

# Sentiments

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## Abstract

This paper seeks to reassess the role of expectations as a source of aggregate economic fluctuations. Our model economy admits a unique equilibrium, leaving no room for sunspots. Nevertheless, the equilibrium business cycle is partly driven by shocks that (i) are orthogonal to all the underlying shocks to technologies, preferences and other economic fundamentals; (ii) are orthogonal to the expectations that economic agents hold about these shocks; and (iii) cause variation in the agents' expectations of aggregate economic activity. These shocks can thus be interpreted as *sentiments*. They emerge when, and only when, information is dispersed; they represent independent variation in higher-order beliefs; and they can be formalized either by allowing a sufficient rich set of private signals or by introducing a certain type of heterogeneous priors. Because the equilibrium is unique, simple Ramsey-like policies can insulate the economy from this type of sentiment shocks. This is in contrast to previous work on sunspot equilibria, where policy analysis is often severely inhibited by equilibrium indeterminacy. Finally, the optimality of policy intervention is addressed by appropriate constrained efficiency concepts.

# 1 Introduction

What causes economic fluctuations? And what is the role of expectations, and market sentiments, over the business cycle? This paper seeks to provide a novel perspective on these questions—one that highlights a distinct role that expectations, and a certain form of rational sentiment, can play as a source of business-cycle fluctuations *when, and only when*, information is dispersed.

The aforementioned questions have been at the core of macroeconomics at least since Keynes argued that economic fluctuations are often triggered by people’s “animal spirits” or random market “sentiments”. Keynes was sufficiently vague that one could give multiple interpretations to his writings, some of which would not be particularly flattering. However, an elegant formalization was provided in the 80’s and 90’s by models in which equilibrium fluctuations were driven by sunspots—random variables that were unrelated to fundamentals, could be interpreted as sentiments, and sustained self-fulfilling variation in expectations of aggregate economic activity.<sup>1</sup>

While many appreciated these models for the crucial role they attributed to expectations, many also grew dissatisfied. First, some felt that the external effects or market frictions upon which these theories relied—e.g., the strong production spillovers in Benhabib and Farmer (1994)—were implausible within the context of business cycles.<sup>2</sup> Second, some argued that these theories were incomplete, that they needed to be enriched in such a way that the indeterminacy would vanish and a unique equilibrium would be selected. Finally, these models were inconvenient for policy analysis, because they would not deliver a simple unique mapping from policies to equilibrium outcomes.

Nowdays, mainstream business-cycle analysis has shifted away from sunspots. Both the RBC and the New-Keynesian paradigms focus on unique-equilibrium models in which the fluctuations are driven solely by exogenous shocks to fundamentals (technologies, preferences, endowments, market structures, and government policies), or by exogenous news about these fundamentals.<sup>3</sup> The endogenous expectations that agents form about aggregate economic activity play only a secondary role: they are, of course, an integral part of the equilibrium and they matter for the propagation of the aforementioned shocks, but they are not themselves the origin of fluctuations.

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<sup>1</sup>Key contributions include Azariadis (1981), Benhabib and Farmer (1994, 1999), Benhabib, Nishimura and Meng (2000), Cass and Shell (1983), Gali (1992), Farmer (1993), Farmer and Woodford (1997), Guesnerie and Woodford (1992), Kiyotaki (1988), Shell (1977), and Woodford (1986, 1987, 1991).

<sup>2</sup>See Basu and Fernald (1994, 1995), Burnside (1996), and Burnside, Eichenbaum, and Rebelo (1995) for evidence against production spillovers at the business-cycle frequency; however, see also Benhabib and Nishimura (1998) and Benhabib, Nishimura and Meng (2000) for how indeterminacy may be possible with small external effects. Also, note that this criticism need not apply to models of self-fulfilling bank runs or currency crises (e.g., Diamond and Dybvig, 1983, Obstfeld, 1986, 1996), where it seems easier to identify strong complementarities among the involved agents.

<sup>3</sup>For the role of news, see Beaudry and Portier (2004, 2006), Christiano, Motto, and Rostagno (2006), Gilchrist and Leahy (2002), Jaimovich and Rebelo (2006), and Lorenzoni (2008).

Nevertheless, the notion that economic outcomes are, in the short run, often driven by market "psychology" or consumer and investor "confidence" remains alive among the media, practitioners in financial markets, and the general public. Indeed, this notion is not uncommon in discussions of the current crisis. Yet, it remains unclear how one could formalize this notion without relying either on a deviation from rationality or on the existence of multiple equilibria.

In this paper, we provide such a formalization. We adhere to the class of convex, unique-equilibrium, rational-expectations economies used in modern business-cycle analysis. We only relax, in a certain way, the convenient but unrealistic assumption that all information is commonly shared in the economy. We then show that one can introduce shocks that cause variation in how optimistic agents feel about aggregate economic activity in equilibrium without affecting how optimistic any of them feels about the fundamentals. In particular, these shocks are independent of all past, current and future economic fundamentals, as well as of the agents's beliefs about these fundamentals; yet, they cause variation in the agents' expectations of aggregate economic activity and, in so doing, also cause variation in actual economic activity.

