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Complex Characteristics Analysis of Time-Delay Digital Supply Chain driven by Cybersecurity

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Abstract. At present, digital economy is the most powerful engine to drive China's economic development, embracing the digital supply chain has increasingly become the consensus of the industry. In this paper, we investigate the short and long-term evolutionary game behaviors of a digital supply chain consisting of a supplier and an online retailer, in which the supplier decides local advertising effort level, and the online retailer decides retail price and cybersecurity effort level. Firstly, two short-term game models (Centralized decision model and Stackelberg game model) are established and the optimal solutions of the two models are obtained. Secondly, the studies of the long-term evolutionary game behavior of digital supply chain are made individually, according to the situation of considering time-delay and do not consider time-delay. Finally, we stabilize the chaotic system by proposing an appropriate control mothed. The results show that the time-delay in the decision-making process of follower's (online retailer) cybersecurity effort level and retail price only cause the decision-making of follower into chaos, and it does not affect the decision-making of leader's (supplier) local advertising effort level; When the system is in a state of chaos, the average profit of both supplier and online retailer maintain a downward trend; The adjustment speed of cybersecurity effort has the greatest impact on the digital supply chain, and radical retail price adjustment will make consumers more sensitive to the cybersecurity effort level in the digital supply chain.

Keywords: Advertising, Chaos, Cybersecurity, Digital supply chain, Time-delay

1. Introduction

In the past 2020, online retail industry continues to develop steadily and becomes an important driving force for consumption growth in China. According to the 46th "Statistical Report on Internet Development in China" released by the China Internet Network Information Center (CNNIC), as of December 31, 2020, the national online retail sales have reached 11.76 trillion yuan, of which the online sales of physical goods have reached 9.76 trillion yuan, accounting for 24.9% of the total retail sales of consumer goods. At the same time, digital companies continue to open up new markets for foreign trade development. In 2020, the total retail sales of import and export goods through the customs cross-border e-commerce management platform have reached 10.3 trillion yuan, which shows that online retail industry has become an important force to respond to new challenges and build a new economy.

With the increasing competition in the online shopping industry, many large digital companies continue to improve the digital level of their supply chain through business model innovation and accelerating the application of digital technology, which provides an important support for industrial transformation and upgrading, especially by building a digital supply chain. The digital supply chain is an important driving force for the upgrading and transformation of online

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shopping industry. In view of the current market environment, building a digital supply chain can in-depth study of changes in customer demand trends, in order to occupy the market in advance.

At present, digital supply chain is mainly applied to some online retail platforms, the most representative enterprise is JD.com in China. By virtue of digital infrastructure, JD.com supermarket has broken through time and space restrictions on commodity circulation, and accelerates the efficient and high-quality circulation of commodities and services on a larger scale. During the peak of the COVID-19 pandemic, JD.com has given full play to the advantages of digital supply chain and transports more than 290,000 tons of daily necessities to consumers across the country, On the other hand, it has provided an average daily sales channel of 350 tons of agricultural products for farmers troubled by their unsalable product. Thus, digital supply chain plays a very important role in economic development, and the exploration of the development of digital supply chain has become an urgent issue of the times.

Online retailer and supplier are the two key decision-makers in digital supply chain. Similar to the traditional supply chain, digital supply chain mainly increases product sales by advertising from supplier. Advertising can attract more and more customers to become registered members of online retailer, and online retailer can collect a lot of information about customers' personal privacy, shopping preferences and so on through the process of customer registration as members and customers purchasing products. Therefore, online retailer must take responsibility to build a cybersecurity platform to protect customer information. Marriott International Hotel Group is fined 18.4 million pounds by ICO (Information Commissioner's Office) for leaking personal information of 339 million guests. JD.com has made sufficient preparations in terms of cybersecurity, for example, JD.com's anti-DDOS(Distributed denial of service attack) system can monitor and prevent unserviceable problems caused by DDOS, and can timely detect and respond to ensure data and cyber security. Moreover, JD.com's three most representative cybersecurity products: "anti-DDOS", "next generation security operation center" and "network fast 1 ADC (application delivery controller)" won the "SKD awards" issued by "SKD labs"(An international well-known third party network information security evaluation and certification agency) in 2019. It can be seen that digital enterprises are paying close attention to cybersecurity issue, therefore, studying the impact of cybersecurity on the digital supply chain has important practical significance.

