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Innovation, Product Sophistication and Export Market Survival: A Study of Indian Manufacturing

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Abstract: *The present study investigates the role of innovation on global market survival of Indian manufacturing firms. Specifically, the study examines whether research and development (R&D) investment enables firms to survive longer in export markets and global value chain markets. To achieve this objective, we source information on firms trading behaviour and R&D investments from the CMIE-Prowess database for the period 2001–18. Using a complementary log-log model, we find that firms investing in R&D experience a lower probability of exiting international markets. In addition, multiple sub-sample analysis indicates that importance of R&D becomes even more prominent for small and medium-sized firms. Based on the empirical findings, the study proposed policy suggestions for India.*

***Keywords*:** Global Value Chains; Research and Development; Survival analysis

***JEL Classification*:** F14; F15; O32; L6

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1 Introduction

The importance of innovation in shaping a firm's export behaviour is well embedded within the trade literature (Azar and Ciabuschi, 2017; Barrios, Görg, and Strobl, 2003; Caldera, 2010; Roper and Love, 2002). Within this strand of literature, the focus of most prior studies using micro-level data is mainly on the propensity and intensity to export, and the impact of innovation on export performance (Azar and Ciabuschi, 2017; Barrios, Görg, and Strobl, 2003; Caldera, 2010; Kumar and Siddharthan, 1994; Roper and Love, 2002; Wakelin, 1998). However, various studies have shown that the key to the export growth in developing economies is not merely the entry into the international markets, but the possibility of longer duration in exporting (Besedes and Prusa, 2010). Theoretical models of export market survival following heterogeneous firm models predict longer duration of exports due to sunk costs (Roberts and Tybout, 1997). Consequently, empirical studies started exploring the survival of firms in the exports markets (Besedes and Prusa, 2006). Even though numerous studies emphasise the importance of innovation on domestic market survival, the association between innovation and global market survival is less studied. Further, the rapid rise of the global value chain (GVC) phenomenon over the past 2 decades has provided firms with another avenue to participate in international market, and obtain higher gains. However, the literature related to GVCs has yet to examine factors affecting survival of participating firms. In addition, given that exporting is an intrinsic characteristic of firms participating in GVCs, the underlying rationale through which research and development (R&D) investments would impact firms' global survival may be similar to the firm survival in the export markets. Moreover, innovation enables firms to upgrade along the GVCs, which in turn increases the probability of firms to survive as they operate close to the upstream end where maximum value gets added (Ito et al., 2019; Kergroach, 2019). In this regard, whilst examining the relationship between innovation, export market, and GVC survival, there exists possibility of positive, negative, or insignificant impact of R&D investments. This follows from the previous studies, which highlight how firms' innovative efforts positively impact firm performance, enhancing their probability of survival in international markets. However, if the costs associated with innovative efforts outweigh benefits, then higher investment in R&D activities may not improve the likelihood of firm survival export markets (or GVCs). On the contrary, it may have negative influence, if the risk and costs associated are extremely high.

In this regard, the core objective of this study is to examine the role of innovation (proxied by R&D investment) in the export survival (and GVCs) of the Indian manufacturing firms. To this end, India provides an ideal testing ground for the following reasons. First, the economic reforms implemented in the early 1990s opened the Indian economy to the international markets with a myriad of trade reform measures aimed at promoting exports. Further, the manufacturing sector contributes around 72% of India's total exports (Economic Survey, 2019). However, despite its importance in the total exports, the manufacturing sector's contribution to overall global trade is still small (1.64% in 2018), compared to the other developing economies. Indian manufacturing's minimal global presence directs towards a possibility that Indian firms find it difficult to survive in the global markets. Second, the recent shock inflicted by the COVID-19 pandemic, and the apparent shift away from China provides Indian firms with an opportunity to establish footholds in international markets. Third, India occupies significant comparative advantage not only in the manufacturing exports involving unskilled labour, but in the mid-skill intensive products (Vashisht, 2016). Moreover, the policymakers' agenda of transforming India into the next manufacturing hub makes it important to examine the factors that could aid Indian firms' survival in the export market, which may foster their survival in the export markets, and boost the stagnant manufacturing sector.

Against this backdrop, we use rich firm-level panel data on Indian manufacturing firms collected by the Center for Monitoring Indian Economy (CMIE) Prowess database over 2001–18 to examine the impact of R&D investment on firm survival in the export and GVC markets. We use complementary log-log model and discuss the details of the estimation in the methodology section. Our findings suggest that firms investing in R&D experience lower hazard rate, i.e. participation in R&D is associated with longer survival in the export and GVC markets.

The rest of the paper is structured as follows. Section 2 presents a brief review of literature exploring the innovation and trade survival nexus. Section 3 sheds light on the data source and variable construction. Section 4 presents a descriptive analysis on exports and GVC market survival of Indian manufacturing firms. Section 5 explains the methodology employed. Section 6 presents the findings of our baseline model. Section 7 documents the results of various sub-sample analyses. Section 8 provides policy implications stemming from the empirical findings and concludes the study.

2 Theoretical Background and Related Literature

From a theoretical perspective, the significance of innovation on trade survival stems from improvement in a firm's competitive advantage. Process innovation enable firms to reduce their cost of production and further establish a foothold in global markets (Wakelin, 1988). Innovation also enables firms to introduce new products and, in turn, replace outdated products. This form of product switching results in reallocation of resources towards highly productive products, which decreases a firm's probability of failure in global markets (Zahra and George, 2002). The existing micro-level literature on innovation also reports that innovating firms have a higher absorptive capacity and that such firms operate closer to the global technological frontier, which reinforces 'learning-by-exporting', thereby positively influencing the survival of firms (Fontana and Nest, 2009; Deng et al., 2014). In addition, innovation also results in differentiated products, resulting in improved profitability for the firm, which affects its survival probability in global markets (Cefis and Marsili, 2006; Tavassoli, 2018; Zhang et al., 2018).

Contrary to the positive effects of innovation, the theoretical literature also documents the possibility of it impeding firms' export survival. This line of reasoning emanates from the fact that innovation requires substantial investment, and the outcome is uncertain. Hence, there exists a possibility that the underlying costs outweigh the gains (Deng et al., 2014). Further, Kafouros et al. (2008) highlighted that intensive global competition and the possibility of imitation limits the gains from innovation. Moreover, innovative efforts of competing firms may also constrain the extent of possible gains (Deng et al., 2014). Therefore, there exists a possibility that innovation has negative effects on survival of firms in global markets (Dai et al., 2020; Zhang et al., 2018).

Existing micro-level empirical studies on export survival highlight firm size, age, experience, ownership structure, financial constraints, differentiated products, and productivity as the key factors determining survival in export markets (Alvarez and López, 2008; Bellone et al., 2010; Fu and Wu, 2014; Inui, Ito, and Miyakawa, 2017;

Padmaja and Sasidharan, 2017). However, there is limited evidence in the context of innovation and export-survival nexus. An exception is a recent study that shows how innovative Chinese firms have a higher survival probability in the export markets than non-innovators (Dai, Liu, and Lin, 2020). The study also finds an inverted U-shaped relationship between innovation intensity and export-survival of Chinese firms. With reference to India, Dzhumashev et al. (2016) examined the effect of exporting and R&D investment on firms' survival for Indian information technology firms, which highlight positive influence of both factors. However, our study deviates from Dzhumashev et al. (2016) by focusing on export market survival, as opposed to domestic market survival, and on the manufacturing sector, as opposed to just one industry (information technology services).

In the context of GVCs, Córcoles et al. (2014), using a product sophistication index, highlighted that a higher complexity of goods enables firms in the auto industry to survive longer in GVCs. Hipp et al. (2020) highlighted that firm survival in the solar photovoltaics industry during 1960–2016 depended on the global innovation system (GIS), and showed that the survival was longer for those parts in the value chain where GIS was sticky compared to parts operating at footloose GIS. Using product and cross-country data, Obashi (2010) revealed that trade in machinery products, both finished and parts and components, have higher survival rates in East Asian countries. Along similar lines, Türkcan and Saygili (2019) documented that survival in global production chains is stronger for parts and components trade and vertically differentiated trade. Shao et al. (2012) found similar results from an export perspective, where Chinese manufacturing experienced longer survival for both differentiated and parts and components products. Córcoles et al. (2015) highlighted market size, product differentiation, and the geographical distance to the same trade integration area are key factors affecting survival of trade relationships in GVCs. Díaz-Mora et al. (2018) also highlighted the importance of GVC participation in establishing stable trade relationships. A common feature amongst these studies is that they examine the importance of GVCs as a factor in sustaining trade relations, whilst this study aims to examine factors that affects GVC trade relations at firm level.

However, whilst examining the impact of innovation on export survival, there remains ambiguity concerning the impact of R&D investment on a firm's survival in the export market. There exist two contrasting views about the impact of innovation on the export market survival. On the one hand, innovation results in improved productivity and profitability of firms and also leads to the learning-by-exporting effect, which reduce exit rates of exporting firms (Bernard, Redding, and Schott, 2011; Fontana and Nesta, 2009; Zhang, Zheng, and Ning, 2018). On the other hand, innovation itself requires large investments and involves high risk and uncertainty (Dai et al., 2020; Zhang et al., 2018). Therefore, failure of such investments to translate into successful output may result in higher exit rates from the export market due to the extreme financial burden, which is imperative for R&D firms. Therefore, from our brief review of existing studies, it is evident that the literature concerning innovation, exports, and GVC-linked firms' survival in the global market has not received adequate empirical attention. Hence, our study advances this strand of literature by exploring this nexus using an unbalanced panel of manufacturing firms.

3 Data and Variables

3.1 Data

The CMIE-Prowess database provides detailed firm-level information for 17,000 manufacturing firms, both listed and unlisted, procured from their audited annual reports and financial statements. The database contains information on firm exports, sales, salaries and wages, assets, R&D investment, business group affiliation, and ownership.[1] The companies included in the database constitute around 70% of the organized sector's economic activity and have been previously employed by various studies, including De Loecker, Goldberg, Khandelwal, and Pavcnik (2016) and Topalova and Khandelwal (2011). For the present study, we use the data pertaining to the firms belonging to two-digit Indian manufacturing industries over the period 2001–18.

