The Pricing of Exchange Rates in Japan: The Cases of the Japanese Automobile Industry Firms after the US Lehman Shock

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Abstract

This paper investigates the time-series dynamics of the sensitivities of stock returns as to three Japanese representative automobile industry firms to the changes of the yen/US dollars exchange rates. Further, we also empirically examine whether the yen/US dollars exchange rates are priced in the Japanese automobile industry firms. We are particularly interested in the period after the US Lehman Shock in this study. Our formal statistical tests firstly demonstrate that recently, the sensitivities of the Japanese automobile industry stocks to the yen/US dollars exchange rates clearly increased. Moreover, the results of our traditional regressions clearly indicate that as to the representative automobile industry firms in Japan, the yen/US dollars exchange rate changes are generally priced in the Japanese equity markets, and their degrees of pricing are highest in the period after the US Lehman Shock.

Keywords: asset pricing, exchange rate sensitivities of stock returns, Japanese automobile industry, Lehman Shock, Welch's tests

1. Introduction

The time-varying exchange rates are the crucial risks for investors in financial markets and the relationships between the dynamics of exchange rates and stock returns were often argued. On this topic, several interesting researches were conducted, for example, by Bartram (2007), Bodnar and Gentry (1993), Du and Hu (2012), Dumas and Solnik (1995), Glen and Jorion (1993), He and Ng (1998), Korajczyk and Claude (1992), Patro et al. (2002), Williamson (2001), and Verdelhan(2010).

In this paper, differently from the viewpoints of the above preceding studies, we particularly focus on the period after the US Lehman Shock. In addition, we also originally focus on the Japanese automobile industry, which is one of the Japanese export-oriented industries. This is because after the US Lehman Shock, the Japanese yen highly appreciated against the US dollars, and thus this environment in money and financial markets would negatively affect the profitability of the Japanese export-oriented industry firms, such as Toyota, Honda, and Nissan. Furthermore, we do not know the existing research which focuses on the Japanese automobile industry's exchange rate risks after the US Lehman Shock period. Therefore, the first objective in this paper is to empirically examine whether exchange rate changes are priced in the Japanese automobile industry firms in the periods around the US Lehman Shock. Furthermore, our second objective in this paper is to investigate whether the exchange rate sensitivities of stock returns of the Japanese automobile industry firms increased in the period after the US Lehman Shock. Again, these viewpoints are different from those in the preceding studies and these are interesting and valuable new characteristics of this research.

The significant contributions of this paper are as follows. First, we find that in the period after the US Lehman Shock, with regard to the Japanese representative automobile industry firms, the yen/US dollars exchange rate changes are most strongly priced in the Japanese stock markets. Second, our formal statistical tests reveal that in the period after the US Lehman Shock, the exchange rate sensitivities of stock returns of the Japanese representative automobile industry firms statistically significantly increased.

The rest of this paper is organized as follows. First, Section 2 describes our data set, and Section 3 explains our research design, Section 4 demonstrates our empirical evidence, and Section 5 concludes the paper.

2. Data

The raw data used in our analyses are obtained from QUICK Corp., and the full sample period in this study is from January 1990 to June 2012. For our empirical studies, we compute some variables. The notations of the variables we constructed for this study are as follows. First, DEF denotes the default spreads (credit-spreads) in the Japanese financial markets, TERM is the term spreads in Japan, IP denotes the log base percentage changes of the seasonally adjusted industry productions in Japan, CPI is the percentage growth rates of the Japanese consumer price index, MVOL denotes the historical stock market returns' volatilities in Japan, and ΔEX is the changes of the yen/US dollars exchange rates.

Furthermore, we computed the sensitivities of three Japanese representative automobile industry's companies' stock returns to the changes of the yen/US dollars exchange rates. These time-series dynamics are displayed in Panels A to C in Figure 1. Explaining three companies' names, 'Toyota' denotes Toyota Motor Corporation, 'Nissan' denotes Nissan Motor Co., Ltd., and 'Honda' denotes Honda Motor Co., Ltd. According to Figure 1, we understand that recently, exchange rate sensitivities of stock returns of these three companies clearly increased.

