Received: 5 October 2019 | Revised: 2 April 2020 | Accepted: 24 May 2020

DOI: 10.1002/hpm.3012

RESEARCH ARTICLE

WILEY

Endangering China's environmental health security goals through negative environmental investor behaviours

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Funding information

Government of Jiangsu Province, Grant/Award Number: 1102129C; Post-doctoral Foundation of China, Grant/Award Numbers: 2018T60508, 2018M511705; National Natural Science Foundation of China, Grant/Award Numbers: 71904066, 71974079

Summary

China sees the need to maximise its environmental health security as a major priority in its sustainable development agenda. This is at the heart of China's "ecological civilisation" and "beautiful China" dream. One of the objectives of this dream is to sensitize investors to invest in health and environmental stocks to support environmental health goals. However, both the Shanghai and the Shenzhen stock markets continue to witness contemporaneous movement (herding behaviour) by investors from environmental stock to perceived safer stocks and this is stifling the growth of the environmental health sector due to capital deprivation. Our paper evaluates the significance and potential effect of this herding trend among environmental stocks using a collection of sophisticated econometric models namely, the state-space model, enhanced state-space model, the cross-sectional SD (CSSD) and the cross-sectional absolute deviation (CSAD). The models are used to evaluate firm-level data collected from the 80 environmental stocks indexed by the KGRM MSCI China IMI Environment 10/40 Index. Three of the models confirm the presence of endemic negative (herding) investor behaviour among environmental stocks in China and this threatens the sustainability of environmental stock capital to promote China's environmental health goals. We have proposed measures to ameliorate the risks posed by such negative contemporaneous investor behaviours.

KEYWORDS
environmental, health, herding behaviour, investor, stock market

1 | INTRODUCTION

The effect of environmental degradation on human health and well-being has gained a self-perpetuating momentum across the globe since the early 1960s. Many countries have responded to the global call enacting various environmental health regulations, policies programs and thresholds.[1] In most of these countries, both public and private organisations are required by domestic and international laws to design enduring sustainable mechanisms to minimize environmental health externalities associated with their operations.[2] Since the United Nations Conference on Environment and Development (Rio de Janeiro Earth Summit, 1992), new frontiers in ecological health security have emerged beyond the previously known areas of environmental concern.[3] Before this Earth Summit in 1992, environmental health security programs among countries focused mainly on natural and few built environmental factors that affect human health, for example, sanitation.[4] Over time, and in response to the UN Decade of Education for Sustainable Development (2005-2014), a new sphere in environmental health security emerged to shift the paradigm to radically promote development that seeks to meet human development goals without compromising on the natural systems, resources and ecosystem upon which the global economy and society depends.[4]

Central to the new sphere in sustainable development is environmental health security. This interest is also due to the increase in the records of industry-induced health casualties over the world. The focus of new environmental concerns on environmentally responsible behaviours at all level of development keeps inspiring advanced research in pro-environment programs in China and many other emerging countries.[5] China's ecological civilization program requires all manufacturing enterprises to adopt environmentally responsible manufacturing (ERM) practices to prevent, detect and respond to environmental-led calamities.[6] China's industries are consciously but systematically readjusting their operational systems, skills, strategies, structures and shared values to positively alter the changing dynamics of the ecosystem and its resulting environmental health concerns.[7]

Most of the environmentally responsible business practices being pursued in China are economically driven system-wide and integrated strategies that seek to eliminate or reduce waste streams associated with supply chain, product and service design, manufacturing processes, product use and disposal of materials.[8] Fundamental in this endeavour is the recognition that waste and pollution may have far-reaching environmental health security implications. Despite the benefits of the previous generation of sustainable techniques that emerged in the early 1980s to support industries (just in time, total quality management, process reengineering, time-based competition, etc.), these alone have not been sufficient to safeguard concerns for the protection of the environment[9] hence need for alternative approaches. Further, as more and more industrial clusters emerge across China, another move to imbed sustainable environmental health practices is driving collaborative networks so that group of firms can optimise environmentally responsible behaviours through shared resources. For example, Biotech, Medtech and Pharmaceutical firms such as Jiangsu Hengrui Medicine, Fosun Pharmaceutical, Sinopharm Group, Harbin Pharmaceuticals, Guangzhou Pharmaceutical Holdings Limited in Jiangsu, Guangdong, Heilongjiang, Shanghai and Jiangxi Provinces have been successful in promoting greater environmental health security through self-regulating collaborative network of environmentally responsible policies, programs and standards.[10] These industry-led initiatives have engendered more exceptional public support, renewed political commitment from top leaders and elicited massive government subsidies for these industries among others.[10]

