Central Bank Communication in the Media and Investor Sentiment

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Abstract

This paper explores the relationship between central bank communication and investor sentiment. We first use media coverage on Fed chair's communication to quantify the degree of confidence and optimism expressed by the Fed chair and call this variable the overconfidence indicator. Second, we relate the overconfidence indicator to investor sentiment. Our results show that an overconfident Fed chair is significantly associated with higher investor sentiment. Further extensions suggest that (i) investors are more sensitive to central bank communication during a recession and that (ii) they adjust rapidly their sentiment following central bank communication, thus showing that there is no underreaction bias. These findings provide additional insights on how central bank communication shapes investor sentiment in the context of the Global Financial Crisis and the zero lower bound on nominal interest rates.

Keywords: Central bank communication; Overconfidence; Investor sentiment; Fed chair

JEL classification: E52, E58

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1 Introduction

Fluctuations in market expectations cause aggregate fluctuations in macroeconomic activity and asset markets. The recent global financial crisis (GFC) is a case in point, as the boom in the housing market has been attributed to exuberant beliefs about future prices while the subsequent burst came with a reversal in these beliefs (Angeletos and La'o, 2013). The GFC is thus depicted as a crisis of beliefs (Gennaioli and Shleifer, 2018).

As a consequence, there has been a renewed interest in the identification of the sources of fluctuations in market expectations that are not necessarily related to economic fundamentals. The macroeconomics literature has resorted to models to explain fluctuations in expectations in terms of "animal spirit", which is considered as an exogenous shock defined as a sentiment that can appear without any modification in economic fundamentals. These models identify sentiment as a shock to an expectation variable that is orthogonal to economic fundamentals, and they evaluate the importance of this shock as a source of economic fluctuations.

Following this line of thought, empirical and theoretical studies show that variations in investor sentiment affect asset prices and economic activity.[1] As an illustration, Angeletos and La'o (2013) show that market expectations and economic outcomes may be affected by shocks which they call sentiment, and Chauvet and Guo (2003) find that investor sentiment shocks played an essential role in several recessions. Baker and Wurgler (2006) offer anecdotal evidence where investor sentiment causes boom and burst in financial markets, such as the October 1987 stock market crash, the Internet bubble, and the ensuing Nasdaq and telecom crash. Hence, given the empirical evidence showing that investor sentiment can predict cross-sectional and time-series stock returns, policymakers closely watch measures of investor sentiment. This paper aims to identify the economic and non-economic variables that are related to investor sentiment. So doing, we highlight an additional variable related to investor sentiment beyond the macroeconomic and financial ones, namely, central bank communication.

Since the ultimate objectives of a central bank are expressed in terms of macroeconomic variables, and that the influence of monetary policy instruments on these variables is indirect, central banks need to impact interest rates at all maturities to achieve their objectives. For this purpose, central banks might try to affect investor sentiment. However, unlike previous studies which assess the relationship between conventional and unconventional monetary policy instruments with investor sentiment (Kurov, 2010 and Lutz, 2015),[2] we focus on another instrument in central banks' toolkit: their communication policy. The two last Fed chairs, Janet Yellen and Ben Bernanke, have prioritized efforts to improve communication, noting that it becomes one of the key tools at monetary policymakers' disposal in time of economic distress (Yellen, 2013).

[1] Investor sentiment is commonly expressed as the degree of "bullishness" or "bearishness" that appears in the stock market: a bullish (bearish) investor expects returns to be above (below) average, whatever average may be (Brown and Cliff, 2004).

[2] Kurov (2010) and Lutz (2015) find that a surprise drop in the fed funds rate has a positive impact on investor sentiment that lasts several months and that unconventional monetary policy shocks have a similar effect on sentiment.

Furthermore, there is a growing literature showing that the media contribute to shaping market sentiment (Starr, 2012), affecting the behavior of economic agents and is a source of information for market participants. This follows the line of thought of Shiller (2000), who argues that investors follow the printed word, suggesting that news' content drive investor sentiment.[3] Consequently, monetary policymakers, aware of the effect of the media on investor sentiment, might use several tools to influence media coverage and to disseminate their communication, such as press conferences, post-meeting statements, congressional hearings, speeches, and interviews. For instance, Berger et al. (2011) show that media coverage is responsive to the European Central Bank communication.

Against this background, this paper proposes to highlight the relationship between media coverage of Fed chair's communication, notably his/her confidence and optimism, with investor sentiment. Since sentiment is defined as the degree of optimism or pessimism that investors have about financial markets, we hypothesize that the confidence and optimism expressed by the Fed chair are likely to be related to those of the investors, and thus, to their sentiment. To test this hypothesis, we proceed in multiple steps. First, we collect articles from four leading economic and financial newspapers (*The New York Times*, *The Wall Street Journal*, the *Financial Times*, and *The Economist*) that cover Fed chair's communication and describe him/her as confident, optimistic, or a variant such as overoptimistic. Second, we count the words relating to confidence or its opposite in proximity to the central banker name. Third, we follow the literature in finance (Malmendier and Tate, 2008; Malmendier et al., 2011) and use word count to quantify the degree of overconfidence expressed by the Fed chair and covered by the media. We call this measure the media-based proxy of Fed chair's overconfidence, or to put it more simply, the overconfidence indicator (OI). Next, we show that the media-based proxy of Fed chair's overconfidence is positively and significantly associated with investor sentiment. As a final step, we draw on the psychology literature to propose further extensions. We find that the overconfidence-sentiment relationship is stronger during the recession and that investors adjust rapidly their sentiment following central bank communication. However, we find no empirical evidence of a "negativity bias", i.e., that the overconfidence-sentiment relationship is stronger to a negative change of Fed chair's overconfidence. Finally, we make several robustness tests showing that the overconfidence-sentiment relationship is robust to various specifications and sentiment measures. A policy implication of these results is that the Fed chair could strategically use communication and cause the media to report his/her confidence to boost investors' sentiment and hence, to avoid fueling negative thoughts about the state of the economy.

The remainder of the paper is structured as follows: Section 2 provides a brief review of the literature, section 3 describes the data and the methodology, section 4 presents the main results and section 5 further robustness tests. The last section concludes.

[3]Survey evidence indicates that over 40% of investors rely heavily on the information derived from mass media when choosing their mutual fund investments (Securities and Exchange Commission, 2000).