In this regard, we begin our empirical analysis by making the data suitable for the survival analysis. As a first step, we drop all firms with missing or negative value on sales. Second, we drop firms with missing information on incorporation year of the firm, which is crucial for the age of the firm. Third, we also delete observations for which the

[1] PROWESS does not provide information about the location of the plant, only the registered office address. It may be possible that the corporate office address is in one city, whilst the plant is in another place.

time series length during the sample period is below 4. We adopt such a strategy since we use lagged value of some variables during the estimation. Further, the computation of total factor productivity (TFP) following semi-parametric estimation requires a minimum 3 years of time series data. Further, with respect to defining export/GVC market exit in the sample, we follow existing literature on firm survival, which defines exit as firms that are involved in global export market (GVC) in year *t*, but not in the year *t+1* (Dai et al., 2020). In this regard, one of the major empirical concerns whilst undertaking survival analysis is censoring, i.e. the inability to observe the complete export (GVC) history of the firms (Besedeš and Prusa, 2006). Therefore, censoring in the data arises from: (i) left-censoring, and (ii) right-censoring. Left-censoring in the export market survival context refers to firms that are involved in the export (GVC) market at the beginning of our study period. In order to account for this issue, we exclude all left-censored spells (Besedeš and Prusa, 2006). Therefore, our analysis corresponds to those firms that began exporting (GVC) after 2001. Unlike the difficulty posed by left-censoring spells, the issue of right-censoring spells can be tackled through survival analysis methods (Schwartz, 2013; Fu and Wu, 2014). Consequently, right-censoring refers to firms that continue to export (GVC) at the end of the study period.

Table 1: Duration Pattern

No	**09**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**Pattern**	
1	✓	✓	✓	✓	✓	X	X	X	X	Left-Censored	Single Spell
2	X	X	X	X	X	✓	✓	✓	✓	Right-Censored	Single Spell
3	X	X	✓	✓	✓	X	X	X	X	Completed	Single Spell
4	X	✓	✓	X	X	✓	✓	X	X	Completed	Multiple Spell

Note: ✓ - firm is exporting (GVC) in the given year; X – firm exits
Source: Authors.

In addition to the issues posed by censoring, another concern is the multiple spells in the data. Table 1 highlights the spell pattern observed during the survival analysis.[2] The table presents the issue of left- and right-censored spells documented in the survival analysis. It also highlights multiple spells, where firms enter, exit, and re-enter the export (GVC) market. This results in measurement errors on the export duration front. One

[2] Though the study period of our analysis is 2001–18, for ease of depiction we show the spell pattern for 2010–18.

widely employed method to circumvent the concern of multiple spells is to treat multiple spells as independent (Besedeš and Prusa, 2006). Therefore, we consider single spell and first spell of multiple spells as the benchmark. Finally, since the objective of the present study is to examine the export (GVC) survival of firms, following the standard practice in the literature, we drop all the firms that never engage in exporting (GVC) activities during the study period. Following our data filtering, we are left with an unbalanced panel of 944 exporting firms and 992 GVC firms over 2001–18.

3.2 Variables

In this study, as mentioned earlier, the objective is to examine the role of R&D on firm survival in the export and GVC markets. Therefore, the export status, GVC participation and R&D activities of the firm are at the centre of our empirical setup. In this regard, the CMIE-PROWESS database provides information on firm's exports allow us to identify both export participation and export intensity of the firm. Consequently, export participation is a binary variable, which takes the value 1 if the firm is an exporter, and 0 otherwise. On the other hand, export intensity is measured as the ratio of exports to total sales. Along the similar lines, the availability of information on firms' imports and exports enables us identify GVC firms as those that are engaged in both importing and exporting activities at the same time (Antràs, 2020; Urata and Baek, 2020; Rigo, 2021; Dovis and Zaki, 2020; Ehab and Zaki, 2021; World Bank, 2020; Banga, 2021).

In addition, the PROWESS database also provides information on firms' R&D expenditure.[3] The information on R&D outlay provided by PROWESS database is further classified based on capital and current account expenditure. The R&D expenditure on the capital account head refers to investment in long-term fixed assets that can be amortized longer than one fiscal period. In contrast, R&D expenditure under the head of current account refers to short-term spending that pertains to the year in account We sum the current and capital account expenses to arrive at the total R&D outlay of the firms during the year. This information enables us to identify firms undertaking investment in innovative activities. Consequently, our R&D measure is also a binary variable, which takes the value of 1 if a firm undertakes R&D and 0 otherwise. Further, we measure R&D intensity as the ratio of R&D expenditure to total assets.

[3] PROWESS does not contain information on product or process innovation.

In addition, the 1956 Companies Act requires Indian firms to report product-level information such as sales, capacity, and quantity of products. This facilitates constructing the product sophistication index as an alternate measure for innovative ability of the firm. However, reporting of such information is not in accordance with any particular classification. Rather, CMIE employs its own classification where each product is given a 20-digit code inspired by National Industrial Classification (NIC) and Harmonized System (HS)schedules.

To construct this index, we first match the unique 20-digit code provided by Prowess with HS classification. This matching is feasible since the Prowess product codes are closely related to ISIC classification, similar to that of HS classification. In this regard, an ideal scenario would be to match products at 6 digits, the lack of detailed information on product names reported by firms acts as a barrier. Hence, we match the 20-digit product code of Prowess with HS-1996 classification at 4 digits by hand. We achieve a match of around 80% between CMIE product codes and HS-4 codes. To elucidate the matching procedure, consider the following example the product category of *Men's or Boy's overcoat* is categorized by the HS-4-digit product code of 6101. Prowess provides a unique 20-digit product code for the same product category of *Men's overcoat*. These names can therefore be easily matched (Refer to Table A1 in appendix for more examples). Further, in case of a single product being matched to multiple HS codes, we take the average PRODY of these products to arrive at the value for Prowess product. Using this, we capture the sophistication of Indian products *(SOPHY)* as the sales-weighted average (*PRODY*),[4] which captures the average tacit technological level of the product. The index captures the average tacit technological level of the product. Equation 1 represents the PRODY index, where x_{jk} are the exports of product k by country j. Hence, the numerator is the value share of product k in the country's overall export basket, and the denominator aggregates the value share of a commodity across all the countries exporting the good. The index is the weighted average of the per capita gross domestic product of the countries exporting that product, with the weights representing relative comparative advantage. The underlying rationale behind using relative comparative advantage is to ensure that the inherent size of the country is accounted for and that size

[4] Product sophistication (PRODY) is measured following Hausmann, Hwang, and Rodrik (2007).

does not lead to distortion of the ranking of the goods. The index thus portrays how rich countries produce more sophisticated products than low-income countries.

$$PRODY_k = \sum_j \frac{x_{j_k}/X_j}{\sum_j x_{j_k}/X_j} Y_j \qquad (1)$$

$$SOPHY_{it} = \sum_k \frac{sales_{it}^k}{\sum_k^k Sales_{it}^k} PRODY_K \qquad (2)$$

Using the PRODY index, we construct the product sophistication measure as *SOPHY* (equation 2), which is weighted average of the PRODY measure highlighting the average sophistication of a product produced by the firms. It is a sales weighted average; hence, a higher sophistication value indicated that the firm generates greater sales through sophisticated products (Eck and Huber, 2016; Banga, 2021). In this regard, the $SOPHY_{it}$ in equation 2 deviates from the original index proposed by Hausman et al. (2007), which examines the same at the country level. The difference between the original index and our measure is the use of weights, where the original is the share of good in country's total exports, whereas this index is at the firm level, using the sale of a product relative to overall sales by the firms as the weights. The modified measure at the firm level has been previously used by Eck and Huber (2016) and Banga (2021). The index enables us to explore the impact of product sophistication in the survival of firms in the export market and GVCs.

In addition, we include a host of firm-specific controls. To this end, we control for firm productivity, age, size, ownership, and previous experience in the export market in five steps. The inclusion of these covariates is based on the prior literature. To elucidate further, the literature documents that firm productivity plays an essential role in firm survival, since more productive firms are more profitable and firms that find it difficult to generate profits through exporting will eventually exit the international market (Roberts and Tybout, 1997; Dai et al., 2020). Therefore, we first posit positive relationships between firms' TFP and export (GVC) market survival. Second, we account for firm size since larger firms exploit their scale advantage, which adds to their competitiveness (Fu and Wu, 2014). On the other hand, larger firms also face a higher risk of exit from foreign markets due to their rigid management modes, and sheer size of operations (Dai et al., 2020). There exists ambiguity concerning the impact of firm size on survival; therefore, this remains an empirical question. Third, prior studies also document that firms with higher share of exports are more likely to survive in foreign markets (Rauch and Watson, 2003; Besedeš, 2008). Hence, we account for the export intensity of the firm, defined as the ratio of exports to total sales. Fourth, we also control for firms' age as the log of number of years since incorporation. Older firms with established track records are less likely to fail in the international market. However, recent literature also shows that younger firms are more involved in global markets. Hence, controlling for age allows us to highlight the implications of firm age on survival of Indian firms in global markets. Finally, we control for ownership structure of the firm. In this regard, we control for foreign ownership[5] and business group affiliation since such firms enjoy networking advantages, and have better access to technology and foreign market information, which sustains their survival in the global markets (Fu and Wu, 2014; Padmaja and Sasidharan, 2017).

Table 2 presents an overview of the variables used in the analysis and their construction. The table also provides descriptive statistics of the data. From the table, we observe that 48% of the firms are involved in exporting, and 45% of the sample observations correspond to GVC firms. Around 18% of the sample exporting firms engage in R&D activities, whilst 20% of the GVC firms report R&D. Further, in terms of our sample pertaining to exports, 2.5% of the firms operate under the umbrella of business groups, whilst 3.3% are foreign-owned. This share increases to 2.8% and 4.1%, respectively, for the sample pertaining to GVC firms.

Table 2: Summary Statistics

Variable		**Obs.**	**Mean**	**Std. Dev.**	**Min.**	**Max.**
Panel A	Export Survival					
ExportDum	=1 if a firm export and 0 otherwise	11,772	0.484	0.5	0	1
RDDum	=1 if a firm invests in R&D	11,772	0.185	0.388	0	1
R&D Intensity	R&D expenditure of the firm relative to its total assets	2,175	0.010	0.025	0	0.742
lnAge	Log of Number of years firm has been in operation	11,772	3.124	0.543	1.099	4.615
LnTFPLP	Log of TFP computed following Levinsohn and Petrin (2003)	11,772	4.255	1.072	0.787	10.102
Lnsize	Log of Total Assets	11,772	6.899	1.575	1.386	12.673
Group Dummy	=1 if a firm is affiliated to a business group	11,772	0.256	0.437	0	1
LnPdy	Log of Product Sophistication Index	3,624	7.987	2.227	0.215	10.087

[5] We consider a firm as foreign if the foreign promoters share is greater than 10%.

