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THE EFFECT OF EXCHANGE RATE VOLATILITY ON STOCK RETURN IN TAIWAN AROUND ABENOMICS

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ABSTRACT

The purpose of this study is to investigate the relationship between stock returns, exchange rates and financial ratios in the automotive and integrated circuit industries in Taiwan around the introduction of Abenomics. We employ panel data from 34 listed companies on the Taiwan Security Exchange over the period 2011-2014. The Panel Smooth Transition Regression (PSTR) model is utilized to estimate the threshold of exchange rates and its effect on stock returns. The main finding of this paper shows that there exists an efficient hedge regime. When the Abenomics applied a policy of quantitative easing to instigate a sharp depreciation of the yen, the effects of the policies absolutely bring out benefit and competitive advantage of Japanese export industries. The depreciation of the exchange rate against other currencies would affect a country's international competitive advantage or exports. If Taiwan exchange rate does not follow the depreciation of the yen and the levels of the exchange rate volatility in the automotive and integrated circuits industries in Taiwan are over 2.30% and 2.72% appreciation, respectively, the both industries will generate exchange losses and further influence the profit of the companies. Therefore, the main contribution of this paper is to provide a means for CEOs of companies in the two industries to exercise hedge options and evade the risk of exchange rate for their firms when the appreciation of currency are over 2.3% and 2.72% for automotive and integrated circuits industries, respectively.

Keywords: Panel smooth transition regression model, Exchange rate, Abenomics, Financial ratios, Stock returns, Automotive and integrated circuits industries.

JEL Classification: C33, G14.

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Contribution/ Originality

The paper's primary contribution is finding that the exchange rate volatility over the threshold level certainly influenced profitability and stock returns of companies in the automotive and integrated circuits industries in Taiwan around Abenomics.

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1. INTRODUCTION

The dynamic relationships between stock returns and exchange rate volatilities have attracted particular attention from both academics and practitioners because of the impact of currency depreciation on stock prices and how the influences on one stock market may be transmitted quickly through contagious effects to others. According to the flow oriented approach (Dornbusch and Fisher, 1980) the exchange rate is basically determined by a country's current account balance or trade balance. The model is based on the assumptions that the domestic currency depreciation causes greater competitiveness for local firms, which in turn results in exports being cheaper on the international market and this leads to an increase in foreign sales. Higher exports will lead to an increase the income of domestic firms. As a result, stock prices will rise in response to the expected increase in cash flow. The stock market can be affected by the exchange rate volatility. A vast amount of literature has researched the relationship between the stock index and the exchange rate. Yang and Doong (2004) showed that exchange rate changes had a direct impact on the future changes in stock prices. Beer and Hebein (2008) findings indicated that strong evidence of positive significance from the exchange rate markets spilling over to the stock markets in Canada, U.S. and India was detected. Tudor and Popescu-Dutaa (2012) explored the effect of causality found between the exchange rate and the stock market in Brazil and Russia. The causality was shown to move from the exchange rate to the stock in the first sub-period for Brazil by Ho and Huang (2015).

As we all know, Japanese economy has been extremely depressed for 26 years since the asset bubble burst in 1989 (The Nikkei 225 index reached its highest point at 38,913). The Japanese economy required a stimulus to escape from this pattern of long-term sluggish growth. The Liberal Democratic Party (LDP) overwhelmingly won a general election which had taken place in Japan on December 16th, 2012. Abe Shinzo regained the power to govern as Prime Minister on December 26th, 2012. Abe's major message was to advocate an economic policy package plan to overcome deflation and achieve economic growth. His prescription for economic reactivation was referred to as Abenomics which represented a new economic policy regime and the new term – Abenomics – that is used to refer to the three pillars or arrows of the Japanese economy and economic policy. The first arrow is unconventional monetary policy; the second arrow is expansionary fiscal policy and the third arrow is economic growth strategies. The Japanese government tried to revive its economy through implementing bold economic policies that would pull its economy out of a prolonged deflation. The Abenomics policy led to a dramatic weakening of the Japanese yen. As shown in Figure 1, the yen became about 49.40% lower against the U.S. dollar in the end of 2014 compared to the same period in 2012, with an extremely loose monetary policy being followed. The Bank of Japan applied a policy of quantitative easing to instigate a sharp depreciation of the yen. The depreciation of the exchange rate against other currencies would affect a country's international competitive advantage or exports.

