Digital Trade Rules and the Position of Chinese Enterprises in the Global Value Chain

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Digital trade rules and higher positions of enterprises in the global value chain (GVC) are both important topics in the context of high-quality economic development. This paper refers to the data of RTA digital trade rules concluded by China in the TAPED database in 2000–2014 and the matched data in the WIOD database, the China Customs Import and Export Database and the China Industrial Enterprise Database to investigate the effects of digital trade rules on Chinese enterprises as to their ascending GVC positions. It finds that signing the RTA digital trade rules can steadily and significantly promote the position ascendance; compared with the digitalization rules on trading objects, signing the digitalization rules on trade modes produces greater effects of driving up the positions, which are realized mainly via the three channels of advancing cross-border flow of R&D factors, promoting corporate digital transformation, and improving professional management. Digital trade rules that are horizontally broader and vertically deeper are in greater favor of Chinese enterprises for ascending in the global value chain, which is especially evident among those in digital industry and processing trade. During the negotiations of digital trade rules, it's imperative to pay close attention to the rules on e-commerce cooperation, awareness of e-commerce importance, intellectual property protection, attempts in big data-related trade in goods, and cross-border data flow, so as to secure the core interests of Chinese enterprises in gaining higher positions. This paper offers great policy implications as to how to sign digital trade rules by China in the future and how to select partners in greater support for Chinese enterprises to ascend to the middle and high end of the global value chain.

Keywords: digital trade rules, corporate position in the global value chain, horizontal width, vertical depth

1. Introduction

Digital trade rules have become the playing field of global trade rules and also the tractive force for the transformation from value chain trade to digital trade. As an

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emerging form of business, digital trade differs greatly from traditional trade in terms of its modes and objects, leaving traditional trade rules incapable of matching the needs of current digital trade development. To seek the opportunity and take the commanding height of digital trade development, the economies have been competing intensely for digital trade rules. Meanwhile, the major issue of global value chain (GVC) is incorporated in the topic of digital trade policies and among the competitive focuses in the digital trade negotiations of the economies. Various economies have different appeals for digital trade rules as they are positioned differently in the global value chain. As micro-players, enterprises' GVC positions have a bearing on China's quality of economic development and even its international status. In such a context, it seems imperative to study the influence of China's signing the digital trade rules on enterprises' GVC positions and the working mechanism to explore new ways of driving up the positions. Can signing of digital trade rules help Chinese enterprises gain higher GVC positions? What are the effects of different horizontal width and vertical depth? In what intrinsic mechanism are the effects produced? Answers to these questions help comprehensively and objectively evaluate the effects of previously signed digital trade rules and investigate how to sign the rules and expand the digital trade network in the future, which supports China to have a greater say in the building of global digital trade rule system. The answers can also help lift Chinese enterprises out of the "low-end locking" dilemma in the value chain and realize the change from a large trader to a trader of quality.

Relevant research, for one category, is the study on digital trade rules. The qualitative analysis is focused on the following two areas: digital trade rules incorporated in trade agreements, such as clauses on cross-border data flow (Wolfe, 2019), and patterns and characteristics of digital trade rules in regional trade agreements (RTA) signed by different economies, such as the comparison between "American and European templates" (Han *et al*., 2019). The quantitative analysis is concentrated in the measurement and economic effects of digital trade rules. The measurement is usually conducted in the two dimensions of width and depth, with width targeting the varieties and quantity of topics and depth targeting restriction degree of topics. In the measurement of width, Elsig and Klotz (2021) only investigated the total number and word count of clauses in e-commerce chapters; Han *et al*. (2019) extended the scope of measurement to entire trade agreements. Mattoo *et al*. (2017) calculated weight based on the number of times digital trade rules are mentioned and then got the sum of weighted clause coverage. In fact, given that a larger number of words might be the result of higher word frequency rather than wider sectors covered (Hou and Wang, 2022), it's more readily accepted by the academic community to measure the width with the number of clauses. In the measurement of depth, Elsig and Klotz (2021) proposed to use whether material commitments are made as a proxy variable, while Han *et al*. (2019) adopted similarity

with the text of digital trade rules in the Trans-Pacific Partnership Agreement (TPP) to measure depth. However, mere measurement of whether material commitments are made cannot distinguish the different binding force of the commitments, and calculation of text similarity against TPP focuses on the similarity of digital trade rules with the "American template", instead of the degree of legal restriction. To shore up these weak areas, Burri and Polanco (2020) referred to the idea of Hofmann *et al*. (2017) in measuring the depth of WTO rules and further identified whether clauses are fully enforceable legally. Given that the dispute settlement mechanism is not necessarily applicable to all the legally binding clauses, Hou and Wang (2022) included whether the dispute settlement mechanism is applicable to the clauses into the investigation of depth.

