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Predictability dynamics of emerging sovereign CDS markets

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HIGHLIGHTS

- Time-varying weak-form efficiency of emerging sovereign CDS markets is analyzed.
- We use permutation entropy with a rolling-window framework.
- Emerging sovereign CDS markets have different degrees of time-varying efficiency.
- CDS markets can be weak-form efficient even in the crises episodes.
- We find strong negative relation between sovereign risk and CDS market efficiency.

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ABSTRACT

We compare the time-varying weak-form efficiency of Credit Default Swap (CDS) markets of 15 emerging countries by using permutation entropy approach. We find that CDS markets have different degrees of time-varying efficiency. Using several robustness test, we find that Thailand, China, South Korea and Malaysia have the most efficient CDS markets while South Africa, Colombia and Turkey are the least efficient. Our results show that CDS markets can be efficient even in the crisis episodes. Our findings also suggest a strong negative relation between sovereign risk and CDS market efficiency.

1. Introduction

Since the trading of credit default swaps (CDSs) began in 1994, market participants have used this credit derivative market not only for transferring credit risk but also as an indicator of the potential default risk of sovereign and corporate bonds. A typical CDS contract involves one party agreeing to sell credit protection (protection seller) to another party (protection buyer) who pays periodically a fee over the contract's tenor. If a credit event occurs, the protection buyer terminates the fee payments and receives compensation from the protection seller. Despite the global importance of this market, there have only been a few studies of its price efficiency in any of the forms defined by Fama (1970), — weak, semi-strong, and strong. Our study focuses on the weak-form of market efficiency for the sovereign sector of the CDS market, a market not covered in previous studies.

The implication of a weak-form efficient sovereign CDS market is that information is impounded into CDS spreads in a timely manner, and that the country's default probability has an unpredictable pattern. Whereas in the case of weak-form inefficiency, the default probability follows a more or less predictable path over a long horizon. In other words, trading the weak-from inefficient sovereign CDS contracts could be profitable for an investor who is skilled enough to exploit market inefficiencies. On the other hand, weak-form efficient sovereign CDSs are less likely to be used as the sole trading instrument to gain speculative returns. From a macroeconomic perspective, if CDSs are assumed to be a general indicator of a country's economy, the predictability pattern may not only be observed in daily CDS changes, but also in other economic indicators as well.

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Only five studies have examined the price efficiency of the CDS market, four focusing on the corporate CDS sector and one on the sovereign CDS sector. Two studies, Zhang and Zhang (2013) and Jenkins et al. (2016), test the semi-strong form for the U.S. corporate CDS market. Both studies find that this sector of the CDS market is informationally efficient. However, although Jenkins et al. (2016) find that the U.S. corporate CDS market is efficient before and after the global crisis in 2008, they call into question its efficiency during the crisis period. Avino and Nneji (2014) find that European corporate CDS spreads are characterized by the existence of a predictable pattern and conclude that this CDS market sector is not weak-form efficient. Investigating the U.S. and European corporate CDS markets, Kiesel et al. (2016) conclude that the market is not truly efficient. Investigating the weak-form, Gunduz and Kaya (2013) is the only study that focuses on the sovereign CDS markets for 10 Eurozone developed countries. They report that the European CDS market has been efficient even during the recent financial crisis.

In this study we look at the pricing efficiency in its weak-form for a sector the CDS market that has not been covered by previous studies: the emerging sovereign CDS market. Our methodological framework differs from prior studies on the weak-form of the efficiency of the CDS market in two ways. First, prior studies generally estimate a fixed level of market efficiency for the entire sample period. In contrast, we employ a time-varying approach by using rolling samples, giving us the flexibility of not being forced to impose cutoff dates which are usually subject to criticism in empirical studies. Second, we employ a relatively new methodology, permutation entropy, introduced by Bandt and Pompe (2002). This methodology, has several advantages over the methodologies used in prior studies.

We find that emerging sovereign CDS markets (1) have different degrees of time-varying dependence structures, (2) can be efficient even in crisis episodes and, (3) exhibit a strong negative relation between CDS market efficiency and sovereign risk.

2. Methodology

As noted above, we apply permutation entropy to test for weak-form efficiency. Given the time series of CDS spreads, we first consider market efficiency as a dependency concept and translate the problem of dependency into a symbolic dynamic. Then we use the special entropy measure associated with these symbols to test the dependence present in the time series. This approach has four advantages as explained by Sensoy et al. (2015). First, the measure depends only on ordinal patterns of time series and since it is unaffected by the data's volatility, it can detect non-linear temporal dependence in contrast to autocorrelation.[1] Second, because there is no assumption about the distribution of the data, it has a general applicability compared to the variance ratio test (Lo and MacKinlay, 1988).[2] Third, no moment is required to apply the methodology to time series. This is relevant because asset returns have been shown to be non-normally distributed and, for some distributions such as the Pareto distribution, the variance is infinite (Rachev et al., 2005). Finally, the test is invariant under monotonic transformation of the data which guarantees that no information is lost.[3] Zunino et al. (2012) and Sensoy et al. (2015) apply permutation entropy in testing the efficient market hypothesis.

