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Research on e–commerce standard internationalization for China´s digital economy

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ABSTRACT

The e-commerce standard internationalization has become the strategic targets of China's digital economy. This paper proposes the system dynamics model through analyzing the internal and external factors of e-commerce standard internationalization under dynamic mechanism. The internationalization trend of China's e-commerce standard is simulated by Vensim under adjusting economy factor, policy support factor, technical-innovation factor and industry supply chain's service factor. The experiment results show that China's international leadership on e-commerce and its influence on standard internationalization from the top-level design, strengthen industry supply chain's standard certification and the technical-innovation of product standard factors, which can promote the high quality made-in-China brand .

KEYWORDS

Digital economy; E-commerce standard internationalization; Dynamic mechanism; System dynamics

1 Introduction

Since the State council issued the deepening reform of the work of Standardization in 2015, standardization has been transformed into a dual system of "government-market", with efforts focused on solving problems of imperfection of management systems and incompatibility of them with the development of a socialist market economy, improving working mechanisms for formulation of standards. China's international leadership on e-commerce and influence on standard internationalization from the top-level design, can promote China's high-quality manufacturers' certification and endorsement (Lei at al., 2020). The e-commerce standard internationalization plays an increasingly important role in promoting sustained and healthy development of China's digital economy and comprehensive social progress, which has practical significance to research development mode, putting forward countermeasures for promoting the internationalization capabilities of China's e-commerce standard.

Standardization is commonly defined as a strategy wherein marketers assume global homogeneous markets and in response offer standardized products and services using a standardized marketing standardization (Lyytinen & King, 2006). Scholars in favor of the stan-

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dardization approach argue that as technology develops and is globally dispersed, cultural distance is minimized, leading to convergence of national cultures into a homogenous global culture. The researches about standardization have been addressed in the existing literature from various perspectives, such as the form and globalization mechanism, the competition and technology strategy of standard.

Some scholars have studied the relationship between industrial standards and technological innovation. Techatassanasoontorn and Suo (2011) proposed that standardization process does not always follow a three-phased S-shaped pattern based on the network economy and complex network theory, which winner-take-all is not a necessary outcome of standards competition. Fomin et al.(2003) analyzed the progress of telecommunication technical standardization by the dynamic models of Design-Sense Making-Negotiation. Jiang et al. (2012) addressed that technological innovation can promote the development of industrial technical standards, which covers technical requirements and technical solutions in detail. Lichtenthaler (2012) suggested that the competition of technology standards among high-tech enterprises is based on superior resources and innovation capabilities.

Many scholars have studied the form mechanism of industrial standard from the perspectives of economy and policy. Cabral and Kretschmer(2006) researched the role of government in industrial standards and the effectiveness of public policy in a context of competing standards with network externalities. Chakravani and Xie(2006) studied how standards competition affects consumer behavior, which standards competition motivates consumers to pay more attention to information that is comparative in nature. Jones and Hudson (2004) analyzed the impact of standardization on the welfare of consumers who rely on signals as indicators of product quality. Standardization can effectively reduce costs of uncertainty in the purchase process, and save the effort and time of consumers to evaluate products. Greenstein and Stango (2006) proposed that technological standards are a cornerstone of the modern information economy, affecting firm strategy, market performance and, by extension, economic growth.

Other scholars have studied the internationalization process of industrial standard based on the standard competition and network theory. Mangelsdorf (2011) analyzed the role of technical standards in bilateral trade relationship between the European Union (EU) and China, and addressed that both China and the EU should increase their efforts to harmonise national standards. Blind (2011) discussed the transfer of the ECMA-376-1 standard into the ISO/IEC 29500:2008 standard parallel to the already existing ISO/IEC 26300:2006 standard with the consideration of the economic efficiency of standards competition. Liu et al. (2012) suggested that network effects make the strong grow stronger and can "tip" the market toward a single, winner-take-all standard in many markets with standards competition with theoretical and empirical evidence. Gao (2010) investigated China's experience of developing and deploying wireless local-area network (WLAN) standards upon actor-network theory, which counter-network is a useful concept to analyze the mechanism of actor-network formation. Lee and Oh (2006) used actor-network theory (ANT) to investigate the internationalization process of mobile standard setting in an international context where firms, industry consortia, and governments collaborate and compete in complex ways. Egyedi (2007) pointed out that government need to consider the overall situation in international standardization activities, so as to choose the most appropriate international standardization strategy.

With the acceleration of global industrial standardization process, the standardization capability of industrial technology is increasingly becoming the supporting element and competitive weapon of industrial independent innovation for each country all over the world.

This paper aims to provide references for accelerating China's E-commerce standard internationalization process and makes a structural dimensions division of industrial standard internationalization capability from four aspects including Economy, technology, policy and industry supply chain. Specifically, three possible results of e-commerce standard competition are predicted, and corresponding strategic options for e-commerce standard internationalization in the era of digital economy are discussed.

