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Sentimental Discount Rate Shocks

Adrian Ifrim¹

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Abstract

This paper argues that the price-dividend ratio variability is explained in a large proportion by shocks affecting the subjective distribution of capital gain expectations: sentimental discount rate shocks affecting average beliefs explain at least 30% and disagreement shocks up to 20% of the variability of stock prices. The results from an estimated FAVAR model including the distribution of survey expectations show that in contrast to discount rate shocks, sentiment shocks produce a hump-shape response in the P/D ratio and introduce additional persistence into the impulse-response functions. These shocks played an essential role during the 2002 dot-com bubble by driving the boom and subsequent bust in asset prices. These results bring additional empirical evidence in favor of asset pricing models with subjective beliefs that match the survey evidence on the dynamics of expectations.

Keywords: sentiment shocks, stock prices, survey data, P/D ratio decomposition

JEL Classification: G40, G12, G14, C22

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1 Introduction

A central question in asset pricing is why do stock prices vary. The Campbell-Shiller price-dividend (P/D) ratio decomposition shows that the P/D ratio varies because of two main components: dividends and discount rates. The current paradigm is that the vast majority of the variability of stock prices can be attributed to discount rates while dividends play an insignificant role.² In this paper I bring evidence that what is usually attributed to pure discount rate shocks hides instead shocks to the subjective distribution of future capital gains. Moreover, these shocks explain around 50% of the variability of the P/D ratio.

This paper contributes to the literature on the determinants of stock price variability by incorporating the distribution of survey expectations on expected capital gains in a structural vector auto-regressive (VAR) framework. I first show that the distribution of subjective capital gain expectations can be accurately captured by two factors: average sentiment and disagreement which explain over 95% of the variance of the distribution. Using these two factors in a standard asset pricing VAR that includes the P/D ratio and dividend growth, I identify jointly four determinants of stock price variability: dividend, discount rate, disagreement, and sentiment shocks. The latter is to be understood as a shock to the agents' beliefs about future capital gains. I call this a Sentimental Discount Rate (SDR) shock for the main reason that it operates as a typical discount rate shock but with two important differences: *i*) the pattern of subsequent decrease in discount rates implied by the Campbell-Shiller decomposition is more persistent compared to a standard discount rate shock *ii*) produces a hump-shaped impulse response of the P/D ratio. The identification of the SDR is based on the findings from the literature of asset pricing with subjective beliefs and imposes that a shock to return expectations can have

²See [Cochrane \(2011\)](#)

a contemporaneous effect on prices while the reverse does not hold. I show that SDR shocks contribute between 30 and 45% to the variability of the P/D ratio for the period 1999M1-2007M11 depending on the identification method used. Disagreement shocks play an important role in driving average sentiment suggesting that there exists a strong interdependence between disagreement and average subjective beliefs. Several robustness tests reveal that the identified sentimental discount rate shocks do not confound with other more broad-based measures of sentiment or business-cycle shocks which brings additional reliability to the identification strategy used. Moreover, sentiment shocks originating in the real economy as proposed for example by [Lagerborg et al. \(2020\)](#) are orthogonal to sentiment shocks originating in the equity markets as proposed in this paper, suggesting a separation between financial and economic sources of sentiment shocks.

The literature on the determinants of asset price movements is vast. [Cochrane \(2008\)](#) shows that P/D ratio variability can be explained almost 100% by subsequent discount rate movements. Dividends vary much less compared to stock prices as famously pointed out by [Shiller \(1980\)](#) and have little explanatory power for the P/D ratio. More recently, [De la O and Myers \(2019\)](#) using analyst forecast on dividends and earnings show that short-term subjective expected dividend growth and earnings account for between 70-90% of the P/D ratio variability with subjective expectations of returns playing an insignificant part. Using the same data and a similar Campbell-Shiller decomposition, [Bordalo et al. \(2020\)](#) bring evidence that expectations about long-term growth in earnings are an important source of price level variability. In reaching this result they impose a constant discount rate but as the same authors point out, subjective expectations of returns and earnings are positively correlated which could explain part of their results. In contrast, [Adam et al. \(2017\)](#) employ a quantitative asset pricing model of subjective beliefs and argue that variation in subjective capital gain expectations can explain the

excess volatility puzzle and the predictability of returns while matching a wide variety of stylized facts about stock prices. The results from the current paper bring additional empirical evidence in this direction by showing that variation in subjective capital gain expectations is an important source of the P/D ratio variability. Consistent with these results, [Chen et al. \(2019\)](#) find that around 75% of the variability of P/D ratio cannot be accounted for by either habit or long-run risks.

This paper is also related to the literature studying the identification of sentiment shocks and their contribution to business cycle fluctuations. In a seminal paper, [Beaudry and Portier \(2006\)](#) argue that news shocks about future TFP account for around 50% of business cycle fluctuations. [Barsky and Sims \(2012\)](#) identify innovations to confidence in a VAR framework and argue based on a DSGE model that confidence shocks reflect in fact news about future productivity and animal spirits do not play a significant role in business cycle fluctuations. [Lagerborg et al. \(2020\)](#) on the other hand, identify sentiment shocks using a proxy SVAR model using as an instrument for confidence the number of mass shootings in the US. Their identified measure of sentiment is not confounded with TFP shocks and moreover, represent a significant source of economic variability. Compared with these studies which aim at identifying sentiment shocks affecting broad economic activity, this paper focuses on sentiment shocks originating in the equity market. As mentioned above, these two sources of sentiment, originating in the broad economy vs equity markets, are not only different but appear to be almost orthogonal.

The nature of the drivers of stock price fluctuations has important implications for monetary and fiscal policy design. Several recent studies have pointed out that under imperfect information, models in which agents hold subjective beliefs about stock prices have real implications on the equilibrium dynamics of the economy. On the monetary front, [Winkler \(2020\)](#) studies the financial accelerator mechanism from [Bernanke et al. \(1999\)](#) under imperfect information in which stock prices affect the real economy through

the supply side of the economy by affecting the financial position of firms. The paper concludes that imperfect information increases macroeconomic volatility and that central banks can promote macroeconomic stabilization by responding explicitly to stock prices. Similarly, [Ifrim \(2021\)](#) shows that imperfect information gives rise to a new channel through which stock prices influence the real economy: belief-driven stock price wealth effects. Taking into account this mechanism in a quantitative model with subjective beliefs shows that monetary policy can increase welfare by responding symmetrically and transparently to stock prices. On a similar note, [Belda \(2022\)](#) brings evidence that the secular decrease in capital gain taxes has been an important driver of the rise in stock price volatility. Using a model with subjective beliefs, the author argues that increasing capital gain taxes has positive welfare benefits. In contrast to this literature, most rational expectations models suggest no policy interventions with respect to stock prices. Thus, understanding the sources of stock price fluctuations is crucial for the appropriate policy recommendation.

The rest of the paper is organized as follows. Section II describes the survey data concerning the distribution of expected capital gains and the factors driving its dynamics. Section III presents the main results regarding the contribution of (sentimental) discount rates to P/D ratio variability. Section IV explores several robustness checks and alternative identification of disagreement shocks and lastly, section V concludes.

2 Factors of Subjective Beliefs Distribution

The data describing the distribution of subjective capital gain expectations is obtained from the Gallup survey which reports investors' subjective beliefs about stock returns over the next 12 months. The series are monthly and span the period 1999M2-2007M10. I use the Gallup survey to measure subjective own portfolio return expectations due to

the large number of respondents each period (around 700) which in principle should come with more reliability in measuring the mean and the dispersion of beliefs. The other time series used are the monthly P/D ratios for the *S&P* 500 index and the dividend growth series, both obtained from Robert Shiller's database.

The statistics characterizing the distribution of beliefs are obtained in two steps. First, since the number of survey respondents is varying over time I reduce the distribution to percentiles by computing the mean at each point in time for the corresponding group. I choose 10 percentiles to obtain a balanced panel of the subjective return distribution. Figure 1 shows the evolution of different sentiment groups (percentiles).

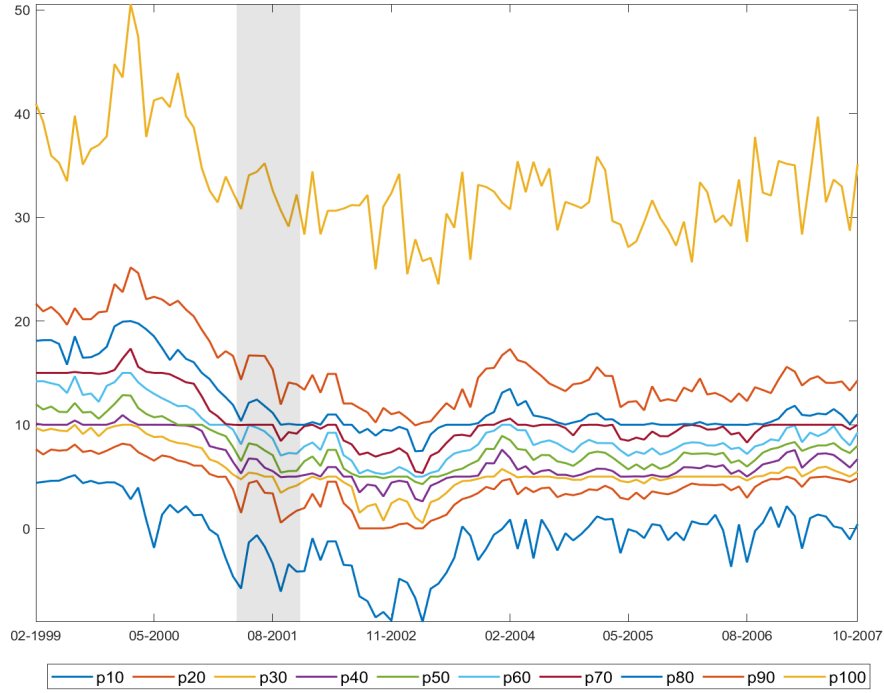


Figure 1: Distribution of Expected 1Y return, Gallup survey data on own portfolio returns 1999M2-2007M10. Each line denotes the mean for the corresponding percentile; shaded bands denote NBER recessions

In the second step, the distribution of subjective expectations on capital gains is summarized using two statistics: the mean and a disagreement index, *DI*. The former

has been widely used in the asset pricing literature to capture the average sentiment of agents. The latter is measured as the difference between the 10% most optimistic agents and the 10% most pessimistic ones. A similar statistic was used to measure disagreement on the bond market yields by [Giacoletti et al. \(2018\)](#). [Atmaz and Basak \(2018\)](#) argues that disagreement in stock market is an important determinant of stock price variability and proposes a model in which agents' beliefs can be well characterized by two sufficient statistics: the average sentiment of agents' beliefs and a measure of dispersion.

