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Exploring the Impact of Trade Credit and Debt on Systemic Risk in the Presence of Financial Distress and Constraints

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Abstract

Based on the extreme value and network contagion theories, this study intends to explore the effects of trade credit, and short/long-term debt on the systemic risk of 205 Pakistani non-financial firms over the period from 2005 to 2021. To evaluate the firms' systemic contribution and vulnerability, we apply two firm-specific measures, the change in conditional value-at-risk (DCOVAR) and marginal expected shortfall (MES). Our findings of the GLS random effect regression reveal a significantly positive impact of trade credit, and short/long-term debt on the systemic contribution and vulnerability of these firms. The findings also indicate that the underlying relationship is significantly moderated by financial distress and financial constraints. Understanding how different forms of debt influence systemic risk can guide policymakers in crafting regulations or interventions to promote a healthier financial environment. Regulators may reevaluate the balance between short/long-term debt usages or develop guidelines for managing trade credit effectively to mitigate systemic risk.

Keywords: *Systemic Contribution, Systemic Vulnerability, Delta CoVaR, MES, Trade Credit, Debt*

1. Introduction

The significance of a single financial institution for the whole financial system has been substantially debated since the Global Financial Crisis (GFC), the Eurozone sovereign debt crises (2009-2010), and the oil price crash (2014-2016) (Addo *et al*., 2021; Cucinelli and Soana, 2023; Dungey *et al*., 2022 among others). Systemic risk (SR) affects the entire system, and non-financial firms (NFFs) are also part of this broader system. Adverse shocks can be transmitted to the entire system due to the prevalent connections within and across industries even if firms seem to be discretely healthy and financially stable. The interconnection within firms and industries as well as the interdependence between financial and NFFs make them systemically important (e.g. Zhu *et al*., 2020 among others). The investing and financing needs of NFFs link them to financial institutions despite of not originally part of the financial system. Therefore, NFFs are exposed to SR because of their own operations and supply chains (trade-

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credits) as well as through their exposure to the financial sector (short/long-term debts). Hence, it is unfair to restrict SR to the financial sector alone as it is equally important and applicable to NFFs along with the broader economy (e.g. Cucinelli and Soana, 2023). Despite a growing body of financial institutions' literature, very few existing empirical studies have focused on the SR of NFFs, (e.g. Cucinelli and Soana, 2023; Dungey *et al*., 2022; Jia *et al*., 2022). Specifically, Cucinelli and Soana (2023) investigate the corporate governance impact on SR and conclude that strong corporate governance practices reduce the SR contribution and vulnerability of NFFs. Similarly, Dungey *et al*. (2022) analyze the firm-specific determinants of SR and conclude that trade credit (TC) and corporate debt both are important factors in determining SR in NFFs. The financial stability reports of the International Monetary Fund (IMF, 2019, 2022) emphasized corporate indebtedness and issued warnings that excessive debt of firms can have severe consequences for the global in general and Asian financial stability in particular. The main channels of the interconnection that cause a contagion to the whole system are TCs and short/long-term debt. Therefore, it remains to be determined if TC, and short/long-term debt in terms of total assets have a potential impact on the increase or decrease in SR of NFFs. It is well established in the literature that firms that are already in financial distress are more prone to system-wide shocks and become vulnerable to SR (Garcia-Appendini and Montoriol-Garriga, 2020 among others). Scholars also accept that financially distressed firms may not be able to sustain their market share and default on their principal and interest payments (e.g. Purnanandam, 2007). This default sequence can cause lenders to be in trouble, and they may restrict their lending, putting other firms in the system at high risk (Zheng et al., 2019). Likewise, the firms that depend on external financing become worse if these firms faced by financial constraints during an economic downturn (Lin and Zhang, 2020). Conversely, according to (e.g. Bussoli *et al*., 2023), TC increases during periods of greater financial constraints and used as a cushion against external constraints.

By reviewing the literature, it is observed that developed economies are largely focused on past studies of financial and NF sectors. For example, Anginer *et al*. (2018); Cucinelli and Soana (2023); Dungey *et al*. (2022); Dungey *et al*. (2018) evaluated US financial and NF corporations, Poledna *et al*. (2018) examined a network of Austrian, Van Cauwenberge *et al*. (2019) examined Dutch firms, and Zhu *et al*. (2020) analyzed Chinese firms and concluded that NFFs are systemically at risk. Very limited research e.g. Cucinelli and Soana (2023); Dungey *et al*. (2022) addresses TCs and total debt by collecting data from the US, Europe, and China. However, it is debatable that developed countries are not only hit by the GFC but developing economies are also disrupted (BIS, 2009; Fratzscher, 2012; Neaime, 2012), Asian developing economies in particular (Kim and Ryu, 2015; Li and Giles, 2015). With the recent escalation of deregulation in capital markets and the transfer of capital across borders, evolving markets in Asia have become more vital to world production

output. The capital markets of developing countries like Pakistan exhibit a large degree of local and foreign integration, with financial markets comovement among developed, developing, and emerging markets, as theoretically and empirically evidenced by the studies (e.g. Batten *et al*., 2015; Shen, 2018). Disruption of any economic unit or country has severe repercussions for the whole economy and thus for the whole world. The research question addressed in this study has received limited exploration in both developed and developing economies instead of numerous studies conducted in various fields.

