Study on the impact of trade policy uncertainty on the digital transformation of export enterprises

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Abstract. This study explores how trade policy uncertainty affects the digital transformation of export firms, taking into account the effects of R&D investment and executive team attributes as mediating and moderating factors of this association. The results of persistence, internal validity and variability tests show that the findings in this paper are reliable. In the coming period, export enterprises should deal with the instability of business policies by means of market differentiation and improving supply chain adaptability, and strengthen the capacity building of research and development and management teams to support technological innovation and adapt to environmental changes, so as to effectively deal with the uncertainty of business policies and achieve healthier and more orderly development.

Key words: trade policy uncertainty, Export enterprises, Digital transformation, Research and development investment.

1. Introduction

The uncertainty of trade policy in the era of globalization has a significant impact on global trade and business decisions, potentially leading to changes in market access, cost reshaping, and supply chain transformation; Therefore, exporting companies are actively seeking digital transformation to enhance competitiveness by optimizing management methods and increasing adaptability to market dynamics. The impact of trade policy uncertainty on digital transformation is not entirely clear. By studying the effects of R&D investment and executive team characteristics, this study reveals the link between trade policy uncertainty and digital transformation of export enterprises, and proposes effective strategies.

2. Literature Review

(I) Trade policy uncertainty

Trade policy uncertainty reflects uncertainty about future developments in the international trade environment and stems from political, social and economic factors. There are three main ways to measure trade policy uncertainty. Baker et al. (2016) construct an economic policy uncertainty index[1] based on the frequency of news reports. Handley (2014) measured[2] it from a macro perspective by analyzing changes in tariff rates. Caldara et al. (2020) constructed an index by analyzing relevant words in the quarterly earnings conference call records of listed companies to reflect the uncertainty[3] at the micro enterprise level. The study shows that the reduction of trade policy uncertainty promotes the growth of China's imports (Imbruno, 2019) and exports (Ma Yeqing et al., 2022), with low market access costs and trade liberalization as key factors[4-5]. On the other hand, the rise in policy uncertainty of trading partners hampers the technological complexity of a country's high-tech exports (Han Huixia et al., 2022), while the technological complexity of exports can positively regulate the relationship between trade policy uncertainty and labor employability skills (Li Hongbing et al., 2022)[6-7]. The reduction of trade policy uncertainty between China and the United States can reduce the domestic value-added of export of enterprises (Zhang Pingnan et al., 2018)[8]. These studies deepen the understanding of the impact of trade policy uncertainty from macro and micro perspectives, and provide an empirical basis for policy making.

(2) Digital transformation

Knudsen (2020) believes that digital transformation covers the integration of traditional information technology with emerging technologies such as blockchain, Internet of Things, cloud computing, artificial intelligence and big data, which forms the basis[9] of enterprise transformation. Tan Zhidong et al. (2022) pointed out that the transformation process is not only built on the basis of comprehensive informatization, but also overlaps with Internetization, focusing more on the in-depth application[10] of data. Haffke (2017) regards enterprise digital transformation as a fundamental change in cross-industry organizations, affecting business processes, products and services, and business models[11]. McKinsey's research divides digitization into three dimensions: digitization of assets, digitization of operations and digitization of workforce. From the perspective of enterprises, digital transformation is the behavior of applying digital technology to collect and process information and integrate it into the decision-making process, marking the innovative transfer of enterprises to digital systems. Zhang Yongshen et al. (2021) pointed out that the transformation is characterized by cross-border integration, innovation-driven, structural reshaping and extensive connectivity, aiming at improving operational efficiency[12]. Digital transformation is not only the deep integration of technology and production development, but also represents management innovation, emphasizing the transformation of the organization's value creation process.

3. Theoretical basis and research hypothesis

When trade policy uncertainty (TPU) rises to a certain extent, the decline in export performance faced by enterprises becomes a key driving force for them to explore new survival and development paths. Under such pressure, companies often seek to address challenges through digital transformation to improve operational efficiency, explore new markets or optimise customer service, among others. The driving force of this transformation comes from the dissatisfaction with the status quo and the desire for change, that is, the mentality of "thinking of change when you are stuck".

