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RELATIONSHIP AMONG R&D, PRODUCTIVITY, AND FIRM EXPORTS: THE MODERATING ROLE OF CREDIT CONSTRAINTS

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Abstract:

Innovative and productive firms are more likely to export and earn a great intensive margin. However, credit constraints may disconnect or distort the linkage between export determinants and export margins. In this study, we explore whether credit constraints affect the role of R&D and productivity play in export propensity (whether a firm exports or not) and export intensity (export share in total annual sales). Using data on Indian manufacturing firms, our empirical results indicate that, while limited access to finance does not affect the R&D–exports linkage, it prevents productive firms from obtaining great export intensity. We also test whether credit constraints affect the roles of other determinants in export margins.

Key words: *Credit constraints, Exports, India, R&D, Productivity*

1. Introduction

A recent and extensive literature has explored the impact of credit constraints on firms' decisions to export and export performance (see Wagner, 2014, for a review study). Starting exports incurs nonrecoverable sunk costs, which depend on the availability of external finance (Aw, Roberts, & Xu, 2011; Manova, 2013). Like other types of investments in intangible assets, an export decision is sensitive to liquidity due to the lack of collaterals

(Brown, Fazzari, & Petersen, 2009). Credit constraints further hamper export performance since it normally takes a longer time to complete export orders and collect payments compared to domestic sales, indicating the requirements of sufficient liquidity (Wagner, 2014).

According to the product cycle theory, innovative and productive firms are more likely to enter into the global market (Hirsch & Bijaoui, 1985). However, the impacts of innovation and productivity on export margins may depend on liquidity for several reasons as follows. The output of R&D depends on credit constraint condition. Limited access to credit hamper productivity and capacity utilization (Gorodnichenko & Schnitzer, 2013; Zhang, 2022). Productive firms with sufficient liquidity are more likely to enter into the global market (Berman & Héricourt, 2010). Few studies have accounted for firms' credit constraint conditions when exploring how R&D and productivity affect exports. In the review paper by Wagner (2014), among the thirty-two empirical studies on export determinants, only one study (Berman & Héricourt, 2010) tested whether credit constraints mitigate the linkage between productivity and export participation.

In this study, we explore whether credit constraints affect the role of R&D and productivity play in export margins represented by export propensity (the decision to export) and export intensity (export share in total annual sales). We extend Berman & Héricourt's (2010) study and test the moderating role of credit constraints on the impact of productivity, R&D as well as other determinants on exporting. The case study is the Indian manufacturing.

India has experienced remarkable economic growth since trade and financial liberalization in 1991. Export promotion plays a significant role in India's national economic policy agendas. Studying corporate finance and export behavior of Indian firms is a good case study of how financial development can affect export behavior. Between 2000–2016, the average growth rate of manufacturing value-added is about 7.9% for India (UNIDO, 2017). However, the share of manufacturing exports in total exports reduced from 85.16% to 83.27%. The empirical issue is whether this reduction is related to financial constraints that export firms faces. By focusing on the Indian economy, this study can have lessons for other developing countries.

The rest of the paper is organized as follows. Section 2 reviews the previous literature on R&D, credit constraints, and exports. Section 3 offers our data sources, variables, and measurement. Section 4 presents the results. Section 5 discusses the findings. Section 6 concludes the paper.

2. R&D, Productivity, and Exports

Firms' R&D investment is one of the crucial determinants of exporting (Cassiman, Golovko, & Martínez-Ros, 2010; Zhang & Xie, 2020). R&D expenditure enhances productivity and is a necessary condition for new products. Innovative firms, which produce new products and own cutting-edge technology, face a small domestic market and tend to export a high share of their products to the global market (Hirsch & Bijaoui, 1985). The export performance relies on the degree of the radicalness of innovation, which depends on innovation expenditures and the time needed to merchandise the innovative products. An innovative firm facing limited access to finance is probably reluctant to promote exporting.

Fauceglia (2015) examines the impact of the credit constraints on firms' exporting decisions using firm-level data across 17 developing countries. They find that credit has a positive effect on the exporting probability. His finding also highlights that access to credits is more beneficial for the R&D-intensive industries than for the other industries, indicating a joint effect of R&D and financial status on exporting.