	*(SOPHY)**					
Foreign	=1 if a firm is foreign-owned	11,772	0.033	0.178	0	1
Panel B	GVC Survival					
GVC	=1 if a firm simultaneously exports and imports	12,766	0.452	0.498	0	1
RDDUM	=1 if a firm invests in R&D	12,766	0.201	0.401	0	1
R&D Intensity	R&D expenditure of the firm relative to its total assets	2,621	0.009	0.0229	0	0.742
LnAge	Log of Number of years firm has been in operation	12,766	3.138	0.535	0.693	4.615
LnTFLP	Log of TFP computed following Levinsohn and Petrin (2003)	12,766	4.217	1.064	0.45	10.102
LnSize	Log of Total Assets	12,766	6.937	1.554	2.351	12.673
Group Dummy	=1 if a firm is affiliated to a business group	12,766	.28	.449	0	1
LnPdy	Log of Product Sophistication Index	3,624	7.987	2.227	0	10.087
Foreign	=1 if a firm is foreign-owned	12,766	.041	.199	0	1

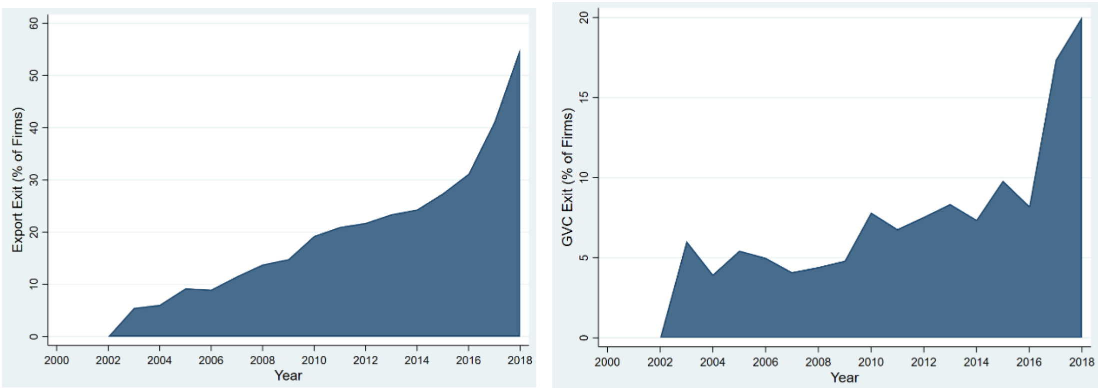
Note: (i) * the number of observations for LnPdy is low since its construction required consistent firm-level information on product sales. (ii) Of the overall sample of 944 export and 992 GVC firms, we are able to match information for only 133 firms which corresponds to 3,624 observations. (iii) GVC denotes global value chain; Exportdum refers to export dummy; RDdum refers to R&D dummy; TFP refers to total factor productivity; Pdy refers to Product Sophistication Index.

Source: Authors' computation using CMIE-PROWESS database.

4 Descriptive Analysis

In this section, we present some stylised facts concerning firm survival of the sample firms. We begin by examining the trend of firm exit from export and GVC markets over the study period. Figure 1 presents the graphical representation, which highlights similar patterns of increasing exit amongst firms in both export and GVC markets.

Figure 1: Dynamics of Export and GVC Market Exit of Firms



(a) Export Exit (b) GVC Exit

GVC = global value chain.

Source: Authors' computation using CMIE-PROWESS database (https://prowessiq.cmie.com/).

From the figure, we observe an increasing trend in the number of firms exiting from the global market. To shed some more light on the pattern of a firm's involvement in global markets, we examine firm participation sequence of the sample firms. In Tables 3 and 4, we present the export and GVC order sequence of the sample. In the tables, each sequence is representative of the number of times a firm participates in the global market and its pattern of involvement. The value 0 indicates when a firm participates in the export (GVC) market, whilst 1 indicates exit. From Table 3, we observe that, out of 994 firms in our export survival sample, 338 have single spell, where an exporting firm exits the market, never to re-enter. Further, we have 33% of the firms that survived in the export market throughout the study period. The table also highlights that the remaining 34% of the firms experience multiple spells. In this regard, 137 firms in the sample exit, re-enter and re-exit the market, whilst 104 firms exit, re-enter, and remain as exporters till the end of the study period.

Table 3: Export Sequence Order

Sequence-Order		Freq.	Percent	R&D (% Total Assets)
0000001		338	35.81	1.1%
0000000		313	33.16	0.7%
0101		137	14.51	0.4%
010		104	11.02	1.6%
01010		22	2.33	3%
010101		18	1.91	2%
01010101		9	0.95	0.3%
0101010		2	0.21	0.4%
0101010101		1	0.11	0%

R&D = research and development.
Note: (i) "0" refers to firm exporting and "1" depicts firm exit from the market. (ii) For brevity, we report the grouped sequence order. The sequences are considered similar based on order similarity, i.e. sequences are similar where the elements appear in the same order. The sequence A-B-B-A is treated identical to A-B-A-A, because the elements A and B appear in the same order in both sequences (first A, then B, and then A again). For example: 001, 00001, 0000001, 000000001, 011111111111111 are all treated as similar since once a firm exits, it does not re-enter.
Source: Authors' computation using CMIE-PROWESS database.

Table 4: GVC Sequence Order

Sequence-Order	Freq.	Percent	R&D (% Total Assets)
010	403	40.63	1.2%
0000	253	25.5	0.8%
001	119	12	1.02%
01010	118	11.9	0.8%
0101	54	5.44	0.5%
0101010	20	2.02	1.4%
010101	11	1.11	0%
010101010	6	0.6	0.2%
01010101	5	0.5	0.4%
0101010101	2	0.2	0.4%
01010101010	1	0.1	0%

GVC = global value chain, R&D = research and development.
Note: (i) "0" refers to firm exporting and "1" depicts firm exit from the market. (ii) For brevity, we report the grouped sequence order. The sequences are considered similar based on order similarity, i.e. sequences are similar where the elements appear in the same order. The sequence A-B-B-A is treated identical to A-B-A-A, because the elements A and B appear in the same order in both sequences (first A, then B, and then A again). For example: 001, 00001, 0000001, 000000001, 011111111111111 are all treated as similar since once a firm exits, it does not re-enter.
Source: Authors.

Table 5: Percentage of Exporting and GVC Firms Undertaking R&D

	R&D (% of firms)	
Year	**Exporters**	**GVC firms**
2002	26.09	25.35
2003	28.00	27.93
2004	22.92	22.67
2005	24.71	26.63
2006	24.66	26.13
2007	23.13	24.81
2008	22.26	24.18
2009	21.75	22.52
2010	23.12	24.79
2011	23.92	24.94
2012	22.12	23.81
2013	21.46	25.16
2014	21.71	25.79
2015	21.89	25.46
2016	20.19	23.35
2017	18.52	22.07
2018	19.02	18.83
Total	21.91	24.19

GVC = global value chain, R&D = research and development.
Note: the percentage is computed as number of exporting (GVC) firms undertaking R&D relative to all exporting (GVC) firms.
Source: Authors' computation using CMIE-PROWESS database.

Similar to the export order sequence, Table 4 presents the GVC sequence order of the sample firms. We observe that out of 992 firms, 253 remain as GVC firms throughout the study period. Further, 40% of the firms exit the GVC framework to eventually re-enter again. On the other hand, our sample has 119 GVC firms that exit the market permanently. Further, almost 22% of the firms experience multiple spells, with 66% of these firms remaining as GVC firms till the end of the study period, whilst 33% exit. Further, Table 5 documents the distribution of exporting and GVC firms undertaking R&D investment. In general, we observe a similar pattern of R&D investment between exporting firms and GVC firms. However, overall, 24% of GVC firms undertake R&D investment compared to 22% of exporting firms. Moreover, a closer inspection of Table 5 reveals a slight downward trend in R&D amongst the exporters and GVC firms.

5 Methodology

We employ a discrete-time hazard model to examine the R&D investment and export-survival nexus. In this regard, the early literature often relied on estimating proportional hazard models like the Cox model. However, recent literature points out certain lacunae associated with the Cox model (Hess and Persson, 2012; Inui, Ito, and Miyakawa, 2017; Zhang et al., 2018; Dai et al., 2020). First, Cox models fail to control for unobserved heterogeneity. Second, the proportional hazard assumptions are unlikely to hold for trade duration data. Third, the model leads to biased results in the case of discrete data. In order to overcome the shortcomings of the Cox model, recent studies use complementary a log-log (cloglog) model (Dai et al., 2020; Hess and Persson, 2012; Inui, Ito, and Miyakawa, 2017; Padmaja and Sasidharan, 2017; Zhang et al., 2018). The cloglog model is a non-parametric approach and does not make any assumptions regarding the distribution of individual heterogeneity. Moreover, this model is well suited for the censored data at hand. In this context, the discrete-time hazard rate h_{it} that a firm i exit the export (or GVC)[6] market at time t can be formally defined as:

$$h_{it}(X_{it}) = prob(T_i < t + 1/T_i) = F(X'_{it}\beta + \gamma_t) \quad (2)$$

Where X_{it} is a vector of explanatory variables, and γ_t is the baseline hazard rate, and is time-varying. Further, by incorporating a binary variable which takes the value 1 for a firm that exits the export market at time t and 0 otherwise, we can represent the basic cloglog model as:

$$h_{it}(X_{it}) = 1 - exp = [-exp(\beta_0 + \beta_1 R\&D_{it} + \beta_2 X + \gamma_t] \quad (3)$$

From equation 3, the main variable of interest is the coefficient of R&D on export survival (and GVC survival) of the sample firms. Moreover, the cloglog model also considers the industry and year-fixed effects to control for industrial heterogeneity and changes over time in the firm's export (and GVC) survival. To estimate equation 3, we employ random effect panel probit estimation. X is a vector of control variables, which includes TFP, size, age, export intensity, foreign ownership, and business group affiliation. In this regard, we use lagged values of export intensity, firm productivity, and

[6] From a GVC perspective, the exit dummy is defined as 0 when a firm stops either importing or exporting activity. However, in our sample, we observe that over 96% of the sample that exits become pure domestic firms as they stop both exporting and importing activities.

firm size to reduce any endogeneity bias in the model. Further, we compare the results from the cloglog against a Proportional Hazard Model and Probit Model.

6 Results

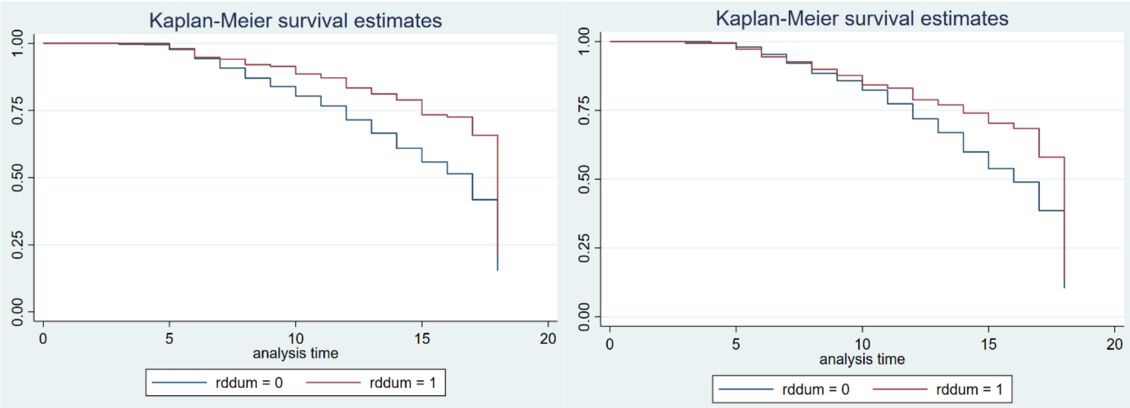
To highlight substantial differences in the survival estimates of firms undertaking R&D vis-à-vis non-R&D firms, we rely on the long rank test. The long rank test is used for the equality of the survivor function (Table 6). From the table, we observe that there is substantial difference between survival function of firms undertaking R&D compared to others.