Despite this seemingly successful effort in China's quest to secure its environmental health security goals, the strategies and policies are not without pitfalls. China believes that a flourishing environmentally stock market is essential to get the needed capital to consolidate environmental health goals.[11] President's Xi's "ecological civilisation" and "beautiful China" dream are founded on a strong public–private partnership through capitalisation of the environmental stock market.

However, Ji and Zhang[12] observed that the environmental stock market in China is not attractive to Chinese and foreign investors alike. In the last decade, the market has not been stable as investors move away in herds to perceived safer stocks intermittently in response to both internal and external shocks. For example, high environmental tariff, tight ecological inspections, closed-down of non-compliant producers have affected investor confidence in the sector.

Further, the regulations for new energy vehicles announced by the government in September 207 helped the dominance and surge in the stock price of BYD (Chinese electronic car manufacturer).[12] Yet this sudden decision failed to give non-Chinese makers enough time to prepare, such as building new plants and designing new models, effectively ensuring fines or forcing them to buy high-priced credits from Chinese manufacturers once the regulations go into effect.[12] When the stock market growth is created by such an artificial process as in the case of BYD, external and institutional investors become apprehensive as they do not know the next move of the state, which can potentially affect the profitability of their investments in the environmental stock market.[13]

The logical thing is for the investors to flee in herds (en-mass) to safer investments making the sector vulnerable to investor herding behaviour.[14] A recent study by KraneShares (a company that sponsors an exchange-traded fund attached to the China environmental health theme) reported on the challenges of the environmental stock market due to frequent environmental stock market fluctuations (returns and prices). Similarly, Broadstock & Cheng[15] also noted that over 50% of ecological stocks in China are overweighted and vulnerable to investor shifts when policies become less favourable. This tendency has the potential to increase market uncertainty and further compound the rate of mass and unexpected herding of investors from the environmental health market in China. This pattern is suspected to be responsible for the nearly 6.4% decline in the KraneShares MSCI China Environment Index from June 2018 to April 2019.

Moreover, as the rate of economic growth begins to slow down in China, environmental investors are more concerned with the need to preserve their capital and have begun deserting long-term investment strategies in the environmental stock market. They are instead opting for more stable and short-term markets such as the healthcare industry.[16] China's culture is highly collectivist as such investors tend to influence many others when they decide to shun a particular market. If this happens in the environmental stock market, the capital needed to stimulate environmental health security goals will reduce.[17] Several studies have already been conducted regarding herding behaviour in other stock markets in many countries including China, but not much has been done in the case of the environmental stock market in China and its repercussions on environmental health security. These studies have also differed in the methodologies used as well as the outcomes they identified.

For example, Christie and Huang[17]; Chang et al[18] and Demirer and Kutan[19] studied herding behaviour based on rational asset pricing conducted on securities in the United States, Europe and China, respectively. These studies observed that herding behaviour contributes significantly to the return on securities during market recessions. Demirer et al[20] also analysed the existence of investor herding behaviour among 60 highly capitalised stocks based on a cross-sectional SD model. The study did not find herding behaviour among investors during period of economic stress. A similar study was conducted in the crude oil and heating oil capital markets by Uchida and Nakaga.[21] The authors used a local-stochastic volatility (LSV) model known as the cross-sectional variability of factor sensitivities to analyse data on daily returns of the stock market. Chen et al[14] developed it for the Japanese securities market and their results confirmed that investor do herd on the stock market. In the healthcare sector, Lulin et al[22] explored the effect of investor herding behaviour on the Chinese stock markets, whereas Tripathi et al[23] used herding techniques to study quarantine behaviour during the epidemic to support control. Similar industry-level studies by (Hwang and Salmon,[24] Chang,[25] and Flammer[26]) are documented in the existing literature with conflicting outcomes based on the differences in the analytical procedure used.