Moreover, the choice of the two statistics is not arbitrary. A principal-component (PC) analysis performed on the distribution of beliefs reveals that the first two components explain 95% of the distribution of beliefs with the first component accounting for 86% while the rest is attributed to the second. The 1st PC is highly correlated with mean beliefs ($> 99\%$) while the second with the disagreement index (correlation 91%). [Figure 2](#) shows the strong co-movement among these series by plotting the first two principal components of the subjective return distribution together with the mean and disagreement index.

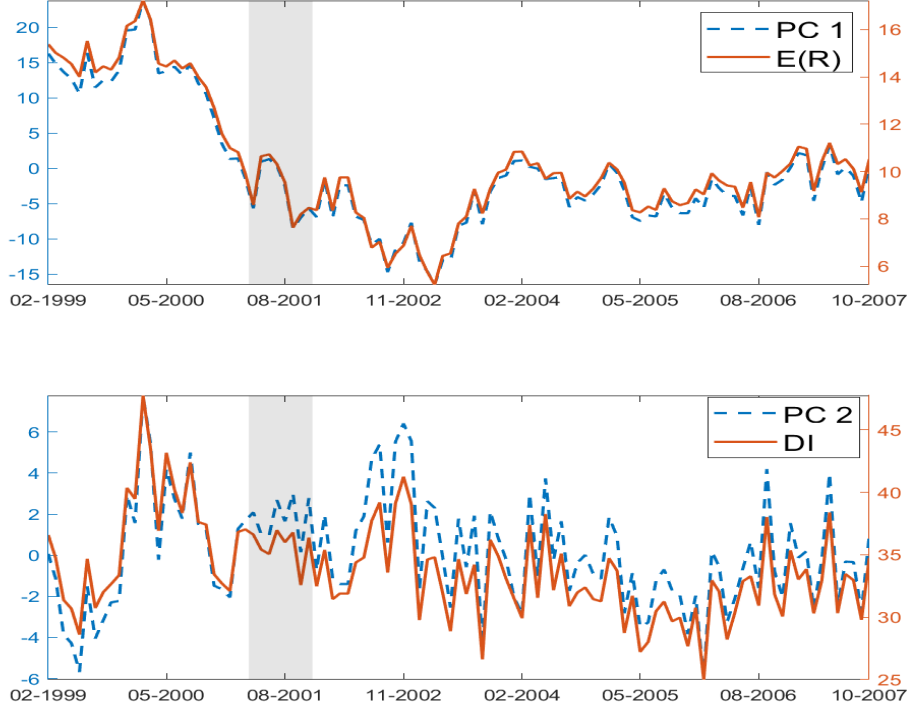


Figure 2: Principal components and Moments of the Subjective Expected Return Distribution. PC i represents the i principal component of the distribution, $E(R)$ the mean and DI the disagreement index computed as the difference between 1st and 10th percentile; shaded areas denote NBER recessions

3 (Sentimental) Discount Rate Shocks

To fix notations, let R_t denote the total return of the asset at time t . Then

$$R_{t+1} = \frac{P_{t+1} + D_{t+1}}{P_t} = \frac{\left(\frac{P_{t+1}}{D_{t+1}} + 1\right)\Delta D_{t+1}}{\frac{P_t}{D_t}} \quad (1)$$

where D_t is the dividend paid by the asset and ΔD_{t+1} denotes the gross dividend growth rate. Linearising

$$r_{t+1} = \rho p d_{t+1} - p d_t + \Delta d_{t+1} \quad (2)$$

where $pd_t \equiv \log(P_t/D_t)$, $\rho = \frac{\overline{P/D}}{1+\overline{P/D}}$ and $\overline{P/D}$ denotes the long term mean of the P/D ratio. Small letters denote variables in logs. Iterating forward equation (2) results in the Campbell-Shiller decomposition

$$pd_t \approx \underbrace{\sum_{j=1}^{\infty} \rho^{j-1} \Delta d_{t+j}}_{\text{Cash Flow}} - \underbrace{\sum_{j=1}^{\infty} \rho^{j-1} r_{t+j}}_{\text{Discount Rates}}. \quad (3)$$

The above equation is an accounting identity and must hold at all points in time and in expected terms. This decomposition will prove useful in the next session in recovering the impulse response profile of the discount rates.

3.1 Classical View: Discount Rate Shocks

Cochrane (2008, 2011) shows that discount rates explain the majority of P/D ratio variability while cash flows are insignificant in explaining the movement in the P/D ratio. Discount rate shocks are defined as shocks to returns that do not affect contemporaneously dividend growth. They are pure price increases due to changes in discounting which can be driven by several habits, long-run risks, or sentiment among others. I identify these shocks in a simple bi-variate VAR with dividend growth and the P/D ratio as endogenous variables using short-run restrictions to identify the discount rate shocks (DR) as a shock that changes the P/D ratio and does not affect dividend growth contemporaneously.³ Formally, letting y_t be the vector of endogenous variables, the VAR(p) can be written as

$$\mathbf{y}_t = c + \sum_{l=1}^p B_l \mathbf{y}_{t-l} + u_t \quad \text{for } 1 \leq t \leq T \quad (4)$$

where \mathbf{y}_t is a $n \times 1$ vector of variables, B_l are $n \times n$ matrices of coefficients to be estimated,

³Returns will not be included in the VAR to avoid imposing restrictions on the relation between the shocks; shocks to returns are a combination of the shocks on dividend growth and P/D ratio according to equation 2.

and u_t is a $n \times 1$ vector of residuals with covariance matrix Σ . The model in 4 can be rewritten in a more compact form as

$$\mathbf{y}_t = B_+ \mathbf{x}_t + u_t \quad \text{for } 1 \leq t \leq T \quad (5)$$

where $B_+ = (B_1 \dots B_p \ c)$ and $\mathbf{x}_t' = (y_{t-1}' \dots y_{t-p}' \ 1)$. The dimensions of B_+ and \mathbf{x}_t are $n \times (np + 1)$ and $(np + 1) \times 1$. Letting P denote the lower Cholesky factor of Σ , by pre-multiplying equation 5 by P^{-1} and taking the transpose we arrive at the structural representation of the VAR model

$$\mathbf{y}_t' A_0 = \mathbf{x}_t' A_+ + \epsilon_t' \quad \text{for } 1 \leq t \leq T \quad (6)$$

where $A_0 = (P^{-1})'$, $A_+ = B_+'(P^{-1})'$ and $\epsilon_t' = u_t'(P^{-1})'$. Notice that $\mathbf{E}[\epsilon_t \epsilon_t'] = I$. The matrices (A_0, A_+) are the structural parameters while B_+ and Σ are the reduced-form parameters. Defining Q as any orthonormal matrix of dimension $n \times n$, the structural parameters (A_0, A_+) and $(A_0 Q, A_+ Q)$ are observationally equivalent in the sense that they produce the same reduced form VAR representation. In this representation, identifying shocks using short-run and/or sign restriction can be accomplished by imposing restrictions on the matrices A_0 and A_+ following the methodology in [Arias et al. \(2018\)](#).

Identification 1. *Discount Rate Shocks*

DR shocks affect the P/D ratio and do not impact dividend growth contemporaneously

Implementation: Cholesky factorization with ordering $y_t = (\Delta D, pd)$

Figure 3 shows the impulse response function from a DR shock and the decomposition from equation 3.

