

# Position in Global Value Chains, Trade Duration, and Firm Survival: Empirical Evidence from China

Qizhong Yang<sup>†</sup>, Tomohiko Inui<sup>††</sup>

The fragmentation of production in global value chains (GVCs) has become an important trend in international trade, where trading firms are facing a competitive global market. We use matched firm-level manufacturing survey and customs data to examine how the position of Chinese firms in the GVCs affects the probability of trade duration and firm survival in the market. The results show that firms with higher upstreamness can more easily continue their current trade activities compared to firms located in less upstream positions. The subsequent estimation of the effect of the firm's GVC position on the probability of firm survival implies that a more upstream position in the GVCs is beneficial for a firm's survival in both the domestic and international markets. These findings show that participation in the GVCs is not the only important determinant of firm performance, but the position in GVCs also matters.

JEL Classification: F10, F14, F23, L25

Keywords: global value chain, upstreamness, trade duration, firm survival

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<sup>†</sup> Corresponding author.  
Faculty of Economics, Toyo University, Japan  
Address: 5-28-20, Hakusan, Bukyo-ku, Tokyo 112-8606, JAPAN.  
E-mail: yang@toyo.jp

<sup>††</sup> Faculty of International Social Sciences, Gakushuin University, Japan

## 1. Introduction

The increasing fragmentation of production in global value chains (GVCs) has become an important trend in international trade, dramatically altering the international organization of production by emphasizing the specialization of each country within the chain (Antràs and Chors, 2018). Revolutionary breakthroughs, cross-integration of information technology, new materials, and new sources of energy have changed the pattern of global manufacturing development: world production is now structured into global value chains. The regional decentralization of production has led to the rise of trade in intermediate goods (especially in the field of manufacturing), which is transforming the mode of production from ‘made in one country’ to ‘made in the world,’ and the mode of trade from ‘trade in goods’ to ‘trade in tasks’ (WTO and IDE-JETRO, 2011).

As specialization in specific activities within value chains increase, firms often cease to be part of complete domestic supply chains (Criscuolo et al., 2015). According to the qualitative definition given by Antràs (2020), a GVCs is a series of stages involved in producing a product or service that is sold to consumers, with each stage adding value, and with at least two stages being produced in different countries. Studies on the quantitative impact of GVCs have also been examined in recent years. Antràs and Chor (2013) develops a property rights model in which a firm’s boundaries are shaped by the characteristics of the different stages of production and their position along the GVCs. Alfaro et al. (2019) develops Antràs and Chor’s (2013) framework into a richer model of firm behavior that can guide empirical analysis using firm-level data. They find that whether a firm integrates upstream or downstream suppliers, depends crucially on the elasticity of demand faced by the firm. Recent research has developed various theoretical frameworks that emphasize the operational impact of the rise of GVCs on the general equilibrium model of international trade. These measures envisage a world in which the organization of production has a certain configuration of sequentiality such as the purely sequential ‘snake’ or the flatter ‘spider’ GVCs (Baldwin and Venables, 2013). In a snake GVCs, each production stage receives its inputs from a unique upstream stage, while in a ‘spider’ GVCs, each production stage draws inputs from several upstream suppliers simultaneously.

This paper investigates the impact of a firm’s position in the GVCs on the probability of firm and trade survival in the Chinese market. The empirical analysis relies on a combined panel of Chinese firm-level trade data over the 2000–2007 period, along with the industry-level input-output dataset provided by the WIOD. The empirical strategy is to investigate Chinese firms’ behavior in terms of survival in the domestic and global trade markets as a function of certain firm characteristics, especially the firm’s position in the GVCs. We also control for a set of fixed effects to control for unobservable factors affecting a firm’s performance.

The empirical results show that trading firms located upstream in the GVCs (regarded as the result of trading more upstream products) can more easily continue the current trade activity compared to firms with lower upstreamness. The subsequent estimation of the effect of the firm's GVC position on the probability of its survival implies that a more upstream position in the GVCs is beneficial to the firm's survival in the domestic market. Combined with the results for trade survival, one can conclude in addition to participation in the GVCs, the position in the GVCs is also an important decisive factor in a firm's performance. This finding suggests two options for firms to improve their performance: First, firms should be motivated to specialize in upstream activities that will increase their upstreamness in the GVCs. At the same time, this result is also in line with prior findings that claim that more productive firms have a higher survival probability (e.g., Baldwin, 1995).

To the best of our knowledge, this study is the first to examine the firm-level GVC position as a determinant of a firm's survival in domestic and international markets. Our work contributes to the literature in three main ways: First, this is one of the first firm-level studies in a growing literature on GVCs, whose importance in international economics has been increasing over the past few years. At the country-industry level, Hummels et al. (2001) proposes that the vertical specialization index can be used to measure the division of labor position of a country's industry in the GVCs. Koopman et al. (2010) puts forward the GVCs participation index and GVC positioning index to measure the division of labor position of a country's industry in the GVCs, which is developed by Wang et al. (2017), who proposes a pair of GVCs participation indices that improves upon the measures in the existing literature. Costinot et al. (2013) develops a theoretical framework for vertical specialization. Antràs and de Gortari (2020) studies the specialization of countries within GVCs in a world with barriers to international trade using a multi-stage general equilibrium model. Although the body of existing literature is small, there are some firm-level analyses of the GVCs. One of the most important references for this study is Chor et al. (2021), who examines how Chinese firms position themselves in global production lines and how this evolves with productivity and performance. Unlike Chor et al. (2021), this study aims to investigate how a firm's position in the GVCs would help itself survive in domestic and global markets. That is, it focuses on a comparatively more original research question that ascertains whether GVC position would allow firms to continue to have a presence in the GVCs.

Second, this study expands the literature on the relationship between GVCs involvement and trade survival. Typically, vertical specialization in world trade is thought to benefit export growth, which indicates a positive relationship between GVCs participation and export growth (Hummels et al., 2001; Timmer et al., 2014). Prior studies further confirm a positive causal relationship

between international activities and firm performance (Banh, 2020; Montalbano et al., 2018). Empirical evidence also shows that a deeper participation in GVCs is a key factor in explaining stability in trade relationships, especially in developing countries (Díaz-Mora et al., 2018). Further, this study adds to the literature by capturing the impact of GVC position on a firm's performance with a continuous upstreamness variable, while prior studies quantifies a firm's international activities with either the GVCs participation measures or the discrete categorical variables.

Third, the study contributes to the literature on international activities and firm survival. An early study by Wagner (2013) investigates the links between firm survival in Germany and typical types of international trade activities—exports, imports, and two-way trade. Franco and Weche Gelübcke (2015) detects a negative effect of FDI on the probability of firm exit in R&D-intensive sectors and regions. They also confirm that the effect of FDI varies across countries of origin and type of ownership. Stirbat et al. (2015) highlights the positive impact of firm experience on export survival, including prior experience or familiarity with the product or destination, and experience with importing. Howell (2015) finds that innovation boosts a firm's survival, with the impact conditioned by the risk, timing, and characteristics of the innovation. These discussions are extended from the perspective of GVC position, which is a factor that would have an increasingly important effect on a firm's survival under the circumstance of globalization, but has not been taken into consideration by prior studies. Moreover, both survival analysis models and linear probability models are employed to detect a robust impact of GVC position.

The remainder of this paper is organized as follows: Section 2 introduces the data and measures of the GVC position. Section 3 presents the empirical model. Section 4 presents the estimation results. The final section concludes.