Clearly, the aforementioned shocks can be interpreted as "sentiments" and the resulting fluctuations resemble those supported by sunspots in models with multiple self-fulfilling equilibria—which is why we call them "sunspot-like fluctuations." However, the fluctuations we document do not rely on the existence of multiple equilibria. Rather, they obtain along a unique equilibrium. They thus exemplify the crucial role that expectations, and a certain type of sentiments, can play as a source of fluctuations in canonical unique-equilibrium models of the business cycle.

What has ruled out these fluctuations in the pertinent literature is the restriction to common information. While uncertainty about the fundamentals can obtain with either common or dispersed information, uncertainty about one another's beliefs and actions can obtain only with dispersed information. It is the latter type of uncertainty, and only this one, that opens the door to our sentiments shocks. Formally, our sentiments shocks are shocks that induce random variation in the agents' higher-order beliefs ("the forecasts of the forecasts of others") while being independent of either the agents' first-order beliefs ("the forecasts of the fundamentals") or the fundamentals themselves. Such independent variation in higher-order beliefs has been ruled out in previous work only because common information imposes that higher-order beliefs collapse to first-order beliefs.

**Preview of model.** The backbone of our model is a multi-good RBC economy. We assume that firms are competitive and prices are flexible to isolate the dispersion of information as the only friction; however, our analysis easily extends to a New-Keynesian variant with monopolistic firms and sticky prices. As in Lucas (1972), Townsend (1983), and others, the economy is segmented in "islands", with firms and workers in any given island having to make certain production and employment choices under asymmetric information about about the productivities (the fundamentals)

of other islands. As in Angeletos and La'O (2009a), trade linkages across the islands imply that the level of production in one island depends on the level of production of other islands; this is the source of a certain type of strategic complementarity that turns out to matter for the business cycle only when information is dispersed. Finally, as in Lagos and Wright (2005), preferences are linear with respect to a certain good (the numeraire); this keeps the analysis tractable by guaranteeing that the heterogeneity of information does not cause wealth inequality, while also permitting us to introduce capital accumulation, adjustment costs, and capital utilization.

We outline two specifications of the information structure that permit us to introduce independent variation in higher-order beliefs. The one maintains the conventional assumption of a common prior, but introduces a sufficiently rich structure of private signals; the other keeps a simpler structure of signals, but introduces heterogeneous priors. Heterogeneous priors have often been used in finance to rationalize diverse opinions about the fundamentals while maintaining the assumption that information is commonly shared (e.g., Harrison and Kreps, 1978; Scheinkman and Xiong, 2003). We are not interested in this. Rather, we combine heterogeneous priors with dispersed information to generate systematic variation in the opinions of each agent about the opinions of others.

Most of our analysis employs the heterogeneous-priors specification. This choice is motivated by three considerations. First, heterogeneous priors afford a much higher level of tractability. Second, like Morris (1995), Scheinkman and Xiong (2003) and others, we think that heterogeneous priors help model an empirically relevant possibility—that people may disagree about certain things even if they happen to share the same information. And finally, like Hansen and Sargent (2000), we have a value in experimenting with certain deviations from the "communism" of models imposed by the standard paradigm. In our context, in particular, we find it reasonable to impose, as in the standard paradigm, that agents share the same statistical model (prior) of the underlying productivity shocks, and that this model should be restricted to match the observed data about productivity; but we see no good theoretical or empirical grounds for imposing an unambiguous, and "objective", model that each agent must use to form beliefs about the beliefs of others. In overall, we are convinced that there is value in certain relaxations of the common-prior assumption in applications. At the same time, we wish to re-iterate that our key positive results do not hinge on heterogeneous priors: our sentiment shocks can also emerge under a common prior.

**Preview of results.** The first set of our results regards the fluctuations caused by our sentiment shocks. We have already discussed what the defining characteristics of these shocks are and how they exemplify the role of expectations as a source of the business cycle. We should only add that the fluctuations they cause succeed in resembling actual business cycles: although we stop short of a serious quantitative exercise, we do show that these fluctuations can be persistent and can feature the right type of co-movement among output, employment, investment, and consumption.

The remaining set of our results regards the policy and welfare implications of these fluctuations. We start by making a simple but important observation: because the equilibrium is unique, we can easily identify simple Ramsey-like policies that can stabilize the economy in response to the aforementioned sunspot-like fluctuations. This is in contrast to sunspot models, where policy analysis is often severely inhibited by equilibrium indeterminacy. Our paper thus strikes a delicate balance by re-introducing a crucial role for sentiments without inhibiting policy analysis.

