



# Differences in beliefs and currency risk premiums <sup>☆</sup>

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## ARTICLE INFO

### Article history:

Received 22 June 2009

Received in revised form

9 December 2009

Accepted 5 January 2010

Available online 7 July 2010

### JEL classification:

D9

E3

G12

### Keywords:

Option pricing

Difference in beliefs

Incomplete markets

Foreign exchange

## ABSTRACT

This paper studies the importance of heterogeneous beliefs for the dynamics of asset prices. We focus on currency markets, where the absence of short-selling constraints allows us to perform sharper tests of theoretical predictions. Using a unique data set with detailed information on foreign-exchange forecasts, we construct an empirical proxy for differences in beliefs. We show that this proxy has a strong effect on the implied volatility of currency options beyond the volatility of macroeconomic fundamentals. We document that differences in beliefs impact also on the shape of the implied volatility smile, on the volatility risk-premiums, and on future currency returns.

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## 1. Introduction

STANDARD ASSET PRICING THEORIES HAVE DIFFICULTY explaining episodes that are not simply linked to fundamentals. Notable examples in the dynamics of capital markets are the equity premium puzzle or the excess volatility puzzle. These puzzles have motivated an increasingly large literature over the last couple of decades that explores

the general equilibrium implications of uncertainty for asset prices. There are three important directions in this literature. The first has focused on economies with homogeneous investors that are uncertain and learn about the state of the investment opportunity set (e.g., David, 1997; Veronesi, 1999; Brennan, 1998; Brennan and Xia, 2001a; Brennan and Xia, 2001b; David, 2008). A second strand of the literature has investigated the effect of knightian uncertainty in economies in which a single agent makes decisions that are robust to model misspecification doubts about the real economy (e.g., Hansen and Sargent, 2005; Maenhout, 2004; Anderson, Hansen, and Sargent, 2003; Cagetti, Hansen, Sargent, and Williams, 2002; Hansen and Sargent, 2007; Leippold, Trojani, and Vanini, 2008).<sup>1</sup> The third stream explores the implications of multiple agents with different beliefs about the growth rate of the economy. In these models, the interaction and

<sup>☆</sup> We thank an anonymous referee, Karim Abadir, Philippe Bacchetta, Gurdip Bakshi, Bruno Biais, Michael Brandt, Mikhail Chernov, Joost Driessen, Darrell Duffie, Bernard Dumas, Tim Johnson, Chris Jones, Antonio Mele, and conference participants at the American Finance Association 2008 meeting in New Orleans, CEPR meeting in Gerzensee, the 2008 Duke-UNC Asset Pricing Conference, the European Finance Association 2007 meeting in Ljubjana, the Swiss Finance Meetings, HEC Paris, Imperial College, London Business School, London School of Economics, Queen's University, University of Amsterdam, and University of Oxford for comments. We would like to thank both Citigroup and Lehman Brothers for their help collecting the market data used in this study. We are also grateful to Reuters for their forecast database. The usual disclaimer applies.

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<sup>1</sup> An alternative tool for handling model misspecification doubts is based on multiple recursive priors. Early contributions of that work are Gilboa and Schmeidler (1989), Epstein and Wang (1994), Epstein and Schneider (2003), Anderson, Hansen, and Sargent (2003), Chen and Epstein (2002), Epstein and Miao (2003).

intertemporal risk sharing of agents with different beliefs affect asset prices and equilibrium risk premia (e.g., Scheinkman and Xiong, 2003; Buraschi and Jiltsov, 2006). In Buraschi and Jiltsov (2006), this interaction impacts the stochastic discount factor thus affecting both expected returns and also the volatility smile and volatility risk premium. Differences in beliefs are motivated as the result of heterogeneous learning about some unobservable and uncertain fundamentals of economy, such as the growth rate of dividend. Depending on the learning behavior of agents, the difference in beliefs is *stochastic* and may directly affect asset prices.