Table 6: Long Rank Test

Variable	Chi Square	P Value
Export Survival		
R&D	15.75	0.0001
GVC Survival		
R&D	13.05	0.0003

GVC = global value chain, R&D = research and development.
Source: Authors.

Figure 2: Survival Rates Based on R&D Investment



(a) Export survival – R&D group (b) GVC survival – R&D group

GVC = global value chain, R&D = research and development.

Source: Authors' computation using CMIE-PROWESS database (https://prowessiq.cmie.com/).

Further, we graphically examine the difference between survival of firms that invest in R&D and non-R&D firms. To this end, we present the Kaplan-Meier survival rates in Figure 2, where Figure 2(a) shows Kaplan-Meier survival estimates[7] for exporters, and Figure 2(b) denotes GVC firms. From the figures, we observe that the probability of survival is smooth for 5–6 years; however, the likelihood of exit increases thereafter. Further, the figure shows that survival of firms investing in R&D is more consistent, and smoother compared to the non-R&D firms. This difference is prominent for both export and GVC survival functions, which adds strength to our hypothesis that R&D plays a significant role in the firm survival in global markets.

6.1 R&D Investment and Export Survival

To empirically examine the role of R&D on firm survival in the export market, we estimate a discrete-time hazard model (equation 3). To contrast the result, we estimate a probit model and the traditional Cox proportional model, followed by our main complementary log-log model. Table 7 documents the findings of our empirical analysis, where Columns (1) and (2) highlight the estimates from the probit model, Columns (3) and (4) present the results of the Cox model, and Columns (5) and (6) present the

[7] Kindly refer to the Figures A1 and A2 presented in the Appendix to for Kaplan-Meier Survival estimates highlighting the heterogeneity of exit across two-digit manufacturing industries.

coefficients from the cloglog estimates. From the table, we observe that our main variable of interest, R&D, has a negative and significant coefficient across all specifications, which highlights the negative relationship between R&D investment and international market exit. This implies that the hazard rate of exiting from the export markets falls substantially for firms that are engaged in innovative activities. In terms of coefficients from the probit model, we observe that exporting firms undertaking R&D have a 2.3% lower hazard rate of exit[8] compared to the non-R&D firms. Further, in terms of our control variables, we find that more productive firms, business group affiliates, and foreign firms are more likely to survive in export markets. Moreover, we find that younger firms are more likely to survive in export markets, echoing the similar results for Indian manufacturing (Padmaja and Sasidharan, 2017).[9] Further, as mentioned, there exists mixed evidence on the role of firm size on export firm survival. In our analysis, we find that larger firms experience higher hazard rate compared to smaller firms. In addition, we also document significant and negative impact of export intensity, which suggests that firms exporting a greater share of their output enjoy learning-by-exporting gains increases their chances of survival. This is line with the findings of the earlier studies (Perez et al., 2013, Fu and Wu, 2014).

[8] The hazard ratio is measured as $e^{(-0.024)} = 0.976$, following which the hazard rate is computed as (1-hazard ratio) *100.

[9] This finding is consistent with the limited evidence on India (Padmaja and Sasisharan, 2017). Moreover, the recent literature on GVC has also documented that younger firms are more involved in GVCs. For instance, Lu et al. (2018) found a negative coefficient on firm age, highlighting that older firms are participating less in GVCs. Minetti et al. (2019) also highlighted that younger firms are more inclined to GVC integration. Further, the 'born global' strand of literature documents that younger firms reap the benefits of 'learning advantage of newness' as young firms are agile in adapting to different market conditions and changes (Autio et al., 2000). The born global strand of literature also highlights the innovative-intensive nature of firms. In this regard, younger firms have an incentive to innovate to remain competitive in global markets (Acemoglu and Cao 2015). Further, Grazzi and Moschella (2017) highlighted that older firms are more rigid compared to younger firms.

Table 7: R&D and Export Survival – Discrete-time Proportional Hazard Model

	Probit Model		Cox-Model		Cloglog Model	
VARIABLES	(1) Export Exit	(2) Export Exit	(3) Export Exit	(4) Export Exit	(5) Export Exit	(6) Export Exit
lexpint	-0.0788***	-0.0743***	-2.455***	-2.414***	-0.0919***	-0.0858***
	(0.0172)	(0.0170)	(0.479)	(0.475)	(0.0209)	(0.0204)
rddum	-0.0243***	-0.0257***	-0.46***	-0.45***	-0.0242***	-0.0255***
	(0.00578)	(0.00578)	(0.131)	(0.131)	(0.00588)	(0.00585)
logage	0.0337***	0.0347***	-0.401***	-0.391***	0.0331***	0.0337***
	(0.00432)	(0.00429)	(0.131)	(0.131)	(0.00436)	(0.00432)
ltfp	-0.0174***	-0.0156***	-0.357***	-0.332***	-0.0184***	-0.0168***
	(0.00327)	(0.00326)	(0.074)	(0.074)	(0.00334)	(0.00335)
group	-0.0220***	-0.0238***	-0.347***	-0.329***	-0.0242***	-0.0272***
	(0.00512)	(0.00509)	(0.115)	(0.115)	(0.00531)	(0.00530)
foreign	-0.0227*	-0.0259**	-0.445	-0.443	-0.0261**	-0.0286**
	(0.0125)	(0.0124)	(0.291)	(0.291)	(0.0132)	(0.0131)
lsize	0.0196***	0.0196***	0.221***	0.209***	0.0200***	0.0209***
	(0.00200)	(0.00198)	(0.044)	(0.044)	(0.00204)	(0.00203)
Log Likelihood	-1,908.5878	-1,845.9446	-2,966.0135	-2,918.0134	-1,907.7986	-1,840.7303
Industry Dummy	Yes	Yes	Yes	Yes	Yes	Yes
Year Dummy	-	Yes	-	Yes	-	Yes
Observations	10,751	10,751	10,751	10,751	10,751	10,751

R&D = research and development.

Note: (i) All columns report marginal effects. (ii) Standard errors are in parenthesis. *** p<0.01, ** p<0.05, * p<0.1.

Source: Authors.

6.2 R&D Investment and GVC Survival

Similar to the preceding analysis, we investigate the importance of R&D on the survival of GVC firms. Table 8 highlights the result of the random effect estimation of the Probit model, Cox model, and the cloglog model. The findings are similar to that of export survival analysis. From the table, we observe a negative and significant coefficient of R&D on firm exit. However, the coefficients indicate a lower hazard rate of 1.6% to 2.6% compared to non-R&D GVC firms. Hence, the results highlight that investment in R&D reduces the hazard rate of exit and increases firm survival in both GVC and export market. Further, in terms of controls, we find that more productive firms, foreign firms, business group affiliates have lower probability of exiting from the GVCs.

Table 8: R&D and GVC Survival – Discrete-time Proportional Hazard Model

	Probit Model		Cox Model		Cloglog Model	
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
VARIABLES	**GVC Exit**	**GVC Exit**	**GVC Exit**	**GVC Exit**	**GVC Exit**	**GVC Exit**
lexpint	-0.0270***	-0.0227**	-0.757***	-0.729***	-0.0277**	-0.0218**
	(0.0103)	(0.0102)	(0.223)	(0.223)	(0.0111)	(0.0107)
rddum	-0.0185***	-0.0198***	-0.303***	-0.287***	-0.0181***	-0.0196***
	(0.00544)	(0.00541)	(0.11)	(0.11)	(0.00549)	(0.00541)
logage	0.0430***	0.0442***	-0.307***	-0.307***	0.0414***	0.0419***
	(0.00444)	(0.00437)	(0.118)	(0.119)	(0.00443)	(0.00431)
ltfp	-0.0210***	-0.0190***	-0.296***	-0.275***	-0.0210***	-0.0179***
	(0.00347)	(0.00343)	(0.06)	(0.061)	(0.00355)	(0.00350)
group	-0.0239***	-0.0260***	-0.316***	-0.319***	-0.0267***	-0.0298***
	(0.00496)	(0.00490)	(0.098)	(0.098)	(0.00517)	(0.00507)
foreign	-0.0237**	-0.0271**	-0.491**	-0.498**	-0.0268**	-0.0297**
	(0.0114)	(0.0113)	(0.24)	(0.24)	(0.0120)	(0.0118)
lsize	0.0226***	0.0229***	0.194***	0.188***	0.0223***	0.0231***
	(0.00204)	(0.00201)	(0.037)	(0.037)	(0.00204)	(0.00198)
Log Likelihood	-2,243.5179	-2,142.1307	-3,669.6571	-3,611.1683	-2,247.1761	-2,086.2874
Industry Dummy	Yes	Yes	Yes	Yes	Yes	Yes
Year Dummy	-	Yes	-	Yes	-	Yes
Observations	11,695	11,695	11,695	11,695	11,695	11,695

GVC = global value chain, R&D = research and development.
Note: (i) All columns report marginal effects. (ii) Standard errors are in parenthesis. *** p<0.01, ** p<0.05, * p<0.1.
Source: Authors.

6.3 Intensive Margins of R&D and Survival in Global Markers

The preceding analysis highlights the positive impact of firms' decision to invest in R&D and global market survival. In other words, firms' exit probability from export and GVC markets reduces if a firm decides to undertake R&D investment. In this section, we examine if the relationship between R&D and firm survival varies based on the R&D intensity. In this regard, we use lagged value of R&D investment in place of R&D dummy in equation 3, and estimate the cloglog model. Table 9 presents the findings of this analysis. From the table, we observe that, similar to our baseline findings, we find that firms exporting a higher share of its sales have a lower hazard rate of exiting from export and GVC markets. In terms of R&D intensity, we find that the coefficient across all specifications is negative, which indicates that the higher level of R&D investment enables firm survival in international markets; however, the coefficient is statistically insignificant. Further, similar to our baseline findings, we find more productive firms, business group affiliates, and small and young firms face a lower hazard of exit from global markets.