This study is seeking to find out whether the environmental stock market in China also experiences investor's herding behaviour. This is done by assembling a collection of four sophisticated econometric models, namely the state-space model, enhanced state-space model, the cross-sectional SD (CSSD) and the cross-sectional absolute deviation (CSAD). We then compare the results of the four methods to determine whether they prove that indeed, there is investor's herding behaviour in the environmental stock market in China. If this is the case, we can then argue that environmental health security in China is endangered by harmful investor behaviour on the stock market.

To the best of our knowledge, this study is the first to apply the econometric model to determine investor's herding behaviour in the environmental stock market. Moreover, this study is innovative because we apply the models to firm-level data instead of industry-level data, which have predominantly been employed in the earlier studies. We also use the daily equally weighted index returns data from the selected environmental stocks on the Shenzhen, and Shanghai stock markets. The Hong Kong stock market is included for standardisation purposes. The three stock markets are essential for this study because they have a high presence of both domestic and foreign investors. Previous researchers have posited that foreign investors with higher information asymmetry tend to herd more than local investors. We briefly explain our methodology, the source of data and analytical procedure and present the empirical. We conclude the study by explaining the environmental health policy implications and future research direction.

2 | MATERIALS AND METHODS

2.1 | Data selection

We collected the data on the 80 environmental stocks indexed on the MSCI China IMI Environment 10/40 from two main sources. Firstly, performance data were collected from May 2015 to August 2017 from the Shenzhen and Shanghai stock exchanges since the KGRM MSCI China IMI Environment 10/40 Index was not established within the period. Data from September 2017 to April 2019 were, however, collected from the KGRM MSCI China IMI Environment 10/40 Index. Since its launch, the KGRM MSCI China IMI Environment 10/40 Index has become a benchmark for investors that identify with China's sustainability vision and wants to encourage environmentally responsible business practices.[27]

We applied a strict data inclusion and exclusion criteria to eliminate outliers, clerical errors, empty and partially recorded information as well as other glaring mistakes in the data. The final results yielded a total of 116 800 average daily returns of 80 environmental stocks for the period under consideration. The 80 stocks were further grouped into the four sectors, namely power generation, materials, automobile and environmental solution per MSCI classifications. We studied the stocks in groups in order to quickly identify herding syndromes in a homogeneous trade where the members face the same decision problem.

The daily return of the securities was computed based on the equally weighted portfolio for the 80 stocks, and the summary statistics is presented in Table 1.

Table 1 also shows the proportion of both domestic and foreign investors in the four sectors. This helps to verify the claim that investor groups (where trade is sufficiently homogeneous) are more susceptible to herd than individual investors. Generally, Table 1 shows persistent growth in the number of foreign investors in the four sectors from 2015 to 2019.

Table 2 shows the summary statistics for the log of the average daily return, the average number of companies and return dispersion used in computing the individual statistics for the sectors. Panel A shows that the average daily returns are positive for the four sectors. Panel B, on the other hand, shows the summary statistics for daily cross-sectional SDs within each sector. Both Panel A and Panel B show that the volatility cross-section in the automobiles sector is relatively high.

TABLE 1 Percentage of share holders in the market by sector (%)

Year	Power generation (%)			Materials (%)			Automobile (%)			Environmental solution (%)		
	Domestic individual	Domestic institution	Foreign investor	Domestic individual	Domestic institution	Foreign investor	Domestic individual	Domestic institution	Foreign investor	Domestic individual	Domestic institution	Foreign investor
2015	92.8452	3.1066	3.0482	93.7272	1.7056	4.1872	92.4242	0.392	6.9638	91.4242	0.392	7.2638
2016	92.7472	0.784	6.3986	90.7676	1.539	6.7232	83.1522	0.5096	14.308	80.2522	0.5096	18.308
2017	88.6312	0.8526	9.5162	88.3372	1.6272	9.9572	80.9484	0.4606	18.231	79.9484	0.4606	18.631
2018	87.4552	0.8918	10.653	89.0134	1.3234	9.2232	85.9366	0.735	12.3284	84.9366	0.735	13.3284
2019	83.7116	0.8918	14.3966	73.6902	1.882	24.4278	81.8892	0.5292	16.5914	80.8892	0.5292	17.5914

TABLE 2 Summary of the statistics for the average daily returns and the cross-sectional SDs