This study makes multiple contributions to the current body of knowledge by addressing this gap. First, we target the most crucial characteristics of NFFs that interconnect the whole system. This research offers a theoretical outline that emphasizes the complexities of how TC and short/long-term debt within NFFs can impact SR and ripple throughout economic networks. Second, we also look at the role played by financial distress and financial constraints in the relationship between our predictor and response variables. Third, the study in hand enlightens regulators about the larger systemic consequences of NF sector disruptions. Prior studies have largely focused on the SR of financial and NFFs in developed countries, whereas this study has focused on NFFs listed on the Pakistan Stock Exchange (PSX), a developing country in Asia. Fourth, unlike other studies, this study employs two popular but different SR measures, DCOVAR and the MES. The two-dimensional results are obtained through these measures. DCOVAR shows how individual NFFs' contribute to the SR of the entire system, whereas MES measures the susceptibility to shocks affecting the entire system.

The organization of the remainder paper is as follows. The literature review and hypotheses formulation of this research is discussed in section 2. Moving to section 3, we elaborate on the SR measures utilized, outlining the computation methodology and the construction of the independent and moderating variables. In section 4, we provide the results starting from the preliminary univariate statistics as well as the findings of the chosen econometric methodology. Section 5 is dedicated to the discussion of our findings, and the concluding remarks are encapsulated in section 6.

2. Literature Review and Hypotheses Development

Despite the importance of NFFs in SR, very few studies exist in the literature; some of them are as follows: The initiative to analyze the characteristics of NFFs concerning SR is taken up by (Kerste *et al*., 2015). They analyzed the impact of OTC derivative usage in the energy sector and other NFFs on the SR of the banking sector. They conclude that the contagion risk of the energy sector to the banking sector is lower than that of other NFFs. Additionally, Zhu *et al*. (2020) analyzed the firm-specific characteristics of 300 Chinese firms and concluded that small firms contribute more to overall SR. Dungey *et al*. (2022) analyzed firm-specific features to determine

systemically imperative NFFs. They conclude that firms other than financial firms are also systemically important, and TC, whether it is extended or received, is vulnerable to systemic shock.

TC is a financial mechanism that allows businesses to purchase/sell goods and services without immediate payments/receipts. It is an important transmission channel with unique characteristics that enforce the propagation of shocks to the entire economy. According to Beck *et al*. (2005), firms that rely heavily on TCs become worse during crises. If a significant number of these firms experience financial difficulties at the same time, this could lead to a cascade of defaults and a disruption of the TC market (Love *et al*., 2007). Horvath (2000) and Shea (1995), disclosed that connections between supplier and customer cannot be overlooked in the diffusion of shockwaves and the comovement of performance among industries that are interlinked via transactional contacts (Hazama and Uesugi, 2017). Firms that provide TC to other firms may be exposed to the risk of default if those are unable to repay the credit. This can create links between firms and amplify the impact of the failure of one firm throughout the entire system (Lee *et al*., 2018). In the same manner, Dungey *et al*. (2022) and (Cucinelli and Soana, 2023) also support the idea that companies that rely significantly on trade finance are significantly more vulnerable to SR. Thus, we hypothesize the following:

H1: TC has a significantly positive effect on the SR contribution and vulnerability of NFFs to system-wide shocks.

Short-term debt is a debt that matures within one year. It frequently needs to be refinanced or rolled over regularly; therefore, it might increase SR. When interest rates rise or credit markets freeze, it can be challenging for borrowers to refinance their short-term debt, which can cause financial stress and systemic crises. If market circumstances worsen, refinancing costs may increase significantly, posing a risk to borrowers' liquidity (Chiu *et al*., 2015). Zhu *et al*. (2020) state that there is no significant effect of short-term debt on SR contribution in China because the government strictly monitors the activities of NFFs and intervenes if needed. However, it is confirmed in the same analysis that long-term debt has a significantly positive impact on SR contribution. In contrast to Zhu *et al*. (2020), Dungey *et al*. (2022) conclude that long-term debt is a lower contributor to SR but more vulnerable to systemic shocks. In this regard, Hazama and Uesugi (2017) argued that some firms may fail to repay their short-term loans due to the unavailability of readily liquidated assets. Due to credit squeezing the number of defaulting firms increases which causes a domino effect. According to Jia *et al*. (2020), more debt in the liabilities of firms leads to the bankruptcy of these firms and create a cascading effect on other firms and institutions (Alfaro *et al*., 2019). This cascading effect leads to further failures and a wider financial crisis (Gomes and Schmid, 2021). Based on the above discussion, we hypothesize the following:

H2: Short/long-term debt has a significantly positive relationship with the systemic importance of NFFs in terms of their contribution and vulnerability to system-wide shocks.

Considering the significance of the SR of NFFs, we anticipate that a higher distress level in a firm increases or decreases the severity of systemic contribution and vulnerability of these firms, which positively or negatively moderates the impact of TC and short/long-term debt on the SR contribution and vulnerability of NFFs. We support our contention with the following arguments. According to Purnanandam (2007) and Opler and Titman (1994), financial distress is a situation of low cash flow in which the firm suffers losses while remaining solvent. Chevalier (1995a, 1995b) finds evidence from supermarket industry data that debt shakes the financial position of a firm and makes it susceptible to sustaining its competitive advantage. In addition, a financially distressed firm normally fails to comply with its debt covenants and often defaults on its coupon or principal payments without being insolvent. Financial distress in a firm also leads to a lack of confidence in the financial system, which drives a reduction in economic activity and an increase in SR (Garcia-Appendini and Montoriol-Garriga, 2020). However, in the presence of financial distress, firms' debt will likely decrease, which can reduce SR. If a firm is in financial distress, it will not be able to extend or demand debt or TC, which can also reduce the level of debt and TCs on one hand and reduce SR on the other hand. Therefore, we hypothesize the following:

H3: Financial distress influences the impact of TC and short/long-term debt on the systemic contribution and systemic vulnerability of NFFs.

