China Economic Journal

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/rcej20

Impacts of the recent USA and China trade dispute on China's aquatic products

Kun Lu, Pierre Failler, Benjamin M. Drakeford, Qinyi Wang & Tong Liu

To cite this article: Kun Lu, Pierre Failler, Benjamin M. Drakeford, Qinyi Wang & Tong Liu (2022) Impacts of the recent USA and China trade dispute on China's aquatic products, China Economic Journal, 15:1, 60-76, DOI: 10.1080/17538963.2021.2019924

To link to this article: https://doi.org/10.1080/17538963.2021.2019924

CHINA ECONOMIC JOURNAL
2022, VOL. 15, NO. 1, 60–76
https://doi.org/10.1080/17538963.2021.2019924

Routledge
Taylor & Francis Group

OPEN ACCESS Check for updates

Impacts of the recent USA and China trade dispute on China's aquatic products

Kun Lu[a,b,c], Pierre Failler[b], Benjamin M. Drakeford[b], Qinyi Wang[d] and Tong Liu[c]

[a]Marine Development Studies Institute of OUC, Key Research Institute of Humanities and Social Sciences at Universities, Ministry of Education, Qingdao, PR China; [b]Centre for Blue Governance, Faculty of Business and Law, University of Portsmouth, Portsmouth, UK; [c]Management College, Ocean University of China, Qingdao, PR China; [d]College of Social Science, Michigan State University, East Lansing, MI, USA

ABSTRACT

This paper uses the Multivariable Grey Model and the Counterfactual Reasoning Method to evaluate the impact of the recent trade dispute between the USA and China from the perspective of its impact on the international trade of China's aquatic products. Regarding imports the recent trade dispute did not have a negative impact, due to substitution possibilities with other countries. China's aquatic products export is heavily dependent on the market in the USA. Nevertheless, the aggravation of the recent trade dispute has not caused significant effects on China's aquatic product exports. Compared with the potential trade loss in terms of exports to China suffered by aquatic product producers and operators in the USA, the economic interests of China's aquatic products producers and operators in terms of exports have not been affected significantly overall. In comparison, the potential trade losses of aquatic product producers and operators in the USA are relatively greater.

ARTICLE HISTORY
Received 8 October 2021
Accepted 15 December 2021

KEYWORDS
Import of aquatic products; export of aquatic products; trade dispute; China's aquatic products international trade; the counterfactual reasoning method

JEL CLASSIFICATION
C53; F14

Introduction

On a global basis, aquatic products constitute the third major source of dietary protein consumed by humans after cereals and milk, representing 6.5% of total protein supply or 16.4% of total animal protein supply (Tacon and Metian 2017). For a long time, China's aquatic products have had a comparative advantage in its agricultural exports. The latest trade statistics show that although China's agricultural products international trade moved from a surplus to a deficit in 2004 (and the deficit has gradually expanded since then), China's aquatic products international trade has always maintained a continuous surplus in the same period (CFSY 2021). Meanwhile, China's aquatic products export is highly dependent on the US market. In 2018, China's aquatic products export volume and value to the US accounted for 13.07% and 15.70% of China's total aquatic products export volume and value, respectively. Until the COVID-19 pandemic in 2019, these two indicators also reached 10.81% and 12.4%, respectively.

CONTACT Pierre Failler pierre.failler@port.ac.uk Centre for Blue Governance, Faculty of Business and Law, University of Portsmouth, Portsmouth PO1 3DE, UK

Since 2001, various trade disputes and conflicts have arisen between China and the USA (since China's accession to the WTO). During Obama's presidency, China was accused or challenged 16 times on issues relating to the harmful dumping of products onto the USA market, export restrictions on rare earth metals, overcapacities in the solar panel and steel industries and illegal taxes on American steel and cars (Felbermayr and Steininger 2019). The recent round of trade disputes between China and the USA broke out during the administration of Trump, who took office as the 44th President of the USA in January 2017. Different from Obama Trump chose more protectionist type measures – largely the implementation tariffs to deal with trade conflicts. By implementing the concept of America first (Janusch and Mucha 2017), the USA and China have been caught in a maelstrom of high tariffs on both sides since then – with one side retaliating against the other. Although both sides singed the economic and trade agreement on 15 January 2020, when Joe Biden took over as the government's new President of the USA, the new government Treasury Secretary Janet Yellen declared that, 'the United States will keep tariffs on China as during the period of Trump, but we will assess how to proceed after a thorough review' through CNBC on 18 February 2021. Obviously, this recent China-US trade dispute has not been effectively resolved with the change of USA presidential powers. In this context, whether and to what extent this round of trade dispute between China and the USA has any impact on China's international trade in aquatic products has obviously become the focus of China's aquatic products international trade management.

A considerable volume of literature on the recent trade disputes between the USA and China has emerged, not only discussing Trump's own motivation (Liu and Woo 2018; Larres 2020), but literature also focusing on the causes of the trade disputes from a historical perspective (Chong and Li 2019), a fiscal constraint perspective (Di, Luft, and Zhong 2019), a special tariff perspective (Bown 2019), a political and economic perspective (Chen, Chen, and Reddy Dondeti 2020; Charnovitz 2019) and through the lens of trade literature (Qiu, Zhan, and Wei 2019). Literature on the impact of the trade disputes on the global economy (Iqbal, Rahman, and Elimimian 2019) have been undertaken, especially the impact on China (Chong and Li 2019; Edwin 2019; Kapustina et al. 2020) and OECD and ASEAN economies (Yu 2019). Apart from the traditional qualitative analysis, there have been few attempts to use quantitative methods e.g. the global trade analysis project model (Rosyadi and Widodo 2018), the multi-country global general equilibrium model (Li, He, and Lin 2018) and scenario analysis (Kapustina et al. 2020) to carry out numerical simulations on the economic effects of the trade disputes. However, research on the impact of the current trade dispute on international aquatic products trade has not emerged. What is available is only from a qualitative perspective e.g. the competitiveness of China's aquatic products exports to the USA (Xu, Liu, and Hu 2018), the development trend of China's aquatic products trade to the USA (Zhai and Li 2019), the challenge and tactics for the international trade of aquatic products in some provinces of China (Qi 2018; Song, Ji, and Ning 2019). So far, there is no quantitative research on the impact of the recent trade dispute between China and the United States on China's aquatic products international trade. Moving forward, policy on the international trade in aquatics products between the two countries should be addressed. Quantitative analysis on the impact of the trade dispute under the presidency of Trump has become the premise and basis for the scientific formulation of aquatic product trade policy between China and the USA in the era of President Biden.

The objective of this article is to present an analysis of the impact of the recent trade dispute between the USA and China on the international trade of China's aquatic products using the Counterfactual Reasoning method based on the Multivariable Grey Model. There are two novel aspects in this paper. First, deviating from existing approaches, it comprehensively uses the Multivariable Grey Model and the Counterfactual Reasoning method to empirically analyse the impact of the recent trade dispute on China's aquatic products international trade. Second, the results provide an empirical criterion to allow for an objective evaluation of the impact of Trump's 'America First' trade policy from the perspective of China's aquatic products international trade – the last reference point for policy making regarding the international trade of aquatic products between China and the USA in the era of President Biden.

