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Volatility, Firm Size and Economic Growth: Evidence from Chinese Stock Market

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Abstract: Forecasting real economic growth by using the information contents of financial asset prices is one of the main themes in financial studies in recent years. Based on the micro-level stock data from Shenzhen Stock Exchange Market, the paper constructs a cross-section volatility measure using sample stocks, investigates the impact of stock price volatility on economic growth, and forecasts economic growth with stock prices volatility of different firm size. The empirical results indicate that stock price volatility is a good indicator for forecasting economic growth. The results also show that volatility of both large and small firms can be useful in forecasting economic growth. In addition, volatility of small firms can better predict economic growth.

Key words: Stock price information; Volatility; Economic growth; Firm size

I. Introduction

During the global financial crisis triggered by the US subprime mortgage crisis in 2007, the contrast between the reaction speed of financial decision makers in China and the US has prompted people to rethink the implicit information in the price of financial assets (Zhen, 2012). Using the implicit information in the financial asset price as a predictor of the real economy reflects the following two facts: on the one hand, the implicit information in the financial assets price essentially reflects expectations of market participants' for future economic status. Because of the forward-looking characteristics of financial asset markets, asset prices are often used to predict the growth of real economy (Campbell, 1999; Stock & Watson, 2003; Næs et al., 2011). On the other hand, using asset prices as leading indicators arouse, at least in part, from the instability in the 1970s and early 1980s of forecasting output based on aggregate monetary supply and of forecasting inflation based on the non-expectational) Phillips curve(Stock & Watson, 2003).

As an important financial asset, the stock price can be determined by the classical discount cash flow model, which

means that the stock price is equal to the sum of the present value of future expected revenues. Since the growth of the real economy will directly affect the expected revenue of investors, it is natural to think that the stock price contains the expected information for future real economic growth. For example, it is often observed that when the real economy is in a depressed state, the stock market liquidity also tends to dry up (Chordia et al., 2005).The empirical link between stock prices and economic activity has been noted at least since Mitchell and Burns(1961), who argue that Dow Jones composite index of stock prices could be served as an indicator for the economic expansion and recession of the United States. In his review article, Campbell (1999) shows that in a simple loglinear model, the log of price-dividend ratio embodies rational discounted forecasts of dividend growth rates and stock returns, making it an appropriate leading variable for forecasting economic growth.

In the existing literature, the stock market volatility is an index of the financial asset prices that are used to predict the cycle of real economic activity. Volatility is a measure of the uncertainty of asset income, which is often used to measure the risk of assets. In general, the greater the volatility of stock market is, the greater the probability of expected and real income will be. In other words, the greater the risk of the stock market will be. Liljeblom & Marianne(1997) uses the VAR method to investigate the relationship between stock market volatility and economic fluctuation, and they find that there is a significant correlation between the two variables. Fomari & Mele(2009) find that the stock market volatility could be used to predict 30%~40% industrial production growth rate of the United States after World War II; in Great moderation of 1980s, if other macroeconomic variables (such as short-term interest rates, interest rate spreads and term spreads, etc.) are added, the stock market volatility can explain 55% the real output growth rate during this period.

As for the domestic literature, most scholars mainly focus the relationship between the volatility of stock market index and economic growth. Zhu & Yu (2007) investigate the relationship between the stock market volatility index and the growth rate of industrial production with Shanghai Stock Exchange Market via Co-integration test. The results show that the stock market index in Shanghai Stock Exchange Market can predict economic growth well during 1997.6~2002.6. Liang & Teng (2005) investigate the relationship between stock market development and economic growth in China over the period 1991-2004 with multivariate VAR, and the empirical results show that there is a significant two-way causality between stock market volatility and economic growth. However, the correlation is negative, indicating that "excessive" volatility exists in the stock market which generates negative effect on economic growth. Wei & Yang(2007) examines the relationship between returns from stock market index and economic growth rate by constructing the interaction model of stock price volatility and economic growth, which is based on the index data in Hongkong stock market. The results show that the positive correlation between stock price index and economic growth is strong. Duan & Yang (2009) investigate the relationship between Chinese stock market and economic growth during the period of 1995~2007. The result shows that there exists strong relationship between stock market liquidity and economic growth, while the correlation between stock market volatility and economic growth is relatively weak.

From the previous literature, most studies focus on the relationship between stock market volatility and economic growth. These studies are mainly based on the stock market return volatility, i.e. the volatility of stock price index. Few studies are based on the volatility of Micro-level stock data to examine its influence on economic growth. The defect of volatility index which is constructed with stock index is that the volatility of stock index only reflects systematic risk of the stock market, without considering unsystematic risk of the stock market. The total risk of stock market can be better

depicted by volatility index which is based on the Micro-level stock structure(Song & Jiang, 2003).

