Journal of Economic Dynamics & Control 79 (2017) 97–125

Contents lists available at ScienceDirect

Journal of Economic Dynamics & Control

journal homepage: www.elsevier.com/locate/jedc

Disaster risk and preference shifts in a New Keynesian model[☆]

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ARTICLE INFO

Article history:
Received 27 October 2016
Revised 4 April 2017
Accepted 6 April 2017
Available online 14 April 2017

JEL Classification:
E20
E31
E32
E44
G12
Q54

Keywords:
Disaster risk
Rare events
Uncertainty
Asset pricing
DSGE models
Business cycles

ABSTRACT

In RBC models, disaster risk shocks reproduce countercyclical risk premia but generate an increase in consumption along the recession and asset price fall, through their effects on agents' preferences (Gourio, 2012). This paper offers a solution to this puzzle by developing a New Keynesian model with such a small but time-varying probability of "disaster". We show that price stickiness, combined with an EIS smaller than unity, restores procyclical consumption and wages, while preserving countercyclical risk premia, in response to disaster risk shocks. The mechanism then provides a rationale for discount factor first- and second-moment ("uncertainty") shocks.

1. Introduction

Recent years have seen renewed interest in the economic impact of 'rare events'. In particular, Gabaix (2011, 2012) and Gourio (2012) have introduced a small but time-varying probability of 'disaster', defined as an event that destroys a large share of the existing capital stock and productivity, into real business cycle (RBC) models. The main result is that an increase in the probability of disaster, without occurrence of the disaster itself, suffices to trigger a recession and a countercyclical risk premium.

However, this literature faces two limitations. First, an increase in disaster risk generates a recession and a drop in stock prices, but it also increases consumption. Yet, recent estimations from option price tails document that disaster risk tends to increase in periods of financial distress and recessions (Siriwardane, 2015), while such episodes are themselves

☆ The views presented in this paper are the authors' and do not reflect those of the Banque de France, the Bank of Finland, or the Eurosystem.

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http://dx.doi.org/10.1016/j.jedc.2017.04.001
0165-1889/

correlated with contemporaneous declines in consumption (see Albuquerque et al., 2015 for e.g). Second, RBC models of disaster risk rely on the elasticity of intertemporal substitution (EIS) being set to a value strictly greater than unity to generate a recession.[1] Should the EIS be lower than unity, the results are completely reversed, in particular the economy enters a boom as disaster risk goes up. Empirical evidence on the EIS is mixed, yet values below unity are realistic and conventionally adopted in macroeconomic calibrations, whether the models feature Epstein–Zin–Weil preferences or not.[2] Therefore, such a contrasting response of output from changes in disaster risk at the unity threshold seems particularly puzzling.

In order to address these caveats, we introduce a small time-varying probability of disaster à la Gourio (2012) into an otherwise standard New Keynesian model. To the best of our knowledge, we are the first to do so.[3] The contribution is threefold. First, we extend the analysis of disaster risk to a medium-scale DSGE setup and show that we can solve it using standard perturbation methods. This is non trivial since a disaster is, by definition, a large event, and therefore an important nonlinearity exists in the model. Yet, we show that Gourio (2012)'s analytic approach can be applied in a larger scale decentralized model. It basically consists in stationarizing the equilibrium system such that it only features the (small) probability of a disaster, instead of the (large) original event itself. Thereby, (small) innovations to the (small) probability of disaster can be accurately simulated, regardless of the disaster regime. This opens the door for further research on nonlinear New Keynesian models where the valuation of rare events in asset pricing can interact with macro-financial frictions and richer policy tools.

Second, we disentangle the respective roles of the EIS and of price stickiness in determining the sign of the main macroeconomic variables in response to a disaster risk shock. We show that, among the four possible combinations of price flexibility/stickiness and EIS above/below the unity threshold, only sticky prices and an EIS smaller than unity can replicate contemporaneous drops in output, consumption, investment, labor, wages, and inflation, in response to a disaster risk shock. In that respect, we improve some macroeconomic predictions from Gourio (2012) while preserving the countercyclical risk premium, and thus generalize the analysis of disaster risk.

