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PD-EGARCH MODEL BASED EXPERIMENTAL RESEARCH OF CALENDAR EFFECT OF SECURITIES MARKET OF CHINA

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Abstract - This paper discusses the problem of calendar effect in the securities market of China, which is an abnormality test and data mining paradigm of financial time series from different dimensionlity. On the basis of retrospect of research on calendar effects from domestic and overseas scholars, panel data-exponential generalized autoregressive conditional heteroskedastic (PD-EGARCH) model is put out; then analysis of elementary statistic results of two typical indices (shanghai stock index and shenzhen component index) are offered. The primary focus of this paper will be selective descriptions of PD-EGARCH model based test of the primary statistic result of various performances of calendar effects. Finally, the testing result shows, behaviors of calendar effects in Chinese stock market is obvious but different from former research results, which shows new characteristics with arbitrage opportunity and leverage, and which is difficult to make clear by traditional explanation.

Index Terms* - *Data mining, financial time series, calendar effect, panel data-exponential generalized autoregressive conditional heteroskedastic (PD-EGARCH) model, arbitrage opportunity.

I. INTRODUCTION

Calendar effect, one of the periodic abnormality performance from the securities market validity hypothesis, means that there are special calendar-based, steady-going and periodic models of finance index, such as returns, variance, sum of trade, difference from buy and sell price, frequency of deal, etc., which shows that capital return is not stochastic but foreseeable on given calendar. As one aspect of data mining, financial time series is one of important data type, and calendar effect- as one of financial data mining paradigm – is very pragmatic and meaningful. Due to the contrary to random walk model, scholars from domestic and overseas have done a lot of demonstration researches on performance of calendar effect. Hitherto, researchers have classified calendar effects performance into monthly effect, weekly effect, month-inner effect, month- alternate effect, holiday effect, etc.. However, the actual performance is different spatio-temporally.

Rozeff and Kinney (1976) found that the January return rate of stock index in New York stock exchange from 1904 to 1974 is obviously higher than other months . Mustafa and Bulent (1983) tested seventeen major stock market, and finally found distinct January effect, but April effect in England. Michael Reutter,Weizsäcker and Frank Westermann (2000) showed that Germany stock index (DAX)，from 1959 to 1999, return rate of September was relatively low. Kilman Shin and Chen Weizheng (2003) pointed out that stock market of Asia had no January effect, but funnily, monthly return of Asia stock market was apt to rise in springs . Zhang Bing (2005) domestically found that stock market of China had no obvious monthly effect, but January effect of small public companies, which combined with great risks.

Cross (1973) showed that from 1953 to 1970, the average Monday return rate of S&P 500 was minus, but Friday was positive, which have marked difference from other weekdays. Jaffe and Westerfield (1985) got same weekly effect in England and Canada market, but in Australia and Japan, Tuesday return rate was minus and lower than Monday’s. Domestically, Zhang Renliang and Hu Bin (1998) tested weekly effect of Asia stock markets, which showed that in market of five dealing days weekly, Monday return rate was lowest, but market of six dealing days weekly was Tuesday, and the end of weekdays was of highest return for each market. Xue Jirui (2000) presented that weekly return rate was generally taken on W shape, and with Friday peak and Tuesday bottom. Zhang Bing (2005) offered that calendar effect was not effective after adducing .

From above researches and analyses, the calendar effect of return performances are largely offered, but rarely returns combined with variances researches, which is of great importance, for in securities market returns and risks have accrete relations. Due to the rareness of integration research of returns and variances on calendar effect, panel data-

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exponential generalized autoregressive conditional heteroskedastic (PD-EGARCH) model is offered, which is famous for variance modeling of financial time series and able to reflect the inner accrete relationship of returns and variances.

II. Modeling and method: PD-EGARCH model

In the research of variance modeling, Engle originally put forward autoregressive conditional heteroskedastic (ARCH, for short) model in 1982, and successfully estimated the variance of inflation index of England. In the following twenties years, several derivative ARCH models had gained deep development. Bollerslev (1986) developed ARCH modeling into generalized ARCH (GARCH, for short), and therefore almost all new achievements are based on GARCH. Nelson (1991) provided exponential GARCH (EGARCH, for short) modeling, which clearly combined asymmetry reaction.

Panel Data (PD, for short), is sample data from different section in time series, and PD modeling is offered by Cheng Hsiao (1986), which is a type of linear econometric modeling and of bidirectional co-variable.