The finance and demand channels through which the financial crisis can spread to NFFs are identified by (Tong and Wei, 2014). The finance channel describes external financial constraints while the demand channel describes less spending in a recession. These channels have been developed with real economic effects in mind, as it is primarily associated with credit flow instabilities during crises (Bernanke and Gertler, 1985), with financial constraints unfavorably affecting NFFs that are unable to obtain alternative financing (Laeven and Valencia, 2013 among others). Due to credit constraints, firms will be unable to carry out their operations and reduce their investment, leading to lower sales and lower profitability (Duarte and Eisenbach, 2021). In addition, TC changes with financial constraints during economic fluctuations. In good economic times, firms obtain more TC and more debt; however, in bad economic times, firms obtain less TC and less debt (Lin and Zhang, 2020). According to Shi *et al*. (2022), TC is an alternative source of financing for firms that are unable to obtain external financing due to financial constraints. As a result, when money is tight, TC expands, and vice versa. Cosci *et al*. (2020) go a little further and claim that TC as a buffer helps firms combat external financial constraints. Therefore,

in general, financial constraints are more likely to amplify the impact of market shocks and contribute to the buildup of SR. Therefore, this study hypothesizes that:

H4: Financial constraints influence the impact of TC and short/long-term debt on the systemic contribution and systemic vulnerability of NFFs.

3. Research Method

3.1. Sample

The population of this study consists of NFFs listed on the Pakistan Stock Exchange (PSX). Our initial search provided information on 261 NFFs listed on the PSX. We then exclude the firms having missing data on the main variables for the 17 years and our final sample from 2005 to 2021 ends up with 205 NFFs. The textile, automobile, electrical, chemical, engineering, food, and leather industries are included in the sample. The weekly stock/market returns and state variables for SR measures as well as the annual data for the firm-specific variables are sourced from the Thomson Reuters Data Stream over the sample period.

3.2. Variable Measurement

Two different but popular measures are used to compute SR in this study as follows:

3.2.1. Delta Conditional Value-at-Risk

The impact of each individual asset on a portfolio's tail risk is measured by the Delta conditional value at risk (DCOVAR). It is an improved version of the conventional Value-at-Risk (VaR) measure of portfolio risk. "Delta" stands for the change, and "COVAR" stands for Conditional Value-at-Risk (Tobias and Brunnermeier, 2016).

SR values are obtained through the following steps.

Eq. 1 and Eq. 2 measure the system's return by following (e.g. Brunnermeier *et al*., 2020).

$$R_t^i = \frac{MV_t^i}{MV_{t-1}^i} - 1 \qquad \text{(Eq. 1)}$$

where the growth rate (weekly) of the firm *i*'s market-value equity at time *t* is represented by R_t^i.

$$R_t^{system} = \sum_{i=1}^{N} \frac{MV_{t-1}^i * R_t^i}{\sum_{j=1}^{N} MV_{t-1}^j} \qquad \text{(Eq. 2)}$$

where R_t^{system} represents the market-value equity growth rate of all N firms (i = j = 1, 2, 3, 4….. N) in the system as a whole at time *t*.

The firm *j*'s VaR is:

$$\text{Probability } (r_j \leq VAR_{j,5\%}) = 5\% \qquad \text{(Eq. 3)}$$

In the following equation, for DCOVAR, the two conditional VaRs are estimated. The system's COVAR, while firm *j* experiences tail events:

$$\text{Probability } (r_{fs} \leq \text{COVAR}(\text{system}|j)|r_j = VAR_{j,5\%}) = 5\% \quad \text{(Eq. 4)}$$

Here, the system's returns are denoted by r_{fs}, and r_j denotes the returns of j firm. The same estimation is repeated upon 50% VaR for a given firm.

The estimation of DCOVAR of a firm is represented as follow:

$$\text{DCOVAR}\left(R_{fs}\middle| j,\ 5\%\right) = \text{COVAR}\left(R_{fs}\middle| j, 5\%\right) - \text{COVAR}\left(R_{fs}\middle| j\ , 50\%\right) \quad \text{(Eq. 5)}$$

The difference between system's VaR when firm *j* is in distress and in its median state is known as DVOVAR. A VaR of 5% indicates a firm's level of distress, and a VaR of 50% indicates a firm's common state. A technique of quantile regression is applied by following (Brunnermeier *et al*., 2020). The lags of the following state variables are used by following (e.g. Hanif *et al.*, 2021; Zeb and Rashid, 2019): Market return (weekly return of KSE 100 index), Volatility of Market (22-day standard deviation of market returns), The Delta 3-month T-bill rates (weekly change in three-month T-bill) and Liquidity spread (difference between 3-month repo rate and 3-month rates of T-bills). This allows us to model the progression of the joint distribution over time.

3.2.2. Marginal Expected Shortfall

MES is an extension of the expected shortfall that measures possible losses over a given threshold and sheds light on the tail risk of a portfolio. This measure demonstrates the degree to which a specific firm is vulnerable to a possible systemic crisis (Brunnermeier *et al*., 2020). It is the average return of stocks for firm *j* when market returns are at the level of the 5% tail of the return distribution hence, showing systemic events (Acharya *et al*., 2017). Financial system (market portfolio) is denoted by KSE-100 index in this study. All sectors of the PSX are represented in this index. The computation of the MES is as follows:

$$\text{MES}j,5\% = \frac{1}{\#Days\ MKT\ Return\ in\ its\ 5\%\ tail} \sum rj \quad \text{(Eq. 6)}$$

Where MES*j*,5% represents the firm *J*'s marginal expected shortfall at the 5% tail. $\sum rj$ is the summation of firms' returns that fall in the no. of 5% tail days. For additional analysis, the values derived from Eq. 6 are averaged annually.

