

# Bond market liberalization, technological innovation and firms' position in the global value chain division of labor

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**Abstract.** Based on the annual data of Chinese listed enterprises from 2004 to 2016, this paper investigates the impact of the opening up of the bond market on the division of labor position of enterprises' global value chains. It is found that the opening up of bond market mainly enhances the division of labor position of enterprises' global value chain by influencing the level of enterprises' technological innovation. The results of mechanism test show that the opening of bond market to the outside world can help enterprises to increase R&D investment, improve technological innovation level and realize the upgrading of the division of labor position in global value chain by alleviating the financing constraints of enterprises and intensifying the competition among enterprises. Heterogeneity analysis shows that the opening up of bond market has a better effect on the GVC status of enterprises in the central and western regions than that of enterprises in the eastern regions.

**Keywords:** Bond market liberalization; level of technological innovation; firms' position in the global value chain division of labor

## 1. Introductory

With the increasing trend of globalization of production, enterprises participate in different segments of the global value chain according to their comparative advantages in terms of resource endowment, and different segments and positions imply different profit-acquiring capacities of enterprises, with enterprises at the higher end of the value chain having a higher value-added of exports. For a long time, Chinese enterprises have relied on their advantages of low labor costs and abundant resources to participate in the division of labor in global value chains. However, due to the disappearance of the "demographic dividend", the shortage of working capital, and the constraints of export technology, most enterprises are still in the downstream of the low value-added chain [1, 2]. For this reason, the 19th National People's Congress of the People's Republic of China proposed to "promote China's enterprises to move towards the middle and high end of the global value chain". Scholars have pointed out that the position of enterprises in the division of labor in global value chains is affected by factors such as financing constraints, the level of technological innovation and the structure of factor inputs [3, 4]. The Global Value Chain Development Report 2021: Beyond Production mentions that developed economies are creating more and more value in global value chains through innovation. This shows that the level of technological innovation of enterprises is an important factor that directly affects their position in the division of labor in global value chains.

Generally speaking, the funds needed for enterprise innovation mainly come from endogenous financing, exogenous financing and government subsidies, however, due to the influence of political factors, risk appetite, information asymmetry and other factors, government subsidies may have a "reverse" incentive effect on enterprise innovation [4]. Therefore, under the circumstance of little change in enterprises' endogenous financing, whether or not to further open up to the outside world and attract exogenous financing is the key to enhancing the level of technological innovation of enterprises.

The opening up of the bond market is an important part of China's opening up to the outside world and plays an important role in attracting cross-border capital and stabilizing the real economy. Theoretically, the opening of the bond market can attract cross-border bond capital inflows into the domestic market, which not only has an impact on the domestic exchange rate, credit and asset prices [6, 7], but also affects corporate investment and financing, innovation decisions, and then

affects the production and management behavior of enterprises. He et al. pointed out that a moderate open-door policy can improve the level of international cooperation, promote economic integration, and effectively improve the position of enterprises in the global value chain division of labor [8]. However, no literature has yet explained how bond market opening up affects enterprises' global value chain division of labor position. Based on the credit financing channel and exchange rate channel, this paper explains the mechanism by which bond market liberalization affects the division of labor position of enterprises in GVCs.

The marginal contributions of this paper are mainly the following two points: (1) Exploring the channels of improving the global value chain division of labor status of Chinese listed companies based on the perspective of bond market opening up to the outside world, and expanding the research on the factors influencing the global value chain division of labor status of enterprises. (2) Analyzing the differentiated impact of bond market opening on enterprises in different regions and of different sizes.

## **2. Literature review**

### **2.1 Study on factors influencing the position of enterprises in the division of labor in global value chains**

At the macro level, the quality of the system is an important factor for enterprises to get rid of the low end of the value chain and lock themselves into the high-end position [9]. Specifically, a good contract enforcement system can not only reduce the high transaction costs of the division of labor refinement, reduce the enterprise transaction costs and financial expense ratio, but also contribute to financial stability and development, optimize the efficiency of market resource allocation, and help enterprises to build the comparative advantage of export products [10, 11]. At the same time, financial stability and development can alleviate the financing constraints of enterprises by creating financial instruments and expanding financial resources, prompting enterprises to increase R&D investment in technological innovation, and promoting the rise of enterprises' position in the division of labor in the global value chain [12, 13]. The intellectual property protection system can provide incentives and institutional safeguards for innovation, which is conducive to the improvement of the level of technological innovation of enterprises, so that enterprises can get rid of the low-end lock of the value chain [14]. In addition, under the guidance of the national "going out" strategy, OFDI plays an important role in the upgrading of enterprises' position in the global value chain division of labor. On the one hand, the influx of FDI can cause industrial agglomeration, form scale effects, improve enterprise production efficiency, and promote the upgrading of enterprises' position in the division of labor in the global value chain, but there is a "ceiling" for this kind of promotion [15]. On the other hand, FDI strengthens the technological advantages of enterprises through the learning effect and technology spillover effect, and improves the quality and complexity of enterprises' export products [16].