3. Research Design

In order to design our empirical examinations in this paper, we divide our full sample period into five sub-periods. Namely, we set the first sub-period as the term from January 1990 to August 1994; the second sub-period as the term from September 1994 to April 1999; the third sub-period as the term from May 1999 to December 2003; the fourth sub-period as the term from January 2004 to September 2008; the latest sub-period as the term from October 2008 to June 2012. After setting the sub-periods as above, for three Japanese automobile companies and for all five sub-periods, we perform two kinds of regressions by referring to the arbitrage pricing model (Ross (1976)). More specifically, our model 1 and model 2 are as follows.

$$RET_{i,t} = \kappa_i + \psi_{i,1}\Delta EX_t + \tau_{i,t}. \tag{1}$$

$$RET_{i,t} = \kappa_i + \psi_{i,1}DEF_t + \psi_{i,2}TERM_t + \psi_{i,3}IP_t + \psi_{i,4}CPI_t + \psi_{i,5}MVOL_t + \psi_{i,6}\Delta EX_t + \tau_{i,t}. \tag{2}$$

Where $RET_{i,t}$ denotes each company's stock return. As exhibited in Tables 1 to 5, we perform regressions by using the above models 1 and 2. We note that our focus in our regressions is on the statistical significance and signs of the coefficients of the variable, ΔEX. Further, in these tests by regressions, we are particularly interested in the recent sub-sample period after the US Lehman Shock.

Furthermore, our next statistical tests are those by using the Welch's *t*-tests. In the tests, by using the historical sensitivities of stock returns of the Japanese automobile industry firms to the yen/US dollars exchange rates, we investigate whether the exchange rate sensitivities of these firms increased after the period of the US Lehman Shock.

4. Empirical Results
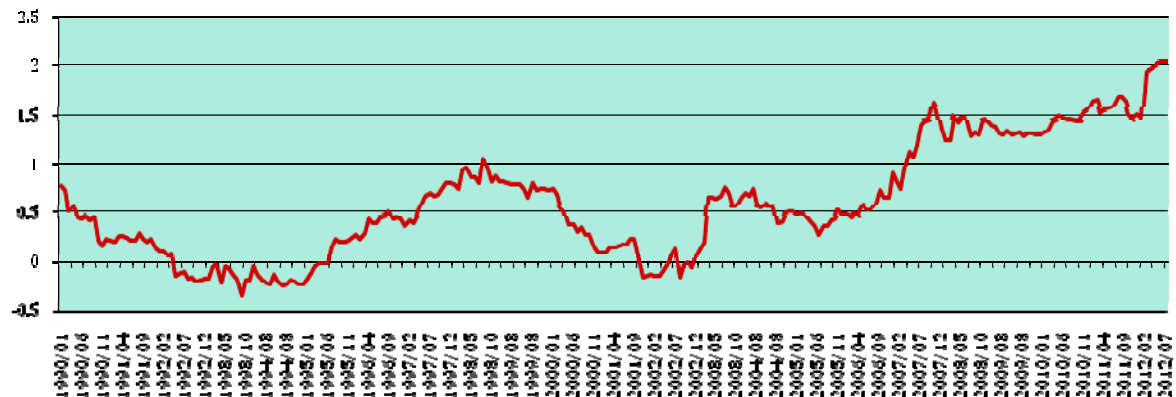
This section describes our empirical results. More concretely, we show our results of regressions in Tables 1 to 5. Because 'Toyota', 'Nissan', and 'Honda' are all Japanese export-oriented industry firms, exchange rate changes are generally priced in our models 1 and 2. However, the statistical significance of the coefficients of ΔEX is extremely strong in Table 5, which shows the results of the period after the US Lehman Shock. Therefore, from our regression tests, we understand that, for the Japanese representative automobile industry firms, the exchange rate changes are most priced in the period after the Lehman Shock in the US.

