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Working Capital Financing for MSMEs Through Digital Innovation: Participation-Efficiency Interdependence on India's Trade Receivables Discounting System (TReDS) Platforms

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Abstract

Micro, Small and Medium Enterprises (MSMEs) contribute to India's GDP and employment but face working capital constraints from delayed buyers' payments. The Trade Receivable Discounting System (TReDS) addresses this by letting MSMEs access finance through competitive bidding on electronic platforms. This study examines how the participation of financers, buyers and MSME sellers, with their lagged effects, shapes platform level financing efficiency, and, in turn, how financing efficiency and stakeholders' participation drive MSME onboarding. Using monthly data from all five RBI-authorised TReDS platforms (April 2022 to June 2026), an unbalanced panel is analysed using dynamic fixed effects model with Driscoll-Kraay standard errors, followed by two robustness checks, an instrumental-variable (2SLS) approach addressing simultaneity, and re-estimation on a restricted sample excluding two recently authorised platforms. Both financing efficiency and MSME onboarding found to be strongly persistence on month-on-month, surviving robustness testing. Growth in MSME onboarding significantly raises same-month financing efficiency, though the robustness check suggest this relationship partly reflects co-movement rather than a pure causal effect. By modelling interdependence between stakeholder participation and platform performance, rather than examining MSME level outcomes of TReDS adoption in isolation, the study offers a novel, platform-level perspective what impact MSMEs onboarding and efficiency across TReDS ecosystem.

1. INTRODUCTION

For developing counties across the world, Micro, Small and Medium Enterprises (MSMEs) contribute significantly in Gross Domestic Product (GDP) and in generating employment *(Ayyagari, Demirguc-Kunt & Maksimovic,2017*). Yet, they face disproportionately higher financing and institutional burden compared to large firms (Beck and Demirguc-Kunt, 2006). The growth of MSMEs depend upon the access to finance. Access to finance significantly improves a firm's productivity and its competitiveness (*Sharma et al. 2024*). Credit constrains hold back a firm by limiting the capital needed for their expansion and as well as for their operation. The high cost of credit, complex lending procedures, problem with the collateral *(Love et al.,2013)*, information asymmetry (Athaide and Pradhan, 2020), and limited awareness of available financial products are found to be the problem with MSMEs in emerging economies like India (*Rao et al,2023*).

In India, MSMEs play significant role in employment generation, contribute nearly 30% of national GDP and over 40% of export as reported by the concerned ministry in 2024-25. MSMEs provides employment to over 265 million individuals, according to data retrieved from the Udyam portal. (*a platform hosted by Ministry of Micro, Small and Medium Enterprises*). However, one of the significant constraints that MSMEs in India face, is no different with its counterparts in developing nations, is limited access to finance (Rao et al., 2023). Delayed payment by the buyers have consistently been a significant challenge for MSMEs in India, negatively affecting their growth and operational efficiency. MSMEs also face significant liquidity constraints attributed to lengthy payment cycles from their customers *(Reserve Bank of India, 2019)*. The delay in receiving payments adversely affect their cash flows, hindering their ability to invest in essential

areas such as business expansion, technological innovations, and workforce development (Murfin & Njoroge, 2015). MSMEs in India heavily rely on short-term borrowing, whose main components are bank loans, trade payables, and inter-corporate loans (Altaf and Shah 2021*)*.

Further, as per a recent report by Global Alliance for Mass Entrepreneurship (GAME) and Dun & Bradstreet (D&B), delayed payments to MSMEs in India are estimated to total INR 10.7 lakh crore, with micro and small enterprises bearing 80% of this burden. As a result of this, the financial health and growth prospects of MSMEs are compromised, and their contributions to economic development gets also affected.

It is needless to mention that the government support is crucial for business development particularly in case of small sized businesses, however, its direction depends on existing political system and cultural characteristics particularly in case of developing countries *(*Alakbarov & Hasanov, 2024). Government over the years have made several attempts by launching various schemes towards MSMEs' development which have uplifted the sector but remains ineffective in many areas *(Chitsimran et al., 2020)*. Some recent academic research outcome indicates that MSMEs competitiveness is mostly related to sustainability, information-knowledge, and networks-open innovation; hence MSMEs managers and owners should pay attention to these factors *(Dambiski Gomes de Carvalho et al., 2021)*.

Access to finance for MSMEs is critical for their survival and development, but such access has remained constrained for MSMEs worldwide *(Michael Troilo, Nick Freeman, and Masato Abe)*. Many enterprises experience difficulty in funding their production cycles because buyers typically require 30 to 90 days to remit payment after delivery *(*Klapper, 2006*)*. Specific financing tools such as leasing and factoring can be useful in facilitating greater access to finance for the SMEs *(*Beck & Demirguc-Kunt, 2006*)*.

Factoring as short-term financial tool seemed to be advantageous for MSMEs in India. However, the growth of the factoring industry in India has been hindered by the absence of a structured regulatory framework, which limited its scalability and market formalization.

1.1 Factoring Services and its accessibility challenges for MSMEs

A significant development occurred in the year 2001 when the Reserve Bank of India (RBI) introduced a guideline to improve accountability and transparency in factoring operations. Further, the Factoring Regulation Act of 2011 established a legal framework for assignment of receivables to factors and allowed Non-Banking Financial Companies (NBFCs) to operate in factoring as a principal business. In spite of these developments, challenges remain in recovering dues from defaulting entities. Apart from this, the factoring industry continues to face issues such as limited market penetration and high transaction costs and continues to primarily serve larger businesses leaving small businesses underserved *(Shankar, CASI Working Paper, 2021)*.

In the context of the above discussion, we may further say that MSMEs faced difficulties in getting factoring services because of strict eligibility criteria, high cost, and need for collateral. The inaccessibility had led the MSMEs to fall back on very expensive informal loans for meeting their requirement of cash to make payment to suppliers of raw material, payment of wages etc., i.e., basically for working capital requirement.

At the same the factoring process, as shown in Fig. 1 below, were mostly manual leading to delays caused by too much paperwork and a lack of standard procedures. While, traditional banks often preferred giving loans rather than invoice discounting, which left MSMEs without collateral or without a solid operational history at a disadvantage. While some NBFCs offered services, but their impact was limited. Additionally, MSMEs struggled to find a transparent and effective credit assessment tools, making it tough for them to get favourable financing terms.

Source: Authors

1.2 The Genesis of TReDS (Trade Receivables Discounting System)

To address the limitations as highlighted in above section, the RBI conceptualised a digital and regulated market place for discounting of trade receivable, so that working capital turnover or efficiency of the MSMEs can be improved. In 2014, RBI issued a guideline for setting up and operationalise the Trade Receivables Discounting System (TReDS) i.e., an electronic platform foe financing MSMEs trade receivables **(**Singh, 2024**).**

The system was designed to digitise the entire system i.e., from uploading of a factoring unit i.e., the invoices to its acceptance, competitive bidding and final settlement. As the process is completely digitised, it reduces the paper work and the delay which occurs in manual factoring.

