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Firms' profitability from firm-specific factor, environmental turbulence, and macroeconomic: evidence from Taiwan's food industry – A review

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Abstract: After a series of shocking domestic food safety scandals in the past few years, environmental concerns have risen in the eyes of the public. The aim of this paper is to analyse the relationships among firm performance, customer capital, R&D innovation, structural capital, firm asset, environmental turbulence, and the macroeconomy by using the panel data model on Taiwanese food industry firms during 2010–2016 and by examining the results of the multiple regime panel smooth transition regression (MR-PSTR) model. The findings show that environmental turbulence and the misery index have a negative relationship on firms' performance, while there is a positive relationship between customer capital and firm performance. However, under high environmental turbulence, customer capital and firm performance are negatively related, meaning that a firm's marketing promotion will be ineffective. This study recommends that the food industry establish a high degree of trust from society and consumers. It is also important for the food industry to establishes a positive attitude towards quality requirements.

Keywords: environmental turbulence; misery index; multiple regime panel smooth transition regression (MR-PSTR) model; structural capital

A series of major food safety scandals have occurred in Taiwan since 2010, and for the food industry, these crises have had a great impact on consumers. Because food safety is of great concern to people and their health, the government, the media, and the general public all attach great importance to it. As such, firms can experience unpredictable and sudden impacts during a rapidly changing industrial environment. Sung et al. (2017) show that firm performance, and environmental turbulence have a positive relationship. Dess and Beard (1984) utilise environmental turbulence to explain an industry's varying impact on the environment.

Taking an overview of the development of Taiwan's food industry generally encompasses food processing, financing, marketing, and research and development. The food industry has changed its strategy from pure manufacturing to marketing service due to limitations such as market size, capital structure, and R&D innovation. Since food companies have an interdependent relationship with society and the general public, a firm's responsibility is to pursue all activities that adhere to social values and meet the needs of the general economy. In addition to seeking profits for shareholders, food firms must establish a high degree of trust, yet environmental turbulence has caused a certain degree of impact on the industry. Therefore, firms and investors are also concerned about changes in the business performance of the food industry, especially those that have invested heavily in customer capital and R&D innovation. The food industry is an important civilian production sector in Taiwan, as it supplies much of the food consumed by the population and continues to create an enormous amount of products to meet the nutritional requirements of society.

Macroeconomic conditions such as unemployment, inflation, and other overall economic factors have a certain influence on consumer confidence, and thus

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it is interesting to see the macroeconomic impacts upon the food industry's operations. Because the competent authorities formulate economic and industrial policies, it is necessary to understand the macroeconomy's influence on the industry as this can offer guidance to firms during macroeconomic changes.

Different from previous literature, this research looks at the impact on the food industry from the perspective of stock price performance or a crisis management point of view. Because Taiwan's food industry has experienced unique environmental turbulence, this paper re-examines firm-specific factors, including customer capital, R&D innovation, structural capital, firm assets, and their impacts on the business performance of the firms.

LITERATURE REVIEW

The food industry comprises a complex network of activities pertaining to supply, consumption, R&D innovation, and services around the world. Given that the food industry is an important business sector driven by the Taiwan government, investors, and shareholders, we shall explore the potential impacts of firm-specific factors, environmental turbulence, and the macroeconomy on business performance through the related literature.

Literature review of environmental turbulence and firms' profitability

Wilden and Gudergan (2015) state that marketing and technological capabilities are primary drivers of a firm's performance and thus of central interest to managers, but the way in which these two capabilities align with changing environments to help secure superior performance remains unclear. The findings of Hung and Chou (2013) contribute to an enhanced understanding of how the degree of leveraging open innovation dimensions depends upon their complementarity, internal R&D, and environmental turbulence. Baba et al. (2017) present findings that both organisational learning and environmental turbulence have a positive effect on SMEs' (small and medium enterprises) ability to innovate.

Taiwan's food industry has been affected by food safety issues, resulting in unprecedented environmental turbulence in this industry. As such, the correlation between environmental turbulence and firms' profitability needs further empirical analysis. We thus offer the first hypothesis.