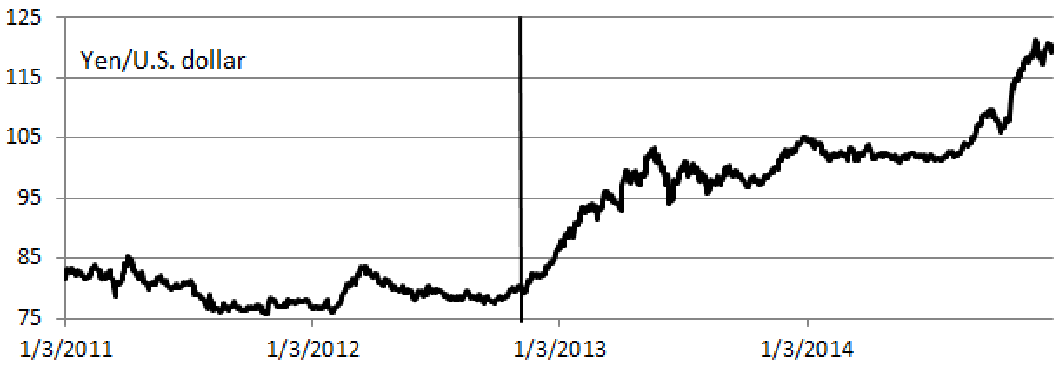

Figure-1. The trend of the yen against the U.S. dollar, 2011-2014.

The top three of Japanese exports (for 2014) are cars (13%), vehicle parts (5.3%), and integrated circuits (2.4%)[1]. These export industries directly receive benefit and competitive advantage from the drastic depreciation of the yen. However, the export of products from countries in direct competition with Japanese exports will become uncompetitive and more expensive, such as China, South Korea, and Taiwan. For instance, Taiwan is an export-oriented country. Integrated circuits are the biggest export industry in Taiwan, consisting of 19% of Taiwan's exports in 2014[2]. Furthermore, exports related to the automotive industry also play an important role in Taiwan. We would like to investigate the promotion of the competitive advantage of automotive and the integrated circuits industries in Japan on the impact of the same ones in Taiwan because of the enormous depreciation of the yen. In this study, we are interested in studying the interrelationship between the volatility of the exchange rate and the stock return in integrated circuits and automotive industries in Taiwan following the dramatic depreciation of the yen around Abenomics. We also intend to investigate the impact of Abenomics on the major exports of both industries in Taiwan. Our main intention is to employ financial ratios as the predictors of stock returns and investigate the relationship between exchange rates, financial ratios and stock returns. There biggest reason for choosing financial ratios as the predictors are because of the extremely large quantity of rich studies that adopt financial ratios as a means to its effects on stock returns. What appeals to us most is that the literature reports mixed evidence on how financial ratios affect stock returns. There is some research that indicates a relationship between financial ratios change and stock returns. (see, for instance, Basu (1977); Bhandari (1988); Banz (1981); Fama and French (1995); Shen (2000); Llorente *et al.* (2002); Lewellen (2004); Elleuch (2009); Alan *et al.* (2011); Sari and Hutagaol (2012); Haddad (2012); Dutta *et al.* (2012); Choi and Sias (2012); Petcharabul and Romprasert (2014) and Narayan and Ahmed (2014). It is crucial for shareholders and potential investors to know the financial characteristics of companies to enable them to make good investment decisions in the stock market. Stock performances of companies can be analyzed based on financial ratios presented in company annual reports. The annual report contains a great amount of information that can be converted into various ratios. Previous studies declare that financial ratios are crucial tools for evaluating future stock performance. Analysts, investors, and researchers employ financial ratios to infer future stock price trends. Financial ratios are used extensively for the valuation of stock prices and analysis is fundamental to predicting the future performance of companies. Various ratios, such as debt ratio, price to earnings ratio, price to book ratio, total assets turnover, current assets turnover, return on stockholder's equity, gross profit ratio, and income before tax ratio, have been included in equity securities valuation. Financial ratios are a possible basis for stock price expectations, which could influence investment decision making. Therefore, selecting appropriate ratios are pivotal to increase the predictive success rate. The purpose of this study is to adopt a Panel Smooth Threshold Regression (PSTR) model, developed by Fok *et al.* (2005) and González *et al.* (2005) to survey and analyze financial data in order to investigate the relationship between exchange rates and stock returns. The PSTR model has the significant advantage of simultaneously solving the nonlinearity and heterogeneity as well as the time instability problems found in the attractive econometric model. This not only allows the regression coefficients to vary according to the company in relation to time but also assesses how individuals move between groups over time depending on changes in the threshold variable. Furthermore, The PSTR model also adopts a parametric approach of the cross-company heterogeneity and of the time instability of the regression coefficients, since there is a smooth change in these parameters as a function of a threshold variable. To the best of my knowledge, non-linearity in the relationship between financial ratios, exchange rates and stock returns has never been investigated in the context of the

[1] For more details regarding the information, the reader is referred to the website of the observatory of economics complexity: Source: https://atlas.media.mit.edu/en/profile/country/jpn/

[2] Source: the website of the observatory of economics complexity: Source: https://atlas.media.mit.edu/en/profile/country/twn/

automotive and integrated circuits industries. The purpose of this paper is to provide a precise estimation of the threshold level of exchange rates below which exchange rates may not have any impact, or a positive impact, on stock returns or above which exchange rates may be detrimental to stock returns, using panel data around Abenomics for the period 2011-2014.