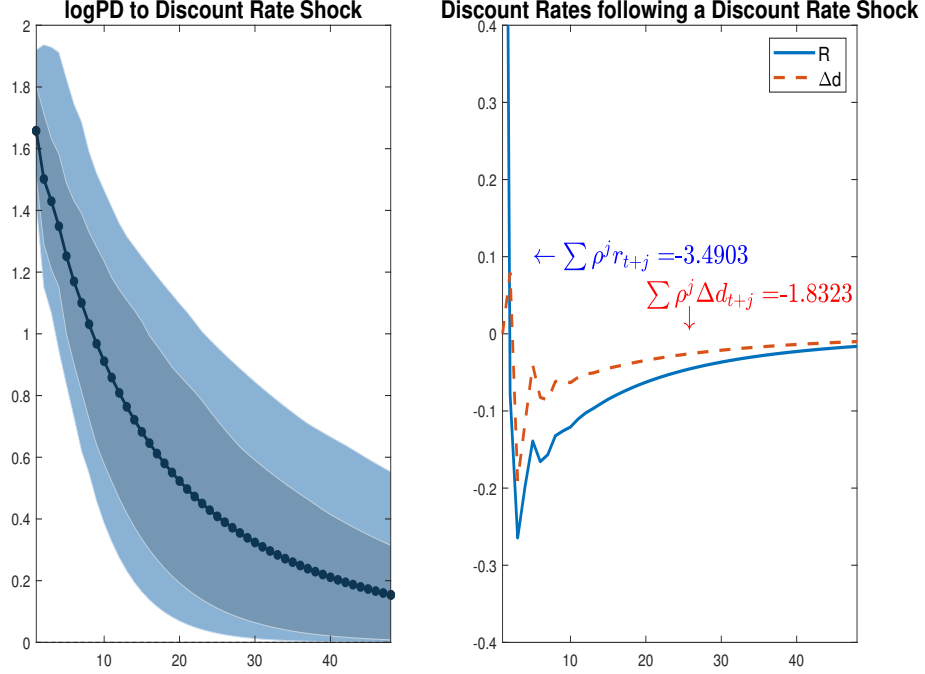


Figure 3: IRF to DR shock and implied subsequent returns (eq.3). 90% and 68% confidence bands based on Identification 1

A pure discount rate shock increases the P/D ratio contemporaneously by increasing prices without any move in dividends. The right panel shows what drives this increase in the P/D ratio. Returns jump at the time of the shock and then turn negative in the next period and remain below 0 before returning to the long-run mean. Overall the discounted sum of returns is negative which sustains the initial price increase. The cash flow part has the wrong sign given the initial price increase which implies that dividends play no role and that all variation is due to discounting.

Figure 4 presents the contributions of the two shocks to the variance of the endogenous variables. Discount rate shocks explain over 95% of the movements in P/D ratios while cash-flows shocks have limited explanatory power.

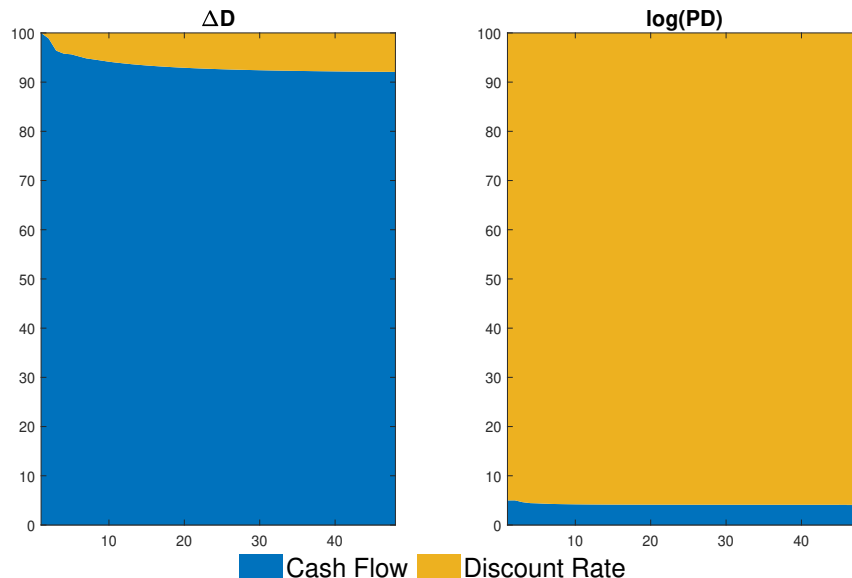


Figure 4: Variance Decomposition of discount rate and dividend growth shocks

The question that is at the core of this paper is whether what is attributed to discount rate shocks is actually hiding other sources of variation. The literature on learning and belief formation suggests that agents do not form expectations according to the rational expectation (RE) paradigm and that swings in agents' sentiment can have a considerable impact on market prices.

3.2 Sentimental Discount Rate Shocks

The previous identification shows that P/D ratios vary to a large extent due to changes in discount rates. The theoretical asset pricing literature has provided different explanations regarding the sources of these variations: changes in risk aversion, long-run risks, and animal spirits among others. The results from [Chen et al. \(2019\)](#) show that 75% of P/D ratio variability cannot be explained by habits or long-run risk mechanisms. The channel that will be investigated here is the one associated with animal spirits or dynamics of agents' subjective beliefs. Following the results from the previous section, market sentiment will be measured by the distribution of subjective (survey) expectations which

can be summarized by two statistics (factors): average beliefs and disagreement. The expanded VAR model will therefore include four variables

$$y_t = (\Delta d, DI, E_t^{\mathcal{P}}(R_{t+1}), pd)' \quad (7)$$

where $E_t^{\mathcal{P}}(R_{t+1})$ is the average subjective capital gains expectation and DI is the disagreement index. Since average beliefs and the disagreement index capture the two principal components of the subjective expected return distribution, the model can be interpreted as a factor-augmented VAR (FAVAR) model. Compared to the usual FAVAR models used in the literature, in the present framework, the factors have clear economic correspondence which in turn will help in the identification of shocks and the interpretation of results.

For the identification of the subjective expectation shock (an exogenous increase in $E_t^{\mathcal{P}}(R_{t+1})$) the quantitative asset pricing literature can be used as a guide in determining the effects and dynamics of such shocks. Bayesian RE models in which part of investors extrapolate past returns as in [Barberis et al. \(2015\)](#), the diagnostic expectations framework of [Bordalo et al. \(2021\)](#) or the internally rational asset pricing framework of [Adam et al. \(2017\)](#) have in common that in equilibrium, subjective beliefs or sentiment affect contemporaneously prices while the reverse does not hold. These quantitative models replicate a wide variety of asset pricing stylized facts including ones related to survey expectations. Formally, letting $\beta_t = E_t^{\mathcal{P}}(R_{t+1})$, the equilibrium price can be written as

$$\begin{aligned} P_t &= F(\beta_t; *) \\ \beta_t &= S(\beta_{t-1}, P_{t-1}; *) + \epsilon_t \end{aligned}$$

where $F()$ represents the equilibrium function mapping subjective beliefs to prices, $S()$ the law of motion of expectations and ϵ_t a sentiment shock.⁴ Notice that while the senti-

⁴The Symbol ”*” denotes other variables, e.g. fundamentals or other shocks, apart from beliefs and prices.

ment shock affects current beliefs and prices, current stock prices do not affect contemporaneously beliefs. Average survey beliefs adjust slowly compared to prices and are well characterized by a constant gain learning updating equation with a small gain parameter, as shown for example in [Adam et al. \(2017\)](#). Given this slow-moving behavior of subjective expectations and the quantitative performance of asset pricing models in replicating jointly survey expectations and stock prices, it is assumed that an exogenous increase in stock prices will not affect contemporaneously agents' beliefs and disagreement. The reverse is not true. A sentiment shock understood as an innovation to subjective beliefs should not affect dividend growth on impact but can affect prices at the time the shock hits, in line with the theoretical predictions discussed before.

A discount rate shock (shock in the pd equation) influences prices contemporaneously without having any effect on dividend growth, Δd . Disagreement shocks do not influence on impact dividend growth but can influence prices and average subjective beliefs. This assumption is in line with the theoretical model proposed by [Atmaz and Basak \(2018\)](#). These assumptions on the effects of shocks on the endogenous variables can be accommodated by short-run restrictions imposed on the VAR model given by equation 6 which is accomplished by the following identification strategy.

Identification 2: Sentimental Discount Rate (SDR) Shocks

SDR shocks affect agents' subjective beliefs and can influence contemporaneously market prices without having any effect, on impact, on disagreement and dividend growth.

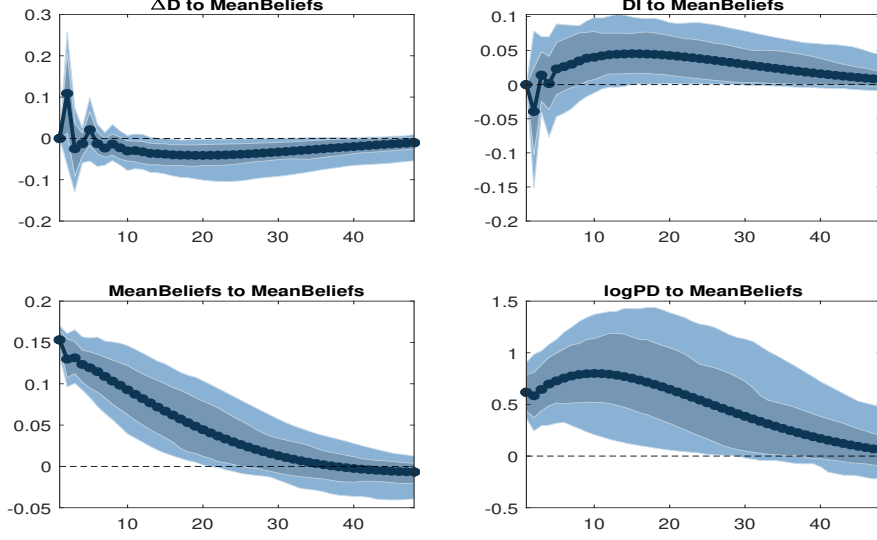
Implementation: Cholesky factorization with ordering $y_t = (\Delta d, DI, E_t^{\mathcal{P}}(R_{t+1}), pd)'$ ^a