Based on above modeling and methods, PD-EGARCH modeling is presented as follows:

Typical PD modeling is:

$$y_{it} = \rho_i + X_{it}\beta + \varepsilon_{it} \qquad i=1,2,\ldots N,\ t=1,2,\ldots,T \tag{1}$$

Where: y_{it} is objective variable, ρ_i is individual impact parameter, $X_{it} = (x_{1it}, x_{2it}, \cdots, x_{kit})$ is $1\times K$ dimension row vector, $\beta = (\beta_1, \beta_2, \cdots, \beta_K)$ is $1\times K$ dimension arrange vector, K is the number of independent variable, ε_{it} is random error, N is the number of cross section, T is the extent of time series of every cross section. The unilateralism impact fixed and conditional heteroskedastic PD modeling, has:

$$\begin{cases} E(\varepsilon_{it}) = 0 \\ E(\varepsilon_{it}^2 | \psi_{t-1}) = \sigma_{it}^2 \\ E(\varepsilon_{it}\varepsilon_{is} | \psi_{t-1}) = 0, t \neq s \\ E(\varepsilon_{it}\varepsilon_{jt} | \psi_{t-1}) = 0, i \neq j \end{cases} \tag{*}$$

Where: information set ψ_{t-1} denotes all foregone information before t point. From (*) we can know that, random error ε_{it} has no autocorrelation from section and time series. And we make more hypothesis that ε_{it} accords with EGARCH modeling, and we can get:

$$\varepsilon_{it} = \sqrt{h_{it}}\, e_{it} \tag{2}$$

$$\log(h_{it}^2) = c_i + \sum_{m=1}^{q}\left(\alpha_{im}\left|\frac{\varepsilon_{i,t-m}}{h_{i,t-m}}\right| + \gamma_{im}\frac{\varepsilon_{i,t-m}}{h_{i,t-m}}\right) + \sum_{n=1}^{p}\theta_{in}\log(h_{i,t-n}^2) \tag{3}$$

Where: $e_{it} \sim i.i.d.N(0,1)$ and $\sum_{m=1}^{q}(\alpha_{im} + \gamma_{im}) + \sum_{n=1}^{p}\theta_{in} < 1$ (which shows the process is balanced); parameter $\gamma_{im} \neq 0$ shows asymmetry reaction effect; c_i, directly shows the hetero-skedasticity from different section.

This paper combined equation (1) (which is called expectation equation) and equation (2), (3) (which are called variance equations) into PD-EGARCH(p,q) modeling, which is able to reflect returns performance of calendar effect integrated variance character. In the expectation equation ρ_i shows returns from different time series sections, meanwhile, in the variance equations c_i shows risks from different time series sections.

III. Experimental Data mining process of calendar effect Acronyms

A. Sample Data Preparation

In this paper, Shanghai stock index and Shenzhen component index are selected, sample range is from 2000.4.1 to 2008.3.31.

For convenience of arithmetic, primitive data is magnified 100 times and the daily return rate equation is as follows:

$$R_t = (\ln P_t - \ln P_{t-1}) * 100 \tag{4}$$

Where: R_t is the return rate of date t, P_t is the closing quotation of date t.

B. Primary Analysis And Test of Sample Data: Basic d、Descriptive Statistic Characteristic

Before the functional process of data mining, basic descriptive statistic characteristic is offered in the following Figure 1. And in this paper the performances of monthly effect and weekly effect are selectively provided.

	Index name	Shanghai stock index	Shenzhen component index
全体样本	Mean	-0.019066	-0.019504
	Std. Dev.	1.293691	-0.019504
	Skewness	0.753774	0.786890
	Kurtosis	9.224636	8.683396
	Jarque-Bera	2418.400	1941.759
	Probability	0.000000	0.000000
	F-Statistic	7.795105	6.806429
	LM-Statistic	7.763289	6.806690

Figure1 The basic descriptive statistic characteristics of daily returns of Shanghai stock index and Shenzhen component index

From Figure 1, we can see that the selected index have obvious skewness and leptokurtic distribution combined with fat tails distribution, and Jarque-Bera statistic shows that normal distribution is denied at 5% probability level. On the other hand, the fluctuation of the selected index is not able to be described by invariable variance, which have effective ARCH characteristic.