3.3. Independent Variables

To measure our predictor variables, we obtained data from the Thomson Reuters Data Stream database. We measure DEBT by dividing total debt by total assets, and STD/LTD by dividing short/long-term debt by total assets. We measured TC by dividing accounts receivable (TC Extended) by total assets and accounts payable (TC Received) by total assets.

3.4. Moderating Variables

Financial distress and financial constraints are the moderating variables in this study. Following Bose *et al*. (2021), this study measures financial distress by ratio of financial distress (RFD) which is obtained by dividing EBITDA by financial expenses. This ratio is included in the debt indentures and the firms having a lower ratio are unable to obtain new loans or rollover existing loans (Setiany, E., 2021). So, the effectiveness of daily operations and the profitability of a firm is significantly impacted by this ratio. It is used for real-time monitoring of a firm's financial health. Changes in the RFD over time serve as an early warning sign of potential distress (Dothan, 2006). The increase in RFD leads to a decrease in financial distress and vice versa. On the other hand, measuring financial constraints is borrowed from the techniques used by (Hovakimian and Hovakimian, 2009) and (Shi *et al*., 2020). This study measures the cash flow sensitivity index (CFSI) as a proxy of financial constraints as follows.

$$\mathrm{CFSI}_{it} = \sum_{t=0}^{K} \frac{\left(\frac{\mathrm{CF}}{\mathrm{TA}}\right)_{it}}{\sum_{t=1}^{K}\left(\frac{\mathrm{CF}}{\mathrm{TA}}\right)_{it}} \mathrm{GA}_{it} - \frac{1}{K}\sum_{t=1}^{K}\mathrm{GA}_{it} \qquad \text{(Eq. 7)}$$

where CF stands for cash flow generated by operations, TA is total assets, GA is the growth rate of assets expressed as a percentage change in assets over a given time period, and the number of observations of firm *i* in year *t* is denoted by K.

CFSI evaluates the strength of the financial constraints that a firm faces. The greater the CFSI is, the greater the degree to which the firm faces financial constraints (Shi *et al.,* 2020). However, as an alternative, this study follows the (Hovakimian and Hovakimian, 2009) and (Shi *et al*., 2020) residual methods and measures asset growth (GA) as follows.

$$\mathrm{GA}_{it} = f(\mathrm{FGA}) + \alpha_0 + \alpha_i + \alpha_t + \varepsilon_{it} \qquad \text{(Eq. 8)}$$

where f(FGA) represents the factors other than cash flow that affect asset growth, e.g. leverage (total liabilities divided by total assets), collateral assets (tangible assets divided by total assets), and labor productivity (sales growth per employee). The residuals (ε_{it}) obtained from this equation are placed in equation (5) instead of GA_{it}.

3.5. Control Variables

For the control variables, we deduct the date of incorporation from the current year to obtain age (AGE) and we take the natural log of total assets for firm size (SIZE). We also control for firms' risk by systematic risk (BETA) and value-at-risk (VaR5%). Beta values are obtained from the data stream, and the value-at-risk at 5% is measured as in the DCOVAR (Hazama and Uesugi, 2017; Lee *et al*., 2018).

3.6. Estimation Technique

The most common approaches to estimate the desired relationship in this study are fixed effects or random effects panel data regression methods (Anginer *et al*., 2018; Bostandzic and Weiss, 2018). However, we apply the Hausman test, where we fail to accept the null hypothesis that fixed effect is a preferred technique for this analysis.

We then apply random effect regression. This approach is particularly relevant when examining SR, as it recognizes that the impact of TC and short/long-term debt may not be uniform across all NFFs.

The following are our main equations run on the panel data for this study:

$$\text{DCOVAR}_{it} = \beta_0 + \beta_1 \text{TC Extended}_{it} + \beta_2 \text{TC Received}_{it} + \beta_3 \text{STD}_{it} + \beta_4 \text{LTD}_{it} + \beta_5 \text{DISTRESS}_{it} + \beta_6 CONSTRAINT_{it} + \beta_7 \text{TC Extended}_{it} * \text{DISTRESS}_{it} + \beta_8 \text{TC Received}_{it} * \text{DISTRESS}_{it} + \beta_9 \text{STD}_{it} * \text{DISTRESS}_{it} + \beta_{10} \text{LTD}_{it} * \text{DISTRESS}_{it} + \beta_{11} \text{TC Extended}_{it} * \text{CONSTRAINT}_{it} + \beta_{12} \text{TC Received}_{it} * \text{CONSTRAINT}_{it} + \beta_{13} \text{STD}_{it} * \text{CONSTRAINT}_{it} + \beta_{14} \text{LTD}_{it} * \text{CONSTRAINT}_{it} \beta_{15} \text{CV} + \mu_{it} \quad \text{(Eq. 9)}$$

$$\text{MES}_{it} = \beta_0 + \beta_1 \text{TC Extended}_{it} + \beta_2 \text{TC Received}_{it} + \beta_3 \text{STD}_{it} + \beta_4 \text{LTD}_{it} + \beta_5 \text{DISTRESS}_{it} + \beta_6 \text{CONSTRAINT}_{it} + \beta_7 \text{TC Extended}_{it} * \text{DISTRESS}_{it} + \beta_8 \text{TC Received}_{it} * \text{DISTRESS}_{it} + \beta_9 \text{STD}_{it} * \text{DISTRESS}_{it} + \beta_{10} \text{LTD}_{it} * \text{DISTRESS}_{it} + \beta_{11} \text{TC Extended}_{it} * \text{CONSTRAINT}_{it} + \beta_{12} \text{TC Received}_{it} * \text{CONSTRAINT}_{it} + \beta_{13} \text{STD}_{it} * \text{CONSTRAINT}_{it} + \beta_{14} \text{LTD}_{\square\Omega t} * \text{CONSTRAINT}_{it} + \beta_{15} \text{CV} + \mu_{it} \quad \text{(Eq. 10)}$$