Another category of relevant research is the measurement of GVC positions and the study on influencing factors. There are two types of research related to the measurement of GVC positions. The first is to directly measure the physical position based on production processes. For instance, Fally (2012) used input-output tables by country (region) to measure the upstream degree and downstream degree index; Miller and Temurshoev (2017) expanded the input-output model to the multi-country framework and added the input-end downstream degree index. The second is to indirectly measure the GVC economic position by revealing the relative importance of a country's sectors as demanders and suppliers of intermediate goods. Koopman *et al*. (2010) initially compared the indirect domestic value-added rate and foreign value-added rate in a country's export to judge if the country is in a relative upstream position. Furthermore, Wang *et al.* (2017) calculated sectors' relative GVC positions from both supply and demand ends, which made up for the shortcoming of previous researches that neglected enterprises as factor demanders. These measurements of GVC positions, however, only calculated the positions at the country or sector level, not at the micro corporate level. After measuring the upstream degree of various industries, Chor *et al*. (2021) took the export share of different trade products in enterprises as weight and got the corporate level weighted. Meanwhile, the academic community unfolded serial research on the influencing factors of GVC positions, among which the influence of RTA signing was relevant to this paper, while most research was confined to the national or sector level (Han and Wang, 2019).

This paper refers to the data of RTA digital trade rules concluded by China in the TAPED database in 2000–2014 and the matched data in the World Input-Output Database (WIOD), the China Customs Import and Export Database and the China Industrial Enterprise Database to investigate the effects of China's signing of RTA containing digital trade rules on Chinese enterprises as to their ascending GVC positions as well as the working mechanism. Compared with previous research, it possibly makes marginal contribution in the following areas. First, the paper offers

a new perspective of research into Chinese enterprises' rising GVC positions and promotes innovation in theory transmission mechanisms. It takes the lead to study from the perspective of RTA digital trade rules to explore the influencing channels. Second, it connects macro-economic policies and micro-level businesses to some extent and better depicts the economic effects of digital trade rules in the GVC context. This paper expands research to the corporate level, which adds to the prevailing industry-focused study, and further identifies the serial heterogeneity impact. Third, it includes the connotation of digital trade into the heterogeneity framework of distinguishing digital trade rules. The paper is the first to differentiate digital trade rules according to the definition of digital trade made by CAICT (2019) before quantitative analysis and accordingly identifies the development characteristics of RTAs digital trade rules concluded by China. Fourth, the paper looks into the heterogeneity influence of China's cooperation with economies experienced differently in signing and offers new ideas for China to select contracting economies in the future. This not only theoretically expands the study on the rising GVC positions of enterprises as a result of signing of digital trade rules, but provides the empirical foundation and some policy implications in the sense that China' s signing of RTA digital trade rules can promote enterprises to integrate in depth into GVC activities and effectively engage in the GVC labor division system.

2. Theoretical Analysis and Research Hypotheses

Signing deep RTAs containing digital trade rules can reduce the digital trade cost among member countries, which not only helps increase the digital trade business of enterprises, but promotes members to start trading digital trade products that are not developed before the signing of the rules. Obviously, digital trade rules will affect variable trade cost and drive deeper corporate involvement in the GVC labor division in the two dimensions of intensive margin and extensive margin, helping lift enterprises out of the dilemma of value chain "low-end locking". This paper hereby proposes:

Hypothesis 1: Signing RTAs containing digital trade rules helps drive up the position of enterprises in the global value chain.

In China, the earliest form of digital trade is cross-border e-commerce, i.e. digitalization of trade modes, which is gradually followed by digitalization of trading objects. Given that sectors covered by RTA digital trade rules develop at different paces, the induced effects will differ; in another word, faster developing sectors covered by the signed RTA digital trade rules may produce greater effects on Chinese enterprises' ascending GVC positions. Accordingly, the paper proposes:

Hypothesis 2: Compared with digitalization rules on trading objects, signing the digitalization rules on trade modes is more benefitial for Chinese enterprises'

ascendance in the global value chain, and greater horizontal width and vertical depth produce greater driving effects.

According to the findings of Lanzolla *et al*. (2021), digital trade rules produce profound impact on enterprises' higher GVC positions mainly through the three channels of advancing cross-border flow of R&D factors, promoting corporate digital transformation, and improving professional management.

(1) Cross-border flow of R&D factors. Signing digital trade rules can bring down the cost of cross-border data flow, increase the degree of spatial knowledge spillover, and therefore advance the cross-border flow of R&D factors (Liu and Zhen, 2022). With respect to the digitalization rules on trade modes, rules on awareness of the importance of e-commerce and exemption from customs duty for electronic transmission can enhance cooperation of the contracting economies in cross-border data, reduce the search cost and negotiation cost for the data flow, and promote cross-border flow of R&D factors. In terms of the digitalization rules on trading objects, rules such as unsolicited commercial messages broaden the scope of cross-border data flow, cut the information cost of the flow (Ma and Fang, 2021), and improve the efficiency of cross-border flow of R&D factors.

Meanwhile, signing digital trade rules facilitates deeper cooperation among contracting economies, which will produce R&D factors-based spatial knowledge spillover effects along with the sharing and learning of digital knowledge and digital R&D resources (Baldwin and Lopez-Gonzalez, 2015). In addition, compared with conventional factors of production, cross-border flow of R&D factors with a higher content of knowledge and technology helps spread innovative knowledge, supports value-added parts in the application of innovation achievements in the global value chain, and thus drives enterprises upstream along the GVC. On such basis, the paper proposes:

Hypothesis 3: Signing RTA digital trade rules promotes the cross-border flow of R&D factors as a way to drive enterprises up along the global value chain.

