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Testing the impact of liquidation speed on leverage using Indian data*

By

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Abstract

The paper investigates the influence of the speed of liquidation of insolvent firms on leverage. The theoretical model presented formalizes the intuitive view that an increase in liquidation speed is expected to decrease average leverage as highly leveraged firms exit. Analysis of Indian data, however, suggests that an increase in liquidation speed increases average leverage. This finding is linked to influential observations at the right tail of the leverage distribution. We propose an asset-weighted variant of the proposition that holds with empirical data.

I. Introduction

High corporate leverage may constrain investment, so liquidation of insolvent, highly leveraged firms may increase an economy's growth potential (Giroud and Mueller, 2016; Caballero et al., 2008). One instrument available to policymakers in overcoming this constraint is regulation of the speed of liquidation of insolvent firms, *inter alia* by shortening the duration of official insolvency proceedings. Intuitively, an increase in liquidation speed should contribute to deleveraging as the liquidated firms are highly leveraged. Indeed, many countries have significant room to reduce liquidation speeds. In 2020, for example, the duration of corporate resolutions (including liquidations and restructurings), averaged over 2 years with variation across countries from 4 months to 6 years (World Bank, 2020).

Empirical studies and model simulations provide some evidence that an increase in liquidation speed can improve macroeconomic outcomes (Srhoj et al, 2023; Ponticelli and Alencar, 2016; Aysun, 2015). The mechanism of action is unclear, however, as the impact of liquidation speed on leverage, or the *liquidation speed channel* (of leverage), has not been studied from the first principles. The apparent lack of academic interest is notable given the policy relevance and quantifiability of the channel. Liquidation speed is an important factor in creditor rights reforms, and it is generally used as an indicator of the efficiency of the bankruptcy process (Garrido et al, 2019; Djankov et al, 2008).

We develop a variant of Holmström and Tirole's (H&T, 1997) influential model of investment under moral hazard to study the liquidation speed channel. The theoretical analysis formalizes the intuitive proposition that an increase in liquidation speed decreases average leverage. Our proposed theory also yields estimators to test the propositions from corporate financial data. Notably, it indicates that the testing can be performed independently from other aspects of creditor rights and economic conditions. This high level of test specificity reflects the theoretical finding that leverage at the firm level is not sensitive to liquidation speed. In theory, the liquidation speed channel is essentially a sampling effect that can be quantified by comparing leverage in liquidated and other firms.

We test the theory with data from India, where the Insolvency and Bankruptcy Code of 2016 (IBC) increased liquidation speed. India is an excellent test case for a novel theory because it is familiar from many influential studies of other aspects of creditor rights reform (Kulkarni et al, 2021; Thapa et al, 2020; Vig 2013). The tests with unweighted data unequivocally reject the theory, indicating that the increase in liquidation speed contributed to an increase in average leverage. The rejections are driven by influential observations at the right tail of the leverage distribution, which may signal novel behavior among highly leveraged firms that is not predicted by the theory. For example, firms may sell assets to service debts, pushing them to extremely high levels of leverage. While there are only a few deviant observations with extremely high leverage, they heavily influence analysis with unweighted data.

The behavior of failing firms may be of interest for some purposes, such as the analysis of cyclical developments, but negligible for other purposes, including the study of long-term economic growth. Indeed, focus on asset-weighted data may be appropriate for the latter. The two tests with such data support the intuitive proposition and broadly concur about a small negative liquidation speed channel for the IBC in India. These findings indicate that asset-weighted average leverage may constitute a suitable policy target variable of creditor rights reforms when liquidation speed is increased.

Our paper contributes to the discussion on the influence of creditor rights on capital structure by considering a previously unresearched channel that complements previous work on other channels such as the bankruptcy risk channel (Schoenherr and Starmans, 2022; Harris and Raviv, 1990) and the liquidation value channel (Vig 2013; Acharya et al., 2011). We further present new findings about creditor rights reforms in India (Kulkarni et al., 2021; Thapa et al., 2020; Vig 2013).

Notably, our discussion integrates the debates on creditor rights and zombie firms. Becker and Ivashina (2022) and Andrews and Petroulakis (2019) provide recent evidence that zombie firms may signal weakness in corporate insolvency regulations. We focus on the weakness of slow liquidation speed, providing theory, estimators, and empirical evidence based on a case study. Our unexpected findings with unweighted data caution against using unweighted average leverage as a general indicator of the scale of the zombie problem due to its susceptibility to influential right-tail observations.

This paper also adds to the literature on judicial efficiency (Kondylis and Stein, 2023) new findings about the implications of the efficiency of bankruptcy regulation. Previous work reveals that slow liquidation may add to liquidation costs, with substantial effects at the macroeconomic level on employment and investment as well as monetary policy effectiveness (Srhoj et al, 2023; Dou et al, 2021; Ponticelli and Alencar, 2016; Aysun, 2015).

