4th Annual Conference for Doctoral Students
SERI-Doctoral Conference (SERI-D) 2025

Does lending to zombies weaken innovation? Empirical Evidence from the Indian Manufacturing sector

Asha K Rai
Research Scholar, Indian Institute of Technology Indore
*This research is part of my doctoral thesis under the supervision of Prof. Ruchi Sharma

Innovation and Economic Growth

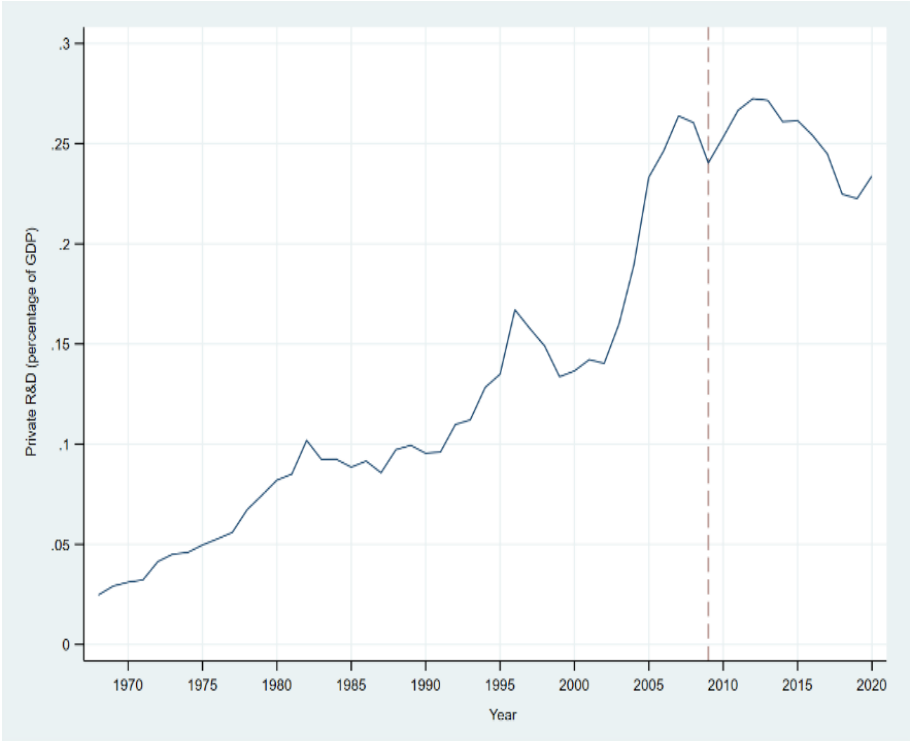
- The Oslo Manual (OECD), defines ***innovation as the development or enhancement of a product or process accessible to potential users or utilised by the organisation.***
- Innovation and technological activities are widely acknowledged as critical factors for economic growth (Aghion & Howitt, 1998; Abrol, 2013; Dhar & Saha, 2014; Joseph & Abrol, 2009; Romer, 1994; Solow, 1956).
- Innovation contributes to sustained long-term growth by generating new technologies, processes, and products primarily via Research and Development (R&D) activities.
- As principal actors in business dynamics, **firms drive innovation through their internal activities and the external environments** (institutional, financial, and competitive) in which they operate.

Public Vs Private R&D: Indian Scenario

- In developed and emerging economies, the ratio of **private to public investment in R&D is generally in the ratio 2:1**.
- By contrast, private sector investments in R&D in India are estimated at only half that of the public sector. Despite ongoing debates regarding the impact of innovation in India, the country allocates approximately **0.64 per cent of its GDP to R&D activities** (NSTMIS, Department of Science & Technology, GOI).
- The **private sector's contribution to total R&D investment in India remains relatively low**, accounting for just **20–25 per cent of the total R&D expenditure** (See, Government of India, Ministry of Finance, Department of Economic Affairs (n-41), 244, 267 and Mani (2021)).
- At 56 per cent, the government's contribution to GERD is disproportionately large compared to other major countries.

Public Vs Private R&D: Indian Scenario

- There is an urgent need for a more balanced investment in private R&D.
- This discrepancy points out the fundamental issues in the Indian financial system, which may be created by the crowding-out impact of evergreen (zombie) lending (Nanda & Nicholas, 2014).
- The 2008 GFC showed how zombie lending could harm innovation and competitiveness. To prevent a rise in bankruptcy caused by the GFCs, the Indian government implemented a forbearance policy, which allowed banks to restructure loans for struggling firms (Chari et al., 2021).
- This diversion of cash limited innovation and growth-oriented firms' access to capital, lowering competitiveness and R&D spending (Ryul & Dwyer, 2024).