Next, Table 6 shows the results of Welch's *t*-tests. First, Panel B of Table 6 shows that the mean value of the sensitivities of stock returns to exchange rates for January 1990 to August 1994 is statistically significantly smaller than the mean value of the sensitivities of stock returns to exchange rates for October 2008 to June 2012. Second, Panel C of Table 6 indicates that the mean value of the sensitivities of stock returns to exchange rates for September 1994 to April 1999 is statistically significantly smaller than the mean value of the sensitivities of stock returns to exchange rates for October 2008 to June 2012. Third, Panel D of Table 6 shows that the mean value of the sensitivities of stock returns to exchange rates for May 1999 to December 2003 is statistically significantly smaller than the mean value of the sensitivities of stock returns to exchange rates for October 2008 to June 2012. Finally, Panel E of Table 6 indicates that the mean value of the sensitivities of stock returns to exchange rates for January 2004 to September 2008 is statistically significantly smaller than the mean value of the sensitivities of stock returns to exchange rates for October 2008 to June 2012.
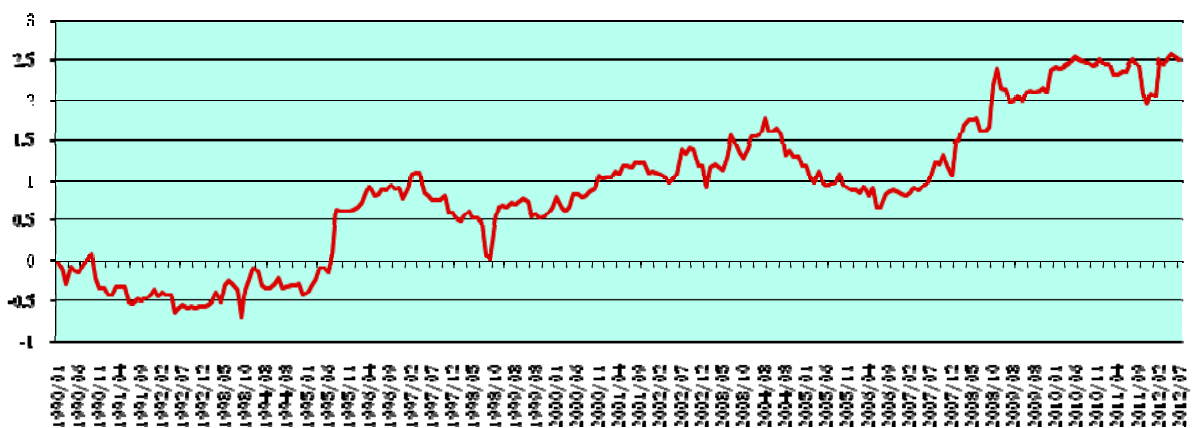
In short, as to 'Toyota', 'Nissan', and 'Honda', the average values of the 36 month historical sensitivities of their

equity returns to the yen-US dollars exchange rates are always higher in the period after the Lehman Shock in the US than those in other four periods. Therefore, our second empirical tests by using the Welch's *t*-tests statistically significantly mean that after the US Lehman Shock, Japanese yen highly appreciated and the equity returns of three Japanese representative automobile firms decreased.

Panel A. Toyota

Panel B. Nissan

Panel C. Honda
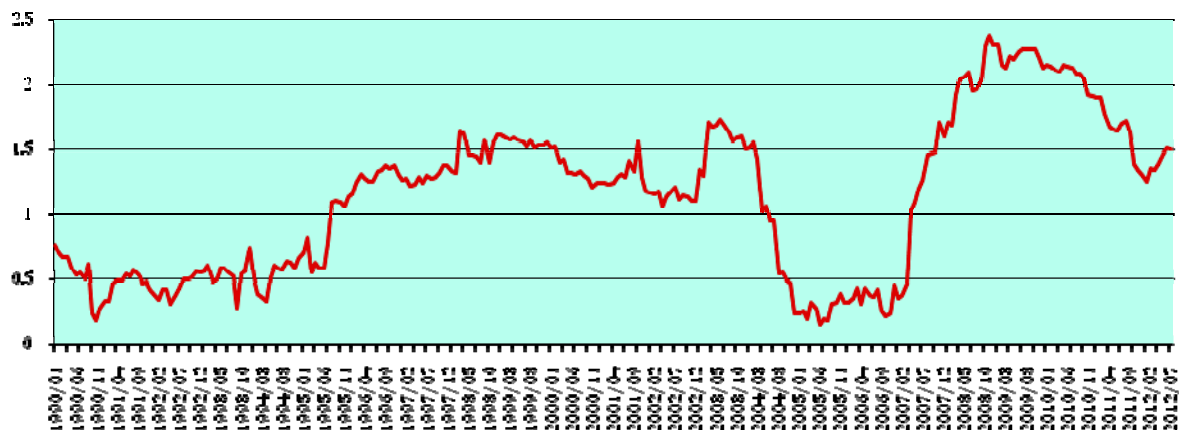
Figure 1. The sensitivities of stock returns to exchange rates: The cases of the Japanese automobile industry firms

