



## Risk premiums and macroeconomic dynamics in a heterogeneous agent model

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### ABSTRACT

We analyze financial risk premiums and real economic dynamics in a DSGE model with three types of agents—shareholders, bondholders and workers—that differ in participation in the capital market and in attitude towards risk and intertemporal substitution. Aggregate productivity and distribution risks are transferred across these agents via the bond market and via an efficient labor contract. The result is a combination of volatile returns to capital and a highly cyclical consumption process for the shareholders, which are two important ingredients for generating high and countercyclical risk premiums. These risk premiums are consistent with a strong propagation mechanism through an elastic supply of labor, rigid real wages and a countercyclical labor share. Based on the empirical estimates for the two sources of real macroeconomic risk, the model generates significant and plausible time variation in both bond and equity risk premiums. Interestingly, the single largest jump in both the risk premium and the price of risk is observed during the current recession.

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### 1. Introduction

Economic models typically have a hard time reproducing the observed risk premiums and real statistics simultaneously. The need for such a consistent model is high. For instance, it would make it possible to extract the information contained in asset prices about future growth and inflation expectations of private investors by controlling for the implied risk premiums. At the same time, a model that can jointly match financial and real statistics would have strong empirical validity. The standard DSGE model with endogenous capital and labor has problems generating sufficiently large premiums and realistic real statistics because investors have various channels through which they can smooth consumption. Various solutions have been suggested in the literature to overcome this problem within the standard representative agent model. Recent examples include, among others, [Lettau and Uhlig \(2000\)](#) who evaluate the potential role of habit formation, [Boldrin et al. \(2001\)](#) suggest frictions in the labor allocation between sectors, [Uhlig \(2007\)](#) proposes real wage rigidity as a possible solution.

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In this paper, we follow Guvenen (2009), Danthine and Donaldson (2002) and Danthine et al. (2008), and focus on the role of heterogeneous capital market participation across agents. This setup implies a number of interesting features that can facilitate the joint explanation of real and financial statistics. First, in such a setup, it is no longer aggregate consumption that drives the pricing kernel of asset prices. There is a well documented literature that suggests that the consumption of wealthy agents, that hold the majority of the capital stock, is more volatile than aggregate consumption. Second, in a context of heterogeneous agents, the valuation of the capital stock is not only determined by aggregate risk, but also by distribution risk. The volatile and highly procyclical nature of profits can potentially contribute significantly to the explanation of the equity risk premium. Importantly, it can help to differentiate between stock and bond risk premiums. The risk sharing between heterogeneous agents does not only affect the pricing of the claims on future profits but also offers the natural context to explain the observed acyclical behavior of real wages and the countercyclical behavior of the wage share. Third, an explanation of the risk premium based on heterogeneous capital market participation across agents has important empirical implications for the financial behavior of the different agents, for instance in terms of wealth accumulation and the resulting wealth distribution. Therefore, this approach has the advantage that the underlying assumptions can be validated more easily compared to alternative explanations which are often based on non-observable features of the utility functions (another popular solution to the equity premium in the context of a representative agent model).

We integrate the models of Danthine, Donaldson and Guvenen in a general framework in which all agents participate in the labor market and have similar preferences, but with heterogeneous attitudes towards risk and intertemporal substitution and with varying degrees of capital market access. The model contains three types of agents: workers, who do not participate in the capital market, bondholders and shareholders. Workers and shareholders will exchange their income risk through a labor contract as proposed in Danthine and Donaldson. Bondholders and shareholders will share their risk through the bond market, as in Guvenen. As a first contribution, we show that this model, driven by a combination of aggregate productivity and distribution shocks, is able to generate significant risk premiums as well as realistic aggregate volatilities and correlations. In particular, the optimal labor contract, motivated by risk sharing considerations, explains the observed rigidity and low volatility in the real wage, as well as the countercyclical wage share. The optimal wage contract and the stochastic distribution risk—which takes up possible shifts in the relative bargaining power of workers and firms—deliver a high volatility in profits, returns to equity and price-dividend ratios. This high volatility in the returns from capital, combined with the high concentration of capital market participation, results in a concentration of risk and a consequently high consumption volatility for the shareholders. The bond trade between bond- and shareholders contributes only marginally to our results. In the face of distribution risk, shareholders are reluctant to bear additional aggregate risk through the bond trade. This result suggests important interactions between the two risk sharing devices in a general setup.

By integrating the two risk sharing mechanisms in a common framework, the specific features of each mechanism and their dependence on specific assumptions become more apparent. Furthermore, we evaluate the performance of the model by studying their implications for both bond and equity returns. This focus on a variety of assets (bonds, as well as stocks) imposes additional discipline in building the model. For one, reproducing observed differences in returns to stocks and bonds has implications for the degree of flexibility one has in modeling the agents' stochastic discount factor. Moreover, the macroeconomic fluctuations that underlie the various risk premiums are model-consistent. Put differently, the general equilibrium framework adopted ensures a joint explanation, without relying on, e.g., reduced form macroeconomic dynamics to mimic risk premiums.

The third contribution of the paper is applied in nature. We estimate the stochastic structure of the model based on real US data over the period 1947q1–2009q1. The resulting series for the productivity and distribution shocks are fed into model. Based on these two real sources of macroeconomic risk, the model generates significant and plausible time variation in the financial premiums. Taking into account the limited stochastic structure of this exercise, the resulting time variation in risk premiums compares well to available proxies and estimates in the literature. The risk premiums display a strong increase during each of the postwar recession periods. In particular, the single largest jump in both the risk premium and the price of risk is observed during the current recession. We also perform predictive regressions for stocks and bonds to further measure the success and limitations of the model.

In Section 2, we present the model and the estimation results for its stochastic structure. Section 3 documents the main financial and real statistics implied by the model, and compares them with analog statistics in the data and implied statistics of the representative agent version of the model. The specific role of the two risk sharing mechanisms is analyzed in detail. In Section 4, we perform a sensitivity exercise to illustrate the role of the stochastic structure, the structural parameters, the specification of the utility function, and the heterogeneity across agents. The difference between the equity and bond premium is discussed in Section 5. Finally, Section 6 presents the results on the implied time variation in the risk premiums, and shows how this variation affects the predictive power of the price-dividend ratio and the yield spread. Our analysis is based on simulation experiments with the first, second and third order approximation of the non-linear model using the Dynare and Dynare++ toolbox.

## 2. The model

We start from a general setup which considers three types of agents. A first group of agents consists of the standard portfolio investors that allocate their wealth between stocks and bonds. These agents act as the marginal investors that clear the bond and stock markets. Therefore, their stochastic discount factor will determine the pricing of the corresponding risks.

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