(2) Digital transformation. Signing digital trade rules can both boost interest of enterprises in digital transformation and broaden the digital trade market, which forces corporate practice of the transformation. From the perspective of digitalization rules on trade modes, rules on e-commerce cooperation and disclosure of e-commerce laws and regulations can clearly picture the digital trade areas allowing cooperation among contracting parties, and the degree of legal protection can be identified according to the legal enforceability of operability clauses. On the other hand, digitalization rules on trading objects such as those on protection of intellectual property can protect corporate behaviors of digital trade. For enterprises, certain legal commitments such as tax reduction or exemption, or reference to dispute settlement mechanisms in digital trade activities can boost corporate determination in implementing digital transformation in response to market competition (Lanzolla *et al*.,

2021).

In the meantime, signing digitalization rules on trade modes such as noncompulsory localization will promote contracting parties to weaken digital trade barriers, open up digital trade sectors wider, and create more opportunities of access to digital trade market (Lin and Bao, 2018). Signing digitalization rules on trading objects such as nondiscriminatory treatment to digital products will improve the diversity of digital trade products in the current market, increase the possibility of acquiring new-generation digital products, and therefore broaden and deepen China's digital trade market. To cope with the fierce market competition, enterprises have to understand the development dynamics and profit-making patterns of the market and timely response to the market demand of digital trade by advisably building new-type digital platforms and providing digitalization services (Tronvoll *et al*., 2020). Accordingly, this paper proposes:

Hypothesis 4: Signing RTA digital trade rules advances digital transformation of enterprises as a way to drive enterprises up along the global value chain.

(3) Professional management. Digital trade rules affect the professional management of enterprises in the following two ways. The first is to overcome shortsighted behaviors of management personnel. Signing RTA digital trade rules can effectively reduce the policy uncertainty in digital trade. Digital trade behaviors of enterprises send the signal of high competitiveness to the outside, in which case the positive view of the outside for the enterprises can boost confidence of the management personnel in their own career development. They tend to overcome the shortsighted behaviors that seek short-term profits when making development strategies and instead pursue long-term interests. To further improve corporate competitiveness in the long run, the management personnel will proactively learn advanced management experience externally and take effective measures to maintain competitive advantages; internally, they will enhance internal control, enlarge financial input into management and adopt more effective management systems to elevate management quality.

The second is to resort to digital technologies to optimize corporate management procedures, lower the time cost of management and improve corporate management efficiency by signing trade mode digitalization rules such as paperless trade management. In terms of the digitalization rules on trading objects, rules such as developing the electronic data interchange system on country of origin enrich corporate approaches of management and innovate in the management modes. Meanwhile, management at the both ends of the "smiling curve" has far greater control and influence on the entire value chain than the manufacturing at the bottom. Improvement of the professional management of enterprises can optimize their function development pathway of "relying on manufacturing, aiming at management" when engaging in the global value chain (Wang *et al.*, 2020) and therefore promote Chinese enterprises to upgrade export functions and ascend to the middle and high end of the global value chain. This paper accordingly proposes:

Hypothesis 5: Signing RTA digital trade rules improves professional management as a way to drive enterprises up along the global value chain.

3. Research Design

3.1. Data Source and Processing

The data in this paper is derived mainly from four sources. First, the data on RTA digital trade rules in 2000–2014 is from the Trade Agreements Provisions on Electronic Commerce and Data (TAPED), which incorporates the 193 valid RTAs (invalid ones excluded) containing digital trade rules worldwide in 2000–2020. Second, the data on corporate-level GVC positions is the result of calculation based on WIOD global input-output tables in the paper. Third, the data on corporate export is sourced from the China Customs Import and Export Database. Fourth, the data on business characteristics is derived from the China Industrial Enterprise Database, and its outliers are processed in the paper by referring to Brandt *et al*. (2012) and reconstructing the panel data. For data treatment, this paper firstly finds the comparison version of ISIC and HS code in the UN database, gets the consolidated version of WIOD and the China Customs Import and Export Database by matching the two, and then calculates the GVC positions of enterprises. Secondly, it consolidates the TAPED database and the China Customs Import and Export Database matched with WIOD industries in the two dimensions of country and year. Thirdly, in reference to Yu (2015), the paper matches the aforesaid databases with the China Industrial Enterprise Database by company name, then matches them by postal code of enterprises and the last seven digits of their phone number, and uses the union set of the matching result to get the final sample.

3.2. Empirical Models

To study the effects of digital trade rules on Chinese enterprises' GVC positions, the paper develops the following model for empirical testing:

$$UP_{fi} = \beta_0 + \beta_1 Digital_{it} + \delta Z + \varphi_t + \theta_f + \varepsilon_{fit} \quad (1)$$

f, i and *t* respectively represent enterprise, China's trade partner and year. The explained variable UP_{fi} refers to GVC position of the enterprise *f* in the year *t*; the explanatory variable $Digital_{it}$ refers to digital trade rule index signed by China with the trade partner *i* in the year *t*. *Z* means control variable set, φ_t year fixed effect, φ_f enterprise fixed effect, and ε_{fit} random error term.