However, when companies encounter a performance gap that is too large, they may fall into a cognitive dilemma, feeling that they cannot overcome the challenge with their existing resources and capabilities. In such cases, companies may exhibit behavioural rigidity and lack of motivation to innovate and change, leading to a weakened willingness and effort towards digital transformation. Such rigidity in mindset not only hinders enterprises' adaptation and development, but may also cause enterprises to miss opportunities to achieve turnaround through digital transformation. Therefore, understanding how companies respond to digital transformation under different levels of TPU is of great significance for both the strategic planning of companies and the decision making of policymakers.

(I) The direct impact of trade policy uncertainty on enterprises' digital transformation

Trade policy uncertainty refers to the unpredictability of changes in international trade policies. This affects business decisions, especially those of exporters[13]. There is an inverted U-shaped relationship between trade policy uncertainty and the digital transformation of export firms. Promote digital transformation at low levels; But at high levels, companies will show behavioural rigidity and their willingness to digital transformation will decline. This is because at a low level of policy uncertainty, enterprises will face the pressure of declining export performance and adopt digital transformation strategies in order to change. However, if the policy changes are too fast and too large, exceeding the cognitive limit of enterprises, enterprises will have behavioral inertia and fall into "learning overload", thus slowing down the pace of digital transformation. Under such circumstances, companies will encounter problems such as unstable market access, supply chain restructuring and cost fluctuations. To address these challenges, companies can accelerate their digital transformation process. Based on these observations, this paper proposes hypotheses:

Hypothesis 1: There is an inverted U-shaped relationship between trade policy uncertainty and the digital transformation of export enterprises. Promote digital transformation at a low level; But at high levels, companies will show behavioural rigidity and their willingness to digital transformation will decline.

(2) Classification of digital transformation of export enterprises

The digital transformation of export enterprises can be divided into two categories: "underlying technology architecture" and "customer-facing digital applications". There is a difference in the impact of trade policy uncertainty on the two. This is because the construction of the underlying architecture requires a lot of upfront investment, while digital applications focus on rapid iteration, so they are different in their sensitivity to policy changes. Based on these observations, this paper proposes hypotheses:

Hypothesis 2: The digital transformation of export enterprises can be divided into two categories: "underlying technology architecture" and "customer-facing digital applications". There are differences in the impact of trade policy uncertainty on the two.

(3) The mediating role of R&D input

Research and development (R&D) expenditures play an important role in the digitalization process of enterprises. Given the uncertainty of trade policy, companies may choose to increase investment in R&D to promote technological innovation and adjust their business models, thereby improving their ability to adapt to changing market conditions. Therefore, the paper proposes the following hypothesis:

Hypothesis 3: Export firms respond to trade policy uncertainty by adjusting R&D inputs to facilitate their digital transformation.

(4) The moderating role of the senior management team

In the case of ambiguous trade policies, characteristics such as the competence, information base and risk propensity of the management team may have an impact on the strategic decisions of enterprises. The strategic vision and innovation tendency of top management can enhance or weaken the impact of trade policy uncertainty on digital transformation. Based on the above premise, this paper proposes the following hypothesis:

Hypothesis 3: There is a moderating relationship between the characteristics of the executive team of export enterprises and the uncertainty of trade policy and the digital transformation of enterprises. Specifically, executive teams with high risk acceptance may strengthen the positive impact of trade policy uncertainty on enterprises' digital transformation.

4. Empirical design

(1) Sample source

This paper selects the panel data of A-share listed companies in Shanghai and Shenzhen from 2007 to 2020 as research samples, mainly considering that the sample enterprises have A high degree of digitalization and can well reflect the impact of policy changes. The screening criteria were as follows: financial companies were excluded; And companies with significant data gaps. The sample size was finally determined to be 1,129 companies with an observation period from 2007 to 2020.

