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Economic growth, volatility, and cross-country spillovers: New evidence for the G7 countries

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ABSTRACT

This study examines the linkages between output growth and output volatility in the G7 countries over the period 1958M2–2013M8. Using the VAR-based spillover index approach by Diebold and Yilmaz (2012) we find that: i) output growth and volatility are highly intertwined; ii) spillovers have reached unprecedented levels during the global financial crisis; and iii) the US has been the largest transmitter of growth and volatility shocks. Generalized impulse response analyses suggest moderate growth spillovers and sizable volatility spillovers across countries. Cross-variable effects indicate that volatility shocks lead to lower growth, while growth shocks reduce output volatility.

1. Introduction

The link between economic growth and volatility is theoretically ambiguous. According to Bernanke (1983), output volatility raises economic uncertainty and thus hampers investment due to its irreversible nature, which in turn leads to lower economic growth. Aghion and Howitt (2006) argue that volatility has a negative effect on growth under credit market imperfections that constrain investments during recessions. On the contrary, higher volatility (economic uncertainty) could increase precautionary saving and therefore lead to higher growth rates (Lensink et al., 1999; Mirman, 1971). Optimal portfolio theory suggests that volatile sectors command high investment rates (Imbs, 2007). Finally, a positive effect of volatility on growth could also be due to a Schumpeterian 'cleansing effect' of recessions (Caballero, 1991).[4]

The empirical literature on the relation between output volatility and economic growth, which has used cross-section and panel data models as well as time series analyses of individual countries, adds to this controversy. Ramey and Ramey (1995), Lensink et al. (1999), Martin and Ann Rogers (2000), Fatás (2002), Rafferty (2005), Badinger (2010) and Posch and Wälde (2011) find that output growth tends to be lower during periods of higher volatility. On the other hand, Kormendi and Meguire (1985), Grier and Tullock (1989), Caporale and McKiernan (1996), Fountas and Karanasos (2006) and Lee (2010) find that countries with higher output volatility tend to experience higher economic growth rates.[5]

Identifying the relationship between economic growth and volatility is aggravated by their complex and intricate linkages. First, causality may run not only from volatility to growth but also from growth to volatility, a point already made by Stiglitz (1993). The empirical literature on this linkage is rather sparse. Fountas and Karanasos (2006) find that higher output growth leads to significantly lower output volatility in two out of the G3 countries (Germany and the US) between the mid-19th century and 1999, while Lee (2010), who uses a panel-GARCH approach for the G7 countries over the 1965–2007 period, finds no significant relationship. More recently, Kodama (2014) finds evidence of a negative casual effect of growth on volatility for a sample of developing countries over the 1966–2005 period.

Second, in a world of highly interdependent economies, economic growth and output volatility spillovers from foreign countries are relevant determinants of a country's own economic growth and output

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[4] See Imbs (2007) for an extended discussion of the link between volatility and growth.

[5] For a comprehensive review and discussion of empirical studies, see Döpke (2004) and Norrbin and Yigit (2005).

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volatility. Due to their high degree of economic integration, this holds particularly true for developed countries, for which a strong role of growth spillovers (Antonakakis and Scharler, 2012) and volatility spillovers (Antonakakis and Badinger, 2012a) has been found.

The aim of this paper is to shed more light on this controversy by examining the linkages between output volatility and economic growth both within and across the G7 countries. As a first study on the linkages between growth and volatility, we use the VAR-based spillover index approach recently introduced by Diebold and Yilmaz (2009, 2012), which is particularly suited for the investigation of systems of highly interdependent variables.[6] Especially, the variant of Diebold and Yilmaz (2012) which uses a generalized vector autoregressive framework, in which forecast-error variance decompositions are invariant to the ordering of the variables, in contrast to Cholesky-factor identification used in Diebold and Yilmaz (2009). In the context of the present study, this is particularly important since it is hard if not impossible to justify one particular ordering of the variables on output growth and volatility among the countries. Thus by fully accounting for the pattern of observed correlation between shocks it increases the relevance from a policy perspective in light of the increased synchronization of shocks and the growing importance of a 'world component' in countries' business cycles (Kose et al., 2003).

A very closely related study to ours, is the one of Yilmaz (2009) that examines output growth spillovers in the G7 countries. Unlike Yilmaz (2009), however, in this study we examine output growth volatility in addition to output growth spillovers. In particular, our study enables an encompassing analysis to unravel the two-way relationships between output growth and volatility, both within countries and accounting for spillovers between countries. Moreover, it allows an assessment of the evolution of spillovers between output volatility and economic growth over time, the identification of the main receivers and transmitters of shocks, and the quantification of their magnitude using impulse response analyses. These are the major contributions of this study.

