Estimating Exchange Rate Exposures of Taiwan's Stock Market

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Abstract

Using daily data from January 3, 1999 through December 31, 2003, this study investigates the first- and second-moment exchange rate exposure of eighteen major industrial sectors in Taiwan's stock market. Our results show that there is limited evidence of asymmetric first-moment exposure, and the second-moment exposure is found to be more important than the first-moment exposure. In addition, the exchange rate volatility is asymmetric, so is the second-moment exposure of industrial sectors.

Keywords: exchange rate exposure, asymmetric exposure, second-moment exposure

1. Introduction

Taiwan is a small open economy. Firms in a more open economy are expected to be more sensitive to movements in the exchange rate. Thus, estimating and managing exchange rate exposures are important issues for managers, investors and policy makers in Taiwan.

Existing studies investigate almost exclusively symmetric foreign exchange rate exposures[1] ([1], [2], [4], [5], [22], [24], etc). Asymmetric exposure is implied in theoretical models purporting to describe actual firm behavior, such as pricing-to-market ([20], [26], [33]), hysteresis ([15], [31]), and asymmetric hedging ([9], [25], [34], [36]). Recently, Miller and Reuer [34], Di Iorio [23], and Koutmos and Martin [29] are the only papers that have attempted to model first-moment asymmetric responses to currency appreciations and depreciations. In addition, the volume of international trade[2] ([14], [16], [19]) and transaction costs of hedging exchange rate risk with derivatives[3] ([8]) could be affected by exchange rate volatilities, so should the firm values and stock returns. Koutmos and Martin [30] is the only paper to investigate the second-moment exchange rate exposure.

The fact that volatility in financial time series is highly persistent with clustering phenomena is well known. The GARCH (1,1) and Exponential GARCH (EGARCH) models are two popular models to characterize high-frequency financial volatility ([7]). The GARCH (1,1) is a linear GARCH model while the EGARCH model is nonlinear. Almost all the previous studies about estimating exchange rate exposures consider only unconditional models, except Koutmos and Martin ([29], [30]) who consider the conditional models. But they only use GARCH (1,1) model in their study. According to Engle and Ng [18], the EGARCH model allows good news (positive return shocks) and bad news (negative return shocks) to have different impacts on volatility, where the linear GARCH model does not. In addition, the EGARCH model does not require the non-negativity constraints as they are required in the GARCH model, since even negative parameter values would not cause the variance to be negative.

Using daily data of the period 1999 to 2003, this study investigates whether the returns of industries in Taiwan are asymmetrically exposed to exchange rate risks. In addition to the asymmetric first-moment exposure, we use the EGARCH model to estimate the volatility of the exchange rate and examine if there are asymmetric effects of the second-moment exposure in Taiwan sector index returns.

The paper is organized as follows. Section 2 describes the sample and data source. Section 3 shows the methodologies. Section 4 contains the results. Finally, section 5 concludes the paper.

2. Data

The data set consists of daily stock returns from 18 major Taiwan industrial sectors. These sectors include cement, foods, plastics, textiles, electric & machinery, ele.appliance & cable, chemicals, glass & ceramics, paper & pulp, steel & iron, rubber, construction, transportation, tourism, wholesale & retail, electronics, automobile, and finance.

The market portfolio (R_m), TAIEX, is a value-weighted index of Taiwan that involves all currently listed common stocks. The exchange rate (R_s) used here is the U.S. Dollar (USD) in terms of the New Taiwan Dollar (NTD). The choice of NTD/USD1 is supported by the following reasons. First, Taiwan is a small and export-oriented economy, and the United States is one of the largest trade partners of Taiwan all the time. Second,

[1] The assumption of symmetry means that no difference exists between the risk effects of currency appreciation and depreciation.

[2] There is no general agreement on the direction of the volume of trade impacted by exchange rate volatility. If it is impacted, however, so should the value of firms and stock returns.

[3] As the exchange rate volatility increases, firms have greater incentives to hedge, and the cost of hedging may be greater with the option hedge.

since U.S. dollar is a leading vehicle currency, prices of tradable goods are often denominated in the U.S. dollar, no matter which countries Taiwan firms trade with ([11]). Third, the currency values of major trade partners of Taiwan (i.e., China and Hong Kong) are pegged to U.S. dollar.

The sample period extends from January 3, 1999 through December 31, 2003, generating 1211 daily observations. All data are obtained from the website of Taiwan Economic Journal (TEJ).

Table 1 presents some descriptive statistics for the daily returns on the market indexes, exchange rates, and sector indexes, including mean, standard deviation, skewness, kurtosis, Jarque-Bera (J-B) normality test statistics. The high kurtosis statistics indicate fat-tailed behavior and/or a small number of extreme positive or negative returns in the sample. Nearly each variable fails in the Jarque-Bera normality test. The hypothesis of a unit root is tested using Augmented Dickey-Fuller (ADF) statistics, and the results show that all variables are stationary. The Ljung-Box $Q(12)$ statistic indicates that independence of returns is rejected and that significant autocorrelation exists in R_m, R_s, and some industrial sectors. The Ljung-Box $Q^2(12)$ statistic indicates that there is significant autocorrelation in the squared return series and the existence of possible volatility clustering in all variables. The ARCH LM test in table 2 shows that there are significant ARCH effects of both series.