Table 1. The results of regressions of exchange rate changes and stock returns: The cases of Toyota, Nissan, and Honda for the period of January 1990 to August 1994

| | The Cases of the Japanese Representative Automobile Industry Firms | | | | | |
| | Toyota | | Nissan | | Honda | |
	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
Constant	0.342	0.194	−1.005	7.767	0.514	6.069
t-value	0.556	0.020	−1.032	0.767	0.743	0.533
p-value	0.581	0.984	0.307	0.447	0.461	0.597
DEF		1.632		6.372**		4.598
t-value		0.708		2.011		1.609
p-value		0.482		0.050		0.114
TERM		−1.495		−9.539**		−6.055
t-value		−0.523		−2.447		−1.616
p-value		0.603		0.018		0.113
IP		−0.466		−0.071		−0.709
t-value		−1.025		−0.101		−1.231
p-value		0.310		0.920		0.224
CPI		−0.487		−1.861		−0.110
t-value		−0.299		−1.099		−0.064
p-value		0.767		0.277		0.950
MVOL		0.016		−0.242		−0.247
t-value		0.057		−0.741		−0.688
p-value		0.955		0.462		0.495
ΔEX	0.038	0.033	−0.336	−0.410	0.443*	0.298
t-value	0.160	0.162	−1.002	−1.643	1.819	1.014
p-value	0.873	0.872	0.321	0.107	0.075	0.316
Adj. R^2	−0.018	−0.035	0.003	0.127	0.022	0.018
Obs.	56	56	56	56	56	56

Notes: We test the pricing of exchange rate changes in the automobile industry firms in Japan. More concretely, the above results are on the Japanese representative automobile industry firms, Toyota, Nissan, and Honda. With regard to companies' names, more exactly, 'Toyota' denotes Toyota Motor Corporation, 'Nissan' denotes Nissan Motor Co., Ltd., and 'Honda' denotes Honda Motor Co., Ltd. Further, in the table, Adj. R^2 denotes the adjusted R-squared values and Obs. means the number of samples in our time-series regressions. As to the statistical significance of the coefficients of the variables in regressions, *** denotes the statistical significance at the 1% level, ** denotes the statistical significance at the 5% level, and * denotes the statistical significance at the 10% level, respectively. Moreover, when we perform all our time-series regressions, we use the method of Newey-West (1987), thus both t-values and p-values are robust to the heteroskedasticity and autocorrelation of the error terms of regressions. Furthermore, with respect to the variables in our regressions, first, DEF denotes the Japanese default spreads (credit-spreads), TERM is the Japanese term spreads, IP denotes the log base percentage changes of the seasonally adjusted industry productions in Japan, CPI is the percentage growth rates of the Japanese consumer price index, MVOL denotes the historical stock market returns' volatilities in Japan, and ΔEX is the changes of the yen/US dollars exchange rates. For each company, we test two types of regressions. As to our regression formulas, first, model 1 includes each company's stock return as the dependent variable, and includes the constant term and ΔEX as the explanatory variables. Further, model 2 includes each company's stock return as the dependent variable, and includes the constant term and all six explanatory variables of DEF, TERM, IP, CPI, MVOL, and ΔEX as the explanatory variables.