## **2. Data and Empirical Strategy**

### **2.1 Industry-level GVC Upstreamness**

We use measures of industry-level GVC upstreamness introduced by Antràs and Chor (2018), whose framework refers to Antràs and Chor (2013), Fally (2012), and Miller and Temurshoev (2017). Antràs and Chor (2013) measures the upstreamness of an industry based on the number of stages in a production chain, up to the final consumer in the industry<sup>1</sup>. Specifically, the upstreamness index for industry  $m$  of country  $i$  ( $U_i^m$ ) index is:

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<sup>1</sup> Similarly, Fally (2012) composes the GVCs measure based on the concept that 'if the product of the industry is used in an industry far from the final consumer in the value chain, the industry is located upstream.' Antràs et al. (2012)

$$U_i^m = 1 \cdot \frac{F_i^m}{Y_i^m} + 2 \cdot \frac{\sum_{n=1}^N \sum_{j=1}^J \alpha_{ij}^{mn} F_j^n}{Y_i^m} + 3 \cdot \frac{\sum_{n=1}^N \sum_{j=1}^J \sum_{o=1}^N \sum_{k=1}^J \alpha_{ij}^{mn} \alpha_{jk}^{no} F_k^o}{Y_i^m} + \dots, \quad (1)$$

where  $Y_i^m$  denotes the value of gross output, and  $F_i^m$  denotes the value of industry  $m$ 's output that goes directly to final uses;  $\alpha_{ij}^{mn}$  is the value of industry  $m$ 's output in country  $i$  that is used as an input to produce one yuan worth of industry  $n$  output in country  $j$ . Thus, the upstreamness index is derived by adding up the product between a weight value and the share of industry  $m$ 's value-added activity within its gross output. Specifically, the share of industry  $m$ 's value-added activity that goes directly to final uses is assigned a weight of 1, the share that is channeled to final use through exactly one other industry is assigned a weight of 2, and so on.

Eq. (1) shows that the minimum value  $U_i^m$  can take is one, and that larger values are associated with relatively higher levels of upstreamness that comes from an entry into the GVCs, an intermediate input originating from industry  $m$ , and multiple stages prior to final demand. Inversely, Eq. (1) equals one if and only if all industry  $m$ 's outputs go directly to final use. Moreover,  $U_i^m$  is identical to industries' total forward linkages in terms of gross output. Industries that have a high total forward linkage supply a significant part of their output as intermediate inputs to other industries, and that is precisely what places industries in an upstream position in the output supply chain with respect to other industries buying inputs from that industry.

We employ the WIOD database released in 2016<sup>2 3</sup>. The WIOD database contains information on linkages in a global full production network, where each country-industry could potentially span a large number of production chains. Based on this setting, the measures of GVC position described below will seek to capture the average position of each country-industry in the production chains in which it is involved. Although our goal is to convert the industry-level measures into firm-level measures using micro data from China, the global input-output table is necessary for us to capture

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proves that Fally's (2012) composition is identical to that of Antràs and Chor (2013).

<sup>2</sup> The WIOD Input-output database is documented in Timmer et al. (2015) and is available at < <http://www.wiod.org>>. In this paper. We utilize the World IO Tables That Covers the 2000–2014 period. The WIOD database covers 28 EU countries, 15 other major countries in the world and 56 industries based on the Nomenclature of Economic Activities (NACE) Rev. 2 classification for each country. For a more detailed description of the database construction, see Timmer et al. (2015).

<sup>3</sup> A global IO table has also been developed by the Institute of Developing Economies-Japan External Trade Organization (IDE-JETRO). Although the IDE-JETRO international IO table, covers other Southeast Asian countries including Thailand, it is only available at five-year intervals from 1985 to 2005. Its industry classification is less detailed (covering 24-26 industries) than that of the WIOD (which covers 56 industries) and is not harmonized throughout the period. Consequently, this paper utilizes the WIOD.

the linkages between China and the rest of the world. Thus, the measure of GVC position of all countries must be derived; those of Chinese industries are used in further calculations.

## 2.2 Firm-level GVC Upstreamness

After deriving the industry-level  $U_t^m$ , these indices are converted into firm-level indices based on Chor et al. (2021) and Ju and Yu (2015). The upstreamness of firm  $f$ 's exports ( $U_{ft}^X$ ) and imports ( $U_{ft}^M$ ) is defined as,

$$U_{ft}^X = \sum_{m=1}^N \frac{X_{ft}^m}{X_{ft}} U_t^m, \quad U_{ft}^M = \sum_{m=1}^N \frac{M_{ft}^m}{M_{ft}} U_t^m, \quad (2)$$

where  $X_{ft} = \sum_{m=1}^N X_{ft}^m$  represents total exports of firm  $f$  within industry  $m$  in year  $t$ , and  $M_{ft} = \sum_{m=1}^N M_{ft}^m$  is the total imports of firm  $f$  within industry  $m$  in year  $t$ . A notable difference from Chor et al.'s (2021) definition is that upstreamness in Eq. (2) is derived by aggregating the weighted industry-level upstreamness in year  $t$ , but not those in the first year. The advantage of this definition is that it can more comprehensively capture a Chinese firm's upstreamness that comes from the change in both the industrial position of the country and the trade performance of the firm itself. However, a potential problem is a risk that this index may purely reflect the change in the upstreamness of Chinese industries, even if a firm's trade performance remains unchanged. To show the robust impact of a firm's upstreamness on survival, this study also defines an upstreamness index that is weighted by the first year of our sample period ( $U\_fix_{ft}^X$  and  $U\_fix_{ft}^M$ ) as follows:

$$U\_fix_{ft}^X = \sum_{m=1}^N \frac{X_{ft}^m}{X_{ft}} U_{2000}^m, \quad U\_fix_{ft}^M = \sum_{m=1}^N \frac{M_{ft}^m}{M_{ft}} U_{2000}^m. \quad (3)$$

It is necessary to stress the distinction between the industry-level measure of upstreamness and the firm-level measures of upstreamness, which is derived from the input-output table that contains information on industry-level linkages of all countries in a full production network so that the index indicates the position of a certain industry, and the firm-level upstreamness is calculated as the value-weighted average of the industry-level index using the share of imports of each industry to capture the importance of that industry in firm  $f$ 's imports. Therefore, instead of a definite position in the world input chain, a high firm-level upstreamness indicates that it purchases a substantial amount of input that belongs to industries with high upstreamness, while a low firm-level upstreamness indicates that the inputs are purchased from industries with low upstreamness<sup>4</sup>. With

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<sup>4</sup> While the Chinese Customs Trade Statistics (CCTS) provides detailed product composition of a firm's exports and imports from which we can further deduce the value of a firm's domestic sales and purchases, we cannot observe

reference to Chor et al. (2021), firm-level upstreamness is interpreted as a summary measure of the GVC position of the firm. In other words, the firm-level measures in Eq. (2) and Eq. (3) seek to capture how firms are situated within the GVCs through exporting and importing activities, even in the absence of detailed information about how each firm structures and positions its specific operation in the global market. An intuitive way to understand the GVC position measures is to consider the upstreamness of non-intermediary firms. In that case,  $U_{ft}^X$  (also,  $U\_fix_{ft}^X$ ) simply captures the average upstreamness of inputs provided by suppliers that are brought into China, and  $U_{ft}^M$  (also,  $U\_fix_{ft}^M$ ) represents the average upstreamness of the final product sold to downstream buyers worldwide.