Theoretically, firms enter into foreign markets when their productivity exceeds a given threshold (Melitz, 2003). Productive firms earn high profits and hence are generally more financially healthy. Among different measures of productivity, total factor productivity (TFP) refers to the derived effect of innovation (Gorodnichenko & Schnitzer, 2013). A firm with a high TFP may also ensure great intensive margins. However, limited access to finance can distort the linkage between export participation and productivity. Berman & Héricourt (2010) use the ratio of cash flow to total assets as an indicator of financial constraint condition. They find that productivity does not affect the export decision unless firms have sufficient cash flow.

For empirical studies, failing to control for the joint effect of firms' credit constraint condition and R&D or productivity indicates misspecification of the models, which may cause ambiguous empirical results. Manova, Wei, and Zhang (2015) demonstrate how credit constraints hinder firms' overall exports, restrict them from expanding into new markets, and reduce their export product range. Pietrovito and Pozzolo (2021) find evidence that credit constraints reduce the likelihood of a business exporting and the percentage of exports in total sales using data from 65 emerging and developing countries. In contrast, Stiebale (2011) studies the impact of financial constraints on export participation and sales in foreign markets using a large panel dataset of the French manufacturing firm and observes that there is no evidence that financial constraints matter when unobserved heterogeneity is considered for export decisions.

Nagaraj (2014) also uses the case of Indian firms to explore the relationship between financial constraints and export market entry decisions. She adds that firms entering the export market are financially healthier than no exporting firms. In a similar vein, Demirgüç-Kunt et al. (2020) argue for firms engaging in international trade, access to credit is particularly important. Exporting often involves longer payment cycles and currency fluctuations, which can strain a firm's cash flow. Credit facilities, such as export credit insurance or export financing, provide support and mitigate the financial risks associated with cross-border transactions.

2.1. Credit constraint in India

Credit constraints significantly impact a country's ability to export goods and services (Manova et al., 2015; Pietrovito & Pozzolo, 2021), which is particularly important for firms operating in developing countries, as they often face more significant financial constraints than their counterparts in developed countries (Fowowe, 2017). Fauceglia (2015) finds that access to credit for firms in developing countries can support economic development by enabling businesses to invest in their operations, expand production capacity, and enter new markets (Nagaraj, 2014). This, in turn, can lead to increased employment, higher wages, and improved living standards for workers. Moreover, access to

credit for firms in developing countries can help address poverty and promote financial inclusion (Wellalage et al., 2019). In a large, randomized experiment, Banerjee et al. (2015) found improved access to credit jump-start microenterprise growth in India.

Credit constraint has long been a longstanding issue in India. According to WBES (2014), 62% of Indian businesses did not seek a loan or line of credit despite needing financing due to a lack of collateral, limited financial literacy, corruption, gender bias, and a perception of high risk among lenders (Chaudhuri et al., 2020; Wellalage & Samujh, 2019) and the situation is dire for the Small and medium-sized enterprises (SMEs) (Yoshino & Hesary, 2018). SMEs are often the main drivers of job creation in developing countries and are a key source of income for low-income households (Ullah, 2020).

To address credit constraints in India, the government has implemented various policies and initiatives to support SMEs in accessing credit. These include credit guarantee schemes, where the government guarantees lenders against default by SME borrowers, and the establishment of specialized lending institutions such as the Small Industries Development Bank of India (SIDBI)¹ to support SMEs.

3. Data and methodology

The World Bank Enterprise Surveys (<https://www.enterprisesurveys.org>) collect data on firm performance and business environment for firms in private sectors for developing countries. The data have been widely used in the literature to explore firm export behavior and credit constraints (Berman & Héricourt, 2010; Gorodnichenko & Schnitzer, 2013; Zhang & Xie, 2020; Zhang, 2022). There is no study using the data to explore the moderating role of credit constraints on the relationship between exporting and productivity or R&D.

The sample from the 2014 wave for India consists of 7,158 manufacturing firms, with the eligibility rate at a value of 76.5% under strict assumptions and 90.6% under weak assumptions. We focus on year 2014 because it was the most recent available data.