At the micro level, the level of technological innovation is one of the most direct factors affecting firms' position in the division of labor in GVCs. Most of the early literature analyzed the impact of financing constraints on enterprises' GVC division of labor position, arguing that the existence of financing constraints restricts the R&D activities of enterprises, which is not conducive to the enhancement of their level of technological innovation, and locks them in the low-end position of the global value chain [17]. Existing literature expands the research on the micro-influencing factors of enterprises' GVC division of labor position, and argues that labor cost and enterprise factor intensity can also affect enterprises' GVC division of labor position, and that the rise of labor cost will increase enterprises' operating expenses and reduce enterprises' current markup rate, but in the long run it can promote technological innovation to improve enterprises' profitability [18]; innovation is an important channel for exports to affect the rate of corporate markup, which in turn is affected by the factor intensity of enterprises. In summary, it can be seen that the level of technological innovation is one of the most direct factors affecting the position of

enterprises in the division of labor in the global value chain, because the level of technological innovation is related to the technological complexity of enterprises' exports and the value of their exports, and enterprises with high technological complexity and value of their exports are able to participate in the high value-added stage [19, 20].

## **2.2 Impact study of bond market liberalization**

Studies on bond market opening have mostly focused on analyzing the macro and micro economic effects of opening bond markets. At the macro level, early literature argues that the opening of the bond market to the outside world is conducive to the formation of an open, developed, and liquid financial market [21], and has an important role to play in promoting the internationalization of currencies [22]. Existing studies have concluded that the opening of the bond market to the outside world is an important factor affecting a country's economic growth, but the results about the impact of bond market opening on the economy are still controversial. Most studies have found that bond capital inflows can not only introduce diversified market participants, enhance market dynamics and competitiveness, and lead to credit expansion and economic growth, but also improve a country's liquidity environment, lower interest rates and expand investment [23]. However, some studies have also argued that the promotion effect of international debt capital on economic growth decreases with the increase in the degree of openness of an economy, i.e., an excessively high level of international debt is rather detrimental to economic growth [24, 25], and some studies have even found that the uncertainty of international debt capital flows negatively affects total investment and GDP [26]. In addition, there are also studies showing that opening the bond market at the right time is beneficial to stabilizing the macroeconomy: for example, opening the bond market can respond to exchange rate shocks by stabilizing foreign exchange reserves when RMB depreciation is expected to ease [27].

At the micro level, it has been argued that bond market liberalization affects firms' production and business activities mainly through the financing constraint channel. However, there are two different views on whether bond market liberalization can alleviate corporate financing constraints. One point of view is that bond market opening can effectively alleviate the financing constraints of enterprises, because bond market opening can not only broaden the financing channels for enterprises and reduce the cost of enterprise financing, but also effectively stimulate enterprise innovation and investment, and the more developed the bond market is, the lower the cost of enterprise financing is [28]. Another view is that the resource allocation function of the bond market is friendlier to firms subject to lower financing constraints, while the opening of the bond market exacerbates the corporate financing constraint gap and does not alleviate financing constraints [29]. When the bond market is opened on a large scale, the influx of cross-border debt capital raises the leverage ratio of non-financial firms through the asset price and credit channels, and the uncertainty of firms' production and operation increases [30].

Throughout the existing literature, no study has been based on a global perspective to analyze the impact and transmission mechanism of bond market liberalization on the division of labor position of enterprises in GVCs. After combing the relevant literature, this paper argues that bond market liberalization can effectively promote the upgrading of enterprises' position in the division of labor in GVCs, and the promotion effect varies according to the region and scale of enterprises.

## **3. Theoretical analysis and research hypotheses**

Bond market liberalization mainly affects the level of technological innovation of enterprises through the credit financing channel and the exchange rate channel, which in turn affects the position of enterprises in the division of labor in the global value chain.

Credit financing channels. After the opening of a country's bond market, it is easier for foreign investors to enter the domestic market to carry out investment activities, domestic enterprises have more opportunities for exogenous financing, the cost of financing declined, and enterprise financing

constraints have been eased: firstly, cross-border debt capital inflows have led to the rapid expansion of credit, and enterprises are faced with more financing opportunities and lower financing costs; secondly, the cross-border capital inflows have led to the increase in the ratio of domestic foreign exchange, and the liquidity of money market. Second, cross-border capital inflows lead to an increase in the domestic foreign exchange ratio, the liquidity of the money market, interest rates are under downward pressure, and the decline in interest rates will lead to a decline in the difficulty of corporate borrowing; third, cross-border capital flows lead to an increase in the liquidity of domestic assets, the rise in asset prices [31], asset price increases imply that the enterprise collateral appreciates, the ability to lend rises, and the relative decline in the financing constraints of enterprises. Improved financing conditions alleviate enterprise financing constraints and possible maturity mismatches in the financial market, and it is easier for enterprises to obtain low-cost financing. On one hand, enterprises are able to hire high-tech talents after obtaining funds, which not only improves their innovation ability, but also facilitates them to make reasonable innovation decisions [32]; on the other hand, obtaining low-cost financing makes up for the shortcomings of insufficient innovation inputs of the enterprises [33, 34]. In summary, the opening of the bond market to the outside world improves the level of technological innovation and expands the innovation achievements of enterprises by alleviating the financing constraints of enterprises, and realizes the rise of the position of domestic enterprises in the division of labor in the global value chain [35, 36].