The platform hosts multiple financers, it makes the bidding process competitive, allowing the MSMEs to get finance at a market determined rate. As the financing on TReDS is extended against receivable owed by the creditworthy buyers, typically, large corporates, PSUs and government entities, the assessment has shifted from MSME seller to the buyer, which has reduced the need of credit history assessment which the traditional credit delivery mechanism considers.

The idea of TReDS itself builds on an earlier recommendation of the 2009 "*A Hundred Small Steps*" report of the High-Level Committee on Financial Sector Reforms, which proposed dematerialising and securitising MSME trade receivables through an electronic exchange, modelled on the Mexican development bank NAFIN's system for auctioning small-firm receivables. Prior to 2016, however, RBI guidelines did not clearly permit securitisation of revolving assets such as trade credit, which constrained the development of a secondary market in receivables *(*Chatnani, 2018*).*

Finally, it may be right to say that TReDS has developed itself as an institutional mechanism to convert MSMEs' locked-up receivables into immediate working capital, thereby easing the liquidity constraints

created by delayed payments and supporting the sector's growth.

1.3 The TReDS platforms & how does it work?

TReDS is an electronic platform designed to provide the financing against the trade receivables for MSMEs (Reserve Bank of India, 2020). The platform enables MSMEs to obtain funds by leveraging their receivable from transaction with corporates, PSUs and other government entities. The platform provides liquidity and supports growth for the MSMEs which directly contributes to the overall economic development of the nation.

The discounting process involves several steps, as depicted in Fig. 2. It starts with creation of FUs (*The standard terminology utilized in TReDS for invoices or bills of exchange includes details of invoices or bills of exchange that validate the sale of goods or services by MSME sellers to the buyers*). This creation of FU can be initiated by either the MSME seller in the case of factoring or the buyer in **reverse factoring**. Once the FU is created, it must be accepted by the relevant counterparty i.e., by MSME buyers in case of factoring or MSME sellers in case of reverse factoring. After the acceptance, financers (Banks and NBFCs) do bid on the uploaded FUs, the buyer or seller accepts the most favourable bidding. Upon selection, the financier disburses the payment to the MSME seller at the agreed financing or discounting rate. The final step of this process occurs when the buyer settles the payment to the financier on the due date. Currently, there are five platforms, names shown in Table 1, offer trade receivable discounting services to MSMEs.

Table 1
Name of the TReDS platforms currently functional
(30th June 2026)

Sl. No.	Name of the Platform
1.	A. TREDS Limited
2.	Mynd Solutions Private Limited
3.	Receivables Exchange of India Limited
4.	C2FO Factoring Solutions Private Limited
5.	KredX Platform Private Limited
Source: RBI	

Source: Compiled by authors

2. LITERATURE REVIEW

2.1 MSME Financing Constraints in India

MSMEs remain central to the economy in terms of GDP contribution and employment creation over 100 million people (Martinravi & Krishnasamy, 2024), yet they continue to face a persistent financing gap. Delayed buyers' payment blocks a large share of MSMEs working capital, an estimated INR 7.34 lakh crore in trade receivable remained overdue payment as at March 2024 (Grewal, 2026). This working capital problem got amplified during COVID-19 pandemic, during that time access to formal credit came under strain (Behera et al., 2020). Export oriented MSMEs face amplified credit strain due to documentation and compliance burden (Vasani & Abdulkareem, 2024).

2.2 Fintech as a Solution to SME Financing Gaps

A growing number of international research shows that Fin-Tech solution is narrowing the financing gap. Cross-country evidence says that access to credit through fin-tech reduces the MSME financing gap, the strongest effect seen among digitally visible firms in developing economies (Asaana, 2026). A broader survey of fintech credit innovations documented rapid growth in digital SME lending and trade finance products across Asian region (Cornelli et al., 2019). Firm level evidence from China shows that lesser information asymmetry between lenders and borrowers leads to better investment efficiency among SMEs which in turn leads to fintech development (Huang, 2022). Accessibility of loan to firms have become easier with fintech based unsecured lending. (Beaumont, Tang, and Vansteenberghe, 2026)

2.3 Platform Participation as a Dynamic Process

Adoption and participation are an outcome of an ongoing process rather than a singular decision. The extent to which benefits are realised depend on the depth of the stakeholder engagement with the digital platform. MSMEs' adoption to digital channel depends upon socio-technical readiness, and sustained government support (Aminullah et al., 2024).

2.4 Prior Evidence on TReDS

The MSMEs that adopted TReDS in comparison of those that have not, experiences a 23% reduction in receivable-realisation cycles and an 8% increase in sales growth within six to twelve months (Grewal 2026). TReDS significantly enhances liquidity and reduces receivable cycles, although the impact on profitability is less pronounced (Rabha and Malakar 2025*).* In an attempt of determining funding costs on TReDS, it was found that the interest rates are primarily influenced by buyers' credit ratings rather than the MSMEs' own creditworthiness, and that increased competition among bidders on invoices leads to lower costs (Sanati, Ramakrishnan, and Kakarlapudi, 2026*).*

2.5 Research Gap

There has been research on MSME financing and the challenges that the SMEs face, also how digital innovation has been assisting MSMEs in procuring low-cost finance, both in Indian and International context. There has been researches on TReDS platforms as well, but those researches are related to how MSMEs are getting benefited through platforms like TReDS. However, an important gap remains unexplored that regarding determining the interconnectedness among the participants (such as MSMEs, buyers, financers) of different platforms and their impact of platform level financing efficiency.

3. THEORETICAL BACKGROUND AND HYPOTHESES DEVELOPMENT

3.1 Two-sided market theory

The TReDS platform operates as a two-sided market (Rochet & Tirole, 2003) which act an intermediary between MSME sellers and buyers. In such markets, the platform's value to participants on one side increases as participation on the other side grows *(*Katz & Shapiro, 1985*)*. As discussed above, after FUs (Factoring Units) are uploaded by the MSME seller, the same has to be accepted by the MSME buyers before eligible to enter into the bidding process for financing. This observation leads to the first hypothesis:

H1: Growth in buyers' registration positively affects growth in MSME onboarding.

The same cross side logic extends to financing side of the market. Banks and NBFCs bid competitively on uploaded FUs, a larger and more active pool of financers increases the intensity of this bidding, raising the likelihood that an uploaded FU is picked up and get financed rather than left unmatched. However, a newly onboarded financer needs a short activation lag before starting with bidding process, which means this cross-side effect is expected to take hold with a lag rather than immediately. This leads to the second hypothesis:

H2: Growth in financer (banks and NBFCs) registration positively affects financing efficiency, with the effect emerging after a short onboarding lag.

A platform's realised efficiency is what makes the platform valuable to the prospective participants. A platform that converts higher share of uploaded FUs into completed financing becomes more attractive to the MSMEs, generating an indirect, same side network effect in which platform demonstrated performance draws further onboarding. This leads to third hypothesis:

H3: Financing efficiency positively affects growth in MSME onboarding.

