

DO MACROECONOMIC STRUCTURAL CHANGES OCCUR IN CHINA'S STOCK MARKETS?

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ABSTRACT

Using a rolling regression approach with varying independent variables, this paper investigates macroeconomic structural changes in the four main stock markets in China and identifies the threshold values of structural changes. Macroeconomic structural changes frequently occur on the Shanghai stock exchange, but only rarely on the Shenzhen stock exchange. In addition, five vertical threshold values are identified for the rate of change in the exchange rate (0%), the rate of change in the consumer price index (25.6%), the rate of change in the industrial production (13.5% and 15%), and the interest rate (10.98%). These threshold values imply that the effect of fluctuations in the renminbi on China's stock markets might be contingent upon different rates of change in the exchange rate, in the consumer price index, in the industrial production, and in the interest rate. Moreover, greater economic growth is not always reflected in the prosperity of the stock market. Higher growth in the price level may have a negative rather than a positive impact on economic growth.

Keywords: macroeconomic factors, structural change, economic growth, exchange rate

INTRODUCTION

Much of the recent debate among financial researchers regarding the Chinese market has focused on explaining why China's accelerated economic growth is not reflected in its stock returns. In 1994 and 1995, in particular, the rate of gross domestic product (GDP) growth remained above 25%, yet stock returns were negative (see Figure 1). It might be argued that the Chinese economy grew so quickly, that stock markets were subject to greater fluctuations. However, in 2001

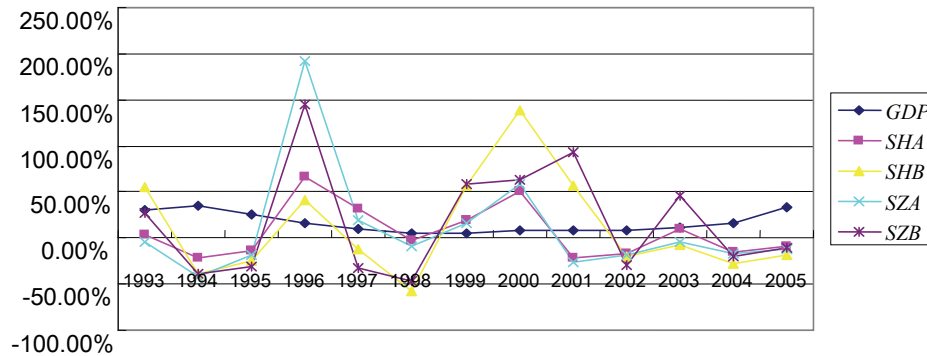


Figure 1. GDP growth rate and stock returns for the four stock markets in China (1993–2005).

Note: GDP, SHA, SHB, SZA and SZB represent the gross domestic product growth rate, Shanghai A share returns, Shanghai B share returns, Shenzhen A share returns and Shenzhen B share returns, respectively

and 2002, the growth of GDP was stable at 8.77% and 8.07%, respectively; yet, most stock returns remained negative. This asymmetry may have resulted from adjustments made to macroeconomic policies in China in 1994. These policy changes may have changed the relationship between the economic growth rate and the stock markets. Additionally, with the establishment of the share markets, Shanghai/Shenzhen A-shares could only be traded by domestic investors using renminbi (RMB thereafter), whereas Shanghai/Shenzhen B-shares were only available to foreign investors using U.S. and H.K. dollars, respectively. It follows that macroeconomic policies could have affected the four different stock markets in different ways. The issues related to these distinctive stock markets are ideal platforms for us to investigate the impact of various macroeconomic factors on Chinese stock returns.

Some previous studies (Kwon, Shin, & Bacon, 1997; Binswanger, 2000) on the impact of various macroeconomic factors on stock returns have used regression analysis. However, while regression analysis can explore the statistical significance of the effects of macroeconomic factors on stock returns, it cannot identify structural changes in the relationships among these factors and stock markets. Other researchers (Barnes, Boyd, & Smith, 1999; Wongbangpo & Sharma, 2002) have therefore delved into structural changes in these relationships, using time series analysis, which allows the identification of the timing of macroeconomic structural changes in stock markets. Yet, this approach does not allow us to determine the threshold values of these changes. Both governments and investors are likely to be more interested in the threshold values, as the relationships among macroeconomic factors and stock returns may

differ, depending on the levels of the macroeconomic factor levels. Hence, in order for governments or investors to effectively formulate public policies or make investment decisions, it is critical for them to understand the threshold values of macroeconomic structural changes.

To identify structural changes in the relationships among various macroeconomic factors and stock returns, Tong's (1983) threshold autoregressive (TAR) model is an ideal tool. The TAR model assumes that the coefficients are different during different regimes. In Tong's TAR model, the threshold variable needs to be determined by a statistical testing method, such as the Akaike Information Criterion (AIC). Moreover, the independent variables in Tong's TAR model contain only lagged dependent variables. Shen and Hakes (1995) modify Tong's TAR model and use the inflation rate as the threshold variable. They also employ Tsay's (1989) arranged autocorrelation to locate the unknown threshold value. A similar approach has been adopted by Shen (1996), and Shen, Lee, and Lee (1999). The current paper follows Shen and Hakes's method and uses five macroeconomic factors as threshold variables. In this way it becomes a rolling regression approach with varying independent variables.

The advantage of this approach is that it can identify different macroeconomic factor levels as having different effects on stock market patterns. This approach is a departure from the TAR model employed in previous studies (Cao & Tsay, 1992; Lizieri & Satchell, 1997; Enders & Sandler, 2002). First, while most prior studies that have employed recursive coefficients to identify structural changes, few have applied recursive t -ratios to do this. Second, most past applications of the TAR model have used piecewise regression in time to investigate structural changes, while only a few studies have applied piecewise regression in variables to investigate structural changes at variable levels. Third, prior research often employs the increasing window rolling regression approach, while our rolling regression uses the fixed window approach. The fixed window rolling regression approach is more sensitive than the increasing window approach in searching for threshold values. Hence, it can more effectively identify the structural changes in the relationships among various macroeconomic factors and stock returns.

Several studies have modelled the relationships among macroeconomic factors and stock returns. Solnik (1987) claims that the exchange rates are positively related to the stock prices. This is confirmed by Soenen and Hennigar (1988), Ma and Kao (1990), and Mukherjee and Naka (1995). Ma and Kao (1990) use the export-led hypothesis and suggest that, for export-driven economies, currency depreciation has a positive effect on the domestic stock market. However, Ajayi and Mougoue (1996) contest this and, using the asset of exchange hypothesis, argue that the demand for, and value of local currencies are

driven by foreign investors' willingness to hold local assets; a position fully supported by Nieh and Lee (2001), Wu (2001), and Sadorsky and Henriques (2001). Recently, Wongbangpo and Sharma (2002) have demonstrated that the relationship between the exchange rate and stock prices is positive in Indonesia, Malaysia and the Philippines, but negative in Singapore and Thailand.