In this section, in describing our methodology we mainly follow the work of Matilla-Garcia and Marin (2008). Let $\{X_t\}_{t\in I}$ be a real-valued time series. For a positive integer $m \geq 2$, S_m denotes the symmetric group of order $m!$ (i.e. the group formed by all the permutations of length m). Let $\pi_i = (i_1, i_2, \ldots, i_m) \in S_m$. An element π_i in the symmetric group S_m is called a *symbol*, and m is usually referred to as the *embedding dimension*.

Now we define an ordinal pattern for a symbol $\pi_i = (i_1, i_2, \ldots, i_m) \in S_m$ at a given time $t \in I$. For this purpose, we consider that the time series is embedded in an m-dimensional space as $X_m(t) = (X_{t+1}, X_{t+2}, \ldots, X_{t+m})$ for $t \in I$. Then, it is said that "t is of π_i type" if and only if $\pi_i = (i_1, i_2, \ldots, i_m)$ is the unique symbol in the group S_m satisfying the two following conditions: (1) $X_{t+i_1} \leq X_{t+i_2} \leq \cdots \leq X_{t+i_m}$ and (2) $i_{s-1} \leq i_s$ if $X_{t+i_{s-1}} = X_{t+i_s}$. The second condition guarantees uniqueness of the symbol π_i. This is justified if the values of X_t have a continuous distribution so that equal values are uncommon, with a theoretical probability of occurrence of 0.

Notice that for all t such that t is of π_i-type, the m-history $X_m(t)$ is converted into a unique symbol π_i. This π_i describes how the ordering of the dates $t + 0 < t + 1 < \cdots < t + (m - 1)$ is converted into the ordering of the values in the time series under scrutiny.

Also, given a time series $\{X_t\}_{t\in I}$ and an embedding dimension m, one could easily compute the relative frequency of a symbol $\pi \in S_m$ by

$$p(\pi) := p_\pi = \frac{\#\{t \in I \mid t \text{ is of } \pi\text{-type}\}}{|I| - m + 1}$$

where $|I|$ denotes the cardinality of set I. Under this setting, the *permutation entropy* of a time series $\{X_t\}_{t\in I}$ for an embedding dimension m is defined as the *Shannon's entropy* of the $m!$ distinct symbols as the following:

$$h(m) = -\sum_{\pi\in S_m} p_\pi \ln(p_\pi).$$

Permutation entropy $h(m)$, is the information contained in comparing m consecutive values of the time series. By definition, $0 \leq h(m) \leq \ln(m!)$ where the lower bound is achieved for an increasing or decreasing sequence of values, and the upper bound for a completely random system where all $m!$ possible permutations appear with the same probability. More simply, higher permutation entropy means that the data-generating process is more complex and unpredictable. If a financial time series has a permutation entropy that is significantly low, it implies market inefficiency because the weak-form of market efficiency suggests the unpredictability of future movements for the financial variables (In our analysis, we normalize the permutation entropies (dividing by $\ln(m!)$) to achieve a maximum level of 1).

2.1. Independence test

Matilla-Garcia and Marin (2008) developed a consistent test of independence by using permutation entropy. Accordingly, let $\{X_t\}_{t\in I}$ be a real-valued time series with $|I| = T$, and $h(m)$ denotes the permutation entropy of this series for a fixed integer embedding dimension $m > 2$. If $\{X_t\}_{t\in I}$ is i.i.d., then the affine transformation $G(m)$ of the permutation entropy, $G(m) = 2(T - m + 1)(\ln(m!) - h(m))$, is asymptotically $\chi^2_{m!-1}$ distributed. Then to test the null hypothesis that $\{X_t\}_{t\in I}$ is i.i.d., the decision rule at $100(1 - \alpha)\%$ confidence level is to accept the null hypothesis if $0 \leq G(m) \leq \chi^2_{m!-1,\alpha}$, otherwise reject the null hypothesis. Later, Lopez et al. (2010) show that the identicalness property in the null hypothesis can be dropped.

[1] Autocorrelation is also sensitive to structural breaks such as mean or volatility shift.

[2] Moreover, the variance ratio test is asymptotic so that for a finite sample the sampling distributions of the test statistics is approximated by its limiting distribution. Lo and MacKinlay (1989) find that for small samples the null distribution is right skewed and under rejects in the left tail.

[3] Another alternative way to test the weak-form efficiency is using the Hurst (1951) parameter. However, Bassler et al. (2006) have recently shown that the estimation of the Hurst parameter alone cannot be used to determine the efficiency of markets. They showed that there are cases that are perfectly consistent with Markov processes when Hurst parameters $H \neq 0.5$.