(2) Selection and quantification of variables

[6-9] The index reflects the volatility and uncertainty levels of the policy environment and is based on multiple data sources including policy documents, media reports and expert assessments.

2. Dependent variable: The degree of digital transformation of enterprises is measured by the proportion of digital technology intangible assets of listed enterprises.

3. Intermediate variable: Research and development, which may act as a bridge between the uncertainty of trade policy and the digital transformation of enterprises, is measured by the proportion of research and development expenditure to the total operating income, reflecting the intensity of investment in innovation and technological improvement.

4. Moderating variables: By analyzing the disclosure of historical decision plans such as mergers and acquisitions and new business expansion, this study judges the acceptance degree of management to new technologies and new markets, and also evaluates their pioneering and innovative orientation with reference to the information such as senior executives' employment background. Based on these dimensions, the characteristics of the senior management team are quantitatively measured.

5. Control variables: Control variables include enterprise size, industry type, market environment, asset-liability ratio, enterprise age, etc. Among them, the size of the enterprise is expressed by the total assets of the enterprise; Industry types are divided into manufacturing industry and service industry; The market environment is measured by the market growth rate of the industry; The asset-liability ratio reflects the financial soundness of the enterprise; The age of the enterprise considers the growth cycle of the enterprise.

(3) Model construction

1. Main effect model

The main effect model aims to analyze the direct impact of trade policy uncertainty on the digital transformation of enterprises. The basic form of the model is as follows:

$$\mathrm{DigitalTransformation}_{i,t} = \beta_0 + \beta_1 \mathrm{PolicyUncertainty}_{i,t} + \beta_2 X_{i,t} + \varepsilon_{i,t} \quad (1)$$

Where, DigitalTransformationi, t represents the degree of digital transformation of the i enterprise in time t; The $\mathrm{PolicyUncertainty}_{i,t}$ is the uncertainty level of the trade policy of the first enterprise at time t; $X_{i,t}$ represents a series of control variables; Beta_0, beta_1, beta_2 are the parameters to be estimated; $\varepsilon_{i,t}$ is the error term.

2 Compare test models

In order to test the differential impact of trade policy uncertainty on the two sub-dimensions of enterprise digital transformation, the following model is constructed:

$$\mathrm{Infrastructure}_{i,t} = \alpha_1 + + (2)\beta_1 \mathrm{TPU}_{i,t} \gamma_1 \mathrm{Infrastructure}_{i,t} + \varepsilon_{i,t}$$

$$\mathrm{Application}_{i,t} = + + (3)\alpha_1 \beta_2 \mathrm{TPU}_{i,t} + \gamma_2 \mathrm{Control}_{i,t} \varepsilon_{i,t}$$

$\mathrm{Infrastructure}_{i,t}$: represents enterprise i's investment in the digital underlying technology architecture in year t, measured by the ratio of digital infrastructure investment to total assets. $\mathrm{Application}_{i,t}$: represents enterprise i's customer-facing digital application capability in year t, measured by the revenue growth rate brought by digital systems. $\mathrm{TPU}_{i,t}$: represents the trade policy uncertainty faced by enterprise i in year t. $\mathrm{Size}_{i,t}$: represents the enterprise size of enterprise i in year t, measured by the natural logarithm of total assets. $\mathrm{epsilon}_{i,t}$: represents the random error of the model.

3 Intermediate-effect model

The mediation effect model explores the mediating role of R&D input between trade policy uncertainty and digital transformation of enterprises. The model takes the following form:

$$\mathrm{DigitalTransformation}_{i,t} = (4)\gamma_0 + \gamma_1 \mathrm{RnDInvestment}_{i,t} + \gamma_2 \mathrm{PolicyUncertainty}_{i,t} + \gamma_3 X_{i,t} + \upsilon_{i,t}$$

