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Time-varying price shock transmission and volatility spillover in foreign exchange, bond, equity, and commodity markets: Evidence from the United States

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A B S T R A C T

We study the cross-market financial shocks transmission mechanism on the foreign exchange, equity, bond, and commodity markets in the United States using a time-varying structural vector autoregression model with stochastic volatility (TV-SVAR-SV). The price shocks are absorbed immediately in two or three days, suggesting that all markets are quite efficient. A slight mean reversion and an overshooting behavior are observed. Considering the volatility spillover effect, we highlight two properties of volatility shocks. First, the effects of the volatility shocks are released gradually. Reaching peak volatility spillover levels would require five to ten days. Second, the dynamics of volatility spillovers vary tremendously over time. Different types of markets respond to certain, but not all, extreme events. Our findings suggest the need to conduct investor monitoring of current events instead of using technical analysis based on historical data. Investors should also diversify their portfolios using assets that can respond to different and extreme shocks.

1. Introduction

Understanding the transmission mechanism of financial shocks is crucial for investors for the purposes of asset allocation, risk management, derivative pricing, and dynamic hedging. Generally, investors concentrate on diversification, using negatively correlated assets to minimize their portfolio risks. However, it is more important to verify whether their assets are affected by the same significant events. Merely stating that assets suffered from identical extreme shocks is insufficient information for portfolio diversification.

It is also essential for policymakers to understand the transmission mechanism of financial shocks, since extreme volatility shock spillover causes financial instability. To stabilize not only the financial markets but also the real economy, they need to develop appropriate policies to prevent large market impacts of volatility shocks from extreme events.

Cross-market contagion or spillover effects have been widely studied in the economic literature. For instance, Arouri, Jouini, and Nguyen (2012) analyze both return and volatility spillover effects between oil and the European stock markets using a vector autoregressive-generalized autoregressive conditional heteroskedasticity (VAR-GARCH) model. They find

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significant volatility transmission between the oil and stock markets in Europe, with the spillover effects being more apparent from the oil to the stock markets. They also show that oil assets in a well-diversified portfolio of sector stocks improve the portfolio's overall risk-adjusted performance. Chang, McAleer, and Tansuchat (2013) study conditional correlation and volatility spillover effects between crude oil and stock index returns using a range of multivariate GARCH (MGARCH) models, including constant conditional correlation (CCC), dynamic conditional correlation (DCC), vector autoregressive moving-average (VARMA)-GARCH and VARMA-asymmetric GARCH (AGARCH) models, in pairwise bivariate cases. Their empirical results provide little evidence of dependence between the crude oil and financial markets. Liow (2015) examines conditional volatility spillovers among public real estate, stock, bond, money, and currency markets domestically and internationally for G7 countries under a VAR-BEKK (Baba–Engle–Kroner–Kraft)-MGARCH framework. He finds low cross-asset volatility spillovers within each of the G7 countries. Hammoudeh, Yuan, McAleer, and Thompson (2010) investigate the conditional own and spillover volatilities and correlations for a range of precious metal indices and the US dollar/Euro exchange rate using a VARMA-DCC model, and use the results to calculate the optimal two-asset portfolio weights and hedging ratios. They point out that the performance of hedging precious metals against each other is limited, but the volatility sensitivity of precious metals to the exchange rate is strong. However, these studies have several limitations. First, the sample periods of their data include economic booms and recessions as well as stable periods, which means the sensitivity of return and volatility correlations across markets may change over time, but their methods do not consider time variation of parameters. Second, these studies focus on highly restricted versions of the MGARCH models in bivariate cases, which may be attributed to some operational reasons. Therefore, the risk associated with possible model misspecification could be sizeable. In sum, their approaches are not sufficiently flexible.

In this study, we investigate return and volatility spillovers using a time-varying structural vector autoregression model with stochastic volatility (hereafter, the TV-SVAR-SV model). This model has recently been introduced by Primiceri (2005) and is widely used in investigating macroeconomic issues (see Clark & Terry, 2010; D'Agostino, Gambetti, & Giannone, 2013; Keating & Valcarcel, 2015; Rafiq, 2014). The proposed method concentrates on modeling financial returns using multivariate stochastic volatility rather than MGARCH models. MSV models are widely discussed by Harvey, Ruiz, and Shephard (1994), Jacquier, Polson, and Rossi (1994), and Kim, Shephard, and Chib (1998). The advantage of the proposed method is that it allows simultaneous shock transmissions in returns and volatilities while also considering time variation of parameters. The TV-SVAR-SV model has advantages over the models used in previous studies, in that it provides extreme flexibility with a parsimonious specification.

Price shock transmissions are investigated by using time-varying impulse response functions. The parameters of the conventional impulse response function are assumed to remain unchanged over the horizon. If this is not the case, the estimated impulse responses are biased. Since the time variation of parameters is considered by the time-varying impulse response function, the TV-SVAR-SV model would provide more accurate impulse response estimates.

The study of volatility spillovers is based on a generalized VAR model in which forecast error variance decompositions (FEVDs) are invariant to variable ordering, according to Diebold and Yilmaz (2012). This is a recent introduction and is popularly used in the investigation of information transmission mechanisms. For instance, Liow (2015) focuses on portfolio diversification and volatility forecasting by investigating the conditional volatility and correlation spillover among G7 countries. Do, Brooks, Treepongkaruna, and Wu (2016) study intraday information transmission by investigating realized spillovers in higher moments (volatility, skewness, and kurtosis) between the stock and exchange markets. Here, we concentrate on investigating the cross-market volatility transmission mechanism. Diebold and Yilmaz (2012) approximate the volatility using daily high and low prices, which seems to be a very noisy and an inaccurate volatility proxy. Our study differs in this sense, since our volatility estimates are obtained from a flexible parametric model. Therefore, the volatility spillover effect can be investigated much more accurately.

Compared to the previous studies discussed above, this study sheds new light on the transmissions of daily return and volatility shocks between the foreign exchange (FX), bond, equity, and sector commodity markets (including agriculture, energy, industrial metals, and precious metal markets) in the United States. A number of variables are estimated simultaneously, and therefore, we avoid the possibility of losing large amounts of information from excluded variables.

This paper is organized as follows. Section 2 introduces the empirical model. Section 3 provides a brief description of the data. Section 4 reports the empirical results, and Section 5 concludes.

2. Method

2.1. TV-SVAR-SV model

According to Primiceri (2005), the TV-SVAR-SV model can be specified as

$$y_t = c_t + B_{1,t}y_{t-1} + \cdots + B_{s,t}y_{t-s} + A_t^{-1}\Sigma_t\varepsilon_t \tag{1}$$

where y_t is a $k \times 1$ vector of observed variables; c_t is a $k \times 1$ vector of time-varying constant terms; $B_{i,t}, i = 1, \ldots, s$ are $k \times k$ matrices of time-varying coefficients; ε_t is $i.i.d(0, I_k)$; A_t is the lower triangular matrix