2 Methodology

2.1 System Dynamics

System dynamics (SD) is a computer-aided approach for strategy and policy design, which is simulation modeling based on feedback systems theory and analytical approach with complements systems thinking (Richardson 2001). The goal of a system dynamics project is to build theoretical understanding and implement policies for improvement. System dynamics modelers seek to include a broad model boundary that captures important feedbacks relevant to the problem to be addressed, represent important structures in the system including accumulations and state variables, use behavioral decision rules for the actors and agents in the system that are grounded in first-hand study, use the widest range of empirical data to formulate the model and build confidence in the conclusions. Therefore, System dynamics model applies to dynamic decision problems arising in complex social, managerial, economic, or ecological systems with characters of interdependence, mutual interaction, information feedback, and circular causality. (Saleh et al., 2010; Weide et al., 2016) The approaches of System dynamics (SD) can be summarized as:

1) Beginning with a problem to focus systems thinking and modeling, defining problems dynamically in terms of graphs over time, employing actual data wherever possible.

2) Striving for an endogenous, behavioral view of the significant dynamics of a system, a focus inward on the structures and decision rules in a system that themselves generate or exacerbate the perceived problem.

3) Thinking of all concepts in the real system as quantities interconnected in loops of information feedback and circular causality, a consequence of the endogenous point of view.

4) Identifying the key variables essential to address the problem and deciding on an appropriate level of aggregation for them. Formulating a richly explanatory behavioral model capable of reproducing, by itself, drawing on all relevant evidence, including qualitative and quantitative data.

5) Testing the structure and behavior of the model against all relevant evidence, including the model's ability to replicate historical data, ensuring the model is robust under extreme conditions, exploring the sensitivity of results to uncertainty in assumptions, and diagnosing the sources of unexpected model behavior.

6) Designing and testing policies to address the concerned problem, testing these against data and comparing to real-world policies that have been tried in the system or similar settings.

7) Translating model-based insights into implementable policies, assist in implementation, assess the results, and improve both the model and policies.

2.2 The Conceptual model of E–commerce standards system

In this section, we design the conceptual model of e-commerce standards system, which conceptual model provides a static description of the underlying application domain. The

e-commerce standards cover the basic technology standards and business standards throughout all roles, as well as support system standards which can guarantee the safe, reliable and high-efficient operation of all links in the trade, e.g. standards for payment, logistics service, credit service, safety certification, together with the basic & reference standards, supervision & management standards, etc. Figure 1 shows the conceptual model of e-commerce standard system.

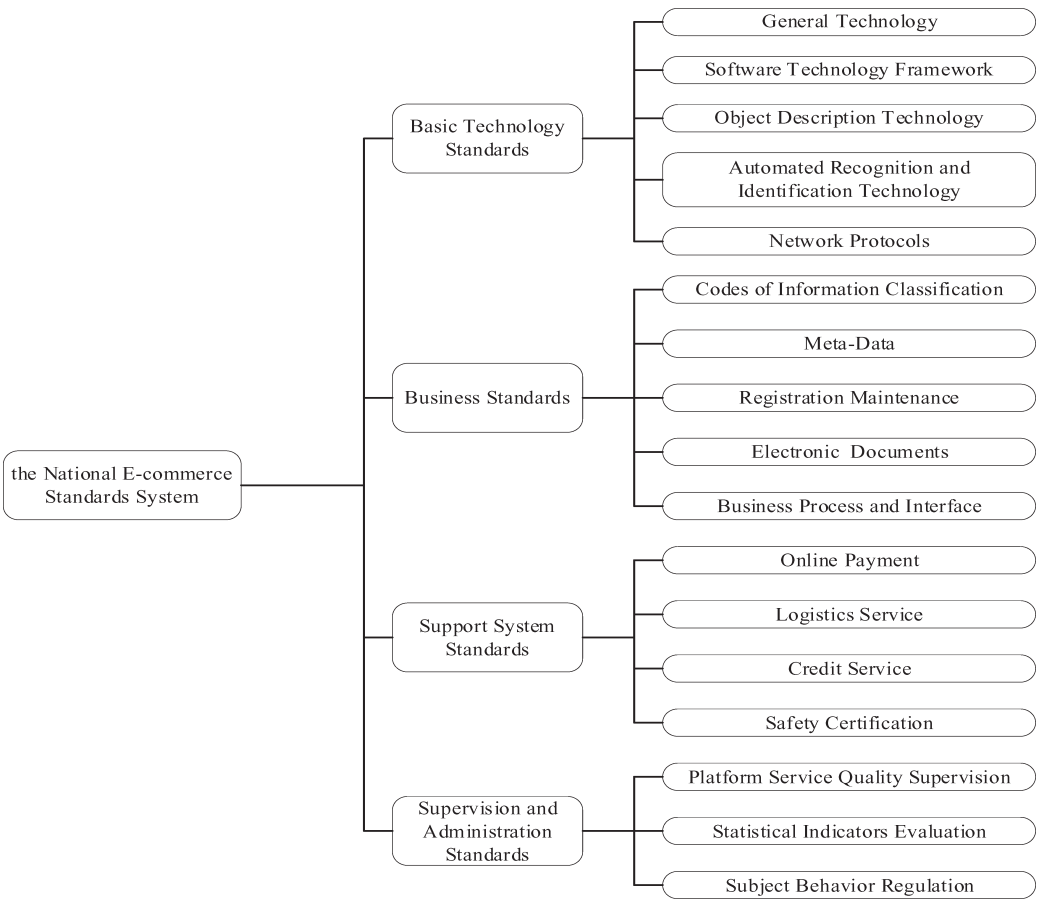


Figure 1 The conceptual model of e-commerce standard system

Basic technology standards the overall and fundamental ones, e.g. standards for e-commerce terminology, including from the existing and commonly used standards for basic data and code, standards for network security technology and protocol, to network basic standards.