Table 2. The results of regressions of exchange rate changes and stock returns: The cases of Toyota, Nissan, and Honda for the period of September 1994 to April 1999

| | The Cases of the Japanese Representative Automobile Industry Firms | | | | | |
| | Toyota | | Nissan | | Honda | |
	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
Constant	0.987	−0.282	−0.438	−33.309	2.191***	−20.097
t-value	1.442	−0.012	−0.356	−1.329	2.697	−0.737
p-value	0.155	0.990	0.723	0.190	0.009	0.465
DEF		1.447		16.184		9.981
t-value		0.133		1.432		0.829
p-value		0.894		0.158		0.411
TERM		0.496		−9.249		−7.256
t-value		0.063		−1.063		−0.806
p-value		0.950		0.293		0.424
IP		0.202		1.949*		1.530
t-value		0.175		1.812		1.541
p-value		0.862		0.076		0.130
CPI		0.181		0.386		1.167
t-value		0.128		0.274		0.654
p-value		0.899		0.758		0.516
MVOL		−0.148		0.444		0.469
t-value		−0.268		0.538		0.701
p-value		0.790		0.593		0.487
ΔEX	0.404**	0.383**	0.157	0.305	1.165***	1.317***
t-value	2.478	2.322	0.493	0.834	6.535	6.702
p-value	0.016	0.024	0.624	0.409	0.000	0.000
Adj. R^2	0.030	−0.053	−0.014	0.023	0.194	0.155
Obs.	56	56	56	56	56	56

Notes: We test the pricing of exchange rate changes in the automobile industry firms in Japan. More concretely, the above results are on the Japanese representative automobile industry firms, Toyota, Nissan, and Honda. With regard to companies' names, more exactly, 'Toyota' denotes Toyota Motor Corporation, 'Nissan' denotes Nissan Motor Co., Ltd., and 'Honda' denotes Honda Motor Co., Ltd. Further, in the table, Adj. R^2 denotes the adjusted R-squared values and Obs. means the number of samples in our time-series regressions. As to the statistical significance of the coefficients of the variables in regressions, *** denotes the statistical significance at the 1% level, ** denotes the statistical significance at the 5% level, and * denotes the statistical significance at the 10% level, respectively. Moreover, when we perform all our time-series regressions, we use the method of Newey-West (1987), thus both *t*-values and *p*-values are robust to the heteroskedasticity and autocorrelation of the error terms of regressions. Furthermore, with respect to the variables in our regressions, first, DEF denotes the Japanese default spreads (credit-spreads), TERM is the Japanese term spreads, IP denotes the log base percentage changes of the seasonally adjusted industry productions in Japan, CPI is the percentage growth rates of the Japanese consumer price index, MVOL denotes the historical stock market returns' volatilities in Japan, and ΔEX is the changes of the yen/US dollars exchange rates. For each company, we test two types of regressions. As to our regression formulas, first, model 1 includes each company's stock return as the dependent variable, and includes the constant term and ΔEX as the explanatory variables. Further, model 2 includes each company's stock return as the dependent variable, and includes the constant term and all six explanatory variables of DEF, TERM, IP, CPI, MVOL, and ΔEX as the explanatory variables.

Table 3. The results of regressions of exchange rate changes and stock returns: The cases of Toyota, Nissan, and Honda for the period of May 1999 to December 2003

	Toyota		Nissan		Honda	
The Cases of the Japanese Representative Automobile Industry Firms						
	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
Constant	0.637	21.121	2.781*	14.765	0.397	−1.606
t-value	0.557	0.949	1.992	0.686	0.485	−0.076
p-value	0.580	0.347	0.052	0.496	0.630	0.939
DEF		15.127		12.217		−8.624
t-value		1.219		0.890		−0.990
p-value		0.229		0.378		0.327
TERM		−14.902		−14.769		9.356
t-value		−0.978		−0.982		0.961
p-value		0.333		0.331		0.342
IP		−0.637		0.876		0.361
t-value		−0.627		0.873		0.448
p-value		0.534		0.387		0.657
CPI		−3.425		0.431		1.337
t-value		−0.749		0.079		0.743
p-value		0.457		0.934		0.461
MVOL		−1.323		−0.580		0.216
t-value		−1.029		−0.457		0.175
p-value		0.309		0.650		0.862
ΔEX	0.144	0.035	1.247***	1.475**	0.693	0.774
t-value	0.291	0.048	3.093	2.282	1.514	1.375
p-value	0.772	0.962	0.003	0.027	0.136	0.176
Adj. R^2	−0.017	−0.077	0.078	0.020	0.036	−0.045
Obs.	56	56	56	56	56	56

