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International Comovement of Economic Fluctuations: A Spatial Analysis

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Summary. — We consider the comovement of economic volatility across multiple countries. Using spatial models with data from 187 countries over the period of 1960–2007, we find a strong spatial comovement of economic volatility. More interestingly, the effect of geographical proximity on economic volatility comovement is strongest during the period of international shocks (1973–86), but almost disappears over the globalization era (1987–2007). By way of contrast, the influence of trade relations in determining the comovement of economic volatility is significant over 1987–2007.

Key words — international business cycles, economic volatility, spatial analysis, globalization, proximity

1. INTRODUCTION

A volatile macroeconomic environment tends to create more uncertainties for consumers and producers, which in turn can cause an underinvestment in human capital and physical capital. This leads to a lower rate of economic growth. In addition, economic volatility can also have an adverse effect on a country's income distribution (Acemoglu, Johnson, Robinson, & Thaicharoen, 2003; Bernanke, 1983; Gaggl & Steindl, 2007). Not surprisingly, business cycles have been an important focus of macroeconomic research since the Great Depression. [1] Empirical studies of business cycles/macroeconomic volatility generally examine three issues: (1) measures of business cycle volatility (Baxter & King, 1999; Blanchard & Simon, 2001; Bullard, 1998; Hodrick & Prescott, 1997); (2) determinants of business cycle volatility (Canova & De Nicolo, 2003; Holland & Scott, 1998; Shapiro *et al.*, 1988); and (3) comovements of business cycle volatility across countries. The last issue has attracted increasing attention. As pointed out by Kose, Otrok, and Whiteman (2008), understanding the nature and changes of world business cycle fluctuations is of essential interest to researchers and policy makers since business cycles synchronization indicates that one country's policy can have considerable impact on the macroeconomy of other countries. At the same time, the magnitude of business cycles comovement has "important implications for international policy coordination" (p. 111).

There is a large body of empirical research on the comovement of business cycles and factors influencing the transmission of economic fluctuations across countries. Some of these studies adopt a bilateral framework and explore correlations of economic fluctuations in a country *pair* (Backus & Kehoe, 1992; Baxter & Kouparitsas, 2005; Bergman, Bordo, & Jonung, 1998; Canova & Dellas, 1993; Clark & van Wincoop, 2001). [2] Other studies document common economic shocks and spillovers among a small number of countries, often the G-7 group or the Euro countries (Bagliano & Morana, 2010; Kose *et al.*, 2008; Stock & Watson, 2005). To identify common shocks, approaches such as the dynamic factor model (Kose *et al.*, 2008) or the factor structural VAR model (Bagliano & Morana, 2010; Clark & Shin, 2000; Stock & Watson, 2005) are employed. These models estimate common trends in several time series and quantify the share of total variation of a series such as the output in a country that is attributable to common shocks in the group and to the country's domestic performance. [3]

In this paper we link the literature on the determinants of economic volatility with the literature on the transmission of volatility across countries in a *multi-country, large-scale* model. [4] We do so by including a spatial measure of other countries' economic volatility as a determinant of country *i*'s economic volatility. Spatial models consider the correlation of observations across space with an underlying assumption that "dependence is present in all directions and becomes weaker as data locations become more and more dispersed" (Cressie, 1993, p. 3). [5]

Our paper contributes to the literature in several ways. First, we consider spillovers of foreign economic volatility as a determinant of a country's economic fluctuations. In previous studies of unilateral determinants of business cycles, it is often assumed economic fluctuations of individual countries are *independent* of one another. Second, we directly quantify the comovement of economic volatility across *multiple countries.* The bilateral framework of volatility comovement literature considers the dependence of business cycles between two countries, but observations of different dyads are still considered independent of one another. This assumption does not necessarily hold either. For example, the same country can enter a large number of dyads and observations of these dyads are

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likely to be correlated. A major advantage of spatial analysis we use over the bilateral framework in previous studies is that we take into account economic fluctuations of all countries *simultaneously* instead of pairing up countries in a specific dyad form. Third, spatial models complement factor analysis mentioned above in the sense that these two methods answer different questions about the comovement of volatility. Factor analysis focuses on the decomposition of current economic fluctuations of an individual country and answer the question, for instance, how much economic volatility a country experiences is caused by foreign volatility and how much is caused by the country's own performance. On the other hand, spatial models investigate *changes* in economic fluctuations and quantify the impact of a *change* in neighboring countries' economic volatility on the *change* in economic volatility in our country of interest. Fourth, taking into account a general measure of spatial dependence of economic volatility in the model provides us with more reliable results—if a country's economic volatility is affected by economic volatility of other countries, omitting a measure of such a multilateral dependence might lead to biased and inconsistent estimated coefficients as well as invalid statistical inferences (Anselin, 1988).