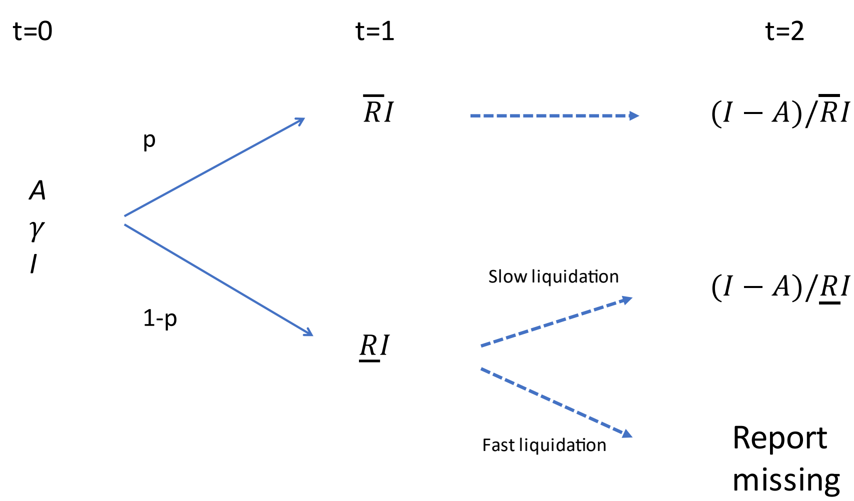
Finally, our findings add to the debate about leverage persistence. An open issue in corporate finance today is the poor statistical fit of theoretically robust models of leverage (Graham, 2022). Previous empirical work indicates marked instability in firm-level and aggregated leverage (DeAngelo and Roll, 2015). Our findings with unweighted data are a further example of the friction between theory and empirical results. Associating this friction with right-tail behavior, we show that asset-weighted data may reveal predictable patterns not discernible in the unweighted data.

Section II deals with the theory. A discussion of the data and the estimation period, and a presentation of the empirical findings are presented in Sections III and IV, respectively. Section V concludes with discussion about the results and future work. Throughout the text, we refer to the Annex of India’s evolving bankruptcy legislation.

II. The Theory

The proposed model has two types of agents: firms and creditors. There are three dates t: the investment date 0, the payoff date 1, and the end-of-fiscal-year reporting date 2. At the investment date, contracts between firms and creditors are signed and investments made. At the payoff date, returns from investment are realized and, if the bankruptcy process is fast, insolvent firms are liquidated. At the reporting date, continuing firms report their financials.

FIGURE 1. MODEL TIMELINE



Specifically:

- **t=0**. Firms have two types of assets: own funds and investment assets. They start with own funds $A > 0$ and an investment project $I > 0$ with variable scale. Own funds may be invested without cost. Beyond that, a firm must borrow $I - A$ from creditors, who require an expected unit return $\gamma > 1$. Investment is subject to moral hazard: entrepreneurs who run their firms privately can choose between good and bad types of investment. The bad investment type yields a private benefit $b > 0$ per unit of investment to the entrepreneur. The probability of success is p_H for the good type and p_L for the bad type, $p_H > p_L$.

- **t=1.** Investment returns $\overline{R}$ if it succeeds and $\underline{R}$ if it fails per unit of investment, $\overline{R} > \underline{R} > 0$. To introduce creditor rights issues into the model, $\underline{R}$ is restricted to be so low (see Eq. (5)) that in equilibrium creditors cannot be fully repaid if the project fails.

- **t=2**. Successful firms report leverage $\frac{I-A}{\overline{R}I}$. Failed firms report leverage $\frac{I-A}{\underline{R}I}$ if the liquidation process is slow. Under fast liquidation, the reports of failed firms are missing.

Following the previous literature, we focus on the case where an investment project is economically viable only if the entrepreneur chooses the good project:

$$p_H\overline{R} + (1 - p_H)\underline{R} > \gamma > p_L\overline{R} + (1 - p_L)\underline{R} + b \qquad (1)$$

Denote by $\overline{R}_f$ the unit return for the firm from a successful project. The firm does not receive income under failure because, due to the agency cost, any re-distribution of firm income from the successful to failed state would be welfare-decreasing. At t=0, the good project is thus expected to yield $p_H\overline{R}_f$ and the bad project $p_L\overline{R}_f + b$ for the firm. We denote by Δp the success probability differential between the good and bad project, $\Delta p \equiv p_H - p_L > 0$. By simple algebra, the firm prefers the good project over the bad project if the incentive compatibility constraint (2) holds:

$$\overline{R}_f - \frac{b}{\Delta p} > 0 \qquad (2)$$

Under (2), the expected return at t=0 from investment to creditors is $\left(p_H\left(\overline{R} - \overline{R}_f\right) + (1 - p_H)\underline{R}\right)I$. The following investment feasibility constraint thus guarantees that the creditors' return requirement holds:

$$(I - A)\,\gamma \leq \left(p_H\left(\overline{R} - \overline{R}_f\right) + (1 - p_H)\underline{R}\right)I\,. \qquad (3)$$