C. Functional Process of Data Mining: Calendar Effect Test of PD-EGARCH Modeling

Based on the above basic descriptive statistic characteristic and experimental test, PD-EGARCH (1 , 1) modeling is used to analysis the actual performance of calendar effect. The end results of model are in the following tables:

			Shanghai stock index			**Shenzhen component index**		
			ρ i	c i	γ i1	ρ i	c i	γ i1
Monthly effect	Jan	Coef.	0.05	1.55	0.03	0.18	1.84	0.08
		Prob.	0.79	0.01	0.79	0.38	0.01	0.52
	Feb	Coef.	0.20	0.10	-0.05	0.30	1.03	-0.03
		Prob.	0.19	0.57	0.75	0.07	0.03	0.88
	Mar	Coef.	0.04	0.37	0.13	0.00	0.11	0.20
		Prob.	0.72	0.05	0.25	0.98	0.39	0.11
	Apr	Coef.	0.02	0.10	0.01	0.03	0.12	-0.03
		Prob.	0.89	0.00	0.90	0.82	0.00	0.55
	May	Coef.	0.05	0.21	-0.10	-0.04	0.68	0.27
		Prob.	0.66	0.00	0.00	0.76	0.05	0.12
	Jun	Coef.	0.05	0.09	-0.17	-0.09	-0.41	-0.03
		Prob.	0.57	0.04	0.00	0.46	0.00	0.78
	Jul	Coef.	-0.07	-0.05	-0.21	-0.02	-0.15	-0.05
		Prob.	0.45	0.37	0.00	0.83	0.13	0.35
	Aug	Coef.	0.00	-0.20	-0.01	-0.03	-0.20	-0.02
		Prob.	1.00	0.02	0.84	0.68	0.02	0.79

	Sep	Coef.	-0.24	-0.31	-0.11	-0.30	-0.28	-0.03
		Prob.	0.01	0.00	0.30	0.00	0.01	0.81
	Oct	Coef.	-0.28	-0.05	-0.41	-0.24	-0.02	-0.31
		Prob.	0.03	0.65	0.00	0.11	0.87	0.01
	Nov	Coef.	0.16	0.15	-0.15	0.06	0.86	0.11
		Prob.	0.15	0.04	0.02	0.68	0.00	0.46
	Dec	Coef.	-0.01	0.09	-0.25	-0.04	0.24	0.02
		Prob.	0.93	0.36	0.00	0.71	0.34	0.91
Weekly effect	mon	Coef.	-0.07	-0.06	-0.18	-0.11	-0.03	-0.19
		Prob.	0.43	0.36	0.00	0.27	0.71	0.00
	Tue	Coef.	0.25	-0.40	-0.32	0.17	-0.14	-0.29
		Prob.	0.00	0.00	0.00	0.02	0.18	0.00
	Wed	Coef.	0.06	-0.10	-0.19	0.07	-0.05	-0.19
		Prob.	0.35	0.04	0.00	0.39	0.28	0.00
	Thu	Coef.	-0.20	-0.07	-0.14	-0.22	-0.11	-0.11
		Prob.	0.01	0.01	0.00	0.01	0.06	0.01
	Fri	Coef.	-0.10	0.04	-0.13	-0.05	0.53	0.08
		Prob.	0.14	0.33	0.02	0.45	0.00	0.07

Figure2 The PD-EGARCH modeling results of daily returns of Shanghai stock index and Shenzhen component index

Where: Coef. is abbreviation of Coefficient, Prob. is abbreviation of Probability.

(1) In the performance of monthly effect, the selected index shows that the returns respectively have peaks in February, March, November, and nadirs in September and October, however, the fluctuation performance have peaks in January, which shows returns and risks are not synchronous and proportionate. And the experimental results are different from foregone tested January effect, but tally with the findings of Kilman Shin and Chen WeiZheng (2003), which said that stock market of Asia had no January effect, but was apt to rise in springs[4].