^aThe estimation uses 2 lags following the indication from the BIC and AIC information criterion. The results are robust to varying the lag order from 1 to 6

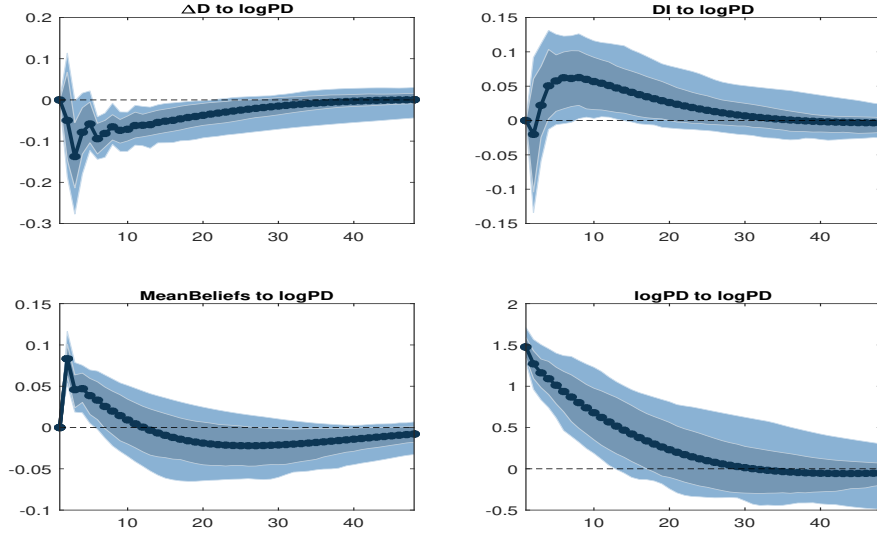
Notice that under identification 2 sentiment or discount rate shocks do not affect

contemporaneously disagreement. This assumption will be relaxed in the next section but will not have any sizable impact on the main message of the paper.

Figure (5) presents the impulse response functions to sentiment and discount rate shocks.



(a) Sentimental Discount Rate Shock



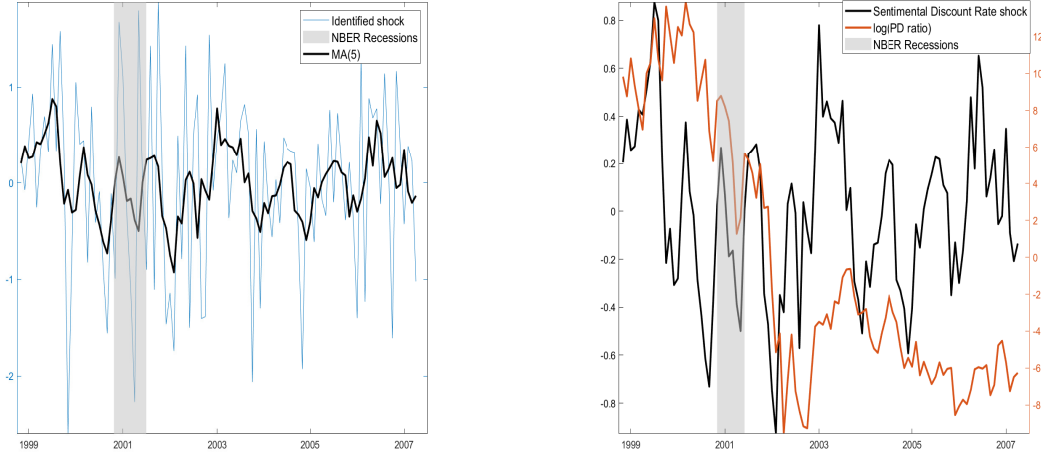
(b) Discount Rate Shock

Figure 5: Impulse Response functions to SDR shocks (panel a) and DR shocks (panel b). Median IRFs together with 90% and 68% bootstrap confidence bands

The main difference between the two shocks is the effect on the P/D ratio and the persistence of the responses. Standard DR shocks increase the P/D ratio on impact after which it decreases monotonically to the long-term mean. In contrast, the SDR

shock produces a hump-shaped response in the P/D ratio which together with subjective expectations show higher persistence over time.

Panel a) from figure 6 presents the identified shock and its smoothed version while panel b) the joint evolution of the P/D ratio and the smoothed series. The latter tracks reasonably well the boom and busts in asset prices during the 2002 crisis and turns negative during large drops in stock prices. The next section presents formally the causal contribution of the sentimental discount rate shocks to the P/D ratio variability.



(a) Identified Shock and smoothed series (b) Evolution of Prices and identified shock

Figure 6: Identified Sentimental Discount Rate Shock

Panel a) presents the identified SDR shock plotted together with the 5-period moving average; panel b) shows the evolution of the P/D ratio together with the smoothed shock.

3.3 *P/D Ratio Decomposition*

The two main shocks of interest have a different effects on prices but it could still be the case that a large part of the P/D variability is explained by standard DR shocks. Figure 11 shows the main result of the paper: *sentimental discount rate shocks account for around 40% of the variability of the P/D ratio in the long run as much as standard discount rate shocks*. This implies that animal spirits or swings in investors' sentiment,

as measured by subjective capital gain expectations, contribute significantly to the boom and busts in asset prices. This evidence is in line with the predictions from models such as Adam et al. (2017) or Adam and Merkel (2019) where agents' subjective capital gain expectations drive to a large extent asset price movements. Under this identification strategy, disagreement shocks have a limited effect on the P/D ratio and seem to operate mainly through average sentiment explaining around 20% from the short-run variation of beliefs.

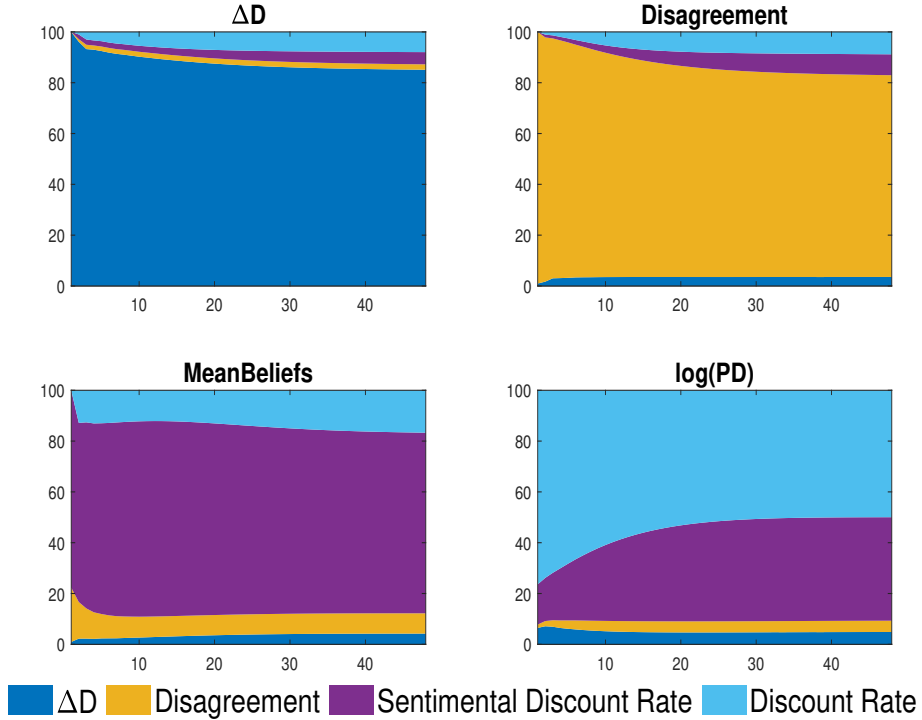


Figure 7: Variance Decomposition of shocks under Identification 2: each colour show the contribution (in %) of each one of the four shocks corresponding to $y_t = (\Delta d, DI, E_t^{\mathcal{P}}(R_{t+1}), pd)$

The asset pricing theory under imperfect information and empirical evidence on the dynamics of survey expectations serve as the foundation for the identification approach employed to recover sentimental discount rate shocks. However, previous results might rely entirely on the restriction that innovations in P/D ratio equation do not affect beliefs

contemporaneously. This leads to the natural question: to what extent are innovations to beliefs already contained in price-dividend ratios? To explore this possibility, I reorder the variables in the VAR such that expectations are orthogonalized with respect to the P/D ratio. Figure 8 presents the contribution of the innovations to the variances of the endogenous variables with the new ordering of the variables. Under Identification 2, SDR shocks explain 40% of the variability of the P/D ratio. Even after the ortogonalizing beliefs with respect to prices by placing $E_t^{\mathcal{P}}(R_{t+1})$ last in the VAR, innovations to the latter still explain at least 20% from the long-horizon forecast error variance of the P/D ratio. Hence, the hypothesis that sentimental discount rate shocks simply reflect information in prices can be easily rejected. This small detour shows that the subjective distribution of survey beliefs encodes additional and exogenous information compared to the one found in prices.