Given that signing different types of digital trade rules may affect corporate GVC

positions differently, on the basis of the Formula (1), the paper refers to the definition of digital trade made by CAICT (2019) and further categorizes digital trade rules into digitalization rules on trade modes and those on trading objects. It respectively develops their horizontal width and vertical depth index to measure the heterogeneity of RTA digital trade rules and replaces the digital trade rule index in Formula (1) with this indicator. The model is constructed as follows:

$$UP_{ft} = \beta_0 + \beta_1 M\_digital_{it} + \delta Z + \varphi_t + \theta_f + \varepsilon_{fit} \tag{2}$$

$$UP_{ft} = \beta_0 + \beta_1 O\_digital_{it} + \delta Z + \varphi_t + \theta_f + \varepsilon_{fit} \tag{3}$$

M_digitalit refers to digitalization rule index on trade modes included in the RTAs signed by China with the trade partner *i* in the year *t*, and is respectively measured with the two indicators: the horizontal width *M_Width* and the vertical depth *M_Depth* of the digitalization rules on trade modes. *O_digitalit* means digitalization rule index on trading objects included in the RTAs signed by China with the trade partner *i* in the year *t*, and is respectively measured with the horizontal width *O_Width* and the vertical depth *O_Depth* of the digitalization rules on trading objects. The former is calculated based on the 26 digitalization rules on trade modes, and the latter based on the 17 digitalization rules on trading objects.

3.3. Variable Setting

3.3.1. Enterprises' GVC Positions

The paper uses the relative GVC position index to measure enterprises' positions in the global value chain. By referring to Wang *et al*. (2017), it uses the ratio of forward and backward production length to calculate an industry's relative GVC position index:

$$GVC\_pos = \frac{PLv\_GVC}{[PLy\_GVC]'} \tag{4}$$

PLv_GVC is value chain upstream degree and means distance from production to end demand in the global value chain measured from the supply end; *PLy_GVC* is value chain downstream degree and means distance from consumption to initial input in the global value chain measured from the demand end. The relative GVC position index represents an industry's relative position in the production chain, with greater value meaning a relative upstream position. Then, the paper refers to the calculation method of Chor *et al.* (2021) to calculate enterprises' export weight in

different industries and get the corresponding relative position indexes of the industries weighted. The corporate relative GVC position index is calculated as follows:

$$UP_{ft} = \sum_{d=1}^{N} \frac{X_{dft}}{X_{ft}} GVC\_pos_{dt} \tag{5}$$

X_{dft} represents export volume of the enterprise f in the industry d in the year t, and X_{ft} total export volume of the enterprise f in the year t. GVC_pos_{dt} is relative GVC position of the industry d in the year t and UP_{ft} relative GVC position of the enterprise f in the year t.

3.3.2. Digital Trade Rules

In reference to the practice of Hofmann *et al*. (2017), the paper first adopts three indicators for measurement, namely whether RTAs containing digital trade rules are signed (*Dummy*), horizontal width of RTA digital trade rules (*Width*), and their vertical depth (*Depth*). Second, it uses the measurement indicators for horizontal width (*M_Width / O_Width*) and vertical depth (*M_ Depth / O_ Depth*) when distinguishing the digitalization rules on trade modes and on trading objects.

Dummy, a dummy variable, is used to measure whether China has signed RTA digital trade rules with enterprises' trade partners. The value is 1 in the case of signing and otherwise 0.

Horizontal width (*Width*) measures variety richness of digital trade rules covered by RTAs (Hofmann *et al*., 2017). The 43 digital trade rules covered by RTAs are first respectively scored, 1 for existence and 0 otherwise; then the scores are aggregated into *width*, which is standardized into *Width*. Apparently, greater value means wider scope and richer varieties of digital trade rules covered by RTAs. The calculation formula is:

$$Width_i = \frac{width_i}{Max(width_i)} = \frac{\sum_1^{43} Provision_k}{Max(width_i)} \tag{6}$$

$Provision_k$ represents width score of the various digital trade rules in the RTA framework and $\sum_1^{43} Provision_k$ is the sum of the width scores of the 43 digital trade rules; $Max(width_i)$ is the highest total score in width among different agreements contracted by China. i refers to RTA signed by China with different economies.

Vertical depth (*Depth*) measures degree of legal protection for RTA-covered digital trade rules during execution (Hofmann *et al*., 2017). First, the paper refers to Burri and Polanco (2020) to respectively score the RTA-covered 43 digital trade rules,

getting 1 if there is no legal enforceability for all the clauses, 2 if there are clauses with legal enforceability and also clauses without legal enforceability, and 3 for legal enforceability for all the clauses. The scores are then aggregated into *depth*, which is standardized into *Depth*. Similarly, greater value means higher legal enforceability and greater protection for digital trade rules in RTAs. The formula is as follows:

$$Depth_i = \frac{depth_i}{Max(depth_i)} = \frac{\sum_1^{43} Provision_k}{Max(depth_i)} \tag{7}$$

$Provision_k$ refers to depth score of the various digital trade rules in the RTA framework; $\sum_1^{43} Provision_k$ is the sum of the depth scores of the 43 digital trade rules and $Max(width_i)$ is the highest total score in depth among different agreements concluded by China. *i* refers to RTA signed by China with different economies.

