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## Does Economic Policy Uncertainty Affect the Export Technological Sophistication of Manufacturing Industries?

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# **Does Economic Policy Uncertainty Affect the Export Technological Sophistication of Manufacturing Industries?**

**Abstract:** Based on data from 19 major countries from 2000-2017, this paper examines the impact of economic policy uncertainty on the export technological sophistication of manufacturing industries. The research shows that in the sample period, the export technological sophistication of manufacturing industries varies among countries, with China and India slowly increasing, Germany and Japan still at a high level, and Canada and Greece in a downward trend. From the empirical results, the expected mechanism of economic policy uncertainty forces the domestic manufacturing industries industry to accelerate R&D innovation by restraining the "technological spillover" effect of imported intermediate goods and the "financing dependence" effect of domestic credit investment, thus promoting the increase of the export technological sophistication in various countries. For countries with high economic growth rate, high degree of development and high degree of economic freedom, the positive impact of economic policy uncertainty on the export technological sophistication of manufacturing industries is more significant. From the perspective of economic policy uncertainty, the paper examines its impact on the export technological sophistication of manufacturing industries with important policy implications. Strengthening bilateral and multilateral consultations among governments and accelerating R&D innovation of domestic enterprises are effective measures to enhance export competitiveness at present.

**Keywords:** Economic Policy Uncertainty; Export Technological Sophistication; R&D Innovation; Manufacturing Industry; Reflection Method

## **1. Introduction**

Since the financial crisis in 2008, the global economic growth has been in a sustained downturn, the international market is sluggish, and domestic demand is insufficient, which have become important factors restricting the economic development of various countries. To speed up economic recovery, governments around the world have actively introduced a variety of economic policies. However, the frequent trade wars launched by US President Donald Trump since he took office have left the prospects of global economic development unclear. In addition, the general establishment of trade barriers and trade protectionism, coupled with countries to compete for the international market at the cost of lowering the price of production and sales, as well as starting price war, the global economic policy uncertainty is significantly increased.

In recent years, the research on economic policy uncertainty and its impact has gradually become the focus of academic circles. The economic policy uncertainty of each country affects the domestic economic operation through the pass-through effect, and then affects the whole world. Under the circumstance of increasingly deepening of economic globalization, the export technological sophistication (ETS), used to measure an important index of the technical level of the manufacturing industries exports, has become a standard judging a country's export competitiveness of manufacturing industries (Xu, et al., 2017). Countries all over the world have begun to pay attention to the improvement of manufacturing industries export technology and export competitiveness to reduce the negative impact of trade barriers and vicious competition by improving the development mode of foreign trade. Then does economic policy uncertainty affect the export technological sophistication of countries' manufacturing industries? What is the transmission mechanism behind this effect? Is the impact of economic policy uncertainty on export technological sophistication different under different economic characteristics? This paper attempts to answer the above questions, which is of great theoretical and practical significance for understanding the economic policy uncertainty in various countries and the export technological sophistication of manufacturing industries, as well as enriching relevant researches.

The following structure arrangement of this paper is as follows: The second part is literature review and theoretical mechanism; The third part is empirical design; The fourth part is the empirical results and analysis; The sixth part is conclusion and revelation.

## **2. Literature review and theoretical mechanism**

### **2.1 Literature review**

The literature involved in this paper is mainly divided into two categories: the first category is related to economic policy uncertainty. The current research about economic policy uncertainty mostly focused on investment (Li & Yang, 2015), risk (Liu, et al., 2017), R&D innovation (Gu, et al., 2018), etc., and the study of the relationship between economic policy uncertainty and export is relatively scarce, and focus on the investigation from the terms of the export scale. Handley (2014) suggested that the trade policy uncertainty hindering the possibility of enterprises entering the export market. Liu & Tong (2018) analyzed the impact of domestic and foreign economic policy uncertainty on China's export trade and its decomposition, and explored the differences of their functions, specific characteristics and impact channels. It is found that the

uncertainty of domestic and foreign policies significantly reduces the binary margin of China's exports. Zhou, et al. (2019) studied the impact of economic policy uncertainty on export stability by starting from the reduction of policy uncertainty faced by China after its entry into the WTO. Research shows that the decline in economic policy uncertainty has led to an increase in export stability. The existing research conclusions basically support the view that economic policy uncertainty has a restraining effect on export scale.

The second category is related to the export technology sophistication. Since Rodrik (2006) and Hausmann, et al. (2007) put forward the concept of export technological sophistication earlier, scholars have made many explorations on the measurement of export technological sophistication, impacting factors and their impact on economic growth, with fruitful results. Wang, et al. (2010) found that infrastructure construction can further affect the export technological sophistication through "export extensive margin" and "export intensive margin". Qi, et al. (2011), based on the perspective of financial development, found that financial development promoted the increase of export technological sophistication by solving the problem of adverse selection caused by the uncertainty of R&D and production. Liu, et al. (2014) proposed a global value chain level measurement framework based on the dual participating structure of product and function, and studied the impact of global value chain participation, participating structure and value source on the export technological sophistication. Lu (2014) studied the impact of technology upgrading on export technological sophistication based on the micro enterprise level, and the research showed that enterprise technology upgrading effectively promoted the stability of export and the improvement of export technology sophistication. Other impacting factors include internet factors (Li & Zhou, 2017), institutional factors (Zhu, 2018) and resource allocation factors (Jiang, et al., 2019). In recent years, some scholars have begun to focus on the relationship between the liberalization of import trade and the export technological sophistication. For example, the research of Sheng & Mao (2017) showed that the liberalization of import trade significantly increases the export technological sophistication of enterprises.

Through literature review, it is not difficult to find that although scholars have conducted many beneficial discussions on the factors affecting the export technological sophistication, few of the above studies have been conducted from the perspective of economic policy uncertainty when examining the factors affecting the export technological sophistication. The permanent impact of economic policy uncertainty on

the international trade of countries throughout the world cannot be ignored, the effects of the global trade disputes continue to expand, increasing trade disputes, to explore the impact of economic policy uncertainty on export technological sophistication of manufacturing industries for stabilizing export performance, enhancing the level of export technology is of great significance. Compared with the existing literature, this paper has a novelty: it studies the impact on the export technological sophistication of manufacturing industries from the perspective of economic policy uncertainty, and explains the theoretical mechanism behind the impact through the extension of relevant theories.