Money supply may have either a positive or negative effect on stock markets, since changes in money supply may affect stock prices via changes in portfolio substitution or inflationary expectations. Dhakal, Kandil and Sharma (1993) explain that an increase in money supply creates an excess supply of money, and thus an excess demand for stocks. This may result in increased stock prices or, alternatively, can also negatively affect stock prices due to inflation. Abdullah and Hayworth (1993), Kwon et al. (1997), and Mookerjee and Qiao (1997) find evidence in favour of a positive effect of money supply on stock markets. In contrast, Wongbangpo and Sharma (2002) find such a positive effect on stock markets only in Malaysia, Singapore and Thailand, with a negative effect in Indonesia and the Philippines.

It is widely recognized that the theoretical relationship between the price level and stock returns is negative (Fama, 1981; Chen, Roll & Ross, 1986; Balduzzi, 1995; Fama & Schwert, 1977; Barnes et al., 1999; Gallagher & Taylor, 2002; Adams, McQueen, & Wood, 2004). Inflation can increase a firm's production costs, decrease its revenue and lower its stock price. DeFina (1991) attributes the negative effect of inflation to nominal contracts that do not allow for immediate adjustments to a firm's revenue and costs. However, some studies argue that inflation may actually have a positive effect on stock markets under certain conditions (Abdullah & Hayworth, 1993; Choudhry, 2001). Indeed, it has been suggested, that stock prices could respond positively to changes in price levels when equity serves as a hedge against inflation.

Several studies show that the level of real economic activity, or industrial production, has an impact on stock markets (Domian & Louton, 1997; Cheung & Ng, 1998; Laopodis & Sawhney, 2002). Increased prosperity may increase expected future cash flows, and thus raise stock prices; whereas the opposite effect is likely to hold during a recession. Binswanger (2000) reports that this was true in the U.S., before the mid-1980s, and that it ceased to be so thereafter. In addition, Maysami and Koh (2000) demonstrate that there is no correlation between the industrial production growth rate and the stock market in Singapore.

Chen et al. (1986) find a negative relationship between the interest rate and stock prices. A higher interest rate raises the cost of debt and reduces corporate profitability, which negatively affects stock prices. It may also discourage mergers, acquisitions and buyouts. Abdullah and Hayworth (1993),

Dhakal et al. (1993), Kwon and Shin (1999), and Wongbangpo and Sharma (2002) provide further support for the findings of Chen et al. (1986).

Based on this literature review, it is clearly apparent that no consensus has been reached vis-à-vis the relationship among macroeconomic factors and stock returns. We argue that the critical reason for this lack of agreement may lie in the fact that this relationship is subject to structural changes.

Consistent with previous work, this study applies the model of Wongbangpo and Sharma (2002) and selects five key macroeconomic factors (the rate of change in the exchange rate, the rate of change in the money supply, the rate of change in the consumer price index, the rate of change in the industrial production and the interest rate) as the independent variables, and the four Chinese stock market returns (i.e., Shanghai A/B-shares and Shenzhen A/B-shares) as the dependent variables. Here, we identify structural changes in the relationships, compare different relationships among the macroeconomic factors and the four stock returns, and classify the threshold values of the structural changes. We also compare the results of the traditional ordinary least squares (OLS) method with those of the rolling regression approach with varying independent variables, and highlight the salient characteristics of the rolling regression approach with varying independent variables. The main contribution of this paper, therefore, is that it sheds light on the threshold values of the macroeconomic factors that trigger structural changes in the relationships among stock markets and the macroeconomic factors.

The structure of the remainder of this paper is as follows. The next section discusses the models and the data, followed by the empirical analysis. The final section, reviews our conclusions.

DATA AND MODELS ANALYSIS

Data

In this study, we employ the model of Wongbangpo and Sharma (2002), which considers stock returns, the exchange rate, money supply, the consumer price index, the nominal interest rate and the gross national product (GNP). However, for convenience in collecting data, in Equation (1) of our model, we substitute the industrial production for GNP. Except for the interest rate, we use the rates of change for all the other variables. The stock returns, including those of the Shanghai A/B- and Shenzhen A/B-shares are compiled from the Taiwan Economic Journal (TEJ) database, and the exchange rate (versus the US dollar), the money supply, the rate of change in the consumer price index (*CPI*), the rate

of change in the industrial production (*IP*) and the interest rate (*INT*) are collected from the International Monetary Fund's International Financial Statistics (IFS) and the National Bureau of Statistics of China (NBSC) site. The frequency of the variables is monthly, and the sample period is from February 1994 to October 2006. The definition of money supply in this paper is the M2 money supply. As the frequency of the data on M2 money supply in mainland China is quarterly, the fuzzy distance weighting method (Shen et al., 1999) is employed to convert the data to a monthly basis. The interest rate is the lending rate. The exchange rate (*EX*) and money supply (*MS*) are revised to the rate of change style, and also adjusted seasonally.

The descriptive statistics for all variables are shown in Table 1. In particular, the standard deviation (SD) of the Shanghai B (*SHB*) is second to that of the Shenzhen B (*SZB*), but the mean of the *SHB* is the lowest among the four stock markets. This means that the relative volatility of the *SHB* is the highest among the four stock markets.

The stationarity of each series is examined using the Phillips and Perron (PP) test. The PP test statistics for each level based on a standard regression with a constant and time trend are reported in Table 2. The PP tests for all the series of variables reject the null hypothesis of the existence of a unit root in the levels. Thus, they are stationary series, and our models do not have the problem of spurious regression.

It is critical to test for multicollinearity among the macroeconomic factors before estimating the models. In Table 3, Panel A shows the correlation tests, and *MS* and *CPI* have a high positive correlation of roughly 0.85. *INT* also has high positive correlations with *MS* and *CPI*, of about 0.86 and 0.75, respectively. This attests to the Gibson paradox that interest rate movements are

Table 1
Descriptive Statistics for Stock Returns and Macroeconomic Factors.

