Time-to-Expiry Seasonalities in Eurofutures

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Abstract. *This article reports a new seasonality in the volatility of Eurofutures contracts as a function of the time left before contract expiry. The fact that futures markets, unlike foreign exchange or equity markets, offer contracts that expire on specific dates, with typically one expiry per quarter for Eurofutures, leads to a new type of volatility seasonality as a function of the time left to expiry for the contract in question. The intraday volatility, averaged over the Eurofutures contracts we studied (Eurodollar, Euromark, and Short Sterling), decreases as a function of the time left to expiry. There is also an unexpected behavior consisting of oscillatory movements in volatility, with peaks every 60 business days, corresponding to rollover activities before each quarterly expiry.*

Keywords. Eurofutures, intraday seasonality, intraday volatility, time-to-expiry seasonality

Acknowledgments. This article would not have been possible without a team effort. We thank Bernard Hechinger for interpreting the data, providing information about the futures markets, and sharing his trading experience and Rakhal Davé for data preparation and data access tools. We thank the software engineers, Beat Christen, Silvano Maffeis, Dan Smith, and Leena Tirkkonen, for making the data accessible. We also thank Paul MacGregor from the Market Data Services Department of the London Financial Futures Exchange for his kind help in providing and interpreting data from LIFFE. Gençay also thanks the Social Sciences and Humanities Research Council of Canada and the Natural Sciences and Engineering Research Council of Canada for financial support.

1 Introduction

The explosive growth of interest rate trading, together with the deregulation and globalization of the financial industry, has fueled the market for interest rate derivatives since the late 1970s and early 1980s. Although there has been extensive academic research on U.S. Treasury bill futures, Eurofutures markets have attracted the attention of researchers only recently (Ballocchi et al. 1999). In 1997, the daily volume for the Chicago Mercantile Exchange (CME) Eurodollar was about 450 times larger than for CME U.S. Treasury bill futures. This takes into account neither the Eurodollar futures traded in other markets nor Eurofutures for many other currencies, whereas CME accounts for the entire U.S. Treasury bill volume. The bid-ask spread on the CME Eurodollar can be as small as half a basis point,[1] compared with quoted spreads on Eurodollar deposits, which are at least 2–25 times higher. Because of the small size of the bid-ask spreads, even tiny moves are tradable in the Eurofutures markets, whereas they would not be in the Eurodeposit market. This means that the Eurofutures markets act as a very sensitive measuring device for interest rate expectations. They are also transparent markets, because transaction prices are public knowledge, which is almost never the case for over-the-counter (OTC) markets. The Eurofutures markets are typically the most liquid markets for interest rate instruments, playing a crucial role in the price discovery mechanism. They yield high-quality intraday data consisting of transaction prices, firm bid and ask quotes, and sometimes volume information. Because of their liquidity and data availability, they are one of the best laboratories in which to investigate market microstructure.

This article reports a new seasonality in the volatility of Eurofutures contracts as a function of the time left before contract expiry. The fact that futures markets, unlike foreign exchange or equity markets, offer contracts that expire on specific dates, with typically one expiry per quarter for Eurofutures, leads to a new type of volatility seasonality as a function of the time left to expiry for the contract in question. The intraday volatility, averaged over the Eurofutures contracts we studied (Eurodollar, Euromark, and Short Sterling), decreases as a function of the time left to expiry. There is also an unexpected behavior consisting of oscillatory movements in volatility, with peaks every 60 business days, corresponding to rollover activities before each quarterly expiry.

Each Eurofutures contract has a specific expiry date and normally comes into existence more than one year in advance, although liquidity can be poor until one year before expiry. The Eurofutures under consideration in this article have expiries in March, June, September, and December (i.e., quarterly expiries).[2] The sample studied covers the period from January 1, 1994, to April 15, 1997, more than three years of tick-by-tick data. The Eurofutures we studied are the Eurodollar (traded at the CME), Euromark, and Short Sterling (all traded at the London International Financial Futures Exchange LIFFE). For each Eurofutures, nine contracts associated with the following expiries are considered: March 1995, June 1995, September 1995, December 1995, March 1996, June 1996, September 1996, December 1996, and March 1997. Between different contracts, sample lengths differ, but at least one year of data for each contract is available.