2 Related Literature

Recent theoretical contributions show that sentiment matters to explain business cycle fluctuations. Milani (2014) estimates fully-specified DSGE models that incorporate sentiment shocks and shows that the sentiment shocks identified within the structure of these models can explain a significant fraction of the US business cycle fluctuations. Benhabib et al. (2015) find that sentiment unrelated to fundamentals can affect output and employment. Finally, Benhabib et al. (2016) show that sentiment-driven fluctuations can generate persistence in business cycles and have cross-sectional and time-series implications for asset prices.

From the empirical side, the literature finds that sentiment can affect asset prices (see, e.g., the surveys by Hirshleifer, 2001 and Baker and Wurgler, 2007), which in turn can influence real activities through corporate financing, investment, and thus, shape macroeconomic fluctuations. Brown and cliff (2004, 2005) document that change in investor sentiment is highly correlated with contemporaneous and long-run stock returns. Finally, Levchenko and Pandalai-Nayar (2020) identify the sentiment shock as being more important than other factors in explaining business cycle co-movement between the US and Canada.

A parallel strand of the literature shows that investors obtain their information from the media, and thus, that investor sentiment can be driven by media coverage of economic and financial news.[4] Hayo and Neuenkirch (2015) find that market participants rely on media reporting to learn about central bank events. As a result, the media have a causal impact on financial markets: they stimulate stock trading and enhance the variability of stock prices (Peress, 2014). Media pessimism also leads to downward pressure on market prices, followed by a reversion to fundamentals (Tetlock, 2007). Moreover, individual investors overreact to stale news, suggesting that the media play a role even when disclosing already available information (Tetlock, 2011). However, it is important to note that media coverage may be influenced from three sides: the policymakers, the preferences of the general public, and the media itself. The literature suggests that media coverage may be influenced by journalistic preferences (Groseclose and Milyo, 2005), , as well as the views and preferences of the audience (Mullainathan and Shleifer 2005; Gentzkow and Shapiro, 2010). Finally, the central bank can also shape the perception of its actions in the media through its communication policy (Berger et al., 2011).

3 Data and Methodology

3.1 The Media-Based Proxy of Fed Chair's Overconfidence

To provide a quantitative measure of the confidence and optimism expressed by the Fed chair, we follow the literature in finance that relies on press portrayal in the major newspapers. As an illustration, Malmendier et al. (2011) use a media coverage proxy to classify a Chief Executive

[4]The use of news can be motivated by theories of rational inattention, where agents have limited information-processing capacity and therefore cannot absorb all available information.

Officer as overconfident if he/she is more frequently described as "confident" and "optimistic" relative to descriptors such as "frugal", "conservative", "cautious", "practical", "reliable" or "steady". The media-based proxy relies on trait theory, which uses a list of 18000 words compiled by Allport and Odbert (1936) to describe traits. More recently, the literature used factor analysis to reduce the number of traits in the list to five traits (Goldberg, 1993), the Five-Factor Model (FFM).[5]

Our measure of Fed chair's overconfidence is based both on media portrayal and the FFM. We use media coverage as a proxy to measure Fed chair's overconfidence for the period 1994M01-2015M09: (i) Alan Greenspan (1994M01-2006M01), (ii) Ben Bernanke (2006M02-2014M01) and (iii) Janet Yellen (2014M02-2015M09). We start our analysis in January 1994 because newspaper articles covering the Fed chair's communication were rare before that period. This might be because the Federal Open Market Committee (FOMC) had not announced its policy decisions before 1994.[6] But in February 1994, the FOMC started issuing a brief statement announcing a decision to change policy. From that period onward, media coverage of the FOMC's policy decisions has largely expanded.

We collect data on how the main financial and economic media portray each central banker during the sample period using the Factiva database. For each central banker, we first collect the articles published in *The New York Times*, *The Wall Street Journal*, the *Financial Times* and *The Economist* that portray the central banker as (a) "confident", "optimistic", "overoptimistic" and (b) "cautious", "conservative", "steady", "pessimistic", "gloomy","not confident" and "not optimistic" (Table 6 in the appendix provides the frequency of the keywords appearing in the articles). It is important to remind that the keywords used to compute the media-based proxy of Fed chair's overconfidence are not chosen arbitrarily but are derived from the FFM. They thus describe the individual's personality trait related to confidence and optimism.

In a second step, we read each article to check if the keywords describe the central banker and whether they are negated. Interestingly, we find that the Fed chair usually expresses confidence regarding inflation, output, and employment: "*Mr. Bernanke called the inflation fears way overstated and said he had 100% confidence he could act quickly enough to keep prices in check.*"[7] or "*This month Ms. Yellen said her confidence in the inflation outlook had been 'bolstered' by recent strong jobs numbers [...]*".[8]

Finally, we compute the media-based proxy of Fed chair's overconfidence using word count. For each month, we compare the number of words used in the newspaper articles and related to the "confident" terms, i.e., category (a), with the number of words related to the "cautious" terms, i.e., category (b). Following Malmendier et al. (2011), we consider that a Fed chair is

[5]The five factors are openness, conscientiousness, extroversion, agreeableness, and neuroticism. Each of the factors represents several highly correlated sub-factors or traits.

[6]Changes in policy decisions had to be inferred by market participants from actions taken by the Open Market Desk of the New York Fed.

[7]Sudeep Reddy, S. (2010). "U.S. News: Inflation Risk Is Low, Fed Says". *The Wall Street Journal*, December 5.

[8]Fleming, S. (2015). "Set for lift-off: All eyes on Fed's signals as rate rise expected". *Financial Times*, December 15.

overconfident if he/she is more described by the terms related to the category (a) than by the terms of the category (b). We measure overconfidence for each Fed chair at month t, OI_t, as:

$$OI_t = \frac{a_t - b_t}{Total_t}; \tag{1}$$

where a_t reflects the number of words used in the published articles at month t and related to the "confident" terms, b_t the number of words related to the "cautious" terms and $Total_t$ the total number of articles that mention the Fed chair. We control for the total number of articles in eq. (1) to address any bias due to different coverage through time. OI_t is a continuous variable that can be positive (negative) if the number of words related to the "confident" terms is higher (lower) than the number of words related to the "cautious" terms. Finally, we multiply the media-based proxy by 10 to ease its numerical interpretation. Fig. 1 shows the evolution of the media-based proxy of Fed chair's overconfidence through the sample period 1994M01-2015M09.