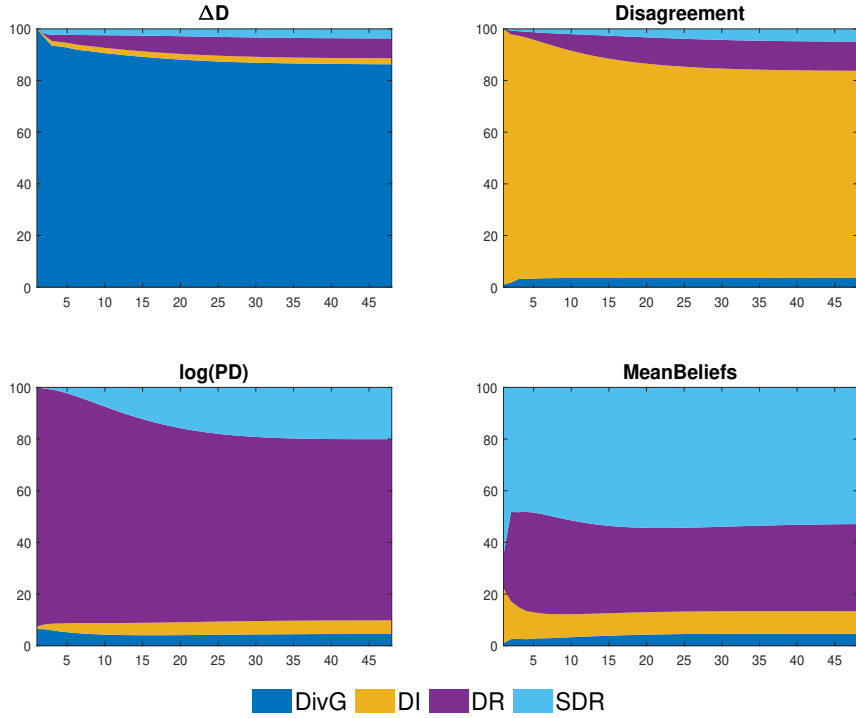


Figure 8: Variance Decomposition of shocks under Identification 2 with swapped order of beliefs and prices: each color show the contribution (in %) of each one of the four shocks corresponding to $y_t = (\Delta d, DI, pd, E_t^{\mathcal{P}}(R_{t+1}))$

It is instructive to back out returns from IRFs of P/D ratios using equation (2) to compute the pattern of subsequent discount rates following the shocks. Figure 9 presents the two sources of variation from the Campbell-Shiller decomposition for the discount rate and sentimental discount rate shocks conditional on assuming that the magnitude of the two shocks is such that it produces the same initial effect on prices.

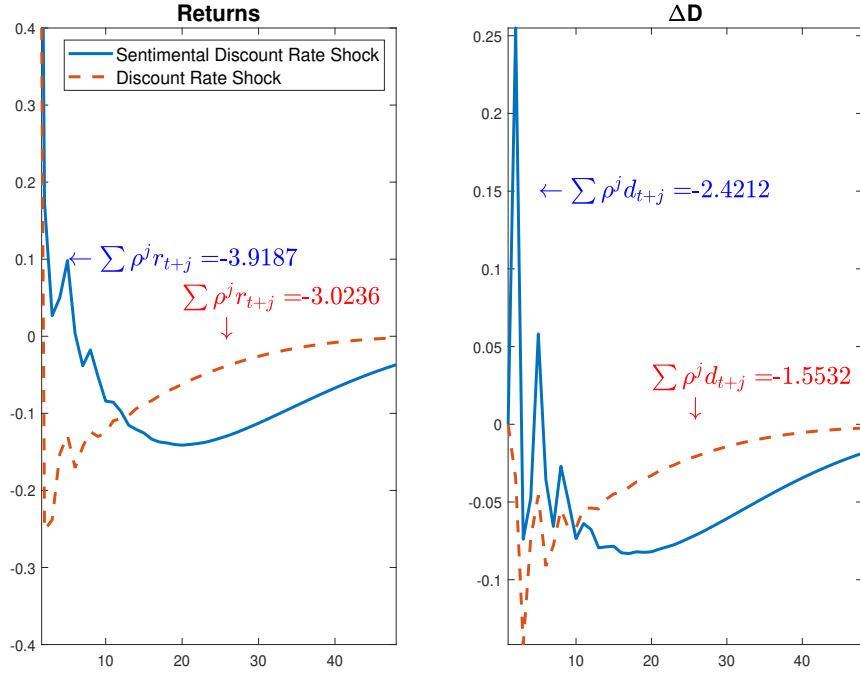


Figure 9: Implied returns and dividends from (S)DR Shocks conditional on same impact effect on the P/D ratio

Compared to standard discount rate shocks, the left panel from figure 9 shows that sentiment shocks produce a more persistent increase in returns following the shock and a larger decrease in later periods before returning to the long-term mean. Both shocks increase prices on impact due to lower cumulative future discount rates, the difference being the inverse hump-shaped pattern of discount rates from sentimental discount rate shocks.

Figure 10 plots the historical decomposition of the P/D ratio and shows that during

the 2000 boom in asset prices, sentimental discount rate shocks were one of the main determinants of the sharp increase in prices and subsequent decrease. This suggests that the identified sentimental discount rate shocks play an important role in the boom and bust phases of asset price cycles. These phases are usually characterized by over-optimism/pessimism which is reflected in the subjective expectations agents hold.

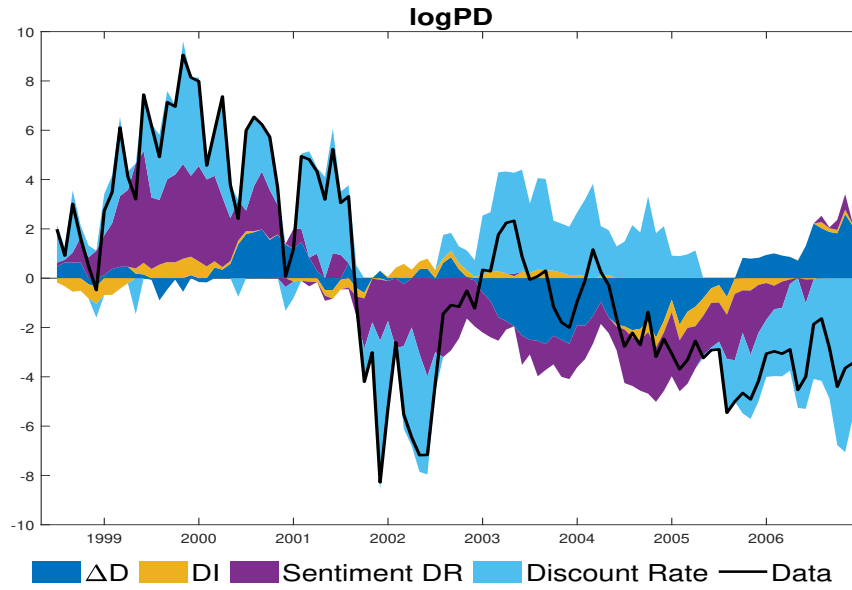


Figure 10: Historical Decomposition of the P/D ratio under Identification 2

4 Robustness

This section considers several robustness checks to the previous identification strategy. First, it explores if the identification of sentiment shocks captures in fact shocks in the real economy at a business cycle frequency or it confounds with other measures of sentiment proposed in the literature. Second, it proposes an alternative identification strategy that adopts an agnostic view on the effects of sentiment and discount rate shocks on disagreement.

4.1 *Business cycle fluctuations*

Sentimental discount rate shocks as identified in the previous section could in principle capture the business cycle movement in the real economy which influences agents' expectations about the stock market and the P/D ratio. To explore this possible scenario, the previous VAR will be augmented with the cycle component of real GDP, denoted by \tilde{y} . Since the estimation is using data at monthly frequency, the output-gap series is not available and instead I will use as proxy the Brave-Butters-Kelley (BBK) index of the cycle component of real GDP.⁵ I assume that none of the identified previous shocks can influence contemporaneously the business cycle component of real GDP while leaving unrestricted the effect of a shock to the real economy on the other variables. This is accomplished using the following ordering in the FAVAR identified with zero short-run restrictions: $y_t = (BBK, \Delta d, DI, E_t^{\mathcal{P}}(R_{t+1}), pd)'$. Figure 11 shows the explained variance of each type of shock.

⁵This index is constructed from 500 time series of real economic activity and quarterly GDP growth, for more details see [Brave et al. \(2019\)](#).

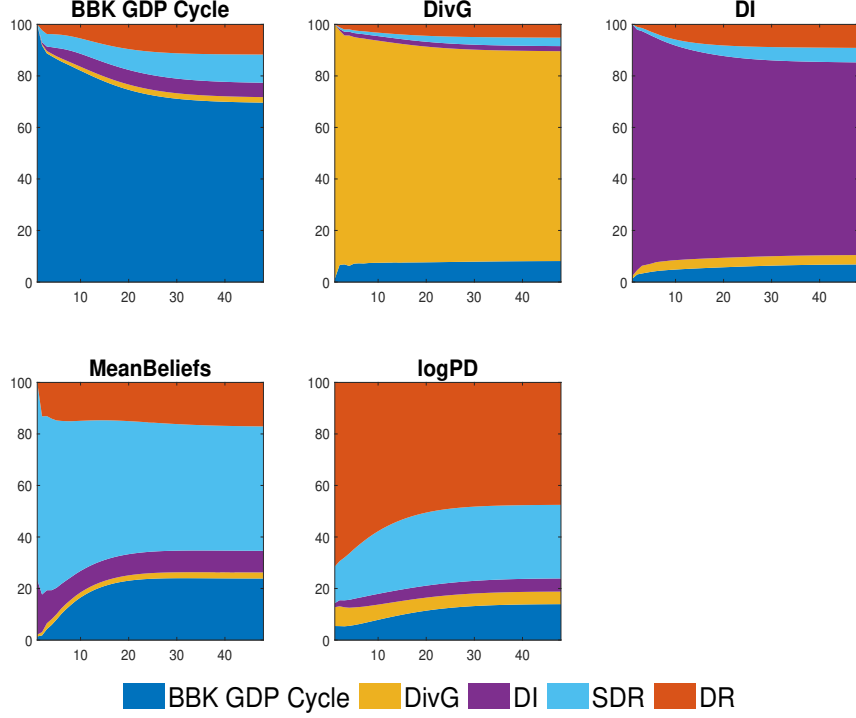


Figure 11: Variance Decomposition of the contributions of shocks to $y_t = (\tilde{y}, \Delta d, DI, E_t^{\mathcal{P}}(R_{t+1}), pd)$ where \tilde{y} denotes the cycle component of real GDP measured by the BBK index. The latter is ordered first in the VAR and the identification of shocks is accomplished using a Cholesky decomposition.