3. Methodology

We use four models to estimate exchange rate exposures of eighteen industrial sectors in Taiwan's stock market. First, we explore the traditional first-moment symmetric exposure of foreign exchange rate. Second, we examine if there is first-moment asymmetric exposure under currency appreciations and depreciations. Third, we examine how exchange rate volatility affects sector index returns (the second-moment exposure). Fourth, we examine if there are asymmetric effects of the second-moment exposure.

3.1. Symmetric first-moment exposure

In the first model, we consider the traditional first-moment symmetric exposure.

$$\mathrm{R}_{it} = \beta_0 + \beta_1 R_{mt} + \beta_2 \mathrm{R}_{st} + \varepsilon_{it} \tag{1}$$

where R_{it} is the industrial sector return on day t; R_{mt} is the equity index return on day t ; R_{st} is the foreign exchange rate return on day t ; ε_{it} is the error term. The market portfolio return variable (R_{mt}) not only plays an important role in ensuring that the estimated exposures are not inappropriately influenced by correlated macroeconomic events, but also dramatically reduces the residual variance of the regression ([6]).

To take into account the volatility clustering of financial time series data, the error term (ε_{it}) is allowed to follow the GARCH (1,1) variance equation, conditional on the information available at time t-1, with a normal distribution of mean zero and variance σ_{it}^2.

$$\sigma^2_{i,t} = \alpha_0 + \alpha_1 \varepsilon^2_{i,t-1} + \alpha_2 \sigma^2_{i,t-1} \tag{2}$$

3.2. Asymmetric first-moment exposure

Asymmetric exchange rate exposure is motivated by the literature dealing with pricing-to-market behavior, hysteresis, and asymmetric hedging.

$$\begin{aligned} &\mathrm{R}_{\mathrm{it}} = \beta_0 + \beta_1 \mathrm{R}_{mt} + \beta_2 \mathrm{R}_{st} + \beta_3 \mathrm{D} R_{st} + \varepsilon_{it} \\ &D = \begin{cases} 1 & \text{if } \mathrm{R}_{\mathrm{st}} > 0 \\ 0 & \text{if } \mathrm{R}_{\mathrm{st}} \le 0 \end{cases} \\ &\varepsilon_{i,t} \mid \psi_{t-1} \sim N(0, \sigma^2_{i,t}) \\ &\sigma^2_{i,t} = \alpha_0 + \alpha_1 \varepsilon^2_{i,t-1} + \alpha_2 \sigma^2_{i,t-1} \end{aligned} \tag{3}$$

A test for asymmetry is equivalent to test that β_2 is statistically significant. For a given value of the market portfolio, the response of R_i will be equal to β_1 if $R_{st} \le 0$ and $\beta_1 + \beta_2$ if $R_{st} > 0$.

3.3. Symmetric second-moment exposure

Based on the arguments that the volume of international trade and transaction costs of hedging exchange rate risk with derivatives could be affected by exchange rate volatility, we incorporate the second-moment exposure factor into our model.

The dynamics of the exchange rate return is specified as equation (4) and we use EGARCH model to evaluate exchange rate volatility:

$$\mathrm{R}_{st} = c + \eta R_{st-1} + a_t \qquad a_t \mid F_{t-1} \sim N(0, h_{st}) \tag{4}$$

$$\mathrm{H}_{st} = \log h_{st} = \omega + \beta \log h^2_{st-1} + \lambda \left| \frac{a_{t-1}}{h_{st-1}} \right| + \gamma \frac{a_{t-1}}{h_{st-1}} \tag{5}$$

Table 3 shows that the coefficient of γ is significantly negative. This indicates that the asymmetric volatility of the exchange rate returns exists and that a positive return shock actually reduces volatility. Specifically, the exposure is high when NTD appreciates and small when NTD depreciates.