3.3.3. Control Variables

Enterprise age (ln*age*) is the natural logarithm after subtraction of an enterprise's year of incorporation from the current year and addition by one. Level of human capital (ln*wage*) is the natural logarithm of per capita wage. Capital intensity (ln*cap*) is measured with the natural logarithm of the ratio between fixed assets and total employment. Enterprise size (*size*) is measured with the annual average number of employees of an enterprise (1000 persons). Liquidity of assets (*liquidity*) is the ratio between current assets and total assets. Market competition intensity (*hhi*) is measured with the Herfindahl Index, aggregating the quadratic sum of each enterprise's market share in the corresponding year.

4. Empirical Testing

4.1. Benchmark Regression

Table 1 lists the results of benchmark regression, while the columns (1), (3) and (5) respectively show the results of separate regression of *Dummy*, *Width* and *Depth* with *UP* without introducing any control variable and with year and enterprise fixed effects controlled. On such basis, the columns (2), (4) and (6) introduce the serial control variables. According to the empirical results, no matter whether the control variables are introduced or not, estimated coefficients of the explanatory variables *Dummy*, *Width* and *Depth* are all significant at the 1% level. This therefore verifies the hypothesis 1 that signing RTAs containing digital trade rules can significantly drive up Chinese

enterprises' positions in the global value chain and that the rules with greater horizontal width and greater vertical depth are more helpful for the position ascendance.

Table 1. Results of the Benchmark Regression

Variable	(1)	(2)	(3)	(4)	(5)	(6)
Dummy	0.0014***	0.0014***				
	(0.0002)	(0.0002)				
Width			0.0030***	0.0031***		
			(0.0006)	(0.0006)		
Depth					0.0022***	0.0022***
					(0.0006)	(0.0006)
Control variable	No	Yes	No	Yes	No	Yes
Enterprise fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
N	618725	618725	618725	618725	618725	618725
R^2	0.9067	0.9067	0.9067	0.9067	0.9067	0.9067

Note: Numbers in the parentheses are robust standard errors; ***, ** and * respectively refer to the 1%, 5% and 10% significance level.

In Table 2, the columns (1) and (2) reveal that estimated coefficients of the horizontal width (*M_Width*) and vertical depth (*M_Depth*) of the signed digitalization rules on trade modes are significant at the 1% level. The columns (3) and (4) disclose estimated coefficients of the horizontal width (*O_Width*) and vertical depth (*O_Depth*) of the signed digitalization rules on trading objects are similarly significant at the 1% level. Obviously, in both horizontal width and vertical depth, the estimated coefficients of the trade mode rules are far higher than those of trading object rules. Faster development of the sectors covered by the signed digital trade rules produces greater effects on the rising GVC positions of Chinese enterprises. The regression results verify the hypothesis 2.

Table 2. Regression Results with the Digital Trade Rules Distinguished

Variable	Digitalization rules on trade modes		Digitalization rules on trading objects	
	(1)	(2)	(3)	(4)
M_Width	0.0032***			
	(0.0006)			
M_Depth		0.0024***		

Variable	Digitalization rules on trade modes		Digitalization rules on trading objects	
	(1)	(2)	(3)	(4)
		(0.0006)		
O_Width			0.0024***	
			(0.0005)	
O_Depth				0.0016***
				(0.0006)
Control variable	Yes	Yes	Yes	Yes
Enterprise fixed effect	Yes	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes	Yes
N	618725	618725	618725	618725
R^2	0.9067	0.9067	0.9067	0.9067

4.2. Robustness Regression

(1) Replacement of measurement indicators on the digital trade rules. To eliminate the interference from rule measurement errors with the regression results, the paper refers to Mattoo *et al.* (2017) to re-measure the horizontal width (*Width*), calculates weight according to the number of times the 43 digital trade rules are mentioned in RTAs, and then multiplies the coverage of each clause by the weight before aggregation. Meanwhile, by referring to Hou and Wang (2022), the paper re-measures the vertical depth (*Depth*), studying if dispute settlement mechanisms are applicable after investigating the legal enforceability of the digital trade rules. Specifically, value 0 is set for no legal enforceability, 1 for legal enforceability but inapplicability of dispute settlement mechanisms, and 2 for legal enforceability and meanwhile applicability of dispute settlement mechanisms. The 43 rules are respectively scored, aggregated and standardized. The result shows after replacement of the explanatory variables, the regression results still stand significantly.

(2) Redivision of the sample interval. Given the existence of certain time-lag effect after RTAs with digital trade rules are signed, the paper here re-divides the sample interval. Since the National Congress of the Communist Party of China is held every five years, when the Central Committee makes deployments of trade strategies according to China's economic situation at the time, the paper refers to Baier and Bergstrand (2007) and makes the division by the interval of five years. According to the result, the research conclusions here remain unchanged despite the redivision of the sample interval.

