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# Ambiguity aversion, asset prices, and the welfare costs of aggregate fluctuations<sup>☆</sup>

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## ABSTRACT

Under the hypothesis that aggregate U.S. consumption is random and, more importantly, viewed as *ambiguous* by consumers, we examine the implications for asset prices and for how consumption fluctuations influence consumer welfare. We consider a simple, Mehra–Prescott-style endowment economy with a representative agent facing consumption fluctuations calibrated to match U.S. data from 1889 to 2008. Our experiment is to restrict preference parameters in order to as well as possible match some asset-price facts—the average returns on equity and a short-term risk-free bond—and then compute the welfare benefits of removing all consumption fluctuations given those parameters. These benefits turn out to be quite large: consumers are willing to pay about 10% of consumption in permanent terms under our benchmark calibration.

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## 1. Introduction

In the literature that analyzes macroeconomic data from the perspective of explicit consumer choice and general-equilibrium theory, the typical assumption is to consider aggregate variables, like consumption, to be random. A central question in macroeconomics is how costly consumers perceive this randomness to be. The subject of the present paper is to examine these costs based on the assumption that consumers are “uncertain” about the randomness, as opposed to just viewing it as risk. Uncertainty is formalized as ambiguity, and consumers are assumed to be averse to ambiguity; the formalization follows [Gilboa and Schmeidler \(1989\)](#) and the dynamic treatment in [Epstein and Wang \(1994\)](#) and [Epstein and Schneider \(2003\)](#).

Asset prices contain important information about the way in which agents like to trade off risk over time and across states of the world. For this reason any reliable measure of the welfare costs should be based on models able to match consumption and features of asset prices at the same time. Ambiguity aversion has particularly sharp implications for asset pricing; indeed, an arguably modest amount of ambiguity aversion can deliver significantly lower risk-free rates and higher

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equity premia, thus providing a possible way forward for understanding some asset-price puzzles.<sup>1</sup> More importantly perhaps, recently [Ilut and Schneider \(2014\)](#) argue, also from a positive perspective, that a large fraction of business-cycle fluctuations can be thought of as coming from variations in “confidence”, modeled with the ambiguity concept used in the present paper. The purpose here is to explore the connection between asset-price determination under ambiguity aversion and the estimates of the welfare costs of fluctuating aggregate consumption. More precisely, the question the paper addresses is under an amount of ambiguity aversion that is empirically plausible and that provides a more quantitatively satisfactory account of asset prices than does the standard utility setting, how will Lucas's welfare-cost calculations ([Lucas, 1987](#)) be revised? Thus, we use asset prices as a way of obtaining information about the perceived costs of fluctuations, and ambiguity aversion is potentially helpful for rationalizing the observed asset prices.

The distinction between uncertainty and risk is certainly not new (see, e.g., [Knight, 1921](#)), but there are several reasons why it seems useful to bring the distinction into macroeconomic analysis at this point in time. First, the evidence of the importance of uncertainty has accumulated, starting with [Ellsberg \(1961\)](#)'s urn experiments. These experiments, defining the “Ellsberg paradox”, produced a clear violation of Savage's axioms for subjective probability. A second reason to consider the theoretical implications of ambiguity aversion emanates from the recent theoretical contributions mentioned above, allowing the concept to be formalized, axiomatized, and used in dynamic models. Given the Gilboa–Schmeidler approach, ambiguity aversion can actually be interpreted as a bias in expectations—a pessimism of sorts, since it involves moving probability mass from more beneficial to less beneficial outcomes—while at the same time allowing a full rationality interpretation, though in the extended sense that there is aversion to uncertainty. Third, ambiguity aversion—and model uncertainty, a closely related concept (see, e.g., [Hansen and Sargent, 2007](#))—has been shown to help in accounting for aggregate phenomena. All in all, the consideration of ambiguity aversion can be viewed as a way of formalizing, still based on an axiomatic analysis and thus amenable to standard welfare analysis, some of these features and analyzing them in otherwise standard models in productive ways.