3.1. Identifying credit-constrained firms

Following previous studies (Bigsten et al., 2003; Zhang, 2022), we use the survey questions about loan applications to identify credit-constrained firms. Conditional on credit demand, the rejection of a loan application implies credit constraints faced by firms. Firms are credit constrained if (1) the most recent loan application was rejected or (2) they did not apply for a loan due to complex application procedures, collateral requirements, and insufficient loan size and maturity. The use of informal financial services is another indicator of credit constraints (Zhang, 2022). Firms that are not constrained by access to finance according to their loan applications but using informal financial services for fixed asset purchases or working capital are also categorized as constrained firms (*Constrained*).

¹ <https://www.sidbi.in/en>

3.2. Empirical models

Since export participation (*Export*) is a Yes/No question, we applied a probit model to evaluate the impacts of credit constraints (*Constrained*) on export propensity by controlling for other determinants. High-tech firms (*High-Tech*) own cutting-edge technology and are motivated to enter into the global market. Firms with foreign ownership (*Foreign-Owner*) may have better export performance than private domestic firms (Manova, 2013). Large firms (*Large-Firm*) in developing countries are often less likely to be constrained by external finance (Kersten et al., 2017), indicating that their export margins may differ from small firms. This yields the specification:

$$\Pr(\text{Export}_i = 1|\mathbf{Y}) = \alpha_0 + \alpha_1 R\&D_i + \alpha_2 \text{Productivity}_i + \alpha_3 \text{High_Tech}_i + \alpha_4 \text{Foreign_Owner}_i + \alpha_5 \text{Large_Firm}_i + \alpha_6 \text{Constrained}_i + v_i \quad (1)$$

where Export_i equals one for export firms and zero otherwise; v_i is the error term.

Export intensity is represented by the export share (*Share*) in the range between 0 and 1 (i.e., 100%). Accordingly, we apply a fractional logit model to estimate the impacts of *Constrained* and other determinants on *Share*. This is:

$$\text{Share}_i = \beta_0 + \beta_1 R\&D_i + \beta_2 \text{Productivity}_i + \beta_3 \text{High_Tech}_i + \beta_4 \text{Foreign_Owner}_i + \beta_5 \text{Large_Firm}_i + \beta_6 \text{Constrained}_i + u_i \quad (2)$$

where Share_i denotes export share out of total sales, in percentage points; u_i is the error term.

Eqn (1) and Eqn (2) are the baseline regression equations. In order to test the moderating role of credit constraints, we modify the basic specifications by adding the interaction between *Constrained* and other explanatory variables, one at a time.

Table 1 presents the list of variables and descriptive statistics, and Table 2 provides the correlation matrix.

Table 1. Variable descriptions and descriptive statistic

Variable	Definition	Mean	SD
Constrained	Dummy (= 1 for constrained firms and 0 otherwise)	0.4822	0.4997
Export	Dummy (= 1 for exporters and 0 otherwise)	0.1828	0.3866
Export-Share	Export share in total sales (exports/total sales)	0.0833	0.2332
R&D	Dummy (= 1 for innovative firms and 0 otherwise)	0.3551	0.4786
Productivity	Total factor productivity (TFP)	0.8803	1.1995
High-Tech	Dummy (= 1 for high-tech firm and 0 otherwise)	0.7009	0.4579
Large-Firm	Dummy (= 1 for firms with more than 100 employees and 0 otherwise)	0.2348	0.4239
Foreign-Owner	Dummy (= 1 for firms with foreign owners and 0 otherwise)	0.0095	0.0970

Notes: High-tech firms are firms under the Standard Industrial Classification (SIC): 23–35 (UNIDO, 2017). TFP is the difference between the logarithmic sales and the sum of cost share-weighted inputs (Gorodnichenko and Schnitzer 2013).

Table 2. Matrix of correlations

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(1) Constrained	1.000							
(2) Export	-0.039	1.000						
(3) Export-Share	-0.029	0.755	1.000					
(4) R&D	0.069	0.204	0.172	1.000				
(5) Productivity	0.066	0.045	0.044	0.040	1.000			
(6) High-tech	0.008	-0.058	-0.172	0.072	0.002	1.000		
(7) Large-Firm	0.013	0.316	0.225	0.184	0.049	-0.009	1.000	
(8) Foreign-Owner	-0.005	0.103	0.075	0.054	0.011	0.026	0.071	1.000