Business standards mainly cover all transaction information, business process and interface for the subject and object information, e.g. Specifications for e-commerce basic data, Specifications for electronic invoice information, etc., which are cover the aspects of electronic document, meta-data, service, etc. in the e-commerce transaction.

Support system standards include the technological requirements related to safe e-commerce transaction, which include standards for platform technology and operation, for example safety certification, online payment, logistics service and credit, etc.

Supervision and management standards provide reference for the e-commerce market supervision, which mainly cover standards for subject behavior supervision, platform service quality supervision, statistical indicator evaluation, and so forth.

3 System dynamics model of E–commerce standards internationalization

Typically, the causal diagram is first step of system dynamics model. This paper constructs the four causal diagrams for e-commerce standard internationalization based on the economy, policy, technology and industrial chain sub-systems. These models are used to visualize the effects of intended policies by analyzing the causal diagram, system flow diagram of every sub-systems. Even if this may have a small impact on policy implementation, it can be helpful for getting a quick impression of the effects of intended policy changes.

3.1 Causal Diagrams of Economic sub–system

The development of e-commerce industry can not only be affected directly by economy factor, but also indirectly affected by relevant policies, technologies and industry chain services. Therefore, e-commerce standard internationalization is influenced by many interactive factors. First of all, EC standard internationalization ability is constrained by national socioeconomic level. The socioeconomic level is mainly reflected by gross regional product (GDP). With the economy development, the more and more the industry international standards and the industry investment will be needed. Meanwhile, the internationalization ability of e-commerce standard enhances the internationalization competition of EC industry, increase EC industry transaction scale and per capita GDP. Besides, from the perspective of market development scale, the standards internationalization ability can strength the EC industry market competition, promote the EC consumption level and attract more consumers. Lastly, the economy development will increase the investment of scientific research technology from government, promote the technology innovation ability for high quality EC industry international standards. The causal diagram of economy sub-system is shown in the Figure 2.

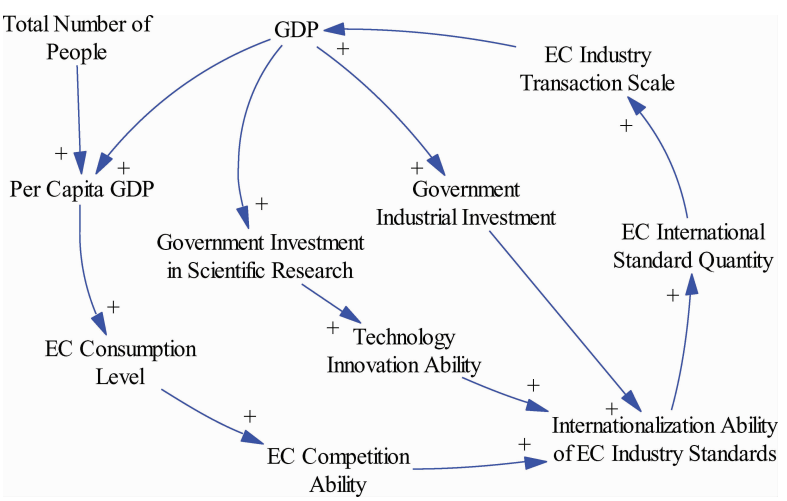


Figure 2 The causal diagram of economy sub-system

3.2 Causal Diagrams of Policy sub–system

The relevant policies from government plays key role in the development of EC standards internationalization. The tax incentive policy will relieve the taxes pressure of EC industry chain, which can increase EC enterprises' development motivation and attract more EC enterprises into industry chain. At the same time, the education support policy will promote the R&D capability, train more and more talents, which provide the strong support for EC industry transaction scale and standard international development. With the standard internationalization policy, more and more e-commerce standards of China will be "bringing in" and "going out" into the international market and be recognized by ISO and other countries. The causal diagram of policy sub-system is shown in the Figure 3.

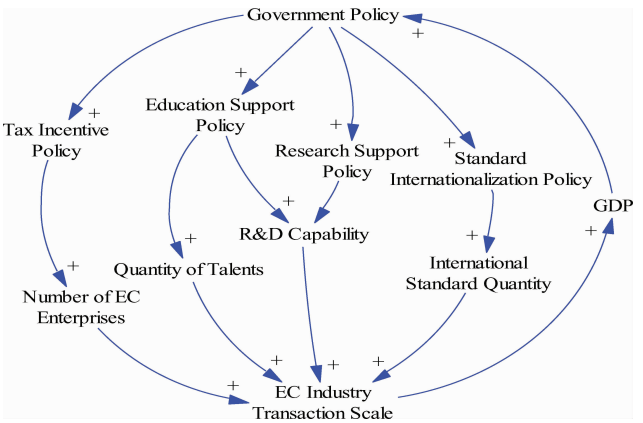


Figure 3 The causal diagram of policy sub-system

3.3 Causal Diagrams of Technology sub–system

The internationalization process of China's e-commerce standard depends on the digital technology development. The innovation of digital technology brings more opportunities for e-commerce industry, which attracts more EC enterprises and makes EC industry's booming development. Besides, the advanced technology development enhances the competition of e-commerce industry. The technology innovation brings excellent service for more consumers, such as the digital logistics technology bring convenience for e-commerce consumers, which the transaction scale of EC industry and GDP have been further promoted. The causal diagram of technology sub-system is shown in the Figure 4.