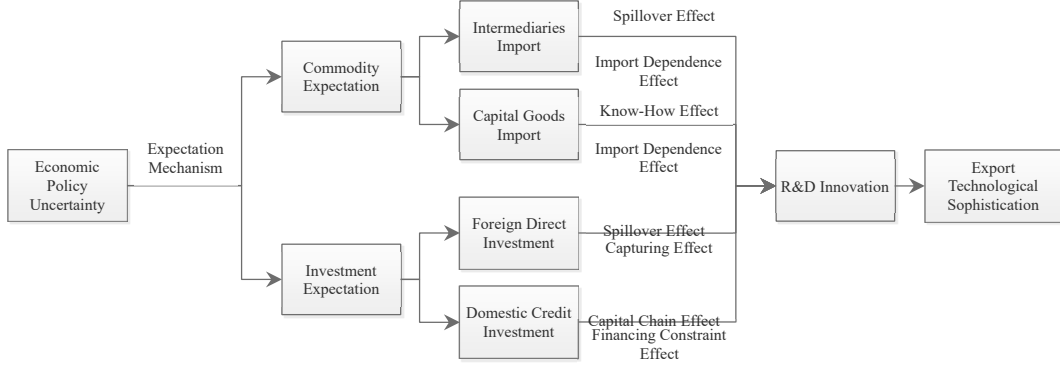
## **2.2 Theoretical mechanism and research assumption**

Most studies show that economic policy uncertainty has a series of negative economic effects: for instance, economic policy uncertainty has a negative impact on investment of enterprise (Li & Yang, 2015; Rao, et al., 2017), economic policy uncertainty has a negative impact on financialization of enterprise (Peng, et al., 2018), economic policy uncertainty has a negative impact on economic growth (Yang, et al., 2014), and economic policy uncertainty has a negative impact on output and price level (Xu & Wang, 2019). Scholars generally believe that the impact mechanism of economic policy uncertainty on economic entities is mainly based on expectations (Jin, et al., 2014; Liu, et al., 2017; Pan & Han, 2018), in which the domestic and foreign economic policy uncertainty would cause manufacturer to delay or slow down the economic behavior of the prospective forecast, so as to avoid the external macro impact brought about by the systemic risk. What's more, the rational behavior decision widely existed in economic activities e.g. investment, consumption, production and trade. From the existing research, it is not difficult to see that the expectation mechanism of economic policy uncertainty will have a restraining effect on many social and economic activities. But will economic policy uncertainty have the same negative impact on export technological sophistication through the expectation mechanism? This paper attempts to give different solutions.

Sufficient studies have shown that an important channel affecting a country's export competitiveness is the level of production technology, and many factors, including import liberalization and trade facilitation, further affect the export technological level through R&D innovation (Sheng & Mao, 2017; Liu, et al., 2018; Xu, et al., 2017). This paper argues that economic policy uncertainty affects industrial R&D innovation through the expectation mechanism, and further affects the export technological

sophistication of manufacturing industries through the R&D innovation channel (the theoretical transmission mechanism is shown in *Fig. 1*). To be specific, the expectation mechanism makes the economic entities of various countries form forward-looking expectations for products and investment, namely, product demand expectation and investment supply expectation. In the product demand expectation mechanism, economic entities predict that the economic policy uncertainty will have a negative impact on their production and export, thus reducing the induced demand for import factors such as imported intermediate goods and capital goods. Imports of intermediate goods and capital goods have a dual effect on product R&D innovation. On the one hand, they can promote R&D innovation through the "technological spillover" effect and the "know-how" effect respectively, thus promoting the technological level of export of domestic manufacturing industries industry (Brandt, et al., 2012; Zhang, 2015). On the other hand, the excessive dependence of domestic economic entities on imported intermediate goods and imported capital goods may also produce the "import dependence" effect in the long term, weaken the internal initiative of their own R&D innovation enthusiasm, and thus inhibit the improvement of their export technology level (Zhang, 2015). For the investment supply expectation mechanism, the domestic economic policy uncertainty may increase the supply of the domestic and foreign investment "caution", makes foreign investors to capture the changes of macro environment, and then choose less volatility in the economic policy of the country or region to conduct direct investment activities such as merger & acquisition and reorganization or investment. Domestic credit investors, in turn, may make decisions to delay or slow current economic activity, thereby avoiding the additional risks associated with lending to domestic exporters. Foreign direct investment and domestic credit investment also has dual effects on product R&D innovation, although foreign direct investment can bring technological spillovers for domestic economic entities, but because the investor has the ownership of enterprises or decision-making power on production, so as to form the "internal control" and "technological capture" on domestic product R&D innovation, thus exerts an adverse effect on export technological level (Lv, et al., 2018). Domestic credit investment is enable to alleviate the fund panic for domestic enterprise in the process of production sales campaign and avoid capital chain "rupture", but an excessive emphasis on credit will also bring their own potential "rely on" financing constraints, and tightening of financing constraints can also get rid of a part of enterprise with low technology, thus the overall level of manufacturing

industries exports technological sophistication can be promoted (Xie & Fang, 2011; Ju, et al., 2013; Zhang, et al., 2017; Liu, et al., 2017).



**Fig. 1 Pass-through mechanism of economic policy uncertainty affecting export technological sophistication**

Based on the above elaboration on the pass-through mechanism of economic policy uncertainty affecting the export technological sophistication of manufacturing industries, the paper puts forward the corresponding hypothesis to be tested.

Hypothesis *H1*: Economic policy uncertainty significantly correlates with the export technological sophistication of manufacturing industries.

Hypothesis *H2*: The product demand expectation mechanism of economic policy uncertainty affect imports of intermediates and capital goods, while imports of intermediate goods has the "technological spillover" effect and "import dependence" effect, the import of capital goods has the "know-how" effect and "import dependence" effect exert dual influence on R&D innovation, and further affect the manufacturing industries export technological sophistication.

Hypothesis *H3*: The investment supply expectation mechanism of economic policy uncertainty affect the foreign direct investment and domestic credit, while foreign direct investment has the "technological spillover" effect and "capturing" effect, the domestic credit investment "capital chain effect" and "financing constraint" effect have dual impact on R&D innovation, and further affect the export technological sophistication of manufacturing industries.