Then, the estimated volatility in equation (5), H_{st}, is added to the mean equation and we get the equation (6). The second-moment exposure is measured by β_4. If the volume of trade is reduced for net exporters due to higher exchange rate volatility, or if the hedging costs with

derivatives increase with greater volatility, then β_4 will be negative.

$$
\begin{aligned}
&\mathrm{R}_{it} = \beta_0 + \beta_1 \mathrm{R}_{mt} + \beta_2 \mathrm{R}_{st} + \beta_3 \mathrm{D}R_{st} + \beta_4 \mathrm{H}_{st} + \varepsilon_{it} \\
&D = \begin{cases} 1 & \text{if } \mathrm{R}_{st} > 0 \\ 0 & \text{if } \mathrm{R}_{st} \le 0 \end{cases} \qquad (6) \\
&\varepsilon_{i,t} \mid \psi_{t-1} \sim N(0, \sigma^2_{i,t}) \\
&\sigma^2_{i,t} = \alpha_0 + \alpha_1 \varepsilon^2_{i,t-1} + \alpha_2 \sigma^2_{i,t-1} \\
&\mathrm{R}_{st} = c + \eta R_{st-1} + a_t \qquad a_t \mid F_{t-1} \sim N(0, h_{st}) \\
&\mathrm{H}_{st} = \log h_{st} = \omega + \beta \log h^2_{st-1} + \lambda \left| \frac{a_{t-1}}{h_{st-1}} \right| + \gamma \frac{a_{t-1}}{h_{st-1}}
\end{aligned}
$$

3.4. Asymmetric second-moment exposure

Finally, we examine if there is also asymmetric second-moment exposure since the asymmetric volatility of the exchange rate returns exists, as shown in table 3. Asymmetric second-moment exposure is examined by testing whether β_5 is statistically significant. For a given value of the market portfolio and the exchange rate, the response of R_i to an exchange rate volatility will be equal to β_4 if $R_{st} \le 0$ and $\beta_4 + \beta_5$ if $R_{st} > 0$.

$$
\begin{aligned}
&\mathrm{R}_{it} = \beta_0 + \beta_1 \mathrm{R}_{mt} + \beta_2 \mathrm{R}_{st} + \beta_3 \mathrm{D}R_{st} + \beta_4 H_{st} + \beta_5 DH_{st} + \varepsilon_{it} \\
&D = \begin{cases} 1 & \text{if } \mathrm{R}_{st} > 0 \\ 0 & \text{if } \mathrm{R}_{st} \le 0 \end{cases} \qquad (7) \\
&\varepsilon_{i,t} \mid \psi_{t-1} \sim N(0, \sigma^2_{i,t}) \\
&\sigma^2_{i,t} = \alpha_0 + \alpha_1 \varepsilon^2_{i,t-1} + \alpha_2 \sigma^2_{i,t-1} \\
&\mathrm{R}_{st} = c + \eta R_{st-1} + a_t \qquad a_t \mid F_{t-1} \sim N(0, h_{st}) \\
&\mathrm{H}_{st} = \log h_{st} = \omega + \beta \log h^2_{st-1} + \lambda \left| \frac{a_{t-1}}{h_{st-1}} \right| + \gamma \frac{a_{t-1}}{h_{st-1}}
\end{aligned}
$$

4. Results

Table 4 shows the results of exchange rate exposure in the traditional first-moment symmetric model. Almost all sectors with negative β_2, and four of them with significantly negative β_2. This indicates that sector index returns are positive when USD depreciates (NTD appreciates). Since Taiwan is an export-oriented economy, this result is contradicted to the international competitiveness of local firms. [4] In addition, the significant α_1 and α_2, and high $\alpha_1 + \alpha_2$ indicate that there is a heteroscedastic volatility and the persistence in volatility is quite strong. The constant variance model is rejected.

When we consider an asymmetric response to currency appreciation and depreciation in table 5, there is only the finance sector with asymmetric exposure. The finance sector is more skillful at using financial derivatives and thus may have asymmetric exposures due to asymmetric financial hedges, such as option hedges.

In table 6, we examine how exchange rate volatility affects sector index returns. The significantly positive β_4 in eight sectors indicates that nearly half of sectors with positive second-moment exposures. There is no general agreement on the direction of the volume of trade impacted by exchange rate volatilities from previous studies. Higher exchange rate volatilities may lower the volume of trade due to uncertainty of cash flows. De Grauwe [17], however, suggests that exporters might increase exports to offset potential revenue losses, and thus the stock returns increase. Our empirical results form table 6 are consistent with the arguments of De Grauwe [17].

In table 7, we examine if there are asymmetric effects of the second-moment exposure. Our results show that there are five of eighteen sectors with significantly asymmetric second-moment exposures. The exposure is high when NTD appreciates. However, the exposure is very small when NTD depreciates. This may be due to the fact that the exchange rate volatility is asymmetric, as shown in table 3. Specifically, the exchange rate is more violate when NTD appreciates, so is the second-moment exposure. Likewise, the exchange rate is less violate when NTD depreciates, so is the second-moment exposure. At the same time, there is only one sector with significantly asymmetric first-moment exposure.

5. Conclusion

Using daily data from January 3, 1999 through December 31, 2003, this study investigates the first- and second-moment exchange rate exposure of eighteen major industrial sectors in Taiwan's stock market. Our results show that, (1) there are four sectors with significant first-moment exposure in the traditional symmetric first-moment model, (2) there is only one sector with significantly asymmetric exposure in the asymmetric first-moment model, (3) the exchange rate volatility significantly affects eight sector index returns, (4) there are five sectors with significantly asymmetric second-moment exposure. There is limited evidence of first-moment exposure, and the second-moment exposure is found to be more important than the first-moment exposure.