Together, the incentive compatibility constraint (2) and the investment feasibility constraint (3) imply that the firm can pledge at most R^0 to creditors at t=0 per unit of investment, where:

$$R^0 \equiv p_H\left(\overline{R} - \frac{b}{\Delta p}\right) + (1 - p_H)\underline{R}\,. \qquad (4)$$

To focus the analysis on the interesting case where firms' access to credit is limited, the pledgeable unit return is restricted strictly to a level below the creditors' return requirement:

$$R^0 < \gamma \; . \qquad (5)$$

Periods t=0 and t=1 correspond closely with the Holmström-Tirole (H&T) model, except that we abstract for simplicity from variation in own funds across firms and an explicit modeling of the financial sector. To support the research focus, we flesh out the liquidation process by introducing a positive liquidation value under failure, and an additional period to support variable liquidation speed.

The optimal contract

At t=0, the representative firm negotiates with creditors about investment scale and the firm's share of investment returns. The optimal contract maximizes the firm's expected returns subject to the domain conditions and the incentive compatibility and investment feasibility constraints:

$$\underset{I,\overline{R}_f}{Max} \quad p_H \overline{R}_f I \quad st. \; I, \overline{R}_f \geq 0; \; (2); (3) \qquad (6)$$

Standard solution methods apply. In the unique maximum (denoted by the asterisk) the representative firm is paid just enough to make the good project preferable; investment is as large as it can be under (2) and (3); and debt is positive. Formally:

$$\begin{aligned} &(a) \qquad \overline{R}_f * = \frac{b}{\Delta p} \\ &(b) \qquad I* = A\frac{\gamma}{\gamma - R^0} \qquad (7) \\ &(c) \qquad I* - A = A\frac{R^0}{\gamma - R^0} \end{aligned}$$

The leverage of firms at t=0 is summarized for further reference by Proposition 1.

Proposition 1. *The leverage of all firms at t=0 is*

$$\frac{I* - A}{I*} = \frac{R^0}{\gamma}$$

Proof: Use (6)(c) with (6)(b) and simplify.

It follows from Proposition 1 and Eq. (4) that at t=0 leverage is increasing in investment returns $(\overline{R}, \underline{R})$, the success probability (p_H), and the success probability differential (Δp); and decreasing in the private benefit from the bad project (b) and the return requirement for outside funds (γ). Liquidation speed does not influence leverage at t=0.

Leverage at the reporting date

Firms diverge at t=1 due to random variation in project outcomes. All firms still have $A\frac{R^0}{\gamma-R^0}$ of debt, but assets are $\overline{R}A\frac{\gamma}{\gamma-R^0}$e if the project succeeds and $\underline{R}A\frac{\gamma}{\gamma-R^0}$ if it fails. Successful firms are therefore less leveraged at t=1 than failed firms (Table 1, col 2). If liquidation is slow, both types of firms report at date t=2. If liquidation is fast, only successful, less leveraged, firms report. Average reported leverage is therefore negatively influenced by liquidation speed. This finding is formalized in Proposition 2.

TABLE 1. AVERAGE LEVERAGE AT T=1 AND T=2

FIRM TYPE	T=1	T=2	
		SLOW LIQUIDATION	FAST LIQUIDATION
SUCCESS	$\frac{R^0}{\overline{R}\gamma}$	$\frac{R^0}{\overline{R}\gamma}$	$\frac{R^0}{\overline{R}\gamma}$
FAILURE	$\frac{R^0}{\underline{R}\gamma}$	$\frac{R^0}{\underline{R}\gamma}$	-
ALL FIRMS	$p_H\frac{R^0}{\overline{R}\gamma}+(1-p_H)\frac{R^0}{\underline{R}\gamma}$	$p_H\frac{R^0}{\overline{R}\gamma}+(1-p_H)\frac{R^0}{\underline{R}\gamma}$	$\frac{R^0}{\overline{R}\gamma}$

`

Proposition 2. *The impact on average reported leverage of a change from slow to fast liquidation is*

$$(1-p_H)\left(\frac{R^0}{\gamma\overline{R}}-\frac{R^0}{\gamma\underline{R}}\right)<0$$

Proof: Dilute from the average reported leverage under fast liquidation $\frac{R^0}{\overline{R}\gamma}$ *the average reported leverage under slow liquidation* $p_H\frac{R^0}{\overline{R}\gamma}+(1-p_H)\frac{R^0}{\underline{R}\gamma}$ *and rearrange. The inequality follows from the assumptions about non-negativity of the variables and* $\overline{R}>\underline{R}$.

To support the empirical analysis, we present two useful variants of this basic result. Proposition 2 applies under a complete shift from slow to fast liquidation. From an empirical point of view, we also consider the intermediate case where ls $(0 \leq ls \leq 1)$ failed firms are liquidated fast, while $1 - ls$ are liquidated slowly. Since firms are unaffected by liquidation speed, the only implication for introducing an intermediate liquidation speed is that the average reported leverage becomes $p_H \frac{R^0}{\overline{R}\gamma} + \frac{(1-p_H)(1-ls)}{n} \frac{R^0}{\underline{R}\gamma}$, where $n = p_H + (1 - p_H)(1 - ls)$ is the number of surviving firms at the reporting date t=2. We refer to ls as "liquidation speed" and use the shorthand ea and ep to indicate ex-ante and ex-post values. Proposition 3 gives the impact of an increase in ls on average reported leverage.