Figure 1: The overconfidence indicator

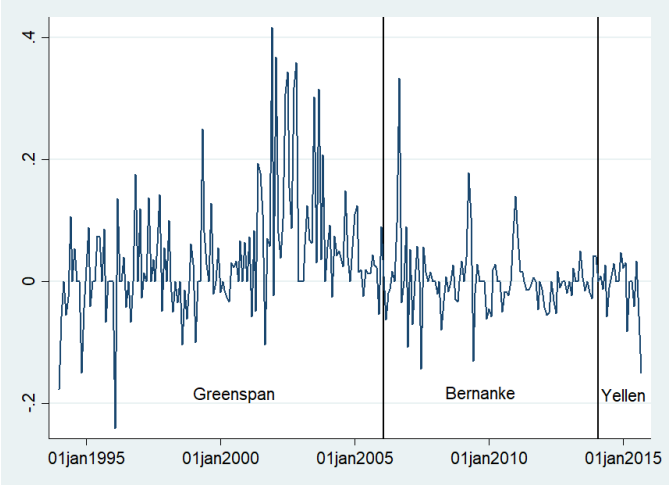


Fig. 1 shows that the media-based proxy does not display any apparent trend through time, except at the beginning of the 2000s. The nineties are characterized by a varying degree of Fed chair's overconfidence with positive and negative values. The bottom points of the media-based proxy observed in 1997 and 1998 might correspond to shocks related to the Asian financial crisis and the collapse of Long-Term Capital Management. Nevertheless, monetary policy is thought to have performed well in the nineties with a more systematic response to deviations of inflation and output (see Bernanke, 2004). This might explain the relative stability of the media-based proxy observed throughout that period. However, the overconfidence indicator increased at the beginning of the 2000s and reached its maximum value in mid-2003. This increase follows the burst of the dot-com bubble and corresponds to an era of economic expansion and an accommodative monetary policy. These economic conditions might explain the confidence and the

optimism expressed by the Fed chair (i.e., Alan Greenspan) and covered by the media. Following Greenspan's tenure, the proxy started to decline progressively until attaining the through in mid-2008, a period coinciding with the collapse of Lehman Brothers and the start of the GFC. Interestingly, the peaks observed during Bernanke's tenure correspond to specific events related to the GFC. For instance, the peak in March 2009 happens when the Fed announced that it would pump an extra one trillion into the financial system by buying Treasury bonds and mortgage securities. Similarly, the peak observed at the end of 2010 happens when the Fed implemented a second round of quantitative easing to pump 600 billion into the banking system. Finally, Fig. 1 shows that the media-based proxy is negative during Yellen's tenure for an extended time. This might be due to the criticisms that Yellen faced for its fuzzy communication about the future pace of the unconventional policy measures, and the resulting confusion felt by the media.[9]

3.2 Investor Sentiment

There are various ways to measure investor sentiment, including surveys, mutual fund flows, premia on dividend-paying stocks, closed-end fund discounts, and first-day returns on initial public offerings (IPOs). Regarding survey measures, Robert Shiller has conducted investor attitude surveys since 1989. UBS/Gallup surveys randomly-selected investor households, and Investors Intelligence (II) surveys financial newsletter writers. Fisher and Statman (2000) show that the level of II sentiment does not have any significant effect on future Standard and Poor's equity returns, which raises doubt as to whether the II index can be considered as a useful measure of investor sentiment. Baker and Wurgler (2007) suggest that economists treat surveys with some degree of suspicion because of the potential gap between how people respond to a survey and how they behave. Furthermore, Da et al. (2015) note that survey-based sentiment measures are not available in high frequency and become less reliable when non-response rates are high, or the incentive for truth-telling is low.

Therefore, we follow Baker and Wurgler (2006) (BW) and we use a sentiment index that combines several market-based variables that reflect investor's optimism and pessimism. Baker and Wurgler (2006) form a composite index of sentiment that is based on the common variation in six underlying proxies for market-based sentiment:

• The closed-end fund discount: the value-weighted average difference between the net asset values of closed-end stock mutual fund shares and their market prices;

• NYSE share turnover: log of the raw turnover ratio detrended by the past 5-year average, where the raw turnover ratio is the ratio of reported share volume to average shares listed from the NYSE Fact Book;

• The number on IPOs: monthly number of initial public offerings;

• First-day returns of IPOs: monthly average first-day returns of initial public offerings;

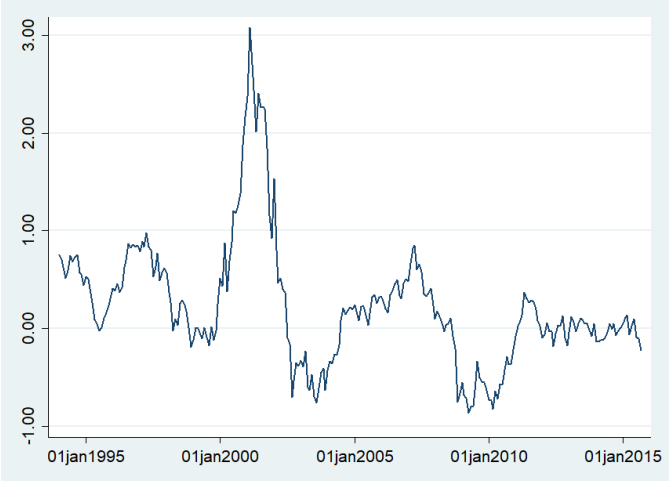
• The equity share in new issues: gross monthly equity issuance divided by gross monthly equity plus debt issuance and

[9] See, for instance: Luce E., (2015). "Waiting for Yellen". *Financial Times*, September 20.

• The dividend premium: log difference of the value-weighted average market-to-book ratios of dividend payers and nonpayers.

Since each sentiment proxy is likely to include a sentiment component as well as non-sentiment related components which reflect economic fundamentals,[10] Baker and Wurgler (2006) use principal components analysis to isolate the common component in the six proxies. They construct a second index that explicitly removes business cycle variation from each of the proxies, and they use the residuals from these regressions as sentiment proxies.[11] The resulting sentiment index is intended to capture the investor's less-than-rational behavior. Fig. 2 shows the BW sentiment index during the period 1994M01-2015M09.