The rest of the paper is organized as follows. Section 2 introduces an empirical model for analyzing the impact of financial ratios on stock returns under different levels of exchange rate. In Section 3, we describe the data and variables. In Section 4, the estimated results of the empirical model are analyzed and some specification tests are applied to examine the correctness of the empirical model, followed by conclusions in Section 5.

2. METHODOLOGY

Panel data analysis has been extensively applied to numerous empirical studies, and a feature of panel data is the combination of the time series and the cross-sectional data. To investigate whether there is a non-linear relationship between stock returns and financial ratios, this study applies a Panel Smooth Transition Regression (PSTR) model proposed by González *et al.* (2005). Since the PSTR model is an extension of the Panel Threshold Regression (PTR) models developed by Hansen (1999). The two models mainly have the same characteristics to allow coefficients to change smoothly from one regime to another, depending on the transition function. The PSTR model is better than the PTR model because the former could permit heterogeneity in the regression coefficients by supposing that coefficients are continuous functions of an observable variable through a bounded function of such variable, referred to as a transition function, and fluctuates between extreme regimes (González *et al.*, 2005). The empirical result of the PSTR model can identify the number of extreme regimes and is suitable for examining the primary issues in this study. The simplest PSTR model with two extreme regimes and a single transition function can be written as follows:

$$y_{it} = \mu_i + \beta_0' x_{it} + \beta_1' x_{it} g(q_{it};\, \gamma, c) + \varepsilon_{it} \qquad (1)$$

Where i=1, ...,N, t=1, ...,T, and N and T stand for the cross-section and time periods of the panel, separately. y_{it} is a dependent variable; μ_i represents the fixed individual effect; x_{it} is a k dimensional vector of time-varying exogenous variables; ε_{it} is the error term. The transition function $g(q_{it};\, \gamma, c)$ is a continuous function of the observable variable q_{it} as the transition variable which is normalized to be bounded between 0 and 1. c is the threshold value. The slope parameter γ denotes the smoothness of the transition rather than discrete movement from one regime to the other. As γ tends to infinity, the transition function between the extreme regimes is sharp and the PSTR becomes a panel threshold model (Hansen, 1999). If, on the contrary, γ tends to zero, the transition function becomes a homogenous or linear panel regression model with fixed effects.

The transition function is normalized to be bounded between 0 and 1; these extreme values are associated with regression coefficients β_0' and $\beta_0' + \beta_1'$. The value of q_{it} determines the value of $g(q_{it};\, \gamma, c)$ and thus the effective regression coefficients $\beta_0' + \beta_1'\, g(q_{it};\, \gamma, c)$ for individual i at time t. Following Granger and Teräsvirta (1993); Teräsvirta (1994); Jansen and Teräsvirta (1996); González *et al.* (2005) and Colletaz and Hurlin (2006) this study considers the transition function as follows:

$$g(q_{it};\, \gamma, c) = \left(1 + exp\left(-\gamma \prod_{j=1}^{m} (q_{it} - c_j)\right)\right)^{-1} \text{ with } \gamma > 0 \text{ and } c_1 \le c_2 \le \ \ldots \le c_m \quad (2)$$

Where $c = (c_1, c_2, \ldots, c_m)'$ denotes an m-dimensional vector of location parameters and the slope parameter γ determines the smoothness of the transitions. i.e. the speed of the transition from one regime to another. Furthermore, the restrictions $\gamma > 0$ and $c_1 \le c_2 \le\ \ldots \le c_m$ are identification restrictions.

The empirical results found analysed in literature on the threshold panel data analysis, González *et al.* (2005) suggested that it was usually sufficient to consider m = 1 or m = 2 and capture the nonlinearities due to regime switching. The optimal transition function is chosen through the nested tests proposed by Teräsvirta (1994). In the case of m=1 corresponded to a logistic PSTR model, the nonlinearity implies two extreme regimes are associated with small and large values of the transition variable q_{it} and that between the two limited extreme regimes, the combined regression coefficients fluctuate from β_0' to $\beta_0' + \beta_1'$ as q_{it} increases, such that the change is centered around c_1. In the case of m=2 referred to a logistic quadratic PSTR specification (Béreau *et al.*, 2010) the transition function has its minimum and symmetric about the point $(c_1 + c_2)/2$ and captures the value 1 at either of the low or high values of the transition variable q_{it}. If the slope parameter γ tends toward infinity, the PSTR model will be divided into a three regime panel threshold regression (PTR) model whose outer regimes will be identical to each other but different from the central regime. According to González *et al.* (2005) and Colletaz and Hurlin (2006) we utilize a three-step procedure for estimating our empirical model. Firstly, we need to test the linearity hypothesis against the PSTR model, and then if the linearity is rejected, we determine to choose the optimal number of transition functions (order of m) as well as the appropriate transition variable. The corresponding statistics of these tests were then specified as follows[3]:

The Wald LM test can be written as:

$$LM_w = \frac{NT(SSR_0 - SSR_1)}{SSR_0} \tag{3}$$

The Fischer LM test can be written as:

$$\mathrm{LM}_F = \frac{(SSR_0 - SSR_1)/mk}{SSR_0/(TN - N - mk)} \tag{4}$$

The likelihood ratio test can be written as:

$$\mathrm{LRT} = -2\left[log\left(SSR_1 - log(SSR_0)\right)\right] \tag{5}$$

Secondly, the estimation step relies on applying nonlinear least squares to obtain the parameter estimates, once the data has been demeaned. Thirdly, this stage is devoted to the application of misspecification tests in order to assure the effectiveness of the PSTR model: parameter constancy and no remaining heterogeneity. The latter test is useful for determining the number of transitions in the model.

3. DATA AND DESCRIPTIONS OF VARIABLES

In this section, our raw data of publicly listed firms is taken from the Taiwan Stock Exchange (TWSE). The period of sampling was from the first quarter of 2011 to the fourth quarter of 2014, amounting to 16 quarters, which includes the period two years before and two years after the implementation of Abenomics. We collected 34 firms which are sorted by industry, namely, 19 automotive industry firms and 15 integrated circuit industry firms. All the variables in the study sample were extracted from the balance sheets, cash flow statement, and income statements of these companies. This implies that the usefulness of this research is not restricted because the data was only taken from Taiwanese companies. The selection of variables to be used as candidates for participation in the study was based upon prior research associated with representative financial indicators that can evaluate stock returns and operating performance. The related research carried out by Wang and Lee (2008); Chung *et al.* (2012); Senyigit and

[3] For more details, see González, Teräsvirta and Van Dijk (2004; 2005). and Colletaz and Hurlin (2006).

Ag (2014); Narayan and Ahmed (2014); Apergis and Payne (2014) comprised of the suggested indicators of stock returns and operating performance. Therefore, this paper adopted the related variables based on prior research and the Taiwanese Economic Journal (TEJ) which is the Taiwanese economic database. Moreover, this paper selected 10 variables. The details of these indicators, Formulas and descriptive statistics of variables in our PSTR model are shown in Table 1 and 2.

Table-1. Formulas of variables.

Variables	Formulas
Stock return ratio (SR_{it})	$(\text{Stock price}_t - \text{Stock price}_{t-1})$ /Stock price_{t-1}
Exchange rate volatility (ERV_{it})	$(\text{Exchange rate}_t - \text{Exchange rate}_{t-1})/\text{Exchange rate}_{t-1}$
Debt ratio (DR_{it})	Total liabilities / total assets
Price to earnings ratio (PER_{it})	Stock price / Earnings per share
Price to book ratio (PBR_{it})	Stock price / book value
Total assets turnover (TAT_{it})	Operation revenue / total assets
Current assets turnover (CAT_{it})	Operation revenue / current assets
Return on stockholder's equity (RSE_{it})	Net income(loss) / stockholder's equity
Gross profit ratio (GPR_{it})	(Operation revenue – operation cost) /operation revenue
Income before tax ratio $(IBTR_{it})$	Income(loss) before tax/operation revenue

Table-2. Descriptive statistics of variables.

Variables	Mean	Std. Dev.	Max.	Min.	Obs.
Stock return ratio (SR_{it})	4.39	18.5	113	-34.0	544
Exchange rate volatility (ERV_{it})	0.0047	0.0248	0.0567	-0.0277	544
Debt ratio (DR_{it})	34.5	16.0	75.1	4.3	544
Price to earnings ratio (PER_{it})	14.9	7.66	95.2	5.75	544
Price to book ratio (PBR_{it})	2.05	1.5	17.1	0.59	544
Total assets turnover (TAT_{it})	0.19	0.07	0.43	0.07	544
Current assets turnover (CAT_{it})	0.39	0.13	1.72	0.09	544
Return on stockholder's equity (RSE_{it})	0.04	0.02	0.12	-0.01	544
Gross profit ratio (GPR_{it})	24.7	10.9	57.0	1.89	544
Income before tax ratio $(IBTR_{it})$	16.0	10.4	68.0	-2.77	544

Notes: Std. Dev., Max., Min., and Obs. denote the standard deviation, maximum, Minimum, observations, respectively.

