Journal of International Economics xxx (2017) xxx–xxx

Contents lists available at ScienceDirect

Journal of International Economics

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

Disaster risk and asset returns: An international perspective☆

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ARTICLE INFO

Article history:
Received 8 August 2016
Received in revised form 1 March 2017
Accepted 1 March 2017
Available online xxxx

JEL classification:
F3
G15
G12

Keywords:
Disaster risk effects
Asset return moments
International macro correlation

ABSTRACT

Recent studies have shown that disaster risk can generate asset return moments similar to those observed in the U.S. data. However, these studies have ignored the cross-country asset pricing implications of the disaster risk model. This paper shows that standard U.S.-based disaster risk model assumptions found in the literature lead to counterfactual international asset pricing implications. Given consumption pricing moments, disaster risk from this literature cannot explain the range of equity premia and government bill rates. Furthermore, the independence of disasters presumed in some studies generates counterfactually low cross-country correlations in equity markets. Alternatively, if disasters are all shared, the model generates correlations that are excessively high. We show that common and idiosyncratic components of disaster risk are needed to explain the pattern in consumption and equity co-movements.

1. Introduction

The risk of disasters has long been proposed as an explanation for a variety of financial market anomalies. Key among these anomalies is the high equity premium in the face of relatively smooth consumption. As originally presented by Reitz (1988) and advanced by Barro (2006, 2009), a low probability of a large decline in output can sufficiently increase the variability in intertemporal marginal utility to deliver the level of equity premium seen in U.S. data. In combination with risk of government default, the potential for these disasters can also explain the level of government bill rates. Moreover, as Wachter (2013) shows, time varying disaster risk can help explain the volatility of equity returns and government bills.

Since disasters are rare in the U.S. time series, this literature uses international data to measure both the frequency and size of these events. To obtain these measures, each country is typically assumed to face the same potential decline in consumption, parameterized from observed disasters across all countries.[1] However, if true, this assumption carries important implications for the magnitude and co-movements in international asset returns. If all countries face a similar disaster risk, this risk should affect the correlation of asset returns across countries, as well.

In this paper, we study the international asset pricing moments and co-movements implied by a standard domestic-based disaster risk model. Using consumption and asset price data for seven OECD countries, we begin by evaluating each country in isolation following the

☆ For useful comments and suggestions, we thank Charles Engel, Mick Devereux, Jessica Wachter, an anonymous referee, and participants at the 2016 International Seminar on Macroeconomics, the International Conference on Capital Markets at INSEAD, the Wharton International Finance Group and the Wharton Macro Lunch Seminar. We are also indebted to Robert Barro for providing us with the asset return data. The views expressed in this paper are those of the authors and do not necessarily reflect those of the Federal Reserve Board. Any errors or omissions are our responsibility.

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[1] In a modification of this approach, Nakamura et al. (2013) estimate endogenous differences in timing, magnitude, and length of disasters while maintaining the assumption that the frequency and size distribution is time invariant and the same across countries. Similar to our model below, they allow for correlation in the timing of disasters. However, they use this information to match the domestic asset pricing moments alone and do not consider the international asset pricing implications. We discuss their approach relative to ours below.

http://dx.doi.org/10.1016/j.jinteco.2017.03.001

standard approach in this literature. Within the constant probability of disaster framework as in Barro (2006), we ask whether differences in exposure to disaster risk can explain the cross-section of asset return moments for each individual country. To examine these implications, we choose model parameters that best fit the asset pricing moments using Simulated Method of Moments. For this purpose, we allow for cross-country deviations in the size of the disaster, the probability of government default, and the dividend leverage parameter. Despite allowing for these deviations, however, the model cannot match the variation in the cross-country data. We then incorporate time-varying probabilities of disasters as in Wachter (2013). Across countries, time-variation in disaster probabilities indeed improves the fit for asset return volatility and the mean returns.

Given the best fit to individual country asset returns, we evaluate the disaster model's ability to match the international correlation of asset returns and consumption growth found in the data. For example, an empirical finding in the data is that international consumption correlations are lower than equity return correlations.[2] To determine whether the model can replicate this pattern, we analyze implied correlations under two extreme assumptions found in the literature about international disasters; that is, independent versus common disaster events.[3] Under the assumption that disaster events occur independently across countries, equity return correlations either mimic those of consumption correlations when disaster risk is constant or else are much lower than consumption when disaster risk is time-varying. By contrast, when disaster events are common, equity return correlations are near one, and are hence too high.

To address the inconsistencies posed by these two extreme cases, we posit a novel generalization of the theoretical framework that incorporates both country-specific and common world disaster shocks. This generalization allows us to combine the domestic-based disaster risk model with international asset return and consumption correlations in the data to uncover country-specific versus common world disaster risk. Our evidence shows that a high degree of common disaster risk is required to explain the pattern that asset return correlations are greater than consumption growth correlations.