The paper is organized as follows. The next section presents the Multivariable Grey Model and the Counterfactual Reasoning Method. The section that follows analyses the measurements of the recent trade dispute effects on China's international trade in aquatic products. Following that, the analysis of the measurements of the recent trade dispute effects on China-USA bilateral trade in aquatic products is presented. Finally, the paper concludes on the impacts of the recent trade dispute between the USA and China on the international trade of aquatic products in China.

Method and data

The recent trade dispute between the USA and China is an independent event rather than a single policy, which includes many individual policy changes on aquatic products trade. Therefore, policy assessment methods, such as the DID (Difference-in-differences Model), RDD (Regression Discontinuity Design) and PSM (Propensity Score Matching), are not applicable to this paper, as these policy assessment methods are constrained by the limitations of relevant theoretical assumptions (Zhao et al. 2015; Lin and Wu 2015) and sample size (Ji 2017). It is important to note that China's aquatic products trade data in 2020 includes the trade dispute effect and the coronavirus effect (as the recent trade dispute began in the second half of 2017 and the global coronavirus outbreak began at the end of 2019). Thus, the corresponding data survey years are limited to 2018 and 2019 in this paper, which presents difficulties for the evaluation of the impact of the recent trade dispute between the USA and China. However, grey-based models can meet these forecasting needs and has advantages over other methods, such as not requiring many samples, nor regular distribution of samples. Further, there is only a small computation workload, no inconsistency between quantitative analysis results and qualitative analysis results as well as high prediction accuracy. As many studies have revealed, the grey model and its extensions have been applied in various fields, including economics (Lei and Feng 2012; Lu et al. 2020), engineering (Hu et al. 2020; Li et al. 2016), and energy (Moonchai and Chutsagulprom 2020; Ayvaz and Kusakci 2017). Therefore, we choose the Grey Model to simulate the international trade level of China's aquatic products.

Multivariable Grey Model (MGM)

The basic form of the multivariable grey model MGM (1, n) is the first order ordinary differential equations with n variables, which is a natural generalisation of GM (1, 1) model in the case of n variables (Zhai, Sheng, and Feng 1997). In comparison, the model has high fitting accuracy and prediction accuracy, it can overcome the shortcomings of the existing GM (1, n) model which cannot predict and supplement the GM (1, 1) model which only considers the influence of a single variable (Chen and Wang 2012). Letting $x_i^{(0)}$ (k) be n grey time series and $x_i^{(1)}$ (k) be corresponding 1-AGO sequence (where i = 1,2, ...,n), $x_i^{(1)}(k) = \sum_{k}^{j=1} x_i^{(0)}(j)$ (where k = 1,2 ...,m), then MGM (1, n) becomes a system of first order ordinary differential equations:

$$\begin{aligned} \frac{dx_1^{(1)}}{dt} &= a_{11}x_1^{(1)} + a_{12}x_2^{(1)} + \ldots + a_{1n}x_n^{(1)} + b \\ \frac{dx_1^{(1)}}{dt} &= a_{21}x_1^{(1)} + a_{22}x_2^{(1)} + \ldots + a_{2n}x_n^{(1)} + b_2 \\ &\vdots \\ \frac{dx_n^{(1)}}{dt} &= a_{n1}x_1^{(1)} + a_{n2}x_2^{(1)} + \ldots + a_{nn}x_n^{(1)} + b_n \end{aligned} \tag{1}$$

Set $X^{(0)}(k) = (x_1^{(0)}(k), x_2^{(0)}(k), \cdots, x_n^{(0)}(k))^T, X^{(1)}(k) = (x_1^{(1)}(k), x_2^{(1)}(k), \cdots, x_n^{(1)}(k))^T$, then Equation (1) can be transformed into:

$$\frac{dX^{(1)}}{dt} = AX^{(1)} + B \tag{2}$$

The continuous time response of Equation (2) is:

$$X^{(1)}(t) = e^{At}X^{(1)}(0) + A^{-1}\left(e^{At} - 1\right) B \tag{3}$$

Where, e^{At} is the identity matrix. To distinguish parameters A and B, formula (2) is discretized, we can get

$$x_i^{(0)}(k) = \sum_{n}^{j=1} \frac{a_{ij}}{2}(x_j^{(1)}(k) + x_j^{(1)}(k-1) + b_i, i = 1, 2, \cdots n; k = 2, 3, \cdots, m \tag{4}$$

Set $a_i=(a_{i1}, a_{i2}, \ldots, a_{in}, b_i)^T$, by using the least square method, it is the identification value is $\widehat{a_i}$:

$$\widehat{a_i} = (\widehat{a_{i1}}, \widehat{a_{i2}}, \cdots, \widehat{a_{in}}, \widehat{b_i})^T = (L^TL)^{-1}L^TY_i, i = 1, 2, \cdots, n \tag{5}$$

Where $L = \begin{vmatrix} z_1^{(1)}(2)z_2^{(1)}(2)\cdots z_n^{(1)}(2) \\ z_1^{(1)}(3)z_2^{(1)}(3)\cdots z_n^{(1)}(3) \\ \vdots \\ z_1^{(1)}(m)z_1^{(1)}(m)\cdots z_n^{(1)}m \end{vmatrix}$, $Y_i = (x_i^{(0)}(2), x_i^{(0)}(3), \cdots x_i^{(0)}(m))^T$, $z_i^{(1)}(k)$ is the generating sequence of nearest neighbor mean of $x_i^{(1)}(k)$ (k = 2, … m; i = 1,2, … n). Hence, the identification values of A and B can be obtained

Now, the calculated value of MGM (1, n) model is:

$$\hat{X}(k) = e^{A(k-1)}X^{(1)}(1) + \hat{A}^{-1}\left(e^{A(k-1)} - I\right)\hat{B} \tag{7}$$

Where k = 1, 2 … n and $\hat{X}^{(0)}(1) = X^{(0)}(1)$;

$$\hat{X}^{(0)}(k) = \hat{X}^{(1)}(k) - \hat{X}^{(1)}(k-1), k = 2, 3 \ldots, m \tag{8}$$

After MGM (1, n) is used to get the prediction, the average relative residual test is usually used to verify the prediction accuracy of the model (Xia, Zhang, and Cao 2013). Firstly, the relative residual sequence e_r *(k)* is obtained according to formula (9). Secondly, the average relative residual e_r can be calculated according to formula (10) by means of the obtained relative residual sequence by formula (9). Finally, we can the prediction accuracy P of MGM (1, n) according to formula (11). The smaller the average relative residual $\overline{e_r}$, the higher the fitting degree of the predicted value of the model to the original value, that is, the higher the prediction accuracy P of the MGM (1, n).

$$e_r(k) = \frac{\left|x^{(0)}(k) - \hat{x}^{(0)}(k)\right|}{x^{(0)}(k)} \tag{9}$$

$$\overline{e_r} = \frac{1}{n-1}\sum_{n}^{k=2}|e_r(k)| \tag{10}$$

$$P = (1 - \overline{e_r}) \times 100\% \tag{11}$$

Considering the deficiency of the MGM (1, n) model in long-term forecasting, this paper uses the technology of equal dimension grey number progressive data processing to reduce the influence of long-term random disturbance or driving factors by continuously adding new information and removing old data information. The specific method is to replace the earliest data in the original data with the first value predicted by the MGM (1, n) model to maintain the equal dimension of the data sequence, and then use the updated data sequence to predict the next value and replace the old data, to achieve the purpose of long-term prediction (Lu et al. 2018).