Notes: We test the pricing of exchange rate changes in the automobile industry firms in Japan. More concretely, the above results are on the Japanese representative automobile industry firms, Toyota, Nissan, and Honda. With regard to companies' names, more exactly, 'Toyota' denotes Toyota Motor Corporation, 'Nissan' denotes Nissan Motor Co., Ltd., and 'Honda' denotes Honda Motor Co., Ltd. Further, in the table, Adj. R^2 denotes the adjusted R-squared values and Obs. means the number of samples in our time-series regressions. As to the statistical significance of the coefficients of the variables in regressions, *** denotes the statistical significance at the 1% level, ** denotes the statistical significance at the 5% level, and * denotes the statistical significance at the 10% level, respectively. Moreover, when we perform all our time-series regressions, we use the method of Newey-West (1987), thus both t-values and p-values are robust to the heteroskedasticity and autocorrelation of the error terms of regressions. Furthermore, with respect to the variables in our regressions, first, DEF denotes the Japanese default spreads (credit-spreads), TERM is the Japanese term spreads, IP denotes the log base percentage changes of the seasonally adjusted industry productions in Japan, CPI is the percentage growth rates of the Japanese consumer price index, MVOL denotes the historical stock market returns' volatilities in Japan, and ΔEX is the changes of the yen/US dollars exchange rates. For each company, we test two types of regressions. As to our regression formulas, first, model 1 includes each company's stock return as the dependent variable, and includes the constant term and ΔEX as the explanatory variables. Further, model 2 includes each company's stock return as the dependent variable, and includes the constant term and all six explanatory variables of DEF, TERM, IP, CPI, MVOL, and ΔEX as the explanatory variables.

Table 4. The results of regressions of exchange rate changes and stock returns: The cases of Toyota, Nissan, and Honda for the period of January 2004 to September 2008

| | The Cases of the Japanese Representative Automobile Industry Firms | | | | | |
| | Toyota | | Nissan | | Honda | |
	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
Constant	0.668	−10.628	−0.461	−1.191	0.860	−7.572
t-value	0.876	−1.000	−0.632	−0.088	1.404	−0.604
p-value	0.385	0.322	0.530	0.931	0.166	0.549
DEF		13.608		4.744		9.925
t-value		1.211		0.270		0.556
p-value		0.232		0.788		0.581
TERM		−8.893		0.457		−3.099
t-value		−0.900		0.027		−0.178
p-value		0.372		0.979		0.860
IP		−0.226		0.073		0.072
t-value		−0.318		0.103		0.113
p-value		0.752		0.918		0.911
CPI		−3.166**		−0.997		−0.222
t-value		−2.523		−0.450		−0.112
p-value		0.015		0.655		0.911
MVOL		0.177		−0.413		−0.158
t-value		0.383		−0.737		−0.302
p-value		0.704		0.465		0.764
ΔEX	1.041***	0.834***	0.923*	0.819	1.561***	1.450***
t-value	4.005	2.706	1.848	1.668	5.326	5.309
p-value	0.000	0.009	0.070	0.102	0.000	0.000
Adj. R^2	0.178	0.235	0.086	0.072	0.309	0.307
Obs.	57	57	57	57	57	57