Hypothesis 1. Environmental turbulence has a non-linear threshold effect among firm-specific factors and a firm's profitability.

Literature review of firm-specific factors and firms' profitability

Guiso and Rustichini (2017) provide evidence that the same biological factor that enhances entrepreneurial skills also induces empire building preferences, which lead high-testosterone entrepreneurs to target a firm size that exceeds a certain profit maximising value. Gourio and Rudanko (2014) utilise cross-industry variation in selling expenses to quantify differences in the degree of friction across markets and find that firms spend substantial resources on marketing and selling. Ek and Guerin (2011) identify that there is still a great distance for most companies to improve the efficiency of structural capital management. Kim (2018) demonstrates that the R&D innovation relationship for high-tech sectors is much flatter, such that the diminishing returns to R&D investment weaken with the increase of technological intensity of industry sectors. In recent years, there has been a large gap in the operating scale of food firms, as their strategies exhibit differences in customer capital, R&D innovation, and capital structure. Thus, we present the next hypothesis.

Hypothesis 2. Firm size has a non-linear threshold effect among firm customer capital, R&D innovation, structure capital, and a firm's profitability.

Literature review of firm-specific factors and firms' profitability

Welsch (2007) finds that people care about growth and employment as well as stability, whereby stability may alternatively be captured through the inflation rate or the long-term interest rate. Schumpeter (2000) points out that the core of economic growth lies in innovation, including production technology innovation and change in production methods.

Guruswamy and Marew (2017) state that growth, gross domestic product (GDP), inflation, and management efficiency are the most vital determinant factors of profitability, with the latter three having a significant and negative relationship with profitability and age, while business risk has a significant and positive impact on profitability.

The food industry is a basic industry that provides people with food. Because the macroeconomy im-

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pacts the food industry through different factors, it is naturally a matter of great concern for both firms and investors. We thus arrive at the next hypothesis.

Hypothesis 3. The macroeconomy has a threshold effect among firm customer capital, R&D innovation, capital structure, and firms' profitability.

METHODOLOGY, MODEL SPECIFICATIONS, AND VARIABLE CONSTRUCTIONS

Model basics

The model of Guiso and Rustichini (2017) derives from the standard conventional theory where the dependent variable is business performance. We thus use the panel data model to estimate the effects of firm-specific factors, environmental turbulence, and macroeconomy on 26 Taiwanese food firms during 2010–2016 as follows in Equation 1:

$$P_{it} = CU_{it} + R\&D_{it} + SC_{it} + A_{it} + EU_{it} + MA_{it} + \varepsilon_{it} \quad (1)$$

In Table 1 we use return on assets (*ROA*) and return on equity (*ROE*) as proxy variables to measure firm performance (P_{it}), error term ε, total number of firms *i*, size of the sample period *T*, and several important independent variables including firm customer capital (CU_{it}), R&D innovation ($R\&D_{it}$), structural capital (SC_{it}), firm assets (A_{it}), environmental turbulence (EU_{it}), and macroeconomy (MA_{it}). We set up the equation as follows and use a panel multiple regime panel smooth transition regression (MR-PSTR) that imposes a common regime-switching mechanism while allowing for con-

Table 1. Main variable descriptions

Variable	Abbreviation	Description
Dependent variable		
Firm performance	(*P*)	return on equity (*ROE*) and return on assets (*ROA*) are two of the most important measures for evaluating how effectively a firm's management team is managing the capital that shareholders entrust to it; this paper used *ROA* and *ROE* as proxy variables to measure company performance
Firm-specific variables		
Customer capital	(*CU*)	firms spend substantial resources on marketing and selling; to measure customer capital, this paper used marketing costs as proxy variables
R&D innovation	(*R&D*)	for the impact of research spending on business performance, this paper took *R&D* expenses as a percentage of net operating income; *R&D* innovation is essentially an investment in technology and future capabilities which is transformed into new products, processes, and services
Structural capital	(*SC*)	ratio refers to the own funds provided by the owners among total assets of thecompany; the higher the ratio is, the greater the protection will be for creditors
Firm assets	(*A*)	in the past, most studies focused on total assets and sales or number of employees; this paper used total assets as a proxy variable
Industry-specific variable		
Environmental turbulence*	(*CU*)	this paper used environmental turbulence to explain the variation of the industrial environment and took the ratio of the standard deviation of the net revenue (*NRE*) of industrial revenue to the average value of net industrial income as the proxy variable
Macroeconomic variable		
Misery index	(*MA*)	index is an economic indicator and helps determine how the average citizen is doing economically; it is calculated by the ratio of the unemployment rate to the annual inflation rate