Based on monthly observations of seasonally adjusted industrial production growth as a proxy measure for output growth for each of the G7 countries over the period 1985M11–2013M8 we identify several empirical regularities: i) output growth and volatility are highly intertwined, with spillovers taking place into all four directions; ii) the importance of spillovers has increased and reached unprecedented levels during the recent financial and economic crisis; and iii) the US has been the largest transmitter of output growth and volatility shocks to other countries. Generalized impulse response analyses point to moderate growth spillovers and sizable volatility spillovers across countries, suggesting that volatility shocks quintuplicate in the long-run. The cross-variable effects turn out negative: volatility shocks lead to lower economic growth, while growth shocks tend to reduce output volatility. Our findings underline the increased vulnerability of the G7 countries to destabilizing shocks and their detrimental effects on economic growth, which are sizeably amplified through international spillover effects and the associated repercussions. In addition, our results suggest that the implementation of stabilization policies to mitigate short-run economic fluctuations contributes to long-run economic growth, while growth-enhancing policies promote economic stability.

The remainder of the paper is organized as follows. Section 2 discusses the application of the spillover index approach to disentangle the intricate relationships between volatility and growth and describes the data used. Section 3 presents the empirical findings. Section 4 summarizes the results and concludes.

[6] This VAR-based spillover index methodology has already attracted significant attention by the economic literature, investigating issues such as stock market interdependencies, volatility spillovers, business cycle spillovers and bond yields spillovers (see, *inter alia*, (McMillan and Speight, 2010; Yilmaz, 2010; Bubák et al., 2011; Antonakakis, 2012b; Zhou et al., 2012; Antonakakis and Vergos, 2013; Antonakakis and Badinger, 2014; Narayan et al., 2014)).

2. Empirical model, methodology, and data

2.1. Definition of spillover indices for output growth and volatility

In the following, we outline our application of the spillover index approach introduced by Diebold and Yilmaz (2009). Building on the seminal work on VAR models by Sims (1980) and the well-known notion of variance decompositions, it allows an assessment of the contributions of shocks to variables to the forecast error variances of both the respective and the other variables of the model. Using rolling-window estimation, the evolution of spillover effects can be traced over time and illustrated by spillover plots.

For the purpose of the present study, we use the variant of the spillover index in Diebold and Yilmaz (2012), which extends and generalizes the method in Diebold and Yilmaz (2009) in two respects. First, they introduce refined measures of directional spillovers and net spillovers, providing an 'input–output' decomposition of total spillovers into those coming from (or to) a particular source (variable) and allowing to identify the main recipients and transmitters of spillovers.

Second, in line with Koop et al. (1996) and Pesaran and Shin (1998), Diebold and Yilmaz (2012) use a generalized vector autoregressive framework, in which forecast-error variance decompositions are invariant to the ordering of the variables (in contrast to Cholesky-factor identification used in (Diebold and Yilmaz, 2009)). In the context of the present study, this is particularly important since it is hard if not impossible to justify one particular ordering of the variables on output growth and volatility among the countries. Of course, the generalized VAR framework has advantages and drawbacks. A disadvantage is that it aggravates the identification of causal effects in a strict sense in the impulse response analysis. On the other hand, by fully accounting for the pattern of observed correlation between shocks it increases the relevance from a policy perspective in light of the increased synchronization of shocks and the growing importance of a 'world component' in countries' business cycles (Kose et al., 2003). We will nevertheless explore the robustness of the results against a more structural approach, using Cholesky-factorizations with alternative orderings.

Starting point for the analysis is the following P-th order, K-variable VAR

$$y_t = \sum_{i=1}^{P} \Theta_i y_{t-i} + \varepsilon_t \tag{1}$$

where $y_t = (y_{1t}, y_{2t}, \ldots, y_{Kt})$ is a vector of K endogenous variables, Θ_i, $i = 1, \ldots, P$, are $K \times K$ parameter matrices and $\varepsilon_t \sim (0,\Sigma)$ is a vector of disturbances that are independently distributed over time; $t = 1, \ldots, T$ is the time index and $k = 1, \ldots, K$ is the variable index. For each of the G7 countries considered (*CAN*, *FRA*, *GER*, *ITA*, *JPN*, *UK*, *US*), the VAR given by Eq. (1) contains observations on output growth ($g_{n,t}$), and output growth volatility ($\sigma_{n,t}$, $n = 1,\ldots,7$), with n denoting the country index. Hence, with 7 countries and 2 variables, our VAR is made up of $K = 14$ variables, i.e., $y_t = [g_t' \sigma_t']'$, where g_t and σ_t are 7×1 vectors with observation on output growth and output volatility for each of the 7 countries respectively. For notational simplicity, both variables $g_{n,t}$ and $\sigma_{n,t}$ in (1), are referred to as $y_{i,t}$ and indexed by $i = 1, \ldots, K = 14$ in the following.

The two key variables, output growth and output growth volatility are derived from monthly, seasonally adjusted data on industrial production for the G7 countries over the period from January 1958 to August 2013, taken from the IMF's International Financial Statistics. Monthly growth rates of real industrial production are obtained using the first difference of their logarithms.[7] The use of the growth rate of industrial production as a proxy of economic growth (business cycles) has

[7] Thus the reference point of this paper is to examine the short- to medium- term dynamics of the relationship between output volatility and economic growth.

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