**Competitive channels.** After the opening of a country's bond market, the qualified foreign investment community enters the home market, and the influx of large amounts of capital accelerates the appreciation of the local currency [37, 38]. On one hand, the appreciation of the local currency means that the relative price of imports falls and the relative price of exports rises, which intensifies the competition among domestic firms and eliminates the inferior firms, while the remaining advantageous firms can use it to integrate resources and optimize the utilization rate of resources, thus increasing the total factor productivity [39]; On the other hand, the appreciation of the local currency compresses the enterprise's interest space, especially in the case of the loss of price advantage, the export enterprises can't make up for the loss of the enterprise's export volume through price reductions, in order to obtain a competitive advantage, the enterprise can only force itself to increase R&D investment to carry out technological innovation, enhance the level of enterprise technological innovation so as to improve the quality of the export products and the complexity of exports, optimize the product structure, and ultimately achieve the enterprise's global value chain Upgrading the status of division of labor [40, 41, 42].

To sum up, the opening of bond market improves the enterprise financing environment, eases the enterprise financing constraints, prompts enterprises to increase R&D investment and improve the level of technological innovation, which is conducive to enterprises to improve the total factor productivity, optimize the product structure, and improve the complexity and quality of export products, and ultimately promotes the enterprises to climb up the status of the global value chain division of labor. Thus, this paper puts forward the following hypothesis:

**Hypothesis 1:** Bond market liberalization increases the level of technological innovation of firms and thus facilitates the upgrading of firms' position in the global value chain.

Due to the different geographic locations of different enterprises, there are differences in the level of economic development, the investment and financing environment and the level of labor force in the regions where the enterprises are located, so the ability of enterprises in different regions to attract and use foreign capital is different, which results in different sensitivities to the opening up of the bond market for the position of enterprises in the global value chain of division of labor in different regions. First, information costs. Based on the early national opening-up policy, the eastern coastal region opened up first and became the earliest region to introduce foreign investment, and over the years, three major economic circles have been formed, namely the "Pearl River Delta", the "Yangtze River Delta" and the "Bohai Rim". Over the years, the economic circles have formed three major economic circles, with a high level of economic development, improved

infrastructure construction, rich experience in attracting foreign investment, and relatively transparent information on foreign investment policies, infrastructure and other information, with low information costs, which makes them more favored by foreign investment; The opening up of the central and western regions is relatively late, and there is a big gap between the level of economic development and that of the eastern regions, with relatively backward infrastructure construction, no complete and mature industrial chain, low information transparency, and a weaker ability to attract foreign investment. Therefore, after the opening of the bond market, it is easier for enterprises in the eastern region to obtain foreign capital. Second, geographic location. The eastern region, especially the eastern coastal region, has convenient transportation and low transportation costs, and enterprises are more inclined to develop export trade [43]; the central and western regions do not have the advantage of the coast, and although they have rich natural resources, a large proportion of the uninhabitable terrain and uncultivable land, the distance from the consumer market of the products, and the high cost of transportation are not conducive to the development of export trade. Third, the labor force. After the opening of the bond market, enterprises in the eastern region can obtain more funds to hire laborers, and the pursuit of wages working environment, education, medical care, etc. will prompt the flow of laborers from the underdeveloped central and western regions to the developed eastern region, promoting the industrial agglomeration of the eastern region, while the industrial agglomeration of the eastern region strengthens its pull on the laborers in the central and western regions, making the labor force in the eastern region more and more abundant and the On the contrary, the labor force in the central and western regions becomes more and more scarce [44].

Hypothesis 2: The effect of bond market liberalization on the upgrading of firms' position in the global value chain division of labor is better for firms in the eastern region than for firms in the central and western regions.

## 4. Description of variables and data selection

### 4.1 Description of variables

#### 4.1.1 Firms' position in the division of labor in global value chains

There have been two main types of measures of GVC position: those based on input-output tables (I-O tables) and value-added trade measures based on the China Industry Business Performance Data (CIED) and the China Customs Trade Database (CCD), listed companies and the China Customs Trade Database (CCD). First, the I-O table measurement method. Hummels et al. [45] proposed the HIY method and used it to systematically measure the vertical specialization indicator, i.e., the value share of imported intermediate inputs in exports:

$$VS = \frac{IM}{Y} \times EX \quad (1)$$

(1) where IM is the imported product intermediate input, Y is total output and EX is exports.

The HIY method assumes that the proportion of imported product inputs in domestic sales production and export production is the same, but in reality, imported product inputs are not strictly produced in accordance with the principle of equal proportionality, and the measurement results will be in error, especially when the trade of imported materials processing accounts for a large proportion. In this regard, Koopman et al. [46] further refined the non-competitive I-O table and differentiated between general trade and processing trade, and established the I-O coefficient matrix to estimate the firms' global value chain division of labor position. However, the method of calculating the GVC division of labor position of enterprises through the I-O coefficient matrix is mainly based on the I-O table, so it can only calculate the GVC division of labor position at the industry level, and can't bring the analysis down to the enterprise level; moreover, the method of calculating based on the I-O table hasn't differentiated between imported products, so it ignores the

problem of secondary imports, and it will still misestimate the GVC division of labor position. Second, the value-added measurement method based on China's industrial enterprise database and China's customs trade database or listed companies and China's customs trade database. This method calculates the increase in a country's value that is included in another country's final consumption, reflecting how much value added a country derives from its export trade. Daudin et al. [47] decompose the value added of the final product and measure the proportion of imported inputs in exports, the proportion of exports that are reprocessed and exported to third countries, and the proportion that are processed and re-exported back to the home country. The value-added measurement method accurately reflects the extent to which a country's exports are dependent on imported intermediate goods, and thus accurately calculates the value added in a country's exports. This paper adopts the second method, using the Domestic value-added rate for exports as a measure of an enterprise's position in the global value chain division of labor.