Sector	# Firms	# Obs.	Mean	SD
Panel A: Average daily return				
Power generation	16	23 360	0.02%	2.41%
Materials	32	46 720	0.02548	2.3559
Automobiles	17	24 820	0.02744	2.7901
Environmental solutions	15	21 900	0.01372	2.6185
Panel B: Cross-sectional standard deviation				
Power generation			1.53%	0.89%
Materials			1.94922	0.6909
Automobiles			1.957	0.7105
Environmental solutions			2.07662	0.5968

2.2 | Analytical procedure

Four different but related econometric models were employed to test the presence of investor's herding behaviour among the 80 environmental stocks on the Shenzhen, Shanghai and the Hong Kong Stock Exchanges. These were two return dispersion models (CSSD and CSAD) and two state spaced models. The first return dispersion models namely cross-sectional SD (CSSD) measures the presence of herding behaviour as follows:

$$\mathrm{CSSD}t = \sqrt{\frac{\sum_{i=1}^{N}\left(r_{i,t}-r_{p,t}\right)^2}{N-1}} \tag{1}$$

where n denotes the number of companies in the aggregate market portfolio, whereas $r_{i,t}$ denotes the stock return observed on the company i for day t and $r_{p,t}$ is the cross-sectional average of the n returns in the market portfolio for day t. This measure also denotes the individual security returns dispersion close to the market average. The key idea in this model is that herd behaviour prevents the return of securities from deviating away from the overall market return since it is assumed that individuals invest largely based on the collective actions in the market. Another advantage of this approach is that it assumes that herding behaviour may largely occur during extreme market movements as investors will usually opt for market consensus during such period. The return dispersion measure in Equation (1) during market stress is estimated using a regression equation

$$\mathrm{CSSD}_t = \alpha + \beta_D D_t^L + \beta_U D_t^U + \varepsilon_t \tag{2}$$

where D_t^L = 1, if the aggregate market portfolio return on day t lies in the *lower* tail of the return distribution; 0 otherwise, and D_t^U = 1, if the aggregate market portfolio return on day t lies in the upper tail of the return distribution; 0 otherwise. Since the formation of herd behaviour means imitating the market consensus, obtaining negative and statistically significant β_D (for down markets) and β_U (for up markets) coefficients implies the presence of herding behaviour among the market participants. This method has been used successfully in earlier studies by Huang, HuiYing et al,[28] Ji and Zhang[14] and returned good results. The second return dispersion model used for this study is proposed by Chang et al.[24] This model uses the cross-sectional absolute deviation of returns (CSAD) as a proxy to measure return dispersion (CSAD). This idea is expressed mathematically as

$$\mathrm{CSAD}_t = \frac{1}{N}\sum_{i=1}^{N}\left|r_{i,t}-r_{m,t}\right| \tag{3}$$

This model disagrees with the assumption of the capital asset pricing model (CAPM). Instead, it believes that return dispersion and market returns have a linear relationship and that is expressed mathematically as

$$CSAD_t = \alpha + \gamma_1 |r_{m.t}| + \varepsilon_t \tag{4}$$

The argument of Chang et al[24] who is the originator of this model is that market recession leads to the formation of a non-linear relationship between market return and return dispersion instead of the linearity assumption proposed in the CAPM. To date, this model has been applied to different studies with a robust outcome. For example, Akerlof and Shiller[29] successfully applied this model to detect herding behaviour robustness of reference in different industries and markets. This study adopts but modifies the quadratic form of Chang et al' s26 general quadratic relationship between $CSAD_t$ and $r_{m,t}$ as follows:

$$CSAD_t = \alpha + \gamma_1 |r_{m.t}| + \gamma_2 r_{m.t}^2 + \varepsilon_t \tag{5}$$

This model measures herd behaviour by looking at the proportional increases in the cross-sectional absolute deviation (CSAD) during extreme market movements. Herd formation will show in this case with a negative and statistically significant non-linear coefficient γ_2 and vice versa.