3.2 Dynamic-capability theory

Credit assessment skills, financer relationship that a platform builds over a period time need not to be reset each month, the same is being carried forward and reinforced, consistent with dynamic -capacity theory *(*Teece, Pisano, & Shuen, 1997*)*. Therefore, a platform which has been effective and efficient at turning uploaded invoices into financed ones in recent months would likely to remain effective in the following month. This leads to the fourth hypothesis

H4: Financing efficiency is persistent - last month's efficiency raises this month.

3.3 Diffusion of innovation theory

MSMEs adoption of digital financing platform may also be shaped by the visible experience of earlier adopters, consistent with diffusion-of-innovation perspective (Rogers, 2003, Bass, 1969), these models

mention that adoption growth is self-reinforcing because prospective adopters respond to the visible base of prior adopters.

Onboarding of one month is, therefore, likely to be correlated with onboarding in the following month rather than occurring independently period to period. This leads to the fifth hypothesis:

H5: Growth in MSME onboarding is persistent i.e., last month's onboarding growth raises this month's onboarding growth.

3.4 Partial-adjustment theory

A platforms capacity to process, verify and enabling FUs for bidding in any given month is not unlimited as its based on same capacity of platform. An increase in MSME onboarding increases the volume of FUs entering in the pipeline in that month provided MSMEs buyers have accepted the same as mostly the newly onboarded participants tend to be well-prepared sellers or buyers who upload or accept readily financeable invoices, this can lift financing efficiency in the very same month. However, as the platforms capacity to process the sudden inflow does not expand as quickly as the inflow, the surge and leave a temporary backlog that is worked through only in the next month, producing a partial pull-back in efficiency once initial boost has passed. It's based on the same underlying logic that motivates including lagged terms in the dynamic-panel specification used later in this paper (Nerlove, M. 1958). This leads to the final hypothesis:

H6: Onboarding surges raise same-month financing efficiency but cause a partial pull-back the next month.

4. OBJECTIVES

The objective of the present research is to:

1. **4.1** To examine the determinants of MSME onboarding growth on TReDS platform, testing whether it is driven by MSME buyers' registration on the platform (H1), financing efficiency (H3), and its own persistence (H5).
2. **4.2** to examine the determinants of financing efficiency on TReDS platforms, testing whether it's driven by financer registration growth (H2), its own persistence (H4), and short-run capacity-adjustment effects following onboarding or buyer-registration surges (H6).

5. METHODOLOGY

5.1. Sources of Data

In this study we have employed a longitudinal, platform level operational data of the TReDS platform from the website of the Reserve Bank of India, which publishes the same on monthly basis. At the time of the study, **five entities / platforms** are operational, providing trade receivable discounting services to

MSMEs and our panel comprises five cross sections (N = 5), which essentially present the entire population.

However, the panel is unbalanced across five platforms, for A.TREDS, Mynd Solutions, and RXIL, as the data available from April 2022, each platform contribute 51 months observation, while other two platforms received RBI's authorization more recently, C2FO from June 2024 (25 observations) and KredX from July 2025 (12 observations), **it is reflecting their later entry into the market rather than it's a data-collection limitation.**

5.2 Variable Definitions and Construction

We have considered four indicators at the *platform-month* level. The variable construction technique is shown in Table 2.

1. (a) FE or financial efficiency is one of the core indicators of the study which is measured by the number of units got financed *divide by*, bills uploaded (*technically known as FU or factoring units*). The three participating variables are expressed as month-over-month (M-o-M) growth rate. These three variables are:
2. (b) growth rate in MSME (*i.e., Sellers*) onboarding (GMO)
3. (c) growth rate in MSME buyer's registration (GBR) and
4. (d) growth rate in financers (GFR) (i.e., *Banks and NBFCs, who take part in the bidding process*) registration with the platform.

Table 2
Variable Definitions and Measurement

Variable	Definition	Measurement
FE*	Financing efficiency	(Factoring units financed ÷ factoring units uploaded) × 100
GMO	Growth in MSME onboarding	Month-over-month % change in the number of onboarded MSME sellers
GBR	Growth in buyers' registration	Month-over-month % change in the number of registered MSME buyers
GFR	Growth in financier registration	Month-over-month % change in the number of financiers (banks and NBFCs)
Source: Compiled by authors		
FE (i.e., financing efficiency) will be between 0 to 100, however, its observed across all the platform-month data we have considered its very close of the upper limit. A linear model with such higher range values may mis-specify the variance near boundary. Therefore, the variable is modelled and transformed as follows*:		
$FE^*_{i} = \ln [FE_{i} / (100 - FE_{i})]$		

[*where i indexes platforms and t indexes months. All regression results reported for financing efficiency use FE*]*

5.3 Lag Structure

To examine whether stakeholders' participation in the current month, along with their participation in the preceding month, affects the current month's outcome, we incorporated a one-month lag (− 1) for all variables. The lagged dependent variable *[i.e., DV (-1)]* captures the persistence or dynamic effect of the outcome over time.

5.4 Methodology and Model Specification

In our panel set up, we have considered five entities (i.e., the platforms), three of which (A.TREDS, Mynd Solutions, and RXIL) are observed for the full 51-month window staring from April 2022 to June 2026, one (C2FO) for 25 months, and one (KredX) for 12 months, in this situation the Arellano-Bond estimator (GMM) is not the most appropriate choice, as it requires a larger number of cross-sectional units to create valid moment conditions and instruments. Therefore, considering the longitudinal depth of our panel, a dynamic panel approach (*Fixed Effects*) has been used.

The models are as follows:

Model 1: Determinants of MSME Onboarding

$$GMO_{i,t} = \alpha + \gamma\, GMO_{i,t-1} + \delta_1\, FE^*_{i,t} + \delta_2\, FE^*_{i,t-1} + \delta_3\, GBR_{i,t} + \delta_4\, GBR_{i,t-1} + \delta_5\, GFR_{i,t} + \delta_6\, GFR_{i,t-1} + \mu_i + \varepsilon_{i,t}$$

Model 2: Determinants of Financing Efficiency

$$FE^*_{i,t} = \alpha + \varphi\, FE^*_{i,t-1} + \beta_1 GMO_{i,t} + \beta_2 GMO_{i,t-1} + \beta_3 GBR_{i,t} + \beta_4 GBR_{i,t-1} + \beta_5 GFR_{i,t} + \beta_6 GFR_{i,t-1} + \mu_i + \varepsilon_{i,t}$$

The autoregressive terms i.e., φ in Model 1 and γ in Model 2 are used to measure the persistence of the respective dependent variable.

6. RESULTS AND DISCUSSION

6.1 Descriptive Statistics

The Table 3 shows below descriptive statistics for the unbalanced panel of five platforms, covering a period of 190 platform – month. The observations cover period from April 2022 to June 2026.