Table 9: R&D Intensity and Export/GVC Survival

	(1)	(2)	(3)	(4)
VARIABLES	**Export-Exit**	**Export-Exit**	**GVC-Exit**	**GVC-Exit**
lexpint	-0.170**	-0.165**	-0.0506*	-0.0362
	(0.0664)	(0.0652)	(0.0274)	(0.0260)
lrdint	-0.0395	-0.0255	-0.146	-0.177
	(0.214)	(0.238)	(0.300)	(0.315)
logage	0.0254**	0.0252**	0.0374***	0.0373***
	(0.0106)	(0.0106)	(0.0104)	(0.0101)
ltfp	-0.0196**	-0.0198**	-0.0237***	-0.0243***
	(0.00960)	(0.00985)	(0.00902)	(0.00934)
group	-0.00933	-0.0119	-0.0300***	-0.0369***
	(0.0111)	(0.0111)	(0.0113)	(0.0112)
foreign	0.00599	0.00427	0.00643	0.00855
	(0.0216)	(0.0215)	(0.0206)	(0.0202)
lsize	0.0277***	0.0292***	0.0293***	0.0318***
	(0.00548)	(0.00561)	(0.00503)	(0.00517)
Log Likelihood	-339.2891	-329.74929	-477.9093	-449.71217
Industry Dummy	Yes	Yes	Yes	Yes
Year Dummy	-	Yes	-	Yes
Observations	2,008	2,008	2,420	2,420

GVC = global value chain, R&D = research and development.
Note: (i) All columns report marginal effects. (ii) Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1
Source: Authors.

7 Sub-Sample Analysis

Participating in international markets requires substantial costs, making the financial condition of a firm an important factor in shaping its decisions as well as its survival (Musso and Schiavo, 2008; Minetti et al., 2019). Moreover, financial constraints could hinder its investment in innovative activities, thereby affecting firm performance and increasing its likelihood of exiting the international market. In order to account for this channel of operation, we proxy for the financial condition of the firm using leverage ratio[10] (Greenaway, Guariglia, and Kneller, 2007; Stiebale, 2011). We interact leverage measure with a firm’s decision to invest in R&D activities. Table 10 documents the result

[10] The leverage ratio is measured as the ratio of firm’s debts to total assets of the firm. A higher ratio indicates higher financial constraint of the firm.

of our findings. We find that firms with higher leverage have lower probability of survival in the export market. Further, we observe that the coefficient of the interaction measure is negative and significant, highlighting that low-leveraged firms that invest in R&D experience lower hazard rate in the export market, i.e. higher survival probability. On the other hand, the coefficient of this interaction variable is significant only at 10% in the context of GVC participation. This can be attributed to the inter-firm relationship between firms in GVCs, which results in firms being dependent on inter-firm trade credit for fostering their GVC integration (Minetti et al., 2019). Therefore, the presence of inter-firm trade credit highlights an alternate avenue, which is instrumental in the firm's GVC participation. The results of other control variables are consistent with our baseline findings.

Table 10: R&D, Finance and Firm Survival in Export (GVC) Markets- (clog-log)

VARIABLES	(1) Export-Exit	(2) Export-Exit	(3) Export-Exit	(4) GVC-Exit	(5) GVC-Exit	(6) GVC-Exit
lexpint	-0.0995***	-0.104***	-0.102***	-0.0195*	-0.0218**	-0.0198*
	(0.0219)	(0.0223)	(0.0222)	(0.0106)	(0.0108)	(0.0107)
rddum	0.00442	0.00426	0.00385	-0.00826	-0.00783	-0.00787
	(0.00957)	(0.0100)	(0.00997)	(0.00566)	(0.00599)	(0.00600)
levrddum	-0.0741***	-0.0814***	-0.0822***	-7.280	-7.667*	-8.085*
	(0.0262)	(0.0271)	(0.0269)	(4.437)	(4.538)	(4.619)
Llev	0.0132*	0.0142*	0.0143**	-0.0416	-0.0666	-0.0872
	(0.00692)	(0.00730)	(0.00722)	(0.163)	(0.172)	(0.183)
logage	0.0314***	0.0327***	0.0334***	0.0384***	0.0392***	0.0401***
	(0.00423)	(0.00441)	(0.00440)	(0.00435)	(0.00445)	(0.00441)
ltfp	-0.00750***	-0.0139***	-0.0134***	-0.0101***	-0.0139***	-0.0134***
	(0.00225)	(0.00307)	(0.00309)	(0.00224)	(0.00298)	(0.00300)
group	-0.0260***	-0.0256***	-0.0276***	-0.0232***	-0.0226***	-0.0252***
	(0.00548)	(0.00548)	(0.00550)	(0.00507)	(0.00513)	(0.00513)
foreign	-0.0179	-0.0252*	-0.0266**	-0.0173	-0.0210*	-0.0232**
	(0.0126)	(0.0131)	(0.0131)	(0.0115)	(0.0119)	(0.0118)
lsize	0.0163***	0.0193***	0.0200***	0.0165***	0.0182***	0.0191***
	(0.00169)	(0.00195)	(0.00196)	(0.00169)	(0.00190)	(0.00191)
Log Likelihood	-1801.0199	-1790.4137	-1774.9802	-1983.1307	-1973.8868	-1934.5586
Industry Dummy	-	Yes	Yes	-	Yes	Yes
Year Dummy	-	-	Yes	-	-	Yes
Observations	10,200	10,200	10,200	10,847	10,847	10,847

GVC = global value chain, R&D = research and development.

Note: (i) All columns report marginal effects. (ii) Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1.

Source: Authors.

Further, to capture the heterogeneity of the sample firms, we classify our sample into small and medium-sized firms (SMEs), and large firms based on total assets. To this end, we classify SMEs as those with assets below the industry median; those above are treated as large firms. Panels A and B in Table 11 present the results of the size classification on export markets and GVC survival. From the table, we observe that R&D enables SME firms to survive longer in both the export and GVC markets; the coefficient however is statistically insignificant for large firms.

In addition, as an alternative to the R&D measure, we use the product sophistication[11] to capture the technological content of the product basket of firms participating in the global market. This enables us to examine how the complexity of a product impacts firm survival in GVCs and export markets. Table 12 highlights that the coefficient of the lagged product sophistication is insignificant for both export market survival and GVC survival. From the GVC perspective, this could be due to India's participation not being extensive. Moreover, within its extent of participation, the manufacturing participation is in low value-added activities. Hence, the sophistication of low value-added production may not be a critical factor in firm survival at lower end of the production chain.

Table 11: R&D, and Export (GVC) Survival by Size

Panel A	Small and Medium Firms		Large Firms	
	(1)	(2)	(3)	(4)
VARIABLES	Export-Exit	Export-Exit	Export-Exit	Export-Exit
lexpint	-0.0721**	-0.0650**	-0.0663***	-0.0546**
	(0.0311)	(0.0303)	(0.0250)	(0.0241)
rddum	-0.0263**	-0.0259**	-0.00596	-0.00720
	(0.0117)	(0.0117)	(0.00682)	(0.00678)
Controls	Yes	Yes	Yes	Yes
Log Likelihood	-1039.4487	-1016.1953	-915.07394	-862.29377
Year Dummy	-	Yes	-	Yes
Observations	5,357	5,357	5,394	5,394

Panel B	Small and Medium Firms		Large Firms	
VARIABLES	GVC-Exit	GVC-Exit	GVC-Exit	GVC-Exit
lexpint	-0.0315**	-0.0261*	-0.0202	-0.0132

[11] Table A2 in appendix reports the PRODY measure across industries.

	(0.0151)	(0.0147)	(0.0157)	(0.0152)
rddum	-0.0245**	-0.0241**	0.000540	0.000144
	(0.0102)	(0.0102)	(0.00682)	(0.00678)
Controls	Yes	Yes	Yes	Yes
Log Likelihood	-1,174.1152	-1,138.3104	-1,133.8675	-1,088.691
Year Dummy	-	Yes	-	Yes
Observations	5,816	5,816	5,879	5,879

GVC = global value chain, R&D = research and development.
Note: (i) All columns report marginal effects. (ii) Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1.
Source: Authors.

Table 12: Product Sophistication and Export Market Exit

VARIABLES	(1) Export-Exit	(2) Export-Exit	(3) GVC-Exit	(4) GVC-Exit
lexport	-7.726	-6.832**	1.039	1.089
	(4.894)	(3.434)	(95.23)	(0.321)
lpdy	-0.0932	-0.122	0.203	0.182
	(0.0753)	(0.0752)	(5.781)	(0.902)
Controls	Yes	Yes	Yes	Yes
Log Likelihood	-290.98448	-286.65201	-345.07959	-331.0018
Industry Dummy	-	Yes	-	Yes
Year Dummy	-	Yes	-	Yes
Observations	3,232	3,232	3,232	3,232

GVC = global value chain.
Note: (i) All columns report marginal effects. (ii) Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1.
Source: Authors.

In the empirical analysis, we examined the role of R&D on firm survival for all manufacturing firms. However, the technology underlying the production is not homogenous for all firms. To factor this in the empirical analysis, we divide the sample firms into two sub-groups: high-tech and low-tech industries[12] (Parameswaran, 2009). Table 13 presents the findings of this sub-sample analysis. From the table, we observe that the investment in R&D increases the firm probability of surviving in both export and GVC markets. However, the relationship is more statistically significant for low-tech firms at 1% compared to 5% significance for high-tech industries. The results highlight the gains in terms of firm survival as an outcome of investment in R&D activities.

[12] High-tech industries are: NIC 20, 21, 26, 27, 28, 29, 30, and 32; and low-tech industries include firms from NIC 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 22, 23, 24, 25, and 31.

Table 13: R&D, and Export (GVC) Survival: Technology Classification

Panel A	High-Tech		Low-Tech	
	(1)	(2)	(3)	(4)
VARIABLES	Export-Exit	Export-Exit	Export-Exit	Export-Exit
lexpint	-0.0633**	-0.0602**	-0.125***	-0.123***
	(0.0279)	(0.0277)	(0.0304)	(0.0302)
rddum	-0.0141**	-0.0141**	-0.0288***	-0.0298***
	(0.00718)	(0.00716)	(0.00908)	(0.00909)
Controls	Yes	Yes	Yes	Yes
Log Likelihood	-786.39855	-776.00441	-1132.9223	-1125.7476
Year Dummy	-	Yes	-	Yes
Observations	4,521	4,521	6,230	6,230
Panel B	High-Tech		Low-Tech	
VARIABLES	GVC-Exit	GVC-Exit	GVC-Exit	GVC-Exit
lexpint	-0.0393**	-0.0361**	-0.0218	-0.0198
	(0.0183)	(0.0181)	(0.0139)	(0.0138)
rddum	-0.0125*	-0.0124*	-0.0198**	-0.0210**
	(0.00687)	(0.00683)	(0.00819)	(0.00817)
Controls	Yes	Yes	Yes	Yes
Log Likelihood	-941.82631	-926.50343	-1,319.9615	-1,302.6563
Year Dummy	-	Yes	-	Yes
Observations	4,989	4,989	6,706	6,706

GVC = global value chain, R&D = research and development.