Proposition 3. *The impact of an increase in liquidation speed from ls_{ea} to ls_{ep} on the average reported leverage of firms (Liquidation Speed Channel) is*

$$LSC = \left(\frac{p_H}{n_{ep}} - \frac{p_H}{n_{ea}}\right)\left(\frac{R^0}{\gamma\overline{R}} - \frac{R^0}{\gamma\underline{R}}\right) < 0$$

Proof: Dilute from the average reported leverage after the increase $p_H \frac{R^0}{\overline{R}\gamma} + \frac{(1-p_H)(1-ls_{ep})}{n_{ep}} \frac{R^0}{\underline{R}\gamma}$ the average reported leverage prior to the increase $p_H \frac{R^0}{\overline{R}\gamma} + \frac{(1-p_H)(1-ls_{ea})}{n_{ea}} \frac{R^0}{\underline{R}\gamma}$ and rearrange. The inequality follows from the assumptions about non-negativity of the variables, $\overline{R} > \underline{R}$, and $ls_{ep} > ls_{ea}$.

Proposition 3 indicates that the liquidation speed channel can be divided into two multiplicative parts: the change in the share of successful firms in reporting firms caused by the increase in liquidation speed, multiplied by the difference in leverage between successful and failed firms. The first term is positive since an increase in liquidation speed increases the share of successful firms in all reporting firms. The second term is negative since failed firms are more leveraged than successful firms. Overall, the liquidation speed channel is always negative.[1]

[1] Proposition 2 is a special case of Proposition 3, characterized by $ls_{ea} = 0$ and $ls_{ep} = 1$.

The formula given in Proposition 3 hints at a subtle, but potentially significant, measurement issue of the liquidation speed channel. If liquidation value approaches zero ($\underline{R} \rightarrow 0$), leverage and *LSC* explode without bound. While this issue is excluded by assumption in the theoretical model, it shows up in the form of influential observations in the empirical analysis.

Proposition 4 presents an alternative formulation of the liquidation speed channel, the "asset-Weighted Liquidation Speed Channel" (WLSC), which is not sensitive to this issue. WLSC weights each report by the share of the reporting firm's assets of the total assets of firms.

Proposition 4. *The impact of an increase in liquidation speed on the asset-weighted average reported leverage of firms at t=2 (asset-Weighted Liquidation Speed Channel) is:*

$$WLSC = \left(\frac{p_H}{n_{ep}} - \frac{p_H}{n_{ea}}\right)\left(\frac{R^0}{\gamma\overline{\overline{R}}} - \frac{R^0}{\gamma\left(p_H\overline{\overline{R}} + (1 - p_H)\underline{R}\right)}\right) < 0$$

Proof: Since the weight equals firm assets divided by total assets of firms, asset-weighted average leverage equals total debt of all firms divided by total assets of all firms. Based on (7), the asset-weighted average leverage of all firms at t=2 is $\frac{R^0}{\gamma\left(p_H\overline{\overline{R}}+(1-p_H)\underline{R}\right)}$ *under slow liquidation and* $\frac{R^0}{\gamma\overline{\overline{R}}}$ *under fast liquidation. The result follows by applying similar steps as in Proposition 3.*

Estimators

The liquidation speed channel cannot be tested directly using the formulas given in Propositions 3 and 4 when the parameters are not known. Instead, they must be inferred from reported financials. To this end, Table 2 shows a summary of reports at t=2 in the model ex-ante, when liquidation speed is slow.

TABLE 2. AVERAGE REPORTED DEBT, ASSETS, AND LEVERAGE UNDER SLOW LIQUIDATION

STAGE	SUCCESSFUL FIRMS	FAILED FIRMS	ALL FIRMS
DEBT (ARD)	$A\frac{R^0}{\gamma - R^0}$	$A\frac{R^0}{\gamma - R^0}$	$A\frac{R^0}{\gamma - R^0}$
ASSETS (ARI)	$\overline{R}A\frac{\gamma}{\gamma - R^0}$	$\underline{R}A\frac{\gamma}{\gamma - R^0}$	$\frac{p_H}{n}\overline{R}A\frac{\gamma}{\gamma - R^0} + \frac{(1-p_H)(1-ls)}{n}\underline{R}A\frac{\gamma}{\gamma - R^0}$
LEVERAGE (ARL)	$\frac{R^0}{\overline{R}\gamma}$	$\frac{R^0}{\underline{R}\gamma}$	$\frac{p_H}{n}\frac{R^0}{\overline{R}\gamma} + \frac{(1-p_H)(1-ls)}{n}\frac{R^0}{\underline{R}\gamma}$

Note: ARD=Average reported debt; ARI=Average reported assets; ARL=Average reported leverage.