As this description makes clear, our objective in this paper is to highlight the international implications of existing U.S.-based disaster risk models in the tradition of Reitz (1988) and Barro (2006). For this purpose, we use a canonical disaster risk model to study its ability to fit international data moments. Therefore, we purposefully take as given the assumptions consistent with that literature and do not develop a new equilibrium model. In this way, the results in our paper most directly contribute to understanding any required modifications and potential limitations of the standard model when facing international data.

Although our analysis provides a unique contribution to understanding the international dimensions of disaster risk models, a number of other papers have also addressed the impact of disasters on the macroeconomy and on asset markets. Gabaix (2008, 2012) considers disaster risk with variable severity of disasters arising from the resilience of an asset's recover rate through a "linearity generating" process. Martin (2008) solves for the welfare cost of business cycles due to disasters, but does not match to asset return data. Backus et al. (2011) use U.S. equity index options to examine the implied disaster risk in consumption. Gourio (2008, 2012) evaluates the impact of disasters in a real business cycle model allowing for recoveries after a disaster. Nakamura et al. (2013) also allow for recovery periods after disasters, but then estimate differing probabilities of entering disasters across countries. However, these papers do not evaluate the international asset pricing implications of disaster risk.

Two recent papers provide an exception. Gourio et al. (2013) and Farhi and Gabaix (2016) examine the co-movements of returns and exchange rates with disasters, but they do so assuming complete markets. By contrast, our goal is to investigate the international asset market implications of existing U.S.-based empirical disaster risk models that, in turn, do not require markets to be complete. As such, we view the contribution in our paper to be complementary, but distinct from all of these papers.

The plan of the paper is as follows. Section 2 reviews the general framework used in the literature as well as the approach used in this paper. Section 3 describes the data and evaluates the model fit for countries in isolation. Section 4 describes the implications for correlations in consumption and asset returns across countries. Concluding remarks are in Section 5.

2. The canonical model and framework

The disaster risk literature is grounded in a theoretical asset pricing tradition beginning with Lucas (1978), which relates returns to intertemporal consumption optimization. Research applying this theory to the data has met with mixed success. For example, as Mehra and Prescott (1985) showed in their seminal work, the risk to U.S. investors implied by historical consumption data was not sufficient to generate the observed equity premium, a regularity often called the "equity premium puzzle". Following this observation, Reitz (1988) suggested that the risk of rare, but severe, disasters could provide a resolution to this puzzle.

The impact of rare disasters has been difficult to quantify, given the infrequency of these events in U.S. data, however. Therefore, Barro (2006) proposed using data on disasters across a large sample of countries to identify both the size and frequency of disasters in a single country. Subsequent papers such as Barro (2009) and Wachter (2013) have also considered the implications of these disasters on various asset pricing moments such as the mean and variance of the equity returns and government bill rates. Moreover, these moments are often measured in real returns in home country prices, and presented as average asset returns (e.g. Barro, 2006; Barro and Ursua, 2008). While much of the consumption-based asset pricing literature on disaster risk has focused upon the behavior of U.S. data moments, the identifying assumption that disasters need to be measured with non-U.S. data has clear implications for the asset pricing moments of those countries as well as their cross-country co-movements. In order to evaluate these implications below, we develop a framework taken from a standard domestic-based model, modified to allow as much latitude for the model to match differing asset and consumption moments across countries. For this purpose, we incorporate country specific parameters to the framework with time-varying disaster risk developed by Wachter (2013). The Barro (2009) model with constant probability of disaster is a special case of this framework. We refer to this general framework as the "canonical model" below.

Since our contribution is to investigate this framework applied to international asset returns, we necessarily inherit both the limitations and generalities of the standard approach. Specifically, the most limited interpretation of our investigation would be that, since the framework was developed to target domestic asset pricing moments, our analysis applies only to a world of multiple closed economies in isolation. Indeed, this narrow interpretation is consistent with the quantitative analysis in Section 3 that focuses exclusively on the analysis within each country. However, in Section 4, we show that this interpretation is likely to be overly restrictive when we examine the co-movements across countries implied by the canonical domestic-based disaster model. As demonstrated there, the domestic-based model implies positive co-movement in consumption and

[2] See, for example, the discussion in Tesar (1995) and Lewis and Liu (2015).

[3] Studies that treat disasters as independent across countries include Barro (2006, 2009) and Wachter (2013). In these papers, the frequency of disasters is calculated as the average number of times that output or consumption declined below a threshold across all countries and years. Studies that treat disasters as common include Gourio et al. (2013) and Farhi and Gabaix (2016).

Please cite this article as: K. Lewis, E. Liu, Disaster risk and asset returns: An international perspective, Journal of International Economics (2017), http://dx.doi.org/10.1016/j.jinteco.2017.03.001