[1] A basis point corresponds to one-hundredth of a percent, and its monetary value (in the case of the Eurodollar futures) is $25. The minimum price movement for the CME Eurodollar is half a basis point.

[2] There are also serial expiry contracts such as contracts expiring in months that do not correspond to the quarterly sequence. The serial expiry contracts are not considered here because they typically exhibit lower liquidity.

2 Definitions

From the tick-by-tick data, the logarithmic price, $p(t_i)$, is calculated by a simple linear interpolation such that

$$p(t_i) = p(t_p) + (p(t_s) - p(t_p))\frac{t_i - t_p}{t_s - t_p} \quad (1)$$

where t_p and t_s are the most recent previous and subsequent ticks relative to t_i. The change of price or return at time t_i, $r(t_i)$, is defined as

$$r(t_i) \equiv r(\Delta t; t_i) \equiv [p(t_i) - p(t_i - \Delta t)] \quad (2)$$

where $p(t_i)$ is the sequence of logarithmic prices equally spaced in time, and Δt is the fixed time interval, such as 1 min, 1 hr, or 1 day. The volatility at time t_i, $v(t_i)$, is defined as

$$v(t_i) \equiv v(\Delta t, S; t_i) \equiv \frac{1}{n}\sum_{k=1}^{n}|r(\Delta t; t_{i-k})| \quad (3)$$

where S is the sample period and n is the hourly time interval. In Equation (3), the absolute value of the returns is preferred to the more usual squared value, because the former quantity better captures the autocorrelation and the seasonality of the data (Taylor 1988; Müller et al. 1990; Granger and Ding 1995).

3 Time-to-Expiry Seasonalities

Futures contracts exhibit volatility seasonalities like those reported in the literature for foreign exchange data (Müller et al. 1990) and also for equity markets (Andersen and Bollerslev 1997; Ghysels and Jasiak 1995). Those seasonalities were attributed to dealing patterns, such as market presence (Dacorogna et al. 1993). The characteristic feature of the futures markets when compared to foreign exchange or equity markets, however, is that each contract has an expiry. We show that this leads to a distinctive type of seasonality as a function of time left before expiry. On a daily or weekly basis, Eurodollar, Euromark, and Short Sterling display a decreasing volatility toward the expiry.

To probe the existence of a seasonality related to contract expiry, a sample consisting of many futures contracts is needed. For each Eurofutures (Eurodollar, Euromark, Short Sterling) and for each contract, we built a series of hourly returns determined by linear interpolation, as explained in Section 2. We then computed daily volatilities, taking the mean absolute value of hourly price differences from 00:00 to 24:00 (GMT) of each working day (weekends and holidays were excluded). The daily volatilities were then plotted against time to expiry. The result is shown in Figure 1. The vertical axis of the figure represents the average volatility computed on all Eurofutures and all contracts together.[3] The horizontal axis represents the time left to expiry, such that the number of business days before expiry decreases toward the origin.[4] Figure 1 spans a period of about 200 business days, because only within that period were we able to compute volatility on at least 35 contracts.

Because of limitations in our data sample, after 200 business days, only a small number of contracts display any real activity. Hence the average is affected by the volatility characterizing only a few Eurofutures and it becomes less significant. The results indicate that there is a downward trend in volatility as the time left before expiry decreases. There is also an unexpected behavior consisting of oscillatory movements in volatility, with peaks every 60 business days, corresponding to rollover activities before each quarterly expiry.

[3]It is labeled average daily volatility index, rather than average volatility, because we did not annualize the volatility, as is conventionally done, since this was unnecessary for the purpose of our study.

[4]The smoothing in Figure 1 is calculated by the maximum overlap discrete wavelet transformation, which is a time series multiresolution technique applicable to nonstationary time series (Percival and Mofjeld 1997).