The counterfactual reasoning method

Counterfactual reasoning (also known as counterfactual thinking) refers to the thinking activities of negating and representing facts that have occurred in the past in order to construct a possible hypothesis. In our daily life, the counterfactual reasoning phenomenon is very common and is expressed in the form of conditional proposition in the mind, and its typical performance pattern is 'if then . . ., will (won't) . . . ' mainly including the premise and the result. In order to measure the impact of the recent trade dispute on the level of China's aquatic products import and export trade, this paper first uses MGM (1, 3) to predict the corresponding international trade data of aquatic products from 2018 to 2019 according to the statistical data of China's aquatic products international trade from 2002 to 2017. Then, the relative residual between the actual value and the predicted value from 2002 to 2017 is calculated year by year, and the average prediction error rate is calculated to verify the accuracy of the model. Finally, by comparing the actual statistics with the simulation values from 2018 to 2019, the impact of the recent trade dispute on China's international trade and China-US bilateral trade in aquatic products is examined using the counterfactual reasoning method.

Variables

The international trade theory and practice have shown that the total level of foreign trade of a country or region is affected by many factors, such as economic scale, exchange rate changes and so on (Hu and Huo 2008; Guo 2013). Economic scale can often reflect the purchasing power and productivity of a country or region, it becomes the main determinant of a country or region's comparative advantage. In practice, it is positively correlated to the trade flow of goods. From the perspective of trade practice, the economic scale of other countries outside China affects the export of China's aquatic products (corresponding to the import of aquatic products of other countries except China), while the economic scale of China affects the import of its own aquatic products (corresponding to the export of aquatic products of other countries except China). In addition, as the introduction of multiple influential factors with high correlation will affect the prediction accuracy of the model, and even lead to ill condition for the matrix and its inverse matrix, the factors introduction of MGM (1, n) model should be few, generally not more than three (Wang et al. 2013). In view of this, combined with the reality of the international trade of aquatics products and the availability of existing data, this paper selects the import value (unit: US dollar), the import volume (unit: kg) and per capita GDP of China (unit: US dollar) as the related variables when calculating the impact of the recent trade dispute on the import level of China's aquatic products. Meanwhile, in terms of export, we use a further three related variables: China's aquatic products export value (unit: ten thousand RMB yuan), export volume (unit: kg) and per capita GDP of other countries except China (unit: US dollar). Accordingly, to examine the effect of the recent trade dispute on China's aquatic products import level from the USA, we choose China's aquatic products import value from the USA (unit: ten thousand US $), import volume from the USA (unit: ton) and China's per capita disposable income (unit: RMB yuan) as the related variables. Further, we choose China's aquatic products export value to the USA (unit: ten thousand RMB yuan), export volume to the USA (unit: ton) and the USA's per capita disposable income (unit: US dollar) as the associated variables when estimating the impact of the recent trade dispute on China's aquatic products export level to the USA.

Data

The trade data of aquatic products in this paper are taken from the UN COMTRADE database (updated to 2019). The per capita GDP data of China and other countries (except China) is official data published by the World Bank. Given the recent trade dispute started in the second half of 2017, and the COVID-19 epidemic started at the end of 2019, data for 2020 on China's aquatic product trade overlay the COVID-19 influence effect as well as the recent trade dispute effect. Therefore, as this paper uses the 'counterfactual reasoning' method to analyze the actual impact of the recent trade dispute, the final data period is limited to 2002–2019 (to separate out the COVID-19 effect).

Measurement of the recent trade dispute effect on the total volume of China's international trade in aquatic products

Simulation of China's aquatic products import level

Based on the original series of three related variables, which include China's aquatic products import value, import volume and China's per capita GDP, we first construct the ternary first-order ordinary differential equations by first-order accumulation using MATLAB software. Then, according to the MGM principle, the predicted values of the above three correlation factors over the time period will be derived by the ordinary least squares (OLS) method. Finally, the accuracy of the MGM (1,3) model of China's aquatic product import level is estimated on the whole by calculating the point-by-point residual value of the actual value and the predicted value of each correlation factor (see Table 1).

Table 1. Forecast of China's aquatic products import level and point by point residual test since China's entry into WTO.

	Import value (US $)			Import volume (kg)			China's per capita GDP (US $)		
Year	Actual value	Predicted value	e_r (%)	Actual value	Predicted value	e_r (%)	Actual value	Predicted value	e_r (%)
2002	1,574,359,435	1,574,359,435	0.00	1,451,991,806	1,451,991,806	0.00	1149	1149	0.04
2003	1,883,975,766	2,017,891,422	7.11	1,440,908,020	1,594,269,993	10.64	1289	1021	−20.74
2004	2,362,929,621	2,353,476,472	−0.40	1,746,387,381	1,766,731,218	1.16	1509	1397	−7.39
2005	2,903,683,647	2,713,141,901	−6.56	1,948,861,208	1,935,966,168	−0.66	1753	1829	4.31
2006	3,191,339,088	3,094,240,601	−3.04	2,185,303,174	2,097,744,149	−4.01	2099	2318	10.42
2007	3,501,565,132	3,493,398,069	−0.23	2,343,710,766	2,247,522,920	−4.10	2694	2863	6.27
2008	3,721,389,868	3,906,557,390	4.98	2,358,938,402	2,380,618,397	0.92	3468	3460	−0.23
2009	3,653,393,729	4,329,055,166	18.49	2,231,543,439	2,492,418,024	11.69	3832	4104	7.10
2010	4,458,514,434	4,755,728,396	6.67	2,504,678,076	2,578,637,816	2.95	4550	4786	5.17
2011	5,759,727,173	5,181,052,315	−10.05	2,726,138,774	2,635,623,059	−3.32	5618	5491	−2.26
2012	5,662,553,981	5,599,309,169	−1.12	2,542,818,900	2,660,692,685	4.64	6317	6203	−1.81
2013	6,182,283,678	6,004,787,957	−2.87	2,768,007,821	2,652,527,307	−4.17	7051	6898	−2.16
2014	6,826,715,327	6,392,015,108	−6.37	2,873,614,665	2,611,600,927	−9.12	7651	7548	−1.35
2015	6,556,152,118	6,756,016,118	3.05	2,711,987,362	2,540,656,305	−6.32	8033	8116	1.03
2016	7,088,059,964	7,092,608,139	0.06	2,646,744,008	2,445,223,994	−7.61	8079	8560	5.96
2017	8,176,080,160	7,398,723,508	−9.51	2,910,720,651	2,334,185,051	−19.81	8759	8827	0.78
e_r (the average relative residual)			5.03			5.70			4.81
P (the model prediction accuracy)			94.97			94.30			95.19
2018	11,744,150,042	7,672,764,241	−34.67	3,358,033,718	2,220,377,397	−33.88	9771	8857	−9.36
2019	15,581,483,213	8,058,877,060	−48.28	4,399,836,182	2,154,021,273	−51.04	10,262	8757	−14.67