Figure 2: Baker and Wurgler's (2006) sentiment index



Baker and Wurgler (2006) find that their sentiment index is in line with most of the speculative episodes of these last decades and that it is negatively related to the returns of smaller stocks, high volatility stocks, unprofitable stocks, non-dividend-paying stocks, extreme-growth stocks, and distressed stocks. Moreover, the BW sentiment index has been widely used in several studies, such as Yu and Yuan (2011) and Stambaugh et al. (2012). Their empirical results are consistent with the evidence that investor sentiment drives prices and returns in the market, which in turn affects macroeconomic activity.

3.3 Empirical Setup

Investor sentiment is a combination of market expectations based on economic fundamentals and non-fundamentals, like, e.g., irrational exuberance (Shleifer and Summers, 1990 and Brown and Cliff, 2005). We thus need to disentangle the component of the BW sentiment index that

[10] For instance, IPO volume depends, in part, on prevailing investment opportunities.

[11] As proxies for the business cycle variation, they use growth in the industrial production index, growth in consumer durables, nondurables, and services, and a dummy variable for NBER recessions.

is related to economic fundamentals from the component that is related to non-fundamentals. We follow the literature and consider that variables such as the unemployment rate, inflation, production growth rate, interest rate, yield spreads, and market volatility constitute relevant proxies for economic fundamentals. We highlight the relationship between the BW sentiment index and the (non)-fundamental variables as follows:

$$Sent_t = \alpha + \beta_1 \underbrace{OI_t}_{\text{non-fundamental}} + \beta_2 \underbrace{X_{Macro,t} + \beta_3 X_{Fin,t}}_{\text{fundamentals}} + \varepsilon_t; \tag{2}$$

where $Sent_t$ reflects the BW sentiment index and OI_t the media-based proxy of Fed chair's overconfidence. $X_{Macro,t}$ is a vector of macroeconomic variables that includes the unemployment rate ($Unemp_t$), the inflation (CPI_t) and the growth rate of the industrial production (Ind_t). We also consider four financial market variables in the vector $X_{Fin,t}$ that have been frequently used as indicators of the business cycle: the 3-month Treasury Bill rate ($Tbill_t$), the default spread defined as the difference in yields between BAA and AAA rate corporate bonds (Def_t), the term spread defined as the difference in yields between the 10-year Treasury bond and the 3-month T-bill ($Term_t$) and the CBOE volatility index ($MktVol_t$). Finally, ε_t is the error term.

The data are obtained from the Federal Reserve Bank of St. Louis. The inclusion of many different explanatory variables at the same time might give rise to multicollinearity problems. Hence, we calculate the variance inflation factors (VIFs) and we find that in all cases, all VIFs are well below the rule of thumb threshold of 10. Table 1 provides the summary statistics of the data.

Table 1: Summary Statistics

	Mean	Median	Std	Min	Max	No. of Obs.
$Sent_t$	0.24	0.13	0.64	-0.87	3.08	261
OI_t	0.02	0	0.09	-0.24	0.41	261
$Unemp_t$	5.99	5.6	1.65	3.8	10	261
CPI_t	0.18	0.19	0.25	-1.8	1.4	261
Ind_t	0.16	0.20	0.66	-4.33	2.05	261
$Tbill_t$	2.59	2.19	2.19	0.01	6.17	261
$Term_t$	1.75	1.87	1.15	-0.69	3.68	261
Def_t	0.96	0.87	0.43	0.55	3.38	261
$MktVol_t$	20.28	19.06	7.99	10.78	62.25	261

This table reports summary statistics for the Barker and Wurgler's (2006) investor sentiment, the media-based proxy of the Fed chair's overconfidence indicator and 7 macroeconomic and financial variables. We present the mean, the median, the standard deviation, the minimum and the maximum values, and the number of observations. The variables are: the investor sentiment ($Sent_t$), the overconfidence indicator (OI_t), the unemployment rate ($Unemp_t$), the inflation rate (CPI_t), the change in the industrial production (Ind_t), the T-bill rate ($Tbill_t$), the default spread (Def_t), the term spread ($Term_t$) and the CBOE volatility index ($MktVol_t$). Our sample period is from January 1994 until September 2015. All variables are measured at a monthly frequency.

Since these variables can be influenced by sentiment and thus carry information about it, the estimated parameters from eq. (2) may be biased and inconsistent. To tackle this issue, the independent variables related to those parameters are instrumentalized. However, an additional issue is the presence of heteroskedasticity, which invalids the diagnostic tests for endogeneity and over-identification. As suggested by Baum et al. (2003), this problem can be addressed with the Generalized Method of Moments (GMM) estimator introduced by Hansen (1982). The GMM estimator uses the conditions to allow for efficient estimation in the presence of heteroskedasticity of unknown form. For the instruments, we use a constant and the lagged values of the explained and explanatory variables since they should signal future developments of the independent variables while being uncorrelated with the error term. Moreover, we face the problem that some instrumental variables are not necessary and distort our results. Hansen (1982) suggests a test for the validity of instruments by making a standard J-test for the validity of the over-identifying restrictions.

4 Results

4.1 Baseline Model

Table 2 shows the estimated results of eq. (2) for the period 1994M01-2015M09. To ease the concern that we use too many variables and over-fit the model, we estimate three separate sets of models. In the first (second) set, we only include macroeconomic (financial) variables. In the third set, we include all the variables. We focus our analysis on the coefficients that have a consistent value and significance across the different specifications.

Table 2: Investor Sentiment and Fed chair's Overconfidence (1994M01-2015M09)

Variable	Specification 1	Specification 2	Specification 3
$Const$	2.08***	0.35	2.07***
	(0.31)	(0.23)	(0.5)
OI_t	2.93***	8.82***	3.27***
	(1.06)	(1.25)	(0.67)
$Unemp_t$	-0.3***		-0.15***
	(0.04)		(0.048)
CPI_t	-0.05		0.005
	(0.16)		(0.09)
IPI_t	-0.2		-0.02
	(0.12)		(0.06)
$Tbill_t$		0.04	-0.07
		(0.03)	(0.05)
Def_t		-0.37**	-0.33**
		(0.15)	(0.16)
$Term_t$		-0.18***	-0.19**
		(0.06)	(0.08)
Vix_t		0.01	-0.01
		(0.007)	(0.007)
J-test	0.9	0.9	0.9
Adjusted-R^2	0.25	0.33	0.35
Obs.	253	253	253

The dependent variable is the BW sentiment index, $Sent_t$. Standard errors are shown in between brackets. Estimates are obtained using two-steps GMM. *, **, *** denote significance at the 10%, 5%, and 1% levels, respectively. J-test is the p-value of the test of over-identifying restrictions. The list of instrumental variables includes a constant and the lags of the dependent and the independent variables. The results are robust to the number of lags included in the set of instruments.