In view of the increasingly important role of the digital supply chain in the upgrading and transformation of traditional industries, and considering that the development of digital supply chain is still in its infancy in China, it is very important to understand the impact of cybersecurity effort leveling on different stakeholders in the digital supply chain. This will help online retailer optimize cybersecurity decisions to promote the further development of the digital supply chain.

This paper discusses the short-term game behavior and long-term evolutionary game behavior of a time-delay digital supply chain composed of a supplier and an online retailer. In the short-term game, the centralized decision-making model and the Stackelberg game model are constructed respectively, and the optimal solutions of the two models are obtained. In the long-term evolutionary game, the Stackelberg game model is taken as the benchmark model, and the complex characteristics of time-delay digital supply chain are analyzed. The main contributions of this paper are as follows: (1) a long-term evolutionary game model based on Stackelberg game is established. (2) The conditions of system bifurcation induced by time-delay generated by Stackelberg game mechanism are studied. (3) In the part of long-term evolutionary game, we not only analyze the influence of time-delay parameter on system stability, but also analyze the influence of adjustment parameters of decision variables, including adjustment speeds of cybersecurity effort level, retail price, and local advertising effort level. (4) The parameter adjustment control method is used to control the chaotic time-delay digital supply chain system, and the control effect is satisfactory.

The remainder of this paper is organized as follows. Section 2 reviews related literatures. Description and assumption of the problem are presented in Section 3. Section 4 formulates two basic models and optimal decisions are obtained. In Section 5, the stability of long-term evolutionary game models with and without time-delay are analyzed theoretically. Section 6 simulates the theoretical results that have been obtained. In Section 7, we control the chaotic system. Section 8 gives some meaningful conclusions.

2. Literature review

The literature review of this paper is mainly from the following four perspectives: digital supply chain, cybersecurity, advertising and complexity theory.

2.1. digital supply chain

What is digital supply chain? Digital supply chain refers to a smart, value-driven, efficient process to generate new forms of revenue and business value for organizations and to leverage new approaches with novel technological and analytical methods [?]. According to the report released by the Material Handling Industry of America (MHIA) in 2017, 80% of enterprises who believe that digital supply chain will dominate in the next five years. The great potential of digitalization in supply chains has been mentioned and validated by many firms. Nasiri et al. [?] explore how companies gain competitiveness through digital supply chains, and discuss how the digital transformation of enterprises promotes the development of smart technologies. Ivanov et al. [?] propose a definition of a digital supply chain twin and analyze the conditions of the design and application of the digital twins. De Giovanni [?] investigates a digital supply chain game model and analyzes the marketing and operation interactions decisions under the centralized and decentralized game scenarios respectively. Today, the focus of supply chain management has shifted from the traditional supply chain to digital supply chain, Buyukozkan et al. [?] aim at multi-criteria nature of the supplier selection process, propose a new digital supply chain approach for the first time to support it. Seepma et al. [?] explore how to use inter-organizational information and communication technology to redesign the public service supply chain into a digital supply chain. According to the above literature, many scholars have carried out research on digital supply chain from the perspective of "how to design digital supply chain", and the literature using game theory for research is rare.

2.2. Cybersecurity

Cybersecurity is "the body of combined technologies, processes, and practices that are put in place to protect data and networks from attacks, damage, or unauthorized access", and a cyberattack in the supply chain can cause time-delay in production and supply [?]. Boyson [?] put forward the idea that supply chain cyber risk management is an emerging and important new branch of supply chain risk management. Massimino et al. [?] find that in the research of supply chain operation, digital confidentiality is not paid enough attention. From the perspective of game theory, Li et al. [?] examine the cybersecurity investment in a two-level supply chain composed of a retailer and n suppliers, they find that there are serious prisoner's dilemma and free riding. Nagurney et al. [?] establish a game theory model composed of retailers and demand markets, and determine their optimal cybersecurity investments and product transactions. Colajanni et al. [?] assume that the demand for products is fixed and build a new cybersecurity investment game theory model, and they find that the marginal expected transaction utility of each retailer is related to this Lagrangian multiplier and its sign. Zheng et al. [?] think the critical problem faced by decision-makers is to prioritize investment in cybersecurity to maximally reduce risks in digital supply chain.

The emergence of digital supply chain has completely subverted the "chain" structure of the traditional supply chain, making the connections between suppliers, retailers and customers present a mesh structure. However, the development of technology has made hacker organizations more systematic, and the global security defense forces also need to strengthen interaction and cooperation. Accordingly, the urgent challenge for digital enterprises is how to obtain the maximum value from digital assets while ensuring the cybersecurity of digital supply chain.