4. EMPRICIAL RESULTS

4.1. Panel Unit Root Tests

All the asymptotic theory for STR and PSTR models extended by González *et al.* (2005) are for stationary regressors. Therefore, in order to avoid the possibility of spurious regressions and provide an analysis of sensitivity and robustness, the properties of the variables need to be tested. Panel unit root tests were conducted using the Levin *et al.* (2002) test, Im *et al.* (2003) test, and the Fisher-type ADF test. The results of each of the panel unit root tests outlined below are reported in Table 3. The results show that the null hypothesis of a unit root for each level variable can be rejected at 1% significant level. It concludes that all variables in level exhibit a stationary behavior and are integrated of order 0, i.e., I (0) process.

Table-3. Results of panel unit-root tests.

	LLC		IPS		ADF-Fisher	
	Intercept	Intercept And Trend	Intercept	Intercept And Trend	Intercept	Intercept And Trend
Stock return ratio(SR_{it})	-7.150***	-4.663***	-8.599***	-5.416***	198.8***	144.7***
Exchange rate volatility(ERV_{it})	-14.17***	-11.72***	-15.44***	-10.82***	340.0***	235.9***
Debt ratio(DR_{it})	-4.628***	-9.510***	-3.960***	-5.939***	137.7***	163.2***
Price to earnings ratio(PER_{it})	-10.19***	-13.09***	-7.539***	-7.405***	183.2***	174.8***
Price to book ratio(PBR_{it})	-6.380***	-13.10***	-4.273***	-7.616***	128.5***	181.6***
Total assets turnover(TAT_{it})	-8.574***	-10.03***	-6.583***	-5.751***	167.4***	152.8***
Current assets turnover(CAT_{it})	-10.21***	-9.785***	-8.430***	-6.003***	197.7***	155.9***
Return on stockholder's equity(RSE_{it})	-4.718***	-8.081***	-5.438***	-5.225***	148.5***	143.2***
Gross profit ratio(GPR_{it})	-3.790***	-9.533***	-3.733***	-6.001***	130.7***	155.7***
Income before tax ratio($IBTR_{it}$)	-3.505***	-8.676***	-3.768***	-5.440***	119.3***	148.1***

Notes:
1. ***, ** and * indicate significance at the 1%, 5% and 10% levels, respectively.
2. The three panel unit root tests are based on the ADF auto-regression given by Eq. $\Delta y_{i,t} = \alpha_i + \beta y_{i,t-1} + \sum_{j=1}^{q_i} \rho_{ij} \Delta y_{i,t-j} + e_{i,t}$.
3. LLC is the homogeneous panel unit root tests of Levin *et al*. (2002). This test imposes the restriction of a common unit root process for all companies under the null. The null hypothesis is of non-stationarity against the alternative hypothesis of stationarity.
4. The IPS is the heterogeneous panel unit root test of Im *et al*. (2003) while the Fisher panel unit root tests are based on Fisher (1932).
5. These panel unit root tests do not impose the common unit root equality restriction. The null hypothesis is of non-stationarity against the alternative of stationarity for some, but not necessarily all.

4.2. Linearity and No Remaining Non-Linearity Results

Prior to the execution of the PSTR approach, we start by testing the linearity against the PSTR model. We test whether the response of stock returns is different, depending on the size and the sign of the exchange rate fluctuation, identified here as the threshold variable. If the null hypothesis of linearity is rejected, we must then determine the appropriate number of transition functions. The results of these linearity tests and specification tests of no remaining nonlinearity are presented in Table 4 for the automotive industry and in Table 5 for the integrated circuits industry. We find that the null hypothesis of linearity is rejected at the 1% significance level for all three tests, implying that the relationship between exchange rate and stock returns in both automotive and integrated circuits industries is indeed nonlinear.

Table 4 and 5 report the test of no remaining non-linearity after assuming a two-regime model. The results indicate that the null hypothesis cannot be rejected and illustrate that all of the nonlinearity and/ or heterogeneity can be captured by one transition function. Thus, this means that in the automotive and integrated circuits industries, there is only one threshold level of exchange rate which separates the low exchange rate regime and high exchange rate regime. However, in Table 4 and 5, when the number of location parameters (m) is equal to 2, the model of the automotive and integrated circuits industry might be a three-regime model.

Table-4. Tests for linearity and remaining nonlinearity in the PSTR model _ for the automotive industry.