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Table 1 Summary statistics of market returns, exchange rate returns, and sector returns

Variables	Mean	Std. Dev.	Skewness	Kurtosis	Jarque-Bera	ADF	Q(12)	$Q^2(12)$
A. Market index returns, R_m	0.000140	0.018779	0.124396	4.687337	146.7835***	-18.14026***	24.556**	12.712
B. Exchange rate returns, R_s	4.77E-05	0.002750	1.466683	56.39228	144277.6***	-7.216173***	142.41***	57.712***
C.Sector index returns								
Cement	-0.000140	0.024288	0.179326	3.394561	14.34581***	-11.51702***	22.342**	114.44***
Foods	-0.000416	0.017995	0.070491	3.795898	32.96594***	-33.86794***	4.3080	80.099***
Plastics	0.000576	0.022085	0.164792	3.816839	39.14821***	-34.15483***	14.515	92.768***
Textiles	-6.61E-05	0.020597	0.047303	3.270278	4.137601	-33.26150***	15.959	126.05***
Elec&Machiney	-0.000158	0.017877	0.049789	3.745422	28.53768***	-34.17628***	19.243*	191.26***
Ele.Appliance&Cable	-0.000340	0.024135	0.079634	3.144786	2.337688	-33.41618***	15.954	217.37***
Chemicals	-9.17E-05	0.018899	-0.009675	3.615772	19.15142***	-31.93223***	15.860	182.37***
Glass&Ceramics	-0.000324	0.021752	0.155156	3.571912	21.36291***	-34.55875***	11.441	93.300***
Paper&Pulp	0.000114	0.023938	0.131407	3.299785	8.019944**	-32.03053***	10.274	226.96***
Steel&Iron	0.000429	0.019463	0.325586	4.151258	88.27277***	-13.49333***	19.178*	92.242***
Rubber	-0.000127	0.022839	0.130594	3.387131	11.00443***	-32.83313***	11.651	99.125***
Construction	-0.000487	0.023363	0.300705	3.236695	21.07745***	-29.75986***	14.809	136.91***
Transportation	0.000282	0.022510	0.238441	3.507084	24.44961***	-32.07277***	9.8207	236.74***
Tourism	-0.000571	0.014333	0.230273	4.823644	178.5105***	-13.00336***	34.595***	232.95***
Wholesale&Retail	-0.000380	0.016022	0.056957	4.434038	104.4205***	-13.63407***	16.623	162.20***
Electronics	9.75E-05	0.021457	0.173016	3.561898	21.97295***	-21.91239***	21.981**	220.10***
Automobile	0.000144	0.021081	0.257976	4.387502	110.5728***	-15.59713***	12.490	190.50***
Finance	1.39E-05	0.019868	0.213225	3.720039	35.33679***	-18.56938***	18.987*	101.66***

Note: 1. Jarque-Bera is a test statistic for testing whether the series is normally distributed.
2. ADF (n) is unit root test.
3. L-B Q (k) and L-B Q^2 (k) is Ljunng-box Q-statistics used to test for serial correlation and k is the length of lag.
4. *, **, *** indicate the estimates are significant at the level of 0.1, 0.05, and 0.01.

Table 2 ARCH LM Test

K	R_{mt}	R_{st}
1	12.49047***	52.48133***
2	37.81893***	53.70621***
3	57.89043***	54.28779***
4	61.89635***	54.39231***
5	62.59111***	54.34739***
6	67.34505***	54.36482***
7	67.62492***	54.44851***
8	67.91105***	54.40212***
9	70.35627***	54.59078***
10	77.87321***	57.17255***
AR(P)	AR(1)	AR(1)

Note: *, **, *** indicate the estimates are significant at the level of 0.1, 0.05, and 0.01.

Table 3 Estimating the exchange rate volatility using EGARCH model

η	ω	β	λ	γ	Q(12)	$Q^2(12)$	ADF
-0.081415	-1.275492	0.909438	0.376218	-0.109784	12.311	0.7427	-18.74205
(-2.850813)***	(-46.56735)***	(444.5485)***	(31.00258)***	(-15.23469)***			(0)***

Note: 1. L-B Q (k) and L-B Q^2 (k) is Ljunng-box Q-statistics used to test for serial correlation and k is the length of lag.
2. ADF (n) is unit root test.
3. *, **, *** indicate the estimates are significant at the level of 0.1, 0.05, and 0.01.