2.3. advertising

At present, many large online retail platforms in China, such as Alibaba, JD.com, have obtained great benefits by building digital supply chains; of course, the role of advertising cannot be ignored. Advertising effort research in the supply chain has a lot advanced in recent years. Choi et al. [?] build a luxury fashion supply chains, consider the situation when there are multiple brand-tier products in the market and analyze the optimal advertisement budget allocation strategy. Malekian et al. [?] consider price promotion and use game theoretic approach to analyze advertising policies in a two-echelon supply chain. Li et al. [?] investigate cooperative advertising strategies in O2O supply chain consisting of a seller and an online platform agent. Gupta et al. [?] focus on the influence of advertising efforts on the optimal pricing decisions and performance in a multi-echelon supply chain. Ahmadi-

Javid et al. [?] assume the retailer advertises locally, and the supplier advertises in national media and bear part of the retailer's advertising cost. Zhou et al. [?] establish a two-echelon supply chain composed of a risk-averse supplier and a retailer, and analyze the cooperative advertising and ordering issue.

2.4. complexity theory

Some researchers analyze the dynamic characteristics of the system by combining the complexity theory and supply chain. Agliari et al. [?] build a simple cobweb demand-supply framework model, use a two-dimensional map to describe the resulting dynamics, and they find that the map has a fixed point and the point might lose stability either via flip bifurcation or supercritical Neimark-Sacker bifurcation. Puu et al. [?] discuss whether Bertrand and Cournot oligopolies can be combined, and obtain some interesting mathematical facts, such as mulistability and coexistence of attractors. Ma et al. [?] focus on a multi-channel supply chain comprised of a supplier, a dual-channel retailer and an online retailer, a price game model is proposed and use the stability region, the bifurcation diagram and the maximum Lyapunov exponent to analyze it. Chang et al. [?] consider a supply chain consisting of one supplier and one retailer, they find some dynamic phenomena such as bifurcation and chaos, the results show that the stability of the system can be lost by Neimark-Sacker bifurcation or flip bifurcation. Ma et al. [?] focus on a supply-chain system under policy intervention, which is composed of the government, an electric vehicle manufacturer and a fuel vehicle manufacturer and investigate the impacts of pricing time on profitability and stability. Bao et al. [?] study the short- and long-term evolutionary game behaviors of two parallel supply chains composed of an electric vehicle manufacturer and a fuel vehicle manufacturer.

It is not difficult to find that most of the above literature are from the perspective of operation management, few researches focus on the long-term evolutionary game behaviorof digital supply chain, and few people pay attention to the inevitable time-delay caused by the Stackelberg game mechanism. The influences of cybersecurity effort level and advertising effort level on the digital supply chain in the long-term evolutionary game process have also rarely been involved.

3. Description and Assumption of the Problem

3.1. Supply Chain Construction and Assumptions

This paper discusses the short-term game and long-term evolutionary game behaviors of the digital supply chain which contains a supplier and an online retailer. The supplier wholesales product to the online retailer, and through the local advertising effort to bring potential customers from the stage of considering buying to the stage of desire and action. The online retailer sells the product to customers at retail price p. Because the supplier's local advertising effort level has the effect of attracting customers to become registered members of online retailer, the online retailer must protect customer information through cybersecurity effort.

The main assumptions of this paper are as follows:

1. In the short-term game, the supplier and online retailer are completely rational, while in the long-term evolutionary game, the supplier and online retailer are bounded rational.
2. This paper only considers one-time investment. If the local advertising effort level is i, and the supplier need incur the cost $k_m i^2/2$. If the cybersecurity effort level is h, the online retailer need incur the cost $k_r h^2/2$, where k_m is the cost coefficient of advertising effort level, k_r is the cost coefficient of cybersecurity effort level.
3. In order to ensure that the supplier and online retailer can make normal profits, $p > w$.

3.2. Symbolic Description

Where the meanings of S, i_0, i, α, β, γ, p, h, w and D are described concisely in Table 1.

Both advertising effort level and cybersecurity effort level are considered simultaneously in the demand function. Assuming that advertising effort level are divided into two categories: national advertising and local advertising. The supplier's national advertising, such as brand name investment, is intended to let potential customers know the product and generate purchase considerations. The function of supplier's local advertising is to bring potential customers from the stage of considering buying to the stage of desire and action through measures such as reducing prices or improving product quality. Based on the existing literature [?], the functional form of market demand can be written as follow

$$D\left(i,p,h\right)=\left(S-\frac{1}{ii_0}\right)(\alpha-\beta p+\gamma h). \qquad (1)$$

Table 1
The parameters description for system.