The second model used to measure herding behaviour among environmental stocks on the Chinese stock markets are the state-space models. Consistent with earlier works of Hwang and Salmon,[22] the measurement of herd behaviour in state-space models has based on cross-sectional variability of factor sensitivities instead of returns. In the first case as proposed by Hwang and Salmon 2004, the relative dispersion of the betas of the securities in the market is estimated as follows

$$E_r(r_{it}) = \beta_{imt} E_t(r_{mt}) \tag{6}$$

where r_{it} and r_{mt} are the excess returns on asset *i* and the market at the time *t*, respectively, β_{imt} is the systematic risk measure, and $E_t(\cdot)$ is the conditional expectation at the time *t*. In equilibrium, only β is needed to price an asset *i*. The fundamental idea in this third model is that investors do not seek equilibrium relationship of Equation (5) in a herd behaviour condition but match their assets with the market return and this gives a bias β term and a commensurable expected rate of return. This is measured as follows

$$\frac{E_t^b(r_{it})}{E_t(r_{mt})} = \beta_{imt}^b = \beta_{imt} - h_{mt}(\beta_{imt} - 1) \tag{7}$$

where $E_t^b(r_{it})$ and β_{imt}^b are the market's biased short-run conditional expectation on the excess returns of asset *i* and its beta at the time *t*, and h_{mt} is a latent herding parameter that changes over time, $h_{mt} \leq 1$, and conditional on market fundamentals. As noted by Hou & Li,[30] herding behaviour is present when ($0 < h_{mt} < 1$) then some degree of herding exist on the market, but the h_{mt} defines its intensity. For the total asset, a measure of herding behaviour is estimating using the SD of β_{imt}^b which is formulated as follows

$$Std_c(\beta_{imt}^b) = \sqrt{E_c\left((\beta_{imt} - h_{mt}(\beta_{imt} - 1) - 1)^2\right)} = \sqrt{E_c\left((\beta_{imt} - 1)^2\right)}(1 - h_{mt}) = Std_c(\beta_{imt})(1 - h_{mt}) \tag{8}$$

where $E_C(\cdot)$ represents the cross-sectional expectation, $Std_c(\beta_{imt}^b)$ is the time-varying interval in response to herding behaviour in the market. In its log form the equation is expressed as follows

$$\log\left[Std_c\left(\beta_{imt}^b\right)\right] = \mu_m + \upsilon_{mt} \tag{9}$$

where $\mu_m = E[\log[Std_c(\beta_{imt})]]$ and $\upsilon_{mt}\tilde{iid}\left(0,\sigma_{m\upsilon}^2\right)$ the first *state-space model* is expressed mathematically as

$$\log\left[Std_c\left(\beta_{imt}^b\right)\right] = \mu_m + H_{mt} + \upsilon_{mt}, \tag{10}$$

$$H_{mt} = \phi_m H_{mt-1} + \eta_{mt},\ \text{where}\ H_{mt} = \log(1-h_{mt})\ \text{and}\ \eta_{mt} \sim iid\left(0,\sigma_{m\eta}^2\right) \tag{11}$$

Regarding the third model, the focus is basically on the dynamism in the movement patterns in the latent state variable, H_{mt}, the state-space model equation. Herding behaviour is deemed to exist in the market when $\sigma_{m\eta}^2 = 0$ and significant, which implies that $H_{mt} = 0$ for all t. A unique aspect of this model for measuring herding behaviour is that herding behaviour H_{mt} is viewed as a dynamic process that evolves. When the ϕ is also significant, it means the structure of herding behaviour is autoregressive.

The fourth model to estimate the presence of herding behaviour in the environmental stock market in China and which is an enhanced or augmented state-space model seeks to increase the first state-space model to ensure the robustness of inference. This is done by simply adding market volatility$\log\sigma_{mt}$ to Equation (8) and return, r_{mt}, as an independent variable to create an augmented state-space model expressed mathematically as;

$$\log\left[Std_c\left(\beta_{imt}^b\right)\right] = \mu_m + H_{mt} + c_{m1}\log\sigma_{mt} + c_{m2}r_{mt} + \upsilon_{mt}. \tag{12}$$

The interpretation of this model follows consistently with the interpretation of the first state model.

3 | RESULTS

In Equation (2), the Newey-West heteroskedasticity and autocorrelation consistent standard errors were used to estimate the CSSD (herding behaviour) among environmental stocks in China due to the significant variation in dispersion and strong correlation. The MSCI China Environment Index represents the market while the lower and upper one and five percentile of the market returns represents market stress. The results of Equation (2) presented in Table 3 show that the (β_D) values are positive and statistically significant and this validates the capital asset pricing model that equity return dispersion is high when prices are rising.