	<i>SHA</i>	<i>SHB</i>	<i>SZA</i>	<i>SZB</i>	<i>EX</i>	<i>MS</i>	<i>CPI</i>	<i>IP</i>	<i>INT</i>
Mean	0.58%	0.18%	0.53%	0.62%	-0.06%	19.46%	4.43%	14.00%	7.38%
S.D.	11.09%	11.95%	10.60%	12.87%	0.22%	6.11%	7.58%	4.48%	2.41%
Kurtosis	27.59	3.48	5.17	14.65	45.49	-0.49	2.15	0.90	-1.04
Skewness	3.31	1.10	1.27	2.52	-6.00	0.85	1.80	0.17	0.82
Min	-36.74%	-30.22%	-26.48%	-29.46%	-2.06%	10.27%	-2.68%	2.10%	5.31%
Max	89.88%	54.00%	53.27%	87.60%	0.23%	33.36%	27.70%	28.90%	12.06%
N	153	153	153	153	153	153	153	153	153

Notes: *SHA*, *SHB*, *SZA*, *SZB*, *EX*, *MS*, *CPI*, *IP* and *INT* represent Shanghai A share returns, Shanghai B share returns, Shenzhen A share returns, Shenzhen B share returns, the rate of change in the exchange rate, the rate of change in the money supply, the rate of change in the consumer price index, the rate of change in industrial production and the interest rate, respectively

Table 2
Unit Root Tests for Stock Returns and Macroeconomic Factors.

Variables	SHA	SZA	SHB	SZB	EX	MS	CPI	INT	IP	Critical values		
										1% level	5% level	10% level
Lag length	10	2	4	5	5	4	6	5	8			
Model 1	-14.71***	-11.78***	-10.52***	-10.70***	-10.30***	-3.51***	-3.52*	-3.49***	-8.66***	-3.47	-2.88	-2.58
Model 2	-14.68***	-11.75***	-10.51***	-10.69***	-10.27***	-3.48**	-3.18*	-3.24*	-8.66***	-4.02	-3.44	-3.14

Notes:

1. *SHA*, *SHB*, *SZA*, *SZB*, *EX*, *MS*, *CPI*, *IP* and *INT* represent Shanghai A share returns, Shanghai B share returns, Shenzhen A share returns, Shenzhen B share returns, the rate of change in the exchange rate, the rate of change in the money supply, the rate of change in the consumer price index, the rate of change in industrial production and the interest rate, respectively.
2. Model 1 is the model with a constant, while Model 2 represents the model with a constant and linear trend.
3. The numbers are the adjusted t-statistics for the PP tests.
4. The lag lengths used in the PP tests are settled by the Newey-West bandwidths.
5. ***, ** and * represent significance at the 0.01, 0.05 and 0.10 levels, respectively.

Table 3
Multicollinearity Tests for Stock Returns and Macroeconomic Factors.

Panel A: Correlation tests.

	SHA	SHB	SZA	SZB	EX	MS	CPI	IP	INT
SHA	1								
SHB	0.38***	1							
SZA	0.87***	0.38***	1						
SZB	0.41***	0.83***	0.45***	1					
EX	-0.15	-0.01	-0.09	0.01	1				
MS	0.06	-0.07	0.07	-0.06	-0.20**	1			
CPI	-0.02	-0.08	-0.04	-0.01	-0.28***	0.85***	1		
IP	-0.04	-0.05	-0.08	-0.05	-0.25***	0.50***	0.51***	1	
INT	0.02	-0.06	0.06	-0.07	-0.11	0.86***	0.75***	0.25***	1

Panel B: Collinearity statistics.

	EX	MS	CPI	IP	INT	Average
VIF	1.13	7.09	3.96	1.71	4.85	3.75

Notes:

1. *SHA*, *SHB*, *SZA*, *SZB*, *EX*, *MS*, *CPI*, *IP* and *INT* represent Shanghai A share returns, Shanghai B share returns, Shenzhen A share returns, Shenzhen B share returns, the rate of change in the exchange rate, the rate of change in the money supply, the rate of change in the consumer price index, the rate of change in industrial production and the interest rate, respectively.
2. *** and ** represent significance at the 0.01 and 0.05 levels, respectively.
3. VIF is the variance inflation factor for every independent variable.

tied in with the rate of inflation. The other relationships among the variables have low correlations. In addition, in Panel B, the variance inflation factor (VIF) of *MS* (7.09) is shown to be higher than 5 but lower than 10, and the VIFs of *CPI* and *INT* (3.96 and 4.85, respectively) are higher than 1. The average VIF for all the independent variables (3.75) is higher than 1. The above results form the

multicollinearity tests strongly indicate there is a multicollinearity problem exists among *MS*, *CPI* and *INT*.

Models Analysis

The prior literature provides many methods to remedy the multicollinearity problem in multiple regression analysis (Belsley, 1991; Neter, Wassermann, & Kutner, 2004). A common method to cope with multicollinearity is to drop one of the highly correlated independent variables, and both Bring (1994) and Piramuthu (2008) employ this method. In addition, the ridge regression approach (Huang & Mintz, 1990; Hawkins & Yin, 2002) and the principal components regression approach (Vigneau, Devaux, Qannari, & Robert, 1997; Banaian, Burdekin, & Willett, 2004) are also used to remedy the multicollinearity problem. The first method is simpler than the latter two, and it can be easily applied in the TAR model. Thus, this paper applies the first method. Some may argue that in this method there is a risk of omitted variable bias. Hence, our models, which will be arranged in three equations and consider all independent variables, will not omit information regarding the dropped variables.

The procedure for arranging our model is as follows. First, to avoid the interaction among *MS*, *CPI* and *INT*, Equation (1) is broken up into three equations, Equations (2), (3) and (4), and are estimated using the OLS method.

$$SR_{it} = a_0 + a_1EX_{it} + a_2MS_{it} + a_3CPI_{it} + a_4INT_{it} + a_5IP_{it} + \varepsilon_{it} \quad (1)$$

$$SR_{it} = b_0 + b_1EX_{it} + b_2MS_{it} + b_3IP_{it} + \varepsilon_{it} \quad (2)$$

$$SR_{it} = c_0 + c_1EX_{it} + c_2CPI_{it} + c_3IP_{it} + \varepsilon_{it} \quad (3)$$

$$SR_{it} = d_0 + d_1EX_{it} + d_2INT_{it} + d_3IP_{it} + \varepsilon_{it} \quad (4)$$

where all the variables are time series: *SR* refers to the Shanghai A (*SHA*), Shenzhen A (*SZA*), Shanghai B (*SHB*) or Shenzhen B (*SZB*) share returns; *EX* is the rate of change in the exchange rate (RMB/USD); *MS* is the rate of change in the money supply; *CPI* is the rate of change in the consumer price index; *IP* is the rate of change in the industrial production; *INT* is the interest rate; a_0 , b_0 , c_0 and d_0 are constants; $a_1 \sim a_5$, $b_1 \sim b_3$, $c_1 \sim c_3$ and $d_1 \sim d_3$ are coefficients; and the ε_{it} are the error terms.