First notice that shocks to the business cycle component of GDP explain the majority of the variation in the BBK index but also a sizable share in subjective beliefs (around 20% in the long run), suggesting that part of the previous contribution of subjective beliefs to P/D ratio variability could be in fact captured by business cycle shocks. Indeed, the contribution of sentiment shocks (light blue area in figure 11) to variations in the P/D ratio is slightly reduced compared to the results arising under identification 2, part of the variability being now related to business cycle movements. Nevertheless, SDR still represents an important share of P/D ratio variability explaining around 30% of the total variance of prices while discount rate shocks explain approximately 45%. Thus, the hypothesis that sentimental discount rate shocks reflect movements in capital gains expectations driven by business cycle fluctuations can be reasonably rejected.

4.2 Other Shocks

It is important to verify if the sentimental discount rate shocks identified in this paper are confounded with other shocks that capture sentiment or confidence. Using a measure of broad economic confidence/ sentiment [Barsky and Sims \(2012\)](#) identify innovations to confidence in a VAR framework and argue based on a DSGE model that confidence shocks reflect in fact news about future productivity. To explore if the identified shocks reflect news about future productivity, I augment the vector of observable under the baseline identification with the series of TFP of [Fernald and Wang \(2016\)](#) which is ordered first. Figure 12 shows that TFP response to the identified sentiment shocks is insignificant both at 68% and 90%. Thus, it appears unlikely that these shocks reflect in fact productivity shocks.

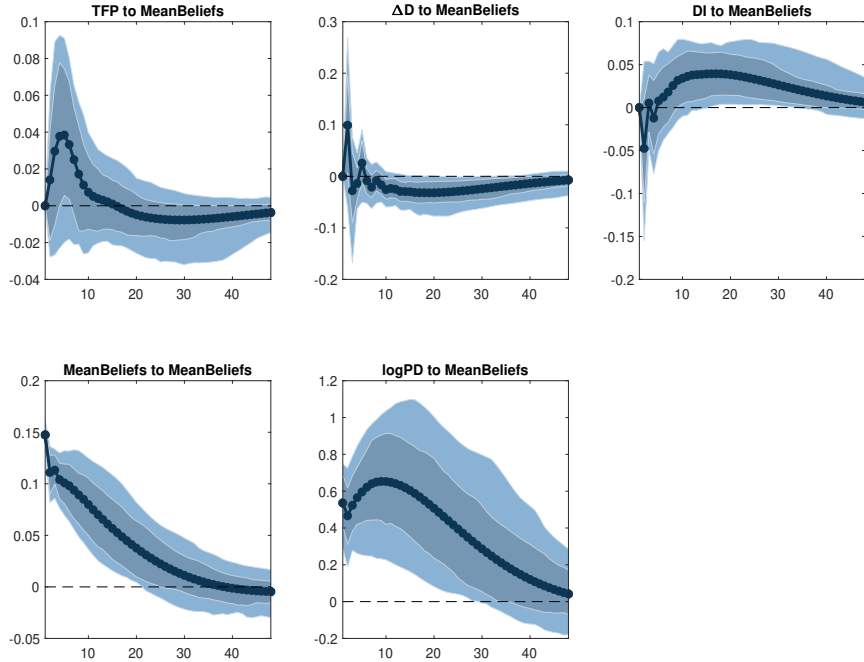


Figure 12: Impulse responses from a sentimental discount rate shock using TFP as observable

Along the same lines, the baseline VAR is next augmented with the uncertainty index of [Jurado et al. \(2015\)](#) to check if shocks to capital gains expectations hide variations in macroeconomic uncertainty. The impulse response functions from figure 14 show that macroeconomic uncertainty is unresponsive, at least in the short run, to capital gain expectations shocks at the 90% level which indicates that the sentiment shocks identified in this paper are not driven by macroeconomic uncertainty. In the long run, a boom in subjective capital gains expectations seems to be associated with a decrease in macroeconomic uncertainty.

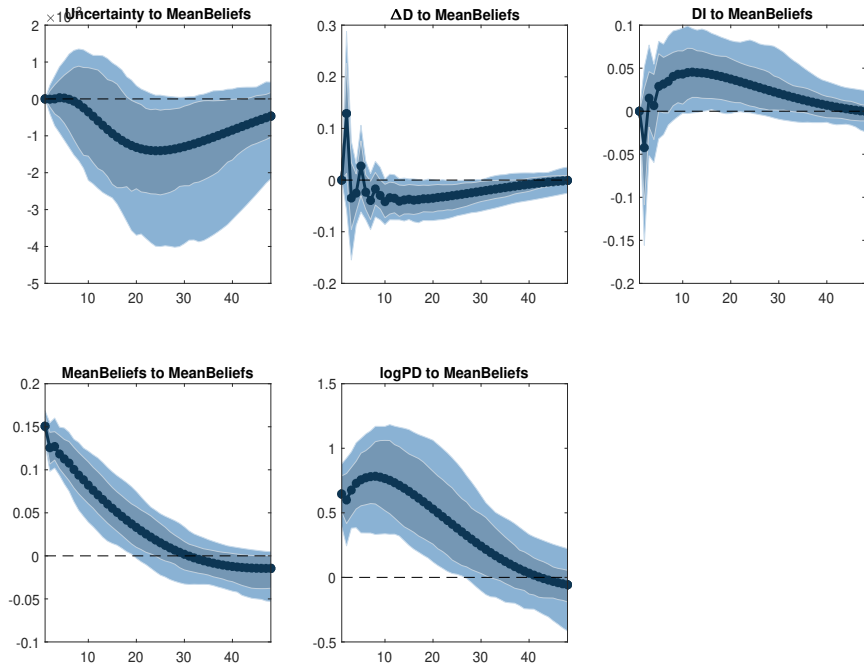


Figure 13: Impulse responses from a sentimental discount rate shock using Uncertainty as observable

Finally, more recently, [Lagerborg et al. \(2020\)](#) identify sentiment shocks using a proxy SVAR model using as an instrument for confidence the number of mass shootings in the US. Similar to this paper, the identified shocks from that paper do not reflect TFP shocks as suggested by [Barsky and Sims \(2012\)](#) and do have a sizable effect on the

real economy at the business cycle frequency. It is unlikely that their measure confounds with the identified shocks from this paper for the simple reason that in their analysis, sentiment shocks do not have a sizable effect on the stock market. Indeed, the correlation between their identified shock and the one analyzed in the present paper is 0. More formally, augmenting the VAR with their identified sentiment shocks (ordered first in the VAR), the impulse responses from figure show that these two shocks are not related.

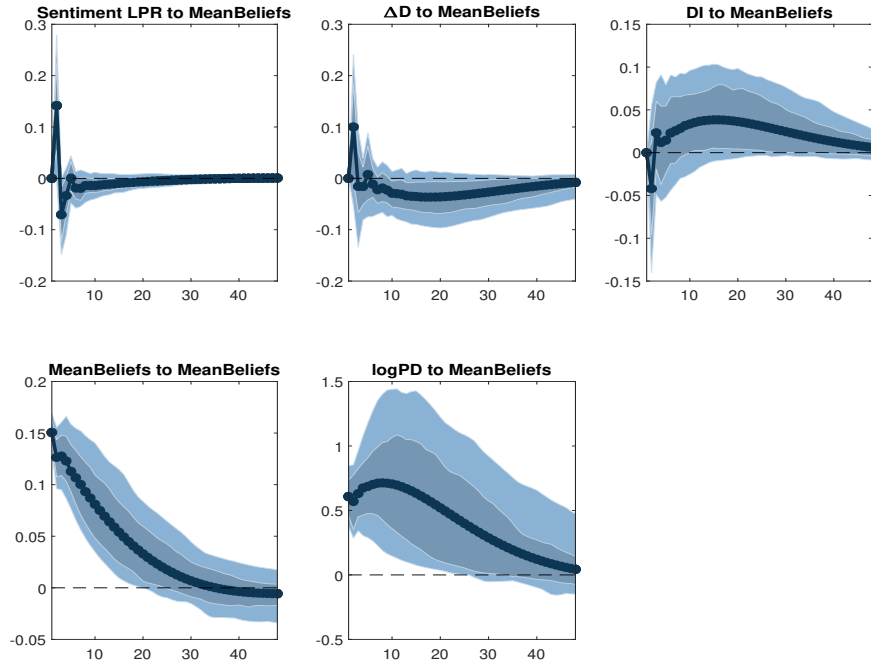


Figure 14: Impulse responses from a sentimental discount rate shock using the measure of sentiment from [Lagerborg et al. \(2020\)](#) as observable

Two conclusions arise from the analysis of this section. First, the identified sentimental discount rate shocks proposed in this paper do not seem to be confounded with other measures of sentiment proposed in the literature. Second, it appears that sentiment shocks originating in the equity market are different than sentiment shocks or confidence waves that happen in the real economy. The latter seems to indicate that the sentiment-related shocks in the real economy and equity market are somewhat disconnected, at

least for the time period analyzed here and in the case of US.