In addition, the sensitivity of different firm size varies to changes of economic status, while few literatures have taken the forecasting ability of different firm size into account, which is used to forecast the effect of stock price volatility on economic growth. Specifically, based on the Micro-level firm data listed in Shenzhen Stock Exchange Market, the article empirically examines the impact of stock price volatility on economic growth by constructing a cross-section volatility measure. Furthermore, through the construction of stock price volatility index of different firm size, this article investigates the impact of stock prices volatility with different firm size for forecasting economic growth.

The rest of this article is organized as follows: Part 2 describes the data sources and the variable measurement. Part 3 investigates the relationship between stock price volatility and economic growth based on the daily Micro-level stock data listed in Shenzhen Stock Exchange Market. Part 4 further investigates the forecasting ability of volatility with differing firm size on economic growth. Part 5 summarizes the conclusion of this article.

II. Data sources and variable measurement

2.1 Data sources

In order to examine the impact of stock price volatility on China's economic growth, we try to analyze the quarterly data of China GDP from 1994 to 2013, which is collected from China Economic Information Network. Due to the fact that GDP data is calculated with the current price, we use the quarterly consumer price index (CPI) to deflate the nominal GDP data, thus we get the real GDP data with 1989 as the base year to eliminate the impact of price.

Mainland China stock markets include the Shenzhen Stock Exchange Market and the Shanghai Stock Exchange Market. Due to the strong homogeneity of these two exchange market, this paper takes all A-shares listed in the Shenzhen Stock Exchange Market as the sample, and calculate the stock price volatility based on the daily data of these A-shares from CSMAR database.

Besides, the CPI data which are used to calculate the real GDP quarterly data, control variable such as financial intermediary index data are both form China Economic Information Network. We can calculate the liquidity index of stock market based on the A-shares listed on the Shenzhen Stock Exchange Market. According to the quarterly returns and one year deposit interest rate of composite index of A-shares in Shenzhen Stock Exchange Market, we can calculate the stock market factors, all the above data are from the CSMAR database.

2.2 Variable measurement

Economic Growth. This paper selects the quarterly growth rate of real gross domestic product (GDP) as an indicator of China's economic growth.

Stock Price Volatility (VOLA). In this paper, quarterly cross-sectional volatility of sample stock (which is the standard deviation of sample stock's daily returns in a quarter) is used as an index to measure the volatility of stock price, namely,

$$VOLA_T = \left[\frac{1}{S_T - 1} \sum_{i=1}^{N_T} \sum_{t=1}^{D_T} (r_{i,t} - \bar{r})^2 \right]^{1/2}$$

where, $r_{i,t}$ is the daily returns of stock i in the quarter T, $\bar{r}$ is the quarterly average of the sample stock's daily

returns, D_T is the number of trading days in quarter T, N_T is the number of stocks which are traded in quarter T, T_i is i stock's number of trading days in quarter T.

$$S_T = \sum_{i=1}^{N_T} T_i$$

Stock Market Liquidity (ILR). This index is measured by the average value of the quarterly liquidity of the sample stock. In this paper, the liquidity index proposed by Amihud(2002) is selected as the proxy of the liquidity of the stock market, namely,

$$ILR_T = \frac{1}{N_T}\sum_{i=1}^{N_T}\left(\frac{1}{T_i}\sum_{t=1}^{D_T}\frac{|r_{i,t}|}{V_{i,t}}\right)$$

where, $V_{i,t}$ is the trade volume of stock i on day *t* in the quarter(in terms of Renminbi), usually multiplied by 10^6. The meanings of other symbols are same as above. This index reflects the illiquidity of the stock market, namely, the greater the value of the index is, the worse the liquidity of the stock market is.

The Stock Market Factor (MKT). It measures the excess returns by the difference of the quarterly returns and the one-year deposit rate of A-share comprehensive indexes in Shenzhen Stock Exchange Market.

Financial Intermediary Index (FI):It is measured by the ratio of the loans in the RMB credit balance sheet in the financial institutions to the nominal GDP in the quarter, where the quarterly loans are based on the average value of the loans at the end of the month in the quarter, namely,

$$FI_T = \frac{(LOAN_{1,T} + LOAN_{2,T} + LOAN_{3,T})/3}{NomiGDP_T}$$

where, $NomiGDP_T$ is the nominal GDP in quarter T, $LOAN_{1,T}$, $LOAN_{2,T}$, $LOAN_{3,T}$ are the number of loans in the first, second and third month in quarter T.