Notes: We test the pricing of exchange rate changes in the automobile industry firms in Japan. More concretely, the above results are on the Japanese representative automobile industry firms, Toyota, Nissan, and Honda. With regard to companies' names, more exactly, 'Toyota' denotes Toyota Motor Corporation, 'Nissan' denotes Nissan Motor Co., Ltd., and 'Honda' denotes Honda Motor Co., Ltd. Further, in the table, Adj. R^2 denotes the adjusted R-squared values and Obs. means the number of samples in our time-series regressions. As to the statistical significance of the coefficients of the variables in regressions, *** denotes the statistical significance at the 1% level, ** denotes the statistical significance at the 5% level, and * denotes the statistical significance at the 10% level, respectively. Moreover, when we perform all our time-series regressions, we use the method of Newey-West (1987), thus both t-values and p-values are robust to the heteroskedasticity and autocorrelation of the error terms of regressions. Furthermore, with respect to the variables in our regressions, first, DEF denotes the Japanese default spreads (credit-spreads), TERM is the Japanese term spreads, IP denotes the log base percentage changes of the seasonally adjusted industry productions in Japan, CPI is the percentage growth rates of the Japanese consumer price index, MVOL denotes the historical stock market returns' volatilities in Japan, and ΔEX is the changes of the yen/US dollars exchange rates. For each company, we test two types of regressions. As to our regression formulas, first, model 1 includes each company's stock return as the dependent variable, and includes the constant term and ΔEX as the explanatory variables. Further, model 2 includes each company's stock return as the dependent variable, and includes the constant term and all six explanatory variables of DEF, TERM, IP, CPI, MVOL, and ΔEX as the explanatory variables.

Table 5. The results of regressions of exchange rate changes and stock returns: The cases of Toyota, Nissan, and Honda for the period of October 2008 to June 2012

	The Cases of the Japanese Representative Automobile Industry Firms					
	Toyota		Nissan		Honda	
	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
Constant	0.964	17.917	2.879	−28.100	1.518	6.964
t-value	0.930	0.859	1.632	−1.107	1.409	0.315
p-value	0.357	0.396	0.110	0.275	0.166	0.754
DEF		−15.041		42.443		7.112
t-value		−0.469		1.100		0.224
p-value		0.642		0.278		0.824
TERM		22.021		−38.808		−9.764
t-value		0.574		−0.831		−0.253
p-value		0.570		0.411		0.802
IP		0.358		0.963**		0.188
t-value		1.497		2.638		0.541
p-value		0.143		0.012		0.592
CPI		−0.240		−3.104		−2.664
t-value		−0.127		−0.949		−1.404
p-value		0.900		0.349		0.169
MVOL		−0.783		0.442		−0.258
t-value		−1.210		0.598		−0.352
p-value		0.234		0.553		0.727
ΔEX	1.800***	1.542***	2.793***	2.180***	1.908***	1.717***
t-value	4.305	3.417	3.920	4.223	3.411	3.929
p-value	0.000	0.002	0.000	0.000	0.001	0.000
Adj. R^2	0.169	0.134	0.176	0.244	0.169	0.125
Obs.	45	45	45	45	45	45

Notes: We test the pricing of exchange rate changes in the automobile industry firms in Japan. More concretely, the above results are on the Japanese representative automobile industry firms, Toyota, Nissan, and Honda. With regard to companies' names, more exactly, 'Toyota' denotes Toyota Motor Corporation, 'Nissan' denotes Nissan Motor Co., Ltd., and 'Honda' denotes Honda Motor Co., Ltd. Further, in the table, Adj. R^2 denotes the adjusted R-squared values and Obs. means the number of samples in our time-series regressions. As to the statistical significance of the coefficients of the variables in regressions, *** denotes the statistical significance at the 1% level, ** denotes the statistical significance at the 5% level, and * denotes the statistical significance at the 10% level, respectively. Moreover, when we perform all our time-series regressions, we use the method of Newey-West (1987), thus both t-values and p-values are robust to the heteroskedasticity and autocorrelation of the error terms of regressions. Furthermore, with respect to the variables in our regressions, first, DEF denotes the Japanese default spreads (credit-spreads), TERM is the Japanese term spreads, IP denotes the log base percentage changes of the seasonally adjusted industry productions in Japan, CPI is the percentage growth rates of the Japanese consumer price index, MVOL denotes the historical stock market returns' volatilities in Japan, and ΔEX is the changes of the yen/US dollars exchange rates. For each company, we test two types of regressions. As to our regression formulas, first, model 1 includes each company's stock return as the dependent variable, and includes the constant term and ΔEX as the explanatory variables. Further, model 2 includes each company's stock return as the dependent variable, and includes the constant term and all six explanatory variables of DEF, TERM, IP, CPI, MVOL, and ΔEX as the explanatory variables.