The histogram of Chinese firms' export upstreamness in 2000 and 2007 is shown in Figure 1. The more right-skewed distribution in 2007 shows a slight increase in the firm's upstreamness during the past seven years. The distribution of a firm's import upstreamness in the same year is shown in Figure 2. An obvious expansion of a firm's upstreamness can be confirmed in its imports. A similar trend is shown by Chor et al. (2021), where they use the same measure of a firm's upstreamness and finds that Chinese firms' import upstreamness significantly increased, while export upstreamness moderately decreased during 2000–2014<sup>5</sup>.

Figure 1. Histogram of Firm's Export Upstreamness

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domestic sales and input purchases by product. Thus, these are efficient measures, only to the extent that these are well-represented by the product composition of the firm's exports and imports. Moreover, since the ASIF data do not tell whether the intermediate inputs are purchased through intra-firm or arm's length transactions, we cannot draw definitive conclusions about the extent of vertical supply chain integration relative to outsourcing.

<sup>5</sup> Specifically, while Chor et al. (2021) uses the same firm-level upstreamness measure, they employ the Chinese Input-Output dataset instead of the multi-country Input-Output tables, and the sample period also differs from that used in this study.

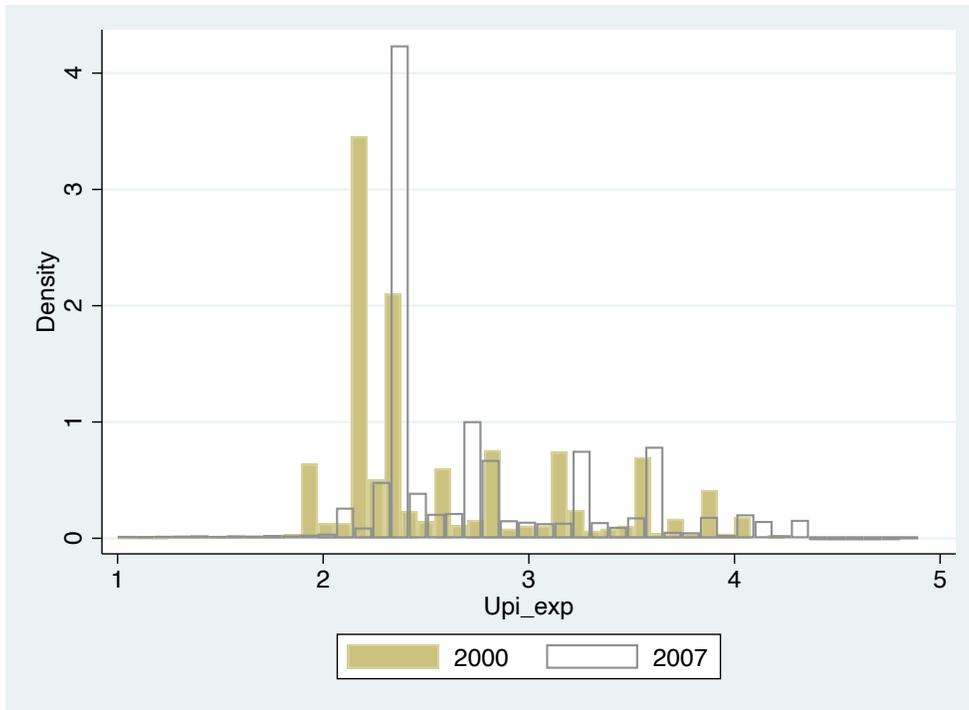
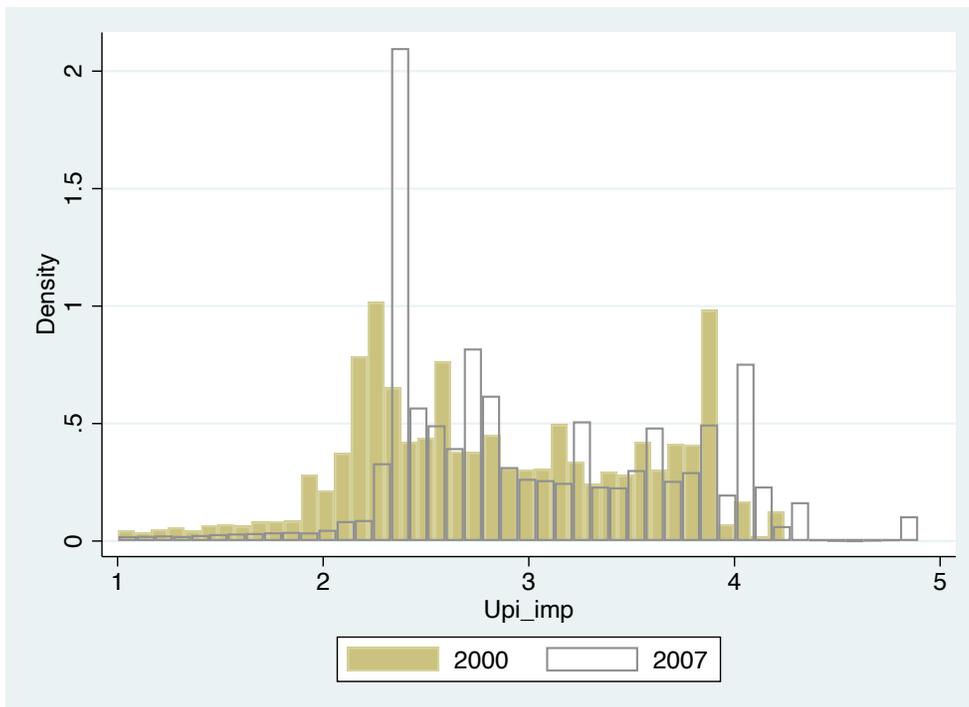


Figure 2. Histograms of Firm's Import Upstreamness



### 2.3 Data on Chinese Firms

In addition to the industry-level WIOD, this study also draws on two main sources of Chinese firm data to calculate firm-level upstreamness, as well as investigate the characteristics along the value chain: firm-level manufacturing data and transaction-level customs data.

The manufacturing data are from the Annual Survey of Industrial Firms (ASIF), which is conducted by the National Bureau of Statistics of China for the 1998–2007 period<sup>6</sup>. These surveys cover all state-owned enterprises (SOEs) and non-SOEs, with annual sales of over 5 million Chinese yuan. Although the sample size varies across years, the dataset of each year provides the basic information for each surveyed firm, including the firm’s identification number, location code, industry affiliation, ownership structure, and the financial and operational information that would appear in a typical balance sheet extracted from accounting statements, such as total sales, employment, average wage, intermediate input, material purchases, value added, fixed assets, inventories, and profits. This comprehensive firm information of the ASIF data enables us to construct a revenue-based productivity measure based on production function estimates following Levinsohn and Petrin (2003).

The transaction-level customs data we rely to examine the evolution of China's international trade activity using the Chinese Customs Trade Statistics (CCTS) from the General Administration of Chinese Customs. The CCTS database covers monthly records of all merchandise transactions passing through Chinese customs from 2000 to 2014, including firm identification (name, address, firm ownership type), HS 8-digit product code, value of imports and exports, quantity of goods, customs regimes, means of transportation, customs code, origin, and destination country. To abstract from the seasonality and lumpiness inherent in monthly trade flows, aggregate this raw data is aggregated to the annual level. Further, the product codes of traded goods are HS8-digit codes, and we convert them to HS6-digit codes. The export and import values are reported as free-on-board (FOB) values in US dollars.