*this paper used the annualized standard deviation calculated by the Taiwan Economic Journal (TEJ 2018) database, which is:

$$\sigma_m = \frac{\sqrt{\sum_{i=1}^{n}\left(NRE_i - N\bar{R}E\right)^2}}{\frac{n-1}{NRE_1 + NRE_2 + NRE_3 + NRE_n}}$$

Source: authors

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siderable heterogeneity in the timing of regime changes across series by setting the threshold of firm assets (A_{it}), environmental turbulence (EU_{it}), and macroeconomy (MA_{it}). We observe changes in independent variables under different threshold variables.

Multiple regime panel smooth transition regression

We estimate Equation 2 using the MR-PSTR model's[1] extreme regimes, where transitions between regimes are smooth. The dependent variable of ΔP_{it} is firms' performance, and the transition function $F(s_{it}; \gamma; c)$ is a continuous function of observable variable s_{it}. c is the threshold value and parameter γ determines the speed and smoothness of the transition. β'_{0i} is coefficient, x_{it} is independent variables, U_i is slope and U_{it} is disturbance term.

$$\Delta P_{it} = U_i + \beta'_{0i} x_{it} + \beta'_{1i} x_{it} \mathrm{F}(s_{it}; \gamma, c) + U_{it} \quad (2)$$

We normalize this to lie between 0 and 1, which denote the two extreme values for regression coefficients. We further consider the following logistic transition function for the time series STAR models by Granger and Teräsvirta (1993), the transition function $F(s_{it}; \gamma; c)$, to be a continuous function of the observable variable s_{it}. The widely used transition function is a logistic specification as in Equation 3:

$$F(s_{it}; \gamma, c) = \left(1 + \exp\left(-\gamma \prod_{j=1}^{m} (q_{it} - c_j)\right)\right)^{-1}$$
$$\text{with } \gamma > 0 \text{ and } c_1 \le c_2 \ldots \le c_m \quad (3)$$

where the transition functions $j = 1$, m is m-dimensional vector of location parameters. q_{it} is associated with the transition variable. It is necessary to employ homogeneity tests for the estimation of MR-PSTR models, and to overcome this problem one may replace the transition function $\mathrm{F}(s_{it}; \gamma; c)$ by its first-order Taylor expansion around $\gamma = 0$. A generalisation of the MR-PSTR model to allow for more than two different regimes is the additive model, whereby $\beta'^{*}_{1} \ldots \beta'^{*}_{m}$ are the parameter vectors. Consequently, testing $\mathrm{H}_0: \gamma = 0$ in Equation 1 is equivalent to testing the null hypothesis $H_0^*: \beta_1^* = \ldots = \beta_m^* = 0$ in Equation 4, which yields the following auxiliary regression:

$$\Delta P_{it} = U_i + \beta'^{*}_{0\,i} x_{it} + \beta'^{*}_{1} x_{it} s_{it} + \ldots + \beta'^{*}_{m} x_{it} s^{m}_{\ it} + U^{*}_{\ it} \quad (4)$$

where U^*_{it} is a disturbance term. We can execute this test by an *LM* test (Wald test). Denoting the panel sum of squared residuals under H_1 as SSR1 (which is the two-regime MR-PSTR model), the corresponding *F*-statistic is thus defined by:

$$LM_F = \frac{(SSR_0 - SSR_1)/MK}{SSR_0/(TN - N - M(K+1))} \quad (5)$$

Linearity tests also serve to determine the appropriate order of m of the logistic transition function in Equation 3. It is an approximate distribution of (MK, TN-N-$M(K + 1)$). We test a set of transition variables to detect the one for which linearity is strongly rejected. Where N is the total number of firms, T is the size of the sample period, and K represents the number of explanatory variables. Based on the null hypothesis, the *LM* and likelihood-ratio test (*LRT*) statistics were distributed as *MK* (chi-square statistic (X^2)).