Number of Location Parameters	m=1			m=2		
	LM_w	LM_F	LRT	LM_w	LM_F	LRT
$H_0: \gamma = 0 \;\; VS. \;\; H_1: \gamma = 1$[3]	51.765*** (0.000)	7.106*** (0.000)	56.746*** (0.000)	62.145*** (0.000)	4.320*** (0.000)	69.521*** (0.000)
$H_0: \gamma = 1 \;\; VS. \;\; H_1: \gamma = 2$[4]	17.680 (0.024)	2.015 (0.045)	18.215 (0.024)	59.689*** (0.000)	3.863*** (0.000)	66.450*** (0.000)
$H_0: \gamma = 2 \;\; VS. \;\; H_1: \gamma = 3$[5]				22.149 (0.138)	1.203 (0.266)	22.997 (0.138)

Notes:
1. r is the number of transition functions, m is the location parameter, and the corresponding P-values are in parentheses.
2. LM_w,LM_F, and LRT denote the statistics of the Wald test, Fisher test, and likelihood ratio test, respectively.
3. H_0: linear model against H_1: PSTR model with at least one threshold variable.
4. H_0:: PSTR with r=1 against H_1: PSTR with at least r=2.
5. H_0:: PSTR with r=2 against H_1: PSTR with at least r=3.
6. ***, ** and * indicate significance at the 1%, 5% and 10% levels, respectively.

Table-5. Tests for linearity and remaining nonlinearity in the PSTR model _ for the integrated circuit industry.

Number of Location Parameters	m=1			m=2		
	LM_w	LM_F	LR	LM_w	LM_F	LR
$H_0: \gamma = 0$ VS. $H_1: \gamma = 1$[3]	26.315*** (0.001)	3.340*** (0.001)	27.873*** (0.000)	35.963*** (0.003)	2.302*** (0.004)	38.961*** (0.000)
$H_0: \gamma = 1$ VS. $H_1: \gamma = 2$[4]	16.204 (0.040)	1.819 (0.075)	16.777 (0.040)	40.421*** (0.001)	2.443** (0.002)	44.263*** (0.001)
$H_0: \gamma = 2$ VS. $H_1: \gamma = 3$[5]				8.080 (0.946)	0.403 (0.981)	8.219 (0.946)

Notes:
1. - 6. notes are the same as Table 3.

In the next step, we adopt the approach presented by Colletaz and Hurlin (2006) to choose the optimal number of location parameters. To this end, we evaluate the PSTR model for one transition function connected with one and two location parameters, and the corresponding value of the residual sum of squares. We, subsequently, follow Colletaz and Hurlin (2006) and Jude (2010) to calculate the statistics of Akaike (AIC) and Schwarz (SBC) criteria. According to the results of these three criteria, which are reported in Table 6, the model with one transition function and one location parameters is suitable and selected for both industries. In addition, we can conclude that two models with only a transition function respectively are sufficient to capture the non-linear behavior of the data, since these three criteria minimal.

Table-6. Determination of the Number of Location Parameters

Industry	Automobile		Integrated Circuits	
Number of Location Parameters	m=1	m=2	m=1	m=2
Optimal Number of Thresholds $\gamma^*(m)$	1	2	1	2
Residual Sum of Squares	75,651	76,137	25,924	26,189
AIC Criterion	5.7129	5.8282	5.0583	5.0807
Schwarz Criterion	5.9330	6.1950	5.3193	5.5158

In order to investigate the relationship between exchange rate volatility (ERV_{it}) and stock return ratio (SR_{it}) as the dependent variable, we adopt a set of the most important independent variables such as debt ratio (DR_{it}), price to earnings ratio (PER_{it}), price to earnings ratio (PER_{it}), price to book ratio (PBR_{it}), total assets turnover (TAT_{it}), current assets turnover (CAT_{it}), return on stockholder's equity (RSE_{it}), gross profit ratio (GPR_{it}), and income before ratio (IBR_{it}) followed by Wang and Lee (2008) and Senyigit and Ag (2014). Exchange rate volatility (ERV_{it}) is used as the threshold variable in this model to examine the different impacts of each explanatory variable on stock return ratio (SR_{it}) in different regimes of the exchange rate volatility (ERV_{it}). Therefore, the empirical model adopted in this study can be presented as follows:

$$\begin{aligned}\mathrm{SR_{it}} = \mu_i &+ \alpha_1\mathrm{DR_{it}} + \alpha_2\mathrm{PER_{it}} + \alpha_3\mathrm{PBR_{it}} + \alpha_4\mathrm{TAT_{it}} + \alpha_5\mathrm{CAT_{it}} + \alpha_6\mathrm{RSE_{it}} + \alpha_7\mathrm{GPR_{it}} + \alpha_8\mathrm{IBR_{it}} \\ &+ (\beta_1\mathrm{DR_{it}} + \beta_2\mathrm{PER_{it}} + \beta_3\mathrm{PBR_{it}} + \beta_4\mathrm{TAT_{it}} + \beta_5\mathrm{CAT_{it}} + \beta_6\mathrm{RSE_{it}} + \beta_7\mathrm{GPR_{it}} \\ &+ \beta_8\mathrm{IBR_{it}})g(\mathrm{ERV_{it}};\ \gamma, c) + \varepsilon_{it} \qquad (6)\end{aligned}$$

Where i denotes listed companies of automotive and integrated circuits industries in Taiwan, i=1,2,…34. t represents the quarterly time serious data from 2011 to 2014, t=1,2,…16.