Further, the ASIF and CCTS data are matched by firm name, address, and phone codes<sup>7</sup>. The unmatched samples (i.e., non-trading firms) are discarded during estimation because the goal is to

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<sup>6</sup> To be exact, the ASIF database after 2008 is also available. Nevertheless, most literature only use the data during 1998–2007, because there is a significant change in statistical methods and dimensions for data collected after 2008 as well as criticism of data reliability. Refer to Hsieh and Klenow (2009) for details.

<sup>7</sup> The two datasets do not completely match for the following reasons: First, the ASIF data includes a large number of non-trade firms, which do not appear in the CCTS data. Second, firms that export via trading agents are reported as exporters in the ASIF data, but their exports will be recorded under the name of the trading agent in the CCTS data. Third, the ASIF data only includes large firms (with annual sales over 5 million Chinese yuan as described above) in the manufacturing industry, while the CCTS data records all trade transactions including those made by small firms and

investigate the impact of the GVC position on firm survival. Table 1 shows the number of firms that appeared in the two datasets. The sample size from the ASIF nearly doubled from 160,000 in 2000 to 330,000 in 2007. From the CCTS data, the number of exporting firms increased from about 60,000 in the year 2000 to approximately 175,000 in 2007; importing firms increased from about 60,000 to 120,000 in 2007. There are slightly more exporting firms than importing firms. The increase in number of Chinese exporting and importing firms implies that China has been enhancing its connection with the GVCs since 2001, when China joined the WTO.

Table 1. Sample Size of the ASIF and CCTS

	ASIF		CCTS			
	N	Prop.	Export		Import	
			N	Prop.	N	Prop.
2000	162,807	8.57	61,783	7.2	61,445	8.78
2001	168,958	8.9	67,216	7.83	65,782	9.4
2002	181,488	9.56	74,949	8.73	72,913	10.42
2003	196,152	10.33	89,610	10.44	81,511	11.65
2004	278,991	14.69	109,047	12.71	91,538	13.08
2005	271,766	14.31	116,472	13.57	89,921	12.85
2006	301,877	15.9	162,931	18.98	118,437	16.92
2007	336,665	17.73	176,254	20.54	118,326	16.91
Total	1,898,704	100	858,262	100	699,873	100

Table 2. Descriptive Statistics

Variable	Interpretation	Obs.	Mean	Std. Dev.	Min	Max
Survive year	Year of firm survival	1,898,701	4.221	2.368	0	8
lnUp Exp	log of export's upstreamness	293,396	0.944	0.250	0	1.588
lnUp Imp	log of import's upstreamness	225,562	1.022	0.279	0	1.588
lnUp Exp fix	log of export's upstreamness based on 2000	293,396	0.933	0.248	0	1.445
lnUp Imp fix	log of import's upstreamness based on 2000	225,562	1.011	0.278	0	1.445
lnTFP	log of TFP using LP method	1,189,456	0.881	0.214	0.335	2.030
lnSize	log of number of employees	1,676,867	4.703324	1.184382	0.693	7.863
lnAge	log of firm's age	1,654,195	2.088591	0.8962085	0	6.011

### 3. Estimation Strategies

This study analyzes whether the role in the GVCs affects a firm's performance, including survival in the domestic market and the global trade market. Theoretically, Melitz's (2003) model indicates that non-export firms are more likely to fail since they tend to be less productive and smaller than exporting firms (Baldwin and Yan, 2011). As for imports, Gibson and Graciano (2011) shows that the probability a of firm's survival can be expected to be higher for importers than for non-importers,

firms outside the manufacturing industry.

as both the price competitiveness and non-price competitiveness of importing firms will be stimulated. Wagner (2013) further notes that exporting and importing firms would acquire know-how with international transactions, exposure to international quality, and a potential reputation for reliability; thus, they can be expected to benefit from the positive effects of both forms of international trade in terms of firm survival. Furthermore, the position in the GVCs may also affect the firm's survival. Though the literature is scarce, GVCs participation is expected to be a way to learn by doing that enables an accumulation of productive capabilities. This statement is supported by Banh et al. (2020), who finds a positive correlation between productivity and GVCs participation in upstream industries. Therefore, more engagement in GVCs will help firms improve their export performance and competitive position in international markets (Díaz-Mora et al., 2018).

Against the above theoretical background, this study aims to investigate Chinese firms' probability of firm survival and trade survival as a function of firm characteristics, especially focusing on a firm's GVC position. We employ the following survival model: Let  $T$  be a non-negative random variable for firm  $f$ , representing the time from establishment to either death at some point in our sample period, or survival until the last year. Assuming that  $T$  follows a cumulative distribution of  $F(t)$  and a probability density function  $f(t)$ , the survival function  $S(t)$  is defined as the probability that firm  $f$  survives at time  $t$ , that is,

$$S(t) = \Pr(T \geq t) = 1 - F(t). \quad (4)$$

The hazard rate function  $h(t)$  for firm  $f$  is defined as:

$$h(t) = \lim_{\Delta t \rightarrow 0} \frac{\Pr(t \leq T \leq t + \Delta t | T \geq t)}{\Delta t} = \frac{f(t)}{S(t)}, \quad (5)$$

which is the death rate for firm  $f$  at time  $t$  conditional on its survival to time  $t$ .

We also use the survival analysis model in Eq. (5) to examine how the GVC position affects trade survival. Specifically, we divide trade survival into two levels: firm-product-country level and firm-country-year level. That is, we would like to observe whether the firm's GVC position will help the firm trade specific products from foreign countries and trade with the specific market.

In the baseline analysis, we employ a parametric model of the hazard rate function (Eq. (5) based on the exponential distribution. Specifically, it is assumed that

$$h(t) = \exp(\alpha GVC_{ft} + \mathbf{X}'_{ft}\boldsymbol{\beta} + \boldsymbol{\Gamma} + \varepsilon), \quad (6)$$

where  $GVC_{f,t_0}$  is the key regressor of interest, and it is one of the two lagged measures of firms' position in GVCs: the average upstreamness of firm exports,  $U_{ft}^X$ , and the average upstreamness of firm imports,  $U_{ft}^M$ . During the estimation, the data for the two variables are converted into logarithmic scale.  $\mathbf{X}'_{f,t_0}$  is a vector of firm-, industry-, and region-level characteristics that shift the hazard rate. specifically, the list of auxiliary firm controls will be firm-specific characteristics,

including productivity, firm size (measured by the number of employees), and the firm's age<sup>8</sup>. As mentioned in the previous section, we use the ASIF dataset to construct standard measures of firm productivity, namely log real value added per worker, as well as revenue-based TFP measures based on production function estimates following the methodology of Levinsohn and Petrin (2003). All continuous control variables are converted into logarithmic scale. A more detailed description of firm characteristics is provided in Table 2.

We also control for a set of fixed effects using  $\Gamma$ . In the trade survival specification, we control for the three sets of fixed effects: industry ( $\gamma_i$ ), year ( $\gamma_t$ ), and trade type ( $\gamma_T$ , i.e., ordinary trade or processing trade). As for the firm survival specification, the first fixed effect is  $\gamma_f$ , which controls for time-invariant firm characteristics such as ownership and the regions and industries to which a firm belongs. The second set is the year fixed effects,  $\gamma_t$ , which controls for time-invariant factors common to the nation, including business cycles, monetary policies, exchange rate shocks.

To obtain survival probabilities, the hazard rate in Eq. (6) can be expressed in the equivalent log-linear model for the random variable  $T_i$ , as follows:

$$\ln(T) = \alpha GVC_{ft} + \mathbf{X}'_{ft}\boldsymbol{\beta} + \Gamma + \varepsilon, \quad (7)$$

where  $\varepsilon$  is the error term that has a distribution that determines  $T$ . A positive coefficient in Eq. (7) represents a higher hazard rate, which means that it is more likely for the event to occur. Given that the event is the failure of a firm to survive in the market, a negative coefficient is expected for the factors that would help the firm to continue to exist in the market.