Third, we show that Gourio (2012)'s mechanism of disaster risk can provide a rationale to discount factor shocks in the New Keynesian literature. Indeed, changes in disaster risk produce a mix of first- and second-moment effects on agents' (endogenized) discount factor. However, in Gourio (2012)'s RBC model, agents become relatively more *impatient* as disaster risk goes up. Those agents save less, and a recession ensues. In contrast, agents' level of *patience* increases in our setup, and the associated drop in consumption triggers the recession. This latter case allows to conciliate disaster risk shocks with exogenous preference shocks, either defined as first-moment discount factor shocks (Christiano et al., 2011; Smets and Wouters, 2003), or as second-moment (volatility) discount factor shocks, as in Basu and Bundick (2017). In all these examples, the shock generates a recession driven by agents' patience and lower consumption.

The intuition works as follows. As in Gourio (2012), we define a disaster as a potential event that destroys part of the capital stock and of productivity growth. Even without the occurrence of such an event, an increase in its probability suffices to create a mix of effects on the depreciation of capital, on the one hand, and on the uncertainty of future returns on capital, on the other hand. Both effects can be captured as an endogenous discount factor in the Euler equation of capital, and therefore, be interpreted as a shift in agents' degree of patience. However, the EIS plays a critical role in the relative valuation of substitution and income effects which determines the sign of this shift. Indeed, as known since (Leland, 1968) and Sandmo (1970), an increase in interest rate risk makes agents more willing to consume (save), such that savings (consumption) go down, if and only if the EIS is larger (smaller) than unity.[4] In a RBC setup, where responses of investment and output just follow savings, an EIS above unity is thus necessary to decrease savings as disaster risk goes up. Should the EIS be smaller than unity, savings would go up and consequently the economy would boom.

The additional presence of sticky prices does not alter the link between the EIS and agents' propensity to consume/save. However, it makes the aggregate dynamics more sensitive to the demand side (consumption) rather than the supply side (savings) of the economy. Take for instance the case of an EIS below unity such that consumption goes down and savings go up in response to an increase in disaster risk. If prices are sticky, firms cannot deflate as much as they would like. Therefore, they find it optimal to reduce their demand for factors of production, capital and labor, to maximize their profits (or minimize their loss). Despite precautionary motives, all quantities co-move and output is driven down. Since the return on capital is more volatile, the risk premium remains countercyclical in all cases. Overall, we thus show that introducing a time-varying disaster risk à la Gourio (2012) into a full-fleshed New Keynesian model is critical, not just to enrich the macroeconomic setting and spectrum of potential policy analysis, but because it literally conditions most of the qualitative effects associated with a change in disaster risk, for a given value of the EIS.

[1] Barro (2009) shows that the aggregate stock market declines with the probability of disaster only when the EIS is greater than one with Epstein–Zin–Weil preferences. Gourio (2012)'s recessionary effects from disaster risk rely on the same condition.

[2] See Section 4 for further related discussion.

[3] Two previous attempts of disaster risk into a New Keynesian model include (Isoré and Szczerbowicz, 2013), considering the capital depreciation effect of disaster risk only, and Brede (2013) where the 'disaster state' is permanent and deterministic, i.e. the economy entering a disaster state stays there forever. In contrast, we keep the essence of Gourio (2012) in considering disaster risk as a time-varying source of uncertainty here. Finally, despite a title close to ours, (Andreasen, 2012) studies skewed shock distributions in a DSGE model, which quite differ from the formalization of disaster risk we adopt here.

[4] Weil (1990) shows that a large EIS implies that the elasticity of savings to a 'certainty-equivalent' interest rate is positive, i.e. savings decrease in the aggregate interest rate risk. On the contrary, a small EIS implies that savings go up with interest rate risk.