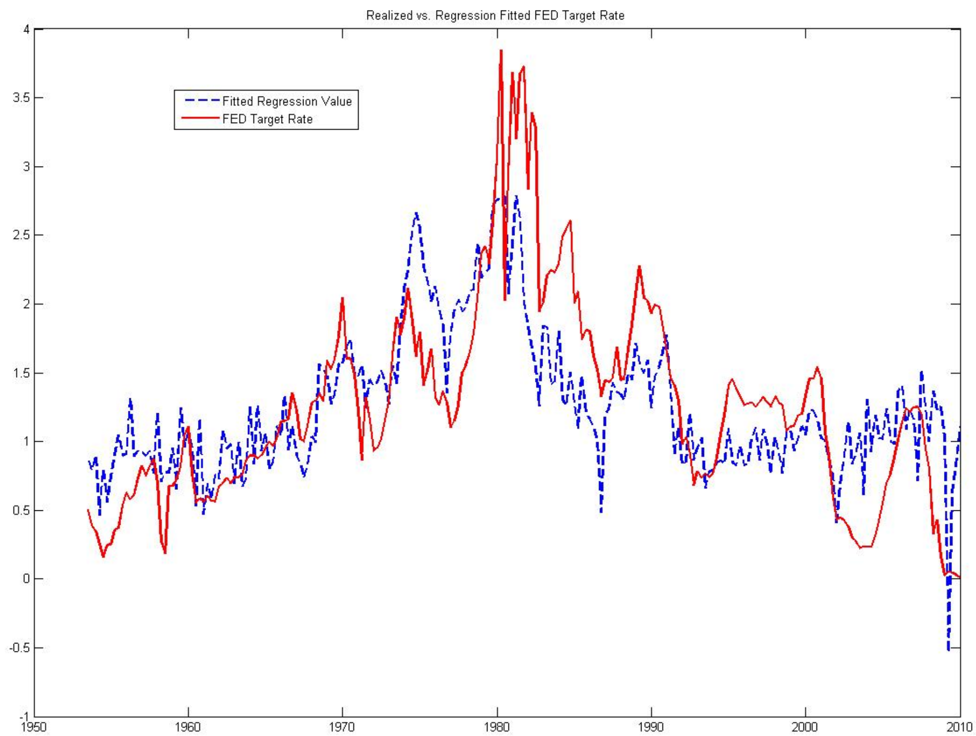
Note: This figure plots the time series of the house price index as used by Robert J. Shiller in his book 'Irrational Exuberance', 2nd. Edition, Princeton University Press, 2005, 2009, Broadway Books 2006, online available on Robert J. Shiller's webpage.

Figure 6: 5-Year Window Rolling Correlations of Consumption Growth and House Price Growth.