Table 2 shows that financial variables are more likely to be related to investor sentiment than the macroeconomic variables. The first specification with macroeconomic variables has an adjusted-R^2 of 25% while the second specification with financial variables has an adjusted-R^2 of 33%. Interestingly, we find that the media-based proxy of Fed chair's overconfidence, OI_t, is significantly and positively related to investor sentiment regardless of the specification considered in the analysis; that is, when the Fed chair is more described by the media with "confident" terms relative to "cautions" terms, investor sentiment is more likely to increase. In terms of economic magnitude, the coefficient related to OI_t in specification 3 shows that an increase of one standard-deviation (SD) of the overconfidence indicator is associated with an increase of 0.45% of a SD in investor sentiment.

Regarding the macroeconomic and financial variables, the results show that the unemployment rate is negatively and significantly related to investor sentiment. Hence, specification 3 suggests that a one SD increase in the unemployment rate is associated with a 0.38% SD decrease of investor sentiment. For the financial variables, the default and the term spread affect

negatively and significantly investor sentiment. More precisely, a one SD increase of the default (term) spread is associated with a decrease of 0.22% (0.34%) SD in investor sentiment.

All in all, these results provide the first empirical evidence showing that media coverage of Fed chair's overconfidence is positively related to investor sentiment. Moreover, we find that some macroeconomic and financial variables are also significantly associated with investor sentiment.

4.2 Negativity and Positivity Bias

Research in psychology shows that an individual's behavior to positive and negative information is asymmetric; the effect of a 1-unit increase in negative news is not the opposite of a 1-unit increase in positive news. Several theories have been proposed by the psychology literature to explain this asymmetry, such as the perspective theory or the cognitive weighting theory (Soroka, 2006). In economics, prospect theory (Kahneman and Tversky, 1979) suggests a similar asymmetry of positive and negative news on an individual's behavior. Prospect theory highlights that people care more strongly about a loss in utility than they do about a gain of equal magnitude.

Earlier studies found empirical evidence of this asymmetry. Nofsinger and Prucyk (2003) consider the volume and volatility effects of 21 macroeconomic news announcements on S&P100 stock index options. They find that bad (good) news is associated with higher (lower) volume and volatility. Soroka (2006) makes a content analysis of economic news in *The Times* and provides evidence of asymmetries in individuals' attitudes to positive and negative information. Finally, Akhtar et al. (2012) find that when a lower consumer sentiment index is announced, equity and futures markets experience a significant negative announcement day effect.

Against this background, we aim to test the asymmetric response of investor sentiment to central bank communication. More specifically, we test whether there is a "negativity" or a "positivity" bias in the overconfidence-sentiment relationship;[12] that is, whether investor sentiment has an asymmetric relationship to a negative or a positive change of Fed chair's overconfidence.[13] The estimation takes the following form:

$$Sent_t = \alpha + \beta_1 \Delta OI_{pos,t} + \beta_2 \Delta OI_{neg,t} + \beta_3 X_{Macro,t} + \beta_4 X_{Fin,t} + \varepsilon_t; \tag{3}$$

where $\Delta OI_{pos,t}$ ($\Delta OI_{neg,t}$) reflects a positive (negative) change of the Fed chair's overconfidence. $\Delta OI_{pos,t}$ ($\Delta OI_{neg,t}$) is different (equal) to 0 where there is a positive change and is equal (different) to 0 where there is a negative change. The rest of the left-hand and right-hand side variables are similar to eq. (2). Table 3 shows the results of the estimation of eq. (3) for the period 1994M01-2015M09.

[12] Chen et al. (2004) document a "positivity" bias by showing that firms added to the S&P500 experience a positive price return, while firms that are removed do not experience a negative price return.

[13] We also use the sign of the overconfidence indicator rather than the sign of the change in the empirical analysis. We find similar quantitative and qualitative results.

Table 3: Investor Sentiment and the Negativity/Positivity Bias (1994M01-2015M09)

Variable	Specification 1	Specification 2	Specification 3
$Const$	1.49***	0.26*	2.39***
	(0.27)	(0.14)	(0.69)
$\Delta OI_{pos,t}$	3.6***	6.69***	3.81***
	(0.97)	(0.53)	(1.35)
$\Delta OI_{neg,t}$	-4.1***	-6.62***	-9.9***
	(0.91)	(0.55)	(2.32)
$Unemp_t$	-0.26***		-0.11*
	(0.04)		(0.06)
CPI_t	0.16		-0.33
	(0.13)		(0.27)
IPI_t	-0.08		-0.46**
	(0.09)		(0.18)
$Tbill_t$		-0.03	-0.16**
		(0.02)	(0.07)
Def_t		-0.71***	-1.15***
		(0.082)	(0.27)
$Term_t$		-0.28***	-0.27***
		(0.04)	(0.1)
Vix_t		0.03***	0.01
		(0.004)	(0.01)
J-test	0.9	0.9	0.9
Adjusted R^2	0.25	0.34	0.37
Obs.	251	248	255

The dependent variable is the BW sentiment index, $Sent_t$. Standard errors are shown in between brackets. Estimates are obtained using two-steps GMM. *, **, *** denote significance at the 10%, 5%, and 1% levels, respectively. J-test is the p-value of the test of over-identifying restrictions. The list of instrumental variables includes a constant and the lags of the dependent variable and the independent variables. The results are robust to the number of lags included in the set of instruments.