### 3. Research Design

#### 3.1 Econometrical model specification

$$TSI_{it} = \alpha_0 + \alpha_1 EPU_{it} + \beta X_{it} + \phi_i + \eta_t + \varepsilon_{it} \quad (1)$$

Where subscripts *i* and *t* represent country and year, respectively. Dependent variable  $TSI_{it}$  denotes the export technological sophistication, core independent variable  $EPU_{it}$  denotes the economic policy uncertainty,  $\phi_i$  and  $\eta_t$  represent the fixed effect of country and year, respectively, and  $\varepsilon_{it}$  denotes the error term.

By referring to relevant literature, the following variables are selected as the control variables  $X_{it}$  of the model: (1)  $EP_{it}$  denotes electricity consumption per capita, which measured for the economic prosperity of each country. (2)  $TD_{it}$  denotes the degree of trade dependence, which measured for the degree to which countries depend on international trade. (3)  $CPI_{it}$  denotes the consumer price index, which measured for the price level of each country. (4)  $UR_{it}$  denotes the urbanization rate, which measured for the urbanization development level of each country. (5)  $GDP_{it}$  denotes  $GDP$ , gross domestic product, measured for the size of each country's economy. (6)  $POP_{it}$  denotes the total population and measures the market size. In order to reduce heteroscedasticity in regression, the dependent variable, independent variables and control variables involved are logarithmically treated.

## 3.2 Indicator description and data sources

### 3.2.1 Indicator description

Economic policy uncertainty. Academic field often use specific events as a proxy indicator of economic policy uncertainty, but due to the lack of continuity and time variability, it is unable to capture the change of policy uncertainty in non-election years or during the change of government, resulting in measurement deviation (Gulen & Ion, 2015). The economic policy uncertainty index used in this paper was constructed by Baker, et al. (2016). Based on text analysis, it extracted and processed news information from newspapers of various countries and expert prediction reports, and strictly tested their continuity, which was jointly published by the University of Chicago and Stanford University (Gu, et al., 2018).

Export technological sophistication. In this paper, based on the two-step method of Hausmann, et al. (2007), the export technological sophistication index of manufacturing industries of the sample countries was calculated, and the quality of export goods was adjusted based on the method of Wang, et al. (2010).

The first step is to calculate the export technological sophistication at the product level:

$$PRODY_k = \sum_i^I \left[ \frac{Exp_{ik} / \sum_k^K Exp_{ik}}{\sum_i^I (Exp_{ik} / \sum_k^K Exp_{ik})} \times pcgdp_i \right] \quad (2)$$

Where  $i$ ,  $I$ ,  $k$  and  $K$  denote the products of country  $i$ , total number of countries  $I$ , product  $k$  and total varieties of products  $K$ , respectively.  $PRODY_k$  denotes the export technological sophistication of product  $k$  in country  $i$ ,  $Exp_{ik}$  denotes the export of



product  $k$  in country  $i$ ,  $\sum_k^K Exp_{ik}$  denotes the total export of country  $i$ , and  $pcgdp_i$  denotes  $GDP$  per capita, the gross domestic product per capita of country  $i$ .  $(Exp_{ik} / \sum_k^K Exp_{ik}) / \sum_i^I (Exp_{ik} / \sum_k^K Exp_{ik})$  denotes the revealed comparative advantage index and as the weight of the weighted average of the export technological index.

Although this method has been widely used to calculate the export technological sophistication, some scholars have pointed out that this method may cause calculation errors due to its failure to consider the quality difference of export products (Xu, 2007). Since the paper calculates the relevant indexes based on HS4-digit export products, the quality of export products may vary greatly. As it is pointed out by Sheng & Mao (2017), if the products exported by a country or region are of relatively low quality in the HS4-digit classification, Hausmann, et al. (2007) two-step method may overestimate the export technological sophistication of that country or region as a whole.

In this paper, the practice of Xu (2007) and Wang, et al. (2010) are used to calculate the quality of export products. First, the quality of export products is calculated according to the formula  $Q_{ik} = prc_{ik} / \sum_i^I (A_{ik} \cdot prc_{ik})$ . Where  $prc_{ik}$  is the export price of product  $k$  in country  $i$ , and  $A_{ik}$  is the proportion of the total amount of country  $i$ 's export product  $k$  in the total amount of country  $i$ 's export product  $k$ . Export product quality  $Q_{ik}$  is regarded as the relative price of country  $i$ 's export product  $k$ , the higher the value is, the higher the product quality is. Therefore, the quality-adjusted export technological sophistication index at product-level is formulated as  $PRODY_k^{adj} = (Q_{ik})^\phi \cdot PRODY_k$ , and  $\phi$  is set as 0.2 according to the practice of Wang, et al. (2010).

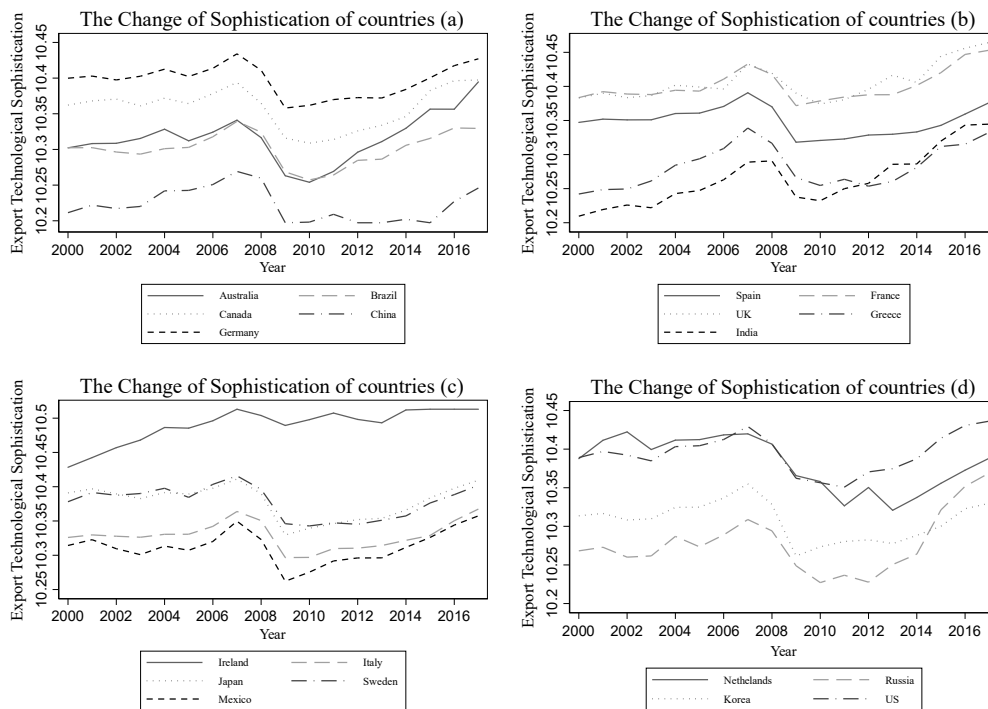
The second step is to calculate the technical sophistication of export at the country level:

$$TSI_i = \sum_k^K \frac{Exp_{ik}}{\sum_k^K Exp_{ik}} PRODY_k^{adj} \quad (3)$$

Where  $TSI_i$  denotes the export technological sophistication adjusted by the economic quality of country  $i$ ,  $Exp_{ik} / \sum_k^K Exp_{ik}$  is the proportion of the country  $i$ 's export product  $k$  in its total export, and serves as the weight to calculate the export technological sophistication adjusted by the quality of the country.