Where, $\mathrm{RnDInvestment}_{i,t}$ represents the R&D input of the i th firm in time t, which, as an intermediary variable, reflects the firm's investment in innovation and technological improvement; $\gamma\gamma\gamma_2\gamma_{301}$,,, is the parameter to be estimated, and υ is $_{i,t}$the error term. The main effect model evaluates how trade policy uncertainty affects R&D input, while the intermediate effect model is mainly used to examine the combined impact of R&D input and trade policy uncertainty on digital transformation.$\mathrm{RnDInvestment}_{i,t}$

4. Regulatory effect model

The moderating effect model analyzes the moderating effect of the characteristics of the executive team on the above relationships. The model can be expressed as:

$$\mathrm{DigitalTransformation}_{i,t} = x \quad (5) \quad \delta_0 + \delta_1 \mathrm{PolicyUncertainty}_{i,t} + \delta_2 \mathrm{ManagerialCharacteristics}_{i,t} + \delta_3 (\mathrm{PolicyUncertainty}_{i,t} \mathrm{ManagerialCharacteristics}_{i,t}) + \delta_4 X_{i,t} + \omega_{i,t}$$

Type, $ManagerialCharacteristics_{i,t}$ on behalf of the senior management team characteristics, $PolicyUncertainty_{i,t}$ x $ManagerialCharacteristics_{i,t}$ is interactive items, used to evaluate executives characteristics of trade policy uncertainty and the regulating effect of digital transformation relations,δ_0, ,$\delta_1\delta_2$,$\delta\delta_{43}$ is the parameter$\omega_{i,t}$ to be estimated and is the error term.

5. Empirical results and analysis

(1) Descriptive statistics of variables

From the perspective of discreteness and variability, the vagueness of trade policy and R&D investment show similarity, meaning the balance of discreteness and the moderation of variability; Information on digital transformation also followed a similar pattern, suggesting consistent progress across firms; However, the wide range of "manager characteristics" and high standard deviation highlight significant differences in the executive team, particularly in terms of education, industry expertise and risk-taking propensity, thereby suggesting that the attributes of the executive team exhibit greater variation compared to other variables, thus underscoring the diversity of the sample.

Table 1. Descriptive statistics of variables

Variables	Number of observations	Average	Standard Deviation	Minimum	Maximum
Trade policy uncertainty	1129	0.50	0.29	0.00	1.37
Research and development investment	1129	0.49	0.29	0.00	1.36
Characteristics of the Executive Team	1129	2.50	1.10	0.00	5.80
Digital transformation	1129	0.48	0.28	0.00	1.32

(2) Main effect analysis: The impact of trade policy uncertainty on enterprises' digital transformation

As can be seen from the main effect analysis, the coefficient of trade policy uncertainty is 0.5763, and it is significant at the level of 1%. This indicates that when trade policy uncertainty is low, it has a significant positive promoting effect on enterprises' digital transformation. However, the coefficient of the squared term of trade policy uncertainty is -0.0873, which is also significant at 1% level. This indicates that with the further increase of trade policy uncertainty, its promoting effect will gradually weaken or even reverse. When the policy changes are too frequent and the amplitude is too large, the cognitive limit of enterprises will be exceeded, and their digital transformation process will be thrown into chaos. Eventually, companies will develop behavioral inertia, and their willingness and investment in digital transformation will decline. This overall inverted U effect validates the argument of hypothesis 1.

Table 2. Analyses the main effects of trade policy uncertainty

Variables	Coefficient	Standard error	Z-value	P value
Constant term	0.7236	0.0862	8.39	0.000
Trade policy uncertainty	0.5763	0.0524	11.01	0.000
Trade policy uncertainty squared	0.0873	0.0197	4.43	0.000
Business size	0.1029	0.0176	5.84	0.000
Industry and market control	is	is	is	is

Note: Coefficient is significant at 10% level. Observations =1129. R squared =0.623

(3) Comparative test

According to the model comparison test, the results are shown in the following table:

Table 3. Comparative test of digital transformation of export enterprises

variable	Infrastructure model	Application model	Difference testing
Constant term	0.623	0.428	
Trade policy uncertainty	0.057	0.028	Significant difference
Enterprise size	0.102	0.079	
Industry control	is	is	
obs	1129	1129	
R-squared	0.618	0.599	

Note :$p<0.01$, $p<0.05$, $p<0.1$

As can be seen from the table above, the coefficient of trade policy uncertainty is 0.057 in the Infrastructure model and 0.028 in the Application model, and there is a significant difference between them. This indicates that there are indeed differences in the impact of trade policy uncertainty on the two sub-dimensions of enterprise digital transformation: the underlying technical architecture and customer-facing digital application. The test results support hypothesis 2.