(3) Control of impact from other policies. Enterprises' GVC positions are also subject to the influence of other macro-policies. Since the Internet development of

destination countries may be an influencing factor, the number of fixed broadband users (10000 persons) (*INT*) in the destination countries is further controlled. Moreover, the year-level characteristics may exert some influence, hence the control of the destination country-year fixed effect. The result reveals that with the Internet development and the destination country-year effect being controlled, the benchmark regression results stand.

(4) Endogeneity. This paper mainly studies the causality between signing of digital trade rules and corporate GVC positions, thus less susceptible to the endogeneity of reverse causality since a single enterprise's GVC position is less likely to affect China's decision in signing RTAs containing digital trade rules with other economies. On the other hand, however, existence of unobservable factors with effects on both signing of the rules and corporate GVC positions is possible, with its endogeneity not to be neglected. Given so, the paper constructs instrumental variables to cope with possible endogeneity issues.

Table 3. Regression Results of the Instrumental Variables

First-stage regression	(1) *Dummy*	(2) *Width*	(3) *Depth*
Number	−0.0110***		
	(0.0002)		
AVE_Width		−0.0015***	
		(0.0000)	
AVE_Depth			−0.0003***
			(0.0000)
Control variable	Yes	Yes	Yes
Enterprise fixed effect	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes
Second-stage regression	(4) *UP*	(5) *UP*	(6) *UP*
Dummy	0.0039***		
	(0.0013)		

Second-stage regression	(4) *UP*	(5) *UP*	(6) *UP*
Width		0.0180***	
		(0.0056)	
Depth			0.0456***
			(0.0159)
Control variable	Yes	Yes	Yes
Enterprise fixed effect	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes
Kleibergen—Paap rk LM test	6300.12	5251.66	694.59
	[0.0000]	[0.0000]	[0.0000]
Kleibergen—Paap Wald rk F test	4982.49	4395.74	564.15
	{16.38}	{16.38}	{16.38}
N	618725	618725	618725

Note: Number in the [] is the p-value of the test statistic, and that in the {} is the critical value of Stock-Yogo test at the 10% level.

The paper selects the number of RTAs containing digital trade rules signed between trade partners and the third countries (*Number*), average width (*AVE_Width*) and average depth (*AVE_Depth*) as the instrumental variable of *Dummy*, *Width* and *Depth* respectively. A larger number of the RTAs signed, the greater width and the greater depth mean the trade partners have more experience in signing RTA digital trade rules and mature in the development of digital trade. In this case, later-comers have access to only a smaller market share and have to pay higher cost to reach the market access threshold. Therefore, the trade partners' signing of RTAs including digital trade rules with the third countries is fully in line with the correlation hypothesis of instrumental variables and cannot directly affect corporate GVC positions.

In Table 3, the columns (1)~(3) are the result of the first-stage regression, showing significantly negative estimated coefficients of the instrumental variables at the 1%

level. As for the reason, if a country has already signed RTAs containing digital trade rules prior to its signing the agreements with China, it means other economies have already enjoyed the first-mover advantage in the country's digital trade market (Lin and Bao, 2018). At this point, China is left with a smaller market share and access to less resources. Since the instrumental variables are not greater than the explanatory variables in quantity and F-statistic of the three instrumental variables is all far greater than the critical value of Stock-Yogo test at the 10% significance level, the possibility of weak correlation is eliminated. The columns (4)~(6) are the result of the second-stage regression. Compared with the benchmark regression, the estimated coefficients of the explanatory variables are slightly increased and all significantly positive, verifying the research conclusion in the paper again.

4.3. Mechanism Validation

This part attempts to validate the intrinsic mechanism of digital trade rules affecting Chinese enterprises' rising positions in the global value chain from the three perspectives of cross-border flow of R&D factors, corporate digital transformation and professional management.

(1) Cross-border flow of R&D factors. In reference to Liu and Zhen (2022), the paper adopts the cross-border flow value of R&D factors between China and the trade partner *i* in the industry *d* in the year *t* for measurement. Specifically, the sum of inflow value and outflow value from China to the trade partner *i* in the industry *d* for "scientific research and development" in the WIOD database is calculated. On such basis, an enterprise's cross-border flow level of R&D factors (*RD*) is calculated according to Chor *et al.* (2021). Table 4 indicates the validation result of the influencing mechanism. The columns (1), (3) and (5) respectively estimate the influence of *Dummy*, *Width* and *Depth* on *RD*, and positive significance of the estimated coefficients signals that signing of RTAs including digital trade rules, greater horizontal width of the rules, and deeper restriction can significantly promote corporate cross-border flow of R&D factors to a greater extent. The columns (2), (4) and (6) list the influence of *RD* on *UP* with the digital trade rules controlled, and the significantly positive estimated coefficient proves that the flow can significantly boost enterprises' GVC positions. In another word, signing of digital trade rules can drive up enterprises' positions in the global value chain by enhancing their cross-border flow of R&D factors. The hypothesis 3 is verified.