We use ARD, ARI, ARL as shorthand for average reported debt, assets, and leverage, respectively. The estimators to test Propositions 3 and 4 are:

$$\widehat{LSC} = \left(\frac{p_H}{n_{ep}} - \frac{p_H}{n_{ea}}\right)\left(ARL^{success} - ARL^{fail}\right) \quad (8)$$

$$\widehat{WLSC} = \left(\frac{p_H}{n_{ep}} - \frac{p_H}{n_{ea}}\right)\left(\frac{ALD^{success}}{ALI^{success}} - \frac{ALD^{fail}}{ALI^{fail}}\right) \quad (9)$$

The information given in Table 2 indicates that $\widehat{LSC}$ and $\widehat{WLSC}$ are, indeed, unbiased. The computation of the estimators requires information about corporate financials from the ex-ante date, and the share of successful and failed firms in all reporting firms ex-ante and ex-post.

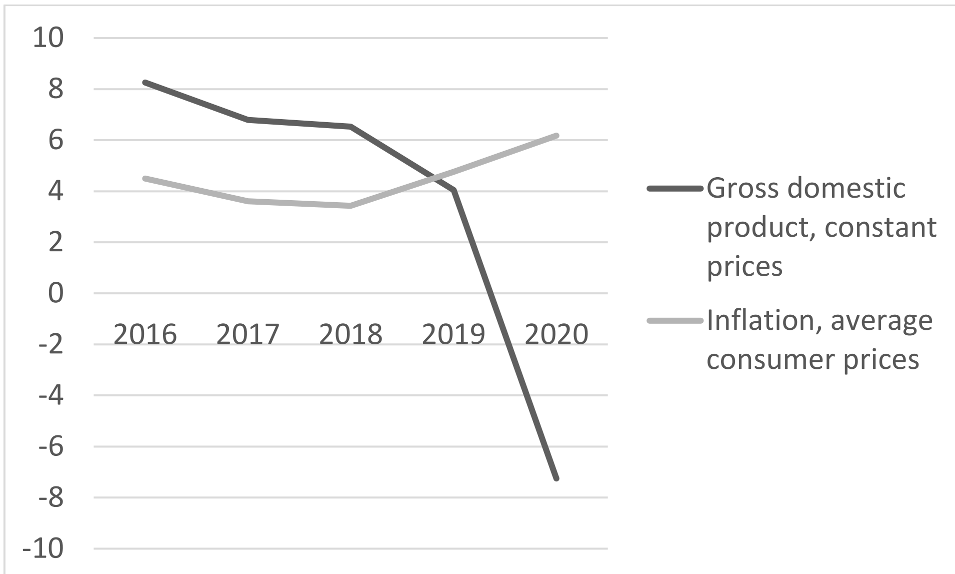
III. The estimation period and the data

The liquidation speed channel is tested with Indian data over the period from April 2015 to March 2020. The estimation period covers 5 fiscal years (April to March) which regulate the financial reporting of firms in India. For simplicity, we refer to each fiscal year by the year of its final reporting quarter: the fiscal year from April 2015 to March 2016 is, for example, referred to as 2016 unless otherwise stated.

Throughout most of the estimation period, economic growth in India was high by global standards, running in the range of 4-8 percent (Figure 2). Inflation remained between 2 and 6 percent. The

Covid-19 pandemic arrives just at the end of the estimation period, contributing to a sharp fall in GDP and a spike in inflation.

FIGURE 2. MACROECONOMIC DEVELOPMENTS IN INDIA, ANNUAL % CHANGES



Note: The horizontal axis year X refers to the calendar year.
Data source: IMF WEO database, October 2021.

The past decades have seen many legislative reforms to make India's bankruptcy law more creditor friendly (Annex). Our focus is on the Insolvency and Bankruptcy Code (IBC), which was enacted on May 2016.[2] The IBC imposes a 180-day limit on the insolvency process, implying a sharp increase in liquidation speed around the enactment date. While the 180-day limit was ambitious due to implementation issues such as court congestion, evidence indicates that the IBC contributed to a substantial increase in liquidation speed. Based on World Bank data, average liquidation speed in India fell from around 51 months to 18 months between 2014 and 2020 (World Bank, 2014 and 2020).

For the estimations, we use the CMIE Prowess database, which covers 1–2 % of registered (listed and unlisted) firms in India. The data are familiar from many previous studies (Kulkarni et al.

[2] The IBC was temporarily suspended due to the global pandemic in May 2020. Since previous changes in creditor rights do not affect our tests, we do not discuss them in detail here.

2021; Thapa et al., 2020; Vig 2013). It is a non-random sample as the CMIE strives to include as many firms as possible. Notably, larger firms are over-represented in the CMIE. For example, the average level of equity capital in CMIE is typically 2 to 3 times larger than in the official numbers given by the Government of India (Ministry of Corporate Affairs, 2021). We believe this sampling issue could bias the findings towards weaker impact (in absolute terms) based on the prior that the enactment of the IBC may have disproportionately influenced smaller firms, which were less impacted by previous creditor rights reforms.