The export technological sophistication of manufacturing industries in each country during the sample period is shown in *Fig. 2*. It is not difficult to see that the variation of technological sophistication of manufacturing industries exports in each country in

the sample period presents the characteristics of travel variability. The technological sophistication of manufacturing industries exports from developing countries such as China, India, South Korea and Russia rose slowly over the sample period; Although the export technological sophistication of manufacturing industries in developed countries such as Germany, Britain, Japan and the United States has not changed much, the export technological sophistication of manufacturing industries has been maintained at a high level due to the high level of r&d investment over the years. Countries such as Canada, Greece, Italy and the Netherlands have shown a downward trend in technological sophistication in manufacturing industries exports.



**Fig. 2 Export technological sophistication of manufacturing industries in 19 countries from 2000-2017**

### 3.2.2 Data sources

In previous studies on the export technological sophistication of manufacturing industries, most of the subject involved was single country, so this paper introduces data from many countries. As in the data provided by Baker et al. (2016), only the relevant data of 19 countries are consistent, these countries are: Australia, Brazil, Canada, China, Germany, Spain, France, UK, Greece, India, Ireland, Italy, Japan, South Korea, Mexico, the Netherlands, Russia, Sweden and the US. For the sake of data availability, this paper selects the above countries from 2000-2017 as the research objects. In 2017, the total *GDP* and export of these countries accounted for 77.5% and 63.2% of the world's total *GDP* and world's total export, respectively. The research

samples are highly representative.

From the UN Comtrade statistical database, more than 1,300 exported industrial products of 150 countries from 2000-2017 at the HS 4-digit level were obtained as the data base to calculate the export technological sophistication at the product level. In addition, the import amount of capital goods and import amount of intermediate goods used in this paper were also from the UN Comtrade database. Export price data are derived from the HS96 unit value of trade (TUV) provided by CEPII. Other variables in the paper: *GDP*, population, consumer price index, urbanization rate, electricity consumption per capita, trade dependence, patent applications, foreign direct investment, and credit proportion of private enterprises were all derived from the World Bank database. Descriptive statistics of relevant variables are shown in *Table 1*.

**Table 1 Descriptive statistics**

Variable	Observation	Mean	S.E.	Min	Max
<i>Dependent Var.</i>					
<i>TSI</i>	627	14.74	0.82	12.67	17.15
<i>Independent Var.</i>					
<i>EPU</i>	684	4.71	0.43	3.33	6.3
<i>Control Var.</i>					
<i>EP</i>	570	8.62	0.81	5.98	9.76
<i>TD</i>	570	3.79	0.47	2.84	5
<i>CPI</i>	684	4.56	0.19	3.46	5.13
<i>UR</i>	684	4.3	0.25	3.36	4.53
<i>GDP</i>	684	28.08	1	25.85	30.48
<i>POP</i>	684	18.01	1.46	15.15	21.05
<i>Mediation Var.</i>					
<i>INTER</i>	684	21.45	3.38	0	25.98
<i>CAPIT</i>	684	0.37	3.07	0	26.48
<i>FDI</i>	554	24.06	1.53	14.51	27.32
<i>FIN</i>	650	4.51	0.59	2.63	5.36

Note: In the mediation variable, *INTER* denotes import of intermediate goods, *CAPIT* denotes import of capital goods, *FDI* denotes foreign direct investment and *FIN* denotes domestic credit proportion of private enterprises.

## 4. Empirical results

### 4.1 Benchmark results

*Table 2* reports the regression results from the balance panel data used from 2000-2017. Column (1) presents the results of economic policy uncertainty *EPU* containing only the core variable. It can be seen that the coefficient of *EPU* is 0.676, represents the elasticity of export technology, indicating that a 1% increase will lead to a 0.676% increase in the export technological sophistication when other factors remain

unchanged. Columns (2)-(5) present the results of including control variables, and the coefficients of *EPU* are still significantly positive after successively adding control variables such as *EP*, *TD*, *CPI*, *UR*, *GDP* and *POP*, indicating that economic policy uncertainty significantly promotes the improvement of manufacturing industries export technological sophistication. Therefore, Hypothesis *H1* is verified. Control variables except *EP* and *TD*, all columns results basically stable, the coefficients of factors such as *CPI* and *GDP* are positive, shows that the impact of price level and economic scale on the export technological sophistication are significant positive. The coefficients of factors such as *UR* and *POP* are negative, shows that the impact of urbanization rate and the factors such as population size on the export technological sophistication are significant negative.

**Table 2 Benchmark results**

	(1)	(2)	(3)	(4)	(5)
<i>EPU</i>	0.676*** (0.12)	0.649*** (0.15)	0.594*** (0.12)	0.074*** (0.01)	0.119*** (0.02)
<i>EP</i>		0.269*** (0.03)	0.429*** (0.02)	-0.058*** (0.02)	-0.059*** (0.02)
<i>TD</i>		-0.165*** (0.03)	-0.249*** (0.03)	0.660*** (0.02)	0.666*** (0.02)
<i>CPI</i>			1.745*** (0.20)	0.446*** (0.09)	0.451*** (0.09)
<i>UR</i>			-1.021*** (0.08)	-1.062*** (0.04)	-1.056*** (0.04)
<i>GDP</i>				1.244*** (0.03)	1.240*** (0.03)
<i>POP</i>				-0.384*** (0.03)	-0.382*** (0.03)
Constant	10.422*** (0.93)	9.659*** (1.01)	4.642*** (1.19)	-12.851*** (0.44)	-13.139*** (0.61)
Year F.E.	Yes	Yes	Yes	Yes	Yes
Country F.E.	Yes	Yes	Yes	No	Yes
<i>R</i> <sup>2</sup>	0.064	0.133	0.246	0.948	0.948
Observation	627	570	570	570	570

Note: Asterisk \*, \*\*, and \*\*\* represent significance levels of 10%, 5%, and 1%, respectively. Year and country fixed effect are controlled by the model. The standard error of clustering robustness at the country level is presented in parentheses.