Table 3
Descriptive Statistics

GMO	n	Mean	S.D.	Min.	Max.
	190	**8.78**	**24.53**	**0.00**	**262.50**
FE	190	92.25	5.81	62.50	99.63
GBR	190	6.89	15.84	-1.18	180.00
GFR	190	2.99	7.45	0.00	66.67
Source: Authors' computation (Stata output)					

The above descriptive statistics shows that MSME onboarding (GMO) grew by 8.8% a month across five platforms with a standard deviation of 24.5%. This high deviation is possibly due to very sharp percentage increase seen in the early months of the two new platforms i.e., C2FO and KredX. When we look at financing efficiency (FE), its constantly high and stable, on an average, 92.3% of uploaded invoices get financed, and the same barely varies from platform to platform or month to month as the S.D is low. This confirms that once an invoice is uploaded and the other stakeholders (buyers and financiers) are in place, TReDS platforms convert it into actual financing almost as a matter of routine. Growth in buyers' registration (GBR) averages 6.9% a month with a SD of 15.85%, while growth of financer registration (GFR) is steadiest among other stakeholders participating measures.

6.2 Correlation statistics and test of multicollinearity

Table 4
Pearson Correlation and Variance Inflation Factors

GMO	**GMO**	**FE**	**GBR**	**GFR**
	1.000			
FE	-0.002	1.000		
GBR	0.215***	0.218***	1.000	
GFR	0.613***	0.015	0.435***	1.000
Test of Multicollinearity				
Model 1 (D.V. = GMO)		**VIF**	**Model 1 (D.V. = FE*)**	**VIF**
FE*$_{t-1}$		2.47	GMO$_{t-1}$	3.38
FE*		2.46	GMO	2.90
GFR		2.39	GFR	2.39
GMO$_{t-1}$		2.25	GFR$_{t-1}$	2.26
GFR$_{t-1}$		2.13	GBR$_{t-1}$	1.37
GBR$_{t-1}$		1.43	GBR	1.34
GBR		1.40	FE*$_{t-1}$	1.09
Mean VIF		2.08	Mean VIF	2.11

** Correlation is significant at the 0.05 level (2-tailed).*

***. Correlation is significant at the 0.01 level (2-tailed).*

Source: Authors' Computation (Stata output)

The correlation as shown in Table 4 shows MSME onboarding (GMO) is strongly and positively (r = 0.613) associated with financers (Banks and NBFCs) registration (GFR) on the platform, it indicates that months in which more financers join a platform to be the same month that more MSMEs have also joined the platform which is likely because a wider pool of financiers makes a platform more attractive to sellers seeking competitive bidding.

Further, MSME onboarding (GMO) is also positively, though more modestly, correlated with buyer registration (GBR) growth (r = 0.215). Financing efficiency (FE), on the other hand, shows a modest positive association with buyers' growth (GBR) which is in line with the idea that buyers accept the uploaded FUs, then only it goes for bidding and get financed.

Additionally, it is important to highlight that multicollinearity does not pose a concern for both the models, as all VIF values fall within the low range of 1.40 to 2.46 for *model 1* and between 1.09 to 3.38 for *model 2*, suggesting stable conditions for regression analysis.

6.3 Panel Unit-Root (Stationarity) Tests

Before running the fixed effect dynamic panel models, we wanted to test whether each variable considered in the study is stable over time i.e., does not drift persistently upward or downward i.e., non-stationarity. The same may produce spurious regression results. We conducted *Fisher-ADF* and *IPS (Im–Pesaran–Shin)* stationarity tests and the results for the same is depicted below in *Table.5*.

Table 5
Panel Unit-Root / Stationarity Tests

Variable	**Fisher-ADF (P-statistic)**	**p-value**	**IPS (W-t-bar)**	**p-value**	**Stationary at I (0) or I (1)**
FE*	22.036	0.0149	-2.1507	0.0158	I (0)
GMO	107.875	0.0000	-7.7673	0.0000	I (0)
GBR	39.118	0.0000	-3.3603	0.0004	I (0)
GFR	147.177	0.0000	-10.2122	0.0000	I (0)

Source: Authors' computation (Stata output).

The results from the Fisher-ADF and IPS tests indicate that all the variables are found to be stationary at I (0) i.e., at level as their p-values are below 5% level of significance. Thus, the variables do not exhibit evidence of unit root and reduces the concern of getting spurious regression results.

6.4 Cross-Sectional Dependence, Serial Correlation, Heteroskedasticity, and Model-Selection Tests

Table 6
Panel Diagnostic and Model-Selection Tests

Test	Applied to	Statistic	p-value	Inference
Pesaran CD (cross-sectional dependence)	Model 1 (GMO)	1.743	0.0812	No significant dependence at 5%
Pesaran CD (cross-sectional dependence)	Model 2 (FE*)	1.844	0.0652	No significant dependence at 5%
Wooldridge test (serial correlation)	Model 1 (GMO)	F (1,4) = 8.996	0.0400	Serial correlation present
Wooldridge test (serial correlation)	Model 2 (FE*)	F (1,4) = 1.428	0.2981	No first-order serial correlation
Modified Wald test (heteroskedasticity)	Model 1 (GMO)	χ^2 (5) = 22,680.31	0.0000	Heteroskedasticity present
Modified Wald test (heteroskedasticity)	Model 2 (FE*)	χ^2 (5) = 211.75	0.0000	Heteroskedasticity present
Hausman test (FE vs. RE)	Model 2 (GMO)	$\chi^2(7)$ = 71.37	0.0000	Fixed effects preferred
Hausman test (FE vs. RE)	Model 1 (FE*)	χ^2 (7) = 37.71	0.0000	Fixed effects preferred

Source: Authors' computation (Stata output).

Before running the dynamic panel regressions (fixed effect) for both the models, to test whether these five platforms move together i.e., in technical terms whether *cross sectional dependency* persists, we applied **Pesaran cross sectional dependence (CD) test**. For **model 1 (D.V. = GMO)**, we got p-value of 0.08 and **model 2 (D.V = FE*)**, we got p-value of 0.06, which is marginally higher than 0.05 indicating no significant dependence at 5% as shown in Table 6.

Further to test whether *serial correlation* exits between the error-terms, we applied **Wooldridge test** for both the models. As indicated in the table, p-value is less than 0.05 in case of **model 1(D.V. = GMO)** showing presence of serial correlation and for **model 2 (D.V = FE*)**, no first order correlation found as the *p-value* is less than 0.05.

To check whether heteroskedasticity exists, we conducted modified Wald test, as the *p-value* is less than 0.00 for both the models as shown in Table 6, we may conclude that *heteroskedasticity* is present which indicates that ordinary standard errors will not be reliable.

Hausman test has also been conducted to determine, results shown in Table 6, whether fixed effect model is appropriate as the p-value for both the models found to be less than 0.05, we conclude that

fixed effect (FE) is appropriate to run the regression.