In Table 1, the average relative error rate between the annual predicted value of China's aquatic products (import value and volume) and the corresponding year's real value from 2002 to 2017 is 5.03% and 5.70%, respectively. The average relative error rate between the annual predicted value of China's per capita GDP and the corresponding year's real value is only 4.81%. According to formula (11), it is clear that the prediction accuracy of the annual import value and volume of China's aquatic products and China's per capita GDP is 94.97%, 94.30% and 95.19%, respectively. This means that the MGM (1, 3) of China's aquatic product import level has a high prediction accuracy. According to the MGM (1, 3), China's aquatic product import value, import volume and China's per capita GDP in 2018 can be predicted. The predicted values can be added to the original data series by using the equal dimension grey number supplement technology while the original data in 2002 will be deleted, and we get the data series of China's aquatic products import value, import volume and China's per capita GDP from 2003 to 2018. Finally, by using the MGM (1,3) of China's aquatic product import level, the predicted value of China's aquatic product import level in 2019 is obtained.

According to Table 1, although the predicted import values of China's aquatic products in 2018 and 2019 show an increasing trend, and the predicted values of China's aquatic product import volume show a decreasing trend, the predicted values of China's aquatic product import value and import volume in 2018 are 4.07139 billion US dollars lower and 1.137656 million tons lower than the actual statistical values, respectively. In 2019, the predicted values of China's aquatic product import value and volume are about 7.52261 billion US dollars lower and 2.245815 million tons lower than the actual statistical values, respectively. Therefore, it is obvious that the recent trade dispute has not caused a negative impact on the import level of China's aquatic products, based on the increase of both China's aquatic product import value and volume.

By investigating the trend of China's aquatic products import volume and value from 2017 to 2019 (Table 2), it is apparent that China's imports of aquatic products increased both in volume and value as China's imports of aquatic products from the rest of the world showed an increasing trend. In fact, the total amount of increase exceeded the amount of China's imports of aquatic products from the USA in the same period. Compared with the amount in 2017, China's aquatic product import volume and value in 2018 increased by 15.37% and 43.64%, respectively. In the meantime, although China's

Table 2. Changes of China's aquatic products import volume and value from 2017 to 2019[a].

Year	Import volume (kg)	Import value (US $)	Average import price (US $/kg)
The total import of China's aquatic product			
2017	2,910,720,651	8,176,080,160	2.81
2018	3,358,033,718 (15.37%)	11,744,150,042 (43.64%)	3.50 (24.51%)
2019	4,399,836,182 (31.02%)	15,581,483,213 (32.67%)	3.54 (1.26%)
Therein, China's total aquatic product import from the USA			
2017	428,597,166	1,318,016,450	3.08
2018	365,558,178 (−14.71%)	1,254,741,112 (- 4.80%)	3.43 (11.62%)
2019	321,817,749 (−11.97%)	914,933,155 (−27.08%)	2.84 (−17.17%)
Therein, China's total aquatic product import from the rest of the world			
2017	2,482,123,485	6,858,063,710	2.76
2018	2,992,475,540 (20.56%)	10,489,408,930 (52.95%)	3.51 (26.87%)
2019	4,078,018,433 (36.28%)	14,666,550,058 (39.82%)	3.60 (2.60%)

[a]In Table 2, the number in parentheses is the year-on-year growth rate.

aquatic product import volume and value from the USA decreased by 14.71% and 4.8%, respectively, China's aquatic product import volume and value from the rest of the world increased by 20.56% and 52.95%, respectively. Similarly, compared with the amount in 2018, China's aquatic product imports volume and value in 2019 increased by 31.02% and 32.67%, respectively. Although China's aquatic product import volume and value from the USA decreased by 11.97% and 27.08% respectively, China's aquatic product import volume and value from the rest of the world increased by 36.28% and 39.82% in the same period. As a whole, China's ability to diversify (countries) for aquatic products import has weakened the reduction amplitude of China's aquatic product import volume and value from the USA, which can be seen as a direct result of this recent trade dispute. In the meantime, we can see that China's aquatic product import has an obvious substitution effect in the selection of import countries for China. According to Table 2, to some extent, we may conclude that the current diversification of China's aquatic product import channels can not only offset but also exceed the negative effect of this recent trade dispute on China's aquatic product import volume and value.

From the perspective of the price of imported aquatic products, the average price of China's imported aquatic products increased from US $2.81/kg in 2017 to US $3.50/kg in 2018 and US $3.54/kg in 2019, with a year-on-year growth of 24.51% and 1.26%, respectively. Over the same period, the average price of China's imported aquatic products from other countries in the world outside the USA also increased from US $2.76/kg in 2017 to US $3.51/kg in 2018 and US $3.60/kg in 2019, with a year-on-year growth of 26.87% and 2.60%, respectively. In contrast, the average price of China's imported aquatic products from the USA increased from US $3.08/kg in 2017 to US $3.43/kg in 2018 with a year-on-year growth rate of 11.62%, and then decreased to US $2.84/kg in 2019 with a year-on-year decrease rate of 17.17%. Therefore, the recent trade dispute seems to have prompted a change in the structure of China's imported aquatic products. According to the characteristics of the average price of China's imported aquatic products in Table 2, it can be considered to a certain extent that after the outbreak of the recent trade dispute, China's aquatic products import have been inclined to aquatic products with higher economic added value. During the same period, the total imports of aquatic products with low economic added value, such as chilled and salted products, have decreased. To some extent, the increasing trend of the average import price of China's aquatic products from 2017 to 2019 on the whole means that there has been a substitution effect among the categories of China's imported aquatic products from the USA. This is because of the decreasing trend of China's aquatic products import price from the USA and the increasing trend of China's aquatic products import price from other countries. Meanwhile, it can be inferred that the import structure of China's aquatic products has been in the stage of transformation and upgrading due to the recent trade dispute, and the trend of China's shifting its focus to import aquatic products with high economic added value from other countries in the world other than the USA is more obvious.

Table 3. Forecast of China's aquatic products export level and point by point residual test 2002–2019.