In this paper, to identify macroeconomic structural changes in the stock markets, we modify the TAR model so that it becomes a rolling regression approach with varying independent variables. This approach consists of four steps. In step one, we first sort the independent variable, *EX*, in Equation (2) in

ascending order. Then the dependent variable, SR (SHA , SZA , SHB or SZB) and the other two independent variables, MS and IP , are placed in order based on EX . In step two, we estimate Equation (2), using the first 60 observations sorted by the OLS method, and obtain the t -ratios for the coefficients of EX , MS and IP . In step three, we drop the first observation and use the following observation, also using 60 observations, and repeat step two. We proceed with this rolling regression approach with varying independent variables until the last observation is used. Thus the first estimated regression uses observations 1 to 60; the second uses observations 2 to 61 and the final (94th) regression involves observations 94 to 153. Based on the above procedure, we obtain 94 t -ratios for EX , MS and IP , respectively. In step four, we plot the t -ratios for the coefficients of EX , MS and IP against the sorted EX , respectively. Taking EX as an example, if the significance level of the t -ratio of the coefficients of EX changes from an insignificant level to a significant level as EX increases, this implies that a structural change has occurred in the relationship between EX and the stock returns. This level of structural change is called a threshold value (hereafter, TV). If the EX levels are below a TV (this is referred to as a low EX regime), then a non-structural change occurs in the relationship between EX and the stock returns. If the EX levels are above a TV (this is referred to as a high EX regime), then a structural change occurs in the relationship between EX and the stock returns. For robustness, we also estimate Equation (2) based on low and high EX regimes [say, equation (2–1) and (2–2)] using the OLS method, to observe the different significant levels of the t -ratios on the coefficients for EX between low and high EX regimes.

$$SR_i = b_0^1 + b_1^1 EX_{i,s} + b_2^1 MS_i + b_3^1 IP_i + \varepsilon_i^1 \quad (2-1)$$

If $EX_{i,s} \leq EX_{TV}$ (non-structural change)

$$SR_i = b_0^2 + b_1^2 EX_{i,s} + b_2^2 MS_i + b_3^2 IP_i + \varepsilon_i^2 \quad (2-2)$$

If $EX_{i,s} > EX_{TV}$ (structural change),

where SR is SHA , SZA , SHB or SZB ; the $EX_{i,s}$ are the rates of change in the exchange rate, sorted in ascending order; MS is the rate of change in the money supply; CPI is the rate of change in the consumer price index; IP is the rate of change in the industrial production; INT is the interest rate; b_0^1 and b_0^2 are constants; $b_1^1 \sim b_3^1$ and $b_1^2 \sim b_3^2$ are coefficients; and ε_i^1 and ε_i^2 are the error terms.

Briefly, if the insignificant (significant) levels of the t -ratios on the coefficients of macroeconomic factors in a low macroeconomic factor regime

change to the significant (insignificant) levels of those in the high macroeconomic factor regime, this implies that a structural change occurs in the relationship between macroeconomic factors and stock returns.

Following the same procedure, we then sort *MS* and *IP* in Equation (2), *EX*, *CPI* and *IP* in Equation (3) and *EX*, *INT* and *IP* in Equation (4), respectively. By estimating the coefficients of the sorted independent variables in these equations, we can observe that the *t-ratios* of the independent variables change as the sorted independent variables move, and arrive at the threshold values. In addition, we also estimate the equations based on low and high macroeconomic factor regimes.

EMPIRICAL ANALYSIS

First of all, this study estimates Equation (1) using the OLS method. Secondly, to avoid the interactions among *MS*, *CPI* and *INT*, Equation (1) is arranged into Equations (2), (3) and (4), which use the variables *MS*, *CPI* and *INT* separately to form the basis for the subsequent rolling regression approach. The results are shown in Table 4, Panel A. Using the OLS method, *EX* has a statistically significant negative relationship with *SHA*, while *MS* has a statistically significant positive relationship with *SHA* in Equation (1). However, in Equation (2), the significance of *MS* disappears and the sign of *INT* changes from negative to positive. For *SZA*, *MS* has a statistically significant positive relationship with *SZA*, while *CPI* has a statistically significant negative relationship with *SZA* in Equation (1) using the OLS method. However, in Equation (2), only *IP* has a statistically significant negative relationship with *SZA*. *SHB* and *SZB* exhibit an insignificant relationship with the five macroeconomic factors. In fact, the results in Table 4, Panel A show that most of the independent variables are not significant in Equations (2), (3) and (4)¹. However, we argue that there might be some particular relationships between the stock returns and the macroeconomic factors, which cannot be explored using the OLS method.

¹ This paper finds that the adjusted R-squared values are very low and the F-statistics are insignificant in our models. The referees have expressed concern that the low adjusted R-squared values imply poor goodness-of-fit and model specification. Based on our review of the literature, Hagerman, Zmijewski, and Shah (1984) and Ritter (1991) also obtain quite low adjusted R-squared values in their empirical evidence, say, 0.02 and 0.07. Ritter (1991) explains that this potential problem may be caused by the reasons that dependent variables are the rates of change in the dependent variables, the dependent variable is so skewed and the residuals are non-normal. Our models and rolling regression approach also employ the rates of change in the independent variables and suffer from quite low adjusted R-squared values and insignificant F-statistics. However, they can shed new light on the relationship between macroeconomic factors and stock returns.

This study also applies the rolling regression approach with varying independent variables to estimate Equations (2), (3) and (4). In this way, we can plot 76 scatter plots for four stock markets. Due to space restrictions, we only show seven plots [Figures 2(a) to 2(g)], which reveal structural changes in the relationships among the macroeconomic factors and stock returns. Figure 2(a) shows a scatter plot of t -ratios of EX against EX on SHA . A cursory look at this figure clearly indicates that the threshold value is around 0%. As EX is below 0%, the t -ratios of EX are negative but insignificant, while when EX is above 0%, the t -ratios of EX are negative and statistically significant. This may imply that a macroeconomic structural change occurs in the relationship between EX and SHA as EX increases. Figures 2(b) to 2(g) also display the same phenomenon.

Once the threshold values are determined, for robustness, we substitute the observations into low and high macroeconomic factor regimes to estimate the coefficients and t -ratios of Equations (2), (3) and (4). Panel B of Table 4 shows five threshold values for the four stock markets. For the first threshold value $EX = 0%$ in SHA , the t -ratios of EX in the low EX regime for the three equations are negative but insignificant, while the t -ratios of EX in the high EX regime are

Table 4
Results of Estimating the Models.