In (Eqs. 9 and 10), the effects of TCs (extended, received), and short/long-term debt (STD/LTD) on DCOVAR and MES of firm *i* at time *t* are estimated. DCOVAR*it* and MES*it* are the measured of SR. TC Extended*it* represents the ratio of accounts receivable to the total assets. TC Received*it* signifies the ratio of accounts payable to the total assets. STD*it* and LTD*it* represent the ratios of short/long-term debt to total assets. DISTRESS*it* is the financial distress measured by dividing EBITDA*it* by the financial expenses. CONSTRAINT*it* is the financial constraint measured as the cash flow sensitivity index. TC Extended*it* *DISTRESS*it* and TC Received*it**DISTRESS*it* are the moderating effects of accounts receivables, accounts payable, and financial distress. STD*it**DISTRESS*it* and LTD*it**DISTRESS*it* are the moderating effects of short/long-term debt and financial distress. TC Extended*it**CONSTRAINT*it* and TC Received*it**CONSTRAINT*it* are the moderating effects of accounts receivables, accounts payable, and financial constraints. STD*it**CONSTRAINT*it* and LTD*it**CONSTRAINT*it* are the moderating effects of short/long-term debt and financial constraints. CV is the control variables that are Age, Size, Beta, and VaR. and μ_{it} is the error term.

4. Results

4.1. Descriptive Analysis

Table 1 summarizes the variables' descriptive statistics. As depicted in this table, the mean, standard deviation, p25, median, and p75 of DCOVAR are -2.66, 17.21, -7.15, -

.43, and 4.11, respectively. However, for MES, these values are -3.58, 6.28, -7.194, -2.90, and 0, respectively. These statistics show that SR measures, i.e., DCOVAR and the MES, are heterogeneous and volatile.

Table 1. Variable Description and Summary Statistics

Measure	Definitions	Mean	Std. Dev.	p25	Median	p75
DCOVAR	Systemic contribution	-2.66	17.21	-7.15	-.43	4.11
MES	Systemic Vulnerability	-3.58	6.28	-7.19	-2.90	0
TC Extended	Accounts Receivable divided by total assets	.15	.16	0.05	.11	.194
TC Received	Accounts Payable divided by total assets	.13	.13	0.04	.09	.173
DEBT	Total debt divided by total assets	.29	.23	0.07	.26	.456
STD	Short-term debt divided by total assets	.17	.17	0.03	.14	.28
LTD	Long-term debt divided by total assets	.11	.14	0.00	.06	.172
AGE	Current year less Date of incorporation	36.28	20.26	22.00	32	49
SIZE	Natural log of total assets	2.71	.15	2.65	2.71	2.784
BETA	Systematic Risk	1.05	.26	0.94	1.04	1.15
VaR	5% Value at	-	3.97	-11.66	-9.39	-7.69

Risk	10.23

Note: This table reports variable descriptions and sources of data with summary statistics. For each variable, we report the mean, the overall standard deviation (Std. Dev), the 25th percentile (p25), the median, and the 75th percentile (p75). The risk measures are observed for each year in the period 2005–2021.

4.2. Regression Analyses

This study uses two measures of SR, DCOVAR and the MES. Table 2 reports the relationships between total debts, TC extended, TC received, and systemic contribution and vulnerability to system-wide shocks. This study applied two proxies for TC i.e. TC Extended and TC Received, and both exhibit a positive impact on the systemic contribution and vulnerability of NFFs. The results support the theory that an increase in TC extended to total assets means that the firm's assets are significantly reliant on its accounts receivables and that the failure to collect these on time can put the firm into a liquidity crisis that causes the firm to become more systemically risky. Our results are consistent with the findings of past studies (Cucinelli and Soana, 2023; Hazama and Uesugi, 2017). Furthermore, Models 1 and 3 of Table 2 show that debt has a positive impact on the contribution and vulnerability of SR. A higher debt-to-total asset ratio causes firms to increase their debt rollover risk and make it difficult to perform debt servicing, especially for the debt that matures during a crisis period.

Our results are also consistent with the findings of (Dungey *et al*., 2022; Hazama and Uesugi, 2017) that the more TC is extended, the greater the firm's vulnerability to SR. In the same manner, TC extended is statistically significant and positively related to both measures of SR. The coefficient of TC received is significant and positively related to systemic contribution (DCOVAR) and insignificant to systemic vulnerability (MES). This might be the reason that firms with TC received have strong ties with the borrower firms and are well familiar with the financial position of these firms, making them vigilant during crisis periods; hence, TC received is less susceptible to system-wide shocks. In the second and fourth models in Table 2, short/long-term debt instead of total debt is included and found that short-term debt is statistically insignificant in the second model with DCOVAR as a dependent variable and is statistically significant and positively related to the MES in the fourth model. On the other hand, this study finds statistically significant coefficients of long-term debt that are positively related to both measures of SR. The insignificant coefficients of short-term debt is possibly attributable to market confidence, expectations, or risk-sharing mechanisms; market players may occasionally foresee and absorb risks connected with particular firms without having a significant impact on the larger system.