Year	Export value (ten thousand RMB yuan)			Export volume (kg)			Per capita GDP of other countries except China (US $)		
	Actual value	Predicted value	e_r (%)	Actual value	Predicted value	e_r (%)	Actual value	Predicted value	e_r (%)
2002	3,726,054	3,726,054	0.00	1,981,924,122	1,981,924,122	0.00	6649	6649	0.00
2003	4,352,592	4,866,706	11.81	2,019,355,465	2,153,195,731	6.63	7353	7520	2.27
2004	5,503,360	5,220,040	−5.15	2,321,613,843	2,298,704,988	−0.99	8149	8156	0.09
2005	6,167,532	5,698,117	−7.61	2,470,689,591	2,460,571,272	−0.41	8672	8786	1.31
2006	7,144,376	6,294,332	−11.90	2,890,987,108	2,635,036,703	−8.85	9217	9384	1.81
2007	7,030,921	6,993,299	−0.54	2,930,557,648	2,817,392,628	−3.86	10,158	9927	−2.27
2008	7,016,366	7,770,927	10.75	2,828,373,493	3,002,270,116	6.15	10,863	10,395	−4.31
2009	6,990,575	8,594,916	22.95	2,826,554,311	3,184,023,768	12.65	10,026	10,775	7.47
2010	8,942,886	9,425,689	5.40	3,227,928,576	3,357,208,827	4.01	10,734	11,063	3.07
2011	10,966,645	10,217,740	−6.83	3,772,420,329	3,517,151,601	−6.77	11,627	11,270	−3.06
2012	11,440,498	10,921,416	−4.54	3,684,606,620	3,660,613,195	−0.65	11,595	11,423	−1.49
2013	12,040,897	11,485,115	−4.62	3,838,814,990	3,786,546,545	−1.36	11,631	11,567	−0.55
2014	12,819,972	11,857,922	−7.50	4,026,352,449	3,896,946,768	−3.21	11,688	11,777	0.76
2015	12,186,915	11,992,659	−1.59	3,905,415,560	3,997,794,815	2.37	10,719	12,155	13.39
2016	13,288,147	11,849,371	−10.83	4,086,251,630	4,100,094,430	0.34	10,743	12,838	19.51
2017	12,488,060	11,399,232	−8.72	3,970,550,282	4,221,002,424	6.31	11,225	14,005	24.77
e_r (the average relative residual)			7.55			4.03			5.38
P (the model prediction accuracy)			92.45			95.97			94.62
2018	12,782,580	10,628,874	−16.85	3936,752239	4,385,052,254	11.39	11,642	15,880	36.41
2019	12332,576	65,194,233	428.63	3875,043015	10,548,138,567	172.21	11,705	8947	−23.56

Simulation of China's aquatic products export level

According to the principle of the grey model, based on the original series of China's aquatic products export value, export volume and per capita GDP of other countries except China, we estimate predicted value of each related factor of China's aquatic products export over the years using the MATLAB software. Next, the accuracy of the MGM (1,3) model of China's aquatic product export level is estimated on the whole by calculating the point-by-point residual value of the actual value and the predicted value of the above three factors (see Table 3).

In Table 3, the average relative error rates between China's aquatic product export value and volume annual predicted value and the corresponding year's real value from 2002 to 2017 are about 7.55% and 4.03% respectively. The average relative error rate between other countries' per capita GDP except China and the corresponding year's real value is only 5.38%. Similarly, it is apparent that the prediction accuracy of the annual export value and volume of China's aquatic products and other countries' per capita GDP except China is 92.45%, 95.97% and 94.62%, respectively. Therefore, the MGM (1, 3) model of China's aquatic products export level exhibits a high prediction accuracy. On this basis, we predict China's aquatic products export value, export volume and per capita GDP of other countries except China in 2018, and then the predicted value of China's aquatic products export level in 2019 is calculated using the equal dimension grey number compensation technology. In particular, the predicted value of China's aquatic products export value in 2018 is about 21.537 billion yuan (RMB) less than the actual value and the predicted export volume of China's aquatic products is about 448,300 tons higher than the actual volume. In 2019, the China's aquatic products export predicted value is about 528.61657 billion yuan (RMB) more than the actual value, and the China's

Table 4. Changes of China's aquatic products export volume and value from 2017 to 2019[a].

Year	Export volume (Kg)	Export value (US $)	Average export price (US $/ kg)
The total export of China's aquatic products			
2017	3,970,550,282	18,476,864,716	4.65
2018	3,936,752,239 (−0.85%)	19,320,833,103 (4.57%)	4.91 (5.47%)
2019	3,875,043,015 (−1.57%)	17,851,604,271 (−7.60%)	4.61 (−6.13%)
Therein, China's total aquatic products export to the USA			
2017	513,639,033	2,866,724,699	5.58
2018	514,726,527 (0.21%)	3,033,262,688 (5.81%)	5.89 (5.59%)
2019	419,036,012 (−18.59%)	2,214,073,160 (−27.01%)	5.28 (−10.34%)
Therein, China's total aquatic products export to the rest of the world			
2017	3,456,911,249	15,610,140,017	4.52
2018	3,422,025,712 (−1.01%)	16,287,570,415 (4.34%)	4.76 (5.40%)
2019	3,456,007,003 (0.99%)	15,637,531,111 (−3.99%)	4.52 (- 4.94%)

[a]In Table 4, the number in parentheses is the year-on-year growth rate.

aquatic products export predicted volume is about 6.673096 million tons more than the actual volume. Compared with the significant growth trend of China's aquatic products export predicted value and volume in 2018 and 2019, the actual export value and volume of China's aquatic products showed a downward trend in the same period. Therefore, the actual export value of China's aquatic products decreased from 127.8258 billion yuan (RMB) in 2018 to 123.32576 billion yuan (RMB) in 2019, while the actual export volume of China's aquatic products decreased from 3.936752 million tons in 2018 to 3.875043 million tons in 2019. Therefore, the recent trade dispute has caused a slight negative impact on China's aquatic products export value and volume.

According to the change trend of China's aquatic products export volume and value from 2017 to 2019 (Table 4), we find that the average export price of China's aquatic products to other countries outside the USA declined from US $4.76/kg in 2018 to US $4.52/kg in 2019 with a year-on-year decrease rate of 4.94%. The average export price of China's aquatic products to the USA also dropped from US $5.89/kg in 2018 to US $5.28/kg in 2019 with a year-on-year decrease rate of 10.34%. It should be noted that China's aquatic products export is heavily dependent on the U.S. market. In 2018, the proportions of China's aquatic product export volume and volume to the USA in China's total aquatic product export volume and value was about 13.07% and 15.70% respectively. The proportions of China's aquatic product export volume and volume to the USA in China's total aquatic product export volume and value was about 10.81% and 12.4% respectively in 2019. Considering this, it can be concluded that the slight decreasing trend of the average export price of China's aquatic products from 2017 to 2019 (overall) resulted from a relatively sharp drop in the average price of China's aquatic products exports to the USA. This is in comparison with a slight drop in the average price of China's aquatic products exports to other countries. Therefore, China's export of China's aquatic products is characterized with high degree of dependence on the U.S. market, which is a key reason for the negative impact of the recent trade dispute on China's aquatic products export.