More precisely, we assume here that consumers display ambiguity aversion toward aggregate stock dividends; we use the Mehra–Prescott two-state model with the mere addition of ambiguity aversion. With the typical parameterized representation of ambiguity aversion, consumers have maxmin preferences and maximize utility based on the worst possible belief within some given set of feasible beliefs. Thus, the pessimistic beliefs are endogenous and fully rational. A small amount of randomness has *first-order effects* on utility if there is ambiguity about this randomness.<sup>2</sup> Thus, ambiguity aversion contrasts the standard model, where risk aversion only leads to second-order effects on utility. The implied costs of small “business cycles”, i.e., of random consumption fluctuations, also are of first order. In this paper, we investigate the asset prices and welfare costs of business cycles in more detail: we derive asset prices and discuss their quantitative nature, and we assess the implied welfare costs of fluctuations.

The first step in our work is to look at asset pricing; here, we demonstrate how one can obtain larger equity premia by assuming ambiguity aversion, along with low risk-free rates. It is, however, known that other asset-pricing facts can be hard to rationalize. The key parameter in the model is the amount of ambiguity aversion, but it interacts nonlinearly with other parameters, such as with the coefficient of relative risk aversion. There is no direct evidence of which we are aware that allows us to calibrate the ambiguity parameter, but the recent paper by [Ilut and Schneider \(2014\)](#) provides what we think is a very reasonable approach to put restrictions on this parameter. In particular, they tie the dispersion of survey forecasts about GDP growth to the ambiguity parameter: they interpret this dispersion as reflecting, precisely, the range of “possible probabilities” that the representative agent can adopt in the minmax expectations formation. We apply this procedure in the context of our simpler model to obtain a narrow range of values for the key ambiguity parameter and then consider other features of preferences that allows the model to match the two main asset-pricing facts (the average returns on short-term risk-free asset, and the equity premium). We of course also do robustness checks as a way of communicating how sensitive our results are to various parameters. As has been pointed out in the literature, in the standard Mehra–Prescott without ambiguity, the level of relative risk aversion that is required to match the equity premium and the risk-free rate in the data is very high (in the range between 48 and 55).<sup>3</sup> The subjective discount factor would have to be very low, in the order of 0.55. With a sufficient amount of ambiguity, however, the required risk aversion parameter is much lower, and a more reasonable subjective discount factor can be accommodated. We find that ambiguity aversion is particularly potent in helping lower the returns on the safe assets. Intuitively, ambiguity aversion moves probability mass from the (lucky) state with a low marginal utility to the (unlucky) state with a high marginal utility, thus raising the present value—the price—of the asset.

The second step of the work is to ask, given that preferences are such that the model asset prices are in line with the data, how consumers then assess the fluctuations from a welfare point of view. Thus, we redo the Lucas-style calculation whereby one asks by how much the representative-consumer utility would rise (expressed as a permanent increase in consumption) if all fluctuations around the trend were eliminated. The answer, in the economy with ambiguity, naturally depends also on the amount of ambiguity: since ambiguity is a form of “worry” about random fluctuations, the elimination of the randomness would eliminate the worry, and consumers would be better off as a result. We show that the costs of business cycles can be sizable, indeed about 10% of consumption in permanent terms.

<sup>1</sup> For this point of view, see, e.g., [Erbas and Mirakhor \(2007\)](#), [Chen and Epstein \(2002\)](#), and [Collard et al. \(2012\)](#).

<sup>2</sup> See the survey by [Epstein and Schneider \(2010\)](#) for earlier work on this point.

<sup>3</sup> For surveys on the equity premium, see for example [Mehra and Prescott \(2008\)](#) or [Kocherlakota \(1996\)](#). [Aiyagari \(1993\)](#) shows how incomplete markets together with costly asset trading both increases the equity premium and lowers the risk-free rate. [Dejong and Ripoll \(2007\)](#) examine asset prices from the perspective of consumers with time-inconsistent preferences; they do not find major effects.

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