4.3. Estimation Results of Pstr

The estimation results of Eq. (6), we present the parameter estimates of the final PSTR models by applying nonlinear least squares to data with individual effects eliminated and employing a specification with one transition function and one location parameter for both industries from Table 7 to Table 9. Firstly, with respect to this specification of the automotive industry in Table 6, the slope parameter in the transition function is equal to 257,510, and the transition function is continuous and smoothly switched between regimes. The threshold parameters in the transition function are estimated to be approximately -2.30%.

As shown for the automotive industry in Table 8, we can find that the coefficients of the debt ratio (DR_{it}), price to book ratio (PBR_{it}), total assets turnover (TAT_{it}), current assets turnover (CAT_{it}), return on stockholder's equity (RSE_{it}) and income before ratio $(IBTR_{it})$ are statistically insignificant for the low and high exchange rate volatility regime. This means that the effects of these financial ratios on stock return ratios are not statistically significant when the exchange rate volatility is below and above the threshold level of -2.30%. The coefficient associated with the price to earnings ratio (PER_{it}) is positive in both regimes. Therefore, statistical significance is in the low exchange rate volatility regimes but statistical insignificance is in the high exchange rate volatility regime. The significant effect of price to earnings ratio on stock returns is positive 1.2723 when exchange rate appreciation is less than 2.3%. The coefficient associated with the gross profit ratio (GPR_{it}) is positive and statistically significant in the low and high exchange rate volatility regimes. This means that when currency appreciation is below or above 2.3%, gross profit ratio on stock returns has the positive effects of 1.3754 and 0.5986, respectively. This study provides an explanation for this result: when the exchange rate appreciation is more than 2.3%, it results in the automotive industry suffering exchange losses and will further impact stock returns because of the decrease in the coefficient of the gross profit ratio on stock returns. It is apparent form Table 7 that for the integrated circuits industry that the slope parameter and the threshold value are 6,939 and -2.72%, respectively. According to Table 9, the financial ratios of debt ratio (DR_{it}), Total assets turnover (TAT_{it}), current assets turnover (CAT_{it}), return on stockholder's equity (RSE_{it}) and gross profit ratio (GPR_{it}) are statistically insignificant in the low and high exchange rate volatility regimes. Price to earnings ratio (PER_{it}) is found to have a positive and significant impact on the stock return ratio in low and high exchange rate volatility regimes. Price to book ratio (PBR_{it}) has a positive sign and statistically significant in the low exchange rate volatility regime. We observe that the coefficient of income before tax ratio $(IBTR_{it})$ is significant in both exchange rate volatility regimes and has a positive sign in the low exchange rate volatility regime and a negative sign in the high exchange rate volatility regime. We can clearly find that when the exchange rate appreciation is less than 2.72% in the integrated circuits industry, price to earnings ratio, price to book ratio and income before tax ratio have significant relationship with stock returns. Furthermore, as the exchange rate appreciates more than 2.72%, there will be exchange losses in the integrated circuits industry. The price to earnings ratio and income before tax ratio on the stock returns have a significant influence of positive 0.3 and negative 0.1, respectively. In this empirical study, we discover that different industries employed during the same period, using the same methodologies and variables in testing the relationship between stock returns produce different results. These results are similar to those of Senyigit and Ag (2014). They utilize the same variables, methodologies and periods to investigate the relationship between three financial ratios and stock returns in United States and Turkey. They find that the explanatory power of independent variables is relatively high and statistically significant in explaining the cross-section of stock returns in the United States; however, not in Turkey. Stickel (1995); Lang and Lundholm (1996) and Barber *et al.* (1998) and Petcharabul and Romprasert (2014) further conclude that different countries and different methodologies used in testing the relationship between financial ratios and stock returns produce different conclusions. We can conclude that when different groups explore the relationship between financial ratios and stock returns they will obtain different results.

Table-7. Parameter estimates for the final PSTR model.

Industries	**Automobile**		**Integrated Circuits**	
(m, γ^*)	(1,1)		(1,1)	
Variables	Coefficient estimate	t-statistic	Coefficient estimate	t-statistic
α_1	0.0253	0.0751	-0.3	-0.6562
α_2	1.2723	1.3853*	0.7	3.8045***
α_3	1.7588	0.2768	40	1.9730**
α_4	129.4066	1.1754	-27.9	-0.1762
α_5	-29.6844	-0.8806	-49.1	-0.4731
α_6	193.9750	0.4313	-1967	1.2307
α_7	1.3754	2.8696***	-2.0	-1.2776
α_8	0.1687	0.2452	4.8	2.0540**
β_1	-0.1182	-0.3888	-0.3	-0.6505
β_2	-0.7645	-0.8292	-0.4	-1.8209**
β_3	0.7151	0.1131	-18.6	-0.9235
β_4	78.9873	0.8595	-104.5	-0.7040
β_5	-3.4518	-0.1130	32.7	0.3178
β_6	-484.8750	-1.0989	2223	1.3827*
β_7	-0.7768	-2.3664***	2.1	1.3969*
β_8	0.5300	0.8589	-4.9	-2.1202**
c	-0.0230		-0.0272	
γ	257,510		6,939	
RSS	75,651		25,924	
AIC	5.7129		5.0583	
SBC	5.9330		5.3193	