DVAR covers not only domestic intermediate goods inputs, but also the value added of imported intermediate inputs produced domestically. Firms with a higher position in the GVC division of labor export more intermediate goods, and vice versa have a higher proportion of intermediate inputs from abroad in their exports [48]. Upward et al. [49] distinguish between processing trade and general trade, and use the KWW method to improve the measure of vertical specialization:

$$VS = IM^p + \frac{IM^o}{Y - EX^p} \times EX^o \quad (2)$$

(2) Where p represents processing trade and o represents general trade; represents imported intermediate inputs under the processing trade mode; is total output minus processing trade exports, i.e., domestic sales plus general trade exports, and  $(IM^o / (Y - EX^p))$  represents the proportion of imports under the general trade mode used in imported intermediate inputs in general trade exports.

The export domestic value-added rate can thus be expressed as:

$$DVAR = \frac{DVA}{EX} = \frac{EX - VS}{EX} = 1 - \frac{VS}{EX} \quad (3)$$

Further analyze the DVAR under both processing trade and general trade:

Enterprises engaged in processing trade exports of general trade is zero, its imported intermediate inputs are all used as raw materials for export products, that is, the enterprise's exports of processing trade is equal to the total production of the enterprise, at this time, the enterprise's exports of domestic value-added rate is:

$$DVAR = 1 - \frac{IM^p}{Y} \quad (4)$$

Enterprises engaged in general trade have zero processing trade imports and exports, but the final flow of their imports will have an impact on the DVAR measurement because imports can be used as both intermediate and final consumer goods. In order to distinguish the final flow of imported products, the HS product codes in the customs data are usually converted to BEC product codes in order to identify the corresponding product types in imports. At this point, the firm's export domestic value-added rate is:

$$DVAR = 1 - \frac{IM^o|_{BEC}}{Y} \quad (5)$$

In addition to processing trade and general trade enterprises, there are many mixed trade enterprises. In calculating the export domestic value-added rate of mixed-trade enterprises, it can be calculated by verifying the proportion of exports from processing trade and general trade in the total exports of the enterprise, and calculating the DVAR of the two types of trade separately and then weighted by the proportion. In this case, the domestic value-added rate of exports of mixed-trade enterprises is:

$$DVAR = \alpha_1 DVAR^p + \alpha_2 DVAR^o = \alpha_1 \left( 1 - \frac{IM^p}{EX^p} \right) + \alpha_2 \left( 1 - \frac{IM^o|_{BEC}}{Y - EX^p} \right) \quad (6)$$

Equations (6)  $\alpha_1$  and  $\alpha_2$  are the shares of processing trade and general trade in total exports, respectively. Meanwhile, it can be seen that when  $\alpha_1$  is zero and not zero, equation (6) represents processing trade enterprises, while when  $\alpha_2$  is zero and not zero, equation (6) represents general trade enterprises, and when both  $\alpha_1$  and  $\alpha_2$  are not zero, the enterprise is a mixed trade enterprise.

For the existence of trade agents, this paper identifies intermediate trade agents according to the methods of Ahn et al. [50] and Zhang et al. [51], and categorizes those with the words "import and export", "economic and trade", "trade" and "science and trade" in the name of the enterprise as intermediate trade agents, and perform the following calculations:

$$IM_{fik}^{total} = IM_{fik}^{custom} + IM_{fik}^{inter} \rightarrow 1 = \frac{IM_{fik}^{custom}}{IM_{fik}^{total}} + \frac{IM_{fik}^{inter}}{IM_{fik}^{total}} \quad (7)$$

(7) Where f, t and k represent the enterprise, year and trade mode respectively.  $IM_{fik}^{total}$  represents the amount of imported intermediates actually used by the enterprise to be estimated,  $IM_{fik}^{custom}$  represents the amount of imported intermediates entered by Customs during the trade process, and  $IM_{fik}^{inter}$  represents the amount of indirectly imported intermediates that may be purchased by the enterprise from intermediary trade agents, i.e., the amount of imported intermediates actually used by the enterprise is the sum of the amount of intermediates recorded by Customs as being imported by the enterprise and the amount of intermediates indirectly imported by the enterprise that may be purchased by the enterprise from intermediary trade agents. Since  $IM_{fik}^{custom}$  can be obtained directly, only the share of the product ( $IM_{fik}^{inter} / IM_{fik}^{total}$ ) that the firm imports from the intermediary trade agent needs to be estimated. ( $IM_{fik}^{inter} / IM_{fik}^{total}$ ) can be replaced by  $\sum_{k=1}^n \beta_{kt} INTEkATE_{kt}$  obtained by statistics in the customs trade database, which can be interpreted as the proportion of the total export value of the enterprise's imports from intermediary trade agents weighted by the import value of the enterprise in different trade modes in different periods. This leads to:

$$IM_{fik}^{total} = \frac{IM_{fik}^{custom}}{1 - \sum_{k=1}^n \beta_{kt} INTERATE_{kt}} \quad (8)$$

In summary, the formula (1) ~ (8) for calculating DVAR in this paper is as follows:

$$DVAR_{fik} = \alpha_1 \left( 1 - \frac{IM_{f11}^{total}}{EX_{f11}} \right) + \alpha_2 \left( 1 - \frac{IM_{f12}^{total}|_{BEC}}{EX_{f12}} \right) \quad (9)$$

The data are from CSMAR and CCD.