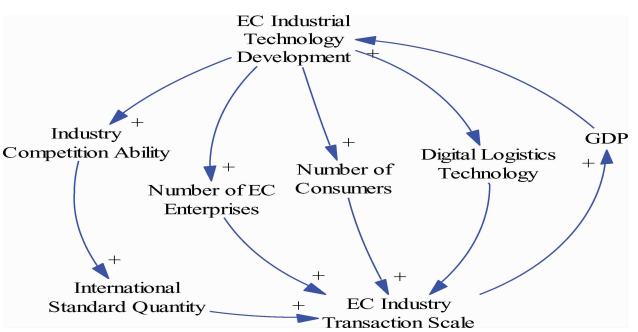


Figure 4 The causal diagram of technology sub-system

3.4 Causal Diagrams of Industry supply chain sub–system

The EC supply chain covers all activities of EC industry including production making, online payment, the logistics and so on. The service level of the EC industry chain will promote the industry revenue and the gross product by increased the satisfaction and willingness of consumer. Standard certification in the industry chain can form and optimize the EC industry standard system. The standard alliance of upstream and downstream enterprises in e-commerce supply chain can also promote the internationalization level of EC industry standard. The causal diagram of industry supply chain's sub-system is shown in the Figure 5.

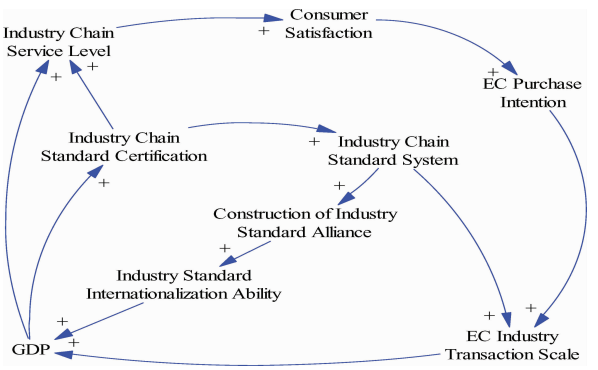


Figure 5 The causal diagram of industry supply chain's sub-system

Based on the causal diagram of the four subsystems, the overall the causal diagram of ecommerce standards internationalization can be concluded as the Figure 6.

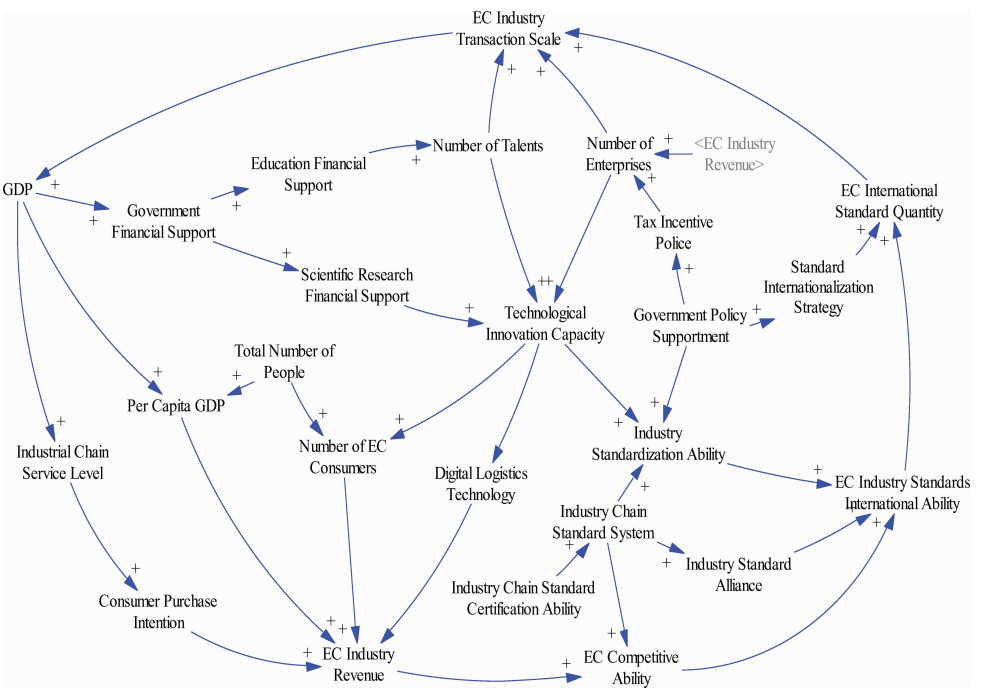


Figure 6 The causal diagram of e-commerce standards internationalization

3.5 Transformation to System Dynamics

In the SD model basically the causal relations of the causal diagram are quantified, which helps the policy maker to quickly understand the effects of their decisions on the target factors by manipulating the independent factors. The SD model of EC standard internationalization is consisted of 4 stock variables, 4 flow connectors, 20 exogenous variables and 12 link connectors. These variables are shown in Table 1.

Table 1 the variable list of EC industry standards internationalization model.

