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Contagion as a domino effect in global stock markets

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ABSTRACT

This paper shows that stock market contagion occurs as a domino effect, where confined local crashes evolve into more widespread crashes. Using a novel framework based on ordered logit regressions we model the occurrence of local, regional and global crashes as a function of their past occurrences and financial variables. We find significant evidence that global crashes do not occur abruptly but are preceded by local and regional crashes. Besides this form of contagion, interdependence shows up by the effect of interest rates, bond returns and stock market volatility on crash probabilities. When it comes to forecasting global crashes, our model outperforms a binomial model for global crashes only.

1. Introduction

Stock market crashes are one of the major risks that investors face. Although such crashes occur infrequently, their impact on the value of asset portfolios can be substantial. The October 1987 crash, for example, reduced stock prices by over 20% in most developed markets. In emerging stock markets, crashes can be even more severe. Asian markets lost over 30% in October 1997 during the Asian crisis. As emerging countries are commonly quite susceptible to macroeconomic shocks, crashes occur more often in their stock markets. While many of these crashes are "local" and remain confined to individual countries, some spread to neighboring emerging markets, resulting in regional stock market crashes. Some may even evolve into global crashes, where developed markets are also affected. The 1997 Asian crisis, for instance, originated in Thailand, then infected other developing Asian countries, and finally financial markets in the United States and Western Europe were affected as well.

For investors as well as policy makers it is important to know whether crashes remain local, or a "domino pattern" occurs, with local crashes evolving via regional crashes into global crashes. If crashes remain local, investors can hedge relatively easy. However, hedging is more difficult, and diversification opportunities diminish rapidly, when local crashes spread regionally or even globally (see Ibragimov and Walden, 2007). In this case, the domino effect may destabilize several markets and even the entire financial system, calling regulators into action. On the other hand, if markets tumble like domino tiles, a local or regional crash can be interpreted as an early warning signal of more turmoil to follow. Kole et al. (2006) show that the gain of including the possibility of global crashes in asset allocation decisions can become rather large if the crash probabilities increase.

This study empirically examines the transmission mechanism of stock market crashes around the globe, using daily data for the US, Europe and several emerging markets in Latin America and Asia for the period from July 1996 to July 2007. In particular, we investigate whether the evolution of crashes exhibits a domino effect. We first identify periods with local, regional and global crashes (and periods without any crash at all). We then use an ordered logit model for the probabilities of occurrence of the different crash types. An ordered logit model is precisely able to capture the natural ordering of crashes by severity. This setup enables the inclusion of both domino-style contagion and normal interdependence between financial markets. A domino effect is present when past occurrences of local, regional or global crashes significantly increase the probability of more severe crashes. We capture interdependence by including variables that represent information from the currency market, the bond market, and short-term interest rates.

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As our main result we find strong evidence in favor of a domino effect. A crash occurring today significantly increases the probability of a more severe crash tomorrow. This result holds for all different types of crashes. The domino pattern indicates that global crashes, which can hardly be diversified, do not occur abruptly but rather evolve out of prior local or regional crashes. Our results confirm that in times of financial distress panic spreads contagiously, as described in Dornbusch et al. (2000). A local crash is a good predictor of more financial turmoil ahead. Additionally, we find that bond market returns, interest rate levels and stock market volatility significantly influence local, regional and global crash probabilities, though currency changes do not. Higher interest rates and higher stock market volatility lead to higher probabilities of more severe crashes, while higher bond returns in emerging markets lead to lower crash probabilities. We do not find that the relation between the financial variables and crash likelihood depends on the type of crash that occurred the day before. Finally, we find that our model, allowing for different types of crashes including local and regional ones, is more successful in detecting and forecasting global crashes than a binomial model for global stock market crashes only.

We contribute to the literature in various ways. First, our explicit distinction between local, regional and global crashes, and our model of the evolution of these crashes as a domino effect sheds new light on the propagation of large negative stock market returns. This adds to the approach of Bae et al. (2003) and (to a lesser extent) of Cumperayot et al. (2006). Bae et al. (2003) consider the number of simultaneous extreme returns in different stock markets. In a multinomial logistic regression model they find significant effects of interest rates, changes in exchange rates and conditional stock market volatility on this number. However, they analyze only one region at a time, and do not investigate which part of the dependence between crashes in different countries can be attributed to reactions on crashes in other financial markets and which part to shocks in other financial variables. We extend their study by explicitly including global crashes in our analysis. These global crashes are most important for investors and regulators, because diversification opportunities evaporate in this case.