Among the above variables, only real GDP quarterly data and financial intermediary index (FI) have the seasonal characteristics which take the four quarters as a cycle. Therefore, we use the X12 method to adjust GDP and FI. The other variables do not have quarterly adjustment for showing no seasonal characteristics.

III. Empirical analysis

3.1 The basic statistical characteristics of variables

Table 1 is the basic statistical analysis of the quarterly adjusted real GDP, financial intermediary index and other variables. From Table 1, we can see that the average quarterly economic growth rate (VGDP_S) from 1994 to 2013 is 2.4489, the mean value of stock price volatility (VOLA) is 7.2621, and the degree of GDP growth rate deviating from the mean value is lower than the degree of stock price volatility. We can see from the mean of the sub-sample that, the average quarterly GDP growth rate maintain steady growth in the first three sub-interval, yet turn to decline in the fourth sub-interval. This is in line with the slowdown in China's economic growth after the global financial crisis in 2008.

We can see from the four sub-intervals of stock price volatility that the volatility of the stock price is the highest and mean value reached 12.9663% from 1994 to 1996; the stock price volatility is 7.9160% from 1997 to 2004, 5.0955% from 2005 to 2007, and 4.6216% from 2008 to 2013. The main reason for this phenomenon is that there is no 10% price limit in

Chinese stock market before 1997, so the stock price volatility is relatively large; while in the three periods after 1997, with the implementation of the stock market price limit system, stock price volatility has decreased significantly.

Before 2008, the mean of GDP growth rate in three sub-intervals continues to rise, but the mean of volatility decrease gradually. It can be seen visually from this phenomenon that the mean value change in stock price volatility (VOLA) and quarterly GDP growth remained the same, the low volatility of stock market is accompanied by rapid economic growth.

Table 1 Basic statistics of variables

Variable	Mean Value	Median	Standard Deviation	Mean value of sub-sample interval			
				1994-1996	1997-2004	2005-2007	2008-2013
VGDP_S	2.4489	2.6019	1.6922	1.7446	2.3655	3.7072	2.2832
VOLA	7.2621	3.8360	9.2877	12.9663	7.9160	5.0955	4.6216
ILR	0.5406	0.3779	0.6436	1.5887	0.4283	0.5977	0.1376
MKT	-2.2349	-3.4566	-7.5917	-3.3004	10.1341	-4.3203	0.498
FI	3.9812	4.0475	0.5822	2.8715	4.0312	4.0032	4.4583

In this paper, we use time series data for empirical analysis. Because the variables in the model may have time trend, the traditional estimation technology may lead to spurious regression. Therefore, before the empirical analysis, it is necessary to test the stability of the variables. In this paper, the unit root test method is used to determine whether each data sequence is a stationary sequence or not. In order to avoid mistakes of adopting falsely and abandoning truely, this paper uses two methods, ADF and KPSS, to test the stability of the sequence. From table 2 we can see that, ADF test and KPSS test both show that quarterly GDP growth rate, stock price volatility, liquidity and excess income are all stationary sequences. Seasonally adjusted financial intermediary index (FI) is a non-stationary sequence. After first order difference of the financial intermediary index (FI) sequence, the ADF test and the KPSS test both show that the sequence with difference is stable.

Table 2 Variable unit root test

	ADF test t value	P_ value	KPSS test LM value	LM critical value (5%)	LM critical value (1%)	Stable /Unstable
VGDP_S	-11.3591	0.0001	0.4223	0.4630	0.7390	Stable
FI	-1.7915	0.3821	0.1575	0.1460	0.2160	Unstable
ILR	-5.2444	0.0002	0.1118	0.1460	0.2160	Stable
VOLA	-3.7639	0.0242	0.0966	0.1460	0.2160	Stable
MKT	-7.5004	0.0000	0.1040	0.4630	0.7390	Stable
DFI	-5.1834	0.0000	0.0760	0.4630	0.7390	Stable

3.2 Prediction model and parameter estimation

In this paper, the following models are used to analyze the impact of stock price volatility on economic growth:

$$y_{t+1} = \alpha + \beta VOLA_t + \gamma X_t + \varepsilon_{t+1}$$

where, y_{t+1} represents the real GDP growth rate in quarter t+1,and $VOLA_t$ represents the volatility of stock price in quarter t. X_t represents control variable in quarter t (vector) (MKT_t，ILR_t，$DLOAN\_RA_t$，y_t).γ is the coefficient of control variable(vector).