#### 4.1.2 Bond market liberalization

Existing studies have not yet systematically formed indicators for measuring the degree of bond market liberalization, so this paper refers to the methods for measuring the degree of stock market liberalization. Methods for measuring the degree of stock market liberalization mainly include measurements based on policies and regulations and facts. Measurement indicators related to policies and regulations are mostly based on official documents of the state, which cannot accurately reflect the continuity and actual situation of stock market liberalization; In contrast, most of the relevant factual measures use the ratio of net position under bond investment to GDP in the International Investment Position Statement to measure the overall openness level of the bond market [52]. This paper draws on the above methods to measure the openness level of the bond market by the ratio of total liabilities under bond investment to GDP in the International Investment Position Statement. Source: State Administration of Foreign Exchange.

#### 4.1.3 Mechanism test variables, grouping variables and control variables

This paper refers to the method of Cui et al. [53], which measures the technological innovation level of enterprises by R&D intensity, where R&D intensity is the amount of R&D investment as a proportion of operating revenue; and the technological output of an enterprise as an indicator to test the technological innovation level of an enterprise, where the technological output of an enterprise is the sum of the number of patents of invention, utility model patents and design patents filed by the enterprise.

In this paper, the sample of enterprises is divided into enterprises in the eastern region and enterprises in the central and western regions according to the different regions where the enterprises are located, in which the eastern region includes Beijing, Tianjin, Hebei, Liaoning, Shanghai, Jiangsu, Zhejiang, Fujian, Shandong, Guangdong, and Hainan; and the central and western region includes Shanxi, Jilin, Heilongjiang, Henan, Hubei, Hunan, Anhui, and Jiangxi provinces. Shanxi, Jilin, Heilongjiang, Henan, Hubei, Hunan, Anhui, Jiangxi.

In addition, the age of the firm, capital factor intensity, financial expense ratio, operating expenses and Tobin's Q are used as control variables in this paper. Data sources: CSMAR, CCD and the National Bureau of Statistics.

Table 1. Description and definition of main variables

Variable name	Variable Definition
Firms' position in the global value chain division of labor	$DVAR_{fik} = \alpha_1 \left( 1 - \frac{IM_{fi1}^{total}}{EX_{fi1}} \right) + \alpha_2 \left( 1 - \frac{IM_{fi2}^{total}}{EX_{fi2}} \middle _{BEC} \right)$
Bond market openness	External bond liabilities/GDP for the year
Level of technological innovation	Amount of R&D investment/enterprise revenue
Technical outputs	Invention Patent + Utility Model Patent + Design Patent
Business Location	Firms in eastern region = 0, firms in central and western region = 1
Age of business	Ln (year of study - year of establishment of the enterprise + 1)
Enterprise factor intensity	Fixed assets of the enterprise/number of persons employed in the enterprise
Financial cost ratio	CSMAR
operating expense	Ln (selling expenses + administrative expenses + financial expenses)
Tobin's Q	CSMAR

## 4.2 Data selection

Firstly, data processing is carried out on the data of the listed companies of Cathay Pacific: (1) retaining the enterprises with business status during the sample period; (2) eliminating the samples with missing or less than 8 employees; (3) eliminating the enterprises with missing key indexes; (4) eliminating the samples with obviously unreasonable observations in the variables such as the obvious anomalies in the total assets, fixed assets, and current assets; (5) eliminating the "PT" or "ST" enterprises; (6) eliminating financial enterprises. Secondly, the data processing of the customs trade database: (1) eliminating the obviously unreasonable observations in the variables, such as the samples with obvious abnormalities in the amount of imports and exports; (2) eliminating the samples with missing enterprise names, postal codes and enterprise telephone numbers. Finally, the last 7 digits of enterprise name, zip code, and enterprise phone number are used to match the listed company database and the customs trade database to obtain the microenterprise data used in this paper.



Through the treatment of missing values, unreasonable observations and making a 1% level of shrinking tail for all variables, a total of 11,135 observations from 2004 to 2016 were finally selected, and the specific descriptive statistics are shown in Table 2. As shown in the table, the maximum value of the enterprise global value chain division of labor status is 1, and the minimum value is -2.9783, which can be seen through the calculation formula, the value of the enterprise global value chain division of labor status ranges between 0 and 1, excluding individual extreme values, the measurement of the enterprise global value chain division of labor status are relatively reasonable. The average value of bond market openness is 1.0009, the maximum value is 2.0673, and the minimum value is 0.2624, with relatively large changes. The standard deviation of the remaining variables is small, and in summary, the descriptive statistics results show that the sample has a good degree of differentiation.