Note: (i) All columns report marginal effects. (ii) Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1.

Source: Authors.

Table 14: R&D, and Export (GVC) Survival: Technology Classification and Product Sophistication

Panel A	High-Tech		Low-Tech	
	(1)	(2)	(3)	(4)
VARIABLES	Export-Exit	Export-Exit	Export-Exit	Export-Exit
lexpint	-0.300**	-0.0970**	0.00370	-0.00238
	(0.128)	(0.0467)	(0.0636)	(0.0495)
lpdy	-0.00165	-0.00379***	-0.000818	-0.000585
	(0.00180)	(0.00105)	(0.00171)	(0.00129)
Controls	Yes	Yes	Yes	Yes
Log Likelihood	-165.88983	-153.14149	-130.93734	-124.06434
Year Dummy	-	Yes	-	Yes
Observations	2,130	2,130	1,102	1,102
Panel B	**High-Tech**		**Low-Tech**	
VARIABLES	GVC-Exit	GVC-Exit	GVC-Exit	GVC-Exit
lexpint	0.000746	-0.0729	0.0279	0.0277
	(0.0396)	(0.137)	(0.0394)	(0.0397)
lpdy	0.00496	0.00503	0.00400	0.00396
	(0.00307)	(0.00833)	(0.00292)	(0.00296)
Controls	Yes	Yes	Yes	Yes
Log Likelihood	-176.72186	-163.31612	-162.15474	-160.44219
Year Dummy	-	Yes	-	Yes
Observations	2,130	2,130	1,102	1,102

GVC = global value chain, R&D = research and development.
Note: (i) All columns report marginal effects. (ii) Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1.
Source: Authors.

In addition, we also examine the role of product sophistication on trade survival from the technology perspective since more technologically intensive industries are more involved in advancing the product. Hence, similar to the analysis documented in Table 13, we repeat the analysis for high-tech and low-tech industries. Table 14 presents the results of this analysis. From the table, we observe that, similar to the earlier findings, sophistication of product does not promote global market survival of GVC firms. However, the coefficient turns significant for exporters from high-tech industries, which highlights the role of product sophistication in the case of the high-tech firms.

In the present study, we define GVC firms as two-way trading firms. Further, as a robustness check, we impose an additional restriction on our identification strategy to account for higher degree of integration of firms in GVCs. Therefore, we use an alternative measure and define GVC firms *(GVC-N)* as simultaneous exporters and importers that import and export a minimum of 10% of sales. Using this measure, the number of GVC firms experiencing failure in the sample increases from 4.8% to 7.3%, which points to the difficulty to sustain deeper integration into GVCs. Table 15 documents the results of survival analysis with our stringent measure of GVC *(GVC-N)* and from the table, we note that investment in R&D reduces the probability of exit for GVC firms with deeper linkages. The findings are consistent with our baseline estimates.

Table 15: R&D and GVC Survival – Alternate Measure of GVC

VARIABLES	(1) GVC-N	(2) GVC-N	(3) GVC-N
lexpint	-0.0209*	-0.0207*	-0.0145
	(0.0123)	(0.0125)	(0.0123)
rddum	-0.0256***	-0.0290***	-0.0305***
	(0.00637)	(0.00673)	(0.00669)
logage	0.0539***	0.0597***	0.0623***
	(0.00508)	(0.00531)	(0.00521)
ltfp	-0.0160***	-0.0225***	-0.0212***
	(0.00269)	(0.00366)	(0.00367)
foreign	-0.0261*	-0.0313**	-0.0377***
	(0.0137)	(0.0141)	(0.0140)
group	-0.0468***	-0.0467***	-0.0535***
	(0.00628)	(0.00634)	(0.00633)
lsize	0.0252***	0.0288***	0.0313***
	(0.00196)	(0.00226)	(0.00226)
Log Likelihood	-3,075.0411	-3,059.5454	-2,962.2866
Industry Dummy	-	Yes	Yes
Year Dummy	-	-	Yes
Observations	11,695	11,695	11,695

GVC = global value chain, R&D = research and development.

Note: (i) All columns report marginal effects. (ii) Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1.

Source: Authors.

8 Policy Relevance and Conclusion

The existing literature highlights mixed evidence on the role of innovative efforts (R&D investment) on a firm's domestic market survival. However, there is a dearth of rigorous empirical evidence on the role of innovation and global market survival. In this context, our study aims to fill this gap using rich firm-level data using an unbalanced panel of 944 exporting firms and 992 GVC firms in India over 2001–18. To test this relationship, we rely on non-parametric approach and apply a complementary log-log model. We find that firm's decision to invest in R&D is a significant factor in aiding survival in global markets. Further, we find the importance of financial health of a firm in its survival in the export market. The outcome of the empirical analysis also reveals positive impact of R&D investment on survival of SMEs in export and GVC markets.

Although our study focuses on India, the empirical results have wide-scale policy implications for India and other emerging economies. First, our study provides evidence for the role of R&D on firm survival in the global market via the channels of export and GVC participation. The results highlight that those innovative activities provide a competitive advantage for firms and therefore are a crucial factor with respect to firm survival. Therefore, the findings call for policies that promote innovative efforts amongst firms that participate in global markets. Second, the study also highlights the importance of financial resources on firm survival. In this context, the results showcase that financially constrained firms undertaking R&D investments experience lower probability of exit, i.e. they survive longer. This highlights the importance of financial support needed to undertake innovative activities. Given that participation in international markets itself is associated with significant fixed costs, undertaking investment in R&D becomes more strenuous for firms. Hence, policies providing financial support for firms could promote their endeavours in R&D activities which in turn could help their longevity in the global market. The importance of policy in terms of financial support gains more prominence due to the unprecedented shock of COVID-19.

Third, the size of the sub-sample analysis carried out in the study highlights the significant impact of R&D on firm survival of SMEs. The finding of this analysis has important policy implications, especially for an emerging economy like India, where SMEs contribute significantly to output, employment, and exports. Hence, policies fostering R&D investment amongst SMEs could aid their survival in both export and

GVC markets. Additionally, the result pertaining to product sophistication highlights an insignificant impact. This can be attributed to integration of manufacturing firms in low value-added activities. Hence, policies should be aimed at promoting involvement of firms in higher value-added products. Finally, the results using the stringent definition of GVC *(GVC-N)* highlight that R&D investment is crucial for firms with deeper linkages in GVCs and a comparison of exit rates between baseline GVC and GVC-N highlights the difficulty of firms in sustaining deeper integration in GVCs, thus highlighting an area of important policy action for policy makers.

References

Acemoglu, D. and D. Cao (2015), 'Innovation by Entrants and Incumbents', *Journal of Economic Theory,* 157(C), pp.255–94.

Alvarez, R. and R.A. López (2008), 'Entry and Exit in International Markets: Evidence from Chilean Data', *Review of International Economics,* 16(4), pp.692–708.

Antràs, P. (2020), 'Conceptual Aspects of Global Value Chains', *World Bank Economic Review,* 34(3), pp.551–74.

Autio, E., H. Sapienza, and J. Almeida (2000), 'Effects of Age at Entry, Knowledge Intensity and Imitability on International Growth', *Academy of Management Journal*, 43(5), pp.909–24.

Azar, G. and F. Ciabuschi (2017), 'Organizational Innovation, Technological Innovation, and Export Performance: The Effects of Innovation Radicalness and Extensiveness', *International Business Review*, 26(2), pp.324–36.

Banga, K. (2021), 'Digital Technologies and Product Upgrading in Global Value Chains: Empirical Evidence from Indian Manufacturing Firms', *European Journal of Development Research,* pp.1–26. https://doi.org/10.1057/s41287-020-00357-x

Barrios, S., H. Görg, and E. Strobl (2003), 'Explaining Firms' Export Behaviour: R&D, Spillovers and the Destination Market', *Oxford Bulletin of Economics and Statistics,* 65(4), pp.475–96.

Bellone, F., P. Musso, L. Nesta, and S. Schiavo (2010), 'Financial Constraints and Firm Export Behaviour', *World Economy,* 33(3), pp.347–73.

Bernard, A.B., S.J. Redding, and P.K. Schott (2011), 'Multiproduct Firms and Trade Liberalization', *Quarterly Journal of Economics,* 126(3), pp.1271–318.

Besedeš, T. (2008), 'A Search Cost Perspective on Formation and Duration of Trade', *Review of International Economics,* 16(5), pp.835–49.

Besedeš, T. and T.J. Prusa (2006), 'Ins, Outs, and the Duration of Trade', *Canadian Journal of Economics,* 39(1), pp.266–95.

Besedeš, T. and T.J. Prusa (2010), 'The Duration of Trade Relationships', in B. Hoekman and G. Porto (eds.), *Trade Adjustment Costs in Developing Countries: Impacts, Determinants and Policy Responses*, Washington, DC: World Bank, pp.265–82.

Caldera, A. (2010), 'Innovation and Exporting: Evidence from Spanish Manufacturing Firms', *Review of World Economics*, 146(4), pp.657–89.

Cefis, E. and O. Marsili (2006), 'Survivor: The Role of Innovation in Firms' Survival', *Research Policy*, 35(5), pp.626–41.

Córcoles, D., C. Diaz-Mora, and R. Gandoy (2014), 'Product Sophistication: A Tie That Binds Partners in International Trade', *Economic Modelling,* 44, pp.S33–S41.

Córcoles, D., C. Díaz-Mora, and R. Gandoy (2015), Export Survival in Global Production Chains', *World Economy,* 38, pp.1526–54. https://doi.org/10.1111/twec.12249.

Dai, M., H. Liu, and L. Lin (2020), 'How Innovation Impacts Firms' Export Survival: Does Export Mode Matter?', *World Economy*, 43(1), pp.81–113.

Deng, Z., H. Guo, W. Zhang, and C. Wang (2014), 'Innovation and Survival of Exporters: A Contingency Perspective', *International Business Review,* 23(2), pp.396–406.

Díaz-Mora, C., R. Gandoy, and B. Gonzalez-Diaz (2018), 'Strengthening the Stability of Exports through GVC Participation', *Journal of Economic Studies,* 45(3), pp.610–37.

Dovis, M. and C. Zaki (2020), 'Global Value Chains and Local Business Environments: Which Factors Really Matter in Developing Countries?', *Review of Industrial Organization*, 57(2), pp.481–513.

Dzhumashev, R., V. Mishra, and R. Smyth (2016), 'Exporting, R&D Investment and Firm Survival in the Indian IT Sector', *Journal of Asian Economics,* 42, pp.1–19.

Eck, K. and S. Huber (2016), 'Product Sophistication and Spillovers from Foreign Direct Investment', *Canadian Journal of Economics*, 49(4), pp.1658–84.

Economic Survey, (2019), 'Ministry of Finance, Government of India', https://www.indiabudget.gov.in/economicsurvey/.