Table 3 shows the parameter estimation results of the model 1~ model 5. Model 1 only includes the stock prices volatility and the real GDP growth rate with lagged one period. A large number of studies show that the stock market liquidity, stock market factor, financial intermediary index are factors which affect economic growth (Næs.etc, 2011; Liang & Teng, 2005; Duan & Yang, 2009 therefore, we gradually added the stock market liquidity, the stock market factor, the financial intermediary index and the economic growth rate variables in the model 2~ Model 5[1].

Table 3 Parameter estimation results

Parameter Estimation	Model 1	Model 2	Model 3	Model 4	Model 5
α	0.0281	0.0278	0.0276	0.0277	0.0354
	(11.9874)	(10.0330)	(10.0063)	(10.0274)	(8.8743)
β^{VOLA}	-0.0005	-0.0005	-0.0005	-0.0005	-0.0005
	(-2.4482)	(-2.4824)	(-2.5739)	(-2.3511)	(-2.5343)
γ^{ILR}		0.0006	0.0018	0.0019	-0.0021
		(0.2179)	(0.5898)	(0.6402)	(0.7195)
γ^{MKT}			0.0001	0.0001	0.0002
			(1.3523)	(1.4716)	(2.1210)
γ^{DFI}				-0.0183	-0.0323
				(-0.9200)	(-1.6193)
γ^{y}					-0.2844
					(-2.5775)
R^2	0.07354	0.0741	0.0959	0.1060	0.1796
D.W.	1.8876	1.8816	1.9834	2.0275	1.6863

Note: t value is in parentheses.

From the parameter estimation results of Model 1~ Model 5, the parameter estimation value of stock price volatility is significantly negative, that is, low volatility in stock market can predict higher real GDP growth rate. If the stock price volatility falls by one standard deviation of 9.2877, it means that the growth rate of real GDP will rise by 0.37%. If the volatility of the stock price is large, the future economy will have a significant decline.

In order to investigate the forecasting ability of stock price volatility on economic growth, we choose other financial variables as control variables in the model. First, we add the liquidity factor of the stock market and the stock market factor on the basis of Model 1, thus we get Model 2 and Model 3 in turn. It can be seen from Model 2 and Model 3 that the coefficient of the stock prices volatility is still significantly negative, and the coefficient has not changed. Secondly,

[1] Caporale & Jung(1997)argue that the time series of economic growth rate follows AR model, i.e., the economic growth rate of period t+1 is affected by the rate of period t. Therefore, we set the economic growth rate of period t as the control variables in Model 1~ Model 8.

we add the financial intermediary index (DLOAN_RA) on the basis of Model 3. From the estimation results of Model 4, we can see that after joining the financial intermediary index, the prediction ability of stock price volatility on economic growth has not changed at all, and its coefficient is still significantly negative. Finally, we add economic growth rate variables lagged with one period on the basis of Model 4, and the parameter estimation results of Model 5 indicate that stock price volatility still has significant prediction ability of economic growth.

In conclusion, the results of Model 1~ Model 5 show that the stock price volatility contains leading information of economic growth. Even after adding control variables in the model, it can not absorb information about future economic change contained in volatility indicators.

IV. Firm size, volatility and economic growth

Næs et al.(2011) argue that, small firms are more sensitive than large firms to the deterioration of the economic situation. Generally speaking, compared with small firms, large firms usually have rich resources and can effectively cope with the impact of changes in the external environment. When the economic situation is deteriorating, large firms can cope with and resolve operational risks effectively. When the economic situation is better, large firms can better get advantage of scale economy and scope economy. Therefore, compared with small firms, the operating performance of large firms usually fluctuates slightly. Along this line, if investors buy stocks of good performance in a period of economic prosperity, or sell stocks of poor performance in the period of economic recession, then we predict that, stock price volatility of small firms is bigger than large firm, and the stock price volatility of small firms can better reflect the basic situation of macro economy in the future.

In order to verify the hypothesis, we need to establish the stock price volatility index of different firm size. First of all, based on the stock market value in last trading day of the last quarter, we divide firms of different sizes into two groups and establish stock price volatility of different firms: the stock price volatility index of small firms($VOLA_S$) and the stock price volatility index of large firms($VOLA_B$).Then, we use these two different stock price volatility indexes to predict economic growth.

Table 4 is a descriptive statistics of the stock price volatility grouped by firm size. As can be seen from Table 4, the mean stock price volatility of large firms (3.7663) is less than the mean stock price volatility of small firms(4.4898). Similarly, the kurtosis and skewness of stock price volatility of large firms are smaller than those of small firms, which is consistent with intuition.