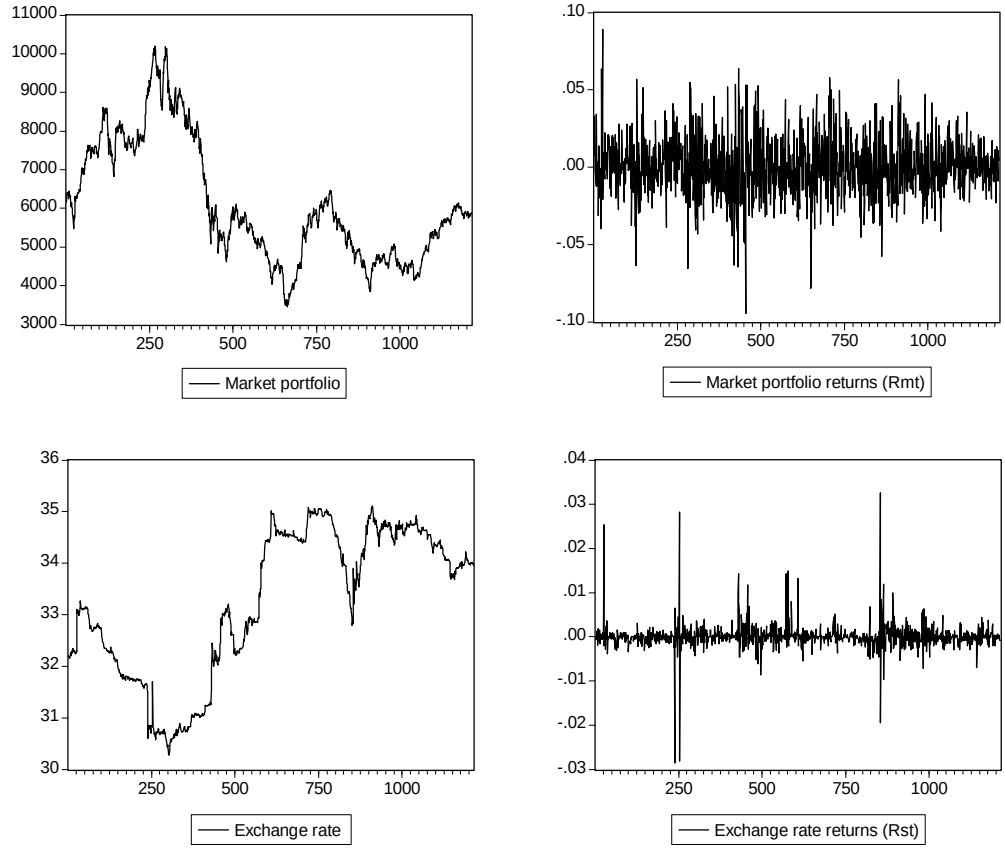

Figure 1 Daily Data of the Market portfolio (return) and the exchange rate (return) during 1999-2003