Table 2. Descriptive statistics of main variables

Regression variable	Variable name	sample size	average value	(statistics) standard deviation	minimum value	maximum values
DVAR	Firms' position in the global value chain division of labor	11135	0.7477	0.5702	-2.9783	1
BON	Bond market openness	11135	0.0100088	0.0063834	0.0026365	0.206733
INNOVATION	innovation capacity	11134	0.0261	0.0310	0	0.1624
AGE	Age of business	11135	2.5550	0.4141	1.3863	3.3322
FACTOR	Enterprise factor intensity	11135	12.4464	0.9005	10.7757	14.8279
FINA	Financial cost ratio	11135	0.0133	0.0265	0.0592	0.1256
OPER	operating expense	11135	18.9818	1.3044	15.9910	22.6961
TOBIN	Tobin's Q	11135	1.9837	1.0808	0.6992	6.8944

## 5. Empirical model and analysis of results

### 5.1 Modeling

#### 5.1.1 Baseline regression model

There are some non-exporting enterprises in the sample of this paper, accounting for about 12.78% (1423/11135) of the total sample, and it is impossible to estimate the sample accurately by directly using the ordinary least squares method because the probability distribution of the explanatory variables will be characterized by a joint distribution after the broken tails, and the value of the DVAR should theoretically be in the interval of (0,1), so this paper refers to the existed research to consider the impact of bond market opening on enterprises' global value chain division of labor position using the two-limit Tobit model [54]. The econometric model of this paper is as follows:

$$DVAR_{i,t} = \alpha_0 + \alpha_1 BON_{i,t} + \alpha_2 X_{i,t} + \delta_{i,t} + \varepsilon_{i,t} \quad (10)$$

In equation (10), subscripts  $i$  and  $t$  represent firms and years, respectively,  $DVAR_{i,t}$  denotes the domestic value-added rate of firms' exports, represents firms' position in the global value chain division of labor,  $BON_{i,t}$  denotes the degree of openness of the bond market,  $X_{i,t}$  denotes the control variables required for this experiment,  $\delta_{i,t}$  denotes year fixed effects, and  $\varepsilon_{i,t}$  denotes a random perturbation term.

### 5.1.2 Mechanism testing

Based on the elaboration of the mediation effect model by Jiang [55], in order to test the role mechanism of bond market opening in affecting the status of enterprise global value chain division of labor through affecting the level of technological innovation of enterprises, the mechanism test part of this paper directly examines the impact of bond market opening on the level of technological innovation of enterprises, and then analyzes the impact of the level of technological innovation on the status of enterprise global value chain division of labor according to the existing literature. This paper adds the following formula to test the role of enterprise technological innovation level in the process of bond market opening to influence the status of enterprise global value chain division of labor.

$$INNOVATION_{i,t} = \chi_0 + \chi_1 BON_{i,t} + \chi_2 X_{i,t} + \delta_{i,t} + \varepsilon_{i,t} \quad (11)$$

In equation (11),  $INNOVATION_{i,t}$  denotes the innovation intensity of enterprises. If the coefficient of bond market openness in Eq. (11) is significant, it proves that bond market openness can indeed affect the level of technological innovation of enterprises.

## 5.2 Empirical results and analysis

### 5.2.1 Benchmark regression results

The estimation results in column (1) of Table 3 show that the regression coefficient of the bond market openness measure is significant at the 1% level, indicating that the higher the bond market openness to the outside world, the higher the domestic value-added rate of the firms, and the higher the firms' position in the value chain division of labor. Columns (2)-(6) gradually add control variables and the regression coefficients of the bond market openness measure are still significant at the 1% level. This indicates that the positive impact of bond market openness on firms' position in the global value chain division of labor does not vary with other control variables, and the results are relatively robust.

Table 3. Tobit benchmark regression

Explanatory variable	Explained variable: firms' position in the division of labor in global value chains					
	(1)	(2)	(3)	(4)	(5)	(6)
BON	0.1168** * (5.1594)	0.1637*** (5.8557)	0.1665*** (5.9482)	0.1521*** (5.3628)	0.1728*** (5.9785)	0.1548*** (5.2239)
AGE		-0.0942*** (-3.2421)	-0.0824*** (-2.8413)	-0.0750** (-2.5752)	-0.0483 (-1.6198)	-0.0526* (-1.7602)
FACTOR			-0.0428*** (-4.1865)	-0.0362*** (-3.4968)	-0.0297*** (-2.9111)	-0.0283*** (-2.7977)
FINA				-1.0176** (-2.5723)	-0.7386* (-1.8587)	-0.6508 (-1.6444)
OPER					-0.0407*** (-4.2608)	-0.0388*** (-4.0607)
TOBIN						0.0230*** (2.8685)
_cons	0.6683** * (15.4906)	0.8361*** (13.2156)	1.3355*** (9.9692)	1.2700*** (9.4367)	1.8507*** (9.5094)	1.7934*** (9.2803)

N	11135	11135	11135	11135	11135	11135
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Note: t-statistics for coefficients are in parentheses; \*, \*\*, and \*\*\* indicate that the estimates are significant at the 10%, 5%, and 1% levels, respectively. This paper controls for time fixed effects. Same table below.