Source: NSTMIS, Department of Science & Technology, Government of India
Figure: Private R&D as a percentage of India's GDP

Note: Figure 1 shows the R&D expenditure of Indian corporates as a percentage of GDP over the years. India's private sector contributes a much smaller percentage to total GERD (about 37 per cent) than the business sector in all the other large economies such as China, the US, Japan and the UK (68 per cent on average) (Mukherjee et al., 2021).

Innovation financing

Bankers are critical figures in ***mobilising individual savings, evaluating the risks involved in a project***, and ***bringing together savers and investors*** through market transactions.

Schumpeter (1911) highlights the role of bank financing in economic development. Banks fund innovative projects and new production combinations, contributing to economic growth.

Schumpeter engaged intensively in identifying the precise channels through which services provided by financial systems in general and financial intermediation, in particular, would support innovation and growth.

Bank financing for unviable firms can inversely impact industry, R&D, and patents because it is a crucial capital source, and changes in availability or cost can affect firm innovation (Nanda & Nicholas, 2014).

- The possible reason for this disparity between private and public investment in innovation in India could be the **misallocation of financial resources, which would otherwise flow to more efficient and innovative firms** (Zhang, 2015).

- Therefore, we assert that **zombie firms may contribute to this issue as they impose financial constraints that suppress innovation** (Song et al., 2019; Wang et al., 2021). Consequently, the existence of zombie firms may partially explain why the corporate sector in India struggles to optimise its innovation capacity.

Financial constraints

- The already scarce financial resources for innovation activities get even costlier due to the presence of zombie firms, and deserving firms cannot fully optimise their innovation capacity (Qiao et al., 2022; Wang & Zhu, 2021).

- Zombie firms increase the risk premium of financing, leading to two significant impacts on healthy firms:
  - crowding out the available financial resources and making it difficult for healthy firms to generate new loans, and
  - increasing the interest premium on the already available financial resources.

- Zombie lending impedes the private sector's ability to address the deficit in R&D spending. Consequently, this results in credit misallocation for more productive purposes (Acharya et al., 2022; Qiao et al., 2022).

- A longer relationship between banking increases innovation; however, innovation reduces if this long relationship is between weak banks and zombie firms (Fischer, 2021).

- Zombie firms can distort credit allocation and finance availability, a common factor in firm innovation.

- Zombie firms hinder creative destruction (Ahearne & Shinada, 2005; Caballero et al., 2008; Kane, 2000), and the relationship between zombie lending and firm innovation is worth investigating.

***This paper**: examines the financial constraints on innovation activities created by zombie firms and zombie lending, filling the potential research gap.*

Understanding zombie firms

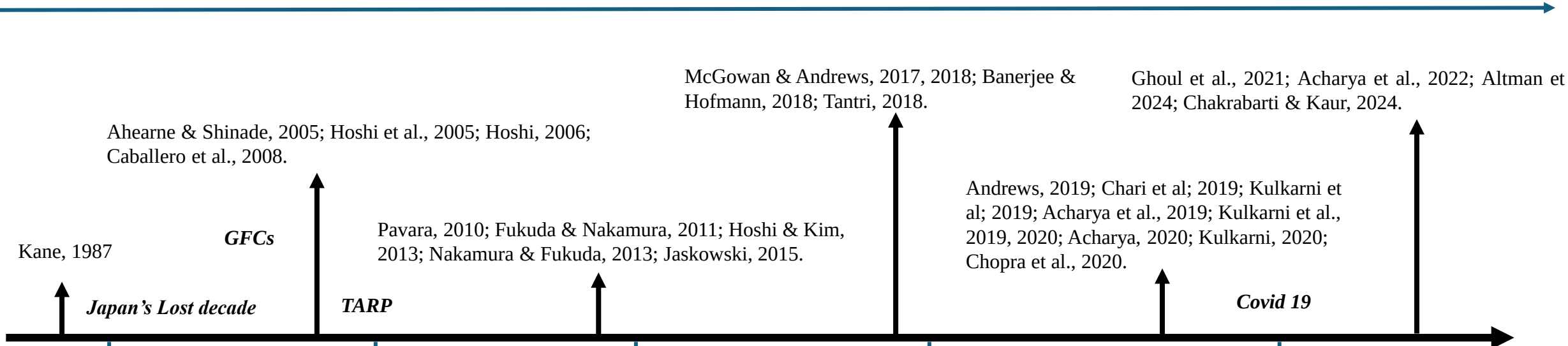
- **Zombie firms:**

  - are unproductive and unprofitable firms that stay afloat by taking on new debts.
  - don’t develop as a firm, innovate, or progress.
  - loss-making and debt-ridden firm that consumes the financial resources of lenders.
  - do not make any major investment and expansion plans in the long run and take credit for survival in the short run.
  - produce negative returns on investments and, as a result, affect the credit functioning of banks.