Note: ***, ** and * indicate significance at the 1%, 5% and 10% levels, respectively.

Table-8. Estimation of coefficients of control variables in PSTR model for the automotive industry

Variables	**Low regime ($c \leq -2.30\%$)**	**The impact on the stock returns**	**High regime ($c > -2.30\%$)**	**The impact on the stock returns**
Debt ratio(DR_{it})	0.0253	insignificant	-0.0929	insignificant
Price to earnings ratio(PER_{it})	1.2723	positive	0.5078	insignificant
Price to book ratio(PBR_{it})	1.7588	insignificant	2.4739	insignificant
Total assets turnover(TAT_{it})	129.4066	insignificant	208.3939	insignificant
Current assets turnover(CAT_{it})	-29.6844	insignificant	-33.1362	insignificant
Return on stockholder's equity(RSE_{it})	193.9750	insignificant	-290.9	insignificant
Gross profit ratio(GPR_{it})	1.3754	positive	0.5986	positive
Income before tax ratio($IBTR_{it}$)	0.1687	insignificant	0.6987	insignificant

Table-9. Estimation of coefficients of control variables in PSTR model for the integrated circuits industry.

Variables	**Low regime ($c \leq -2.72\%$)**	**The impact on the stock return**	**High regime ($c > -2.72\%$)**	**The impact on the stock return**
Debt ratio(DR_{it})	-0.3	insignificant	-0.6	insignificant
Price to earnings ratio(PER_{it})	0.7	positive	0.3	positive
Price to book ratio(PBR_{it})	40	positive	21.4	insignificant
Total assets turnover(TAT_{it})	-27.9	insignificant	-132.4	insignificant
Current assets turnover(CAT_{it})	-49.1	insignificant	-16.4	insignificant
Return on stockholder's equity(RSE_{it})	-1967	insignificant	256	insignificant
Gross profit ratio(GPR_{it})	-2.0	insignificant	0.1	insignificant
Income before tax ratio($IBTR_{it}$)	4.8	positive	-0.1	negative

5. CONCLUSIONS

In this paper, we provide empirical insights with respect to the asymmetric impact of financial ratios on stock returns for a panel of listed companies within the automotive and integrated circuits industries in Taiwan. We utilize the panel smooth transition regression (PSTR) model, developed by González *et al.* (2004; 2005) to investigate the relationship between eight financial ratios such as debt ratio, price to earnings ratio, price to book ratio, total assets turnover, followed by Senyigit and Ag (2014) current assets turnover, return on stockholder's equity, gross profit ratio and income before tax ratio, adopted by Wang and Lee (2008) as the independent variables and stock returns as the dependent variable from the first quarter 2011 to the fourth quarter 2014. The exchange rate volatility is employed as the threshold variable. The results confirm the presence of asymmetric effects between stock returns and the gross profit ratio for the automotive industry, and between stock returns and the price to earnings ratio and income before tax ratio for the integrated circuits industry, based on the volatility of exchange rate. We also find out that the indicators related to the profitability of collected financial ratios in this study can effectively assess and predict stock returns. There are insignificant relationships between other variables and stock returns. This study provides a valid interpretation of these results: We employ the exchange rate volatility as the threshold variable to explore the relationship between the financial ratios and stock returns. The profits of export companies are influenced by exchange benefits or losses. The results we investigated in this study are consistent with the expectations, that is, the indicator of profitability such as price to earnings ratio, gross profit ratio and income before ratio have a significant relationship with stock returns. The main finding of this paper shows that there exists an efficient hedge regime. When the Abenomics applied a policy of quantitative easing to instigate a sharp depreciation of the yen, the effects of the policies absolutely bring out benefit and competitive advantage of Japanese export industries. The depreciation of the exchange rate against other currencies would affect a country's international competitive advantage or exports. If Taiwan exchange rate does not follow the depreciation of the yen and the levels of the exchange rate volatility in the automotive and integrated circuits industries are over 2.3% and 2.72% appreciation, respectively, the both industries will generate exchange losses and further influence the profit of the companies. It is important for the CEOs of these companies of both industries to exercise their real hedge options and evade the risk of exchange rate for their firms.

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