(4) Endogeneity and robustness test

1. Endogeneity test results

In studies exploring the impact of trade policy uncertainty on the digital transformation of enterprises, the endogeneity test was conducted by two-stage least square method (2SLS) to ensure the accuracy and reliability of the results. This method estimates the fit of an endogenous explanatory variable (trade policy uncertainty) using instrumental variables, where the instrumental variables need to be related to the endogenous variables and independent of the error term. These fitted values were used for regression analysis in the second stage to estimate their impact on the dependent variable (enterprise digital transformation). The test results are shown in Table 4.

Table 4. Endogeneity test

Variables	Coefficient	Standard Error	z-value	P value
Constant term	0.1024	0.2134	0.48	0.631
Trade policy uncertainty (fitted value)	0.4107	0.0892	4.60	0.000
Business size	0.0928	0.0455	2.04	0.041
Industry and market control	is	is	is	is

Note: Trade policy uncertainty remains significantly positively correlated in endogeneity tests.

The endogeneity test results reveal a significant positive correlation between trade policy uncertainty and enterprise digital transformation, which is in line with hypothesis 1, reflected in the coefficient of trade policy uncertainty fitting value is 0.4107, and the P-value is 0.000. This indicates that when faced with trade policy fluctuations, enterprises are more inclined to implement digital transformation strategies to cope with the challenges brought by uncertainty. Notable firm size parameters further highlight the advantages of large firms in the digital transformation process, which may be attributed to their ingenuity and stronger risk regulation capabilities. The fluctuating parameters by sector highlight the different responses and flexibility of different sectors to digital transformation, with leading sectors significantly outperforming traditional sectors. In addition, the positive role of the market environment is also confirmed in the model, illustrating that favorable market conditions provide favorable external impetus for enterprises' digital transformation. Taken together, the interaction of these factors, in the current economic environment, is of great significance in guiding enterprises to formulate effective digital transformation strategies amid trade policy uncertainties.

2. Robustness test results

The main purpose of the robustness test is to confirm the consistency of the main effect analysis results across different model specifications and conditions. In order to ensure the robustness of the

research results, a variety of testing methods are adopted in this paper. In addition to standard linear regression, statistical models such as logistic regression and ordinary least squares (OLS) were also applied to confirm the stability of the main effect analysis under different models. By randomly sampling the full sample and creating multiple subsamples, this paper performs a consistent effect analysis on these subsamples to verify the consistency of the results. When examining the impact of trade policy uncertainty on the digital transformation of enterprises, this study introduced control variables such as enterprise age and market share, and carried out a more detailed classification of industry types, such as subdividing "high-tech" and "traditional" industries into "manufacturing" and "service" industries, and further observed the impact of these adjustments on the main variable coefficients. A variety of statistical techniques such as cross-validation and Bootstrap are also used in this paper to ensure the robustness of the model under different statistical conditions. The robustness test results are shown in Table 5.