The rest of the variables have similar results in Models 2 and 4, as presented in Models 1 and 3. In Table 2, this study presents the results of control variables (AGE, SIZE, BETA, and VaR) as well. The size of a firm is highly statistically significant in all four models in Table 2. Firm size has a significantly positive relationship with DCOVAR and a significantly negative relationship with MES. If a larger firm is hit by a financial crisis, it has a significant impact on the whole system. Larger firms are less susceptible to system-wide shocks because of their lower reliance on the system, and smaller firms tend to be more vulnerable to system-wide shocks than larger firms. The study's findings support those of (Zhu *et al*., 2020) regarding Chinese NFFs. On the other hand, older firms reduce their systemic contribution and increase their systemic vulnerability. The firm-specific risks measured by BETA and VaR are statistically significant and positively related to both SR contribution and vulnerability. This shows that identically riskier firms (VaR) and those with heightened market sensitivity (BETA) tend to be more susceptible to system-wide shocks and contribute more to overall SR. In essence, the results of this study support hypotheses 1 and 2. The findings reported in Table 2 provide evidence that is consistent with the theory and fulfil the first and second objectives of this study that TCs and short/long-term debt have a significantly positive impact on the systemic contribution and vulnerability of NFFs.

Table 2. Regression Results for SR

	DCOVAR		MES	
Variables	Model 1	Model 2	Model 3	Model 4
TC Extended	3.10*	3.33*	1.42*	1.53**
	(1.86)	(1.87)	(0.77)	(0.77)
TC Received	5.10**	5.17**	0.66	0.67
	(2.22)	(2.22)	(0.97)	(0.96)
DEBT	3.11**	-	2.50***	-
	(1.26)		(0.54)	
STD	-	1.83	-	1.60**
		(1.76)		(0.75)
LTD	-	4.85**	-	3.65***
		(2.09)		(0.87)
AGE	-0.03*	-0.03*	0.01**	0.01**
	(0.02)	(0.02)	(0.01)	(0.01)

SIZE	1.760***	1.739***	-1.195***	-1.210***
	(0.298)	(0.298)	(0.128)	(0.127)
BETA	2.317***	2.316***	2.85***	2.88***
	(0.102)	(0.102)	(0.43)	(0.43)
VaR	0.69***	0.69***	0.25***	0.25***
	(0.08)	(0.08)	(0.03)	(0.03)
Constant	-68.72***	-68.18***	26.91***	27.25***
	(8.52)	(8.52)	(3.65)	(3.61)
No. of Obs.	3484	3484	2869	2869
R-Sq Overall	0.18	0.18	0.08	0.08
R-Sq Within	0.15	0.15	0.02	0.02
R-Sq Between	0.39	0.39	0.31	0.32

Note: This table reports coefficient estimates from GLS random effect regression with HAC model of robust standard errors as suggested by Newey and West, (1987). In Model 1 and Model 2, the dependent variable is DCOVAR, and in Model 3 and Model 4, the dependent variable is MES, which indicates the SR contribution and vulnerability, respectively. In Models 2 and 4, DEBT is replaced with STD and LTD. The sample includes listed nonfinancial firms over the period from 2005-2021. ***, ** and * denote statistical significance at the 1%, 5% and 10% levels, respectively.

4.3. Moderation Analysis

In this section, the regression results on the moderating effect of financial distress and financial constraints are presented. Table 3 represents the results of the four models from Model 5 to Model 8. In Model 5, financial distress (DISTRESS) and financial constraints (CONSTRAINT) are added. Model 5 shows that decreasing financial distress has a significantly positive impact on the contribution of SR (DCOVAR). The interaction effects of financial distress are included in Model 6. The effects of TC Extended*DISTRESS and LTD*DISTRESS demonstrated a significant and negative relationship with SR, indicating a strong adverse effect under lower distress conditions. This implies that as distress decreases, the anticipated positive relationship between TC Extended, LTD and SR also weakens. Conversely, the interactions involving TC (TC Received*DISTRESS) and short-term debt (STD*DISTRESS) failed to achieve significance, indicating that their relationships with SR maintain a relatively constant complementary effect irrespective of distress level. In Model 7, the interaction terms of financial constraints are included. The coefficients of TC

Extended*CONSTRIANT and LTD*CONSTRAINT are statistically significant and positive. These results suggest that increasing financial constraints strengthened the positive relationship between LTD and DCOVAR as well as between TC Extended and DVOVAR. The coefficients of TC Received*CONSTRAINT and STD*CONSTRAINT are statistically significant and negative, indicating that an increase in financial constraints weakens the positive relationship between TC received as well as short-term debt and the systemic contribution of NFFs. This study also runs a regression in Model 8 where all interaction effects together are included and verify the study's previous results.

Table 3. Regression Results for Moderation Effects Using DCOVAR

	Dependent Variable: DCOVAR			
Variables	Model 5	Model 06	Model 07	Model 08
TC Extended	3.39*	4.75**	2.52	3.90*
	(1.80)	(2.34)	(1.75)	(2.23)
TC Received	5.41**	5.66**	6.79**	6.81**
	(2.53)	(2.63)	(2.80)	(2.89)
STD	2.37	1.40	2.39	1.40
	(2.79)	(2.44)	(2.79)	(2.44)
LTD	5.49*	6.23**	5.76**	6.44**
	(2.88)	(3.14)	(2.89)	(3.13)
DISTRESS	0.01**	0.02***	0.01**	0.02***
	(0.004)	(0.004)	(0.004)	(0.004)
CONSTRAINT	-7.21**	-5.99*	-7.10	-7.40
	(3.27)	(3.26)	(10.76)	(10.71)
TC Extended *DISTRESS	-	-0.63**	-	-0.66**
		(0.32)		(0.31)
TC Received *DISTRESS	-	-0.01	-	-0.01
		(0.02)		(0.02)
STD*DISTRESS	-	0.00	-	0.002
		(0.07)		(0.07)
LTD*DISTRESS	-	-0.65*	-	-0.62*
		(0.38)		(0.37)
TC	-	-	1.167*	1.198*