Table 3 reveals that a positive (negative) change of the overconfidence indicator is significantly associated with higher (lower) investor sentiment. Regarding the economic magnitude, specification 3 shows that an increase of one SD of $\Delta OI_{pos,t}$ ($\Delta OI_{neg,t}$) is associated with an increase (decrease) of 0.41% (0.46%) SD in investor sentiment. Some parameters related to the macroeconomic and financial variables have consistent significance and are in line with the findings of the baseline model (see Table 2): the unemployment-sentiment relationship is negative, and an increase of the default spread or the term spread is associated with lower investor sentiment.

Overall, we do not find evidence that a negative change of the overconfidence indicator has a stronger relationship to investor sentiment than a positive change.

4.3 Investor Sentiment during Recession

The literature from psychology and economics finds that investors' sensitivity to news is higher during a period of recession. As an illustration, Garcia (2013) shows that that the link between media content and the Dow Jones Industrial Average returns is concentrated in times of hardship, proxied by the NBER recession dates. To explain this finding, the psychology literature argues that emotions affect decision-making abilities, and thus, that investors use different decision-making rules in recessions than in expansions (Gino et al., 2009). Against this backdrop, we test if there is a "recession effect" on the overconfidence-sentiment relationship as follows:

$$Sent_t = \alpha + (1 - D_t)\beta_1 OI_t + D_t\beta_2 OI_t + \beta_2 X_{Macro,t} + \beta_3 X_{Fin,t} + \varepsilon_t; \tag{4}$$

$$Sent_t = \alpha + (1 - D_t)\beta_1 \Delta OI_{pos,t} + D_t\beta_2 \Delta OI_{pos,t} + \beta_3 X_{Macro,t} + \beta_4 X_{Fin,t} + \ \varepsilon_t; \tag{5}$$

$$Sent_t = \alpha + (1 - D_t)\beta_1 \Delta OI_{neg,t} + D_t\beta_2 \Delta OI_{neg,t} + \beta_3 X_{Macro,t} + \beta_4 X_{Fin,t} + \ \varepsilon_t; \tag{6}$$

where D_t is a dummy variable that takes on the value one if and only if date t is during a recession and 0 otherwise. We follow the NBER classification to identify recession periods (Fig. 3 in the appendix). Our sample thus contains 28 recession months. Eq. (4) uses the overconfidence indicator in level while eqs. (5) and (6) use positive and negative changes of the overconfidence indicator, respectively. Table 4 shows the estimated results of eqs. (4), (5) and (6) for the period 1994M01-2015M09.

Table 4: Investor Sentiment during Recession (1994M01-2015M09)

Variable	Specification 1	Specification 2	Specification 3
$Const$	2.29***	3.53***	3.28***
	(0.25)	(0.71)	(0.77)
$OI_{rec,t}$	11.75***		
	(0.89)		
$OI_{norec,t}$	3.37***		
	(0.29)		
$\Delta OI_{pos,rec,t}$		20.18***	
		(4.18)	
$\Delta OI_{pos,norec,t}$		2.22***	
		(0.82)	
$\Delta OI_{neg,rec,t}$			-19.03***
			(5.39)
$\Delta OI_{neg,norec,t}$			-10.07***
			(2.04)
$Unemp_t$	-0.15***	-0.34***	-0.18***
	(0.02)	(0.07)	(0.06)
CPI_t	-0.37***	-0.67***	-0.57**
	(0.07)	(0.18)	(0.27)
IPI_t	-0.01	0.45***	-0.61***
	(0.04)	(0.09)	(0.16)
$Tbill_t$	-0.08***	-0.2***	-0.17**
	(0.02)	(0.06)	(0.08)
Def_t	-0.56***	-0.09	-1.21***
	(0.1)	(0.18)	(0.24)
$Term_t$	-0.26***	-0.19**	-0.24**
	(0.04)	(0.08)	(0.09)
Vix_t	0.003	-0.02***	0.0001
	(0.004)	(0.07)	(0.01)
J-test	0.9	0.9	0.9
Adjusted R^2	0.46	0.41	0.38
Obs	251	253	255

The dependent variable is the BW sentiment index, $Sent_t$. Standard errors are shown in between brackets. Estimates are obtained using two-steps GMM. *, **, *** denote significance at the 10%, 5%, and 1% levels, respectively. J-test is the $p$value of the test of overidentifying restrictions. The list of instrumental variables includes a constant and the lags of the dependent variable and the independent variables. The results are robust to the number of lags included in the set of instruments.

Table 4 shows that the relationship between the media-based proxy of Fed chair's overconfidence and investor sentiment is stronger during recession. Interestingly, this finding holds even when distinguishing between positive and negative changes in the indicator. As a case in point, specification 1 shows that a one SD increase of the overconfidence indicator during a recession (expansion) is associated with an increase of 0.55% (0.27%) SD in investor sentiment. Our results

thus support the hypothesis that the overconfidence-sentiment relationship is stronger during bad times, and are in line with the literature that shows that investors are more sensitive to news during recessions.

Regarding the macroeconomic and financial variables, we find that unemployment, inflation, the 3-month Treasury Bill rate, and the default and term spreads are negatively and significantly related to investor sentiment. These findings are in line with those of the baseline model (see Table 2).

4.4 Underreaction Bias

The literature in finance and psychology shows that with the underreaction hypothesis, investors incorporate and reflect new information into prices slowly. Investors' underreaction might occur as a result of conservatism or overconfidence. This psychological bias implies that individuals are slow to change their beliefs in the face of new evidence. Barberis et al. (1998) rely on the conservatism bias to show that the way investors form sentiment is consistent with the underreaction hypothesis. Hence, investors are reluctant to adjust their sentiment immediately to changes in the news. Daniel et al. (1998) use overconfidence to model investor behavior. In their model, an overconfident investor overestimates the precision of his private signal compared to the public signal. They find that overconfident investors hold too firmly their information and discount public signals, that is, stock prices overreact to private signals and underreact to public signals.