Based on these diagnostic findings, particularly the presence of heteroskedasticity and serial correlation, **Fixed Effects regression with Driscoll-Kraay standard errors** was adopted for the subsequent analysis to obtain reliable statistical inference.

6.5 Regression Results

As mentioned above, both the regression models have been estimated by *Fixed Effect regression with Driscoll-Kraay standard error (S.E.)*, which is appropriate for cross-sectional dependence and heteroskedasticity given the panel's structure. The results of the two models are shown below:

Model 1 - Determinants of MSME Onboarding (D.V. = GMO)

Table 7
Regression results for Model 1

Variable	Coefficient	D-K S.E.	t	p-value
GMO$_{-1}$	0.2392	0.0365	6.56	0.000***
FE*	0.0161	0.0078	2.07	0.044**
FE*$_{-1}$	-0.0152	0.0117	-1.30	0.200
GBR	0.0156	0.0483	0.32	0.748
GBR$_{-1}$	-0.0135	0.0175	-0.77	0.444
GFR	-0.2463	0.1776	-1.39	0.172
GFR$_{-1}$	0.1625	0.0898	1.81	0.077*
Constant	0.0430	0.0184	2.34	0.024**

*Observations = 185; Platforms = 5; Within R^2 = 0.5824; F = 14.65 (p = 0.000); Maximum Driscoll-Kraay lag = 3. *** p < 0.01, ** p < 0.05, * p < 0.10.*

Source: Authors' computation (Stata output).

The above table for the regression **Eq. 1** indicates MSME onboarding (GMO) shows persistence i.e., last month's growth in MSME onboarding (GMO$_{-1}$) carries over positively into current month which is consistent with H5.

Current months' financing efficiency (FE*) has small but statistically significant impact on MSME onboarding (GMO), consistent with H3, this indicates that the platform which finance higher share of uploaded invoices attract newer MSMEs at that same month, though the impact is modest. But, the lagged effect of financing efficiency (FE*$_{-1}$) has no statistically significant impact on current month's MSME onboarding.

Contrary to H1, Growth in buyers' registration (GBR), whether same month or lagged, does not have any statistically significant effect MSME onboarding (GMO). This does not necessarily mean that buyer participation (GBR) is irrelevant to onboarding of MSMEs (GMO), rather it suggests the effect is fully mediated by financing efficiency rather than impacting on MSME onboarding on its own. Buyers accept the uploaded FUs, this allows those invoices to get financed and Table 4 shows financing efficiency (FE) is modestly positively correlated with buyers' registration growth (GBR) – it's the realised efficiency that draws more sellers (MSMEs). This indirect pathway helps us to understand even though buyers' registration (GBR) is not significant in multivariate model, a bi-variate correlation is showcasing an effect that, once financing efficiency is included, as control, the effect is absorbed by that variable.

Finally, while not finally hypothesised, Growth in financer registration (GFR) of last month (GFR_{t-1}) has positive but marginally significant impact on MSME onboarding (GMO) of current month. It's consistent with sellers being drawn to platforms that offer a deeper pool of potential financiers. The model explains 58.2% of the within-platform variation in MSME onboarding.

Model 2 - Determinants of Financing Efficiency (D.V. = FE*)

Table 8
Regression results for Model 2

Variable	Coefficient	D-K S.E.	t	p-value
FE^*_{t-1}	0.6376	0.0492	12.96	0.000***
GMO	2.2232	0.4521	4.92	0.000***
GMO_{t-1}	-1.0931	0.1789	-6.11	0.000***
GBR	0.9139	0.1483	6.16	0.000***
GBR_{t-1}	-0.6508	0.2367	-2.75	0.008***
GFR	1.7185	1.0848	1.58	0.120
GFR_{t-1}	1.8126	0.8765	2.07	0.044**
Constant	0.8423	0.1645	5.12	0.000***

*Observations = 185; Platforms = 5; Within R^2 = 0.4630; F = 40.13 (p = 0.000); Maximum Driscoll-Kraay lag = 3. *** p < 0.01, ** p < 0.05, * p < 0.10.*

Source: Authors' computation (Stata output).

The regression results for *Model 2*, financing efficiency (FE) is highly persistence which means once a platform reaches high and stable rate of financing, it tends to continue the same in the next month as well, consistent with H4. Consistent with H6, growth in MSME onboarding (GMO) in the same month increases financing efficiency (FE) suggesting that when more sellers join a platform in a given month, more share of uploaded invoices get financed in that month which is likely and very interestingly,

because these new entrants i.e., MSMEs tend to be well-prepared sellers uploading readily-financeable invoices.

Very interestingly the impact reverses in the following month, which indicates a surge in onboarding in the previous month (GMO_{-1}) creates a partial dip in efficiency. A similar same month positive and next month negative pattern appears for buyers' registration (GBR) reinforcing H6's prediction that both onboarding and buyer-registration surges create temporary friction before smoothing out. However, growth in financer registration (GFR) has no same month impact, but a rise in financier registration last month (GFR_{-1}) raises this month's financing efficiency, most expectedly because it takes financers to actively begin with bidding once they join a platform. Overall, the model explains 46.3% of the within-platform variation in financing efficiency ($F = 40.13$, $p < 0.001$).

6.6 Walt Test of Joint Significance

Wald test of joint significance is conducted to examine whether the current or lagged values of each explanatory variables, taken together, have statically significant impact on dependent variable. The test is relevant in dynamic model set up as the effect of a variable may not arise not only from its current value but may also from its lagged values i.e., previous period value (-1). The results of these joint significance tests for both models are presented below.

Table 9
Results of Joint Significance Tests

Model	***Variables Tested Jointly***	***F-statistic***	***p-value***
Model 1 (GMO)	FE* & FE^*_{-1}	3.05	0.0566*
Model 1 (GMO)	GBR & GBR_{-1}	0.30	0.7435
Model 1 (GMO)	GFR & GFR_{-1}	2.45	0.0969*
Model 2 (FE*)	GMO & GMO_{-1}	28.68	0.000***
Model 2 (FE*)	GBR & GBR_{-1}	19.64	0.000***
Model 2 (FE*)	GFR & GFR_{-1}	7.42	0.0015***

**** p < 0.01, ** p < 0.05, * p < 0.10. Source: Authors' computation (Stata output).*

The above Table 9 shows, that for **Model 1** i.e., for the MSME onboarding, only financing efficiency (FE*) and growth in financier registration (GFR) are jointly significant (at the 10% level); buyer registration, whether current or lagged, does not meaningfully explain MSME onboarding once the other factors are controlled for.

Similarly, for **Model 2**, all three independent variables i.e., GMO, GFR and GBR, jointly along with their respective lagged variables meaningfully explain the impact on financing efficiency i.e., FE.

6.7 Robustness Check: Addressing Potential Simultaneity Bias

Since the contemporaneous values of the other equation are included as regressors in both the models (FE□ *in Model 1 and GMO□ in Model 2), potential simultaneity problem may be a concern. To examine this issue, we re-estimated both the models using two-stage least squares (2SLS), instrumenting each contemporaneous regressor with its second lag (FE□$_{-2}$* for Model 1 and GMO□$_{-2}$ for Model 2). For comparability IV estimates were obtained using fixed effect specification.