Ehab, M. and C.R. Zaki (2021), 'Global Value Chains and Service Liberalization: Do They Matter for Skill-Upgrading?', *Applied Economics,* 53(12), pp.1342–60.

Fontana, R. and L. Nesta, (2009), 'Product Innovation and Survival in A High-Tech Industry', *Review of Industrial Organization*, 34(4), pp.287–306.

Fu, D. and Y. Wu, (2014), 'Export Survival Pattern and Its Determinants: An Empirical Study of Chinese Manufacturing Firms', *Asian-Pacific Economic Literature*, 28(1), pp.161–77.

Grazzi, M. and D. Moschella, (2018), 'Small, Young, and Exporters: New Evidence on the Determinants of Firm Growth', *Journal of Evolutionary Economics,* 28(1), pp.125–52.

Greenaway, D., A. Guariglia, and R. Kneller (2007), 'Financial Factors and Exporting Decisions', *Journal of International Economics,* 73(2), pp.377–95.

Hausmann, R., J. Hwang, and D. Rodrik (2007), 'What You Export Matters', *Journal of Economic Growth,* 12(1), pp.1–25.

Hess, W. and M. Persson (2012), 'The Duration of Trade Revisited', *Empirical Economics,* 43(3), pp.1083–1107.

Hipp, A. and C. Binz (2020), 'Firm Survival in Complex Value Chains and Global Innovation Systems: Evidence from Solar Photovoltaics', *Research Policy,* 49(1), 103876–83.

Inui, T., K. Ito, and D. Miyakawa (2017), 'Export Experience, Product Differentiation and Firm Survival in Export Markets', *The Japanese Economic Review,* 68(2), pp.217–31.

Ito, K., K. Ikeuchi, C. Criscuolo, J. Timmis, and A. Bergeaud (2019), 'Global Value Chains and Domestic Innovation', *RIETI Discussion Paper Series* 19-E-028 https://www.rieti.go.jp/en/publications/summary/19040008.html.

Kafouros, M.I., P.J. Buckley, J.A. Sharp, and C. Wang (2008), 'The Role of Internationalization in Explaining Innovation Performance', *Technovation,* 28(1-2), pp.63–74.

Kergroach, S. (2019), 'National Innovation Policies for Technology Upgrading through Gvcs: A Cross-Country Comparison', *Technological Forecasting and Social Change,* 145, pp.258–72. https://doi.org/10.1016/j.techfore.2018.04.033.

Kumar, N. and N.S. Siddharthan (1994), 'Technology, Firm Size and Export Behaviour in Developing Countries: The Case of Indian Enterprises', *Journal of Development Studies,* 31(2), pp.289–309.

de Loecker, J., P.K. Goldberg, A.K. Khandelwal, and N. Pavcnik (2016), 'Prices, Markups, and Trade Reform', *Econometrica,* 84(2), pp.445–510.

Lu, Y., H. Shi, W. Luo, and B. Liu (2018). Productivity, Financial Constraints, and Firms' Global Value Chain Participation: Evidence from China. *Economic Modelling,* 73, pp.184–94.

Minetti, R., P. Murro, Z. Rotondi, and S.C. Zhu (2019), 'Financial Constraints, Firms' Supply Chains, and Internationalization', *Journal of the European Economic Association,* 17(2), pp.327–75.

Musso, P. and S. Schiavo (2008), 'The Impact of Financial Constraints on Firm Survival and Growth', *Journal of Evolutionary Economics,* 18(2), pp.135–49.

Obashi, A. (2010), 'Stability of Production Networks in East Asia: Duration and Survival of Trade', *Japan and the World Economy,* 22(1), pp.21–30.

Padmaja, M. and S. Sasidharan (2017), 'Sunk Costs, Firm Heterogeneity, Export Market Entry and Exit: Evidence from India', *Journal of Quantitative Economics,* 15(2), pp.367–93.

Parameswaran, M. (2009), 'International Trade, R&D Spillovers and Productivity: Evidence from Indian Manufacturing Industry', *Journal of Development Studies,* 45(8), pp.1249–66.

Rauch, J.E. and J. Watson (2003), 'Starting Small in An Unfamiliar Environment', *International Journal of Industrial Organization,* 21(7), pp.1021–42.

Rigo, D. (2021), ‘Global Value Chains and Technology Transfer: New Evidence from Developing Countries’, *Review of World Economics,* 157(2), pp.271–94.

Roberts, M.J. and J.R. Tybout (1997), ‘The Decision To Export in Colombia: An Empirical Model of Entry With Sunk Costs’, *American Economic Review,* 87(4), pp.545–64.

Roper, S. and J.H. Love (2002), ‘Innovation and Export Performance: Evidence from the UK and German Manufacturing Plants’, *Research Policy,* 31(7), pp.1087–1102.

Schwartz, M. (2013), ‘A Control Group Study of Incubators’ Impact to Promote Firm Survival’, *Journal of Technology Transfer,* 38(3), pp.302–31.

Shao, J., K. Xu, and B. Qiu (2012), ‘Analysis of Chinese Manufacturing Export Duration’, *China and World Economy,* 20(4), pp.56–73.

Stiebale, J. (2011), ‘Do Financial Constraints Matter for Foreign Market Entry? A Firm-Level Examination’, *World Economy,* 34(1), pp.123–53.

Tavassoli, S. (2018), ‘The Role of Product Innovation on Export Behavior of Firms: Is It Innovation Input or Innovation Output That Matters?’, *European Journal of Innovation Management,* 21(2), pp.294–314.

Topalova, P. and A. Khandelwal (2011), ‘Trade Liberalization and Firm Productivity: the Case of India’, *Review of Economics and Statistics*, 93(3), pp.995–1009.

Türkcan, K. and H. Saygili (2019), ‘Global Production Chains and Export Survival’, *Eastern European Economics,* 57(2), pp.103–29.

Urata, S. and Y. Baek (2020), ‘The Determinants of Participation in Global Value Chains: A Cross-Country, Firm-Level Analysis’, ADBI Working Paper No: 1116, Asian Development Bank Institute.

Vashisht, P. (2016), ‘Creating Manufacturing Jobs in India: Has Openness to Trade Really Helped?’, *Journal of Asian Economics,* 42, pp.53–64.

Wakelin, K. (1998), ‘Innovation and Export Behaviour at the Firm Level’, *Research Policy,* 26(7-8), pp.829–41.

World Bank (2020), ‘*World Development Report* 2020*: Trading for Development in the Age of Global Value Chains*’, Washington, DC: World Bank Publications.

Zhang, D., W. Zheng, and L. Ning (2018), ‘Does Innovation Facilitate Firm Survival? Evidence from Chinese High-Tech Firms’, *Economic Modelling*, 75, pp.458–68.

Appendices

Table A1: Product Matching

HS-Product Name	HS-Code	Prowess Product Name	Prowess Product Code
Calendars of any kind, printed, including calendar blocks	4910	Calendars	46185400000000000000
Coats; men's or boys' overcoats, car-coats, capes, cloaks, anoraks, ski-jackets, wind-cheaters, wind-jackets and similar articles; knitted or crocheted	6101	Men's overcoats, etc. knitted or crocheted	36240404000000000000
Shirts; men's or boys', knitted or crocheted	6105	Men's shirts, etc., knitted or crocheted	36240420000000000000
Footwear; waterproof, with outer soles and uppers of rubber or plastics, (uppers not fixed to the sole nor assembled by stitch, rivet, nail, screw, plug or similar)	6401	Waterproof footwear	40201600000000000000
Umbrellas; sun umbrellas (including walking stick umbrellas, garden umbrellas and similar umbrellas)	6601	Umbrellas	70760000000000000000
Glass; multiple-walled insulating units of glass	7008	Multiple walled insulating units of glass	12030800000000000000
Razors and razor blades; (including razor blade blanks in strips)	8212	Razors and razor blades	57402828000000000000

Source: Authors' computation using CMIE-PROWESS database. (https://prowessiq.cmie.com/).

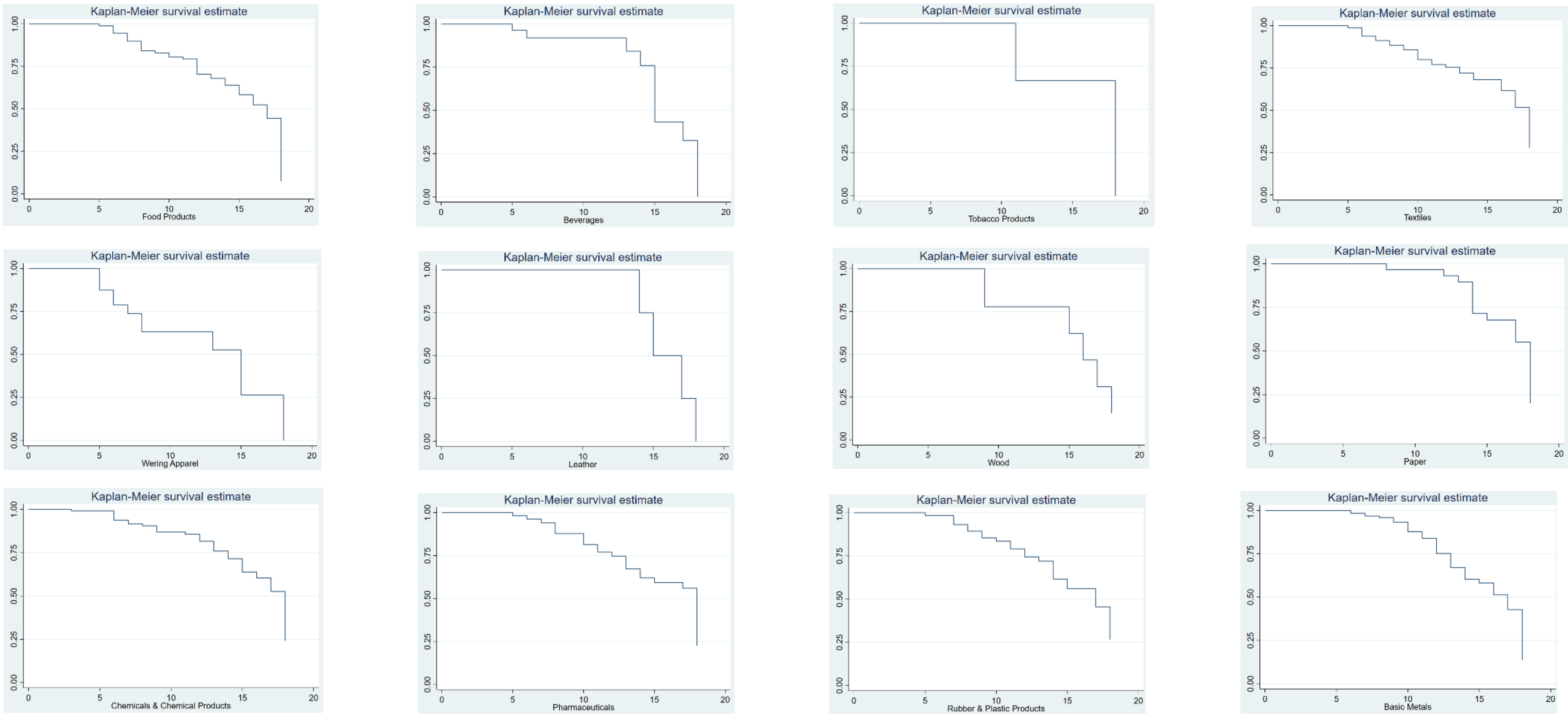
Table A2: Product Sophistication Across Industries