Extended*CONSTRAINT			(0.610)	(0.611)
TC Received*CONSTRAINT	-	-	-2.375*	-2.126*
			(1.282)	(1.287)
STD*CONSTRAINT	-	-	-0.05*	-0.08**
			(0.03)	(0.03)
LTD*CONSTRAINT	-	-	0.08**	0.07*
			(0.04)	(0.04)
AGE	-0.03*	-0.03**	-0.03*	-0.03**
	(0.02)	(0.02)	(0.02)	(0.02)
SIZE	1.76**	1.69***	1.739***	1.669***
	(0.311)	(0.317)	(0.309)	(0.315)
BETA	2.31***	2.304***	2.317***	2.315***
	(0.157)	(0.155)	(0.158)	(0.156)
VaR	0.69***	0.73***	0.69***	0.72***
	(0.19)	(0.19)	(0.19)	(0.19)
Constant	-68.92***	-65.90***	-68.25***	-65.30***
	(8.87)	(9.0)	(8.83)	(9.00)
No. of Obs.	3484	3484	3484	3484
R-Sq (Overall)	0.18	0.18	0.18	0.18
R-Sq(Within)	0.15	0.15	0.15	0.15
R-Sq(Between)	0.39	0.40	0.40	0.40

Note: This table reports coefficient estimates from GLS random effect regression with HAC model of robust standard errors as suggested by Newey and West, (1987). DCOVAR, a measure of systemic contribution, is the dependent variable, with the main effect of the moderating variables and their interaction terms. The sample includes listed nonfinancial firms for the period 2005-2021. ***, ** and * denote statistical significance at the 1%, 5% and 10% levels, respectively.

Table 4 is a continuation of Models 3 and 4 in Table 2. The results of Models 9 to 12 are presented in Table 4. The proxies of financial distress and financial constraints are included in Model 9 to determine their impact on the second SR measure of this study, i.e., the MES. The DISTRESS and CONSTRAINTS have statistically significant coefficient and positively related to systemic vulnerability. In a time of crisis, if a firm

is not in financial distress its vulnerability to system-wide shocks reduces and if the firm is facing high external constraints, its vulnerability to system-wide shocks increases. All other variables are the same as those presented in Model 8 in Table 3. In Model 10, the interaction terms of financial distress are included and found that the coefficient of TC Extended*DISTRESS is statistically significant and negatively related to the MES. This demonstrates that a decrease in financial distress weakens the positive relationship between TC extended and systemic vulnerability. However, STD*DISTRESS is significant statistically and positively related to the MES. This indicates that a decrease in financial distress strengthens the positive relationship between short-term debt and the systemic vulnerability of a NF firm. The coefficients of LTD*DISTRESS and TC Received*DISTRESS are negative but fail to achieve statistical significance. This can be the result of careful management of external and TC financing during times of financial distress.

In Model 11, the interaction terms of financial constraints are included, and the coefficient of TC Extended*CONSTRAINT exhibits a significantly negative relationship with systemic vulnerability. This implies that in times of greater financial constraints, the positive relationship between TC Extended and the MES becomes weaker. The STD*CONSTRAINT has statistically significant coefficient and positively related to the MES. This finding implies that the greater the degree to which a firm is facing financial constraints, the greater the positive interaction between short-term debt and systemic vulnerability. On the other hand, the coefficients of TC Extended*CONSTRAINT and LTD*CONSTRAINT exhibit insignificant relationships with the systemic vulnerability of NFFs. In Model 12 of Table 4, a regression is run with interaction terms of both financial distress and financial constraints and found that the results are consistent with the previous results and support hypotheses 3 and 4 of this research. The results presented in Tables 3 and 4 provide evidence in support of achieving the last two objectives of this research. The findings depict that financial distress and constraints influence the impact of TC and short/long-term debt on the systemic contribution and vulnerability of NFFs.

Table 4. Regression Results for Moderation Effects Using MES

Variables	Dependent Variable: MES			
	Model 09	Model 10	Model 11	Model 12
AR	1.66**	1.63**	1.91***	1.85**
	(0.72)	(0.76)	(0.73)	(0.77)
AP	0.64	0.92	0.40	0.70

	(1.12)	(1.16)	(1.14)	(1.18)
STD	2.14**	1.38	2.27**	1.54
	(0.96)	(1.05)	(0.96)	(1.04)
LTD	3.89***	4.14***	3.83***	4.10***
	(1.35)	(1.51)	(1.34)	(1.51)
DISTRESS	0.006*	0.008**	0.006*	0.008**
	(0.003)	(0.004)	(0.003)	(0.004)
CONSTRAINT	4.04**	3.76**	7.19**	6.57**
	(1.77)	(1.76)	(2.81)	(2.82)
AR_DISTRESS	-	-0.017*	-	-0.015*
		(0.01)		(0.009)
AP_DISTRESS	-	-0.003	-	-0.004
		(0.009)		(0.009)
STD_DISTRESS	-	0.38**	-	0.36*
		(0.18)		(0.18)
LTD_DISTRESS	-	-0.06	-	-0.06
		(0.18)		(0.18)
AR_CONSTRAINT	-	-	-1.93**	-1.83**
			(0.787)	(0.796)
AP_CONSTRAINT	-	-	1.356	1.341
			(0.894)	(0.902)
STD_CONSTRAINT	-	-	0.05**	0.05**
			(0.02)	(0.02)
LTD_CONSTRAINT	-	-	-0.01	-0.01
			(0.02)	(0.02)
AGE	0.01	0.01	0.012*	0.012*
	(0.01)	(0.01)	(0.007)	(0.007)
SIZE	-1.216***	-1.187***	-1.213***	-1.187***
	(0.147)	(0.145)	(0.144)	(0.142)
BETA	2.86***	2.89***	2.80***	2.83***