Type of Variables	Name of Variables
Stock Variable	EC Transaction Scale, EC International Standard Quantity, Technological In novation Capacity, GDP.
Flow Connector	GDP Increment, Innovation Capacity Increment, EC International Standard Quantity Increment, Transaction Scale Increment.
Exogenous Variable	Per Capita GDP, Industrial Chain Service Level, Scientific Research Financial Support, Education Investment Factor, R&D Input Factor, Number of EC Consumers, Industry Revenue, Standardization Policy, etc.
Link Connector	Industry Chain Standard Certification Ability, Tax Incentive Policy Factor, Service Conversion Rate, Standard Transforming Factor, Logistic Technology Factor, Talent Transforming Factor, etc.

We construct the system flow diagram and provide SD scheme for the international development of EC industry standard. In the system flow diagram of Figure 7, stock variables are similar to substantial variables, and exogenous variables corresponding to dashboard variables. Sinks and sources are special kinds of stock variables that represent the environment of the SD scheme. These variables are connected by two kinds of arrows, which one flow is a connection between stock variables representing the flow of instances, the other connections are called links representing causal relations.

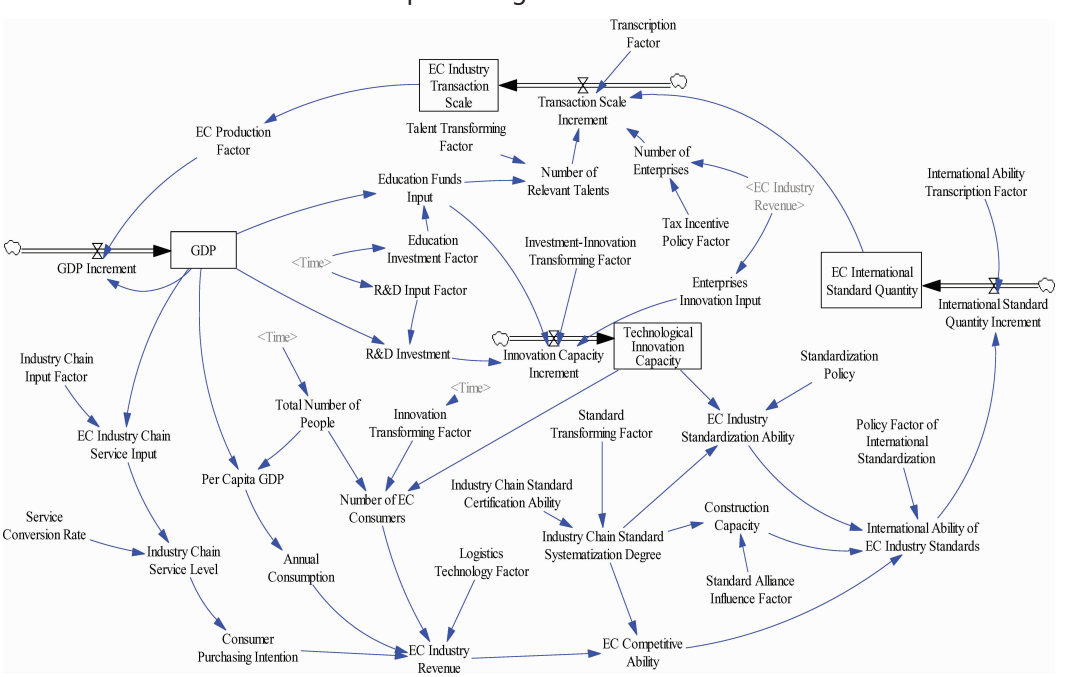


Figure 7 The system flow diagram of E-commerce standards internationalization

Quantification of the causal relations requires a level of detail and precision that adds an extra complexity to the modeling of the application domain. The equations and the variables of system dynamics are as following :

GDP= INTEG [GDP Increment, initial value 636463]

GDP Increment=GDP*EC Profit Factor

Industry Profit Increment= ((Number of Enterprises/10^5*0.5+Number of Relevant Talents/ 10^4*0.3+EC Industry International Standard Quantity/10^3*0.2) *Profit Transcription Factor)+36840

Industry Standard Alliance Construction=Industry Chain Standard System Degree of Systematization*Standard Alliance Interfering Factor

Industry Chain Input Factor=0.01

Industry Service Level=EC Industry Chain Service Input/10^4*Service Conversion Rate

Industry Chain Standard Accreditation Ability=1

Standard Transcription Factor=1+RAMP (0.1, 2014, 2024)

Industry Chain Standard System Degree of Systematization=Industry Chain Standard Accreditation Ability*Standard Transcription Factor

Production Transcription Factor=9000

Per Capita GDP=GDP/Total Number of People

Annual Consumption=Per Capita GDP*0.1

Talent Transcription Factor=8.4502

Number of Enterprises=EC Industry Profit*Tax Incentive Factor

Enterprises Innovation Input=EC Industry Profit*0.1

Innovation Capacity Increment=(R&G Investment*0.5+Enterprises Innovation Input*0.3+ Education Funds Input*0.2)*Input-Innovation Transcription Factor/10^-5

Innovation Transcription Factor=WITH LOOKUP (Time, ([(2014,0)—(2024,6)], (2014,3.789), (2015,3.802), (2016,3.859), (2017,3.867), (2018,3.85), (2019,3.763), (2020,4.073), (2021,4.409), (2022,4.772),(2023,5.17),(2024,5.59)))