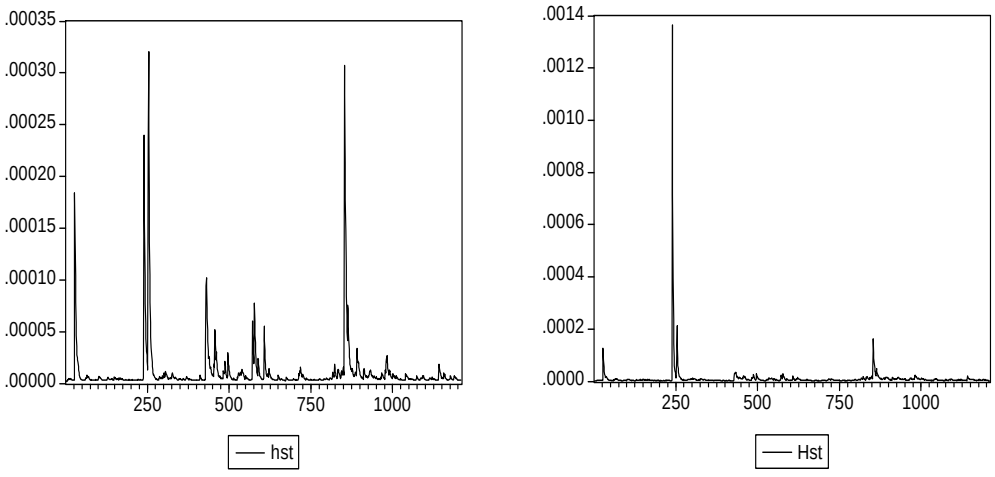

Figure 2 Volatility of the exchange rate return

Table 4 Results of symmetric first-moment exposure

Sector	β_1	β_2	α_1	α_2
Cement	0.754333	-0.245816	0.115694	0.795544
	(29.05551)***	(-1.146276)	(6.136043)***	(25.49524)***
Foods	0.608789	-0.220413	0.101114	0.827785
	(33.95731)***	(-1.401772)	(4.987338)***	(26.36432)***
Plastics	0.832141	-0.046948	0.040782	0.938470
	(40.04733)***	(-0.320427)	(4.765784)***	(79.82166)***
Textiles	0.781672	-0.043932	0.077774	0.877347
	(41.50679)***	(-0.339190)	(4.667849)***	(35.08355)***
Elec. & Machinery	0.697049	0.088073	0.075163	0.903618
	(47.72028)***	(0.764937)	(5.503578)***	(49.56936)***
Ele.Appliance & Cable	0.940738	-0.344107	0.072725	0.894088
	(40.66545)***	(-2.311291)**	(5.070872)***	(56.79838)***
Chemicals	0.683387	-0.255641	0.062932	0.932396
	(40.10594)***	(-1.755520)*	(5.744444)***	(88.67378)***
Glass & Ceramics	0.623927	0.034028	0.176273	0.407414
	(24.33646)***	(0.192031)	(5.281984)***	(4.314305)***
Paper & Pulp	0.668588	-0.355637	0.080611	0.882721
	(24.92647)***	(-1.693097)*	(5.427033)***	(46.42005)***
Steel & Iron	0.508483	-0.261400	0.044288	0.932033
	(24.98954)***	(-1.709086)*	(5.967082)***	(79.46586)***
Rubber	0.736767	-0.274124	0.059312	0.925197
	(29.12236)***	(-1.235166)	(4.766529)***	(61.12760)***
Construction	0.641994	-0.258785	0.170199	0.756725
	(26.13191)***	(-1.355700)	(6.026140)***	(19.17039)***
Transportation	0.692338	-0.233351	0.099169	0.860357
	(28.09731)***	(-1.091992)	(5.425050)***	(37.26331)***
Tourism	0.296191	-0.102701	0.095283	0.866558
	(19.26696)***	(-0.728836)	(8.565366)***	(75.46611)***
Wholesale & Retail	0.483574	0.188371	0.100079	0.847296
	(28.66755)***	(1.433364)	(5.521123)***	(35.87868)***
Electronics	1.064958	0.006171	0.069200	0.916268
	(92.18868)***	(0.077152)	(6.128967)***	(72.39313)***
Automobile	0.554198	-0.108191	0.090807	0.866452
	(25.07146)***	(-0.711620)	(5.914173)***	(41.73762)***
Finance	0.803848	-0.105636	0.113494	0.812507
	(48.04270)***	(-0.848056)	(5.158900)***	(25.29641)***

Note: *, **, *** indicate the estimates are significant at the level of 0.1, 0.05, and 0.01.

Table 5 Results of asymmetric first-moment exposure

Sector	β_1	β_2	β_3	α_1	α_2
Cement	0.751385	-0.685083	0.709006	0.117906	0.788565
	(28.95202)***	(-1.420168)	(1.161519)	(6.137083)***	24.61594)***
Foods	0.608930	-0.172984	-0.072073	0.101219	0.827594
	(33.93803)***	(-0.635314)	(-0.177158)	(4.979076)***	(26.34185)***
Plastics	0.831361	-0.174331	0.228278	0.040792	0.938697
	(39.99610)***	(-0.581005)	(0.603007)	(4.778603)***	(80.18943)***
Textiles	0.781333	-0.147818	0.185642	0.078028	0.877447
	(40.99462)***	(-0.757716)	(0.593360)	(4.661389)***	(35.13348)***
Elec. &	0.696712	-0.076528	0.264704	0.074260	0.904556
Machinery	(47.79418)***	(-0.344535)	(0.915802)	(5.488927)***	(50.05237)***
Ele.Appliance	0.940109	-0.591035	0.390233	0.072978	0.893725
& Cable	(40.49711)***	(-1.752737)*	(0.954675)	(5.023285)***	(56.37313)***
Chemicals	0.683374	-0.262478	0.011520	0.062901	0.932428
	(40.10516)***	(-1.348195)	(0.032503)	(5.745732)***	(88.72598)***
Glass	0.624141	0.069421	-0.054541	0.176331	0.407352
& Ceramics	(24.01273)***	(0.136688)	(-0.093135)	(5.272901)***	(4.312885)***
Paper	0.668401	-0.381341	0.041069	0.080551	0.882783
& Pulp	(24.81042)***	(-1.164238)	(0.082520)	(5.422611)***	(46.44578)***
Steel	0.506689	-0.561401	0.524712	0.043633	0.932764
& Iron	(24.92967)***	(-2.250335)**	(1.293058)	(5.901962)***	(79.27720)***
Rubber	0.737097	-0.209717	-0.112651	0.059174	0.925399
	(29.07514)***	(-0.685911)	(-0.206393)	(4.764486)***	(61.26076)***
Construction	0.641763	-0.282332	0.038773	0.170380	0.756360
	(26.08688)***	(-1.126511)	(0.097208)	(6.024187)***	(19.11362)***
Transportation	0.692108	-0.290766	0.091661	0.099493	0.859767
	(28.07679)***	(-0.838637)	(0.182409)	(5.424571)***	(36.96908)***
Tourism	0.296277	-0.083183	-0.029493	0.095326	0.866539
	(19.27917)***	(-0.340748)	(-0.089155)	(8.532368)***	(74.36381)***
Wholesale	0.483454	0.131932	0.088322	0.099790	0.847631
& Retail	(28.64837)***	(0.649533)	(0.286184)	(5.517251)***	(35.88336)***
Electronics	1.064871	0.121712	-0.181171	0.068700	0.916515
	(91.73455)***	(0.853136)	(-0.931148)	(6.101515)***	(72.54915)***
Automobile	0.555774	0.192251	-0.498663	0.090940	0.866324
	(24.96067)***	(0.845104)	(-1.404555)	(5.974116)***	(42.26940)***
Finance	0.802565	-0.420276	0.525327	0.118045	0.805233
	(48.17602)***	(-1.807730)*	(1.709034)*	(5.116273)***	(24.04677)***