TABLE 3 Coefficient of regression for $\text{CSSD}_t = \alpha + \beta_D D_t^L + \beta_U D_t^U + \varepsilon_t$

Return Dispersions	Market return in the extreme upper/ lower 1% of the return distribution			Market return in the extreme upper/lower 5% of the return distribution		
Sectors	α	β_D	β_U	α	β_D	β_U
Power generation	1.45%	0.14%	0.194%**	1.33%	0.454%***	0.169%***
R^2		(0.442)	(0.405)		(0.357)	(0.456)
Materials	1.819	0.699***	0.442***	1.6895	0.541***	0.451***
R^2		(0.471)	(0.490)		(0.577)	(0.327)
Automobile	1.758	0.167	0.026	1.7218	0.497***	0.160***
R^2		(0.519)	(0.514)		(0.457)	(0.404)
Environmental Solutions	2.073	0.146	0.149*	2.048	0.449***	0.142***
R^2		(0.493)	(0.414)		(0.457)	(0.470)

Table 4 presents the estimate of herding behaviour based on the alternative CSAD non-linear Equation (4). Consistent with the earlier suggestions by Chang et al (2000), three different regression models were run for each sector. The first regression model used the entire sample, whereas the remaining two regressions were applied only to the restricted data on the fluctuations in the market index (up and down markets streams). Using different models help to detect an asymmetric effect in investor's herding behaviour. The higher R^2 values of the non-linear CSAD model show that it fits better than the CSSD model; hence, its estimates are more credible. Thus, the outcome in Table 4 is more reasonable than those in Table 3 since the proportion of variation in the herding attributed to the independent variables is higher. Since the first non-linear term (γ2) in the CSAD model is statistically significant, that estimate is used to infer herding behaviour, and it prevails in the four sectors analysed.

The γ_2 in Table 4 is negative and statistically significant, and that suggests a non-linear and declining relationship between market return and equity return dispersion. The regression model applied to the restricted data (up and down markets streams) shows that investors herd during market losses for all the sectors. Table 5, on the other hand, presents the result of herding behaviour using the first state-space model. Similar to the CSAD, the first state-space model shows a high persistent, H_{mt} which is strong and statistically significant, and that confirms the presence of investor herding behaviour. The $\hat{\phi}_m$ estimates are highly persistent improve, and the $\sigma_{m\eta}$ values are large and statistically significant. This further confirms the presence of herding behaviour among environmental stocks across the sectors. The results from the second state-space model in Table 6 also affirm the robustness of inference of herd behaviour noted among the environmental stocks using the CSAD and the first state-space model. In the second model, two additional market variables (market return and market volatility) are added to better estimate the degree of herding, given the state of the market. The results show that the inclusion of market returns and market volatility variables does not affect the statistical significance of H_{mt}. Secondly, changes in the volatility of factor sensitivities or dispersion in the betas for the 80 environmental stocks denoted by $Std_c\left(\beta^b_{imt}\right)$ could be attributed to investors' herding behaviour, and not just changes in market fundamentals.

Table 6, on another hand, shows that the coefficients for the market volatility term ($\log\sigma_{mt}$) are positive and statistically significant. This means that the volatility of factor sensitivities$Std_c\left(\beta^b_{imt}\right)$, in all the four sectors, grows in the same direction with market volatility. That observation affirms previous studies such as References 9,12,31,33 and 34 that investors tend to herd during highly volatile market conditions. This notwithstanding, the results in Table 6 show that the dispersion of the betas $Std_c\left(\beta^b_{imt}\right)$, for all stocks in the materials and environmental solution sectors, is significantly higher than in the other sectors. This is not surprising because in Table 1, the materials and environmental solutions sectors have the highest numbers of foreign investors and this may support previous findings[34,35] that foreign investors tend to herd more than domestic investors. Another observation is the relatively high value for $\hat{\phi}_m$ the materials and environmental solutions sectors. Besides, having more foreign investors than the others, the combined percentage of stocks within these sectors is approximately 59%. This high volume and value of trade make the two sectors highly susceptible to investor's pro-cyclical behaviour.