4. Estimation results

4.1. Export propensity model

In Table 3, Regression 1 is the estimation results of the basic specification model. *Constrained* is significant and negative, indicating that credit constraints, as a stand-alone factor, reduce the probability of exporting at a value of 17.2%. Our findings supports the argument of Fauceglia (2015) and Banerjee et al. (2015) who suggest that only the most productive firms can overcome the fixed costs associated with exporting, and that credit constraints may prevent potentially productive firms from entering export markets. In line with the theoretical expectation, innovative and productive firms are more likely to enter into the global market, so do firms with foreign ownership. Foreign owned firms have a greater probability of exporting than innovative firms. Compared to small firms, the probability of exporting is 86.3% higher for large firms. High-tech firms have lower incentives to export, a counterintuitive finding. The industrial sector dummy regarding the level of technology may not capture firm heterogeneity within a particular sector. For interaction terms in Regression 2–6, only the one between *Large-Firm* and *Constrained* is significant. For large firms, the probability of exporting would reduce by 21.8% when they are under a credit constraint condition. Except for firm size, the impacts of export determinants on export propensity do not rely on firms' credit constraint condition.

Table 3. Estimated results of the probit model (dependent variable: *Export*)

	(1)	(2)	(3)	(4)	(5)	(6)
R&D	0.502*** (0.038)	0.516*** (0.051)	0.501*** (0.038)	0.502*** (0.038)	0.501*** (0.038)	0.502*** (0.038)
Productivity	0.041*** (0.015)	0.041*** (0.015)	0.058** (0.023)	0.041*** (0.015)	0.041*** (0.015)	0.041*** (0.015)
High-Tech	-0.240***	-0.240***	-0.239***	-0.215***	-0.238***	-0.240***

	(0.039)	(0.039)	(0.039)	(0.053)	(0.039)	(0.039)
Large-Firm	0.863***	0.863***	0.863***	0.863***	0.967***	0.863***
	(0.039)	(0.039)	(0.039)	(0.039)	(0.054)	(0.039)
Foreign-Owner	0.893***	0.893***	0.891***	0.893***	0.876***	0.892***
	(0.163)	(0.163)	(0.163)	(0.163)	(0.163)	(0.224)
Constrained	-0.172***	-0.158***	-0.143***	-0.135**	-0.097**	-0.172***
	(0.037)	(0.050)	(0.047)	(0.064)	(0.046)	(0.037)
R&D: Constrained		-0.030				
		(0.074)				
Productivity: Constrained			-0.031			
			(0.031)			
High-Tech: Constrained				-0.054		
				(0.079)		
Large-Firm: Constrained					-0.218***	
					(0.078)	
Foreign-Owner: Constrained						0.001
						(0.326)
Constant	-1.184***	-1.190***	-1.199***	-1.201***	-1.220***	-1.184***
	(0.042)	(0.044)	(0.044)	(0.048)	(0.044)	(0.042)
Observations	7,165	7,165	7,165	7,165	7,165	7,165
Pseudo-R2	0.1300	0.1300	0.1301	0.1302	0.1312	0.1300

Notes: *** $p < 0.01$, ** $p < 0.05$, and * $p < 0.1$; marginal effects are reported; standard errors in parentheses.

4.2. Export intensity model

Table 4 reports the estimation results for the export intensity model. For the basic regression (Regression 1), the results indicate that credit-constrained firms have a smaller export share than unconstrained firms, with a gap of 26.3%. Our findings support Cassiman, Golovko, & Martínez-Ros (2010) and Zhang & Xie (2020) findings who shows that that firms with better access to credit are more likely to start exporting and can export a larger variety of goods to a wider range of destinations (Manova, 2013). This suggests that improving access to financial capital could enhance firms' export capabilities.

Innovative firms export more than conservative firms since R&D raises export share by 9.8%. The coefficient of productivity implies that a 10-percentage point increase in productivity raises export share by 9.1%. Firms with foreign owners have better export performance than domestic firms. Large firms are more successful than small firms in the

global market. However, high-tech firms have a smaller export margin than low-tech firms. In general, the estimation results from the basic specifications for the export propensity model and export intensity model are consistent with each other regarding the directions of the covariates' impacts on export propensity and export intensity. For the regressions with the modified specifications (Regressions 2–6), only the coefficients of interactions between *Large-firm* and *Constrained* and between *Productivity* and *Constrained* are significant. Credit-constrained large firms have a smaller export share than unconstrained large firms. Thus, credit constraint condition affects both export propensity and export intensity of large firms. The magnitude of *Productivity: Constrained* suggests that the export performance of productive firms is severely affected by credit constraints, in line with findings in Berman & Héricourt (2010).

