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Volatility transmission in emerging European foreign exchange markets

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ABSTRACT

This paper studies the dynamics of volatility transmission between Central European (CE) currencies and the EUR/USD foreign exchange using model-free estimates of daily exchange rate volatility based on intraday data. We formulate a flexible yet parsimonious parametric model in which the daily realized volatility of a given exchange rate depends both on its own lags as well as on the lagged realized volatilities of the other exchange rates. We find evidence of statistically significant intra-regional volatility spillovers among the CE foreign exchange markets. With the exception of the Czech and, prior to the recent turbulent economic events, Polish currencies, we find no significant spillovers running from the EUR/USD to the CE foreign exchange markets. To measure the overall magnitude and evolution of volatility transmission over time, we construct a dynamic version of the Diebold–Yilmaz volatility spillover index and show that volatility spillovers tend to increase in periods characterized by market uncertainty.

1. Introduction

The financial and economic turbulence during 2008–2009 renewed interest in understanding the nature of contagion effects among financial markets (Aloui et al., 2011). The recent economic crisis included a significant fall in asset prices along with large and unexpected movements in foreign exchange rates (Muller and Verschoor, 2009). The crisis deeply affected the financial sectors in Europe (Moshirian, 2011), not excluding European emerging markets. Motivated by the impact of the recent crisis, this study analyzes the dynamics of volatility transmission to, from and among Central European (CE) foreign exchange markets. In particular, we analyze volatility spillovers among the Czech, Hungarian and Polish currencies together with the US dollar during the period 2003–2009, and the extent to which shocks to foreign exchange volatility in one market transmit to current and future volatility in other currencies.

Despite their growing integration with developed markets, in terms of volatility transmission, European emerging markets are under-researched. The joint behavior of the volatility of CE currencies is of key importance for international investors contemplating the diversification benefits of allocating part of their portfolio to CE assets. In fact, according to Jotikasthira et al. (2010), developed-country-domiciled mutual and hedge fund holdings already account for about 13–19% of the free-float adjusted market capitalization in Central Europe (16.6% in the Czech, 17% in the Hungarian and 13.3% in the Polish equity markets). Since international stock market co-movements tend to be stronger in periods of distress and therefore high volatility (King and Wadhwani, 1990), an increase in foreign exchange volatility further amplifies the variability of internationally allocated portfolios for investors whose consumption is denominated in a developed-country currency. The associated rise in the cost of hedging foreign exchange risk then plays an important role in the investment decision-making

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process and requires a good understanding of the underlying foreign exchange volatility. The importance of volatility in the construction of portfolios in the CE foreign exchange markets is also shown in de Zwart et al. (2009).

Further, there are even more fundamental reasons to be interested in analyzing volatility transmission in European emerging markets. The new EU members committed themselves to adopting the euro upon satisfying the set of Maastricht convergence criteria, one of which is exchange rate stability. Foreign exchange volatility is a measure of currency stability. This precondition is to some extent in contrast with historical evidence that foreign exchange risk is pronounced in new EU members (Kočenda and Valachy, 2006). Finally, Kočenda and Poghosyan (2009) show that both real and nominal macroeconomic factors play important roles in explaining the variability of and contribute to the foreign exchange risk in the set of countries we study. As these countries are in the process of coping with the Maastricht criteria to qualify for euro (EUR) adoption, identifying patterns of volatility transmission requires a detailed analysis.

Soriano and Climent (2006) review the relevant volatility transmission literature: studies that aim at foreign exchange volatility transmission are less frequent than those covering equity markets. Studies of volatility transmission analyzing forex data are chiefly based on low-frequency data. Kearney and Patton (2000) employ a series of multivariate GARCH models on the members of the former European Monetary System (EMS) prior to their complete monetary unification and find that less volatile weekly data exhibit a significantly smaller tendency to transmit volatility compared to more volatile daily data. Hong (2001) pursues a different approach, finding the existence of Granger-causalities between 2 weekly nominal US dollar exchange rates with respect to (the former) Deutsche mark (DEM) and Japanese Yen (JPY). Hong (2001) belongs to a strand of literature that develops formal testing tools for causality in variance using low-frequency data. Following the seminal paper by King and Wadhwani (1990), Cheung and Ng (1996) and Hong (2001) develop tests of spillover effects based on a residual cross-correlation function. Finally, Diebold and Yilmaz (2009) employ a vector autoregressive model as a basis for the variance decomposition of forecast error variances in order to measure the magnitude of return and volatility spillovers.