4 | DISCUSSION OF FINDINGS

The objective of this research is to examine whether the environmental stock market investors in China exhibit this kind of behaviour and to what extent. We are inspired by the view that the stability of the environmental stock market in China is critical to the attainment of the overall sustainability objectives of the world's largest producer of carbon emissions and for that matter its environmental health security. The behaviour of investors in the environmental stock market can potentially affect China's environmental health security goals. Herding behaviour, which is a contemporaneous loss of investor confidence and movement from environmental stocks to perceived safer stocks by investors, is a major challenge in the realisation of China's environmental health goals. This study applied an

TABLE 4 Coefficient of regression for $CSAD_t = \alpha + \gamma_1 |r_{m.t}| + \gamma_2 r_{m.t}^2 + \varepsilon_t$

Absolute deviation	Whole sample			Down market (R_m < 0)			Up market (R_m > 0)		
Sector	**α**	**γ_1**	**γ_2**	**α**	**γ_1**	**γ_2**	**α**	**γ_1**	**γ_2**
Power generation	1.016	0.162***	–0.017***	0.981	0.117***	–0.029***	1.02508	0.095**	–0.003
R^2		(0.593)	(0.732)		(0.605)	(0.467)		(0.673)	(0.645)
Materials	1.196	0.193***	–0.013**	1.150	0.165***	–0.024***	1.09858	0.117***	0.0004
R^2		(0.791)	(0.582)		(0.701)	(0.504)		(0.714)	(0.544)
Automobile	1.111	0.404***	–0.044***	1.153	0.371***	–0.056***	1.12308	0.121***	–0.029***
R^2		(0.671)	(0.638)		(0.604)	(0.613)		(0.573)	(0.727)
Environmental Solutions	1.214	0.129***	–0.040***	1.327	0.171***	–0.049***	1.39258	0.169***	–0.017***
R^2		(0562)	(0.561)		(0.619)	(0.654)		(0.589)	(0.789)

TABLE 5 State space model 1 for $\log\left[Std_c\left(\beta_{imt}^b\right)\right] = \mu_m + H_{mt} + \upsilon_{mt}$ and $H_{mt} = \phi_m H_{mt-1} + \eta_{mt}$

Industry	μ	ϕ_m	$\sigma_{m\upsilon}$	$\sigma_{m\eta}$
Power generation	−0.675***	0.940***	0.075***	0.099***
	(0.667)	(0.620)	(0.657)	(0.654)
Materials	−0.645***	0.940***	0.019***	0.091***
	(0.675)	(0.604)	(0.574)	(0.552)
Automobile	−0.570***	0.945***	0.047***	0.091***
	(0.496)	90.561)	(0.752)	(0.520)
Environmental Solutions	−0.647***	0.957***	0.040***	0.067***
	(0.496)	(0.561)	(0.752)	(0.520)

TABLE 6 State-space model 2 $\log\left[Std_c\left(\beta_{imt}^b\right)\right] = \mu_m + H_{mt} + c_{m1}\log\sigma_{mt} + c_{m2}r_{mt} + \upsilon_{mt}$ and $H_{mt} = \phi_m H_{mt-1} + \eta_{mt}$

Industry	μ	ϕ_m	$\sigma_{m\upsilon}$	$\sigma_{m\eta}$	$\log\sigma_m$	r_m
Power generation	0.451***	0.941***	0.075***	0.097***	0.659***	−0.005
R^2	(0.704)	(0.070)	(0.904)	(0.727)	(0.754)	(0.640)
Materials	0.879***	0.971***	0.019***	0.091***	0.672***	0.005
R^2	(0.607)	(0.575)	(0.676)	(0.775)	(0.560)	(0.706)
Automobile	−0.747***	0.944***	0.047***	0.091***	−0.151***	0.046
R^2	(0.572)	(0.741)	(0.891)	(0.795)	(0.667)	(0.510)
Environmental Solutions	0.897***	0.977***	0.040***	0.067***	0.776***	0.027
R^2	(0.665)	(0.721)	(0.584)	(0.650)	(0.614)	(0.704)

ensemble of more sophisticated econometric models to firm-level data of 80 environmental stocks classified into four main sectors by the KGRM MSCI China IMI Environment 10/40 Index.