EMPIRICAL RESULTS

Panel unit root

Table 2 shows results that the null hypotheses of the LLC (Levin et al. 2002) and IPS (Im et al. 2003) unit root tests are rejected by all variables, including *ROA*, *ROE*, firm customer capital (*CU*), *R&D*, structural capital (*SC*), firm assets (*A*), environmental turbulence (*EU*), and macroeconomy (*MA*) with first differences. In other words, the panel sample data selected in this study are all stationary. Therefore, this study can be followed by an empirical analysis of the panel threshold regression model.

Descriptive statistics

Table 3 reports that environmental turbulence (*EU*) is between 0.193 and 0.516%, because due to the emergence of food safety problems, Taiwan's food industry has faced significant negative impacts from environmental variability. Firm performance is between –21.2 and 48.98%, and the mean is 5.436% for return on equity (*ROE*), denoting that the sector's firms exhibit great differences in terms of business performance. Conversely, customer capital (*CU*), R&D innovation

[1]We adopt the PSTR model, which was developed by Gonzalez et al. (2005), to study firms' profitability from the aspects of firm-specific factors, environmental turbulence, and the macroeconomy.

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Table 2. Panel unit roots

Variable	LLC				IPS			
	level	*p*-value	difference	*p*-value	level	*p*-value	difference	*p*-value
ROE	0.185	0.415	19.499	0.000	0.32	0.466	13.231	0.000
ROA	0.125	0.549	18.541	0.000	0.33	0.07	12.111	0.000
Firm-specific								
CU	0.651	0.782	–9.395	0.000	2.283	0.989	–10.763	0.000
R&D	2.512	0.996	–2.992	0.000	4.488	0.979	–6.916	0.000
SC	0.223	0.402	19.499	0.000	0.31	0.456	13.231	0.000
A	2.703	0.956	–2.993	0.000	4.589	0.968	–6.965	0.000
Industry-specific								
EU	–1.671	0.579	–6.581	0.000	–1.563	0.17	–12.241	0.000
Macroeconomic-specific								
MA	0.648	0.762	–9.395	0.000	–2.283	0.987	–10.766	0.000

IPS – Im et al. (2003); LLC – Levin et al. (2002); for explanation of variables see Table 1

Source: authors' own calculations based on data provided by the Taiwan Economic Journal database (TEJ 2018)

(*R&D*), and structural capital should exude different degrees of influence on a firm's performance. Firm customer capital (*CU*) is between –3.912 and 0.909%, meaning there is a big difference in the focus that firms put into marketing and promotion resources; firm structural capital (*SC*) is between 0.209 and 0.848%, which is a big difference among the firms. Firm R&D innovation (*R&D*) is between –0.25 and 0.086%, which reveals a great difference among the firms. The Taiwan misery index shows that Taiwanese people's economic capacity has a direct impact on the profitability of the food industry and affects the specific performance of the firms. The firm asset (*A*) is between 705 and 41 0470 NT$ million. The Taiwan misery index (*MA*) shows that Taiwanese people's economic capacity has a direct impact on the profitability of the food industry and affects the specific performance of the firms. The Taiwan misery index (*MA*) is between 3.11 and 7.28%, and its standard deviation is 0.993, showing that *MA* has changed greatly in recent years.

Panel multiple regression model and robustness analysis

This paper examines firm performance (*ROA*, *ROE*), firm customer capital (*CU*), *R&D*, structural capital (*SC*),

Table 3. Descriptive statistics

Variable	Standard deviation	Mean	Median	Minimum	Maximum
ROE	6.500	5.436	3.810	–21.200	48.980
ROA	5.116	5.655	4.275	–1.370	28.010
Firm-specific					
CU	0.304	0.642	0.711	–3.912	0.909
R&D	0.232	0.017	0.008	–0.250	0.086
SC	0.153	0.587	0.591	0.209	0.848
A (NT$ million)	6.098	29 214	7 914	705	41 0470
Industry-specific					
EU	0.076	0.442	0.469	0.193	0.516
Macroeconomic-specific					
MA	0.993	5.282	5.500	3.11	7.28

for explanation of variables see Table 1

Source: authors' own calculations based on data provided by the Taiwan Economic Journal database (TEJ 2018)