Although one can learn much from the analysis of daily or weekly data, this relatively low-frequency data may fail to detect both the effect of information that is incorporated very quickly as well as any short-run dynamic effects (Wongswan, 2006). A limited number of recent studies make use of intraday or high-frequency data, hoping to address these and related issues. In an early study Baillie and Bollerslev (1991) examine volatility spillover effects in four foreign exchange spot rates (GBP, JPY, DEM, and CHF) vs. USD, recorded on an hourly basis, and fails to uncover the presence of volatility spillover effects between the currencies or across markets. Engle et al. (2009) study volatility spillovers based on a daily high-low range as a proxy for volatility. Finally, Wongswan (2006) makes use of high-frequency data to study the international transmission of fundamental economic information from developed economies (United States, Japan) to emerging economies (Korea, Thailand).

An important benefit of using high-frequency data is the improved estimation of volatility and, consequently, an improved inference about volatility transmission. To the best of our knowledge there are only two studies at the moment that that make use of high-frequency data to construct realized measures of integrated variance as means of analyzing volatility spillovers in foreign exchange markets. Melvin and Melvin (2003) provide evidence of statistically significant intra- and inter-regional volatility spillovers in the DEM/USD and JPY/USD forex markets. In a more recent study, Cai et al. (2008) study the transmission of volatility and trading activity across three major trading centers (Tokyo, London, and New York) and two currency pairs (EUR/USD and USD/JPY) using minute-by-minute forex mid-quotes. Our work directly contributes to this strand of literature by studying the CE region.

The contribution of our paper to the existing literature is a thorough study of volatility transmission among CE exchange rates and the US dollar using high-frequency data. By relying on model-free non-parametric measures of ex-post volatility, our analysis is in sharp contrast to the existing empirical literature on CE exchange rates that employs almost exclusively a GARCH framework to study the dynamics of exchange rate volatility. We propose a simple and flexible multivariate time-series specification for the series of realized volatilities of the four exchange rates, allowing explicitly for the time-varying nature of the volatility of realized volatility itself. The model is essentially a multivariate generalization of the HAR-GARCH model of Corsi et al. (2008). Within the model we formally test for volatility spillovers by running simple pairwise Granger causality tests. However, to properly assess the overall magnitude and dynamics of the volatility spillovers we construct a dynamic version of the Diebold–Yilmaz spillover index.

The onset of the sub-prime crisis of 2008 brought about a substantial change in the behavior of the exchange rates under research. Recursive estimation of our model indicates that a structural break occurred around the beginning of 2008 and was characterized by a dramatic increase of the level of exchange rate volatility. We therefore analyze the volatility spillovers by fitting our model separately for two sub-samples (2003–2007 and 2008–2009). Our empirical results document the existence of volatility spillovers between the CE foreign exchange markets. We find that each CE currency is characterized by a different volatility transmission pattern: spillovers affecting the Czech koruna and Polish złoty were detected while the Hungarian forint seems irresponsive during the pre-crisis period (2003–2007). The picture changes quite dramatically when we look at the crisis period of 2008–2009: spillovers decrease in general but the level of the Diebold–Yilmaz index increases substantially with respect to the pre-2008 period. This is due to the increased *contemporaneous* dependence of the realized volatility innovations; direct evidence comes from the dramatic increase in the average correlation in the unconditional innovations of volatility transmission between pre-crisis and post-crisis periods. Thus, we find that in periods characterized by increased market uncertainty, the CE exchange rates and US dollar volatilities co-move more closely, which has important implications for the stability of the region as a whole.

The rest of the study is organized as follows. In Section 2, we set out our theoretical framework and modeling strategy, and derive the dynamic version of the volatility spillover index. We describe the data in Section 3 and report the empirical results in Section 4. Section 5 concludes the paper with a short discussion and suggestions for future research.

2. Methodology

Following the approach of Andersen et al. (2007) we assume that the vector of the logarithmic spot exchange rate, $\boldsymbol{x}_t$, belongs to the class of jump-diffusions

$$\boldsymbol{x}_t = \boldsymbol{x}_0 + \int_0^t \boldsymbol{\mu}_u du + \int_0^t \boldsymbol{\Theta}_u d\boldsymbol{w}_u + \boldsymbol{l}_t,$$

where $\boldsymbol{\mu}_t$ denotes a vector drift process, $\boldsymbol{\Theta}_t$ is the spot co-volatility process, $\boldsymbol{w}_t$ is a standard vector Brownian motion and $\boldsymbol{l}_t$ a vector pure-jump process of finite activity (i.e. the associated Levy density is bounded in the neighborhood of zero). We make no parametric