### 5.2.2 Mechanism test results

In order to test the role played by the level of technological innovation of enterprises in the process of bond market opening up affecting the position of enterprises in the division of labor in the global value chain, according to equation (11), the effect of the independent variable bond market opening up (BON) on the mediator variable level of technological innovation (INNOVATION) is examined by using a two-restricted Tobit regression. The results are shown in Table 4: the coefficient of INNOVATION (R&D intensity) in column (1) is significantly positive at the 1% level, indicating that the opening up of the bond market has increased the R&D investment of enterprises and improved the technological innovation level of enterprises; the coefficient of INNOVATION (innovation output) in column (2) is also significantly positive at the 1% level, indicating that the opening up of the bond market has improved the innovation output of enterprises and improved the technological innovation level of enterprises. innovation output, enterprise technological innovation level can be improved. This indicates that the positive impact of bond market openness on the level of technological innovation of enterprises does not change with the change of proxy variables, and the results are relatively robust. The reasons are as follows: firstly, after the bond market was opened up, the situation of financing difficulties was improved, and enterprises had more channels to obtain low-cost financing to provide financial support for technological innovation activities. Secondly, after the bond market is opened to the outside world, foreign capital flows into the domestic market to accelerate the appreciation of the local currency, the domestic export enterprises have lost the price advantage, the competition among enterprises has increased, and the competition has increased forcing the enterprises to increase their own R&D investment and improve the level of technological innovation. The increase in the level of technological innovation is conducive to enterprise innovation technology, improve the quality and complexity of export products, thereby optimizing the product structure, and ultimately make the enterprise global value chain division of labor position to the high-end position extension. That is, the opening up of the bond market increases the R&D investment of enterprises, improves the technological innovation level of enterprises, and promotes the upgrading of their position in the division of labor in the global value chain. Thus, Hypothesis 1 is proven.

Table 4. Regression results of mechanism test for bond market opening to the outside world

Explanatory variable	Explained variable: level of technological innovation	
	(1) Innovation (R&D intensity)	(2) Innovation (technical outputs)
BON	0.1139*** (13.0158)	1.5338*** (8.3452)
AGE	-0.0168*** (-9.4955)	-0.2740* (-1.8591)
FACTOR	-0.0029*** (-4.3488)	-0.2686*** (-6.1991)
FINA	-0.2429*** (-7.2166)	-11.8511*** (-5.4239)
OPER	-0.0025*** (-4.9772)	1.0532*** (17.5331)
TOBIN	0.0045*** (7.1635)	0.0613* (1.8099)

_cons	-0.0704*** (-3.5403)	-19.6987*** (-17.0054)
N	11134	11135

### 5.2.3 Heterogeneity analysis results

In the benchmark regression model, this paper introduces a cross term between the dummy variable for the region where the enterprise is located and the proxy variable for the openness of the bond market to the outside world to test the differential impact of the openness of the bond market to the outside world on the position of the global value chain division of labor of the enterprises in the eastern region and the enterprises in the central and western regions. As shown in Table 5, the coefficient of the interaction term between bond market opening to the outside world and the dummy variable for the region of the enterprise is significantly positive, indicating that the proximity of the region of the enterprise to the central and western parts of the country strengthens the effect of bond market opening to the outside world on the enhancement of the enterprise's position in the division of labor in the global value chain, i.e., the enhancement of the position of the enterprise's division of labor in the global value chain by the opening up of bond market to the outside world is better than that by the enterprises in the eastern part of the country, which is contrary to the conclusion of the hypothesis stage of this paper. This is contrary to the conclusion of the hypothesis stage of this paper, and the main reasons may be as follows:

First, the ability to attract foreign investment has been strengthened. First, the Chinese Government strongly supports the development of the central and western regions, especially the western region, and encourages the flow of foreign capital to the central and western regions through a series of policies, such as optimizing taxation, increasing and revising the catalog of industries with advantages for foreign investment in the central and western regions, and guiding foreign capital to promote the optimization of the industrial chain layout in the central and western regions, and to build up the comparative advantages of the central and western regions. Secondly, the implementation of the "Belt and Road" initiative not only helps enterprises in the central and western regions to synchronize real information, improves the quality of information disclosure in the capital market to a certain extent, and reduces the information cost of foreign capital entry, but also helps enterprises to improve their ability to attract foreign capital by building a diversified financing system [56, 57]. It can be seen that after the opening of the bond market, enterprises in the central and western regions attracted and utilized more foreign capital. Second, the location export disadvantage is improved. On the one hand, the implementation of the "Belt and Road" initiative and the entry into force of RCEP have promoted the construction of transportation facilities in the central and western regions and reduced transportation costs [58]; On the other hand, the "Belt and Road" also allows the central and western regions of China and Asia and Europe to realize the interconnection, which has opened up the obstacles that existed in carrying out inland trade, expanded the transportation channels for enterprises in the central and western regions, reduced the cost of exporting, and facilitated the export activities of enterprises. Third, industrial agglomeration. The land supply policy implemented by the government in favor of the central and western regions has reduced the supply of land in the eastern region, leading to an increase in real estate prices in the eastern region and further piling up labor costs in the eastern region [59, 60]. After the opening of the bond market, competition among enterprises has intensified, and under the pressure of rising costs of land and labor, some enterprises in the eastern region have moved to areas with low housing prices and low labor costs in the central and western regions, while the process of undertaking enterprises in the eastern region in the central and western regions can not only give full play to the comparative advantages of the region to achieve industrial agglomeration, but also enhance the enterprises in the region through the spillover effect of the transfer of enterprises and labor force on the technological innovation level of enterprises in the region through the spillover effect of technology from enterprise and labor transfer. Further, the transfer of enterprises means the reduction of jobs, which continues to promote the transfer of labor in the eastern region, accelerates

the accumulation of human capital and industrial agglomeration in the central and western regions, and ultimately facilitates the enhancement of the position of enterprises in the global value chain division of labor. Thus, hypothesis 3 can be explained.