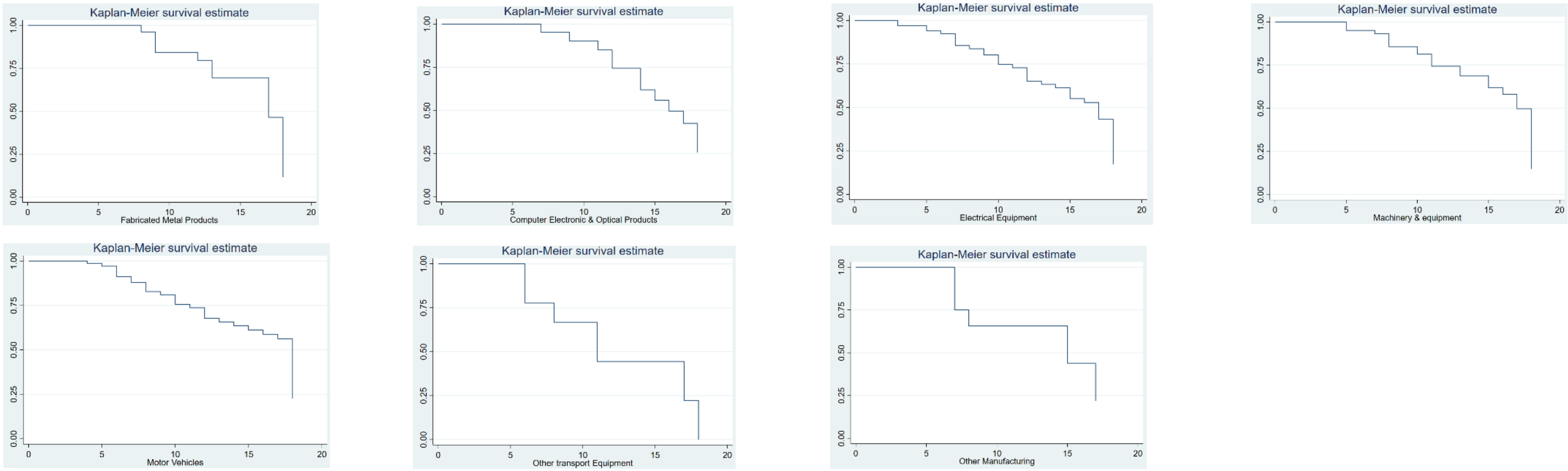
Industry	Mean	Std.	Freq.
Food, Beverages and Tobacco	7.801	2.428	1,030
Textiles and Wearing Apparel	9.014	0.596	29
Wood and Paper	8.716	1.431	33
Pharmaceuticals	7.940	2.346	743
Rubber, Plastics and Non-Mineral Products	9.468	1.137	92
Basic Metals	8.953	2.021	67
Fabricated Metal Products	8.229	2.017	34
Electrical Equipment	8.183	1.984	75
Machinery and equipment	8.934	1.427	115
Motor Vehicle	7.873	2.104	1,406
	7.987	2.227	3,624

Note: Table reports the log value of product sophistication index across two-digit NIC manufacturing industries.

Source: Authors' computation using CMIE-PROWESS database. (https://prowessiq.cmie.com/).

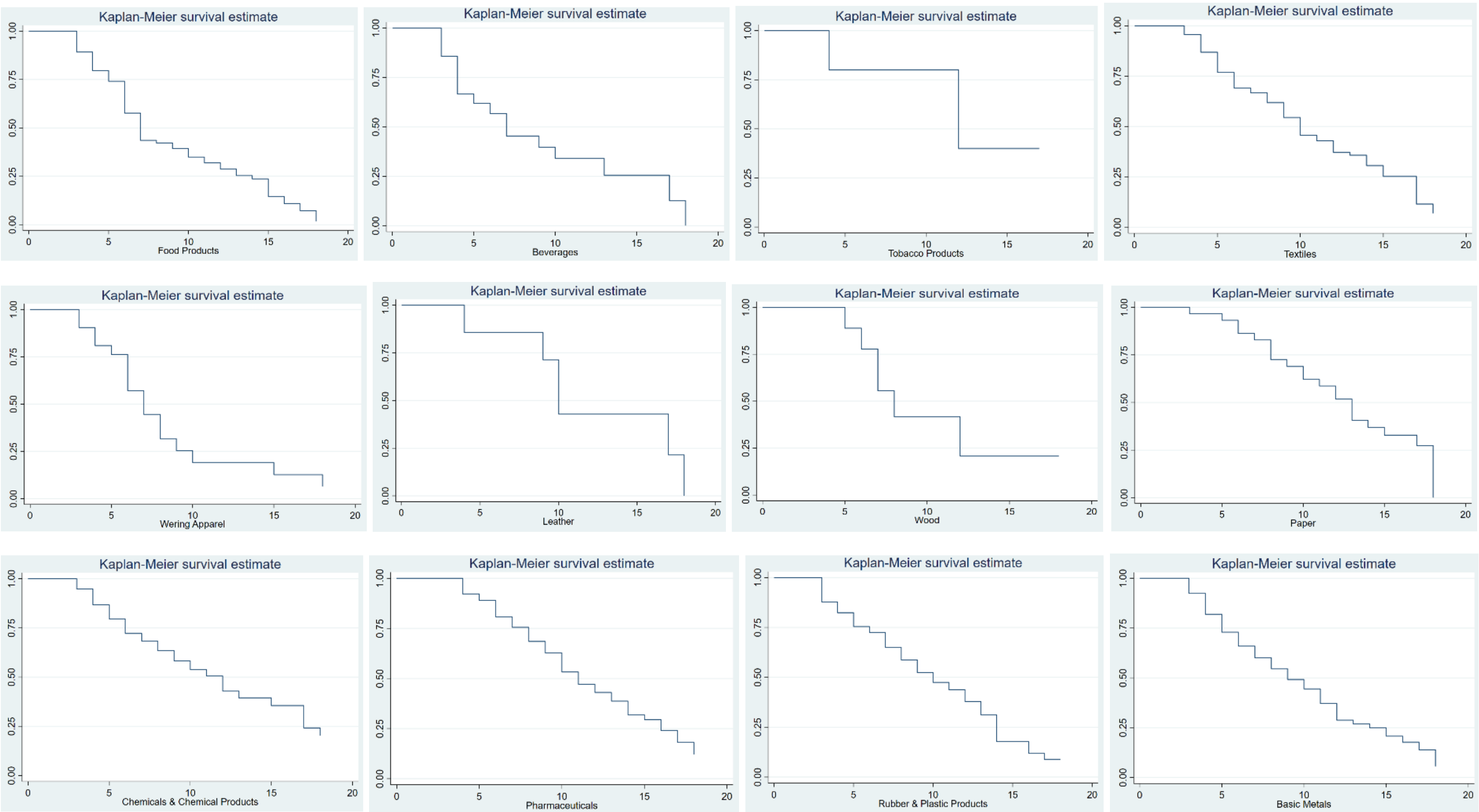
Figure A1: Kaplein Meier Survival Estimates: Exporters

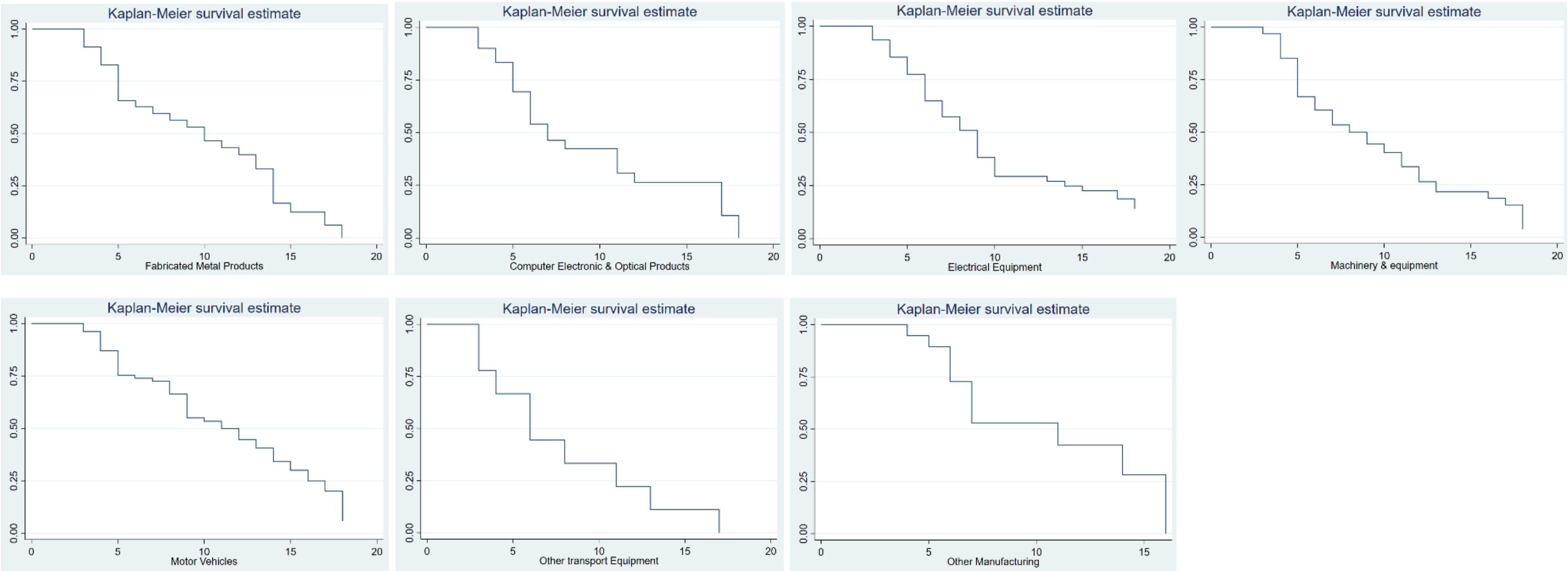




Source: Authors' computation using CMIE-PROWESS database (https://prowessiq.cmie.com/).

Figure A2: Kaplein Meier Survival Estimates: GVC Firms





GVC = global value chain.

Source: Authors' computation using CMIE-PROWESS database (https://prowessiq.cmie.com/)

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