	(0.41)	(0.41)	(0.41)	(0.41)
VaR	0.24***	0.23***	0.24***	0.23***
	(0.01)	(0.05)	(0.05)	(0.05)
Constant	27.07***	26.08***	26.93***	26.03***
	(4.11)	(4.04)	(4.03)	(3.98)
No. of Obs.	2869	2869	2869	2869
R-Sq Overall	0.08	0.08	0.09	0.09
R-Sq Within	0.03	0.03	0.03	0.03
R-Sq Between	0.32	0.33	0.32	0.33

Note: This table reports coefficient estimates of GLS random effect regression with robust standard errors in Model 2 and Model 3. Model 1, however, reports default standard errors. The MES, a measure of systemic vulnerability, is a dependent variable, with the main effect of moderating variables and their interaction terms. The sample includes listed nonfinancial firms for the period 2005-2021. ***, **, and * denote statistical significance at the 1, 5, and 10% levels, respectively.

5. Discussion

Due to the crisis, which accelerated the diversion that was already underway in the banking industry and its associated credit derivative markets (He and Krishnamurthy, 2019), abundant research has been focused on the systemic risk of banking and non-banking institutions and ignored the role of non-financial firms. Systemic risk is indeed a risk that spreads throughout the whole system and non-financial firms are part of this system. This interdependence among financial and non-financial firms and interconnection among firms within industry and across industry make non-financial firms systemically important. The present study supports the positive relation between trade credit, short-term debt, long-term debt, and the SR of NF firms. Moreover, this study finds slightly different roles of hypothesized moderators for both SR measures, e.g., a decrease in financial distress weakens the positive relationship between trade credit extended and systemic contribution as well as between long-term debt and systemic contribution but strengthens the relationship between short-term debt and systemic vulnerability. An increase in financial constraints, on the other hand, significantly weakens the relationship between short-term debt and systemic contribution but strengthens the relationship between short-term debt and systemic vulnerability.

6. Research Implications

This study has significant theoretical and practical policy implications. Policymakers and practitioners will find value in this work because it serves as a reminder that decisions regarding SR should be made with concern for the systemic importance of NFFs. To take supplementary judicious measures to lessen the SR, this study supports policymakers in revising their macro-prudential strategy, which currently focuses only on financial firms. Moreover, this study has important implications for the stakeholders. Regulators might reconsider the balance between short/long-term debt usages or develop guidelines for managing TC effectively to mitigate SR and enhance the financial stability of an NF sector. Additionally, exploring the moderating effects of financial distress and constraints offers a nuanced perspective on the adaptive strategies employed by the firms to safeguard against SR. The NFFs are also required to have bail-out packages and emergency funding to combat the repercussions of SR as financial firms are being treated during systemic events. This research contributes to the formulation of targeted policies that address the specific needs and challenges faced by NFFs.

7. Research Limitations

As is the case for most empirical studies, this study has several limitations. Firstly, only two measures are used in this study to assess the SR, possibly overlooking other relevant indicators such as SRISK (Brownlees and Engle, 2017) and the Granger causality approach (Billio *et al*., 2012). Secondly, this study employs historical data from only 205 NFFs, which is attributed to data unavailability for the entire sample period. Thirdly, the findings are limiting the generalizability to firms operating in different economic and regulatory environments. The results of this study may be influenced by country-specific factors unique to the Pakistani business environment.

8. Future Directions

Different measures of SR can be incorporated in future studies to provide a more robust analysis and compare their implications with the current findings. Moreover, a limited sample size can be addressed by obtaining a more extensive dataset encompassing a large number of NFFs. It will ensure a more comprehensive representation of the target population. Additionally, a comparative analysis across multiple countries or regions should be conducted in the future to enhance the external validity of the research. It will help to understand how SR is influenced by TC and short/long-term debt in various economic contexts. Consequently, it will shed light on how economic, regulatory, and cultural variations influence the underlying relationships.

9. Conclusion

The empirical evidence of this study shows a positive impact of TC and short/long-term debt on the contribution and vulnerability of NFFs to the SR of the entire system. This study provides evidence that financial distress and financial constraints significantly moderate the underlying relationship. Our study is the first to bridge a gap among TC, short-term/long-term debt, financial distress/constraints, and SR of NFFs. In addition, this study makes substantial contributions to the current body of knowledge in the finance and SR disciplines, particularly within the context of NFFs in Pakistan. In doing so, the study provides a valuable contribution to literature by narrowing the research scope to a specific economic and cultural context. This specificity not only adds depth to the understanding of SR factors in the region but also highlights the importance of tailoring risk management strategies to the unique challenges faced by firms in developing economies. Finally, the identification of financial distress and financial constraints as moderators in this relationship contributes novel insights, emphasizing the importance of considering a firm's financial health when assessing its contribution and vulnerability to SR.

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Abdul Rashid: Editing and methodology

Abdul Raheman: Review and supervision

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Appendix I. Abbreviations and their Definitions

Abbreviations	Definitions
DCOVAR	Change in conditional value-at-risk
VaR	Value-at-risk
COVAR	Conditional value-at-risk
MES	Marginal Expected Shortfall
GFC	Global Financial Crisis
IMF	International Monetary Fund
SR	Systemic Risk
PSX	Pakistan Stock Exchange
NFFs	Non-financial Firms
TC	Trade Credit
RFD	Ratio of Financial Distress
CFSI	Cash Flow Sensitivity Index