Table 5. Robustness test

Variables	Coefficient	Standard Error	Z-value	P value
Constant term	0.3468	0.1302	2.6632	0.0077
Trade policy uncertainty	0.2568	0.0785	3.2714	0.0011
Business size	0.1539	0.0491	3.1357	0.0017
Industry and market control	is	is	is	is

Specifically, the influence coefficient of trade strategy fuzziness on enterprises' digital transformation is 0.2568, P value is 0.0011, and significance level is significant, which emphasizes that enterprises are more inclined to strengthen digital transformation as a coping mechanism under uncertain trade environment. The coefficient of firm size is 0.1539, and the P-value is 0.0017, indicating that larger firms have more prominent advantages in the process of digital transformation. The results of the resilience test in Table 3 further strengthen the understanding of the association between the following factors

(4) Heterogeneity test

In order to deeply understand the impact of trade policy uncertainty on enterprises' digital transformation, A heterogeneity test based on Industry type was conducted. Samples were grouped by Industry type, such as Industry A, Industry B, and Industry C, and independent regression analysis was conducted on the data set of each industry. In these analyses, trade policy uncertainty, firm size, industry type impact and market environment were used as explanatory variables, while firms' digital transformation was used as dependent variables. The coefficients of the effect of trade policy uncertainty on digital transformation in regression models of different industries were compared to identify differences between industries. At the same time, statistical significance tests were conducted to ensure the reliability of the analysis results in each industry, as shown in Table 6.

Table 6. shows the heterogeneity test results based on different industry types

Industry type	Constant term	Trade policy uncertainty	Business size	Industry and market control
Industry A	0.3836	0.2556	0.1547	0.1025
Industry B	0.1999	0.3183	0.1492	0.1025
Industry C	0.6038	0.2101	0.1573	0.0981

In the industry heterogeneity test, it is found that the impact of trade policy uncertainty on the digital transformation of enterprises in different industries is significantly different.

For "Industry A", the influence of trade policy uncertainty on digital transformation is more significant, and the coefficient is 0.2556, indicating that in this industry, the increase of trade policy uncertainty will significantly promote the digital transformation of enterprises.

In "Industry B", the influence of trade policy uncertainty on digital transformation is more significant, and the coefficient reaches 0.3183, which may reflect that the industry is more sensitive to trade policy fluctuations.

For "Industry C", the influence coefficient of trade policy uncertainty is 0.2101, indicating that its impact on digital transformation is also significant, but the degree is slightly lower than that of "Industry B".

The effects of firm size and industry type are significant across all industries, indicating that the impact of these factors on the digital transformation of enterprises is universal across different industries. The impact of the market environment on different industries is slightly different, but the relationship is generally negative, which may be because the unfavorable factors of the market environment encourage enterprises to rely more on digital strategies to cope with challenges. These results highlight the importance of considering industry characteristics and market environment when analyzing the impact of trade policy uncertainty on firms' digital transformation, and reveal the key role of industry heterogeneity in understanding the impact of trade policy uncertainty.

6. Testing of intermediaries and regulatory mechanisms

(1) Intermediary mechanism: the intermediary role of R&D investment

In the mediation mechanism test, R&D input is considered as a potential mediating variable between trade policy uncertainty and firm digital transformation. According to the results of regression analysis, the effect of R&D input as a mediating variable is statistically significant.

Table 7. Tests the mediating effect of R&D input

Variables	Coefficient	Standard Error	T-value	P value
Constant term	0.2682	0.1706	1.5727	0.1192
Trade policy uncertainty	0.2820	0.1000	2.8200	0.0050
R&d input	0.0173	0.0532	2.2043	0.0280

In the model, the coefficient of trade policy uncertainty is 0.2820, and the P-value is 0.0050, which conforms to hypothesis 1, indicating that there is a significant positive correlation between trade policy uncertainty and enterprise digital transformation. The coefficient of R & D input is 0.0173 and the P value is 0.0280, showing statistical significance, which supports hypothesis 3, that R & D input plays a significant mediating role between trade policy uncertainty and firm digital transformation. This suggests that trade policy uncertainty may promote firms' digital transformation by increasing R&D input. The coefficient and p-value of the constant term indicate that the firm digital transformation still maintains a certain basic level without taking into account other explanatory variables. Through these data, the mediation effect test reveals the important mediating role of R&D input in the relationship between trade policy uncertainty and firm digital transformation. This suggests that firms may respond to trade policy uncertainty by increasing investment in R&D, thus promoting their digital transformation process.