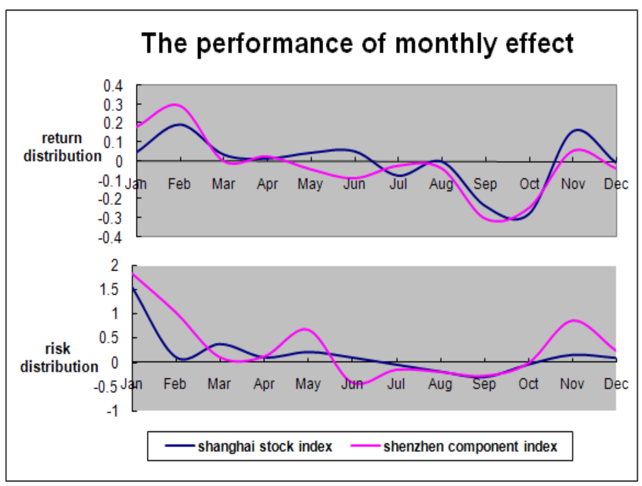

Figure3 The return and risk performance of monthly effect of Chinese stock market

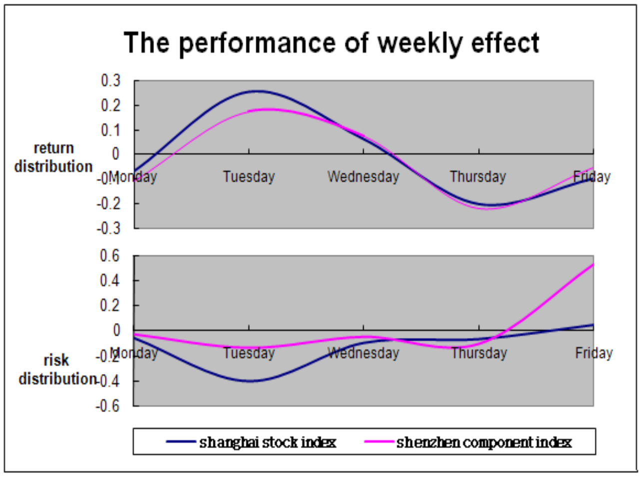

Figure 4 The return and risk performance of weekly effect of Chinese stock marke

(2) In the performance of weekly effect, the selected index shows that the returns respectively have peaks in Tuesday, and nadirs in Thursday, funnily, the fluctuation performance have nadirs in Tuesday, which offers prominent arbitrage opportunity on Tuesday. Additionally the experimental results are contrary to foregone tested Tuesday effect, which is just like the point of Zhang Bing (2005), who pointed out that calendar effect was not effective after adducing [5].

IV THE DISCUSSION OF EXPLANATION OF CALENDAR EFFECT

In the monthly effect, traditional explanation considers that our securities market has capital liquidity restriction. In December, most public companies have to draw back partial capital from market due to given time audit report forms. And in September and October, holiday and tourism consumption draws part capital into consume field. The above explanations have some power, but are not entirely enough for the actual performance of Chinese stock market. On the other hand, the mainly public companies throw daylight on annals in March or April, which has no help in explanations of the above performance.

In the explanation of weekly effect, the traditional balance cycle factors considers that five dealing days weekly and T+1 liquidation system makes that Friday bears more risk and time cost than other days, which should gain more compensation. But the fact is rather contrary.

The only feasible reason may be that, from dynamic decision-making aspect, when investors have found some special calendar effects, they all change their investment strategy via that phenomenon, and the foregone calendar effect will lose power, even be on the contrary, following the addition of arbitrage opportunity. And so the original balance is broken continuously, and new short-term balance is formed. The competitive mechanism of information going-after makes capital market into a relatively steady,self-adaptive equilibrium.

Panel Data (PD, for short), is sample data from different section in time series, and PD modeling is offered by Cheng Hsiao (1986), which is a type of linear econometric modeling and of bidirectional co-variable.

V.CONCLUSION

In this paper, the daily returns and fluctuations of shanghai stock index and Shenzhen component index are statistically analyzed and tested, and we conclude that:

(1) After 2000, Chinese securities market has obvious monthly effect and weekly effect, and capital returns are not absolutely random, but special calendar based foreseeable, which does not accord with risk premium theory and shows arbitrage opportunity.

(2) The factual behaviors of calendar effects in Chinese stock market is obvious different from former research results, which shows new characteristics and is difficult to make clear by traditional explanation. from dynamic decision-making aspect, when investors have found some special calendar effects, they all change their investment strategy via that phenomenon, and the foregone calendar effect will lose power, even be on the contrary, following the addition of arbitrage opportunity. And so the original balance is broken continuously, and new short-term balance is formed. The competitive mechanism of information going-after makes capital market into a relatively steady, self-adaptive equilibrium.

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