This table includes Panels A and B which are the estimations for the whole sample and the subsample which are below and above the threshold values (TV) using the OLS method. Panel B presents five TVs for four stock markets. In the first column, Low EX means the rates of change in the exchange rates are below the TV, while High EX means the rates of change in the exchange rates are above the TV.

Panel A: The whole sample.

Market Returns	Equations	Macroeconomic Factors						N
		Constant	EX	MS	CPI	INT	IP	
		coef. (t)	coef. (t)	coef. (t)	coef. (t)	coef. (t)	coef. (t)	
<i>SHA</i>	(1)	-0.04 (-0.74)	-9.25(-2.21**)	0.72(1.87*)	-0.37(-1.61)	-0.54(-0.66)	-0.31(-1.20)	153
	(2)	0.01(0.38)	-8.21(-1.99**)	0.15(0.90)			-0.30(-1.29)	153
	(3)	0.03(0.81)	-8.82(-2.11**)		-0.05(-0.35)		-0.16(-0.70)	153
	(4)	0.02(0.60)	-8.50(-2.06**)			0.12(0.31)	-0.22(-1.03)	153
<i>SZA</i>	(1)	-0.06(-1.19)	-6.35(-1.60)	0.85(2.30**)	-0.49(-2.19**)	-0.33(-0.43)	-0.39(-1.59)	153
	(2)	0.01(0.42)	-4.87(-1.24)	0.25(1.52)			-0.42(-1.90*)	153
	(3)	0.04(0.42)	-5.56(-1.38)		-0.02(-0.18)		-0.25(-1.09)	153
	(4)	0.02(0.58)	-5.25(-1.33)			0.33(0.91)	-0.31(-1.51)	153
<i>SHB</i>	(1)	0.01(0.09)	-2.09(-0.45)	0.05(0.12)	-0.17(-0.66)	0.01(0.01)	-0.06(-0.20)	153
	(2)	0.03(0.91)	-1.53(-0.34)	-0.11(-0.59)			-0.09(-0.34)	153
	(3)	0.01(0.40)	-2.01(-0.44)		-0.13(-0.88)		-0.05(-0.21)	153
	(4)	0.04(0.91)	-1.41(-0.31)			-0.24(-0.58)	-0.13(-0.55)	153
<i>SZB</i>	(1)	-0.01(-0.21)	-0.98(-0.20)	0.33(0.73)	-0.32(-1.15)	-0.32(-0.33)	-0.05(-0.18)	153
	(2)	0.03(0.85)	-0.04(-0.01)	-0.10(-0.50)			-0.06(-0.23)	153
	(3)	0.01(0.30)	-0.85(-0.17)		-0.19(-1.15)		0.02(0.07)	153
	(4)	0.04(0.98)	0.01(0.002)			-0.32(-0.72)	-0.09(-0.35)	153

(continued on next page)

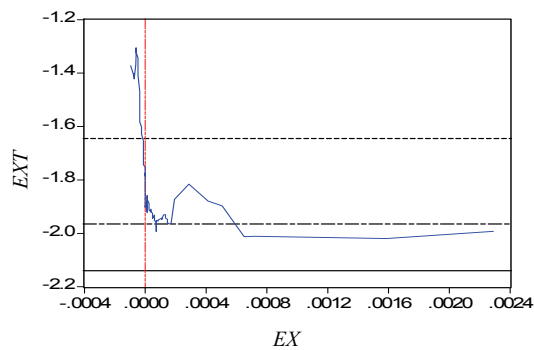
Table 4 (continued)

Panel B: The subsamples of low and high macroeconomic factor regimes.