Table 6. The results of Welch's tests on the sensitivities of stock returns to the yen/US dollars exchange rates: The cases of Toyota, Nissan, and Honda

Panel A Means and Standard Deviations of the Sensitivities of Stock Returns to Exchange Rates for Five Periods

Sample Periods	Statistic	Toyota	Nissan	Honda
January 1990 to August 1994	Mean	0.0766	−0.3458	0.4976
	SD	0.2727	0.1796	0.1224
September 1994 to April 1999	Mean	0.4646	0.5317	1.2180
	SD	0.3611	0.4241	0.3150
May 1999 to December 2003	Mean	0.3314	1.0465	1.3775
	SD	0.3212	0.2705	0.1873
January 2004 to September 2008	Mean	0.8086	1.1830	0.8656
	SD	0.4108	0.3342	0.6512
October 2008 to June 2012	Mean	1.5276	2.3158	1.9210
	SD	0.2181	0.1885	0.3456

Panel B Results of Welch's Tests: The Mean Value of the Sensitivities of Stock Returns to Exchange Rates for January 1990 to August 1994< The Mean Value of the Sensitivities of Stock Returns to Exchange Rates for October 2008 to June 2012

t-value for Welch's tests	29.8616***	72.4867***	26.5991***
p-value	0.0000	0.0000	0.0000

Panel C Results of Welch's Tests: The Mean Value of the Sensitivities of Stock Returns to Exchange Rates for September 1994 to April 1999< The Mean Value of the Sensitivities of Stock Returns to Exchange Rates for October 2008 to June 2012

t-value for Welch's tests	18.3336***	28.2635***	10.6382***
p-value	0.0000	0.0000	0.0000

Panel D Results of Welch's Tests: The Mean Value of the Sensitivities of Stock Returns to Exchange Rates for May 1999 to December 2003< The Mean Value of the Sensitivities of Stock Returns to Exchange Rates for October 2008 to June 2012

t-value for Welch's tests	22.3055***	27.8396***	9.5757***
p-value	0.0000	0.0000	0.0000

Panel E Results of Welch's Tests: The Mean Value of the Sensitivities of Stock Returns to Exchange Rates for January 2004 to September 2008< The Mean Value of the Sensitivities of Stock Returns to Exchange Rates for October 2008 to June 2012

t-value for Welch's tests	11.3775***	21.6727***	10.5358***
p-value	0.0000	0.0000	0.0000

Notes: 'Toyota' denotes Toyota Motor Corporation, 'Nissan' denotes Nissan Motor Co., Ltd., and 'Honda' denotes Honda Motor Co., Ltd. In panel A, 'Mean' denotes the mean values of 36 month historical sensitivities of stock returns to the yen/US dollars exchange rates. Further, 'SD' means the standard deviations of 36 month historical sensitivities of stock returns to the yen/US dollars exchange rates. In panels B to E, *** denotes the statistical significance at the 1% level, ** denotes the statistical significance at the 5% level, and * denotes the statistical significance at the 10% level, respectively.

5. Conclusions

This paper empirically examined the yen/US dollars exchange rate sensitivities of three representative automobile industry firms in Japan. Our clear and robust contributions in this paper are as follows.

● First, with regard to the Japanese representative automobile industry firms, our regression tests indicated

that, in general, the yen/US dollars exchange rate dynamics are statistically significantly priced with positive signs in the equity markets in Japan. Further, in the period after the US Lehman Shock, as to the Japanese representative automobile industry firms, the yen/US dollars exchange rate changes are most strongly priced with positive signs in the Japanese stock markets.

● Second, our formal statistical tests revealed that in the period after the US Lehman Shock, the yen/US dollars exchange rate sensitivities of three representative automobile industry firms in Japan are the highest. Thus after the US Lehman Shock, the Japanese representative automobile industry firms' exchange rate sensitivities clearly increased.

As our empirical studies demonstrated, in order to further deepen our knowledge regarding the (in)efficient financial markets, in particular, after the US Lehman Shock, related future international researches by using international data shall be valuable. Further investigations of financial crisis and financial markets based on some financial theory or models shall be also our future works.

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