Parameter	Description
S	Sales saturate asymptote.
i_0	National advertising effort level.
i	Local advertising effort level.
α	Market demand scale unaffected by other market factors.
β	Customers' Sensitivity to retail price.
γ	Customers' sensitivity to cybersecurity effort level.
p	Retail price of unit product.
h	Cybersecurity effort level of online retailer.
w	Wholesale price of unit product.
D	The total quantity of market demand.

where α, β, γ and i_0 are positive constants, S is the sales saturate asymptote. $D(i,p,h)$ is an increasing function for cybersecurity effort level h and local advertising effort level i, but a decreasing function for retail price p.

4. short-term game behavior analysis

Currently, some companies that benefit from the digital supply chain are mainly online retail platforms in china, such as Taobao, JD.com and Suning. They through the supplier's local advertising effort level to predict consumer acceptance of the product and determine its retail price, and online retailer collects a large amount of prospect information through big data technology to achieve the purpose of precision push. Therefore, it is particularly important to build a safe and reliable cybersecurity environment. Based on the above demand and cost functions, the profit functions of the supplier and online retailer can be written as follows:

$$\pi_s = w\left(S - \frac{1}{ii_0}\right)(\alpha - \beta p + \gamma h) - \frac{k_m i^2}{2}, \quad (2)$$

$$\pi_r = (p-w)\left(S - \frac{1}{ii_0}\right)(\alpha - \beta p + \gamma h) - \frac{k_r h^2}{2}. \quad (3)$$

4.1. Centralized decision-making model

Centralized decision-making model refers to the online retailer and supplier make up the unified system, and the unified system makes centralized decisions to optimize the entire digital supply chain. Based on the comprehensive consideration of the return and cost, and the goal of their decisions is to maximize the overall profit of the digital supply chain. Let the first-order partial derivatives of the overall profit be equal to zero, the optimal decision under the centralized decision-making can be obtained. Under centralized decision-making, the overall profit of digital supply chain can be written as:

$$\pi_c = p\left(S - \frac{1}{ii_0}\right)(\alpha - \beta p + \gamma h) - \frac{k_m i^2}{2} - \frac{k_r h^2}{2}. \quad (4)$$

The first-order partial derivative of Equation (4) can be written as follows:

$$\begin{cases} \frac{\partial \pi_c}{\partial i} &= \frac{p}{i_0 i^2}(\alpha - \beta p + \gamma h) - k_m i = 0, \\ \frac{\partial \pi_c}{\partial p} &= \left(S - \frac{1}{i_0 i}\right)(\alpha - 2\beta p + \gamma h) = 0, \\ \frac{\partial \pi_c}{\partial h} &= \gamma p \left(S - \frac{1}{i_0 i}\right) - k_r i = 0. \end{cases} \quad (5)$$

The existence of the optimal solution of Equation (5) can be proved by calculating the Hesse matrix H of Equation (5).

$$H = \begin{pmatrix} -\frac{2p(\alpha - \beta p + \gamma h)}{i_0 i^3} - k_m & \frac{(\alpha - 2\beta p + \gamma h)}{i_0 i^2} & \frac{\gamma p}{i_0 i^2} \\ \frac{(\alpha - 2\beta p + \gamma h)}{i_0 i^2} & -2\beta\left(S - \frac{1}{i_0 i}\right) & \gamma\left(S - \frac{1}{i_0 i}\right) \\ \frac{\gamma p}{i_0 i^2} & \gamma\left(S - \frac{1}{i_0 i}\right) & -k_r \end{pmatrix}. \quad (6)$$

Obviously, the first order principal minor determinant of H is $H_1 < 0$; the second order principal minor determinant of H is $H_2 > 0$; the third order principal minor determinant of H is $H_3 < 0$. That is, the total profit function is convex and there is an optimal solution.