The empirical literature supports this theoretical evidence. Chan (2003) shows that investors ignore the balance of the headlines, i.e., they pay attention only to the news that supports their prior. McCombs (2004) argues that the news media effect on financial markets can be achieved only in the long-term. Finally, most of the research on stock returns after specific news items support the hypothesis of underreaction.[14] We thus hypothesize that investors might be slow in fully reflecting changes of the media-based proxy of Fed chair's overconfidence in their sentiment. To test this hypothesis, we estimate the following model:

$$Sent_t = \alpha + \beta_1 OI_{t-\tau} + \beta_2 X_{Macro,t} + \beta_3 X_{Fin,t} + \varepsilon_t; \tag{7}$$

where $OI_{t-\tau}$ (with τ= 1, 2, or 3) is the lagged value of the media-based proxy of Fed chair's overconfidence. The rest of the left-hand and right-hand side variables are similar to eq. (2). Eq. (7) tests whether investors are quickly adjusting their sentiment to central bank communication, or whether they are reluctant to incorporate the new public information in their information set. Table 5 presents the results of the estimation for the period 1994M01-2015M09.

[14] For a review of the literature, see Kräussl and Mirgorodskaya (2017).

Table 5: Investor Sentiment and the Underreaction Bias (1994M01-2015M09)

Variable	Specification 1	Specification 2	Specification 3
$Const$	2.38***	1.91***	1.55***
	(0.54)	(0.48)	(0.58)
OI_{t-1}	4.56***		
	(0.96)		
OI_{t-2}		2.38***	
		(0.54)	
OI_{t-3}			1.74*
			(1.01)
$Unemp_t$	-0.14***	-0.14***	-0.11*
	(0.04)	(0.04)	(0.05)
CPI_t	-0.18	0.16	0.11
	(0.13)	(0.1)	(0.16)
IPI_t	-0.08	-0.07	-0.05
	(0.08)	(0.06)	(0.11)
$Tbill_t$	-0.13**	-0.1**	-0.06
	(0.05)	(0.04)	(0.06)
Def_t	-0.58***	-0.39**	-0.44*
	(0.19)	(0.17)	(0.24)
$Term_t$	-0.33***	-0.26***	-0.11
	(0.08)	(0.07)	(0.13)
Vix_t	0.005	0.008	0.009
	(0.009)	(0.008)	(0.01)
J-test	0.9	0.9	0.9
Adjusted R^2	0.35	0.36	0.36
Obs.	253	251	254

The dependent variable is the BW sentiment index, $Sent_t$. Standard errors are shown in between brackets. Estimates are obtained using two-steps GMM. *, **, *** denote significance at the 10%, 5%, and 1% levels, respectively. J-test is the p-value of the test of overidentifying restrictions. The list of instrumental variables includes a constant and the lags of the dependent variable and the independent variables. The results are robust to the number of lags included in the set of instruments.

Table 5 suggests no evidence of an underreaction bias from investors when the Fed chair communicates his/her confidence and optimism. Quite the opposite, the results show that the overconfidence-sentiment relationship is stronger one month after the Fed chair's communication. Hence, we find that the relationship between the overconfidence indicator and investor sentiment is stronger at $t+1$, and then, $t+2$. At $t+3$, the relationship is significant at the 10% level only.

In terms of economic magnitude, a one SD increase in the overconfidence indicator is related to an increase of 0.64% SD of investor sentiment at $t+1$, 0.33% at $t+2$ and 0.24% at $t+3$. Hence, these findings are not in accordance with the literature about the underreaction bias of investors. However, and interestingly, if we compare these results with those of the baseline model (Table 2 - specification 3), it seems that investor sentiment has the strongest relationship to Fed chair's overconfidence one month after the communication and not at the same month.

This shows that investors need some time to digest the communication of the Fed chair and to adjust their sentiment.

Finally, regarding the macroeconomic and financial variables, we obtain similar results as in the baseline model (Table 2); that is, the unemployment rate and the default and the term spread are negatively associated to investor sentiment.

5 Robustness Tests

We consider several robustness tests to assess the relevance of our findings. First, we employ a vector autoregressive (VAR) model to (i) highlight the dynamic overconfidence-sentiment relationship and to (ii) consider potential endogeneity problems. More specifically, we use a bivariate VAR between the overconfidence indicator and investor sentiment.[15] Since the overconfidence indicator is found to have an instantaneous relationship to sentiment (cf. section 4.1); the ordering of the variables is as follows: (1) overconfidence indicator, (2) sentiment index.[16] Second, we test whether the overconfidence-sentiment relationship is robust to different sentiment measures, such as (i) the Yale's International Center for Finance stock market confidence index and (ii) the University of Michigan's Consumer Sentiment Index. Third, Blinder et al. (2017) find that in the aftermath of the GFC, central banks (including the FOMC) communicated more extensively. We thus split our sample before and after the GFC to check whether investor sentiment reacts differently to central bank communication following the burst of the GFC.[17] Fourth, recent evidence (Aastveit et al., 2017) show that monetary policy in the US is found to have weaker effects when uncertainty is high. We include the Economic Policy Uncertainty (EPU) index developed by Baker et al. (2016) to control for any uncertainty-related "signaling channel" expressed by the Fed chair. Fifth, to control for persistent unobserved factors, we include the lagged value of the overconfidence indicator as an additional right-hand side variable in eq. (2) and we exclude it from the set of instruments. Sixth, we add the lagged dependent variable as an additional regressor to overcome a potential omitted variable bias. Seventh, the procedure of separating the fundamentals from non-fundamentals in eq. (2) does not guarantee that no important fundamental is omitted. Hence, we include additional control variables in the empirical specification to make sure the part left is a relevant proxy of the non-fundamental part of the sentiment.[18] Finally, we use another normalization to compute the overconfidence indicator and we include it in the baseline specification, eq. (2):

$$OI_t = \frac{a_t - b_t}{a_t + b_t}; \tag{8}$$

[15] The lag length is equal to 12 and is determined using the AIC criteria.

[16] The impulse response is robust to the ordering of the variables. Results available upon request.

[17] We consider the collapse of Lehman Brothers in September 2008 as a breakpoint.

[18] The additional control variables are: (i) the personal consumption expenditure, (iii) the trade-weighted U.S. exchange rate, (iii) the S&P 500 index, (iv) the spread between the 3-Month Treasury Bill and the Federal Funds Rate and (v) the spread between the 10-Year Treasury Constant Maturity with the Federal Funds Rate.

