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# Sentiment and the U.S. business cycle

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ABSTRACT

Psychological factors are commonly believed to play a role on cyclical economic fluctuations, but they are typically omitted from state-of-the-art macroeconomic models.

This paper introduces "sentiment" in a medium-scale DSGE model of the U.S. economy and tests the empirical contribution of sentiment shocks to business cycle fluctuations.

The assumption of rational expectations is relaxed. The paper exploits, instead, observed data on expectations in the estimation. The observed expectations are assumed to be formed from a *near*-rational learning model. Agents are endowed with a perceived law of motion that resembles the model solution under rational expectations, but they lack knowledge about the solution's reduced-form coefficients. They attempt to learn those coefficients over time using available time series at each point in the sample and updating their beliefs through constant-gain learning. In each period, however, they may form expectations that fall above or below those implied by the learning model. These deviations capture excesses of optimism and pessimism, which can be quite persistent and which are defined as sentiment in the model. Different sentiment shocks are identified in the empirical analysis: waves of undue optimism and pessimism may refer to expected future consumption, future investment, or future inflationary pressures.

The results show that exogenous variations in sentiment are responsible for a sizable (above forty percent) portion of historical U.S. business cycle fluctuations. Sentiment shocks related to investment decisions, which evoke Keynes' animal spirits, play the largest role. When the model is estimated imposing the rational expectations hypothesis, instead, the role of structural investment-specific and neutral technology shocks significantly expands to capture the omitted contribution of sentiment.



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## 1. Introduction

Economists have always recognized the importance of expectations for aggregate economic behavior. Some of the most influential economic thinkers of the past century attributed explicitly to the volatility of expectations a prime role in explaining the existence and depth of business cycles.

Keynes emphasized in the *General Theory* the importance of changes in expectations that are not necessarily driven by rational probabilistic calculations, but which are rather motivated by what he famously labeled "animal spirits". In particular, entrepreneurs' animal spirits related to their investment decisions were theorized of being a major determinant of economic fluctuations. Pigou (1927) also thought of business cycles as being largely driven by expectations and he stressed entrepreneurs' errors of optimism and pessimism as key drivers of fluctuations in real activity.

Expectations maintain a central, although different, role in modern state-of-the-art general equilibrium models. Expectations are almost universally modeled as formed according to the rational expectations hypothesis. As a result, at least in models with a determinate equilibrium, expectational errors can be solved out as a function of fundamental shocks and they disappear as autonomous sources of dynamics. Hence, there is typically no scope for fluctuations in expectations in the spirit of those emphasized by Keynes, and which are driven by animal spirits, market psychology, sentiment, or by any expectational shift that cannot be reconnected to primitive structural disturbances.[2]

In state-of-the-art DSGE models, the main sources of fluctuations are typically shocks to demand, such as exogenous shifts in preferences, risk-premia, and monetary and fiscal policies, shocks related to technology, such as Hicks-neutral or investment specific technology shocks, or to market power, such as price and wage markup shocks. While the empirical DSGE macro literature disagrees on the relative contributions of each shock, most of it implicitly agrees on assigning a nil role to explanations based on non-fundamental expectational shifts, such as swings in sentiment that are not necessarily motivated by fundamentals.

This paper offers an alternative approach. It revisits a benchmark DSGE model that is often used to characterize the dynamics of the U.S. economy at business cycle frequencies. But the model is extended to incorporate "sentiment", which represents waves of optimism and pessimism that are exogenous to the state of the economy.

The stringent informational requirements of rational expectations are relaxed. In their place, I will exploit observed data on expectations, obtained from the Survey of Professional Forecasters, in the estimation.

The observed expectations are assumed to be, on average, the outcome of a near-rational expectation formation process, which allows for learning by economic agents. Agents form expectations based on a linear model that has the same structural form of the system solution under rational expectations (i.e., the model used by agents is correctly-specified, since it contains the same regressors). The paper, however, relaxes the assumption that economic agents in the model have an informational advantage over the econometrician estimating the model. Here, at each point in the sample, economic agents can observe only historical data up to that point and they form beliefs about the reduced-form model coefficients by estimating simple regressions. The framework allows for deviations from rational expectations, but the deviation is meant to be small: agents still use a correctly-specified model. Such small deviations set the learning literature apart from starker alternatives that abandon rational expectations to assume, for example, simple heuristic rules (e.g., Grauwe, 2012).

Although expectations are formed, on average, from the learning model, economic agents can, in every period, form expectations that deviate from the point forecasts that their learning model yields. These deviations of actual expectations from their levels that can be explained by a near-rational model with learning are interpreted as denoting exogenous waves of undue optimism or pessimism, and define the "sentiment" terms in the model. Sentiment shocks are, therefore, identified from the dynamic interactions between observed expectations and realized macroeconomic time series.

The DSGE model is estimated using Bayesian techniques and adding data on observed expectations about consumption, investment, and inflation to the set of observables to match. The main scope in the empirical analysis lies in studying the empirical contribution of these newly-defined sentiment shocks to macroeconomic fluctuations.

**Main Results.** The empirical results show that sentiment shocks explain a sizable portion of U.S. business cycle fluctuations. Sentiment explains more than forty percent of the variability of output and consumption at business cycle horizons, and around sixty percent of the variability of investment and inflation. The most important component of sentiment consists of sentiment related to future investment expectations, which is found to be the single main driver of business cycle movements. Inflation is driven by structural price markup shocks in the short-run; their transmission is, however, very quick, and market participants' sentiment about inflationary pressures becomes predominant at frequencies above one year.

If learning and sentiment are shut down and the conventional assumption of rational expectations is re-imposed, technology shocks become the dominant source of aggregate fluctuations (in both forms of investment-specific and neutral technology shocks), as theorized by the RBC literature. The contribution of technological changes for booms and busts significantly rises to close the gap induced by the omitted role of households and firms' sentiment.

[2] Animal spirits may, instead, be reintroduced under rational expectations by assuming equilibrium indeterminacy: the expectational errors in that case are not only a function of structural disturbances, but also of exogenous sunspot variables. There is a conspicuous literature, surveyed in Benhabib and Farmer (1999), which is focused on studying indeterminacy and sunspots in macroeconomic models. The work in this area has, however, been more often theoretical than empirical (Lubik and Schorfheide, 2004, and Farmer et al., 2015, are two exceptions, which provide techniques to perform econometric analyses of sunspots in general equilibrium models). This paper's approach differs from the indeterminacy literature as it can imply self-fulfilling fluctuations even when the equilibrium is unique.