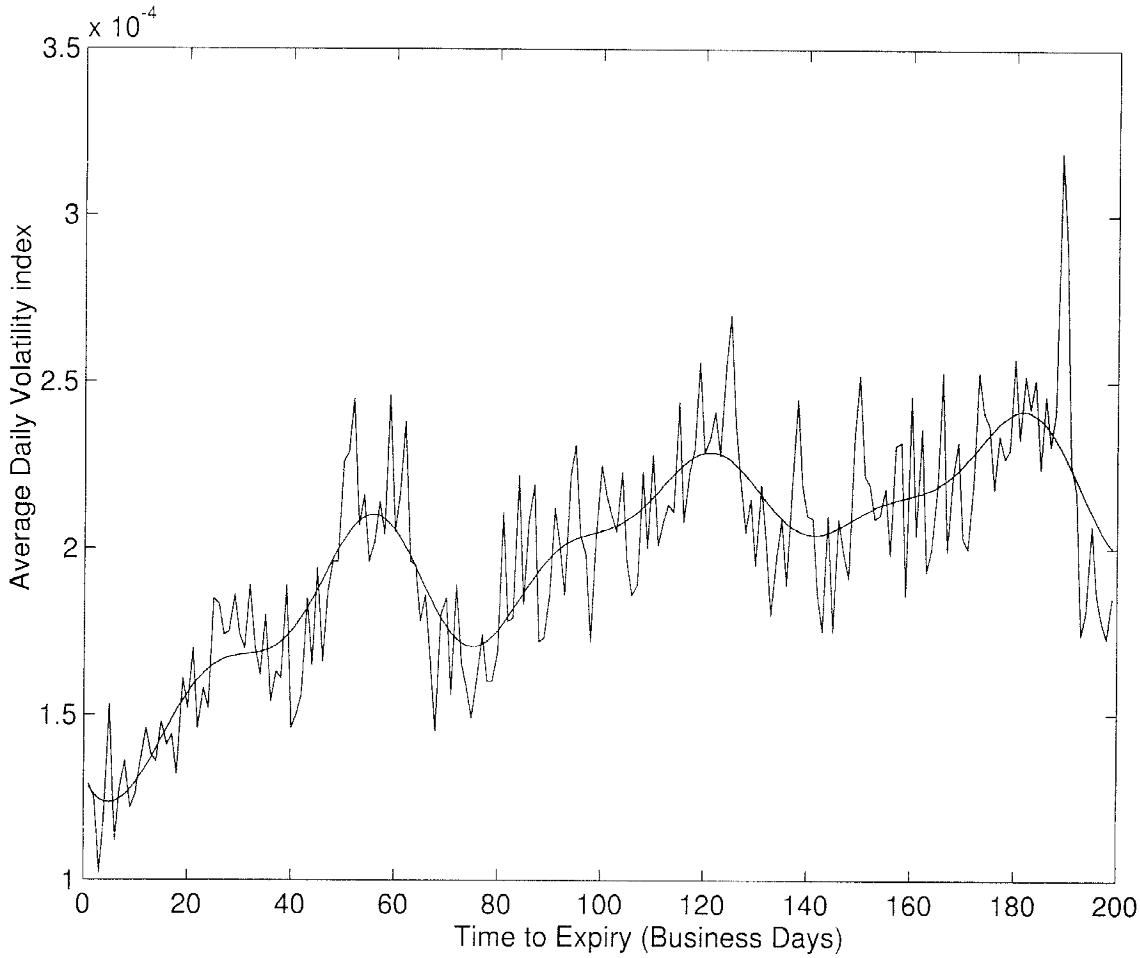

Figure 1
Volatility as a function of time to expiry.

These results are also confirmed by a volatility study on each single Eurofutures. Eurodollar, Euromark, and Short Sterling show decreasing volatility at least for the 200 business days before expiry. All Eurofutures display oscillatory movements with peaks around expiry dates.

4 Conclusions

We have shown that price volatility displays a dependence on the time left to expiry. On average, volatility tends to decrease as we move toward expiry and peaks approximately every 60 business days, near quarterly expiries. The findings of this article suggest that a model of volatility for futures markets should correct for (or take into account) the seasonality originating from the expiry effect.

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