An important potential issue to address when estimating Eq. (7) is the endogeneity. The endogeneity comes from selection and omitted variable biases, and from reverse causality. The selection and omitted variable biases can be addressed by the fixed effects discussed above, which are able to capture unobservable characteristics affecting a firm's behavior. The reverse causality problem exists when a firm's GVC position is determined by its survival. To address this problem, we conduct a bundle of robustness checks, which include the instrument variables in the subsequent sections.

Finally, similar to other studies that employ duration data, we need to address the censoring problem. Our data are left-censored if the firm was established before the first year of the

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<sup>8</sup> Another potential factor that may affect Chinese firms' trade survival is the exchange rate. However, during the sample period of our data (2000–2007), it was not until July 2005 that the Chinese Yuan abandoned its peg to the US dollar and moved to a more flexible currency. Moreover, after that the exchange rate regime of Chinese Yuan is a managed floating exchange rate system with reference to a basket of currencies, which resulted in a relatively constant exchange rate during August 2005 to the end of the sample period.

observation period. On the other hand, right-censoring occurs when the firm still exists in the last year of the observation period. For right-censoring, we adjust for this by treating right-censored observations as survivors at the end of the observation period. In the case of left-censored data, we assume that these firms were established at the beginning of our observation period.

## 4. Empirical Results

### 4.1 Impact of GVC Position on Trade Survival

Table 3 shows the effect of a firm's GVC position on trade survival. In the first two columns, we examine how upstreamness affects firm-country-year-level trade. The negative coefficients in Column 1 indicate that firms with higher export upstreamness enjoy longer export durations. Specifically, a 1% higher firm export upstreamness is linked to a 0.014%<sup>9</sup> lower hazard ratio. Column 2 reexamines the specification using the upstreamness index derived from Eq. (3). The next two columns further show that a 1% increase in import upstreamness decreases the hazard ratio of import duration by 0.023%, and the result is insensitive to the method of measuring upstreamness. Columns 5–8 further show the effect on firm-product-country-year-level trade. Consistent with the firm-country-year-level trade, the negative coefficients on the firm's upstreamness are found in specifications, meaning that the higher firm's upstreamness of exports and imports both help them to continue the current product-level trade. These findings are consistent with earlier works, such as Zhu et al. (2019), who shows that both forward and backward GVCs participation has a positive impact on trade duration of Chinese firms<sup>10</sup>. In summary, it can be said that the survival probability of both the firm's trade of specific products and the trade in specific markets can benefit from a deeper involvement of both forward and backward participation in the GVCs.

In terms of the control variables, firm size and firm productivity have a reasonably negative sign, which are consistent with prior literature. Intuitively, larger and more productive firms are more competitive in the global market. The tariff rate is positively related to the hazard ratio, reflecting

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<sup>9</sup> Recall from Eq. (7) that  $\ln(T) = \alpha GVC_{f,t_0} + \mathbf{X}'_{f,t_0} \boldsymbol{\beta} + \sigma \varepsilon$ , which indicates that one unit increase in  $\mathbf{X}'_{f,t_0}$  is associated with  $\exp(-0.0138) - 1 = -1.37\%$  decrease in the hazard rates. Given that the firm's upstreamness is in the logarithmic scale, it can be interpreted, thus: A 1% increase in upstreamness is associated with a 0.014% decrease in the hazard ratio. Discussion on the estimated coefficients of the following survival models is based on the same theory.

<sup>10</sup> While the magnitude of the impact of GVC upstreamness on firm's trade survival in this paper seems modest compared to Zhu et al. (2019), it is worth stressing that the impact of GVC upstreamness is observed on the premise of GVCs participation, so that it reflects the "net effect" of position change on GVCs after stripping off the effect of participation itself on survival.

that trade tariffs act as a pure barrier to trade. The coefficients of firm age are counterintuitively positive and significant, meaning that younger firms are less likely to die<sup>11</sup>.

According to Antràs (2020) and Zhu et al. (2019), there are two potential channels for the positive relationship between GVC upstreamness and trade duration. The first is the sticky nature of GVCs relationships. The huge matching cost of suitable suppliers and buyers within the GVCs shapes the sunk cost of exporting and importing, which consequently forms a high entry barrier to latent rivals. This is especially true if there are limited trading partner candidates, which are more likely to occur when the product is traded upstream of the GVCs. The stickiness of the GVCs relationship is also related to the initial cost that comes from relationship-specific investments that would obtain a depressed return were the GVCs links broken. Thus, trading activities at the upper end of the GVCs where high initial investments (e.g., purchasing specialized equipment and R&D activities) have usually been made are more likely to have a stable survival duration.

The second channel is the spillover benefits from the learning-by-importing and learning-by-exporting effects via repeated interactions—thanks to the sticky GVCs relationship discussed above—with productive firms that are usually located upstream of the GVCs. This means that a more upstream position enjoys easier access to leading technology, know-how, and skilled labor. Moreover, since the positive impact on the survival probability is obtained after controlling for firm productivity, we can further infer that a closer position to the leading firms in the GVCs would bring intangible assets such as reputation and brand power. These spillover effects help upstream traders achieve competitive advantage in GVCs, leaving new entrants to face entry barriers.

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<sup>11</sup> A similar work by Zhu et al. (2019) which examines the relationship between participation in the GVCs and export duration also finds that exports of the younger enterprises may survive longer. Their explanation is that older firms may have a more dynamic export market portfolio than younger exporters.

Table 3. Parametric Model Analysis of GVC Position on Trade Survival Probability

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	firm-country-year		firm-country-year		firm-product-country-year			
lnUp Exp	-0.0138** (0.00632)				-0.122*** (0.00240)			
lnUp Exp fix		-0.0313*** (0.00618)				-0.0488*** (0.00347)		
lnUp Imp			-0.0237*** (0.00651)				-0.0233*** (0.00186)	
lnUp Imp fix				-0.0132** (0.00650)				-0.0170*** (0.00211)
lnSize	-0.0701*** (0.000876)	-0.0702*** (0.000876)	-0.128*** (0.00138)	-0.128*** (0.00138)	-0.0231*** (0.000384)	-0.0260*** (0.000392)	-0.0413*** (0.000295)	-0.0401*** (0.000313)
lnTFP	-0.0405*** (0.00307)	-0.0407*** (0.00308)	-0.0753*** (0.00443)	-0.0753*** (0.00443)	-0.00124 (0.00126)	-0.00276** (0.00127)	-0.0213*** (0.000893)	-0.0224*** (0.000905)
lnTariff	0.917*** (0.0150)	0.927*** (0.0151)	0.382*** (0.0404)	0.406*** (0.0403)	0.463*** (0.00630)	0.402*** (0.00626)	0.737*** (0.00997)	0.653*** (0.0100)
lnAge	0.0987*** (0.00143)	0.0988*** (0.00143)	0.168*** (0.00250)	0.168*** (0.00250)	0.0488*** (0.000666)	0.0510*** (0.000673)	0.0430*** (0.000551)	0.0377*** (0.000561)
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Ordinary trade FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2,185,923	2,185,923	1,131,880	1,131,880	4,950,321	4,950,321	5,787,675	5,787,675

Robust standard errors in parentheses.