Apart from the cross-sectional SD model, the remaining three robust models namely the cross-section absolute deviation, state-space model and augmented state-space model yield evidence of endemic herding tendencies among the environmental stocks on the Chinese stock market. The literature presented earlier shows an enormous amount of studies that warn of the dire consequence of persistence herding behaviour on any stock market. For example, the destabilising effect of investor herding behaviour on stock price synchronicity as validated in Reference 18 and that potentially stimulate sharp fluctuation in environmental stock prices en masse. The impact of such abrupt changes is loss of investor confidence, disinterest and diversion of capital to safer securities.[29] The resulting investor disinterest deprives the sector of the needed capital and this can stagnate the sector and that may result in substantial negative ramification for other "sustainability dependent" sectors, including food security and public health safety. While China has achieved high economic growth in the last two decades, and has successfully lifted many of its citizens out of poverty, a quarter of its population has access to substandard tap water, 122 million Chinese still lives below the international poverty line and over 100 million have low-level social security and this can be compounded by weak environmental market. A decade ago, Akerlof and Shiller[29] warned about ramifying effect of this impending danger as a result of economic behaviour of human beings similar to animalistic instincts. Secondly, a weak private sector support for China's ecological civilization and environmental health goals due to investor disinterest may force China to divert resources intended for other critical social sectors to meet the sustainability objectives in response to excessive global pressure on China. There is also the danger of developing an environmentally responsible society that is overly controlled by the state as it may result in higher environmental taxes and charges with paradoxical consequences.[30] In the BYD case recounted in earlier sections of the paper, government must desist from sudden and seemingly bais announcement of strict regulations that tends to create doubt in the minds of foreign investors. The state must find alternative ways to provide support for local industries to compete at par with international ones instead of creating artificial conditions for them to excel. This may avert a potential and an unprecedented crash in the environmental stock market if herding behaviour persists among investors. Moreover, China's 13th 5-year Plan lacks precision on public–private consensus building and investor sensitisation to avert any panic response to changes in market conditions.[20] As domestic investors are less likely to herd, equipping them to reduce better exposure to fluctuations is needed to support the sustainable goals. Further, China must use its experience and leadership in sustainable development policies to highlight its readiness to engage the global investor community and reduce the unintended opaqueness and uncertainty that usually hover around media portrayals of China's investment terrain.[31] This may help foreign investors to confidently explore all the available opportunities the environmental stock market offers them to the hilt.

5 | CONCLUSIONS

The destructive health effect of global warming and other environmental damages is well documented at the beginning of this paper. For example, drywalls that are cheaply produced in China have the potential to emit high levels of sulphur gas that corrodes electrical wiring and also causes breathing problems, bloody noses and headaches for building occupants. A recent study conducted by Scientific American found out that household contaminants such as phthalates which is a hazardous chemical emitted by vinyl floors, cause autism in kids. Similarly, women exposed to high levels of polybrominated diphenyl ether (PBDE) flame retardants common in cushions, carpet padding and mattresses have a 97% chance of acquiring poisonous chemicals in their bloodstreams and can avert or abort the pregnancy or suffer from other fertility issues, as a result. These health impacts of poor environmental control cannot be disregarded.

Significantly, China's effort at meeting its environmental health goals through sustainable development occupied several pages of the inaugural address of President Xi Jinping at the 18th National Congress of the Communist Party of China, July 2018. This “beautiful China” dream that outlines China's ecological civilisation has become a global blueprint document not only for China but also its nearest neighbours and friends. However, the availability of capital and the confidence of investors are critical to the attainment of this objective. The extent to which herding or procyclical behaviour exists on the Chinese environmental stock market was examined in this paper. The results confirm the presence of endemic herding behaviour on the environmental stock market, and this can threaten the stability of the environmental health security once it depends on funds from environmental stock investments. We note that investors mostly herd during a period of market stress, and this is more prevalent among foreign and group of investors. We have proposed measures to improve the risk posed by such behaviours. Further research is needed in other countries, especially among the BRICS using the same models to validate the generalizability of this observed herding behaviour among environmental stock investors.

ACKNOWLEDGEMENTS

The authors are indebted to the National Natural Science Foundation of China (Grants nos. 71974079, 71904066) for supporting this project. The Post-doctoral Foundation of China (2018T60508, 2018M511705 and 2018T60508) and the Post-doctoral Foundation of Government of Jiangsu Province number 1102129C also supported this project.

CONFLICT OF INTEREST

The authors declare no potential conflict of interest.

ETHICS STATEMENT

This article does not require any human/animal subjects to acquire such approval.

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How to cite this article: Zhou L, Antwi MO, Antwi HA, Boafo-Arthur A, Mustafa T. Endangering China's environmental health security goals through negative environmental investor behaviours. *Int J Health Plann Mgmt*. 2020;35:1398–1411. https://doi.org/10.1002/hpm.3012