We considered two commonly used empirical measures of leverage: the debt-to-equity ratio, and the debt-to-assets ratio. The former is available in the database. The latter is computed by dividing total debt with total assets. We select the debt-to-assets ratio as the leverage indicator because it is well defined for firms that have no own capital. Such firms, whose continuation is potentially directly impacted by the IBC, are a focus of this study.

There are 106,490 leverage observations distributed over our 5-year period, which gives about 20,000 firms per year (Table 3). Average leverage is very high at 2.7. Almost one-fifth of the observations show leverage above unity, and a few exceed 1,000. While not numerous, these right-tail observations heavily influence average reported leverage. Average reported debt is at Indian rupees (INR) 45 million, and assets at INR 119 million which gives an asset-weighted average leverage of 39 % ($=\frac{45}{119}$).

TABLE 3. DATA DESCRIPTION

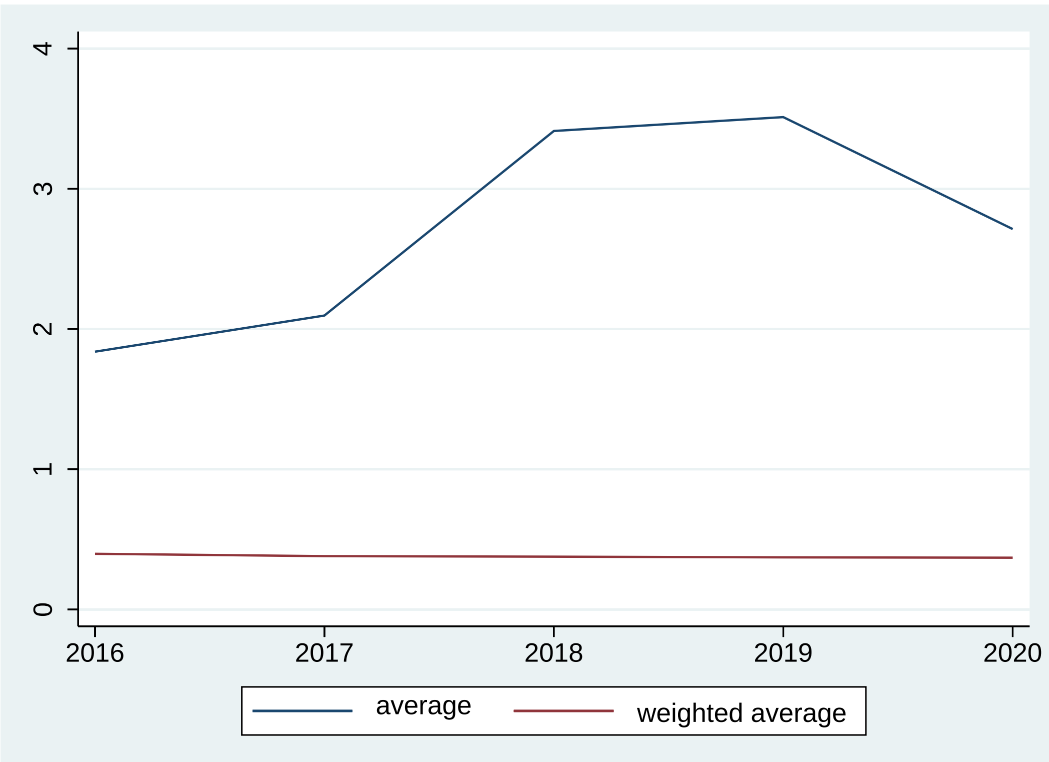
Variable	Obs.	Average	Std. Dev.	Min.	Max.
Leverage	106,490	2.7	81.5	0.00000251	10277
Debt	106,490	44.9	444.7	0.0013	44152
Assets	106,490	118.6	1173.7	0.0013	130748

Note: Leverage Debt-to-Assets; Debt: total debt in INR million; Assets: total assets in INR million; Obs.: the number of observations; Std. Dev.: standard deviation.

Data source: CMIE Prowess.

We combine CMIE data with a comprehensive data set by the Insolvency and Bankruptcy Board of India (IBBI) on corporate liquidations and voluntary resolutions in 2017–2020.[3] A voluntary resolution is an agreement between the debtor firm and its creditors to address the insolvency. Under the IBC, voluntary resolutions and liquidations share the 180-day limit. We classify both voluntarily resolved and liquidated firms as failed in the analysis. Based on the data, about two percent of the firms in the 2016 cross-section failed in 2017–2020.

FIGURE 3. AVERAGE REPORTED LEVERAGE (ARL) AND ASSET-WEIGHTED AVERAGE REPORTED LEVERAGE (WARL)



Note: The figure shows the averages in the cross-sections of each year. Leverage is defined as the debt-to-assets ratio of a firm. The horizontal axis year X refers to the fiscal year from April of year X-1 to March of X.