Second, we add to the ongoing debate on contagion and interdependence, as discussed in Dornbusch et al. (2000) (see also Pericoli and Sbracia, 2003), by using a framework in which we allow for both types of transmission mechanisms. Interdependence means spillovers of shocks resulting from the normal dependence between markets, due to trade links and geographical position, among others. So, interdependence refers to the dependence that exists in all states of the world. Contagion, on the other hand, constitutes a form of dependence that does not exist in tranquil periods but only occurs for large or extreme shocks to financial markets. Contrary to interdependence, this dependence cannot be linked to observed changes in macroeconomic or financial variables. Dornbusch et al. (2000) argue that this type of dependence is a result of "irrational" phenomena, such as financial panic, herd behavior and loss of confidence. We define contagion as the dependence that still exists after correcting for interdependence. Contrary to the common approach, our logistic framework does not measure contagion as correlation between residuals, but instead we construct contagion variables based on past extreme events. This enables us to distinguish between contagion and interdependence in the occurrence and evolution of local, regional and global crashes.

Most other studies concerning interdependence and contagion are based on bivariate analyses, and do not investigate dependence at the global level. The most popular approach is based on correlations between returns in different markets.[1] Kleimeier et al. (2008) show that these correlation based tests may lead to wrong conclusions due to different trading hours. Using time-aligned data they find contagion during the Asian crisis, contrary to Forbes and Rigobon (2002). Other authors attempt to model the volatility transmission mechanism by means of multivariate GARCH models[2] or use extreme value theory[3] to avoid the problem that increased correlations in periods of turmoil may be mostly a result of increased volatility.[4] Rodriguez (2007) uses copulas to measure contagion and finds evidence for contagion based on changes in dependence of extreme returns. Other studies making the distinction between interdependence and contagion are Connolly and Wang (2003) and Fazio (2007), where the latter concludes that interdependence exists between regions and contagion only within regions, and the former reject interdependence between regions while finding contagion between regions. Recently, Boyer et al. (2006) investigate the spread of crises through asset holdings of international investors, and find that this is an additional channel through which crises can spread. Our research is complementary to these studies.

A small number of previous studies consider crises and contagion in a multicountry environment. For instance, Dungey and Martin (2007) use factor models with world, regional and country factors and define contagion as the correlation between the residuals. This approach, however, is not specifically suited for measuring dependence among extreme shocks. The logistic approach, as pointed out by Bae et al. (2003), is more suitable to deal with extreme values, for the reason that it is closely related with extreme value theory. Christiansen and Ranaldo (2009) apply the methodology of Bae et al. (2003) to the stock markets of the EU and its new members and find evidence of an increased dependence of new EU stock markets to those in Western Europe. Other studies that use a multicountry environment are Favero and Giavazzi (2002) on exchange rate contagion, and Kose et al. (1990) who use a Bayesian framework to model output, consumption and investment. However, these two approaches are also not specifically suited for analyzing crashes. Kamin (1999) and more recently Dungey et al. (2008) empirically analyze whether the role of economic fundamentals (linkages) and contagion varies across financial crises. Although some differences are found, generally all crises seem to have much in common. Using information from the business cycle, Candelon et al. (2008) find a significant increase in the cross-country comovements of five Asian stock markets during the Asian crisis. For a comprehensive overview on recent developments in the contagion literature we refer to Dungey et al. (2005).

The paper proceeds as follows. In Section 2 we describe the data set, and provide our definition of stock market crashes as well as the classification into local, regional and global crashes. In Section 3 we put forth the methodology for analyzing the domino effect based on the ordered logit model. In Section 4 we discuss the empirical results concerning the patterns in the different types of crashes, including several sensitivity tests. Section 5 explores the economic relevance of our model compared to a binomial crash model for global crashes only. We conclude in Section 6.

2. The dynamics of stock market crashes

In this section we first discuss our data and definitions of local, regional and global stock market crashes. We then document the dynamic properties of the different crash types, to examine the appropriateness of modelling contagion as a domino effect.

[1] See King and Wadhwani (1990), Lee and Kim (1993), Loretan and English (2000) and Forbes and Rigobon (2002).

[2] See Hamao et al. (1990), Longin and Solnik (1995) and Ng (2000).

[3] See Kaminsky and Schmukler (1999), Longin and Solnik (2001) and Hartmann et al. (2004).

[4] See Boyer et al. (1999), Loretan and English (2000) and Forbes and Rigobon (2002).