Using data from 187 countries over 1960–2007, we find strong comovement of economic volatility across countries, *geographically and economically*. In other words, a country's economic volatility is positively associated with its geographical neighbors' and trade partners' economic volatility. Our results show that the comovement of economic volatility changes over time. The effect of geographical proximity on the comovement of economic volatility rises from 1960–72 (the Bretton Woods era) to 1973–86 (the common shock period), but almost *disappears* over the period of 1987–2007 (the period of globalization). Conversely, clustering among trade partners becomes quite evident during the globalization era of 1987–2007. The role of geographical distance in affecting comovement among countries is declining, but the importance of economic ties has increased over the past few decades. These findings are robust to different measures of economic volatility.

The comovement of economic volatility implies that nations may share the benefits of having an interdependent and more predictable economic system. They, however, also share the risks of world economic fluctuation contagions. Nevertheless, a deeper understanding of this comovement can enhance our awareness so that governments are better prepared to cope with these risks and are more cautious when implementing policies that might affect other countries adversely.

The remainder of the paper is organized as follows: we describe variables and data in Section 2 and present the general spatial lag model setup in Section 3. Empirical results for geographical-proximity and economic-proximity spatial regressions are discussed in Sections 4 and 5, respectively. Section 6 provides robustness checks, and Section 7 concludes the paper.

2. VARIABLES AND DATA

Our empirical model seeks to understand how the economic volatility of a country of interest is correlated with economic volatility of multiple other countries. We do so by employing a spatial lag model. Our study focuses on economic volatility comovement among geographical neighbors and trade partners as geographical proximity and economic ties are often studied in previous economics research about connections between countries (Anselin, 2010; Clark & van Wincoop, 2001). In addition, we will also look at volatility comovement among countries having a similar culture or a similar administrative structure. In this section, we present the variables in our regressions as well as our sample. The setup of a spatial lag model will be discussed in Section 3.

(a) *Dependent variable*

The dependent variable in our model is a measure of economic volatility. To ensure our empirical results are robust and not bound by one specific definition, we construct three different measures of economic volatility (hereafter represented by σ), commonly used in previous studies (Backus & Kehoe, 1992; Blanchard & Simon, 2001; Bullard, 1998; Fiorito & Kollintzas, 1994; Hodrick & Prescott, 1981, 1997; Jaimovich & Siu, 2009; Kose, Prasad, & Terrones, 2003; Ravn & Uhlig, 2002). These measures capture volatility in national output growth or output level, and they include: (1) output growth volatility; (2) volatility of residuals from a growth regression; and (3) the Hodrick–Prescott filtered output volatility. We focus on the measure of output growth volatility and report results based on the other two measures in the section of robustness checks.

Following Bullard (1998) and Ramey and Ramey (1995), we calculate the standard deviation of output growth (σ^{VG}) as:

$$\sigma_i^{VG} = \sqrt{\frac{\sum [g_{it} - (\sum g_{it}/T)]^2}{T-1}}, \tag{1}$$

where g_{it} is the growth rate of real GDP between time $t-1$ and t in country i and T denotes the time span.

Blanchard and Simon (2001) consider an alternative measure as the unexpected fluctuations of economic growth (also called growth residuals). In constructing the volatility of growth residuals (σ^{VGR}), we estimate an AR(1) growth regression (Blanchard & Simon, 2001):

$$g_{it} - \bar{g}_i = a_i(g_{it-1} - \bar{g}_i) + \epsilon_{it}^{\mathrm{VGR}}, \tag{2}$$

where $\bar{g}_i = \sum g_{it}/T$ is the average growth rate in country i over T years, and a_i is an AR(1) parameter for country i. We then obtain the standard deviation of the residuals from the above growth regression as:

$$\sigma_i^{\mathrm{VGR}} = \sqrt{\frac{\sum (\epsilon_{it}^{\mathrm{VGR}})^2}{T-1}}. \tag{3}$$

The Hodrick–Prescott (HP) filter separates the trend component of a macroeconomic variable Y_t from its cyclical component. We construct the third measure of volatility by calculating the standard deviation of the cyclical component of HP filtered real GDP, with real GDP normalized as 100 in year 1995 (Buch, Doepke, & Pierdzioch, 2005). [6] Formally, after extracting the trend component of real GDP, the HP output volatility (σ^{VHP}) can be written as:

$$\sigma_i^{\mathrm{VHP}} = \sqrt{\frac{\sum \epsilon_{it}^2}{T-1}}, \tag{4}$$

where $\epsilon_{it} = Y_{it} - Y_{it}^{\mathrm{HP}}$ is the difference between real GDP (Y_{it}) and the HP trend (Y_{it}^{HP}) at time t for country i.

(b) *Independent variable and control variables*

For any country i, our main variable of interest on the right-hand side of the regression is a spatial lag term or a weighted average of economic fluctuations of all countries j ($i \neq j$). The