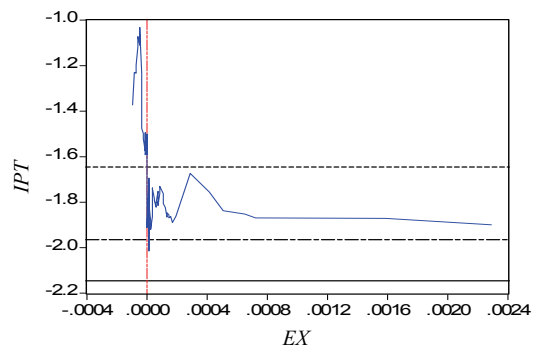
Market Returns	TV	Equations	Macroeconomic Factors							N		
			Below TV	Constant	EX	MS	CPI	INT	IP			
			Above TV	coef. (t)	coef. (t)	coef. (t)	coef. (t)	coef. (t)	coef. (t)			
SHA	EX=0%	(2)	Low EX	-0.01(-0.03)	-6.33(-0.17)	0.19(0.61)				-0.21(-0.91)	61	
			High EX	0.02(0.34)	-8.87(-1.74*)	0.17(0.68)				-0.38(-0.97)	92	
		(3)	Low EX	0.02(0.70)	-23.54(0.71)			-0.18(-0.74)		-0.14(-0.61)	61	
			High EX	0.03(0.48)	-9.22(-1.79*)			-0.05(-0.22)		-0.18(-0.44)	92	
		(4)	Low EX	0.03(0.58)	-14.45(0.38)				-0.13(-0.19)	-0.16(-0.75)	61	
			High EX	0.03(0.45)	-9.02(-1.77*)				0.14(0.24)	-0.26(-0.76)	92	
	SZA	EX=0%	(2)	Low EX	0.01(0.03)	-3.64(-0.09)	0.22(0.62)				-0.28(-1.07)	61
				High EX	0.02(0.48)	-5.36(-1.16)	0.29(1.28)				-0.57(-1.99**)	92
(3)			Low EX	0.03(0.81)	-5.41(-0.82)			-0.20(-0.74)		-0.20(-0.78)	61	
			High EX	0.05(0.93)	-5.68(-1.20)			-0.01(-0.04)		-0.32(-0.83)	92	
		(4)	Low EX	0.04(0.73)	-5.01(-0.54)				-0.23(-0.29)	-0.23(-0.92)	61	
			High EX	0.03(0.49)	-5.56(-1.20)				0.45(0.88)	-0.41(-1.68*)	92	
SHA		CPI=25.60%	(2)	Low CPI	0.01(0.12)	-8.72(-1.15)	0.12(0.40)				-0.17(-0.81)	90
				High CPI	-0.01(-0.11)	-8.31(-2.11**)	0.28(0.85)				-0.39(-0.82)	63
	(3)		Low CPI	0.02(0.71)	-9.04(-1.16)			-0.20(-0.28)		-0.11(-0.57)	90	
			High CPI	0.04(0.50)	-8.86(-2.03**)			-0.06(-0.21)		-0.23(-0.45)	63	
		(4)	Low CPI	-0.02(-0.30)	-8.17(-1.08)				0.56(-0.68)	-0.09(-0.30)	90	
			High CPI	0.02(0.24)	-8.69(-2.13**)				0.19(0.26)	-0.29(-0.62)	63	
	SHA	INT=10.98%	(2)	Low INT	-0.02(-0.58)	-1.67(-0.55)	0.33(1.19)				-0.25(-1.48)	123
				High INT	-0.49(-0.88)	-19.62(-1.30)	1.99(0.99)				-0.73(-0.82)	30
(3)			Low INT	0.02(1.24)	-1.38(-0.45)			0.20(0.69)		-0.18(-1.06)	123	
			High INT	0.08(0.53)	-29.47(-1.93*)			-0.63(-0.87)		-0.06(-0.07)	30	
		(4)	Low INT	-0.01(-0.17)	-1.50(-0.49)				0.43(1.08)	-0.12(-0.77)	123	
			High INT	-0.89(-0.86)	-30.58(-1.96**)				7.88(0.91)	-0.28(-0.33)	30	
SHB		IP=13.50%	(2)	Low IP	-0.01(-0.02)	-100.41(-1.35)	-0.65(-1.41)				1.25(1.65*)	64
				High IP	-0.03(-0.49)	-1.55(-0.45)	0.14(0.83)				-0.08(-0.23)	89
	(3)		Low IP	-0.08(-1.06)	-95.59(1.29)			-0.46(-1.12)		1.05(1.40)	64	
			High IP	-0.01(-0.16)	-1.75(-0.50)			0.01(0.08)		-0.03(-0.07)	89	
		(4)	Low IP	0.05(0.48)	-86.66(-1.20)				-2.22(-2.03**)	1.21(1.65*)	64	
			High IP	-0.04(-0.57)	-1.63(-0.48)				0.38(1.06)	-0.05(-0.14)	89	
	SHB	IP=15%	(2)	Low IP	0.04(0.60)	0.02(0.00)	-0.48(-1.50)				0.49(0.87)	88
				High IP	0.04(0.48)	-0.93(-0.26)	0.18(0.92)				-0.46(-1.03)	65
(3)			Low IP	-0.01(-0.18)	-1.36(-0.05)			-0.37(-1.18)		0.23(0.44)	88	
			High IP	0.05(0.60)	-1.43(-0.39)			0.01(0.09)		-0.33(-0.67)	65	
		(4)	Low IP	0.06(0.87)	1.61(0.06)				-1.28(-1.79*)	0.38(0.71)	88	
			High IP	0.03(0.40)	-0.88(-0.25)				0.60(1.36)	-0.47(-1.10)	65	
SZB		IP=15%	(2)	Low IP	-0.01(-0.13)	-7.18(-0.24)	-0.33(-0.91)				0.76(1.17)	88
				High IP	0.06(0.95)	-0.11(-0.04)	0.07(0.40)				-0.46(-1.21)	65
	(3)		Low IP	-0.04(-0.64)	-8.52(-0.28)			-0.21(-0.59)		0.59(0.94)	88	
			High IP	0.04(0.57)	-0.98(-0.32)			-0.11(-0.85)		-0.22(-0.54)	65	
		(4)	Low IP	0.01(0.13)	-5.56(-0.19)				-1.00(-1.76*)	0.70(1.16)	88	
			High IP	0.06(0.94)	-0.14(-0.05)				0.17(0.44)	-0.45(-1.23)	65	

Notes:

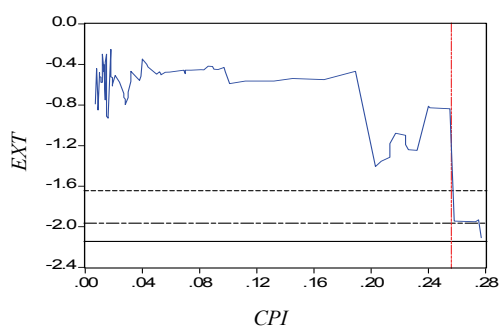
1. SHA, SHB, SZA, SZB, EX, MS, CPI, IP and INT represent Shanghai A share returns, Shanghai B share returns, Shenzhen A share returns, Shenzhen B share returns, the rate of change in the exchange rate, the rate of change in the money supply, the rate of change in the consumer price index, the rate of change in industrial production and the interest rate, respectively.
2. ** and * represent the levels of significance at the 0.05 and 0.10 levels, respectively.



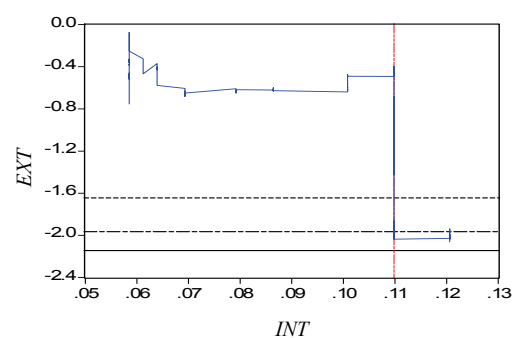
(a) The t -ratios of EX in sorted EX on SHA



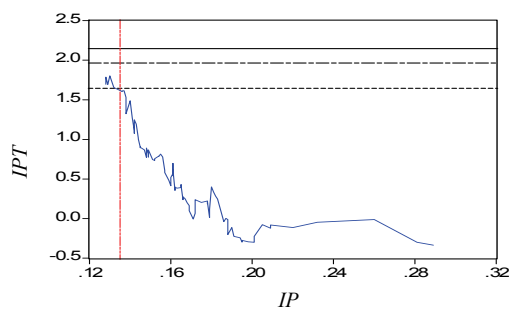
(b) The t -ratios of IP in sorted EX on SZA



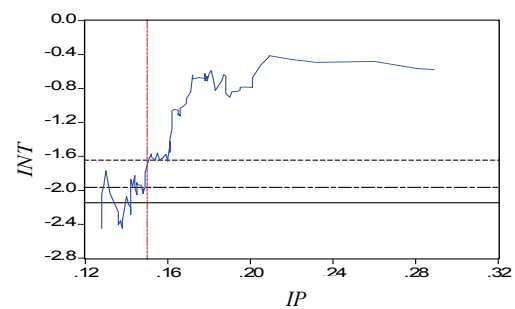
(c) The t -ratios of EX in sorted CPI on SHA



(d) The t -ratios of EX in sorted INT on SHA

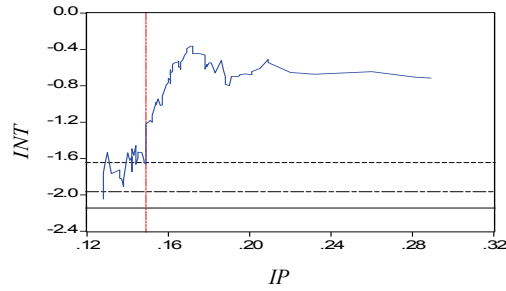


(e) The t -ratios of IP in sorted IP on SHB



(f) The t -ratios of INT in sorted IP on SH

Figure 2. Scatter plots of t -ratios by the rolling regression approach with varying dependent variables (continued on next page).