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

## 4.2 Impact of GVC Position on Firm Survival

To examine how GVC position affects a firm's survival probability, we next estimate Eq. (7) using a parametric model and continuous upstreamness indices<sup>12</sup>. In Table 4, the first two columns show the impact of a firm's upstreamness in exports, determined by Eq. (2) and Eq. (3) for the probability of survival: Column 1 shows that higher export upstreamness is positively related to survival probability after controlling for firm and year fixed effects. Specifically, a 1% increase in the firm's upstreamness of exports decreases the hazard ratio by 0.16%. The next column further shows the robustness of this positive impact. Columns 3–4 show how a firm's upstreamness affects its survival. The positive and significant coefficient of a firm's GVC position in Column 3 shows that when a firm's upstreamness in imports increases by 1%, the hazard ratio decreases by 0.12%, which is further confirmed to be robust to the measurement method in the next column. Given that the average yearly change in Chinese firms' upstreamness of exports and imports is 1.0% and 2.9%, respectively, from 2000 to 2007, this result indicates that the firm's upstreamness in the GVCs plays a role in its survival that cannot be ignored.

As for the control variables, the estimated coefficients of market size and productivity are both negative and significant, as expected. Theoretically, firms operating at larger scales and higher levels of productivity are more competitive than their smaller and less productive counterparts in both domestic and global markets, and are more resilient to macroeconomic shocks. Firm age has a negative impact on the survival probability. One possible explanation is drawn from our datasets: Since the data mainly cover the period after China's accession to the WTO in 2001, the increased market competition crowded out some of the struggling older firms without enough competitiveness to further survive, including those so-called zombie firms.

Overall, the estimations are in line with previous studies that confirmed that forward and backward participation in the GVCs will decrease a firm's risk of bankruptcy (Wagner, 2013), and that a deeper involvement in GVCs is beneficial to a firm's performance (Díaz-Mora et al., 2018).

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<sup>12</sup> To intuitively observe the impact of GVCs position on firm's survival, we first conduct the nonparametric Kaplan-Meier estimation of Eq. (5), plotting the grouped survival probabilities separately for firms participating and not participating in GVCs. The Kaplan-Meier estimator based on Kaplan and Meier (1958) is given as  $\hat{S}(t) = \prod_{i=1}^t \frac{n_i - k_i}{n_i}$ , where  $n_i$  is the number of firms at risk at the beginning of  $i$ , and  $k_i$  is the number of observed failed firms in this period. We regard the firm with export and import activities as the GVCs forward-participating and backward-participating firms, respectively. The results show that both, forward and backward participation, are related to a higher probability of firm survival (the results are available on request). This result is consistent with Wagner's (2013) findings on a strong positive link between firm survival and both, imports and two-way trading firms.

To further relate firm survival with GVC position, we need to consider the different environments firms face in their own positions from the following two aspects: First, the exposure to the global frontier firms that participate in a GVCs through FDIs help domestic exporters in increase productivity through two channels (Antràs, 2020), which is further empirically proven by Chor et al. (2021). On the one hand, participation in the GVCs enables firms to obtain inputs at a lower cost from the international market than they would from domestic suppliers. On the other hand, cost reduction coupled with GVCs-related exports tends to increase the scale of operations of firms participating in GVCs, which tends to reduce the average cost when economies of scale exist. Criscuolo and Timmis (2018) argues that in addition to participation in the GVCs, the role of the firm in the GVCs also determines the productivity-enhancing effect by providing a positive relationship between a firm's productivity and its GVCs centrality. Havranek and Irsova (2011) further examines the channel of this enhancing effect and suggests that the positive productivity spillovers to industries come from backward linkages along the GVCs. Hence, firms with relatively high export upstreamness can expect a larger benefit from participation in the GVCs to their productivity, which consequently makes them enjoy a longer period of survival in the domestic market. Second, as discussed in Criscuolo and Timmis (2015), growing evidence shows that GVCs can intensify the propagation of cross-country macroeconomic shocks raised by international trade. Thus, firms within the GVCs are potentially exposed to a myriad of risks. Specifically, it is the downstream position that is more vulnerable to supply shocks higher up the value chain<sup>13</sup>. In other words, upstream firms tend to have a more stable connection to suppliers' inputs. Moreover, given that the GVCs is particularly a powerful vehicle for technology transfer (Antràs, 2020), traders with high import upstreamness tend to gain from upstream lead firms with a constant value chain. In sum, firms with higher import upstreamness in the GVCs are more resilient to macroeconomic shocks and can more conveniently benefit from productive upstream firms; and thus, have a higher survival probability than more downstream firms.

In combination with the results for trade survival, one can conclude that in addition to participation in the GVCs, position in the GVCs is also an important determinant of a firm's performance. Essentially, this study shows that a firm survive more easily when it is involved in the GVCs. However, participation in GVCs should not be the final goal of a firm's globalization strategy because the merit of GVCs participation is further dependent on the firm's GVC position.

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<sup>13</sup> Acemoglu et al. (2015) however points that the upstream industries further from the final consumers are more exposed to demand shocks, which indicates a negative impact of export upstreamness on firm's survival. Nevertheless, the empirical evidence of this study infers a positive effect to firm's existence duration through the learning effect, which thus means that the enhancing effect of a high export upstreamness exceeds the hindering effect.

A more upstream position in the GVCs reinforces the positive impact of GVCs participation on survival probability. In light of prior work, this finding suggests the following options for firms to improve their performance: First, as an upstream position can amplify a firm’s resilience to economic shocks (Criscuolo et al., 2015), firms should be motivated to directly increase their upstreamness of both exports and imports by specializing in upstream activities such as design, R&D, and innovation. Meanwhile, given the causal relationship from an increase in productivity to a higher upstreamness indicated by Chor et al. (2021), this result also extends to the prior findings that provide an indirect path of firm performance improvement—more productive firms have higher survival probability (e.g., Baldwin, 1995). More recent work by Bloom et al. (2021) finds that firms with better management, which is positively related to higher TFP levels, are more likely to import inputs of higher quality from more advanced countries, which in turn, implies a better access to upstream suppliers. Thus, effective management will also contribute to the firm’s own survival.

Table 4. Parametric Model Analysis of GVC Position on Firm Survival Probability

	(1)	(2)	(3)	(4)
	Exports		Imports	
lnUp Exp	-0.173*** (0.0390)			
lnUp Exp fix		-0.165*** (0.0389)		
lnUp Imp			-0.130*** (0.0335)	
lnUp Imp fix				-0.126*** (0.0334)
lnSize	-0.137*** (0.00875)	-0.137*** (0.00874)	-0.136*** (0.00874)	-0.136*** (0.00874)
lnTFP	-0.252*** (0.0572)	-0.252*** (0.0572)	-0.251*** (0.0572)	-0.251*** (0.0572)
lnAge	0.191*** (0.0154)	0.191*** (0.0154)	0.190*** (0.0154)	0.190*** (0.0154)
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Observations	105,731	105,731	105,731	105,731

Robust standard errors in parentheses.