Table 4. Mechanism Verification for the Cross-Border Flow of R&D Factors

Variable	(1)	(2)	(3)	(4)	(5)	(6)
	RD	*UP*	*RD*	*UP*	*RD*	*UP*
Dummy	0.2526***	0.0013***				
	(0.0048)	(0.0002)				
Width			0.7586***	0.0028***		
			(0.0189)	(0.0006)		
Depth					0.6593***	0.0020***
					(0.0211)	(0.0006)
RD		0.0003***		0.0004***		0.0004***
		(0.0001)		(0.0001)		(0.0001)
Control variable	Yes	Yes	Yes	Yes	Yes	Yes
Enterprise fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
N	618725	618725	618725	618725	618725	618725
R^2	0.7387	0.9068	0.7380	0.9067	0.7375	0.9067

(2) Corporate digital transformation. The paper uses the total input coefficient to measure the digitalization level of an industry based on ICT input in the input-output table by referring to Cai and Niu (2021), and in reference to Chor *et al*. (2021), calculates the digitalization level of enterprises and uses it as proxy variable of corporate digital transformation (*DT*). Obviously, higher value represents greater level of the transformation. According to the result in Table 5, the columns (1), (3) and (5) respectively estimate the influence of *Dummy*, *Width* and *Depth* on *DT*. The significantly positive estimated coefficients at the 1% level indicate that signing of RTAs including digital trade rules, greater horizontal width of the rules, and deeper restriction can significantly advance corporate digital transformation. The columns (2), (4) and (6) illustrate the effects of *DT* on *UP* with the digital trade rules controlled, and the significantly positive estimated coefficient means that the transformation can significantly promote enterprises' GVC positions upstream. In other words, signing of digital trade rules can drive up Chinese enterprises' positions in the global value chain by advancing corporate digital transformation. The hypothesis 4 is verified.

Table 5. Mechanism Verification for the Corporate Digital Transformation

Variable	(1) *DT*	(2) *UP*	(3) *DT*	(4) *UP*	(5) *DT*	(6) *UP*
Dummy	0.0029***	0.0014***				
	(0.0003)	(0.0002)				
Width			0.0082***	0.0030***		
			(0.0008)	(0.0006)		
Depth					0.0062***	0.0022***
					(0.0008)	(0.0006)
DT		0.0034***		0.0035***		0.0035***
		(0.0012)		(0.0012)		(0.0012)
Control variable	Yes	Yes	Yes	Yes	Yes	Yes
Enterprise fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
N	618725	618725	618725	618725	618725	618725
R^2	0.8601	0.9068	0.8601	0.9067	0.8601	0.9067

(3) Professional management. This paper refers to Wang *et al*. (2020) in measuring the level of professional management of an industry based on its factor income, and refers to Chor *et al*. (2021) for mapping it to the corporate level as the level of corporate professional management (*MGT*). Higher value represents higher management capability of enterprises. In Table 6, the columns (1), (3) and (5) respectively estimate the influence of *Dummy*, *Width* and *Depth* on *MGT*. The significantly positive estimated coefficients illustrate that signing of RTA digital trade rules, greater horizontal width of the rules, and deeper restriction can significantly improve enterprises' level of professional management. The columns (2), (4) and (6) show the significantly positive estimated coefficient of *MGT* on *UP*, meaning that higher level of professional management can significantly elevate enterprises' GVC positions. Signing of digital trade rules can drive up Chinese enterprises' positions in the global value chain by improving professional management. The hypothesis 5 is verified.

Table 6. Mechanism Verification for the Professional Management

Variable	(1) *MGT*	(2) *UP*	(3) *MGT*	(4) *UP*	(5) *MGT*	(6) *UP*
Dummy	0.0007***	0.0014***				
	(0.0003)	(0.0002)				
Width			0.0040***	0.0030***		
			(0.0010)	(0.0006)		
Depth					0.0037***	0.0022***
					(0.0011)	(0.0006)
MGT		0.0127***		0.0127***		0.0127***
		(0.0017)		(0.0017)		(0.0017)
Control variable	Yes	Yes	Yes	Yes	Yes	Yes
Enterprise fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
N	618725	618725	618725	618725	618725	618725
R^2	0.9376	0.9068	0.9376	0.9068	0.9376	0.9068

5. Heterogeneity Analysis[1]

5.1. Distinguishing whether the Contracting Economies Have Richer Experience than China in Signing RTA Digital Trade Rules

Given that the number of RTAs containing digital trade rules signed by the economies can be used to measure richness of the economies' signing experience, the paper selects the difference of number of the RTAs signed by the contracting economies and China (*GAP*) as proxy variable of the difference between the two in richness of the experience. Value greater than 0 signals richer experience of the contracting economies, while value less than 0 means richer experience for China. Then, *Dummy*, *Width* and *Depth* are respectively multiplied by *GAP* as interactions, which are included into the Formula (1). Results show that estimated coefficients of the core explanatory variables are all positively significant and those of the interactions are

[1] Due to the space limitations, the results are not shown in the main text, but are available upon request.

all negatively significant. This means the richer signing experience of the contracting economies than China, the smaller promoting effect of signing of digital trade rules on Chinese enterprises' rising GVC positions; the richer experience of China than the contracting economies, the greater promoting effect.