Based on above calculation, the optimal solutions of the channel members in the digital supply chain are listed as follows:

$$\begin{cases} i_c^* = \frac{-\gamma\left[-6\alpha\beta k_r\sqrt[3]{\theta_1}i_0^2\left(\gamma^2 S-2\beta k_r\right)^2+\gamma\sqrt[3]{12\theta_1^2}-2\sqrt[3]{18}k_m\beta i_0^2\gamma^5\left(2\beta k_r-\gamma^2 S\right)^3\right]}{\sqrt[3]{6}i_0(2\beta k_r-\gamma^2 S)\left[\sqrt[3]{2\theta_1^2}-2\sqrt[3]{3}k_m\beta i_0^2\gamma^4(2\beta k_r-\gamma^2 S)^3\right]}, \\ p_c^* = \frac{\sqrt{\frac{2}{3}}k_m\gamma^5}{\sqrt[3]{\theta_1}}+\frac{\alpha k_r}{2\beta k_r-\gamma^2 S}+\frac{\gamma\sqrt[3]{\theta_1}}{\sqrt[3]{18}\beta i_0^2(2\beta k_r-\gamma^2 S)^3}, \\ h_c^* = \frac{2\sqrt[3]{18}k_m\beta i_0^2\gamma^4\left(2\beta k_r-\gamma^2 S\right)^3+\sqrt[3]{\theta_1}\left[3\alpha i_0^2\gamma S\left(\gamma^2 S-2\beta k_r\right)^2-\sqrt[3]{12\theta_1^2}\right]}{3i_0^2(2\beta k_r-\gamma^2 S)^3\sqrt[3]{\theta_1}}. \end{cases} \tag{7}$$

Where:

$$\theta_1 = 9\alpha k_m\beta^2 k_r i_0^4\gamma^3\left(2\beta k_r-\gamma^2 S\right)^5+\sqrt{3}\sqrt{k_m^2\beta^3 i_0^6\gamma^6\left(2\beta k_r-\gamma^2 S\right)^9\left[4k_m\gamma^6+27\alpha^2\beta k_r^2 i_0^2\left(2\beta k_r-\gamma^2 S\right)\right]}$$

4.2. Stackelberg game model

In the planning period, supplier chooses the appropriate online retailer to cooperate and makes decision on the local advertising effort level with its limited funds, so as to bring potential customers from the stage of considering buying to the stage of desire and action through measures such as reducing prices or improving product quality. In response to the supplier's decision, the online retailer determines the cybersecurity effort level and sets the retail price. If the supplier's local advertising effort level achieves satisfactory decision-making results, correspondingly, more and more customers will register as members on the online retail platform, and online retailer also collects more customer information. Therefore, online retailer must improve cybersecurity effort level to protect customer information from being leaked.

On this basis, the supplier is leader and the online retailer is follower. To obtain the Stackelberg game equilibrium point, the best online retailer's response function is obtained by calculating the first-order partial derivatives of online retailer's profit function equal to 0.

$$\begin{cases} \frac{\partial\pi_r}{\partial p} = \left(S-\frac{1}{ii_0}\right)(\alpha-2\beta p+\gamma h+\beta w)=0, \\ \frac{\partial\pi_r}{\partial h} = \gamma(p-w)\left(S-\frac{1}{ii_0}\right)-k_r h=0. \end{cases} \tag{8}$$

According to Equation (8), the best online retailer's response functions can be written as

$$\begin{cases} p_s^* = \frac{ii_0\left(\gamma^2 wS-\beta k_r w-\alpha k_r\right)-\gamma^2 w}{ii_0(2\beta k_r-\gamma^2 S)+\gamma^2}, \\ h_s^* = \frac{\gamma(ii_0 S-1)(\beta w-\alpha)}{ii_0(2\beta k_r-\gamma^2 S)+\gamma^2}. \end{cases} \tag{9}$$

After substituting the Equation (9) into the Equation (2), and solving $\frac{\partial\pi_s}{\partial i}=0$, the equilibrium point of the digital supply chain members is:

$$\begin{cases} i_s^* = -\frac{\left[k_m i_0\gamma^2\left(2\beta k_r-\gamma^2 S\right)+\sqrt[3]{(\theta_2+\theta_3)}\right]^2}{3k_m i_0^2(\gamma^2 S-2\beta k_r)^2\sqrt[3]{(\theta_2+\theta_3)}}, \\ p_s^* = \frac{\alpha k_r\left[\begin{matrix} k_m i_0\gamma^2\left(2\beta k_r-\gamma^2 S\right) \\ +\sqrt[3]{\theta_2+\theta_3} \end{matrix}\right]^2+w\left(\begin{matrix} i_0^2 k_m^2\gamma^4\left(\beta k_r-\gamma^2 S\right) \\ -k_m i_0\gamma^2\sqrt[3]{\theta_2+\theta_3}\left(\gamma^2 S-\right. \\ +\sqrt[3]{(\theta_2+\theta_3)^2}\left(\right. \end{matrix}\right.}{(2\beta k_r-\gamma^2 S)\left(\sqrt[3]{(\theta_2+\theta_3)^2}+\sqrt[3]{\theta_2+\theta_3}i_0 k_m(\gamma^2(\gamma^2 S-2\beta k_r))+\gamma^4 i\right.} \\ h_s^* = \frac{\gamma(\alpha-\beta w)\left(\sqrt[3]{\theta_2+\theta_3}k_m i_0\left(6\beta k_r-\gamma^2 S\right)\left(2\beta k_r-\gamma^2 S\right)+\gamma^4 i_0^2 k_m^2\left(\gamma^2 S-2\beta k_r\right)\right.}{(2\beta k_r-\gamma^2 S)\left(\sqrt[3]{(\theta_2+\theta_3)^2}+\sqrt[3]{\theta_2+\theta_3}i_0 k_m(\gamma^2(\gamma^2 S-2\beta k_r))+\gamma^4 i_0^2 k_m^2(\right.} \end{cases} \tag{10}$$

Where:

$$\theta_2 = k_{mm}^{3\,3}\gamma^6\left(\gamma^2 S-2\beta k_r\right)^3-27k_m^2\beta^2 k_r^2 i_0^5\left(\gamma^2 S-2\beta k_r\right)^4 w(\alpha-\beta w)$$

$$\theta_3 = 3\sqrt{3}\sqrt{-k_m^4\beta^2 k_r^2 i_0^8\left(2\beta k_r-\gamma^2 S\right)^7 w(-\alpha+\beta w)\left(2k_m\gamma^6+27\beta^2\right.}$$

Lemma 4.1 *The digital supply chain has a unique positive equilibrium point* (i_s^*, p_s^*, h_s^*) *if and only* $\sqrt[3]{(\theta_2+\theta_3)} < 0$.

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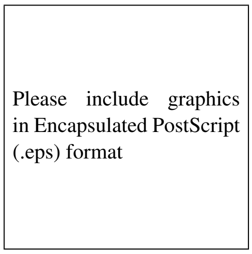

Fig. 1. Figure caption.

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Code your tables using LaTeX environments `table` and `tabular`. Each table should have a brief and self-explanatory caption that should be put above the table. Do not use the period at the end of the table caption. If the table does not fit into one column it may be placed across both columns using `\begin{table*}` so that it appears at the top of a page.

All tables coded with `table` and `\caption` will be numbered automatically.

Column headings should be brief, but sufficiently explanatory. Standard abbreviations of units of measurement should be added between parentheses. Vertical lines should not be used to separate columns. Leave some extra space between the columns instead. Any explanations essential to the understanding of the table should be given in footnotes at the bottom of the table. SI units should be used, i.e., the units based on the metre, kilogramme, second, etc.

Tables should be presented in the form shown in Table 2. Their layout should be consistent throughout.

5.10. Equations

Do not put in equation numbers, since this is taken care of automatically. The equation numbers are always consecutive and are printed in parentheses flush with the right-hand margin of the text and level with the last line of the equation. For multi-line equations, use the `eqnarray` environment. Refer to equations in the text as Eq. (1), Eqs. (3) and (5).

6. Fine tuning

6.1. Type area

Check once more that all the text and illustrations are inside the type area and that the type area is used to the maximum.

6.2. Capitalization

Use sentence case in the title and the headings.

6.3. Page numbers and running headlines

You do not need to include page numbers or running headlines. These elements will be added by the publisher.

7. Submitting the paper

Submit the following to the journal Editorial office, online submission form or Editor-in-Chief (whichever is applicable for the journal):

1. The main LaTeX document as well as other required files (eps, etc.).

Table 2

Table caption

Dataset	Models	α_1	α_2	α_3	α_4	α_5	α_6
CSDS	Linear	0.164	0.22	0.123	0.3	0.200	0.258
	Logistic	0.189	0.155	0.157	0.201	0.154	0.144
KCDS	Linear	0.155	0.183	0.160	0.218	0.176	0.156
	Logistic	0.187	0.125	0.151	0.184	0.187	0.125

2. Identical high resolution PDF file with all fonts embedded. First produce a Postscript file from LaTeX with DVIPS version 5.56 or higher. The option "-M" (don't make fonts) should be indicated. Use Adobe Acrobat Distiller and choose the job option Press-Optimized.) Please make sure you do not submit more than one version of any item.

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