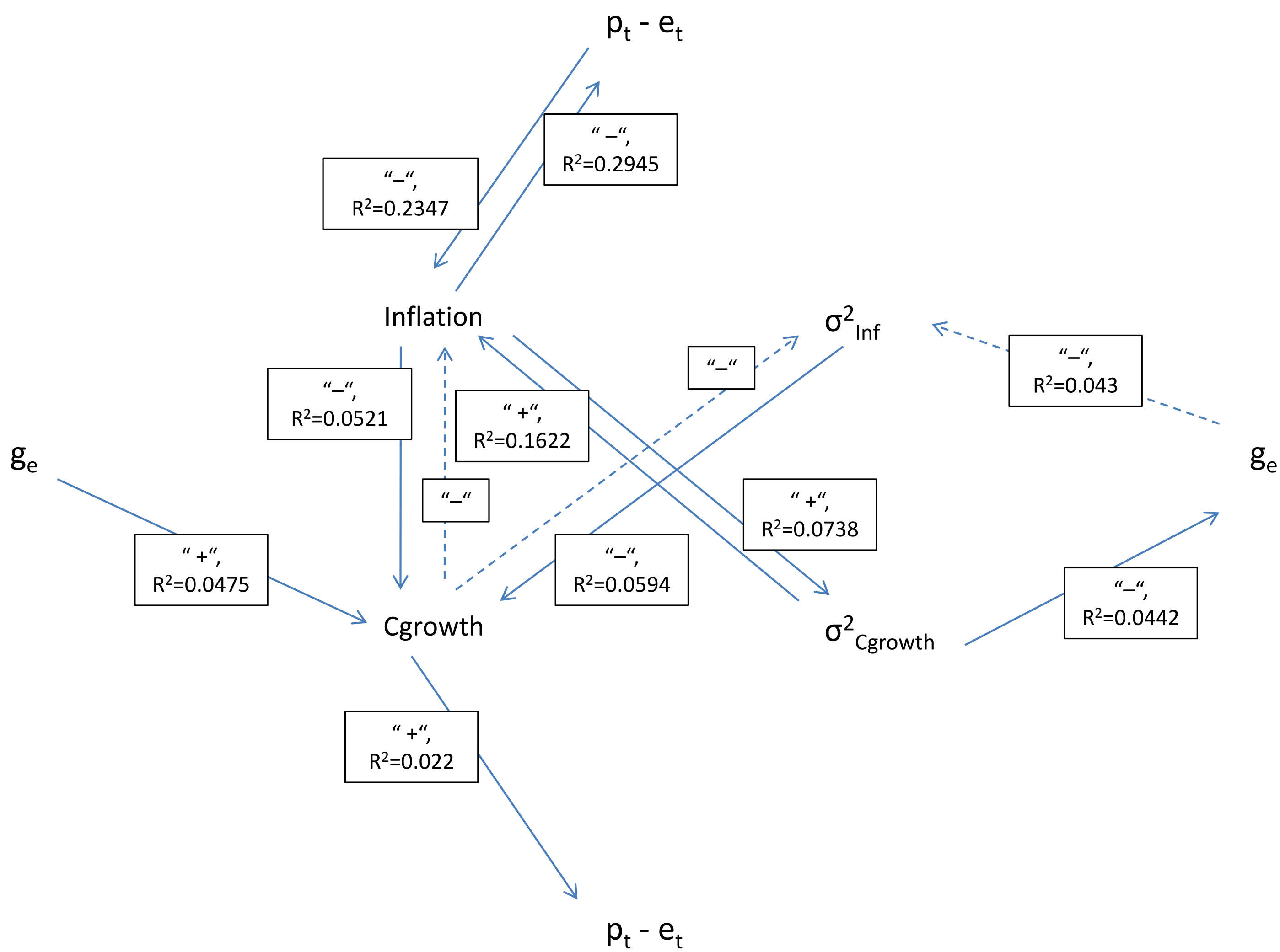
Note: This figure plots the time series of the 5-year window rolling correlation of consumption growth and as a proxy for asset price inflation house price growth.

Figure 7: Realized Values of The Risk-Free Rate vs. Fitted Values from a Regression on Consumption Growth, Money Inflation and Asset Price Inflation as reported in Table 8.



Note: This figure plots the time series of the 3-month risk-free rate from the Fama-Bliss treasury file and its fitted value from the regression model reported in Table 8 where the risk-free rate is regressed on consumption growth, (money) inflation and house price growth. The risk-free rate is a proxy for the FED target rate as its correlation with the FED fund rate is $> 98\%$ which was not available for the full sample period.

Figure 8: Further Relations between Macroeconomic Variables and Asset Valuation Ratios



Note: This figure illustrates additional predictive relations between the variables that are considered here. g_e denotes earnings growth, $Cgrowth$ the level of consumption growth, $Inflation$ the level of inflation and $p_t - e_t$ is the price-earnings ratio. σ^2_{Inf} is the inflation volatility and $\sigma^2_{Cgrowth}$ the volatility of consumption growth. The volatilities for consumption growth and inflation are estimated using a bivariate BEKK-model. Note that only those relations are shown which are not already reported and discussed in other sections and which produced significant results as predictive variables in a univariate predictive two-step GMM regression with the variable towards which the respective arrow points as regressand. In addition, Granger causality tests were carried out in order to verify whether the regression results can be considered as hints for a causal relation or whether the results are better to be interpreted as correlations. For those variables where the null is rejected that it does not Granger cause the other variable, the arrow is in bold and the sign of the regression coefficient together with the adjusted R^2 are reported. For the other predictive relations that are significant in the regressions but for which it is not possible to reject the null that the regressor does not Granger cause the regressand, the arrow is dashed and only the sign of the coefficient is reported. This should emphasize that these relations are not to be considered as potential causal relations but are to be interpreted even more cautiously as correlations only.