Table 4 Descriptive statistics of the stock price volatility grouped by firm size

	Mean Value	Median	Standard Deviation	Skewness	Kurtosis	J-B Statistics
$VOLA_S$	4.4898	3.0924	4.5874	4.8780	31.7916	3080.438
$VOLA_B$	3.7663	2.9626	2.7645	4.2810	27.1400	2186.816

In order to forecast economic growth with stock prices volatility of different firm size more accurately, we use stock price volatility of small firms and large firms to forecast economic growth, in which each model includes control variables in Table 3 (see Table 5).

Model 6 mainly examines the forecasting ability of stock price volatility on economic growth of small firms. Model 7 mainly examines the forecasting ability of stock price volatility on economic growth in large firms. Model 8 examines

the forecasting ability of stock price volatility to economic growth of both small and large firms. As seen from the parameter estimation results of Model 6~ Model 8, the parameter estimation results of stock price volatility index of small and large firm are both significantly negative. The results also show that volatility of both large and small firms can better forecast economic growth. Further, Model 8 also includes stock price volatility of both large and small firms. We realize that the prediction effect of stock price volatility of small firms on economic growth is still very significant, and the regression coefficient of stock price volatility of large firms becomes positive, but not significant. This may be caused by the high correlation between the stock price volatility of large firms and small firms (the correlation coefficient of two parts is 0.8737). From this point of view, it is also clear that the stock price volatility of small firms is more sensitive to the economic situation than large firms, namely, volatility of small firms can better predict economic growth.

Table 5 The result of the forecasting model of stock price volatility on economic growth based on firm size

Parameter Estimation	Model 6	Model 7	Model 8
α	0.0374	0.0379	0.0327
	(10.4498)	(8.6899)	(7.3944)
β_S^{VOLA}	-0.0012		-0.0023
	(-3.7295)		(-3.2596)
β_B^{VOLA}		-0.0015	0.0024
		(-2.3520)	(1.7576)
γ_S^{ILR}	-0.0004		-0.0002
	(0.9047)		(0.5180)
γ_B^{ILR}		-2.9E-5	0.0049
		(0.0054)	(0.8984)
γ^{MKT}	0.0002	0.0002	0.0001
	(1.9882)	(2.1620)	(1.5222)
γ^{DFI}	-0.0353	-0.0410	-0.0308
	(-1.8807)	(-2.0674)	(-1.6301)
γ^{y}	-0.2623	-0.2460	-0.2609
	(-2.4545)	(-2.1875)	(-2.4315)
R^2	0.2510	0.1684	0.2838
D.W.	1.8067	1.7201	1.7808

Note: t value is in parentheses

V. Conclusion

The extraction of information in the price of financial assets is an emerging perspective in the field of finance research in recent years, and the use of implicit information in financial asset prices to predict real economic growth has also become the research focus for academic (Campbell, 1999; Stock & Watson, 2003; Næs et al., 2011). As an important

financial asset, stock price reflects investors' expectations for the future growth of real economy. Therefore, early studies consider stock price as an indicator of economic growth is appropriate (Campbell, 1999; Mitchell & Burns, 1938).

In the extant literature, the stock market volatility is one of the most important indicators used to predict the economic cycle. The stock market volatility is a measure of the uncertainty for stock returns, which mainly reflects the systematic risk of stock market. Previous literature mainly focuses on the relationship between stock market volatility (i.e. the volatility of the stock index) and economic growth. The volatility measurement based on the stock index reflects only the systemic risk of stock market, while neglecting the unsystematic risk of the stock market. In addition, firms of different size varies in sensitivity under different economic conditions, while previous research hardly consider the forecasting ability of stock price volatility of firms with different sizes on economic growth. Therefore, while most previous literatures mainly focus on the forecasting ability of stock market liquidity on economic growth, this article mainly examines the impact of volatility on economic growth by constructing Micro-level stock data, and further investigates the forecasting ability of stock price volatility of firms with different size on economic growth.

Based on the micro-level stock data in the Shenzhen Stock Exchange, the article constructs a cross-section volatility measure using sample stocks, and empirically investigates the impact of stock price volatility on economic growth, and the forecasting ability of stock price volatility of firms with different size on economic growth. The empirical results show that, (1) during the period examined in this article, the impact of stock price volatility on economic growth is significantly negative, which indicates that the low volatility of stock market can predict higher actual economic growth. Specifically, if the stock market volatility declines in one standard deviation of 9.2877, it means that the growth rate of GDP will rise about 0.37%; (2) the stock price volatility of small firms is more sensitive than large firms on the status of the economy, i.e., volatility of small firms can better predict economic growth.

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