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Table 4. Results for the multiple regression model

Predictor	*ROE* (Model A)		*ROA* (Model B)	
	coefficient	*p*–value	coefficient	*p*–value
Constant	4.655	0.243	5.642**	0.046
Firm–specific				
CU	15.443***	0.000	19.602***	0.000
R&D	–52.329***	0.000	–65.668***	0.000
SC	5.388***	0.000	2.609**	0.034
A	–8.599	0.150	–1.596***	0.000
Industry–specific				
EU	–14.199 ***	0.000	–13.707***	0.000
Macroeconomic–specific				
MA	–2. 082 **	0.044	–1.660 **	0.020
R–squared	0.359		0.482	
Adjusted *R*–squared	0.347		0.471	

p–values ***, **, and * indicate significance at the 0.01, 0.05, and 0.1 levels, respectively; for explanation of variables see Table 1

Source: authors' own calculations based on data provided by the Taiwan Economic Journal (TEJ 2018)

firm assets (*A*), environmental turbulence (*EU*), and macroeconomy (*MA*) by employing a panel of 26 Taiwanese food industry firms over the period 2010–2016. Our main estimates rely on data from Taiwan Economic Journal (TEJ) sources. We apply the panel multiple regression model and present the results in Table 4.

We find a positive relationship between firms' performance and customer capital (15.443) (Model A), implying that a company's investment in marketing expenses is very helpful to its performance. Through marketing strategies such as advertising or media introduction, consumers are encouraged to purchase firms' products, thus contributing to higher firm operating performance. In other words, customer capital is important, and the influence on a firm's business growth cannot be ignored. However, *R&D* innovation and performance have a negative relationship (–52.329), implying that firm investment in *R&D* resources is not helpful for performance, as there may be insufficient innovative technology capabilities or a lack of *R&D* innovation talents. Therefore, the food industry should pay attention to the benefits of *R&D* investment. There is an also positive relationship between firms' performance and structural capital (5.388).

Environmental turbulence (–14.199) and the misery index (–2.082) both have a negative relationship with firms' performance by reducing it. In terms of environmental turbulence, since the food industry provides consumers with food needed to sustain life, it is important for the industry to have a good image.

For industrial policy recommendations, the empirical analysis shows that environmental turbulence is negatively related to the food industry. Therefore, it is important to maintain stability in the food industry. It is also necessary for the industry to establish the proper attitude towards food quality that will result in good corporate social responsibility.

For a firm's policy, since the food industry is different from other industries, due to food health and safety and concerns about consumer health, it is recommended that good quality management and corporate governance can help firms establish a scientific management mechanism and maintain the pursuit of a better food safety attitude. For the competent authority, since the food industry is a source of consumer health, in addition to regular inspection mechanisms, advocating self-discipline with higher quality standards will further help firms.

This paper also conducts robustness analysis in *ROA* (Model B) and finds results that are consistent between Model A and Model B. There is a positive relationship among customer capital, structural capital, and firm performance. Conversely, *R&D* innovation, firm assets, environmental turbulence, the misery index, and performance have a negative relationship with each other.

Panel threshold model

In Table 5 we use the transition variable, and the *LRT* tests support the non-linear relationship between

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Table 5. Test of linearity and testing the number of regimes

	Statistics	*p*-value
Test of linearity		
Wald test (*LM*)	92.160	0.000*
Fisher test (*LMF*)	7.470	0.000*
LRT test (*LRT*)	113.661	0.000*
Sequence of homogeneity tests for selecting *m*		
H_3: $B_3 = 0$	$F_3 = 4.434$	0.000
H_2: $B_2 = 0 \mid B_3 = 0$	$F_2 = 2.596$	0.003
H_1: $B_1 = 0 \mid B_2 = B_3 = 0$	$F_1 = 22.879$	0.000*
Testing number of regimes: test of no remaining non-linearity		
Wald Test (*LM*)	8.735	0.120
Fisher Test (*LMF*)	1.467	0.015
LRT Test (*LRT*)	8.850	0.010