5.2. Distinguishing whether the Enterprise is in the Digital Industry

Nature of different industries determines their different degrees of dependence on digital trade, and therefore signing digital trade rules produces different effects on enterprises in various industries as to their GVC positions. Compared with those in non-digital industries, enterprises in the digital industry are the core participants in digital trade. After digital trade rules are signed, the players in the digital industry are immediately affected and will adjust their own digital trade activities right away accordingly, such as drafting business strategies to include the contracting partners into their market plans, increasing input into digital trade infrastructure, and standardizing digital trade procedures. This paper refers to Cai and Niu (2021) to regard ICT industries in the input-output tables as digital industry and other industries as non-digital industries. The result discloses that compared with non-digital industries, enterprises in the digital industry are more likely to ascend upstream in the global value chain after digital trade rules are signed.

5.3. Differentiating the Trade Modes

Chinese enterprises operating in different trade modes are driven by different forces to ascend in the global value chain (Wang *et al.*, 2019). The ascendance of processing trade enterprises is mainly contributed by the wider transnational supply network of intermediate goods, while that of regular trade enterprises is the result of domestic supply network of intermediate goods. The paper categorizes the samples into processing trade and regular trade enterprises by trade modes and finds that signing digital trade rules has greater influence on processing enterprises as to their higher GVC positions. This is because the driving effect of the rule signing on cross-border flow of R&D factors can promote the transnational supply network of intermediate goods to expand to some extent, while the influence on domestic supply network is limited.

6. Further Analysis Based on Specific Digital Trade Rules

Based on CAICT (2019), this paper introduces the eight digital trade clauses that are frequently covered by the RTAs signed by China for analysis. Specifically, they are e-commerce cooperation (*cooperation*), awareness of the importance of e-commerce

(*importance*), paperless trade management (*paperless*), and banned category in electronic authentication legislation (*law*) as rules on trade mode digitalization, and intellectual property protection (*ipm*), attempts in big data-related trade in goods (*bigdata*), personal information protection for digital trade users (*information*), and cross-border data flow (*freeflow*) as rules on trading object digitalization. As specific rules are studied here, it's unnecessary to measure the number of digital trade rules covered by the RTAs, i.e. horizontal width. Whether specific digital trade rules are signed (*dummy*) and vertical depth of the signed rules (*depth*) are adopted as two indicators to investigate the influence of signing of the aforesaid eight clauses on Chinese enterprises' GVC positions.

The regression result points to different influence of specific digitalization rules on trade modes and on trading objects over *UP*. E-commerce cooperation, awareness of the importance of e-commerce, intellectual property protection, attempts in big data-related trade in goods, and cross-border data flow are the core interests of China, making it imperative to hold our ground in signing the rules and ensure their legal enforceability. Paperless trade management, banned category in electronic authentication legislation, and personal information protection for digital trade users exert temporary negative effects, but they are not significant. This is because these clauses are the basic business requirements for China to unfold digital trade activities, making such input inevitable in the development of new digital trade sectors. Though their execution comes with cost and cannot drive up Chinese enterprises' GVC positions for now, they are an inevitable path for corporate digital transformation. Identification of how to carry out the clauses in the signing process and greater legal enforceability can effectively lower the search cost and facilitate corporate digital transformation. In the long term, the hinderance for the rising GVC positions of enterprises may be gradually reduced and even turned into facilitation.

7. Conclusions and Policy Implications

This paper refers to the data of RTA digital trade rules concluded by China in the TAPED database in 2000–2014 and the matched data in the WIOD database, the China Customs Import and Export Database and the China Industrial Enterprise Database to investigate the effects of signing digital trade rules on Chinese enterprises as to their ascending GVC positions. The findings are as follows. First, signing RTAs with digital trade rules can significantly drive up the GVC positions of Chinese enterprises. The greater horizontal width and vertical depth of the rules, the greater driving effects. Compared with the digitalization rules on trading objects, those on trade modes promote the position ascendance to a greater extent. Such positive influence is mainly realized through facilitating cross-border flow of R&D factors, promoting digital

transformation of enterprises, and improving professional management. Second, by distinguishing digital and non-digital industries, the paper finds the promoting effect of the rule signing on the rising positions is more noticeable for enterprises in the digital industry. Compared with regular trade, such effect is greater for processing trade enterprises. Third, the richer signing experience of the contracting economies than China, the less facilitation of the rule signing on Chinese enterprises' rising positions; the richer experience of China than the contracting economies, the greater facilitation. The advantage in experience can help Chinese enterprises break the GVC "low-end locking" fast. Fourth, given the clause heterogeneity, the paper further analyzes the eight digital trade clauses that appear frequently. E-commerce cooperation, awareness of the importance of e-commerce, intellectual property protection, attempts in big data-related trade in goods, and cross-border data flow produce significant promoting effects on Chinese enterprises' GVC position rise and are the core interests of China during negotiations. On such basis, the paper proposes firstly to rationally select the digital trade partners and establish China's own network of digital trade. Secondly, it's critical to accurately seize the core interests, which should be gradually deepened during digital trade negotiations. Thirdly, while continuing to enhance the digitalization of trade modes, it's also important to pick up pace to advance the digitalization of trading objects.

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