(g) The t -ratios of INT in sorted IP on SZB

Figure 2. (continued)

Notes:

1. The vertical axis represents the t -ratios of macroeconomic factors (for example, EXT represents t -ratios on the coefficients of the rate of change in the exchange rate), and the horizontal axis represents the levels of the macroeconomic factors.
2. The horizontal lines, —, -.- and ..., represent the levels of significance at the 0.01, 0.05 and 0.10 levels, respectively.
3. The vertical red dotted line represents the threshold value of structural change.

all negative and statistically significant. As for the other threshold values in the four stock markets, most of the equations show that there are significant differences between the low and high macroeconomic factor regimes for the t -ratios of EX , INT and IP . These prove that the relationships among the macroeconomic factors and stock returns are indeed different between the low and high macroeconomic factor regimes. These results imply that some macroeconomic structural changes occur in the relationships between the macroeconomic factors and stock returns. The results of Panel B show that there are more significant independent variables in the three equations than in the case of Panel A. Thus, the rolling regression approach, with its varying independent variables, provides greater insight into the relationships among the macroeconomic factors and stock returns than does the OLS method.

To sum up, we report the macroeconomic factors for the structural changes and threshold values in Table 5. It is worth noting that seven macroeconomic structural changes and five key threshold values emerge from the relationships among the macroeconomic factors and Chinese stock returns. Overall, three macroeconomic structural changes occur in SHA , two occur in SHB and only one occurs each of SZA and SZB . As for the differences between the A- and B-shares, four macroeconomic structural changes occur in the A-shares and three occur in the B-shares. Furthermore, EX , CPI , IP and INT are the key factors in the case of the A-shares, whereas only IP and INT are deemed significant in the case of the B-shares. These differences may be attributed to the

Table 5
Macroeconomic Factors of Structural Change.

This table shows the results for the macroeconomic factors affecting structural changes in four markets. There are three types of signs. The first one, for instance, in *SHA*, is that for variable *EX* in row 1. Here, we use the sign "(−) 0% −*" to indicate when the threshold value (TV) of *EX* is 0%, the estimated coefficient for *EX* is negative and its *t*-ratio is insignificant when *EX* is below its TV and negative and its *t*-ratio is statistically significant at the 0.1 level when *EX* is above its TV. This implies that a structural change occurs in the relationship between *EX* and the stock returns, as the value of *EX* is zero. The second one, for example, in *SHA*, is that for variable *INT* in row 1. Here, we use the sign "(−) 0% (+)" to indicate when the TV of *EX* is 0%, the estimated coefficient for *INT* is negative and its *t*-ratio is insignificant when *EX* is below its TV and positive and its *t*-ratio is insignificant when *EX* is above its TV. However, no structural change occurs in the relationship between *INT* and *SHA*. The third one, in *SHA*, is that for *EX* in row 2. Here, we use the sign "(+ or (−))" to indicate that no threshold variable has been identified and the coefficients are positive or negative but insignificant regardless of the order of the change of signs.

Market Returns	Threshold Variables	Macroeconomic Factors of Structural Change				
		<i>EX</i>	<i>MS</i>	<i>CPI</i>	<i>INT</i>	<i>IP</i>
<i>SHA</i>	<i>EX</i>	(−) 0% −*	(+) 0% (+)	(−) 0% (−)	(−) 0% (+)	(−) 0% (−)
	<i>MS</i>	(+) or (−)	(+) or (−)			(+) or (−)
	<i>CPI</i>	(−) 25.60% −**		(−) 25.60% (−)		(−) 25.60% (−)
	<i>INT</i>	(−) 10.98% −**			(+) 10.98% (+)	(−) 10.98% (−)
	<i>IP</i>	(+) or (−)	(+) or (−)	(+) or (−)	(+) or (−)	(+) or (−)
<i>SZA</i>	<i>EX</i>	(−) 0% (−)	(+) 0% (+)	(−) 0% (−)	(−) 0% (+)	(−) 0% −**
	<i>MS</i>	(+) or (−)	(+)			(−)
	<i>CPI</i>	(+) or (−)		(+) or (−)		(+) or (−)
	<i>INT</i>	(+) or (−)			(+) or (−)	(−)
	<i>IP</i>	(+) or (−)	(+) or (−)	(+) or (−)	(+) or (−)	(+) or (−)
<i>SHB</i>	<i>EX</i>	(+) or (−)	(−)	(−)	(−)	(−)
	<i>MS</i>	(+) or (−)	(+) or (−)			(+) or (−)
	<i>CPI</i>	(+) or (−)		(+) or (−)		(+) or (−)
	<i>INT</i>	(+) or (−)			(+) or (−)	(−)
	<i>IP</i>	(+) 13.50% (−)	(−) 13.50% (−)	(−) 13.50% (+)	−* 15% (+)	+* 13.50% (−)
<i>SZB</i>	<i>EX</i>	(+) or (−)	(−)	(−)	(−)	(+) or (−)
	<i>MS</i>	(+) or (−)	(+) or (−)			(+) or (−)
	<i>CPI</i>	(+) or (−)		(+) or (−)		(+) or (−)
	<i>INT</i>	(+) or (−)			(+) or (−)	(+) or (−)
	<i>IP</i>	(−) 15% (−)	(−) 15% (+)	(−) 15% (−)	−* 15% (+)	(+) 15% (−)

Notes:

1. *SHA*, *SHB*, *SZA*, *SZB*, *EX*, *MS*, *CPI*, *IP* and *INT* represent Shanghai A share returns, Shanghai B share returns, Shenzhen A share returns, Shenzhen B share returns, the rate of change in the exchange rate, the rate of change in the money supply, the rate of change in the consumer price index, the rate of change in industrial production and the interest rate, respectively.
2. (−) represents statistically negative insignificance.
3. − represents statistically negative significance.
4. (+) represents statistically positive insignificance.
5. + represents statistically positive significance.
6. (+) or (−) represents that no threshold variable has been identified and the coefficients are positive or negative insignificant regardless of order of change of signs.
7. ** and * represent the levels of significance at the 0.05 and 0.10 levels, respectively.
8. Percentages represent the threshold values of structural change.