Table 4. Estimated results of the fractional logit model (dependent variable: *Export-Share*)

	(1)	(2)	(3)	(4)	(5)	(6)
R&D	0.974*** (0.077)	0.992*** (0.101)	0.972*** (0.077)	0.974*** (0.077)	0.974*** (0.077)	0.974*** (0.077)
Productivity	0.091*** (0.032)	0.090*** (0.032)	0.166*** (0.047)	0.091*** (0.032)	0.090*** (0.032)	0.091*** (0.032)
High-Tech	-1.189*** (0.076)	-1.189*** (0.076)	-1.186*** (0.076)	-1.169*** (0.100)	-1.187*** (0.076)	-1.189*** (0.076)
Large-Firm	1.160*** (0.075)	1.159*** (0.075)	1.159*** (0.075)	1.160*** (0.075)	1.289*** (0.101)	1.161*** (0.075)
Foreign-Owner	1.081*** (0.226)	1.081*** (0.226)	1.072*** (0.225)	1.080*** (0.226)	1.058*** (0.229)	0.984*** (0.307)
Constrained	-0.263*** (0.075)	-0.240** (0.113)	-0.121 (0.099)	-0.240** (0.116)	-0.133 (0.105)	-0.268*** (0.076)
R&D: Constrained		-0.041 (0.150)				
Productivity: Constrained			-0.141** (0.066)			
High-Tech: Constrained				-0.045 (0.150)		
Large-Firm: Constrained					-0.285* (0.149)	
Foreign-Owner: Constrained						0.233 (0.446)
Constant	-2.510*** (0.080)	-2.519*** (0.088)	-2.581*** (0.088)	-2.521*** (0.090)	-2.569*** (0.088)	-2.509*** (0.080)

Observations	7165	7165	7165	7165	7165	7165
Pseudo-R ²	0.1457	0.1453	0.1472	0.1457	0.1462	0.1456

Notes: *** $p < 0.01$, ** $p < 0.05$, and * $p < 0.1$; marginal effects are reported; standard errors in parentheses.

4.3. Additional analysis

For the main results, we use interaction terms to test differences in export margins between credit constrained and unconstrained firms. There are likely some unobserved factors influencing export margins for those two types of firms. In addition, firms may enter into the global market for the reason of good liquidity, indicating that the variable *Constrained* may be endogenous in the model specifications. We further estimate the basic specification of the probit model and the fractional logit model for credit-constrained and unconstrained firm groups separately.

In the model specification, productivity is also probably endogenous. Firms that enter into the global market may have access to advanced technology, which raises productivity. Thus, for the models for the subsample, we apply a control function to control for endogeneity, following Wooldridge (2015). In the first stage, the control function approach estimates an OLS model for *Productivity* on other control variables and an instrumental variable. In the surveys, firms answered the revenue and the number of employees three years ago. We create labor productivity three years ago as an instrumental variable. In the second stage, the probit and fractional logit models are modified by including the residual from the OLS regression (U^{OLS}). Table 5 presents the estimation results for the probit and fractional logit models.

As shown in Table 5, U^{OLS} is significant in the four regressions, indicating that we cannot reject the endogeneity of productivity. For the *Export* models, the coefficient of *Productivity* is greater for unconstrained firms than for constrained firms (1.84 versus 1.29). Thus, the impact of productivity on firms' decision to enter into the global market is lower for credit constrained firms than for credit unconstrained firms. The estimates of the *Export-Share* models indicate a similar impact of productivity on the export intensive margin (1.3 versus 1.38). Above all, the new estimation results reveal a different exporting-credit constraint relationship.