Data sources: CMIE Prowess database, author calculations.

Average reported leverage shows a marked increase after the enactment of the IBC, almost doubling by 2019 (Figure 3). The sharp increase is surprising given the shortening liquidation time. Instead of vanishing with faster liquidation, it seems that insolvency increased. Asset-weighted

[3] We thank Nirupama Kulkarni and Harneet Singh from CAFRAL for the data, which have been collected from the IBBI website.

average leverage is at much lower levels and slightly but steadily decreasing from around 0.4 to 0.37. The stark difference between the non-weighted and asset-weighted leverage indicators in terms of levels and dynamics speaks to the influence of the right-tail observations in the non-weighted data.

IV. Empirical findings

We select fiscal year 2016 as our ex-ante year. Since it ends in March 2016, just 31 days before the enactment of IBC, analysis of the 2016 cross-section of firms likely gives fairly accurate values of the ex-ante variables. We report channel strength over two ex-post periods: fiscal 2017, and the four-year stretch 2017–2020. Together, the estimators yield insights into channel strength and dynamics.

TABLE 4. COMPUTING THE ESTIMATORS

ep	2017	2017-2020
$\boldsymbol{p_H}/\boldsymbol{n_{ep}}$	0.998	0.990
$\boldsymbol{p_H}/\boldsymbol{n_{2016}}$	0.997	0.982
$ARL_{ea}^{success}$	1.840	1.849
ARL_{2016}^{fail}	1.238	1.244
$ARD_{2016}^{sucsess}/ARI_{2016}^{success}$	0.394	0.381
$ARD_{2016}^{fail}/ARI_{2016}^{fail}$	0.794	0.722
$\widehat{LSC}$	0.001	0.005
$\widehat{WLSC}$	-0.0005	-0.0027

Note: p/n is the proportion of successful firms of reporting firms, ARL is average reported leverage, ARD/ARI is the asset-weighted average leverage of firms. $\widehat{LSC}$ *and* $\widehat{WLSC}$ *are the un-weighted and asset-weighted liquidation speed channel estimates calculated based on Equations (8) and (9).*

Data sources: CMIE Prowess, own calculations.

In discussing the channel strength estimates, it helps to see the intermediate steps of our calculations. We start with an analysis of the liquidation speed channel during the single ex post year 2017.

In the data for year 2016 there are 22,940 firms of which 75 failed and 22,865 succeeded in 2017. The ex-ante proportion of successful firms to all reporting firms is therefore $\frac{p_H}{n_{2016}} = \frac{22865}{22940} \approx 0.997$. In the data of 2017, there are 22,455 firms of which 45 failed and 22,410 succeeded during that year. The ex-post proportion of successful firms to all reporting firms is therefore $\frac{p_H}{n_{2017}} = \frac{22410}{22455} \approx 0.998$. Combining these numbers with the average reported leverages of successful and failed firms in 2016 (Table 4), the non-weighted liquidation speed channel (8) becomes:

$$\begin{aligned}\widehat{LSC}[2016;2017] &= \left(\frac{p_H}{n_{2017}} \quad - \quad \frac{p_H}{n_{2016}}\right)\left(ARL_{2016}^{success} - ARL_{2016}^{fail}\right)\\ &= (0.998 \ \ - 0.997)(1.85 - 1.24)\\ &= (\ 0.001\ )\ (+0.61\ \ )\\ &= \ 0.001\end{aligned}$$

Since $\widehat{LSC}[2016;2017]$ is positive, Proposition 3 is rejected, and these intermediate steps reveal the culprit. The third (next to last) step of the calculation shows a positive leverage differential between successful and failed firms (+0.61), which contrasts with the theoretical assumption that failed firms are more levered than successful firms. The second step also shows that ARL (1.85) is remarkably high among successful firms.

In contrast, the asset weighted liquidation speed estimator (9) is negative, supporting Proposition 4:

$$\begin{aligned}\widehat{WLSC}[2016;2017] &= \left(\frac{p_H}{n_{ep}} - \frac{p_H}{n_{ea}}\right)\left(\frac{ALD^{success}}{ALI^{success}} \quad - \frac{ALD^{fail}}{ALI^{fail}}\right)\\ &= (0.985 \ \ - 0.997)(0.39 - 0.79)\\ &= (0.001)\ (-0.4\ )\\ &= -0.0005\end{aligned}$$

Based on similar calculations, we get a positive unweighted channel and a negative asset-weighted channel also for the period 2017-2020 (Table 4). The unweighted estimators therefore consistently indicate a positive and the asset-weighted estimators a negative liquidation speed channel. The asset-weighted estimator is small but markedly increasing in absolute terms: it is almost six times stronger during the four year period 2017-2020 than in 2017. It therefore seems that the channel was rapidly strengthening during the ex-post period.