Table 10
Simultaneity Check - Baseline Fixed-Effects vs. Instrumental-Variables (2SLS) Estimates

Model	Instrumented Variable	Estimator	Coefficient	S.E.	p-value
Model 1 (GMO equation)	FE*	Baseline FE	0.0161	0.0078	0.044**
Model 1 (GMO equation)	FE*	IV (2SLS)	0.0426	0.0155	0.006***
Model 2 (FE* equation)	GMO	Baseline FE	2.2232	0.4521	0.000***
Model 2 (FE* equation)	GMO	IV (2SLS)	0.8765	1.3788	0.525

Note: Both contemporaneous cross-terms instrumented with their own second lag (t-2). Baseline estimated via standard fixed-effects for comparability with the IV estimator; figures are not directly comparable to the Driscoll-Kraay estimates in Tables 7–8. **** p < 0.01, ** p < 0.05, * p < 0.10. Source: Authors' computation (Stata output).*

Table 11
First-Stage Instrument Strength Diagnostics

Model	Excluded Instrument	Cragg-Donald Wald F-statistic	Stock-Yogo 10% Critical Value	Instrument Strength
Model 1	FE*t-2	32.727	16.38	Strong - well above critical value
Model 2	GMOt-2	170.685	16.38	Strong - well above critical value

Source: Authors' computation (Stata output), following Stock and Yogo (2005).

As reported in Table 10 and Table 11, the instruments satisfy the conventional strength criteria with Cragg–Donald F-statistics of 32.727 for Model 1 and 170.685 for Model 2, both exceeding the Stock–Yogo 10% critical value of 16.38.

For model 2, the coefficient on GMO decreases from 2.22 in baseline FE model to 0.87 under 2SLS and becomes statistically insignificant as the p-value increases above 0.05. This suggests that strong contemporaneous association between GMO and FE* observed in baseline model may partly reflect simultaneity between MSME onboarding activity and financing and financing efficiency. However, this result concerns only the contemporaneous relationship; the effect of lagged GMO on subsequent financing efficiency remains unaffected.

For model 1, the coefficient on FE* increases from 0.01 in baseline FE model to 0.04 under 2SLS and remains statistically significant. Thus, the positive contemporaneous effect on financing efficiency on onboarding is robust to correlation for potential simultaneity.

Overall, the 2SLS results indicate that potential simultaneity affects the magnitude and the significance of the contemporaneous GMO-FE* relationship, whereas the positive effect on FE* on GMO remains robust.

6.8 Robustness Check: Restricted-Sample Estimates Excluding Newly-Launched Platforms

The panel is unbalanced, three platforms (A. TREDS, Mynd Solutions, and RXIL) have been in operational, as reported by RBI in its database, since April 2022, while two platforms namely C2FO and KredX have recently been given the license, the data for these two platforms are available for much lesser time period. More importantly, these two platforms have shown early-stage volatility in MSME onboarding and financing efficiency.

To check, in what extent the results in Table 7 and Table 8 are driven or influenced by these newer platforms, both these models have been re-estimated on the restricted balanced sub-panel of the three old platforms by using the same Fixed Effects with Driscoll-Kraay standard errors procedure as the main results, so that the two sets of estimates are directly comparable. The results of restricted sample test, for both the equation tested in the main model, are depicted in Table 12 *and* Table 13.

Table 12
Model 1 (MSME Onboarding) - Full Sample vs. Restricted Sample

Variable	Full Sample (N = 5)	Restricted Sample (N = 3)
GMOt-1	0.2392*** (0.0365)	0.4652*** (0.1359)
FE*	0.0161** (0.0078)	0.0063 (0.0039)
FE*t-1	-0.0152 (0.0117)	-0.0036 (0.0025)
GBR	0.0156 (0.0483)	0.0766*** (0.0204)
GBRt-1	-0.0135 (0.0175)	-0.0848*** (0.0208)
GFR	-0.2463 (0.1776)	-0.0044 (0.0702)
GFRt-1	0.1625* (0.0898)	-0.0213 (0.0704)
Constant	0.0430** (0.0184)	0.0148 (0.0083)

*Driscoll-Kraay standard errors in parentheses. *** p < 0.01, ** p < 0.05, * p < 0.10. Source: Authors' computation (Stata output).*

Table 13
Model 2 (Financing Efficiency) - Full Sample vs. Restricted Sample

Variable	Full Sample (N = 5)	Restricted Sample (N = 3)
FE*t-1	0.6376*** (0.0492)	0.7755*** (0.0412)
GMO	2.2232*** (0.4521)	3.6842*** (1.3255)
GMOt-1	-1.0931*** (0.1789)	-3.3477* (1.7369)
GBR	0.9139*** (0.1483)	1.8893** (0.8104)
GBRt-1	-0.6508*** (0.2367)	-2.0689*** (0.7440)
GFR	1.7185 (1.0848)	-0.1973 (2.3330)
GFRt-1	1.8126** (0.8765)	-1.6036 (2.5023)
Constant	0.8423*** (0.1645)	0.6422*** (0.1254)

*Driscoll-Kraay standard errors in parentheses. *** p < 0.01, ** p < 0.05, * p < 0.10. Source: Authors' computation (Stata output).*

The persistence is most stable in the study, MSME onboarding own lag (H5) rises from 0.24 to 0.47, and financing efficiency's own lag (H4) rises from 0.64 to 0.77 and both remain highly significant with restricted sample excluding the new platforms.

The same month effect of MSME onboarding (GMO) on financing efficiency (FE) remained highly significant and its co-efficient value has also increased. However, pull-back (H6) remined negative with higher co-efficient value but looses its significance at 5%, significant at 10%. This indicates this relationship was not distorted by the two newly launched platforms with higher early volatility.

Other results are more sensitive with restricted sample. The same month effect of financing efficiency (FE) on MSME onboarding (GMO), as defined in H3, loses its significance.

GBR i.e., growth in buyers' registration did not have statistical significance on MSME onboarding (GMO) both for same-month and lagged month. But becomes significant in the restricted sample, both same-month and lagged. This is an unexpected reversal suggesting buyer registration may matter more for onboarding among the three established platforms than across the full, more heterogeneous panel.

Growth in financer registration (GFR) lagged effect was on financing efficiency (FE) as indicated in H2, loses its significance in the restricted sample, indicating this specific finding is also sensible to the inclusion of two newer platforms.

7. PRACTICAL IMPLICATIONS OF STUDY

The findings of the study carry implication for different group including regulators *(RBI- overseeing the platform and SEBI - overseeing the equity-market pathway many of these same MSMEs*), Ministry of MSME and for the MSMEs as well.