*denotes significance at the 5% level; *H* – hypothesis; *B* – the testing of the number of regime; *F* – *F*-statistics

Source: authors' own calculations based on data provided by the Taiwan Economic Journal database (TEJ 2018)

Table 6. Results of multiple regime panel smooth transition regression (MR-PSTR) model estimation and robustness test (threshold variable: *A*)

Variables	Low-scale firms	High-scale firms
Dependent variable is defined as *ROE*		
CU	−49.723***	2.829***
	(3.177)	(3.135)
R&D	−47.409***	−147.792***
	(20.130)	(43.288)
SC	−22.577	19.233***
	(24.107)	(23.889)
Robustness analysis: dependent variable is defined as *ROA*		
CU	−2.847	2.747*
	(2.722)	(2.990)
R&D	−0.339	−88.884
	(59.313)	(60.231)
SC	−1.396	13.614***
	(4.998)	(4.350)

*, **, and *** denote 10, 5, and 1% significance levels, respectively; values in the brackets are the standard error values; for explanation of variables see Table 1

Source: authors' own calculations based on data provided by the Taiwan Economic Journal database (TEJ 2018)

business performance and threshold variables. The results show that the *LRT* tests support the non-linear relationship between firm customer capital (*CU*), *R&D*, structural capital (*SC*), firm assets (*A*), environmental turbulence (*EU*), and macroeconomy (*MA*), and firm performance (*ROA*, *ROE*) under different thresholds.

We next apply a sequence of tests to determine the order *m* of the logistic function. In practice, it is usually sufficient to consider $m = 1$ or $m = 2$ for the transition function, as these values allow for commonly encountered types of variation in the parameters. The testing results show that a reasonable number of thresholds is $r = 2$, which means that there are two regions and each region has two regimes.

As Table 6 indicates, by taking the scale (*A*) as the threshold we find that customer capital (*CU*) has a trade-off relationship between small scale and large scale. Large-scale firms engaged in marketing exhibit a positive and significant relationship with firm performance (2.829), while small-scale companies have a negative and significant relationship with firm performance (–49.723); this implies small-scale firms' marketing has limited benefit to their performance. Therefore, small-scale firms should think about the development of other suitable marketing models, so that such investment in marketing resources can promote efficiency. In addition, the fact that structural capital (*SC*) has a positive relationship to large-scale firms indicates that their structural capital is beneficial for own firm performance. We find that R&D innovation (*R&D*) and firm performance are negatively related between small scale and large scale, on the other hand, we also find that structural capital (*SC*) has a trade-off relationship between small scale and large scale.

As Table 7 indicates, under high environmental turbulence (*EU*) as the threshold we find that customer capital (*CU*) and firm performance are negatively related (–0.090), meaning that marketing promotion is ineffective under this situation; for example, when food safety problems occur in Taiwan, consumers' purchasing confidence is negatively impacted. During such a time, it is inefficient or even negative to invest more in marketing promotions. There is a positive relationship between firms' performance and customer capital (*CU*) (2.747), as marketing strategies should create product attractiveness and stimulate consumers' willingness to buy the product.

When there is high environmental turbulence (*EU*), there is a non-significant positive relationship between structural capital (*SC*) and firm performance (28.614). However, under low environmental turbulence (*EU*), structural capital (*SC*) has a positive and significant relationship with firm performance (29.096). This study suggests that a turbulent industry

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Table 7. Results of multiple regime panel smooth transition regression (MR-PSTR) model estimation and robustness test (threshold variable: *EU*)

Variables	Low environmental turbulence		High environmental turbulence	
Dependent variable is defined as *ROE*				
CU	2.747*	(2.990)	–0.090*	(1.776)
R&D	–95.574***	(67.901)	–32.767***	(67.255)
SC	29.096***	(24.876)	28.614	(20.717)
Robustness analysis: dependent variable is defined as *ROA*				
CU	2.049**	(0.951)	–0.031*	(0.021)
R&D	–80.903***	(15.649)	–31.317***	(15.038)
SC	13.324***	(3.474)	11.778	(1.224)

*, **, and *** denote 10, 5, and 1% significance levels, respectively; values in the brackets are the standard error values; for explanation of variables see Table 1

Source: authors' own calculations based on data provided by the Taiwan Economic Journal (TEJ 2018)

should strongly execute structural capital. In addition to stabilising a firm's operations, this can help out with investor confidence. We find that R&D innovation (*R&D*) and firm performance are negatively related between small environmental turbulence and large environmental turbulence.