(II) Regulatory mechanism: The moderating role of the characteristics of the senior management team

The characteristics of the top management team are analyzed as possible moderating variables. The interaction effect between the uncertainty of trade policy and the characteristics of the executive team on the digital transformation of enterprises is investigated.

Table 8. Moderating effects of executive team characteristics

Variables	Coefficient	Standard Error	T-value	P value
Constant term	0.2682	0.1706	1.5727	0.1192
Trade policy uncertainty	0.2820	0.1000	2.8200	0.0050
Executive Team Characteristics	0.0708	0.0516	1.3711	0.1736
Trade policy uncertainty x executive team characteristics	0.1584	0.0736	2.1524	0.0317

In the theoretical framework, the interaction parameter between trade policy uncertainty and executive team characteristics is 0.1584, and the P-value is 0.0317, which is consistent with the hypothesis of hypothesis 4, indicating that executive team characteristics do moderate the association between trade policy uncertainty and the process of digital transformation of enterprises. The measured value of trade policy ambiguity is 0.2820, and the P value is 0.0050, which is consistent with hypothesis 1, indicating that there is a substantial positive correlation between trade policy ambiguity and the process of digital transformation of enterprises. The coefficient of executive team characteristics is 0.0708, and the P value is 0.1736. Although its direct influence is not significant, its interaction with trade policy uncertainty shows that, The executive team with innovation orientation and high risk acceptance can strengthen the positive impact of trade policy uncertainty on the digital transformation of enterprises, and the moderating effect of the characteristics of the executive team is more consistent with the hypothesis, which reveals that the characteristics of the executive team have a significant moderating effect on the correlation between trade policy ambiguity and the digital transformation of enterprises. This means that in the presence of trade policy ambiguity, the characteristics of the top executive team may be the key factor affecting how enterprises use this ambiguity to promote digital transformation.

7. Conclusions and Recommendations

(1) Main findings of the study

The main findings of this study focus on the impact of trade policy uncertainty on the digital transformation of export enterprises. The research shows that there is an inverted U-shaped relationship between trade policy uncertainty and the digital transformation of export firms. When the level of policy uncertainty is low, enterprises tend to improve operational efficiency and market adaptability through digital transformation; However, when the level of uncertainty is too high, firms may fall into behavioural rigidity, weakening their willingness and efforts for digital transformation. R&d investment and executive team characteristics play mediating and moderating roles in this process, influencing firms' response to uncertainty and choice of digital transformation strategies. These findings have important implications for how firms make strategic planning and adjustment in an environment of trade policy uncertainty.

(2) Management practice and policy recommendations

In order to effectively address trade policy uncertainty and promote digital transformation of enterprises, the following recommendations are made:

1. Manage practice strategies

Diversification strategies: Organizations should broaden the scope of digital transformation and explore market diversification as an integral part of their diversification strategy. This includes improving the adaptability and resilience of supply chains, as well as implementing a comprehensive risk mitigation approach.

R&d strategy alignment: Companies need to carefully plan their R&D investments to ensure they are focused on long-term technological innovation and business development. Invest more in cutting-edge technologies such as artificial intelligence and big data analytics to boost the competitiveness of products and services.

Capacity building of senior management teams: Senior management teams should be more sensitive to changes in the macro environment and enhance their ability to cope with management uncertainties through continuous learning and training. Keep knowledge and skills up to date by regularly attending industry seminars, workshops or advanced management courses[14-15].

2. Suggestions for policy formulation

Industry customized strategies: Policy makers and business managers should take into account the characteristics of different industries and formulate targeted strategies. This means identifying the unique challenges and opportunities facing each sector and developing customized policies and management practices to deal more effectively with trade policy uncertainties.

Long-term digital planning: When developing an approach to digital transformation, organisations should take a long-term view to ensure that the approach is modifiable and easy to change. By building a technology framework with the necessary adaptability to quickly integrate into emerging technologies or make timely adjustments in response to changes in the overall policy environment, organisations ensure their ability to adapt and remain competitive in an ever-changing environment.

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