7.1 For the Reserve Bank of India (RBI)

1. Since financing efficiency is highly persistent (H4), the RBI can treat FE ratio as low-maintenance supervisory indicator, if a platform shows sustained decline i.e., decline for prolonged period, may warrant for early attention as the study shows pattern is non-reversal or self-correcting quickly.
2. Growth in financer registration (GFR) is associated with a next-month financing efficiency (FE) in full-sample results. These results suggest that RBI should expediate the process of onboarding a greater number of financers such as banks and NBFCs on TReDS platform so as to ensure competitive bidding and quick financing. However, this relationship loses its significance and also reverse its sign in the restricted sample robustness check. So, the result should be treated as suggestive rather than conclusive.
3. Financers depth (i.e., onboarding of banks and NBFCs) is the strongest attribute for increasing the financing efficiency, also it is found to have moderate but significant positive relation with MSME buyers onboarding. In this regard, it's worth noting that banks and NBFCs financing through TReDS have already been eligible for priority-sector lending classification (PSL) since RBI's 2016 circular. The modest and often flat growth in in financer registration observed in the study, despite long standing PSL classification incentive suggest PSL eligibility alone is not sufficient to rapidly deepen the financers base.

7.2 **For the Securities and Exchange Board of India (SEBI)**

1. Progress of any small enterprises typically happen along a financing ladder, i.e., staring from trade credit, then TReDS-based receivables financing then, for some, through SME IPOs on BSE SME or NSE Emerge. Therefore, a firm's track record on TReDS platform could serve as signal of working capital discipline that merchant bankers and SME exchanges may factor into for IPO due diligence.
2. Since financer depth is found to be strongest drivers of both efficiency and MSME onboarding while considering full sample (N = 5), SEBI could examine whether its regulated institutional investors, particularly credit focused Alternative Investment Funds (AIFs) could be allowed or permitted to participate as financer on TReDS, it would widen financer base and make the bidding process more competitive and MSMEs would be benefited from the same.

7.3 **For the Ministry of MSME**

1. *T*he financing efficiency (FE) across platform (Full Sample) averages over 92%. This means 92% of the uploaded FUs get financed in the same month. Its evidences a fact that the platforms are doing well i.e., technology is not a problem. However, success of a platform strongly depends upon its stakeholder's participation, given this fact the Ministry of MSME's should increase its outreach efforts to bring more participants particularly the financers to ensure competitive bidding on uploaded invoices.
2. The findings suggest that buyer's registration does not drive MSME onboarding, but appears to work indirectly through financing efficiency. It implies that mandatory buyers' registration pushes alone may not be that effective as it was believed. Awareness campaigns aimed at buyers should be paired with, not substituted for, financier-side outreach.
3. As found the surge in onboarding may create temporary efficiency dip in the following month, the ministry may encourage the platform readiness before large scale promotional pushes.

7 .4 For MSMEs sellers and buyers

1. For MSMEs, though limited choice available for choosing platform, but as found choice of platform is grounded on financing efficiency, MSMEs may choose the platform which provides higher efficiency i.e., quickly finances uploaded FUs.
2. The results suggest that MSMEs may be benefited from choosing a platform with deeper and more attractive pool of financer i.e., wider bidding pool is associated with better financing outcome.
3. MSMEs can be benefited beyond meeting immediate working capital requirement through TReDS. It may also help them in improving their credibility which, in turn, will assist them in approaching various fund-raising channels.

8. LMITATIONS OF THE STUDY

The conclusion of the study has to be read with some caveat in mind, these are as follows:

1. **8.1** The panel covers a small number of TReDS platform observed monthly over a short period. The short period window starting from April 2022 is too short to capture full business cycle, interest rate cycles or major regulatory shifts which may unfold in longer period.
2. **8.2** The analysis completely based on platform level data available on RBI's website. It does not provide invoice or firm level micro-data. Therefore, the analysis cannot differentiate how MSME sector, size, geography or invoice value effect the MSME onboarding or financing efficiency of the platforms.
3. **8.3** Financing efficiency itself is measured only as the share of uploaded invoices that get financed. It does not take discounting rate, cost of financing or turnaround time of a successful bid into the consideration.
4. **8.4** The regression specification, while grounded in theory, includes only a limited set of stakeholder-participation variables and their lags; other plausible drivers — seasonality, macroeconomic conditions, platform-specific marketing or technology investment, and the entry of new platforms — are absorbed only indirectly through platform fixed effects rather than modelled explicitly.

9. SCOPE OF FUTURE RESEARCH

Once more year's data becomes available on RBI's website, the researchers can study impact of any structural or policy changes on MSME onboarding or Financing efficiency. A large time period would make it possible to use statistical study like event studies or difference-in-differences, which can, in turn, provide stronger evidence about cause and effect. At the same time, there are only five platforms which are operational in this segment as reported as per RBI's database. As the number of platforms increase in future i.e., the cross section, the regression outcome would be more robust.

Future studies can examine whether MSME participation and financing efficiency differ based on the sectors the MSME belongs to, size of MSME and its location. Discounting rate or bidding spread can also be ascertained and whether such spread is influenced by invoice value, reputation of buyers i.e., buyer's creditworthiness etc. can be analysed in future studies.

Another very interesting area of research would be to compare India's TReDS system with similar invoice-financing platforms in other emerging economies. This will help us to understand whether India's MSME onboarding growth rate and financing efficiency of the platforms are better than the other economies.

Finally, future studies comprehensive and detailed one, can be undertaken to determine whether TReDS platform actually helped MSMEs in mitigating the working capital challenge they faced for decades and the same has positively impacted their profitability and growth.

10. CONCLUSION

In this study, we looked at what drives MSMEs to join TReDS platforms, and what makes the platform efficient at financing the uploaded invoices. We used monthly data from all the five RBI approved TReDS

platform – the complete set exists in India. We found both MSME onboarding and financing efficiency tend to carry forward from one month to the next – this finding is most dependable findings in the study. Second, we found that when financing efficiency is high in a given month, more MSMEs join the platform that same month. Third, a sudden jump in new MSME joining tends to be followed by a small, temporary dip in financing efficiency the next month, most likely because the platform needs a short time to absorb the new volume.

We tested the robustness of the results in two different ways, once by checking whether in case of some results, two variables moving together rather than one causing other, and tested the regression outcome by dropping two platforms which have recently started their operation i.e., restricted sample robustness check. The persistence findings and the efficiency-drives-onboarding remained intact in both the checks.

Overall, the study offers regulators, platform operators, and MSMEs a clearer, evidence-based picture of what actually keeps TReDS platforms growing and working well and the study was honest about which parts of that picture are solid versus still emerging. As more months of data become available, especially for the two recently launched platforms, this analysis can be extended and the less certain findings re-tested.