4.3 Agnostic identification of disagreement shocks

The baseline identification strategy 2 implies that neither the discount rate nor the sentiment shocks have a contemporaneous effect on disagreement. Indeed, some theoretical papers argue that this is indeed the case although the evidence on this is almost absent and the literature has not yet reached a consensus. To explore the effects of relaxing the assumption of shocks on disagreement, I use a mixed identification strategy combining zero and sign restrictions following the methodology developed by [Arias et al. \(2018\)](#).⁶ The identification restrictions are summarized in Table I while the periods on which the restrictions have been imposed are presented in Table II. The model is estimated with Bayesian techniques using an uninformative normal-diffuse prior.

	SDR	DR	Disagreement	Dividend	GDP
Mean Beliefs	+	0			
logP/D	+	+			
DI			+		
ΔD	0	0	0	+	
GDP cycle	0	0	0	0	+

Table I: Identification Restrictions

"+" denotes a positive impact of the shock from the column on the endogenous variable on the corresponding row; the entries with "0" represent short-run restrictions.

	SDR	DR	Disagreement	Dividend	GDP
Mean Beliefs	3	1			
logP/D	1	3			
DI			3		
ΔD	1	1	1	3	
GDP cycle	1	1	1	1	3

Table II: Periods for which Restrictions from table I have been imposed

⁶This methodology implies imposing joint restrictions on the parameters of the matrices A_0 and A_+ defined in equation 6.

I impose that all shocks have a significant impact on the variable where it originates for at least 1 quarter (3 periods) while the zero restrictions are imposed only on impact. Furthermore, the identification also imposes that a positive SDR shock has a non-negative effect on impact on the P/D ratio (column 1 row 3 in Table II). It is further assumed that discount rates or sentimental shocks do not impact the cyclical component of GDP on impact.⁷ As argued previously, the effects of the shocks on the disagreement index are left unrestricted. The contributions of the shocks to the variance of the endogenous variables are presented in Figure 15.

Sentimental/Discount Rate shocks contribute equally to the variability of P/D ratio, both accounting for around 35% from the explained long-run variance while disagreement shocks explain around 20%. The main result from the previous section thus remains unchanged: around 50% of the variability of prices can be accounted by innovations affecting the subjective distribution of capital gains. What changes under this alternative identification strategy is the contribution of disagreement shocks to the dynamics of mean beliefs and vice-versa. Disagreement shocks account for 70% of the short-run variance of average sentiment, decreasing to around 40% in the long run while sentiment shocks account for 30% of the disagreement index variability. These results suggest that average subjective beliefs and disagreement are tightly interconnected.

⁷Several studies have pointed out that stock prices do have an impact on the real economy either through wealth effects as in [Ifrim \(2021\)](#) or through the effect on the financing conditions of firms as in [Bernanke et al. \(1999\)](#); [Winkler \(2020\)](#). Nevertheless, since the analysis uses monthly data, the assumption that these shocks do not affect GDP contemporaneously seems reasonable.

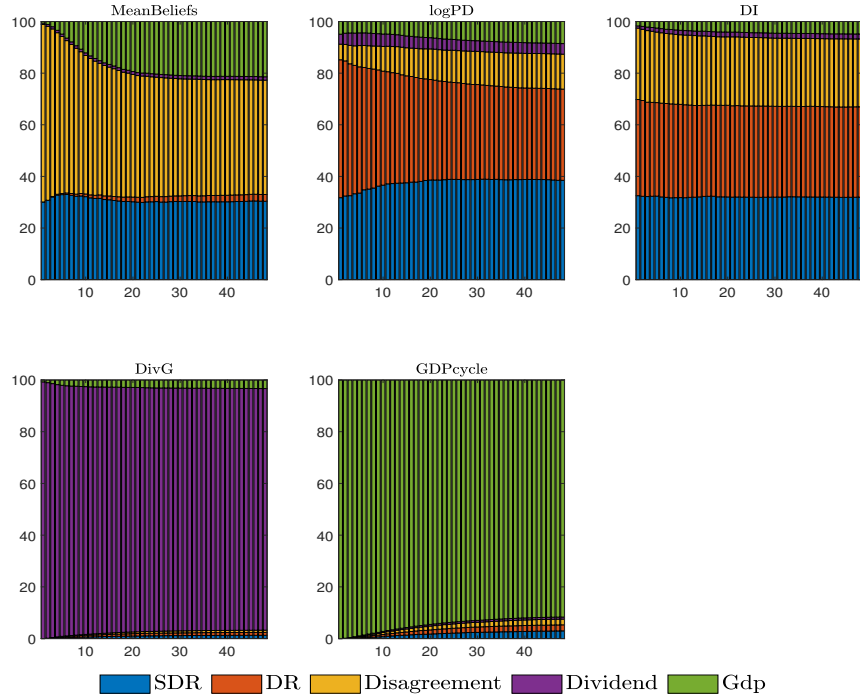


Figure 15: Variance Decomposition of $y_t = (\tilde{y}, \Delta d, DI, E_t^{\mathcal{P}}(R_{t+1}), pd)$ based on the identifying restrictions from Tables I and II

5 Conclusions

The vast majority of the empirical asset pricing literature suggests that P/D ratios vary due to movements in discount rates. This paper argues that a large share of these movements is associated with shocks affecting the subjective distribution of capital gain expectations that can explain around 50% of P/D ratio variability: at least 30% due to shocks to average subjective capital gain expectations and up to 20% attributed to disagreement shocks.

The distribution of survey data on capital gain expectations can accurately be characterized by two factors explaining over 95% of its variability: average sentiment and disagreement. Using these factors, I augment a standard asset pricing VAR with the sub-

jective distribution of beliefs and identify standard and sentimental discount rate shocks (SDR) with the latter to be understood as shocks to agents' subjective average beliefs. The identification is inspired by the theoretical predictions of asset pricing models with subjective beliefs and assumes that SDR shocks can affect contemporaneously prices and beliefs while standard discount rate shocks do not have a short-run effect on beliefs due to their slow-moving dynamics. Sentiment shocks behave in a similar way to standard discount rate shocks when it comes to the qualitative effects on price and expectations but differently from a quantitative standpoint: sentimental discount rate shocks produce a hump shape response of the P/D ratio and introduce more persistence in the impulse response functions. Using a historical decomposition of the P/D ratio, I show that the 2002 dot-com boom in the stock market has been predominantly fueled by the identified sentimental discount rate shocks.

The main result of the paper is robust when considering business cycle shocks and under an alternative identification strategy that remains agnostic to the nature of disagreement shocks while maintaining the identification strategy for sentimental discount rate shocks. Under this identification method, disagreement shocks play a more important role in driving average beliefs suggesting a tight connection between average sentiment and subjective disagreement. Moreover, the identified shocks do not confound with other measures of broad economic sentiment or confidence.