following reasons. Illiquidity, lower stocks outstanding and foreign currency trading could account for the differences between A- and B-shares. The B-shares were illiquid and the B-share market had less than 10% of the total number of stocks outstanding. In addition, *SHB* and *SZB* were traded using U.S. and H.K. dollars, respectively. As far as the differences between the Shanghai and Shenzhen shares are concerned, five macroeconomic structural changes occur in the case of Shanghai shares, but only two occur in the case of Shenzhen shares. Cajueiro and Tabak (2004) contend that the market efficiency of the Shanghai A-share market is greater than that of the Shenzhen A-share market, implying that the former can more efficiently react to fluctuations in macroeconomic factors. This may account for the very limited number of macroeconomic structural changes in Shenzhen shares. Interestingly, *EX*, *CPI*, *IP* and *INT* are vertical affecting factors in the case of *SHA*, but only *EX* and *IP* are vertical affecting factors in the case of *SZA*. This may imply that, compared with the Shanghai A-share market, the Shenzhen A-share market is more sensitive to external Chinese macroeconomic factors, whereas the Shanghai A-share market may be more sensitive to internal Chinese macroeconomic factors than the Shenzhen A-share market.

The first threshold value is the level at which *EX* is equal to zero for Shanghai A-shares, and it indicates that the relationships between *EX* and Shanghai A-shares are distinct when the RMB is in a period of appreciation or depreciation; in this regard, the depreciation of the RMB has a statistically significant negative effect on Shanghai A-shares. This is consistent with Ajayi and Mougoue's (1996) asset of exchange hypothesis that, which holds that, as currency depreciates, foreign investors expect the depreciation to continue and will sell host stocks. As a result, stock prices fall. Currency depreciation may, therefore, have a negative effect on stock returns. Since foreign investors could not invest in Shanghai A-shares before December 2002, Ajayi and Mougoue's (1996) explanation may not be entirely applicable to Shanghai A-shares. This study suggests that another cause may lie in the managed floating exchange rate system, linked to the US dollar, which was in place in China before the reform of the RMB exchange rate system on July 21, 2005. When the RMB depreciated against the US dollar, China's central bank would decrease money supply to mitigate the effects of depreciation. This will often cause investors to expect the interest rate to rise, which will in turn indirectly cause stock prices to decrease. In addition, *IP* has a statistically significant negative effect on Shenzhen A-shares during the period of the RMB's depreciation. This negative effect of *IP* is contrary to the finding of Domian and Louton (1997). In the case of China, when the RMB is depreciating, the higher *IP* may accelerate the increase in the *CPI* and then impact Shenzhen A-shares.

The second threshold value is the level at which the *CPI* is equal to 25.6%. This indicates that the depreciation of the RMB has a statistically significant negative effect on Shanghai A-shares, as long as the rate of change in the consumer price index remains above 25.6%. The negative relationship is again consistent with Ajayi and Mougoue's (1996) asset of exchange hypothesis. The effect of *CPI* exceeding 25.6% might cause the currency to depreciate, and hence *SHA* and *EX* exhibit a negative relationship with high levels of *CPI*.

The third threshold value is the point at which *INT* equals 10.98%. The RMB's depreciation has a statistically significant negative effect on Shanghai A-shares when *INT* is above 10.98%. During periods of high interest rates, the depreciation of the RMB has a negative effect on Shanghai A-shares, which is again consistent with Ajayi and Mougoue's (1996) asset of exchange hypothesis.

The remaining threshold values are related to *IP*. We find that the two vertical levels of *IP* are 13.5% and 15% and they imply three key relationships between *IP* and the stock returns, as presented in Figure 3. The first key relationship (Figure 3) shows that as long as the level of *IP* is below 13.5%, *IP* has a statistically significant positive effect on Shanghai B-shares, confirming the findings of Domian and Louton (1997). The second and third key relationships indicate that, as long as the level of *IP* is below 15%, *INT* has a statistically significant negative effect on Shanghai/Shenzhen B-shares, which agrees with the finding of Chen et al. (1986). With high *IP* levels, inflation may increase a firm's production costs, decrease its future cash flow and reduce its revenue, in which case the stock returns will then decline. Hence, it is beneficial to stock markets if industrial production exhibits a steady growth rate. However, if *IP* grows too fast, a high inflation rate and the depreciation of the RMB may be detrimental to stock returns. Interestingly, if industrial production maintains a steady growth rate, the high interest rates may exert a negative effect on the B-shares. This implies that the interest rate might become an important factor in the case of the B-shares under conditions of a slower growth in industrial production.

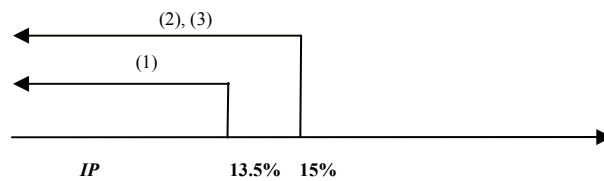


Figure 3. Relationships among the macroeconomic factors and stock markets with different threshold values of *IP*.

Notes:

1. As the level of *IP* is below 13.5%, *IP* has a positive effect on Shanghai B-shares.
2. & 3. As the level of *IP* is below 15%, *INT* has a negative effect on Shanghai/Shenzhen B-shares.

CONCLUSIONS

This paper investigates the macroeconomic structural changes in China's four main stock markets. The traditional OLS method only examines whether the rate of change in the exchange rate and the industrial production growth rate exhibit statistically significant negative relationships with certain stock market returns. This paper provides deeper insight into the relationships among the macroeconomic factors and stock returns, by using a rolling regression approach with varying independent variables. Seven macroeconomic structural changes are identified in the relationships among the macroeconomic factors and Chinese stock returns. Most of the macroeconomic structural changes occur in Shanghai shares, but a few are found in Shenzhen shares. This outcome may stem from the fact that the Shanghai shares react more efficiently to fluctuations in the macroeconomic factors. As regards the differences between the A- and B-shares, the rate of change in the exchange rate, the rate of change in the consumer price index, the rate of change in the industrial production and the interest rate are key factors affecting the A-shares; however, only the rate of change in the industrial production and the interest rate have important effects on the B-shares. These differences may have been caused by illiquidity, lower outstanding stocks and foreign currency trading. In addition, this study identifies five main threshold values of the structural changes in the relationships among the macroeconomic factors and the four Chinese stock markets. These threshold values indicate that the effects of changes in the renminbi on the Chinese stock markets might depend on the rates of change in the exchange rate, the rates of change in the consumer price index and interest rates. Furthermore, a high rate of economic growth does not necessarily cause the stock markets to prosper. The subsequent high growth in the price level may, in fact, have an even greater negative effect than a positive effect on economic growth.

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