Note: *, **, *** indicate the estimates are significant at the level of 0.1, 0.05, and 0.01.

Table 6 Results of symmetric second-moment exposure

Sector	β_1	β_2	β_3	β_4	α_1	α_2
Cement	0.749837	-0.668147	0.664722	10.53715	0.119701	0.785866
	(28.85516)***	(-1.373030)	(1.078331)	(0.848093)	(6.112825)***	(23.67662)***
Foods	0.606772	-0.147204	-0.143144	27.35044	0.101611	0.823521
	(33.84608)***	(-0.544724)	(-0.354194)	(1.267855)	(4.905450)***	(24.92519)***
Plastics	0.828898	-0.179855	0.216717	-4.106718	0.033972	0.952395
	(40.04666)***	(-0.589198)	(0.569485)	(-0.455240)	(4.481975)***	(92.49948)***
Textiles	0.780885	-0.148244	0.191016	-1.518656	0.080730	0.874363
	(41.05563)***	(-0.733663)	(0.598459)	(-0.101824)	(4.820223)***	(33.66041)***
Elec. &	0.697122	-0.037300	0.184731	22.91310	0.072415	0.908466
Machinery	(48.15826)***	(-0.166420)	(0.630619)	(5.806273)***	(5.514389)***	(51.59161)***
Ele.Appliance	0.938136	-0.569122	0.337536	15.22366	0.080146	0.885795
& Cable	(40.36515)***	(-1.709696)*	(0.832512)	(1.300267)	(5.284901)***	(47.15478)***
Chemicals	0.681374	-0.197667	-0.102554	26.83843	0.055431	0.941728
	(39.68487)***	(-0.990473)	(-0.284722)	(2.887230)***	(5.603790)***	(97.69845)***
Glass &	0.623583	0.070352	-0.052756	-2.381643	0.175834	0.414611
Ceramics	(24.01663)***	(0.138906)	(-0.090304)	(-0.222517)	(5.276978)***	(4.383275)***
Paper & Pulp	0.666101	-0.369651	-0.013159	19.02145	0.079473	0.886176
	(25.00398)***	(-1.146020)	(-0.026414)	(0.728734)	(5.251731)***	(44.30367)***
Steel & Iron	0.507396	-0.588946	0.582150	-10.77347	0.045587	0.929600
	(24.97177)***	(-2.311537)**	(1.382336)	(-1.621247)	(5.647990)***	(66.21056)***
Rubber	0.732969	-0.091404	-0.341557	35.18593	0.054630	0.933296
	(29.01838)***	(-0.275584)	(-0.578551)	(2.999207)***	(4.689203)***	(64.33530)***
Construction	0.640248	-0.096244	-0.221845	36.11015	0.164162	0.765219
	(26.02003)***	(-0.348470)	(-0.505602)	(4.363020)***	(5.930116)***	(19.62208)***
Transportation	0.689250	-0.250482	0.020852	13.45611	0.100556	0.859784
	(28.10442)***	(-0.713572)	(0.040837)	(1.883636)*	(5.512952)***	(35.85181)***
Tourism	0.293887	-0.036065	-0.129297	20.97619	0.096667	0.866131
	(19.04100)***	(-0.150635)	(-0.388333)	(2.486509)**	(8.611484)***	(73.98414)***
Wholesale &	0.483896	0.136590	0.044620	21.62793	0.096561	0.852067
Retail	(28.71281)***	(0.692092)	(0.152508)	(2.229936)**	(5.383351)***	(35.32399)***
Electronics	1.065169	0.110025	-0.160727	-5.857192	0.069052	0.917963
	(92.01490)***	(0.756542)	(-0.808787)	(-1.356656)	(6.175162)***	(72.77584)***
Automobile	0.553592	0.292649	-0.648043	25.42939	0.091896	0.864586
	(24.90684)***	(1.171107)	(-1.737364)*	(3.972608)***	(5.861170)***	(40.49983)***
Finance	0.802449	-0.399097	0.489338	10.38012	0.130845	0.791150
	(48.64220)***	(-1.705356)*	(1.566824)	(0.887309)	(5.266520)***	(21.17518)***

Note: *, **, *** indicate the estimates are significant at the level of 0.1, 0.05, and 0.01.