Table 5. Heterogeneity results

Explanatory variable	Explained variable: firms' global value chain division of labor position (DVAR)
BON	0.1601*** (5.3648)
BON*AREA	0.0427** (2.5540)
Observed value	11135

#### 5.2.4 Robustness check

To further examine the robustness of the empirical results and the reasonableness of the model setup, this paper discusses the robustness of the estimation results to the measurement errors of the variables in several ways. First, Replacement of control variables. Considering the stochastic impact of different control variables on the estimation process of key indicators, this paper takes M2 growth rate as the macro-level control variable and corporate cash flow ratio, current asset ratio and cost of overhead as the micro-level control variables to test the robustness of the above estimation results. Second, the bond market openness indicator is replaced. According to equation (6) in the third part of this paper, DVAR, which is processed by BEC but not processed by intermediary identification, is used as a substitute indicator for the enterprise's global value chain division of labor status for testing. At the same time, considering that there may be a measurement error in the proxy variable for bond market openness, total cross-border capital inflows in the Balance of Payments Account are used as a substitute indicator for bond market openness to test the robustness of the basic equation. robustness. Third, considering the time continuity of enterprises' global value chain division of labor position, this paper adds the lagged one-period variable of DVAR in the regression model, and since the fixed effects of enterprises are not effectively controlled in the Tobit regression, the endogeneity test is further carried out with a systematic GMM model.

The regression results are shown in Table 6: The results in column (1) of Table 6 indicate that the positive effect of bond market openness on firms' GVC division of labor position remains significant at the 1% level after replacing the control variables. Column (2) shows that after BEC identification without the treatment of intermediaries or trade agents, the facilitating effect of bond market openness on firms' GVC division of labor position remains significant at the 1% level and the difference with the estimated coefficients in Table 3 is small. Column (3) shows that the positive effect of bond market openness on firms' global value chain division of labor position remains significant at the 1% level after replacing the proxy variable for bond market openness. Column (4) of the lagged one period Tobit regression results show that the sign of the key explanatory variable bond market openness is still positive and significant at the 1% level; Column (5) of the endogeneity test results of the systematic GMM model shows that the sign of the regression coefficient of bond market openness remains unchanged and significant at the 1% level. In summary, the results of this paper are robust.

Table 6. Robustness test results

Explanatory variable	Explained variable: level of technological innovation				
	(1)	(2)	(3)	(4)	(5)
BON	0.1563** * (5.2738)				
DVAR (BCE)		0.1424** *			

		(4.8641)			
BON(INFLOW)			0.1034** * (5.2239)		
L. DVAR				0.1209** * (4.5992)	
AR (2)					0.131
Hansen					0.535
N	11135	10024	11135	8822	8822

## 6. Conclusions and policy recommendations

### 6.1 Conclusions

The theoretical analysis of this paper shows that the opening up of the bond market to the outside world affects the level of technological innovation of enterprises through the cross-border capital flow effect and the competition effect, which in turn affects the position of enterprises in the global value chain division of labor. The empirical results show that: the cross-border capital flow caused by the opening of the bond market widens the financing channels of domestic enterprises, and the enterprises can obtain external funds at low cost to provide long-term and stable financial support for technology R&D activities, which is conducive to enhancing the level of technological innovation of the enterprises; at the same time, the competition among enterprises caused by the opening of the bond market not only eliminates the disadvantaged enterprises and makes the advantageous enterprises integrate resources to improve the utilization rate of resources, but also forces the enterprises themselves to increase R&D investment, improve innovation output and the position of enterprises in the global value chain. That is to say, the opening up of bond market promotes the upgrading of enterprises' position in the division of labor in the global value chain by improving the level of technological innovation of enterprises. Heterogeneity analysis shows that the opening up of bond market has a better effect on the GVC status of enterprises in the central and western regions than that of enterprises in the eastern regions.

### 6.2 Policy recommendations

First, in view of the fact that opening up the bond market to the outside world can effectively improve the position of enterprises in the global value chain division of labor, we should promote the opening up of the bond market at the right time, benchmark the mature mechanisms and advanced concepts of foreign markets, improve the construction of the bond market infrastructure, and appropriately relax the restrictions on the access of foreign investors while strictly qualifying for the examination, so as to attract high-quality capital, make full use of domestic and foreign resources, and push forward the position of enterprises in the global value chain division of labor. Upgrade. Secondly, we should refine information disclosure requirements, such as innovation information and risk information, and require enterprises to strengthen information disclosure by combining qualitative and quantitative methods, and at the same time guide enterprises to moderately shorten the time lag of updating key information, improve the timeliness and effectiveness of enterprise information disclosure, reduce financing costs due to asymmetric information, establish a favorable business environment, strengthen top-level design and improve the level of policy implementation, and improve the policy system of enterprise financing services, so as to provide a better financing environment for enterprises and improve the quality of financing services. The top-level design should be strengthened and the level of policy implementation should be improved, so as to improve the policy system of enterprise financing services and alleviate the financing pressure for enterprises with financing difficulties. Third, further open up the capital market, introduce advanced technology from abroad, and increase competition in the domestic

market, so as to enhance the productivity and technology level of enterprises. Fourth, guide enterprises to increase R&D investment and talent cultivation, optimize the structure of resource endowment, and improve the quality and complexity of export products, so as to enhance their position in the division of labor in the global value chain.

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