Table 5. Forecast of China's aquatic products import level from the USA and point by point residual test 2002–2019.

	Import value (ten thousand US $)			Import volume (ton)			China's per capita disposable income (RMB yuan)		
Year	Actual value	Predicted value	e_r (%)	Actual value	Predicted value	e_r (%)	Actual value	Predicted value	e_r (%)
2002	10,585	10,585	0.00	112,496	112,496	0.00	4532	4532	0.00
2003	13,346	15,684	17.52	111,273	131,715	18.37	5007	4929	−1.54
2004	24,523	23,139	−5.64	162,043	160,482	−0.96	5661	5653	−0.14
2005	34,276	31,210	−8.94	209,491	191,637	−8.52	6385	6496	1.75
2006	40,914	39,902	−2.47	246,149	225,031	−8.58	7229	7469	3.32
2007	46,262	49,189	6.33	256,168	260,366	1.64	8584	8581	−0.03
2008	53,031	59,014	11.28	254,842	297,150	16.60	9957	9839	−1.18
2009	54,932	69,272	26.10	292,418	334,651	14.44	10,978	11,249	2.48
2010	72,118	79,803	10.66	356,505	371,843	4.30	12,520	12,814	2.35
2011	112,893	90,381	−19.94	476,171	407,345	−14.45	14,551	14,531	−0.13
2012	111,508	100,697	−9.69	431,877	439,358	1.73	16,510	16,395	−0.70
2013	106,214	110,351	3.89	458,304	465,595	1.59	18,311	18,392	0.44
2014	118,068	118,828	0.64	491,121	483,202	−1.61	20,167	20,502	1.66
2015	108,631	125,489	15.52	438,548	488,674	11.43	21,966	22,697	3.33
2016	103,328	129,550	25.38	376,524	477,774	26.89	23,821	24,937	4.69
2017	131,802	130,063	−1.32	428,597	445,430	3.93	25,974	27,173	4.62
e_r (the average relative residual)			10.33			8.44			1.77
P (the model prediction accuracy)			89.67			91.56			98.23
2018	125,474	125,893	0.33	365,558	385,641	5.49	28,228	29,340	3.94
2019	91,493	123,224	34.68	321,818	330,780	2.78	30,733	31,841	3.61

Measurement of the recent trade dispute effect on the China-US bilateral trade in aquatic products

Simulation of China's aquatic products import level from the USA

To examine the effect of the recent trade dispute on China's aquatic products import level from the USA, we choose China's aquatic products import value, import volume and China's per capita disposable income to build the MGM (1, 3) about China's import level of aquatic products from the USA. In the same way, using MATLAB software, we obtain the results, which are shown in Table 5. The average relative error rate between the annual predicted values and the actual values in the corresponding years for the value and volume of China's aquatic product imports from the USA from 2002 to 2017 is 10.33% and 8.44%, respectively. Meanwhile, the average relative error rate between the annual predicted values of China's per capita disposable income and the actual values in the corresponding years is only 1.77%. As such, the prediction accuracy of the annual value and volume of China's aquatic product imports from the USA and China's per capita disposable income is 89.67%, 91.56% and 98.23%, respectively. As such, the MGM (1, 3) model of China's aquatic product import level from the USA has relatively high prediction accuracy. Therefore, we simulate China's per capita disposable income, China's aquatic product import value and volume from the USA in 2018. Then, using the equity-dimensional grey number replacement technology, we obtain the predicted values of China's aquatic product import level from the USA in 2019.

In Table 5, the predicted value of China's import of aquatic products from the USA is about 4.19 million US dollars more than the actual value and the predicted volume is about 20,083 tons more than the actual value in 2018. In addition, the predicted value of

Table 6. Forecast of China's aquatic products export level to the USA and point by point residual test 2002–2019.

	Export value (ten thousand RMB yuan)			Export volume (ton)			USA's per capita disposable income (US $)		
Year	Actual value	Predicted value	e_r (%)	Actual value	Predicted value	e_r (%)	Actual value	Predicted value	e_r (%)
2002	668,408	668,408	0.00	258,771	258,771	0.00	28,153	28,153	0.00
2003	830,649	823,338	−0.88	321,178	321,523	0.11	29,192	29,336	0.49
2004	796,548	924,038	16.01	333,510	364,071	9.16	30,643	30,720	0.25
2005	1,047,413	1,043,119	−0.41	404,162	406,272	0.52	31,710	32,015	0.96
2006	1,401,155	1,174,700	−16.16	501,044	445,967	−10.99	33,549	33,210	−1.01
2007	1,338,326	1,312,220	−1.95	501,330	481,294	−4.00	34,855	34,306	−1.57
2008	1,410,699	1,449,117	2.72	492,069	510,913	3.83	35,906	35,316	−1.64
2009	1,388,926	1,579,649	13.73	501,582	534,218	6.51	35,500	36,266	2.16
2010	1,729,530	1,699,848	−1.72	558,932	551,586	−1.31	36,524	37,192	1.83
2011	1,839,050	1,808,618	−1.65	541,669	564,615	4.24	38,052	38,141	0.24
2012	1,810,186	1,908,965	5.46	533,460	576,395	8.05	39,780	39,169	−1.54
2013	1,920,208	2,009,376	4.64	565,017	591,773	4.74	39,521	40,335	2.06
2014	2,031,715	2,125,323	4.61	576,621	617,647	7.11	41,440	41,703	0.64
2015	1,941,658	2,280,918	17.47	546,919	663,255	21.27	42,925	43,334	0.95
2016	1,974,191	2,510,697	27.18	540,898	740,492	36.90	43,812	45,283	3.36
2017	1,937,549	2,861,550	47.69	513,639	864,227	68.26	45,583	47,595	4.41
$\mathbf{e_r}$ (the average relative residual)			10.14			11.69			1.44
P (the model prediction accuracy)			89.86			88.31			98.56
2018	2,008,020	3,394,752	69.06	514,727	1,052,638	104.50	48,075	50,297	4.62
2019	1,527,710	685,638,528	↑	419,036	204,746,758	↑	50,504	557,359	↑

China's aquatic imports from the USA in 2019 is about 317.31 million US dollars more than the actual value, while the predicted volume is about 8,962 tons more than the actual value in 2019. Moreover, compared with the actual situation in 2017, both the actual value and the predicted value of China's aquatic products import from USA in 2018 and 2019 showed a decreasing trend after the outbreak of the recent trade dispute. This means that the recent trade dispute has led to a decline in the value and volume of aquatic products imports from the USA, which has objectively increased the export pressure of US aquatic products and harmed the economic interests of the aquatic product producers and operators in the USA. Compared with the situation in 2018, the decline in the value and volume of China's aquatic products import from the USA in 2019 indicates that the continued aggravation of the recent trade dispute will further reduce the scale of China's aquatic products import from the USA, which would further damage the economic interests of aquatic product producers and operators in the USA.