As Table 8 indicates, in regards to the high misery index range (*MA*), customer capital (*CU*) (1.732) and structural capital (*SC*) (24.062) reveal a non-significant positive relationship. In other words, more marketing promotions have a limited benefit to a firm's performance. At this time, food firms should carefully consider suitable business strategies and structural capital (*SC*) to stabilise their business performance.

This paper also finds, for R&D innovation (*R&D*) in all terms of thresholds, that these R&D innovation variables (*R&D*) are impacted negatively significant with firm performance, implying that R&D innovation (*R&D*) in the food industry has much room for improvement.

Table 8. Results of multiple regime panel smooth transition regression (MR-PSTR) model estimation and robustness test (threshold variable: *MA*)

Variables	Low misery index	High misery index
Dependent variable is defined as *ROE*		
CU	3.034* (1.747)	1.732 (0.021)
R&D	–112.192*** (29.075)	–78.641*** (16.229)
SC	21.294*** (5.198)	24.062 (2.380)
Robustness analysis: dependent variable is defined as *ROA*		
CU	2.575* (1.267)	1.775 (0.931)
R&D	–91.233*** (21.184)	–75.752 (13.345)
SC	6.841** (3.572)	7.142 (1.164)

*, **, and *** denote 10, 5, and 1% significance levels, respectively; values in the brackets are the standard error values; for explanation of variables see Table 1

Source: authors' own calculations based on data provided by the Taiwan Economic Journal (TEJ 2018)

CONCLUSION

In the wake of a slew of shocking food-safety scandals over the past years in Taiwan, quite a bit of environmental turbulence has occurred for related firms. Having examined the relationships among firm performance, customer capital, *R&D* innovation, structural capital, firm assets, environmental turbulence, and macroeconomy by using the panel data model on 26 Taiwanese food industry firms during 2010–2016 and by adopting the results of the MR-PSTR model, this study finds that there are non-linear threshold effects for the scale effect, environmental turbulence, and misery index. Hypotheses 1–3 of this study are all supported. From the result of the panel multiple regression model, we find a positive relationship between firm business performance and customer capital, indicating that marketing promotion positively impacts company performance, because it helps consumers to quickly recognise and purchase products and to establish firm visibility. However, environmental turbulence is a bad influence on the food industry. When there is greater environmental

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turbulence, marketing promotion negatively influences company performance. Therefore, because the overall image of the food industry is important, firms should execute good corporate social responsibility and a sound corporate governance business philosophy, as they will provide a great boost to the stability and sustainability of the food industry. Conversely, because *R&D* innovation and performance have a negative relationship, the food industry should pay more attention to the benefits of *R&D* investment.

Secondly, while structural capital contributes to the development of corporate performance, the food industry has shown that the former is not effective in the context of the environmental turbulence and the high misery index. This study suggests that when faced with large environmental turmoil and weak overall economic conditions, the major shareholders of a food firm should have more confidence in their firm's operations and sustainability in order to influence external investors to have more confidence in the future development of the overall food industry.

Finally, for industrial policy recommendations, it is important to establish a proper attitude towards the food quality requirements of the food industry and exude good corporate social responsibility, so that consumers will have strong trust in the food industry, which is an important factor in this sector's stability. For future research, corporate governance has become a very important issue in recent years, and the food industry faces the challenges of operating food safety and management. It is thus worth discussing the influence of corporate governance in the food industry from the perspective of corporate governance. Fama and Jensen (1983) and John and Senbet (1998) show the importance of corporate governance toward a firm's business performance. Therefore, this study will continue to explore the relevance of food firms' business performance and corporate governance.

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