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Appendices

Appendix A Additional Figures and Results

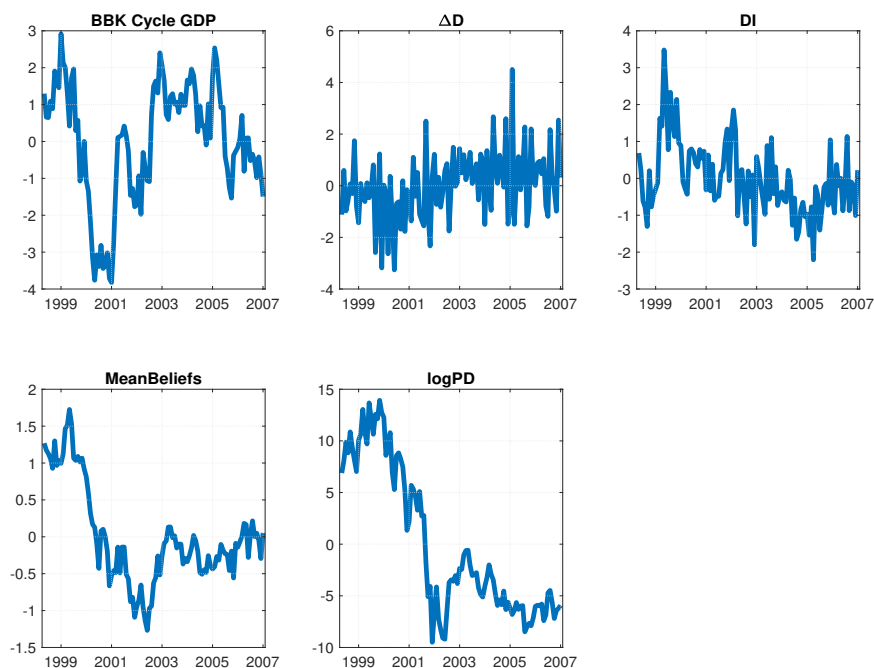


Figure A.1: Time series 1999M2-2007M10 used in the VARs

IRFs under Identification 2

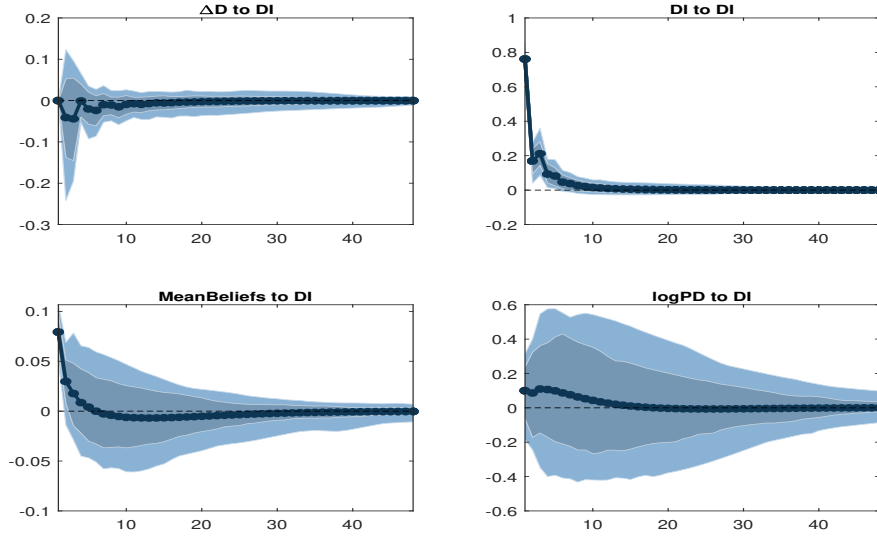


Figure A.2: IRFs to a 1σ Disagreement shock

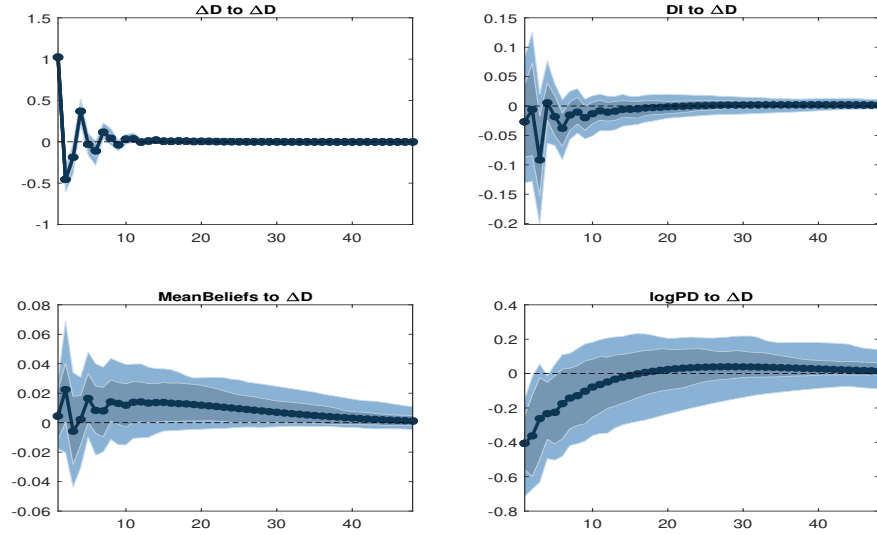


Figure A.3: RFs to a 1σ dividend growth shock

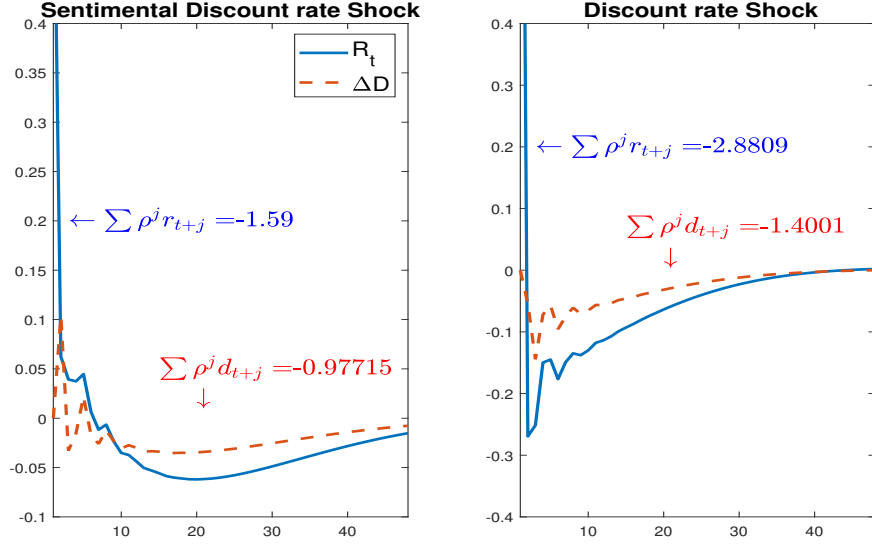


Figure A.4: PD decomposition from 1σ (S)DR shocks

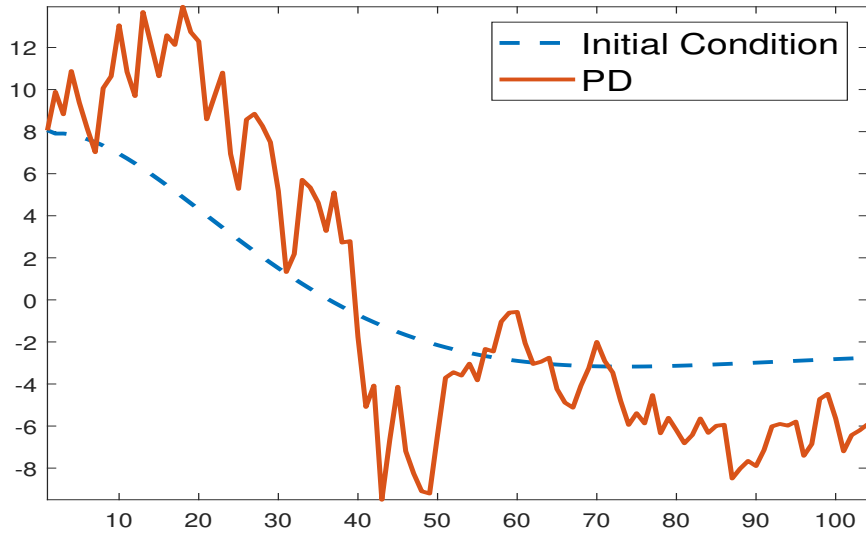


Figure A.5: The Influence of initial condition in HD

IRFs under Agnostic identification of disagreement shocks

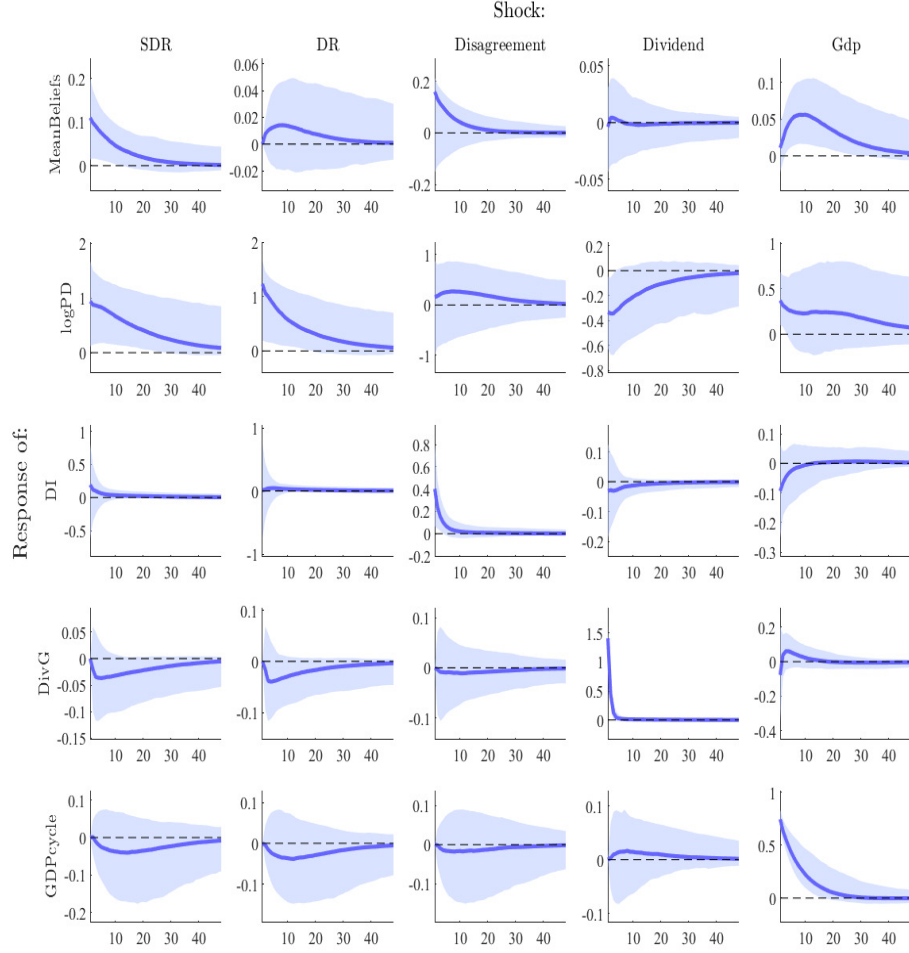


Figure A.6: Impulse Response functions from the Identification with short-run and zero restriction from Tables I and II