Simulation of China's aquatic products export level to the USA

To examine the effect of the recent trade dispute on China's aquatic products export level to the USA, we use China's aquatic products export value, export volume and the USA's per capita disposable income to build MGM (1, 3) regarding China's export level of aquatic products to the USA (Table 6). The average relative error rate between the annual predicted values and the actual values in the corresponding years for the value and volume of China's aquatic product exports to the USA from 2002 to 2017 is 10.14% and 11.69%, respectively. Meanwhile, the average relative error rate between the annual predicted values of the USA's per capita disposable income and actual values in the corresponding years is only 1.44%. In Table 6, it is apparent that the prediction accuracy of the annual value and volume of China's aquatic product exports to the USA and the USA's per capita disposable income is 89.86%, 88.31% and 98.56%, respectively. Therefore, the MGM (1, 3) model of China's aquatic product export level to the USA has also relatively high prediction accuracy. Based on this model, we can simulate the USA's per capita disposable income and China's aquatic product export value and volume to the USA in 2018. Then, using the equity-dimensional grey number replacement technology, we can get the predicted values of China's aquatic product export level to the USA in 2019.

Compared with the situation in 2017, the value and volume of China's aquatic products exports to the USA in 2018 shows a slight increase. However, influenced by the recent trade dispute, the value and volume of China's aquatic products exports to the USA in 2018 did not reach the increasing range of predicted values, with a decrease of 69.16% and 105.26% respectively. Furthermore, compared with the situation in 2018, although the predicted values of China's aquatic products export value and volume to the USA in 2019 showed a sharp increase, the actual value showed a downward trend in both. As such, the outbreak of the recent trade dispute has an apparent squeezing effect on the value and volume of China's aquatic products exports to the USA. Theoretically speaking, this would increase the pressure on China's aquatic products export and reduce the economic interest of China's aquatic product producers and operators. However, we can see that China's aquatic product export level to other countries other than the USA only exhibits small fluctuations because of the substitution effect of China's existing aquatic product export channels (Table 4). Given the change range of China's aquatic product imports from the USA (Table 2) to some extent, it can be concluded that the outbreak and aggravation of the recent trade dispute have not caused significant extrusion effect on China's aquatic product exports. Furthermore, compared with the potential loss of economic interests in terms of exports to China suffered by aquatic product producers and operators in the USA, the economic interests of China's aquatic products producers and operators in terms of exports have not been affected significantly on the whole. In other words, the negative impact of the recent trade dispute on China's aquatic product exports is not as great as the negative impact on aquatic product producers and operators in the USA. Therefore, the potential trade losses of aquatic product producers and operators in the USA are relatively greater.

Conclusion

Based on China's aquatic products international trade data from 2002 to 2017, this paper uses the MATLAB software to predict the values of China's aquatic products import and export from 2018 to 2019 using the multivariable grey model – MGM (1, 3). The paper then evaluates the overall impact of the recent trade dispute on China's aquatic products import and export level by using the counterfactual reasoning method. The main conclusions are as follows:

(1) The recent trade dispute has led to a decline in the value and volume of aquatic products imports from the USA, which has objectively increased the export pressure of US aquatic products and harmed the economic interests of the aquatic

product producers and operators in the USA. The continued aggravation of the recent trade dispute will further reduce the scale of China's aquatic products import from the USA. However, China's aquatic product import exhibits a substitution effect in the selection of import countries. The current diversification of China's aquatic product import channels can not only offset but also exceed the negative effect of this recent trade dispute on China's aquatic product import volume and value.

(2) The import structure of China's aquatic products has been in the stage of transformation and upgrading due to the outbreak of the recent trade dispute and has shifted focus to import aquatic products with high economic added value from countries other than the USA. In addition, there has been a substitution effect among the categories of China's imported aquatic products from the USA.

(3) As China's aquatic products export is heavily dependent on the market in the USA, the outbreak and aggravation of the recent trade dispute have not caused significant extrusion effect on China's aquatic product exports. This results from the substitution effect of China's existing aquatic product export channels. Compared with the potential trade loss in terms of exports to China suffered by aquatic product producers and operators in the USA, the economic interests of China's aquatic products producers and operators in terms of exports have not been affected significantly overall. In comparison, the potential trade losses to aquatic product producers and operators in the USA are relatively greater.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Funding

This work was supported by the Centre for Blue Governance Visiting Fellow Scheme [2019/202].

ORCID

Pierre Failler http://orcid.org/0000-0002-9225-9399
Benjamin M. Drakeford http://orcid.org/0000-0002-5194-0735

References

Ayvaz, B., and A. O. Kusakci. 2017. "Electricity Consumption Forecasting for Turkey with Nonhomogeneous Discrete Grey Model." *Energy Sour* B12 (3): 260–267. doi:10.1080/15567249.2015.1089337.

Bown, C. P. 2019. "The 2018 US-China Trade Conflict after Forty Years of Special Protection [J]." *China Economic Journal* 12 (2): 109–136.

Charnovitz, S. 2019. "Grading Trump's China Trade Strategy [J]." *European Yearbook of International Economic Law*. 10, 217–256.

Chen, A. W., J. Chen, and V. Reddy Dondeti. 2020. “The US-China Trade War: Dominance of Trade or Technology? [J].” *Applied Economics Letters* 27 (11): 904–909. doi:10.1080/13504851.2019.1646860.

Chen, X., and B. Wang. 2012. “Multi-factor Grey Prediction Model and Its Application [J].” *Mathematics in Practice and Theory* 42(1): 80–83. (in Chinese).

China Fishery Statistical Yearbook[M]. 2021 June. *Fisheries and Fisheries Administration Bureau under the Ministry of Agriculture and Rural Affairs of the People’s Republic of China*. China Agriculture Press, IV.

Di, D., G. Luft, and D. Zhong. 2019. “Why Did Trump Launch A Trade War? A Political Economy Explanation from the Perspective of Financial Constraints [J].” *Economic and Political Studies* 7 (2): 203–216. doi:10.1080/20954816.2019.1595327.

Edwin, L.-C. L. 2019. “The US–China Trade War, the American Public Opinions and Its Effects on China [J.” *Economic and Political Studies* 7 (2): 169–184. doi:10.1080/20954816.2019.1595330.

Felbermayr, G., and M. Steininger. 2019. “Trump’s Trade Attack on China – Who Will Have the Last Laugh? [J].” *CESifo Forum* 20 (1): 27–32.

Guo, W. 2013. *Study on Influential Factors of China’s Agricultural Trade Flow Based on Gravity Model [D]*. Hunan: Hunan University. (in Chinese).