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

### 4.3 Robustness Checks

As discussed in Section 3.4, a concern on potential endogeneity is raised in view of selection and omitted variables bias and reverse causality. The set of fixed effects in Eq. (7) allows little room for selection and omitted variable bias, the reverse causality problem remains unaddressed. We employ an instrument for our key explanatory variable  $GVC_{ft}$  and run a 2SLS probit model regression to address this endogeneity problem discussed in Section 4. We use the average upstreamness of export/import of the colleague firms of firm  $f$ , that is, firms belonging to the same industry as firm  $f$  as instrument. The detailed definitions are as follows:

$$\text{Instrumented } U_{ft}^X = \frac{1}{k} \sum_{k \in I^f} U_{kt}^X, \text{ Instrumented } U_{ft}^M = \frac{1}{k} \sum_{k \in I^f} U_{kt}^M. \quad (8)$$

Information on the firm's industry is available in the ASIF dataset, allowing the identification of each firm's competitors within the same industry. The intuition is that firms from the same industry are likely to have a similar pattern of intermediate purchase and production processes, and thus, their firm-level upstreamness will be positively correlated to that of firm  $f$ . The pivotal detail is that the upstreamness of competitors is only related to a firm's upstreamness but not to its own performance. In other words, the exclusion restriction is satisfied<sup>14</sup>. Another notable thing is that the use of nonlinear probability models allows us to control for a more specified level of fixed effects in the trade survival analysis. Here, instead of the original sets of fixed effects (i.e., the industry, year, and trade fixed effects), the study controls for the firm-HS6-country fixed effect,  $\gamma_{fpj}$  for the product-level trade survival—accordingly controlling for  $\gamma_{fj}$  for the firm-country level trade survival analysis—to deal with the time-invariant factors. In both cases, the year fixed effect,  $\gamma_t$  is also controlled. Moreover, the study controls for the new sets of fixed effects in the following series of robustness checks.

The results for trade survival are shown in Columns 1–4 of Table 5. The coefficients on the GVC position show no qualitative change in the positive impact of both GVC upstreamness of exports and imports on firm-country-year-level trade. The next two columns show the results for the impact of the GVC position on a firm's product-level trade survival. The positive impact of export upstreamness is confirmed to be robust, while no significant result is detected in the case of import upstreamness—The last two columns are responsible for firm survival. The negative and significant coefficients of the firm's upstreamness confirm the enhancing effect of GVC upstreamness on the probability of survival in the domestic market. Common to all specifications, the coefficients of the control variables in all specifications remain unchanged.

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<sup>14</sup> For both specifications, the first stage results are available on request. Typically, the results from the first stage confirm that the instrument has an expected positive and significant effect on the firm's upstreamness, and the F-statistics are large enough to reject the possibility of weak instruments.

Table 5. 2SLS Analysis of GVC Position on Survival

	(1)	(2)	(3)	(4)	(5)	(6)
	firm-country-year		firm-product-country-year		firm survival	
	trade survival		trade survival		firm survival	
lnUp Exp	-0.0967*** (0.00809)		-0.284*** (0.00583)		-0.825*** (0.0213)	
lnUp Imp		-0.0499*** (0.00797)		0.00550 (0.00456)		-0.675*** (0.0199)
lnSize	-0.0818*** (0.00150)	-0.0876*** (0.00196)	-0.0835*** (0.00102)	-0.0944*** (0.000809)	-0.0770*** (0.00195)	-0.0892*** (0.00181)
lnTFP	-0.0451*** (0.00377)	-0.0870*** (0.00508)	0.000995 (0.00231)	-0.0184*** (0.00172)	-0.0800*** (0.00748)	-0.0686*** (0.00748)
lnTariff	1.743*** (0.0219)	1.095*** (0.0316)	1.223*** (0.0154)	0.522*** (0.0164)		
lnAge	0.103*** (0.00188)	0.142*** (0.00294)	0.0687*** (0.00130)	0.0407*** (0.00123)	0.0656*** (0.00189)	0.0682*** (0.00189)
Firm-(Product)-Country FI	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE					Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,349,621	626,807	3,029,129	3,813,978	757,495	757,672

Robust standard errors in parentheses.

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Next, we conduct an alternative approach for survival models to deal with the problem of potential correlation between the fixed effects and firm characteristics. Specifically, a logistic probability model is employed to reexamine the impact on firm survival and trade survival<sup>15</sup>. In Table 6, results shown in Columns 1–4 distinguish how the two types of GVC upstreamness affect trade survival. There is no qualitative change in the coefficients of export and import upstreamness throughout both the aggregated and product-level trade. The last two columns are responsible for this effect on firm survival. The export upstreamness in Column 5 and import upstreamness in Column 6 consistently show a positive impact on survival probability. The signs of the control variables in all specifications are also consistent with previous cases. Consequently, the logistic models present similar results to the survival analysis model, confirming the robustness of our previous findings on the impact of GVC position on trade duration and firm survival.

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<sup>15</sup> For upstreamness, we choose the yearly-varying measure of Eq. (2). The robustness check employs the same model using the alternative upstreamness index defined in Eq. (3) and can be found in Table A3. The results show that the previous findings are robust and insensitive to the method of measuring upstreamness.

Table 6. Logistic Model Analysis of GVC Position

	(1)	(2)	(3)	(4)	(5)	(6)
	trade survival			firm survival		
	firm-country-year	firm-country-year	firm-product-country-year	firm-product-country-year	firm-product-country-year	firm-product-country-year
InUp Exp	-0.0335*** (0.0121)		-0.430*** (0.00922)		-0.194*** (0.0598)	
InUp Imp		-0.0418*** (0.0135)		-0.0122* (0.00640)		-0.173*** (0.0491)
InSize	-0.223*** (0.00421)	-0.324*** (0.00708)	-0.204*** (0.00277)	-0.177*** (0.00216)	-0.261*** (0.0130)	-0.260*** (0.0130)
InTFP	-0.0949*** (0.00944)	-0.205*** (0.0138)	0.0168*** (0.00611)	-0.0532*** (0.00448)	-0.296*** (0.0680)	-0.296*** (0.0679)
InTariff	4.118*** (0.0478)	2.330*** (0.0973)	3.002*** (0.0342)	6.668*** (0.0374)		
InAge	0.493*** (0.00602)	0.881*** (0.0127)	0.414*** (0.00396)	0.467*** (0.00377)	0.379*** (0.0232)	0.377*** (0.0231)
Firm-(Product)-Country FE	Yes	Yes	Yes	Yes		
Firm FE					Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,349,903	627,123	3,029,294	3,924,603	100,036	100,036

Robust standard errors in parentheses.

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Finally, Eq. (7) is reexamined by simultaneously controlling for the firm's export and import upstreamness (derived from Eq. (2) and Eq. (3)) to comprehensively observe how a firm's GVC position affects its performance<sup>16</sup>. Table 7 presents the results of this study. The first two columns report the results from the parametric survival model estimation using different types of upstreamness. Findings are consistent with the main conclusion that both, export and import upstreamness, simultaneously decrease the hazard ratio of death. The latter two columns further report the results obtained from the logistic models, and no substantial difference is observed. In each specification, there is no qualitative change in the magnitudes of the coefficients.

Table 7. Firm Survival Analysis by Controlling Two Upstreamness Indices

	Exponential		Logit	
	(1)	(2)	(3)	(4)
lnUp Exp	-0.135*** (0.0420)		-0.137** (0.0639)	
lnUp Exp fix		-0.128*** (0.0419)		-0.125* (0.0638)
lnUp Imp	-0.0888** (0.0363)		-0.133** (0.0526)	
lnUp Imp fix		-0.0872** (0.0361)		-0.139*** (0.0523)
lnSize	-0.138*** (0.00876)	-0.137*** (0.00875)	-0.262*** (0.0130)	-0.262*** (0.0130)
lnTFP	-0.253*** (0.0572)	-0.253*** (0.0572)	-0.298*** (0.0680)	-0.298*** (0.0680)
lnAge	0.191*** (0.0154)	0.191*** (0.0154)	0.379*** (0.0232)	0.379*** (0.0232)
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Observations	105,731	105,731	100,036	100,036

Robust standard errors in parentheses.