#### 4.2 Pass-through mechanism results

The above research conclusions indicate that economic policy uncertainty has a positive impact on the export technological sophistication of manufacturing industries on the whole, and this positive effect of export technology is different from the negative economic effect of some scholars on the economic policy uncertainty. Based on the analysis of the theoretical mechanism mentioned above, it can be seen that the impact of economic policy uncertainty on the export technological sophistication of manufacturing industries rests with its expectation mechanism, that is, economic policy uncertainty prompts economic entities to produce product demand expectation and investment supply expectation. Among them, the expected demand for intermediate

goods and capital goods, as well as foreign direct investment and domestic credit in the demand for investment supply, all act on the R&D innovation of production technology in domestic manufacturing industries industry, and then affect the technological sophistication of export. In order to further analyze the pass-through mechanism of economic policy uncertainty affecting the export technological sophistication of manufacturing industries, the following econometric models are constructed as follows:

$$TSI_{it} = \alpha_0 + \alpha_1 RD_{it} + \beta X_{it} + \phi_i + \eta_t + \varepsilon_{it} \quad (4)$$

$$RD_{it} = \kappa_0 + \kappa_1 (EPU_{it} \cdot PASS_{it}) + \kappa_2 PASS_{it} + \lambda X_{it} + \phi_i + \eta_t + \varepsilon_{it} \quad (5)$$

Where  $RD_{it}$  is research and development innovation,  $PASS_{it}$  is the pass-through variable, including the import amount of intermediate goods  $INTER_{it}$ , the import amount of capital goods  $CAPIT_{it}$ , foreign direct investment  $FDI_{it}$  and the proportion of domestic credit  $FIN_{it}$ .  $EPU_{it} \cdot PASS_{it}$  is the interaction term between economic policy uncertainty and pass-through variables, and measures the pass-through mechanism corresponding to the economic policy uncertainty. The control variables  $X_{it}$  are consistent with the benchmark model (1). The results of impact mechanism analysis are shown in *Table 3*.

In *Table 3* column (1) shows the relationship between R&D innovation and export technological sophistication. The R&D innovation coefficient is 0.095 at the 1% significance level. It is not difficult to see that R&D innovation significantly promotes the improvement of export technological sophistication of manufacturing industries industry. Columns (2)-(5) are the regression results of each pass-through path, in which columns (2)-(3) are the regression results of the expectation mechanism of demand for intermediate goods' import and capital goods' import, respectively. The interaction term coefficient between the uncertainty of economic policy and the import of intermediate goods and capital goods is 0.146 and -0.040, indicating that the economic policy uncertainty generates the expectation of a decline in the demand for imported products. Hypothesis *H2* is verified. The difference of interaction coefficient on significance shows that the positive impact of decrease of the demand for intermediates' import on R&D innovation is more evident compared with the decrease of demand for capital goods' import, a possible reason is that the "import dependence" effect of imports of intermediate goods is stronger than the "technological spillover" effect, indicating the import products' over-reliance on for domestic entities has weakened the their R&D innovation initiative, and economic policy uncertainty broke the over-reliance on imported goods, so as to objectively aroused the enterprise independent R&D innovation vitality. However, the "know-how" effect and "import dependence" effect of

imported capital goods offset each other, so the decline of domestic enterprises' import demand for capital goods does not have a significant impact on R&D innovation activities. Compared with the variable *CAPIT*, the coefficient of *INTER* is -0.170, and it passes the significance test at the level of 5%, which shows that the import of intermediate products does significantly restrain the increase of export technological sophistication, which further supports the above demonstration. Columns (4) to (5) are the regression results of investment supply expectation mechanism of foreign direct investment and domestic credit investment, respectively. The interaction term coefficients of economic policy uncertainty and foreign direct investment, and the interaction term coefficients of economic policy uncertainty and domestic credit investment were 0.090 and 0.288, respectively, both of which were statistically significant, indicating that the investment supply expectation generated by economic policy uncertainty had a positive impact on R&D innovation. Hypothesis *H3* was verified. From the perspective of interaction coefficients, the decrease in domestic credit investment has stronger promoting effect on R&D innovation than foreign direct investment, shows that domestic credit investment "financing dependence" effect is higher than "capital chain" effect, the domestic export enterprises tend to be through access to domestic credit funds to solve their own problem of "capital chain", but excessive dependence can cause enterprises into more debt disputes, and continued weakness in R&D innovation activities. The economic policy uncertainty makes domestic credit suppliers strengthen credit constraints to avoid credit risks, which also forces exporting enterprises to maintain their export competitiveness by improving production technology. In addition, the tightening of credit and financing constraints has accelerated the elimination of some inefficient enterprises, thereby increasing the export technological sophistication at the national level as a whole. From the variable results of variable *FDI*, foreign direct investment significantly and negatively correlates with export technological sophistication, it shows that the "capturing" effect is stronger than the "technological spillover" effect for foreign direct investment, and the economic policy uncertainty stimulates the inner motive of enterprises to improve R&D innovation, and further promote export technological sophistication by triggering the decline in foreign direct investment.