Hu, Q., and X. Huo. 2008. “Analysis of the Influence Factors and Development Potential of China’s Aquatic Product Export Trade Based on Gravity Model [J].” *Agrotechnical Economics* 12 (3):100–105. (in Chinese).

Hu, Z., X. Xu, Q. Su, H. Zhu, and J. Guo. 2020. “Grey Prediction Evolution Algorithm for Global Optimization.” *Applied Mathematical Modelling* 79: 145–160. doi:10.1016/j.apm.2019.10.026.

Iqbal, B. A., N. Rahman, and J. Elimimian. 2019. “The Future of Global Trade in the Presence of the Sino-US Trade War [J].” *Economic and Political Studies* 7 (2): 217–231. doi:10.1080/20954816.2019.1595324.

Janusch, H., and W. Mucha. 2017. “America First: Power and Geopolitics in US Trade Policy under President Trump [J].” *Sicherheit and Frieden* 35 (3): 8–12. doi:10.5771/0175-274X-2017-3-8.

Ji, D. 2017. “A Review of Research on Breakpoint Regression Design[J].” *Journal of Wuxi Commercial Vocational and Technical College* 17(3): 24–28.(in Chinese).

Kapustina, L., Ľ. Lipková, Y. Silin, and A. Drevalev. 2020. “US-China Trade War: Causes and Outcomes [C].” Innovative Economic Symposium 2019 – Potential of Eurasian Economic Union (IES2019), SHS Web of Conferences, 73, 01012. doi:10.1051/shsconf/20207301012

Larres, K. 2020. “Trump’s Trade Wars: America, China, Europe, and Global Disorder [J].” *Journal of Transatlantic Studies* 18 (1): 103–129. doi:10.1057/s42738-019-00040-y.

Lei, M., and Z. Feng. 2012. “.A Proposed Grey Model for Short-term Electricity Price Forecasting in Competitive Power Markets.” *International Journal of Electrical Power and Energy Systems* 43 (1): 531–538. doi:10.1016/j.ijepes.2012.06.001.

Li, C., C. He, and C. Lin. 2018. “Economic Impacts of the Possible China–US Trade War [J].” *Emerging Markets Finance and Trade* 54 (7): 1557–1577. doi:10.1080/1540496X.2018.1446131.

Li, K., L. Liu, J. Zhai, T. M. Khoshgoftaar, and T. Li. 2016. “The Improved Grey Model Based on Particle Swarm Optimization Algorithm for Time Series Prediction.” *Engineering Applications of Artificial Intelligence* 55: 285–291. doi:10.1016/j.engappai.2016.07.005.

Lin, C., and H. Wu. 2015. “The Research Status and Potential Problems of Dual Difference Method in China [J].” *Journal of Quantitative and Technical Economics* 32(7): 133–148.(in Chinese).

Liu, T., and W. T. Woo. 2018. “Understanding the U.S.-China Trade War [J].” *China Economic Journal* 11 (3): 319–340. doi:10.1080/17538963.2018.1516256.

Lu, H., X. Ma, K. Huang, and M. Azimi. 2020. “Carbon Trading Volume and Price Forecasting in China Using Multiple Machine Learning Models.” *Journal of Cleaner Production* 249: 119386. doi:10.1016/j.jclepro.2019.119386.

Lu, K., H. Liu, L. Bao, and J. Sun. 2018. “Forecast and Development of Sea Cucumber Cultivation Yield in Shandong Province during the 13th Five-Year Plan Period [J].” *Marine Development and Management* 15 (7):94–100. (in Chinese).

Moonchai, S., and N. Chutsagulprom. 2020. "Short-term Forecasting of Renewable Energy Consumption: Augmentation of a Modified Grey Model with a Kalman Filter." *Applied Soft Computing* 87: 105994. doi:10.1016/j.asoc.2019.105994.

Qi, H. 2018. "Reflection on the Transformation of Dalian Aquatic Product Export Market under Sino-US Trade Friction[J]." *China Aquatic Products* 23 (9):52–55. (in Chinese).

Qiu, L. D., C. Zhan, and X. Wei. 2019. "An Analysis of the China–US Trade War through the Lens of the Trade Literature [J]." *Economic and Political Studies* 7 (2): 148–168. doi:10.1080/20954816.2019.1595329.

Rosyadi, S. A., and T. Widodo. 2018. "Impact of Donald Trump's Tariff Increase against Chinese Imports on Global Economy: Global Trade Analysis Project (GTAP) Model [J]." *Journal of Chinese Economic and Business Studies* 16 (2): 125–145. doi:10.1080/14765284.2018.1427930.

Song, Z., W. Ji, and L. Ning. 2019. "The Impact of Sino-US Trade Friction on the Import Trade of Aquatic Products to the USA in Zhanjiang City and Its Development Countermeasures [J." *China's Fishery Economy* 37(1): 59–70.(in Chinese).

Tacon, A. G. J., and M. Metian. 2017. "Food Matters: Fish, Income, and Food Supply—A Comparative Analysis [J]." *Reviews in Fisheries Science & Aquaculture*. doi:10.1080/23308249.2017.1328659.

Tai Leung Chong, T., and X. Li. 2019. "Understanding the China–US Trade War: Causes, Economic Impact, and the Worst-case Scenario [J]." *Economic and Political Studies* 7 (2): 185–202. doi:10.1080/20954816.2019.1595328.

Wang, C., L. Wang, Y. Cao, Y. Zhu, and J. Zhang. 2013. "Application of Improved Multivariable Grey Model in Urban Water Consumption Prediction [J]." *Water and Power Science* 31(2): 27–29.(in Chinese).

Xia, Y., Q. Zhang, and S. Cao. 2013. "Study on the Growth Trend of China's Export of Agricultural Products to SCO Countries [J]". *Statistics and Decision* 20. 79–82. (in Chinese). doi:10.13546/j.cnki.tjyjc.2013.20.039

Xu, W., Z. Liu, and B. Hu. 2018. "Analysis on Export Competitiveness of Chinese Aquatic Products to U.S. [J]." *China's Fishery Economy* 36(6): 45–53.(in Chinese).

Yu, M. 2019. "Introduction to the Special Issue on Understanding the Current China-U.S.'Trade War' [J]." *China Economic Journal* 12 (2): 97–99. doi:10.1080/17538963.2019.1616919.

Zhai, J., J. Sheng, and Y. Feng. 1997. "MGM (1, N) Grey Model and Its Application [J]." *Systems Engineering Theory & Practice* 5: 110–114. (in Chinese).

Zhai, Y., and M. Li. 2019. "China's Export of Aquatic Products to the USA under the Background of Trade Disputes [J]." *Agricultural Outlook* 43 (8):81–84+89. (in Chinese).

Zhao, L., R. Liu, J. He, and B. Han. 2015. "Research on Tax Policy Evaluation Method Based on Positivism [J]." *Tax Research* 21 (10):115–119. (in Chinese).