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

## 5. Concluding Remarks

<sup>16</sup> We do not reexamine the trade survival specification by simultaneously controlling for export and import upstreamness, because the impact of a firm's export (and correspondingly, import) upstreamness on the import (and correspondingly, export) survival needs much more careful investigation and is beyond the scope of this paper. It will be a fruitful topic for future work.

In recent years, the prevalence of GVCs in international trade and production has been increasingly fragmented across countries. While firms benefit from better access to high-quality inputs and larger customers, as well as the knowledge and technology spillover through participating in the GVCs, they also face more intensive competition in both the domestic and international markets, which can even affect the survival of firms.

This study investigates the impact of a firm's position in the GVCs on the probability of firm and trade survival in the Chinese market. The empirical analysis relies on a combined panel of Chinese firm-level trade over the 2000–2007 period, along with the industry-level input-output dataset provided by the WIOD. The empirical strategy is to investigate Chinese firms' behavior in terms of productivity and survival in the market as a function of a series of firm characteristics, especially the firm's position in the GVCs. We also employ a set of fixed effects to control for unobservable factors affecting a firm's performance.

The results show that firms with higher upstreamness can more easily continue their current trade activity compared to firms located in less upstream positions. Results of estimation of the effect of the firm's GVC position on the probability of firm survival implies that a more upstream position in the GVCs is beneficial to the firm's survival in the domestic market.

This study's findings have critical implications for firm management. Combined with the conclusions of Ju and Yu (2015) and Chor et al. (2021), the results show that firms with higher upstreamness in the GVCs—reflected by a wider span of production stages that firms undertake—which usually results from an increase in productivity, are spurred to keep more capital stocks and make higher annual investments, resulting in a higher probability of survival in both the domestic market and the increasingly competitive global market. Hence, even under the circumstances of the rising trade tensions between China and the US, as well as the global economic slowdown from the COVID-19 pandemic, firms will be motivated to actively participate in GVCs and further consider the role to play as well as the manner of participation.

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## Appendix A1. Manufacturing Industry Classification of the WIOT

Code	Industry	Code	Industry
A01	Crop and animal production, hunting and related service activities	C24	Manufacture of basic metals
A02	Forestry and logging	C25	Manufacture of fabricated metal products, except machinery and equipment
A03	Fishing and aquaculture	C26	Manufacture of computer, electronic and optical products
B	Mining and quarrying	C27	Manufacture of electrical equipment
C10- C12	Manufacture of food products, beverages and tobacco products	C28	Manufacture of machinery and equipment n.e.c.
C13- C15	Manufacture of textiles, wearing apparel and leather products	C29	Manufacture of motor vehicles, trailers and semi-trailers
C16	Manufacture of wood and of products of wood and cork, except furniture	C30	Manufacture of other transport equipment
C17	Manufacture of paper and paper products	C31- C32	Manufacture of furniture; other manufacturing
C18	Printing and reproduction of recorded media	C33	Repair and installation of machinery and equipment
C19	Manufacture of coke and refined petroleum products	D35	Electricity, gas, steam and air conditioning supply
C20	Manufacture of chemicals and chemical products	E36	Water collection, treatment and supply
C21	Manufacture of basic pharmaceutical products and pharmaceutical preparations	E37- E39	Sewerage; waste collection, treatment and disposal activities; materials recovery
C22	Manufacture of rubber and plastic products	F	Construction
C23	Manufacture of other non-metallic mineral products	G45	Wholesale and retail trade and repair of motor vehicles and motorcycles

Appendix A1. Manufacturing Industry Classification of the WIOT (Continued)

Code	Industry	Code	Industry
G46	Wholesale trade, except of motor vehicles and motorcycles	K66	Activities auxiliary to financial services and insurance activities
G47	Retail trade, except of motor vehicles and motorcycles	L68	Real estate activities
H49	Land transport and transport via pipelines	M69_	Legal and accounting activities; activities of
		M70	head offices; management consultancy activities
H50	Water transport	M71	Architectural and engineering activities; technical testing and analysis
H51	Air transport	M72	Scientific research and development
H52	Warehousing and support activities for transportation	M73	Advertising and market research
H53	Postal and courier activities	M74_	Other professional, scientific and technical
		M75	activities; veterinary activities
I	Accommodation and food service activities	N	Administrative and support service activities
J58	Publishing activities	O84	Public administration and defence; compulsory social security
J59_J	Motion picture, video and television		
60	programme production, sound recording and music publishing activities	P85	Education
J61	Telecommunications	Q	Human health and social work activities
J62_J	Computer programming, consultancy and related activities; information service activities	R_S	Other service activities
K64	Financial service activities, except insurance and pension funding	T	Activities of households as employers; undifferentiated goods- and services-producing activities of households
K65	Insurance, reinsurance and pension funding, except compulsory social security	U	Activities of extraterritorial organizations and bodies

Source: World Input-Output Tables.

Appendix A2. List of Countries of the World Input-Output Tables

ISO Code	Country	ISO Code	Country
AUS	Australia	IRL	Ireland
AUT	Austria	ITA	Italy
BEL	Belgium	JPN	Japan
BGR	Bulgaria	KOR	Korea Rep.
BRA	Brazil	LTU	Lithuania
CAN	Canada	LUX	Luxembourg
CHE	Switzerland	LVA	Latvia
CHN	China	MEX	Mexico
CYP	Cyprus	MLT	Malta
CZE	Czech Rep.	NLD	Netherlands
DEU	Germany	NOR	Norway
DNK	Denmark	POL	Poland
ESP	Spain	PRT	Portugal
EST	Estonnia	ROU	Romania
FIN	Finland	RUS	Russian Federation
FRA	France	SVK	Slovak Rep.
GBR	United Kindom	SVN	Slovenia
GRC	Greece	SWE	Sweden
HRV	Croatia	TUR	Turkey
HUN	Hungary	TWN	Taiwan
IDN	Indonesia	USA	United States
IND	India	ROW	Rest of the World

Source: World Input-Output Database.

Appendix A3. Logistic Model using Fixed-weighted Upstreamness

	(1)	(2)	(3)	(4)	(5)	(6)
	trade survival		firm-product-country-year		firm survival	
	firm-country-year	firm-country-year	firm-product-country-year	firm-product-country-year	firm survival	firm survival
lnUp Exp fix	-0.0981*** (0.0165)		-0.718*** (0.0114)		-0.184*** (0.0599)	
lnUp Imp fix		-0.165*** (0.0228)		-0.0515*** (0.00888)		-0.174*** (0.0489)
lnSize	-0.255*** (0.00311)	-0.538*** (0.00613)	-0.128*** (0.00184)	-0.223*** (0.00158)	-0.261*** (0.0130)	-0.260*** (0.0130)
lnTFP	-0.0937*** (0.00829)	-0.184*** (0.0122)	0.00918* (0.00501)	-0.0714*** (0.00377)	-0.296*** (0.0680)	-0.296*** (0.0679)
lnTariff	3.704*** (0.0433)	1.693*** (0.133)	2.318*** (0.0294)	2.627*** (0.0545)		
lnAge	0.465*** (0.00550)	0.830*** (0.0115)	0.372*** (0.00340)	0.484*** (0.00338)	0.379*** (0.0232)	0.377*** (0.0231)
Firm-(Product)-Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE					Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,618,205	745,688	3,650,015	4,722,662	100,036	100,036

Robust standard errors in parentheses.

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1