**Table 3 Impact mechanism regression results**

	(1) <i>TSI</i>	(2) <i>RD</i>	(3) <i>RD</i>	(4) <i>RD</i>	(5) <i>RD</i>
<i>RD</i>	0.095*** (0.01)				
<i>EPUINTER</i>		0.146**			

		(0.07)			
<i>INTER</i>		-0.170**			
		(0.07)			
<i>EPU-CAPIT</i>			-0.040		
			(0.05)		
<i>CAPIT</i>			0.023		
			(0.06)		
<i>EPU-FDI</i>				0.090**	
				(0.03)	
<i>FDI</i>				-0.043**	
				(0.02)	
<i>EPU-FIN</i>					0.288*
					(0.13)
<i>FIN</i>					0.189
					(0.17)
<i>EP</i>	-0.151***	1.060***	1.093***	0.652***	0.894***
	(0.02)	(0.05)	(0.04)	(0.13)	(0.03)
<i>TD</i>	0.626***	0.168***	0.085***	0.070	0.161***
	(0.02)	(0.02)	(0.03)	(0.08)	(0.02)
<i>CPI</i>	0.610***	-0.527***	-0.618***	-0.525	-1.232***
	(0.07)	(0.10)	(0.13)	(0.32)	(0.25)
<i>UR</i>	-1.076***	-0.477***	-0.653***	0.838*	0.152
	(0.10)	(0.14)	(0.13)	(0.44)	(0.09)
<i>GDP</i>	1.210***	0.226***	0.255***	-0.014	-0.014
	(0.02)	(0.04)	(0.03)	(0.07)	(0.03)
Constant	-12.200***	-1.188*	-0.497	-0.112	1.392
	(0.81)	(0.61)	(0.82)	(2.00)	(0.91)
Year E.F.	Yes	Yes	No	Yes	Yes
Country E.F.	Yes	No	Yes	Yes	Yes
<i>R</i> <sup>2</sup>	0.948	0.818	0.824	0.592	0.870
Observation	510	510	510	280	484

Note: Asterisk \*, \*\*, and \*\*\* represent significance levels of 10%, 5%, and 1%, respectively. Year and country fixed effect are controlled by the model. The standard error of clustering robustness at the country level is presented in parentheses.

### 4.3 Heterogeneity analysis

It can be seen from the benchmark regression results that economic policy uncertainty has a positive impact on the export technological sophistication of manufacturing industries on the whole, while the impact based on country-level characteristics may have heterogeneity.

In order to further investigate the heterogeneous effects of economic policy uncertainty on the export technological sophistication of manufacturing industries, this paper divides the two groups according to national characteristics such as economic development momentum, degree of economic development and economic freedom. Firstly, the economic growth rate is taken as the indicator to measure whether the economic development momentum is strong, and the sample is divided into low growth rate countries and high growth rate countries. Secondly, according to the degree of economic development, the sample is divided into developed countries and developing countries. Among them, developing countries include China, India, South Korea, Mexico, Brazil and Russia. Finally, the sample is divided according to the economic freedom index provided by the Heritage Foundation of the United States, and the

sample is divided into countries with high degree of freedom and countries with low degree of freedom using the mean value of economic freedom of the sample as the standard. The correlation regression results are shown in *Table 4*.

In *Table 4*, columns (1)-(2), (3)-(4) and (5)-(6) represent the regression results of economic growth grouping, economic development grouping and economic freedom grouping, respectively. The results show that there is impact heterogeneity: First, in the economic growth grouping, it can be found that the sample coefficient of *EPU* of high-growth countries is 0.125, which is significantly higher than that of low-growth countries (0.049), indicating that economic policy uncertainty has a significant positive impact on the export technological sophistication of high-growth countries. Secondly, in the grouping of economic development degree, the coefficient of the sample of *EPU* of developed countries is 0.202, which is different from the coefficient of -0.143 of developing countries, indicating that the economic policy uncertainty has a promoting effect on the improvement of the export technological sophistication of developed countries, while it has a potential restraining effect on developing countries. In the grouping of economic freedom, the coefficients of *EPU* are 0.073 and 0.246 respectively, indicating that for countries with different economic freedom, the economic policy uncertainty has a positive impact on the export technological sophistication, but the impact is greater in countries with higher economic freedom. The possible explanations for these results is that, nowadays, countries with huge momentum of economic development and enormous potential of market development mainly represented by countries such as China, India and Brazil, these countries also achieved rapid growth in exports, but as a result of these countries to engage in labor and resource intensive industries mainly, generally is not high technology content, in the production from abroad has a higher technological content of products and capital goods tend to have different degree of dependency. In addition, due to the lack of competitive advantage in quality, the export products of domestic manufacturing industries industry in such countries maintain their competitiveness by constantly squeezing profit space and relying on price advantage, and thus often suffer from capital chain rupture and other problems, so they are more sensitive to domestic financing constraints. Despite the fact that the economic policy uncertainty negatively correlates with the economic society, it will also impose a "reversed transmission mechanism" on domestic manufacturing industries enterprises, breaking the enterprise for imported products and domestic credit financing excessive dependence on the aspects of arouse



enterprise' intrinsic motivation of R&D innovation and increase the intensity of R&D and the "internalized" efficiency of production technology, so as to promote the rise of the export technology. However, it is worth noting that, on account of internal factors such as low economic freedom and immature financing platform, the developing countries, making economic policy uncertainty aggravate may partly "zoom in" some ubiquitous problems such as insufficient ability of R&D innovation in export enterprises at home, thus bring adverse effect to the promotion of export technological sophistication.

In addition, due to the difference in the distribution of data between groups, it is usually impossible to directly compare the coefficients between groups, so chi-square  $\chi^2$  test is used to investigate the coefficient differences between groups. The chi-square test results of the three samples are 304.91, 2.64 and 66.66, respectively. The test results of economic growth grouping and economic freedom grouping significantly reject the null hypothesis that "there is no systematic difference between groups", while the test results of development grouping show that the coefficient difference between groups is not significant at 10% level.

**Table 4 Heterogeneity regression results**

	(1) Low Growth	(2) High Growth	(3) Developing	(4) Developed	(5) Low Freedom	(6) High Freedom
<i>EPU</i>	0.049 (0.04)	0.125*** (0.04)	-0.143*** (0.03)	0.202*** (0.06)	0.073* (0.04)	0.246*** (0.04)
<i>EP</i>	0.152** (0.06)	-0.108*** (0.03)	-0.494*** (0.06)	-0.019 (0.03)	-0.063*** (0.03)	-0.089*** (0.02)
<i>TD</i>	0.168*** (0.02)	0.695*** (0.03)	0.471*** (0.04)	0.631*** (0.03)	0.712*** (0.03)	0.529*** (0.03)
<i>CPI</i>	0.692* (0.38)	0.359*** (0.09)	0.176** (0.07)	1.101*** (0.24)	0.448*** (0.12)	0.489* (0.26)
<i>UR</i>	-3.487*** (0.21)	-0.895*** (0.07)	-3.037*** (0.20)	-1.167*** (0.11)	-0.873*** (0.05)	-1.488*** (0.14)
<i>GDP</i>	1.602*** (0.04)	1.276*** (0.03)	2.884*** (0.19)	1.251*** (0.07)	1.195*** (0.03)	1.086*** (0.03)
<i>POP</i>	-0.442*** (0.05)	-0.341*** (0.02)	-1.609*** (0.13)	-0.411*** (0.08)	-0.318*** (0.03)	-0.271*** (0.03)
Constant	-19.667*** (1.40)	-14.689*** (0.48)	-25.243*** (2.25)	-15.927*** (0.99)	-13.390*** (1.07)	-9.171*** (1.34)
Year E.F.	Yes	Yes	No	Yes	Yes	Yes
Country E.F.	Yes	No	Yes	Yes	Yes	Yes
Difference intra-group	304.91***(0.00)		2.64(0.13)		66.66***(0.00)	
$R^2$	0.973	0.978	0.975	0.948	0.974	0.932
Observation	274	296	180	390	246	324