We then proceed to examine whether it is optimal to stabilize these fluctuations. The answer to this question is complicated for two reasons. First, we wish to answer this question without giving an informational advantage to the government; we thus require the planner to respect the geographical segmentation of the information. Second, because agents have heterogeneous priors, it is not obvious what the welfare criterion should be; we thus consider three plausible criteria.

In the first two welfare criteria, the planner is paternalistic in the sense that he takes a certain stand on what the "objective" truth is, thus overruling the heterogeneous priors of the agents. It is then hardly surprising that these two welfare criteria open the door to policy intervention, although it is still interesting to understand their precise policy implications. Our third welfare criterion assumes a non-paternalistic planner: the planner does not take any stand of his own and does not question how the agents can have different priors, nor who is "right" and who is "wrong". Rather, the planner only asks whether there is an allocation different than the equilibrium that would improve the ex-ante utility of every agent under the agent's own prior. Our preferred welfare criterion is thus very similar to the concept of Pareto optimality for the case of subjective probabilities (e.g., Debreu, 1956); the only difference is that in our setting information is dispersed.

The surprising result, then, is that the equilibrium ceases to be efficient when, and only when, heterogeneous priors are combined with dispersed information. In particular, the competitive nature of our economy guarantees that the equilibrium is Pareto optimal whenever information is commonly shared, no matter whether the agents start with a common prior or not. Moreover, the dispersion of information does not by itself open the door to policy intervention: sunspot-like fluctuations that obtain under a common prior are fully efficient. However, sunspot-like fluctuations that obtain under heterogeneous priors are inefficient. We conclude that in this case policy intervention can be warranted even if the planner fully respects the heterogeneous priors of the agents. We further show that the optimal policy then mitigates these sunspot-like fluctuations, but does not fully eliminate them: the efficient allocation also features sunspot-like fluctuations.

**Related literature.** Our paper is closely related to two strands of the macroeconomics literature: the sunspots literature; and the literature on informational frictions. We have already discussed the relation of our paper to the former. Early contributions in the latter strand include Phelps (1970), Lucas (1972, 1975), Barro (1976), King (1982), and Townsend (1983); more recent

contributions include Mankiw and Reis (2002), Morris and Shin (2002), Sims (2003), Woodford (2003), Mackowiak and Wiederholt (2007), Lorenzoni (2008), and Angeletos and La'O (2009a). These papers have emphasized how informational frictions can induce inertia in the response of the economy to certain shocks in the fundamentals and/or generate fluctuations due to noise in information about these fundamentals. However, none of them has identified the type of sunspot-like fluctuations that we document here. This defines the primary contribution of our paper.

A secondary, methodological, contribution of our paper is to introduce heterogeneous priors in a business-cycle model. As mentioned before, heterogeneous priors have long been incorporated in finance; e.g., see Scheinkman and Xiong (2003) on asset bubbles, Panageas (2005) on the q-theory of investment, and Pavlova and Rigobbon (2007) on exchange rates. Apart from the difference in context, a crucial difference is that these earlier papers restrict information to be commonly shared. This restriction rules out both the sunspot-like fluctuations and the normative implications we document in this paper. Morris (1994) combines heterogeneous priors with asymmetric information, but towards a different goal, namely to revisit the no-trade theorems.

Our paper builds heavily on Morris and Shin (2002), which was the first to bring to light the potential role that higher-order beliefs can play in applications, and more broadly on the literature that studies the role of higher-order beliefs in games.<sup>4</sup> Angeletos and La'O (2009a) shows how to embed these abstract insights within canonical business-cycle models and proceed to study their implications for the response of the economy to productivity shocks and to noise in information about these shocks. We complement this work by showing how higher-order beliefs can be the source of a distinct type of fluctuations, helping formalize a certain type of sentiments. Related in this respect is Izmalkov and Yildiz (2009), which studies a different context—an abstract binary-action coordination game—but also interprets a certain property of higher-order beliefs as sentiment.

Finally, a number of recent papers have studied the response of the economy to news about future aggregate productivity; see Beaudry and Portier (2004, 2006), Christiano, Motto, and Rostagno (2006), Danthine, Donaldson, and Johnsen (1998), Gilchrist and Leahy (2002), Jaimovich and Rebelo (2006), and Lorenzoni (2008). We share with these papers the focus on how expectations matter for the business cycle. However, our contribution is clearly distinct: in all these papers, fluctuations are driven either by fundamentals or by forecasts of these fundamentals.

**Layout.** The rest of the paper is organized as follows. Section 2 explains the key concepts with a simple game. Section 3 introduces our business-cycle model. Section 4 characterizes the equilibrium. Section 5 studies the sunspot-like fluctuations obtained in our model. Section 6 revisits the equilibrium with policy. Section 7 studies efficiency. Section 8 discusses the robustness of our results and potential extensions. Section 9 concludes. The Appendix includes all the proofs.

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<sup>4</sup>(e.g., Carlsson and van Damme; 1993; Morris and Shin, 2003; Lipman, 2005; and Weinstein and Yildiz, 2007).