Table 7 Results of asymmetric second-moment exposure

Sector	β_1	β_2	β_3	β_4	β_5	α_1	α_2
Cement	0.749025	-0.753912	0.724687	-18.83345	32.28421	0.119199	0.785896
	(28.75542)***	(-1.480221)	(1.153612)	(-0.382118)	(0.637085)	(6.102200)***	23.60690)***
Foods	0.606722	-0.152763	-0.139931	25.41277	2.189513	0.101495	0.823806
	(33.83755)***	(-0.557892)	(-0.345865)	(0.936649)	(0.053857)	(4.905414)***	(24.97436)***
Plastics	0.828503	-0.206477	0.229053	-15.19378	12.57464	0.034067	0.952302
	(39.90715)***	(-0.650819)	(0.589729)	(-0.991992)	(0.722406)	(4.475292)***	(92.27367)***
Textiles	0.779789	-0.220469	0.230295	-28.21099	30.04696	0.082498	0.871158
	(41.11117)***	(-0.969394)	(0.701858)	(-0.921182)	(0.835562)	(4.851949)***	(32.84401)***
Elec. &	0.697858	0.013909	0.161606	41.35499	-22.53760	0.072275	0.908276
Machinery	(48.29890)***	(0.061974)	(0.558787)	(4.163605)***	(-1.900476)*	(5.459424)***	(51.08280)***
Ele.Appliance	0.938154	-0.567140	0.336611	16.00590	-0.901532	0.080170	0.885754
& Cable	(40.31021)***	(-1.692866)*	(0.830578)	(0.758736)	(-0.036882)	(5.280864)***	(47.10046)***
Chemicals	0.681740	-0.134368	-0.145319	46.99368	-23.44801	0.055547	0.941511
	(39.61779)***	(-0.645375)	(-0.397735)	(1.484648)	(-0.689710)	(5.586932)***	(97.45805)***
Glass &	0.623711	0.178934	-0.139682	32.91557	-38.80041	0.175319	0.417500
Ceramics	(24.05038)***	(0.338614)	(-0.232949)	(0.782941)	(-0.886897)	(5.278903)***	(4.398168)***
Paper & Pulp	0.665903	-0.398475	-4.00E-05	5.970281	15.22473	0.079519	0.886151
	(24.99850)***	(-1.199194)	(-7.96E-05)	(0.218376)	(0.377481)	(5.234472)***	(44.21721)***
Steel & Iron	0.506884	-0.667452	0.624062	-42.34375	35.11617	0.045728	0.929379
	(24.90618)***	(-2.474785)**	(1.449127)	(-2.248963)**	(1.768607)*	(5.653064)***	(65.94396)***
Rubber	0.733812	0.024151	-0.401106	80.82956	-51.55195	0.054935	0.932576
	(29.08314)***	(0.065457)	(-0.653431)	(1.560620)	(-0.928897)	(4.681774)***	(63.64361)***
Construction	0.640174	-0.062975	-0.245038	50.42539	-15.16835	0.162379	0.767444
	(25.96721)***	(-0.220860)	(-0.554643)	(1.280255)	(-0.374932)	(5.903460)***	(19.72294)***
Transportation	0.688973	-0.124298	-0.052308	60.44327	-54.72225	0.100521	0.859995
	(28.13627)***	(-0.361493)	(-0.104160)	(2.417713)**	(-2.007346)**	(5.504109)***	(35.99672)***
Tourism	0.293933	-0.028258	-0.134455	24.34137	-3.659076	0.096598	0.866226
	(19.01227)***	(-0.114195)	(-0.401256)	(0.848614)	(-0.120178)	(8.602637)***	(73.98605)***
Wholesale &	0.482330	-0.109654	0.234289	-44.22414	77.85972	0.096609	0.851819
Retail	(28.51121)***	(-0.433068)	(0.719910)	(-1.469926)	(2.250072)**	(5.375004)***	(34.44362)***
Electronics	1.065011	0.085738	-0.143866	-14.06940	9.095442	0.068736	0.918160
	(91.93379)***	(0.545328)	(-0.705006)	(-0.537721)	(0.345198)	(6.143442)***	(72.74759)***
Automobile	0.554242	0.433169	-0.742413	74.61516	-54.39718	0.092122	0.864125
	(24.98600)***	(1.577667)	(-1.900862)*	(2.564780)**	(-1.823782)*	(5.839492)***	(40.06921)***
Finance	0.802663	-0.352247	0.453905	25.52162	-17.31613	0.129595	0.793520
	(48.58710)***	(-1.470699)	(1.447602)	(1.152797)	(-0.603785)	(5.242256)***	(21.36460)***

Note: *, **, *** indicate the estimates are significant at the level of 0.1, 0.05, and 0.01.