Note: Asterisk \*, \*\*, and \*\*\* represent significance levels of 10%, 5%, and 1%, respectively. Year and country fixed effect are controlled by the model. The standard error of clustering robustness at the country level is presented in parentheses.

#### 4.4 Robustness analysis

##### 4.4.1 Robustness for model specification

In this paper, the model specification robustness and endogeneity are tested in turn.

First of all, in the robustness of model specification, GLS model, Ordered Logit model, Tobit model and Poisson model are adopted successively in this paper. In the GLS model, the panel with heteroscedasticity and first-order sequence correlation is introduced to calculate with generalized least square method. In Ordered Logit model, it was divided into five quintiles according to the ascending order of export technological sophistication of manufacturing industries, and the corresponding quinary limited dependent variable was generated. In Tobit model, the interval value of export technological sophistication of manufacturing industries is 12-17, so minimum and maximum value are set as left centered value and right centered value, respectively.

Secondly, in terms of endogeneity, this paper holds that endogenous problems are mainly divided into two categories: first, reverse causality. In most scholars point of view, economic policy is macro policy that belongs to the national level, medium level activities such as manufacturing industries industry hardly ever has the obvious impact on economic policy. Therefore, there is no reverse causality between economic policy uncertainty and export technological sophistication of manufacturing industries (Tan & Zhang, 2017; Jia & Zhang, 2018). Second, omit variables. In this paper, the fixed effects at the country and year level are strictly controlled in the econometric model, and the endogeneity problem caused by missing variables is effectively avoided. In addition, this paper takes the first-stage lag of the core variable and the national risk index provided by the International Country Risk Guide (ICRG) as instrumental variables, and applies the panel 2SLS least square method to model regression to further alleviate the endogenous impact.

From the results of columns (1) to (4) in *Table 5*, it is not difficult to find that the coefficient of *EPU* is basically significantly positive, indicating that economic policy uncertainty effectively promotes the export technological sophistication of manufacturing industries, which is consistent with the benchmark regression results. Taking *FGLS* model in Column (1) as an example, the coefficient of *EPU* is 0.083, indicating that an increase of 1% in economic policy uncertainty will lead to an increase of 0.083% in export technological sophistication. After taking heteroscedasticity and serial correlation into account, the regression coefficient value is lower than 0.119 of the baseline regression result. Column (5) reflects the regression results of 2SLS least square method, with a coefficient of *EPU* is 0.307, indicating that an 1% increase in economic policy will lead to an increase in export technological sophistication of 0.307%, which is consistent with the benchmark regression. it indicates that the

regression results are still stable after the endogeneity problem is alleviated.

**Table 5 Model specification robustness regression results**

	(1) <i>FGLS</i>	(2) <i>O-Logit</i>	(3) <i>Tobit</i>	(4) <i>Poisson</i>	(5) <i>IV</i>
<i>EPU</i>	0.083*** (0.03)	1.258*** (0.36)	0.074** (0.03)	0.008*** (0.00)	0.307*** (0.10)
<i>EP</i>	-0.051* (0.03)	-0.261 (0.33)	-0.058* (0.03)	-0.004*** (0.00)	-0.038 (0.03)
<i>TD</i>	0.653*** (0.03)	6.784*** (0.58)	0.660*** (0.03)	0.047*** (0.00)	0.646*** (0.03)
<i>CPI</i>	0.468*** (0.11)	6.248*** (1.39)	0.446*** (0.10)	0.033*** (0.01)	0.418*** (0.11)
<i>UR</i>	-1.103*** (0.07)	-9.604*** (1.10)	-1.062*** (0.08)	-0.069*** (0.00)	-1.062*** (0.09)
<i>GDP</i>	1.248*** (0.03)	11.354*** (0.85)	1.244*** (0.03)	0.084*** (0.00)	1.213*** (0.04)
<i>POP</i>	-0.389*** (0.03)	-3.371*** (0.39)	-0.384*** (0.03)	-0.025*** (0.00)	-0.375*** (0.03)
Constant	-12.875*** (0.58)		-12.851*** (0.61)		-13.152*** (0.72)
Wald Test					10.06***
Instrumental P					0.00
Year F.E.	Yes	Yes	Yes	Yes	Yes
Country F.E.	Yes	Yes	Yes	Yes	Yes
Observation	285	285	285	285	270

Note: Asterisk \*, \*\*, and \*\*\* represent significance levels of 10%, 5%, and 1%, respectively. Year and country fixed effect are controlled by the model. The standard error of clustering robustness at the country level is presented in parentheses.

#### 4.4.2 Robustness for substituted index

In addition to the robustness of model specification, the robustness of index construction is also an issue worthy of attention. The export technological sophistication adjusted by product quality is the main index in this paper. However, there are many construction indexes used to measure the level of export technology. The following three representative indicators are selected for the robustness analysis in turn. The first is the export technological sophistication with non-quality-weighted, that is, the non-quality-weighted index which is not included in the two-step calculation of Hausmann, et al. (2007). The second index, calculated based on Michaely (1984) method, differs from the first method in that its first-stage weight is the proportion of the country's exports rather than the comparative advantage index. The third is the economic sophistication of the computation based on reflection. Hausmann & Hidalgo (2010) firstly create a reflection method based on capacity theory, that is, to measure the economic sophistication at the national level by "diversity" and to measure the economic sophistication at the product level by "ubiquity". Reflection method is an iterative method in nature. The symmetric set representing national diversity and product universality is obtained through multiple iterations respectively under the condition of equilibrium, and then the corresponding economic sophistication index at the national level (*ECI*) and the economic sophistication index at the product level