Within the class of heterogeneous belief models, one can identify at least two different approaches with somewhat different empirical implications. The first (neoclassical) approach considers rational, risk-averse agents, with identical preferences and endowments, no trading frictions, but incomplete and heterogeneous information. In this case, even if dividends have constant volatility, agents have different optimal portfolio demands and in equilibrium the stochastic discount factor varies with different levels of difference in beliefs.<sup>2</sup> As a result, differences in beliefs directly increase expected returns (e.g., Buraschi, Trojani, and Vedolin, 2008), generate excess realized volatility (e.g., Dumas, Kurshev, and Uppal, 2009), and impact option-implied volatility (e.g., Buraschi and Jiltsov, 2006). The second approach builds on the interaction between behavioral biases and trading frictions, the Miller (1977) conjecture. For example, Scheinkman and Xiong (2003) study a model with overconfident and risk-neutral agents. They show that, in this context, short-selling constraints can support rational asset price bubbles in equilibrium. Empirically, Diether, Malloy, and Scherbina (2002) use equity returns to show that negative opinions are not fully revealed and thus difference in beliefs has a negative impact on expected stock returns. Understanding the link between uncertainty, differences in beliefs and asset prices is very important. However, the empirical evidence is mixed. Diether, Malloy, and Scherbina (2002) focus on equity expected returns and find supporting evidence for Miller's (1977) conjecture. On the other hand, Anderson, Ghysels, and Juergens (2005) and Buraschi and Jiltsov (2006) use a different time period and empirical methodology and find supporting evidence for a neoclassical (i.e., risk-based) interpretation of the impact of differences in beliefs on asset prices.

Knowing whether differences in beliefs matter even in the absence of short-selling constraints is important to improve our understanding of the link between uncertainty and asset prices. The goal of this paper is to study empirically this link and to disentangle the different implications of heterogeneous agent models. The analysis entails three key elements. The first is the ability to measure empirically the dispersion of beliefs. Uncertainty is a precondition for differences in beliefs to matter in theoretical models, but it is considerably harder to measure

economic uncertainty than dispersion of beliefs. The second key aspect is to focus on implications for both the first moment and the second moment, given that these are markedly different for different models. Finally, we select a setting that gives the best empirical opportunity to neoclassical models by focusing on the foreign-exchange (FX) market. We choose this market for a number of reasons. First, the marginal investor in the FX market is unaffected by short-selling constraints. Second, there is a large literature that documents the relative unimportance of macro fundamentals in explaining the dynamics of exchange rates (e.g., Meese and Rogoff, 1983), thus leaving open the question of what might possibly help explain its dynamics. Third, exchange rates are unlikely to be driven by private information and are thus an ideal laboratory to investigate a different source of information-driven trades, such as heterogeneous beliefs in the absence of private information. In this context, a rejection of the neoclassical risk-based null hypothesis that differences in beliefs explain asset price dynamics would be very important as one may argue that, a fortiori, this hypothesis would be rejected even more strongly in less favorable contexts. Obviously, failure to reject the null hypothesis in FX markets would not necessarily rule out the explanatory power of the Miller's (1977) argument in other markets with binding short-selling constraints or indeed, the possibility of some other, as yet unspecified, behavioral explanation.

The description of a noteworthy event in the foreign exchange (FX) markets is useful to illustrate intuitively the potential link between exchange rates and differences in beliefs. At the beginning of 2004, the FX market was approaching an 'overwhelming consensus' that the yen would continue to appreciate against the dollar.<sup>3</sup> The combination of a historically small interest rate differential, large and opposing current account imbalances, and strong economic growth in Japan generated the belief that only the Bank of Japan's persistent currency intervention was stopping further declines in the dollar/yen exchange rate from becoming a 'one-way bet.'<sup>4</sup> Consistent with this scenario, at the beginning of 2004 about 75% of forecasters in our sample were predicting yen appreciation over the coming three months. Fig. 1, Panel 1, shows an histogram of dollar/yen forecasts at the beginning of January 2004 that illustrates the low disagreement of professional investors. At the same time, dollar/yen implied volatility fell to a multi-year low. Over the subsequent months, however, the Bank of Japan intervened massively spending more than \$100 billion buying dollars and selling yen. These record levels of intervention, coupled with veiled U.S. criticism of Japan's actions, created active disagreement in the market over the future of the dollar/yen exchange rate.<sup>5</sup> With

<sup>2</sup> The implications of heterogeneous beliefs on the equilibrium risk premium and interest rates have originally been studied by Detemple and Murthy (1994), Zapatero (1998), and Basak (2000). See Basak (2005) for a survey of this literature.

<sup>3</sup> See, for example, *Institutional Investor* February 12, 2004. For further details on the FX market in the first quarter of 2004, see the report of the Federal Reserve Bank of New York at <http://www.newyorkfed.org/newsevents/news/markets/2004/fxq104.pdf>.

<sup>4</sup> See, for example, *Financial Times* January 9, 2004.

<sup>5</sup> Shortly after Japan's most significant intervention, U.S. Treasury Secretary John W. Snow warned of the dangers of propping up currencies artificially. For an account of these events, see *Business Week*, March 22, 2004, "Don't Let Japan's Mr. Dollar Get Away With It", [http://www.businessweek.com/magazine/content/04\\_12/b3875047.htm](http://www.businessweek.com/magazine/content/04_12/b3875047.htm).

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