Total Number of People = WITH LOOKUP (Time, ([(2014,130000)—(2024,150000)], (2014,136782), (2015,137462), (2016,138271), (2017,139008), (2018, 139538), (2019,140005), (2020,140444),(2021,140817),(2022,141133),(2023,141118),(2024,141102)))

Technological Innovation Capacity = INTEG (Innovation Capacity Increment,1)

Input-Innovation Transcription Factor=1

Education Investment Factor = WITH LOOKUP (Time,([(2014,0) — (2024,0.06)], (2014,0.041), (2015,0.0424), (2016,0.0422), (2017,0.0414), (2018,0.0411), (2019,0.0404), (2020,0.0406), (2021,0.0404),(2022,0.0402),(2023,0.04),(2024,0.041)))

Education Funds Input=GDP*Education Investment Factor

Service Conversion Rate=0.5

Consumer Purchasing Intention=Industry Service Level/100+1.13

EC Competitive Ability=EC Industry Profit*Industry Chain Standard System Degree of Systematization/10^5

EC Industry Profit=Annual Consumption*Number of EC Consumers*Consumer Purchasing Intention*Logistics Technology Factor+14250

EC Industry Standards Ability=Industry Chain Standard System Degree of Systematization*Technological Innovation Capacity *Standardization Policy

Number of EC Consumers=Total Number of People*Technological Innovation Capacity/Innovation Transcription Factor

EC Industry Chain Service Input=GDP*Industry Chain Input Factor

EC Production Factor=EC Industry Production/10^8+0.085

EC Industry Production= INTEG (Industry Production Increment,163900)

EC Industry Standards International Ability= EC Industry Standards Ability*0.2+ EC Competitive Ability*0.3+International Standardization Policy Factor*0.3+Industry Standard Alliance Construction Capacity*0.2

Number of Relevant Talents=Education Funds Input/Talent Transcription Factor

R&G Input Factor=WITH LOOKUP(Time,([(2014,0)—(2024,0.04)], (2014,0.0202),(2015,0.0206), (2016,0.0208), (2017,0.0213), (2018,0.0218), (2019,0.0223), (2020,0.0226), (2021,0.023), (2022,0.0235),(2023,0.0239),(2024,0.0243)))

R&G Input=GDP*R&G Input Factor

International Standard Quantity Increment=International Ability Transcription Factor*EC Industry Standards International Ability

EC International Standard Quantity=EC International Standard Quantity=INTEG (International Standard Quantity Increment,100)

4 Experiments and Discussion

4.1 Validation of Simulation Model

The validity and reliability of the SD model should be testified by compared simulation data with real data from "China Statistical Yearbook (2014-2019)", "China E-Commerce Development Report 2019-2020"and "Annual Report of Chinese Standardization Development (2014-2019)". The SD model can truly reflect the international development of the EC industry standard in Table 2 and Table 3, which the experiment results show the deviation between the simulation data and the real data of GDP and e-commerce transaction scale from 2014 to 2019.

Table2 Comparison of real and simulated GDP from 2014 to 2019

Year	Real GDP (billion yuan)	Simulation GDP (billion yuan)	Relative error%
2014	63646.3	63646.3	0.00
2015	68905.2	69160.6	0.37
2016	74412.7	75179.8	1.03
2017	82075.4	81753.0	0.39
2018	90030.9	88934.6	1.22
2019	99086.5	96784.6	2.33

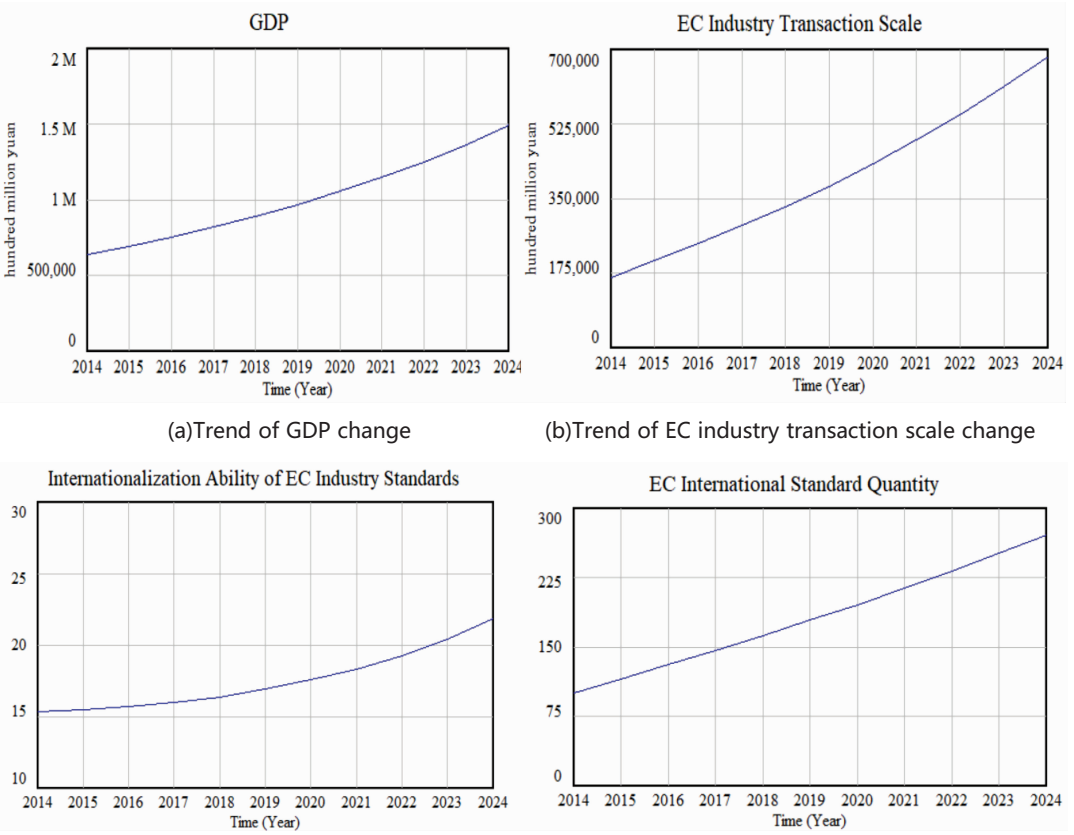
Table3 Comparison of real and simulated e-commerce transaction scale from 2014 to 2019