Declarations

Author Contribution

Dr. Debjyoti Dey : Ideation, data collection and methodology CS Sapana Dey : Statistical Analysis, Lit review and Summarisation

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Figures

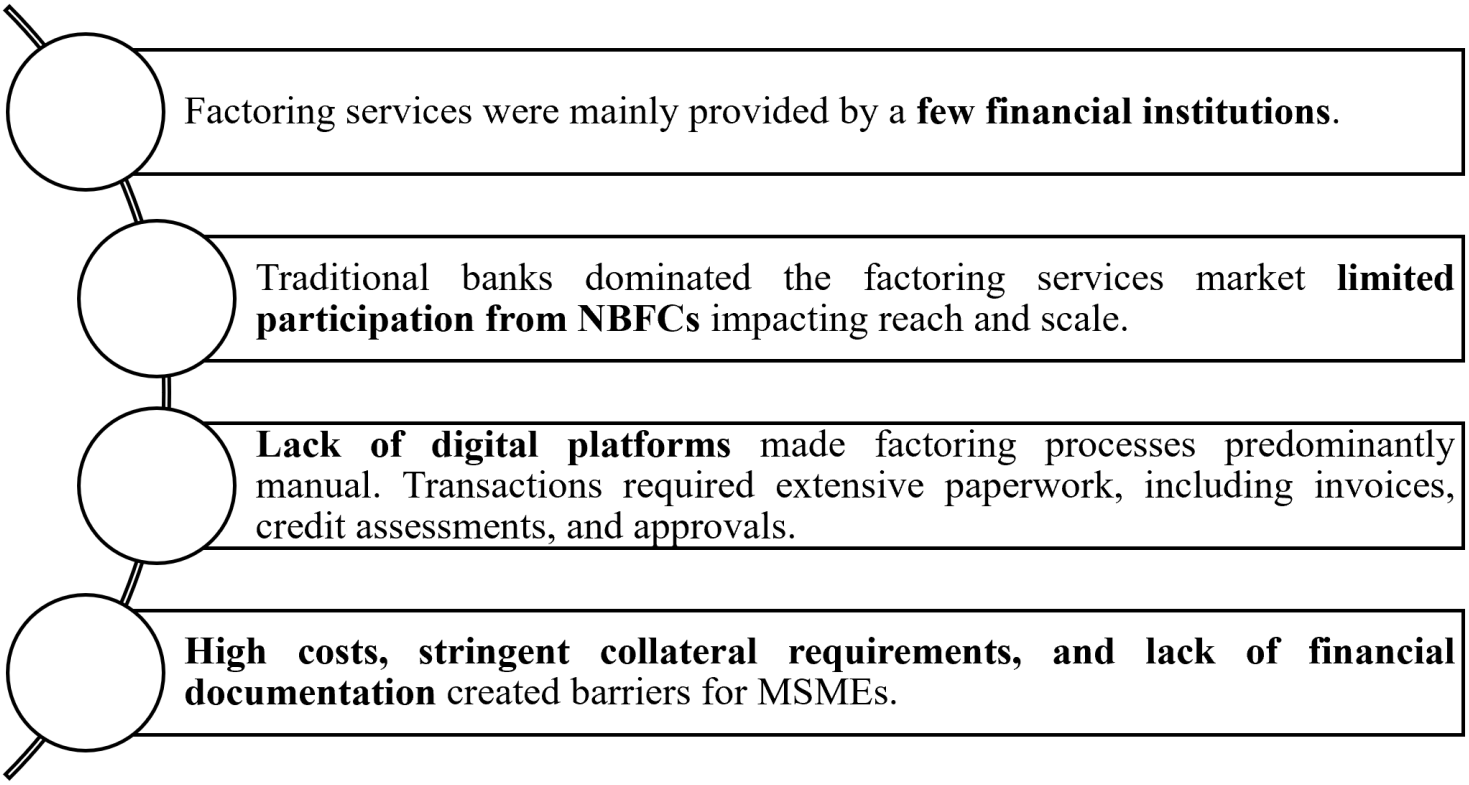


Figure 1

Challenges in Factoring Services in case of MSMEs

Source: Authors

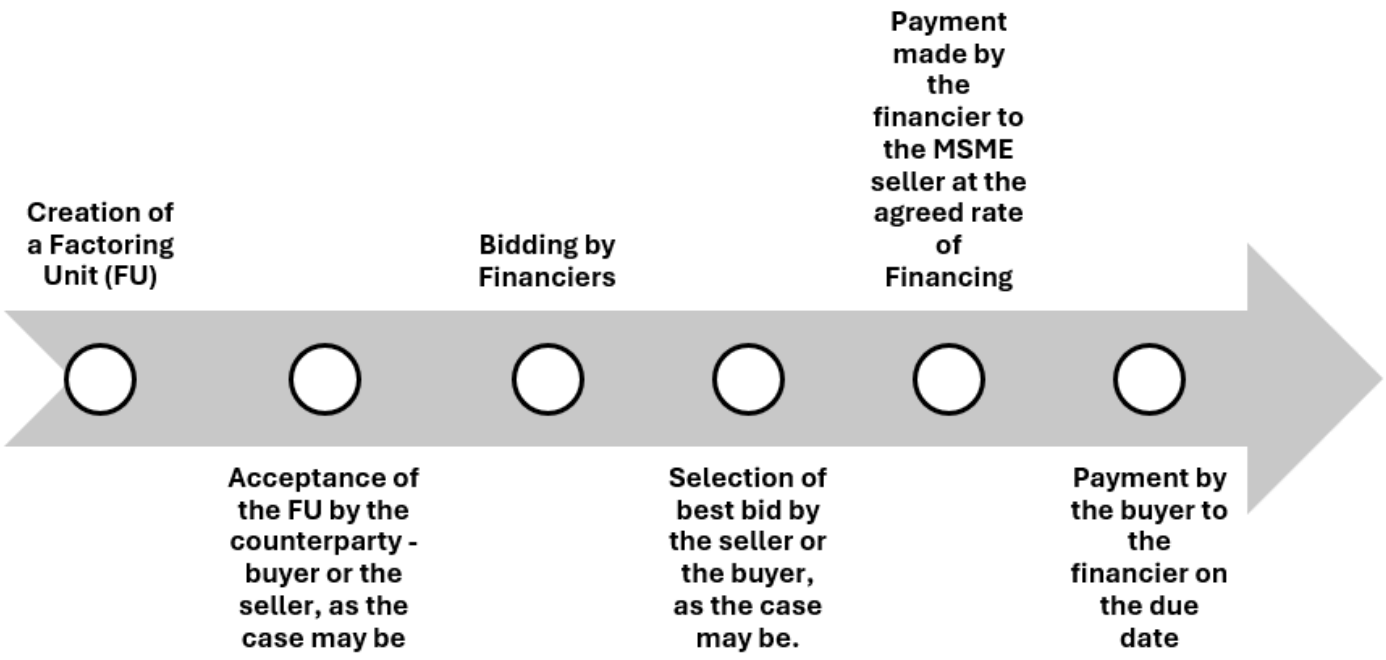


Figure 2

Steps involved in financing or discounting through TReDS (in case of standard factoring/Reverse factoring)

Source: Compiled by authors