Table 5. Estimation Results of the models for *Export* and *Export-Share*, using a control function approach

Variable	<i>Export</i>		<i>Export-Share</i>	
	Credit unconstrained firms	Credit constrained firms	Credit unconstrained firms	Credit constrained firms
R&D	0.735*** [0.095]	0.855*** [0.1]	0.859*** [0.107]	0.913*** [0.116]
Productivity	1.841*** [0.25]	1.285*** [0.184]	1.301*** [0.275]	1.383*** [0.208]
High-Tech	-0.363***	-0.523***	-1.161***	-1.246***

	[0.096]	[0.103]	[0.103]	[0.115]
Large-Firm	1.508***	1.166***	1.192***	0.834***
	[0.096]	[0.101]	[0.108]	[0.118]
Foreign-Owner	1.183***	1.556***	0.751**	1.239***
	[0.416]	[0.365]	[0.32]	[0.308]
U1st	-1.872***	-1.645***	-1.218***	-1.83***
	[0.264]	[0.24]	[0.292]	[0.268]
Constant	-3.493***	-3.347***	-3.524***	-3.892***
	[0.215]	[0.197]	[0.22]	[0.215]
Observations	3710	3455	3710	3455
Pseudo-R ² /adj. R ²	0.1604	0.123	0.1644	0.1469

Notes: *** $p < 0.01$, ** $p < 0.05$, and * $p < 0.1$; marginal effects are reported; standard errors in parentheses.

5. Discussion

This paper investigates whether credit constraints affect the role of R&D and productivity in export margins represented by export propensity (the decision to export) and export intensity (export share in total annual sales) for manufacturing companies in India. Companies in developing countries often face more pronounced credit constraints and export barriers due to weaker financial institutions (Aw et al., 2011; Nagaraj, 2014), higher transaction costs, and more regulatory hurdles (Fowowe, 2017). Studies have highlighted how these factors disproportionately affect SMEs, which are less likely to have established credit histories or collateral (Banerjee et al., 2015; Yoshino & Hesary, 2018). Moreover, the lack of access to finance is often cited as a major obstacle to innovation and development in export sectors (Chaudhuri et al., 2020; Wellalage & Samujh, 2019).

Our empirical findings highlight the central role of access to finance in bolstering exporting in developing countries. Our findings are consistent with Pietrovito and Pozzolo (2021) and Fauceglia (2015), who show that credit constraints play a significant role in firms' decisions to engage in export activities. This empirical evidence aligns with the research conducted by Cassiman, Golovko, and Martínez-Ros (2010) and Zhang & Xie (2020), who also identified a positive correlation between access to credit and export intensity. Our findings highlight the critical dependency of exporting on access to external capital and point out that firms in developing countries frequently encounter challenges in accessing finance. Addressing these financial constraints, therefore, emerges as a paramount incentive to foster export growth. Additionally, we also find empirical evidence that innovative, productive, large, and foreign-owned firms have a higher likelihood and intensity of exporting; credit constraints remain a significant barrier affecting even large firms' ability to participate fully in the global market, supporting findings of previous studies (Berman & Héricourt, 2010; Demirgüç-Kunt et al., 2020; Zhang & Xie, 2020; Zhang, 2022). This underlines the importance of targeted financial policies and reforms to catalyze the internationalization of firms, contributing to a more understanding of the dynamics at play in the relationship between financial development and firm-level export decisions.

6. Conclusions

For developing countries, exporting contributes substantially to economic growth regarding foreign exchange earnings and labor employed. Accordingly, export incentives are provided to alleviate barriers and encourage exports.¹ Since exporting depends on external capital and firms in developing countries generally face limited access to finance, improving financial services and financial support is considered one of the important incentives. Our empirical results reveal the channels through which credit constraints affect exports, which may be informative for policymakers. For example, large firms with limited access to credit are more reluctant to export and more different to improve export share once they enter the global market. Credit constraints substantially reduce export shares for productive firms. Financial support programs may target large and productive firms to enhance their export extensive and intensive margins. In summary, our study provides compelling evidence supporting the pivotal role of financial development and institutional reform in mitigating credit constraints and fostering export activities, particularly for firms in developing countries. Additionally, our study suggests that improving the overall financial infrastructure and accessibility to credit in developing countries could serve as a foundational policy measure to support export-oriented economic strategies. Enhancing the financial sector's efficiency and ability to cater to the diverse needs of firms across sizes and productivity levels could democratize access to export opportunities, contributing to more equitable economic growth.

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¹ For financial assistance and other export incentives in India, see <https://www.dripcapital.com>.

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