Year	Real Income (billion yuan)	Simulate Income (billion yuan)	Relative error%
2014	163900	163900	0.00
2015	217900	203252	6.72
2016	261000	243978	6.52
2017	291600	286433	1.78
2018	316300	331145	4.69
2019	348100	361858	6.83

Through the simulation performance within the limits of error, the constructed SD model can be used to simulate the international development of EC industry standards, which the relative error of GDP is 3% and that of e-commerce transaction scale is 6%.

4.2 Simulation Experiment

Based on a cross-sectional time series panel dataset between 2014 and 2024 covering four main variables of the GDP, EC industry transaction scale, EC standards internationalization ability and EC international standard quantity, we simulate the internationalization trend of Chinese EC standard, which shows in the Figure 8.



(a)Trend of GDP change

(b)Trend of EC industry transaction scale change

(c) The ability trend of EC standards internationalization

(d) The quantity trend of EC international standard

Figure 8 The simulation results of e-commerce standards internationalization model

The simulation result of the Figure 8(a) shows that the GDP has been increased in the last ten years, which led to increasing investment for EC industry from government. The government's investment can promote the technological innovation ability and talent cultivation of EC industry, which the transaction scale of EC industry has increased by policy supported shown as Figure 8(b). In order to face the fierce international competition of EC industry standard, it is important to promote the EC industry ability of technological innovation and industry supply service, as shown in Figure 8(c). With the prosperity of the international EC

market, the quantity of EC international standard has been increased, as shown in Figure 8(d).

4.3 Results Analysis and Countermeasures

The online use of Vensim PLE platform gives an opportunity to easily understand the behavior of EC standard internationalization system. The online simulation enhances the exploration behavior, where each variable can be visualized independently. It allows observing the changes that influence the entire model by adjusting the public policy factor, investment-innovation factor, as well as industrial supply chain.

1) The analysis of simulation is based on adjusting the policy support factor.

Current, Current1, Current2 represent the normal, upper and lower level of standardization policy, as shown in Figure 9, which the policy support factor is 1, 1.5 and 0.5. The standardization policy act as a catalyst for the promotion of EC standard internationalization ability, which the Standardization Administration of China (SAC) is responsible for aligning national standards with international standards. China government should increase their representation activities in international standardization organizations, which take comments on the drafting of standards into account and allow to include national preferences in international standards. The international development of EC industry standard can be promoted effectively in these ways.

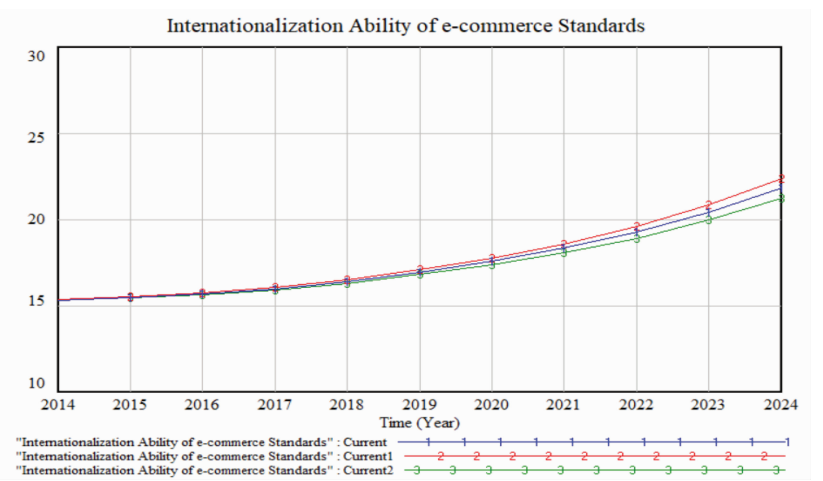


Figure 9 The experiment of adjusting the policy support factor

(2) The simulation analysis by adjusting the investment-innovation factor.