Table 7 in the appendix shows the value of the coefficient reflecting the overconfidence-sentiment relationship. The results suggest that even when using different sentiment measures as dependent variable and controlling for the (i) the economic policy uncertainty index, (ii) persistent unobserved factors, (iii) omitted variable bias, and (iv) additional macroeconomic and financial variables in the empirical specification; investor sentiment is positively and significantly related to the media-based proxy of Fed chair's overconfidence. Furthermore, Fig.(4) and the Granger-causality Wald tests suggest that a positive shock of the overconfidence indicator is significantly associated with a highly persistent increase in the investor sentiment, and that overconfidence Granger-cause sentiment while sentiment does not Granger-cause overconfidence.[19] Interestingly, we find that the IRF is no longer significant after 18 months, thus showing that the sentiment-overconfidence relationship dies out after one year and half. However, we do not find evidence of a stronger overconfidence-sentiment relationship after the GFC. Finally, the alternative overconfidence measure described in eq. (8) delivers similar qualitative results as the baseline one, eq. (1), although its significance is at the 10% level only.

Conclusion

Sentiment is a central concept to understanding fluctuations in market expectations that are not necessarily related to economic fundamentals. In this paper, we highlight an additional variable related to investor sentiment, central bank communication. We assess the relationship of the optimism and the confidence expressed by the chair of the Federal Reserve, as covered by the media, with investor sentiment. For that purpose, we collect articles from four leading economic and financial newspapers (*The New York Times*, *The Wall Street Journal*, the *Financial Times*, and *The Economist*) that cover Fed chair's communication. Second, we use word count as in Malmendier et al. (2011) to quantify the degree of optimism and confidence expressed by the Fed chair and covered by the newspapers for the period 1994M01-2015M09. We call this measure the overconfidence indicator. Finally, we relate the overconfidence indicator to the Baker and Wurgler's (2006) investor sentiment index. The results show that an overconfident Fed chair is positively and significantly associated with investor sentiment.

Furthermore, we find that investors are more sensitive to central bank communication during a recession and that they adjust rapidly their sentiment following the communication of the central bank. However, we do not find evidence of a "negativity bias"; i.e., that a negative change of the overconfidence indicator has a stronger relationship with investor sentiment than a positive one. These findings shed some new light on the role of central bank communication in shaping investor sentiment, in particular during a recession and in the context of the zero lower bound on nominal interest rates.

[19] To save space, Granger causality Wald tests are available upon request.

Appendix

Table 6: Frequency of the keywords

Keyword	**Frequency**
confident	148
optimistic	400
overoptimistic	12
Total	**560**
cautious	285
conservative	23
steady	16
pessimistic	16
gloomy	21
not confident	17
not optimistic	12
Total	**390**

This table reports the number of keywords used in the articles and published in *The New York Times*, *The Wall Street Journal*, the *Financial Times* and *The Economist* to describe the Fed chair during the period 1994M01-2015M09.

Table 7: Robustness Tests (results)

Different sentiment measures		
	Yale's stock market confidence index	Michigan's Consumer Sentiment Index
OI_t	0.53***	0.46***
	(0.10)	(0.15)
	Pre-crisis period (1994M01-2008M09)	**Post-crisis period (2008M10-2015M09)**
OI_t	1.86***	2.38***
	(0.38)	(0.53)
Controlling for the EPU index		
OI_t	1.61***	
	(0,54)	
Controlling for a lagged effect in the overconfidence indicator		
OI_t	2.82***	
	(0.44)	
OI_{t-1}	0.047	
	(0.39)	
Controlling for omitted variables bias		
OI_t	1.34***	
	(0.20)	
Additional control variables		
OI_t	1.6***	
	(0.48)	
Alternative measure of overconfidence		
OI_t	0.63*	
	(0.35)	

This table reports the results related to the overconfidence-sentiment relationship (OI_t) when (i) using different sentiment measures as dependent variable, (ii) splitting the sample before and the after the GFC, (iii) controlling for economic policy uncertainty, (iv) controlling for persistent unobserved factors, (v) controlling for omitted variables bias, (vi) adding additional control variables, and (vii) using an alternative measure of the overconfidence indicator. Standard errors between brackets

Figure 3: NBER based recession indicator for the United States

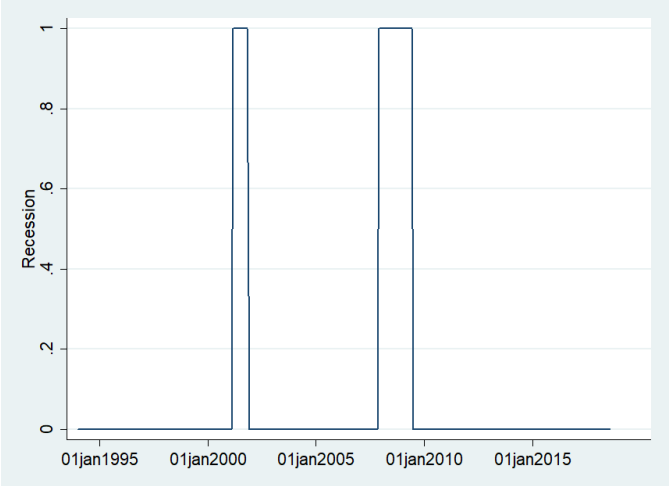
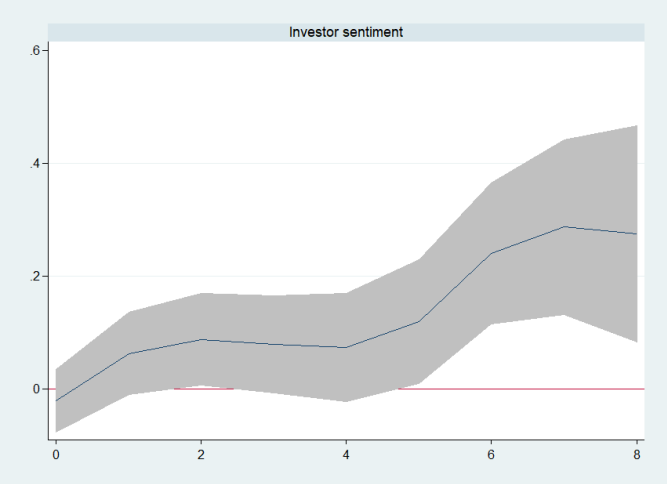


Figure 4: Effect of overconfidence on sentiment measure



Note: The figure presents the orthogonalized response of a one-standard-deviation impulse of the overconfidence indicator on the sentiment measure. Time (horizontal axis) is in months. The dark shaded area indicate 95% confidence intervals.

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