We explored the data in more detail to gain further insight about what causes the rejection of the theory in unweighted data. It seems that the rejections are driven by influential observations at the right tail of the 2016 cross-section. Eight firms display extreme leverage at or above 1,000. These firms are mostly private firms from various sectors, age groups, and geographical areas. Their debts averaged INR 14 million, while their assets averaged around INR 8,000. Although these extreme-leverage firms account for less than 0.1 percent of the observations, they are highly influential. When omitted, the unweighted channel strength estimators turn negative, and Proposition 3 is saved.

On the other hand, we find no good reason to omit them. While it is impossible to fully validate the financials, it seems risky to brush them off as data error. The two published auditor reports of high-leverage firms we managed to track down from online sources confirm the extreme leverage of both firms. In one of the reports, the auditors state that the financials seem accurate, but that the firm has not defaulted on its dues. It therefore seems possible that, rather than measurement error, at least some of the influential observations reflect novel behavior such as asset sales by indebted firms to service debts and thereby avoid the insolvency process.

Truncating the right tail is also problematic in the sense that the resulting *LSC* estimate depends markedly on the position of the cut. This finding indicates that the channel estimates from truncated samples are arbitrary.

V. Discussion and conclusions

Liquidation speed is an instrument to promote deleveraging of the corporate sector. In this paper, we developed a theory about how liquidation speed impacts corporate leverage and test that theory with a case study of India's Insolvency and Bankruptcy Code (IBC) enacted in 2016. Our empirical findings indicate that the theory fails for unweighted data and holds up for asset-weighted data. The failure with unweighted data seems associated with right-tail observations that reflect behavior not predicted by theory.

Variable selection and outlier treatments are approaches widely used in the leverage literature to mitigate right-tail issues. While such approaches may be appropriate for some purposes, we take the view that they are not universally applicable. For example, long term economic growth may be relatively unaffected by much of the right tail. In contrast, in our discussion about corporate liquidation the right tail is a focus of interest. Our findings about the predictability of the asset-weighted liquidation speed channel hopefully opens avenues for empirical work in other studies involving right-tail effects.

The analysis with weighted data shows only a small impact from liquidation speed to leverage. We think that the modest impact estimate may partly reflect over-representation of larger firms in our sample as larger firms may have been less influenced by the IBC than smaller firms. However, the findings may also reflect court congestion, and the reluctance by banks to make use of the IBC, which has been documented by previous authors (Kulkarni et al., 2019).

The theory yields many hypotheses about asset-weighted leverage that have not been tested here, but should be testable under standard empirical designs. Indeed, we have explored the possibility to estimate the total impact of the IBC on corporate leverage, and not just the liquidation speed channel. However, identification under the IBC is not straightforward, implying in a large diversion from our focus here. We plan to return to this issue in future work.

Among the most interesting predictions of our theory is the invariance of firms to liquidation speed. This characteristic of the problem greatly simplifies empirical design. Without the need to estimate behavioral parameters, the analysis is reduced to comparisons of averages across groups and time. Our experience with influential observations and several earlier studies (Eggertsson et al., 2019; Eggertsson and Krugman, 2012) suggest that the invariance may not hold universally. We look forward to extensions of the theory and empirical contributions to gain further insights into this important issue.

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ANNEX

Timeline of India's bankruptcy legislation

FIGURE A1. TIMELINE OF MAJOR CHANGES IN INDIA'S BANKRUPTCY LEGISLATION.

1985 The Sick Industrial Companies act

1993 Recovery of Debts and Bankruptcy act

2003 SAFRAESI

2013 The Companies act of 2013

2016 The Insolvency and Bankruptcy Code

Under the Sick Industrial Companies Act of 1985 (SICA), an insolvency process could only be initiated by the company in question, designated public entities, or banks. Upon initiation, the insolvency process was handled by the Board of Industrial and Financial Reconstruction (BIFR), a development finance institution owned by the Ministry of Finance. SICA's recovery process was widely regarded as inefficient and characterized by its ponderous pace and low recovery rates (Kulkarni et al., 2019).

In 1993, debt recovery tribunals were introduced to speed up recovery of the non-performing loans of financial institutions. The Securitization and Reconstruction of Financial Assets and Enforcement of Security Interest Act of 2003 (SARFRAESI) was designed to overcome SICA drawbacks and promote rapid recovery of secured debt.

SAFRAESI, however, limited recovery to secured debt. Recovery of unsecured credit from the non-financial sector was still governed by SICA . Over the past decade, a series of further reforms were undertaken to further promote recovery, including recovery of unsecured debt.

The series of reforms started with the Companies Act (enacted in August 2013), which replaced the BIFR with National Company Law Tribunals (NCLTs). NCLTs are comprised of judicial and technical experts appointed by the Ministry of Corporate Affairs. SICA was repealed in 2016 and replaced with the Insolvency and Bankruptcy Code (IBC) enacted in May 2016. Under the IBC, any creditor may initiate the insolvency process, which must be resolved in under 180 days by an NCLT. The implementation of the IBC was suspended between May 2020 and March 2021 due to the Covid-19 pandemic.