Current, Current1,Current2 represent that the investment-innovation factor is 1, 1.5 and 0.5. Based on the simulation result shown in Figure 10, Investment-innovation transforming factor play the key role on international ability of EC industry standards, especially in the capability of transforming capital investment into technical innovation achievement. Due to the long time of technology research and development, the emergence of innovation will be stimulated by the R&D capability, which will leads to the promotion of ability of EC internationalization standard. Therefore, Chinese companies should take the more chances to find a worldwide consensus for technical specifications and market access requirements.

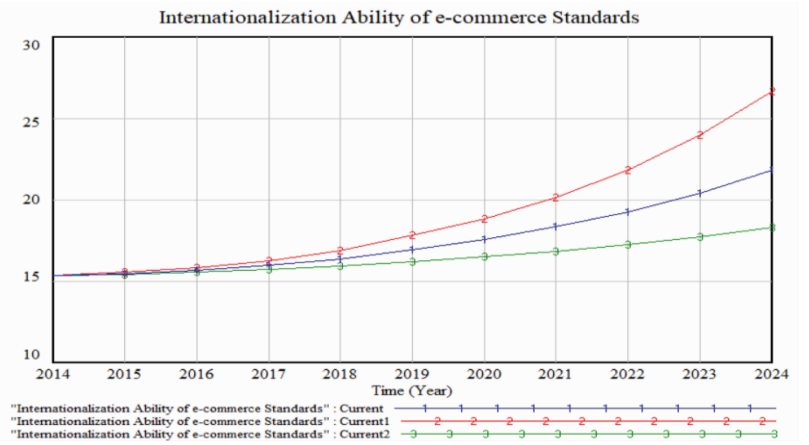


Figure 10 The experiment of adjusting technology-innovation factor

(3) The analysis of simulation is based on adjusting industry chain service factor.

Current, Current1, Current2 represent that the certification ability of industry chain standard is 1, 1.5 and 0.5, as shown in Figure 11. The industry chain standard certification ability represents the standards consensus of upstream and downstream enterprises in the industry. The simulation result show that the international ability of EC industry standard is significantly affected by the certification ability of industry chain standard. The higher the certification ability means the stronger harmonization of the industry standard degree, and the more application the industry standards. China should increase the transparency of the domestic standardization system by allowing foreign companies to participate in technical, standard certification committees of EC industry.

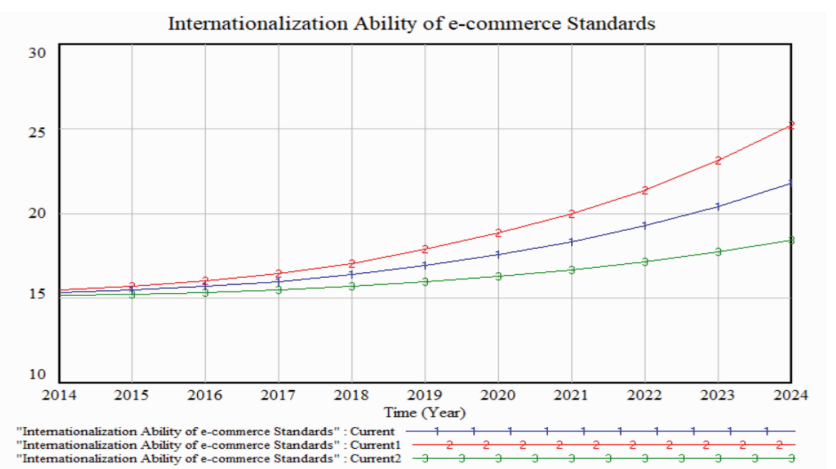


Figure 11 The experiment of adjusting industry chain service factor

By establishing the mode, three typical international development modes of Chinese EC standard are obtained under the initiative of " The Belt and Road" , which are "technology-innovation driven" , "policy-driven" and "industry-chain driven" modes.

The "policy-driven" mode of the standard "going out" is a regulation realization path.

The government regulation of tax incentive policy will play an important role in achievement of China's e-commerce standard internationalization. It is necessary to re-evaluate the relationship between China and the rest of world by seeking reasonable paths and feasible choices for mutual reform in promoting mutual opening up.

The "technology-innovation driven" mode of the standard "going out" is a technology realization path. Digital technology innovation will benefit e-commerce industry and become proactive in the face of fierce international standard competition. China's standard is expected to become an independent international standard, which we should pay more attention to adopting the strategy of preemption for digital technology innovation.

The "industry- chain driven" mode of the standard "going out" is an economic realization path. Our standard is expected to become an international standard compatible with the relevant industries in the world. The formation and expansion of user locking, industry chain standard certification are the key factors under this mode. China's standard is expected to become a subset of the existing international standard system in terms of big-picture view and world vision.

5 Conclusion

This paper expounds the shortage of the backward country on standard which participate in the competition of international standard from the system dynamic mechanism. System dynamics model of e-commerce standard internationalization unites social and behavioral science with the nitty-gritty details, carefully design and construction of original models with many interacting variables. Based on the qualitative analysis of Vensim PLE, the simulation results show that China's e-commerce standard internationalization ability can be reconstructed by the industry supply chain's standard certification, technical-innovation support along with "The Belt and Road" policy.

Author Contributions:

Y.L. and H.G. conceive and design the study; Y.L. and Z.T. perform the experiments; Y.L. and Z.W. write the original draft. All authors read and approved the manuscript.

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