(*PCI*) are calculated through standardized processing. To be specific, the country and product economic sophistication index are calculated as follows:

$$\pi_{c,n} = (1 / \pi_{c,0}) \sum_{p=1}^P D_{cp} \pi_{c,n-1} \quad (6)$$

$$\pi_{p,n} = (1 / \pi_{p,0}) \sum_{c=1}^C D_{cp} \pi_{p,n-1} \quad (7)$$

Where  $c$  denotes country,  $p$  denotes export product,  $\pi_{c,0} = \sum_{p=1}^C D_{cp}$  and  $\pi_{p,0} = \sum_{c=1}^C D_{cp}$  denote the diversity of national product production and universality of product being produced, respectively.  $D_{cp}$  is the dummy variable connecting countries and export goods. When a country has a comparative advantage in the production of a product,  $RCA_{cp} \geq 1$ ,  $D_{cp}$  is set to 1; otherwise, it is set to 0. After  $n$ th iterations of equations (6) and (7), the equilibrium condition of  $\pi_{c,n} = \pi_{c,n+2}$  and  $\pi_{p,n} = \pi_{p,n+2}$  are satisfied. At this point, a symmetric set can be obtained. When  $n$  is equal to an even number,  $\pi_{c,n}$  and  $\pi_{p,n}$  are regarded as the national diversity and product universality, respectively. Finally, the two economic sophistication indicators are standardized in order to obtain  $ECI = (\pi_c - \overline{\pi_c}) / stdev(\pi_c)$  and  $ECI = (\pi_p - \overline{\pi_p}) / stdev(\pi_p)$ . In terms of economic interpretation, the higher the economic sophistication  $ECI$  is, the higher the economic sophistication of the country is, while the higher the economic sophistication  $PCI$  is, the lower the economic sophistication of the product is<sup>①</sup>. The above indicators are calculated based on the 4-digit export data of HS96 standard, and the relevant results are shown in *Table 6*.

**Table 6 Index robustness regression results**

	(1) Non-Weighted <i>TSI</i>	(2) Michaely <i>TSI</i>	(3) <i>ECI</i>	(4) <i>PCI</i>
<i>EPU</i>	0.064*** (0.02)	0.013*** (0.00)	0.012** (0.01)	-0.005*** (0.00)
<i>EP</i>	0.058*** (0.02)	-0.062*** (0.02)	-0.066* (0.04)	0.005** (0.01)
<i>TD</i>	0.143*** (0.02)	0.002** (0.01)	0.012** (0.02)	-0.004 (0.01)
<i>CPI</i>	0.210*** (0.05)	0.020* (0.01)	0.064*** (0.02)	-0.002** (0.01)
<i>UR</i>	0.117** (0.06)	0.124*** (0.05)	0.220* (0.13)	-0.011*** (0.04)
<i>GDP</i>	0.195*** (0.02)	0.113*** (0.02)	0.019*** (0.05)	-0.001*** (0.01)
<i>POP</i>	-0.077*** (0.02)	-0.108*** (0.02)	-0.006 (0.05)	0.001 (0.01)
Constant	17.051*** (0.36)	10.140*** (0.22)	1.076*** (0.74)	0.459** (0.20)
Year F.E.	Yes	Yes	Yes	Yes
Country F.E.	Yes	Yes	Yes	Yes
$R^2$	0.333	0.125	0.106	0.101
Observation	570	570	570	33,159

Note: Asterisk \*, \*\*, and \*\*\* represent significance levels of 10%, 5%, and 1%, respectively. Year and country fixed effect are controlled by the model. The standard error of clustering robustness at

<sup>①</sup> The reflection method has been improved and supplemented for many times since it was proposed. The calculation in this paper is based on the research of Hausmann, et al. (2013), which is introduced in detail.

the country level is presented in parentheses.

## **5. Results and discussion**

Based on the data of 19 major countries from 2000-2017, this paper examines the impact of economic policy uncertainty on the export technological sophistication of manufacturing industries, and divides the expectation mechanism of economic policy uncertainty into product demand expectation and investment supply expectation to further explore the pass-through mechanism behind the impact.

The main conclusions of this paper are as follows: (1) from the perspective of the change of export technological sophistication of manufacturing industries, the export technological sophistication of manufacturing industries from developing countries such as China, India, Korea and Russia experienced a slow increase in the sample period; The technological sophistication of manufacturing industries exports in developed countries such as Germany, the UK, Japan and the US has not changed much, but remains high. Countries such as Canada, Greece, Italy and the Netherlands have shown a downward trend in technological sophistication in manufacturing industries exports. (2) from the empirical results, the economic policy uncertainty has a significant positive relationship with the export technological sophistication of manufacturing industries on the whole, and the promoting effect is more obvious for countries with fast economic growth, high degree of development and high degree of economic freedom. (3) from the point of view of impact mechanism, economic policy uncertainty mainly restrains the "import dependence" effect of imported intermediates in product demand expectation mechanism and the "financing constraint" effect of domestic credits in investment supply expectation, objectively stimulated internal R&D motive of export enterprises at home, force enterprises to promote their export technological sophistication.

The research conclusion in this paper has important policy implications: mainly relying on comparative advantage in cost, developing countries acquire international market share and maintain their export competitiveness by engaging in the production of assembly and other labor-intensive and resource-intensive products. The trade pattern not only makes export enterprises at home rely more on imported intermediates and capital goods, but also weaken their R&D innovation enthusiasm, harmful to export competitiveness. In addition, export enterprises that have been engaged in simple processing of low value-added products for a long time often have "capital turnover" problems due to the constant squeeze of profit space, and thus fall into the dilemma of domestic credit "financing constraints", and have no time to pay attention to their own

R&D innovation. The important conclusion that the economic policy uncertainty "forces" enterprises to realize "brehtaking leap" in R&D innovation and technical transformation also reveals the widespread problems of "big but not strong" in export and low degree of economic liberalization pervasively existed in China, India and other developing countries. On the one hand, the stability and continuity of domestic economic policies are the premise to ensure the steady economic growth of all countries. Therefore, countries around the world should further strengthen bilateral and multilateral consultations and information sharing to avoid major fluctuations in economic growth. On the other hand, R&D innovation has always been regarded as the core driving force of economic growth, especially in the era of deepening economic globalization and increasing uncertainty of economic policies in various countries, only by stimulating enterprises' enthusiasm for R&D and improving production technology can enterprises effectively maintain and enhance the export competitiveness of manufactured products.

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