- **Zombie lending** refers to undercapitalised banks and financial institutions providing loans to underperforming and unviable firms (Acharya et al., 2022).
- The impact of zombie lending increases more during the forbearance scheme.
- Zombie lending: When banks credit insolvent or near-insolvent firms, preventing their exit from the market.
- Bad borrowers need to be liquidated, and their assets need to be sold out to good borrowers. But forbearance keeps the bad borrowers alive.

Related Literature

Identification of zombie firms | **Determinants, evidences, consequences, crowding-out effects of zombie firms** | **Zombie lending, undercapitalized banks, forbearance policy** | **Policy implications**



First time the term "zombie" was used to define unviable firms surviving on government bailouts by Edward J. Kane.

Zombie firms create congestion effects; Reduces investors' market confidence, Hampers international upgradation, Overcapacity problem

A weak banking sector leads to an increase in zombie share.

Impact of zombie firms on productivity, employment & investment.
Impact of zombie Firms on Innovation.

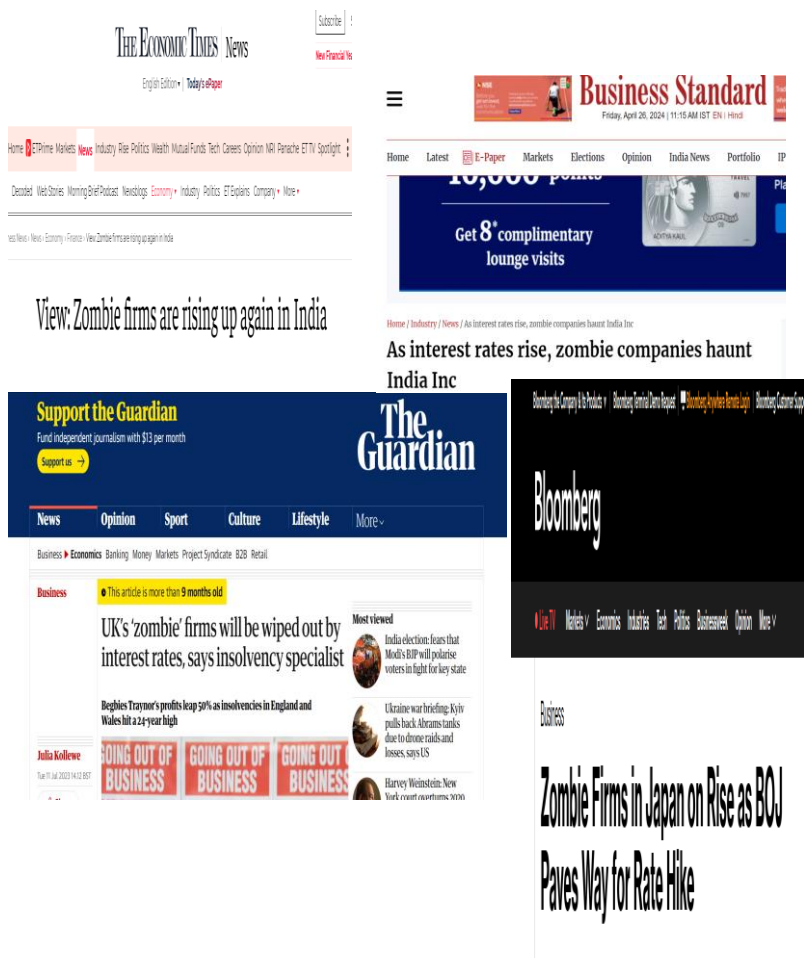
Increased lending to zombie firms by undercapitalized banks. Credit to healthier firms has been reduced and reallocated to the weakest companies as forbearance provided an incentive to hide true asset quality. Confirms an increase in the number of zombie firms in the country due to increased zombie lending.
More focus on policy implications.

Related literature

- **Financial misallocation:** (Hirata, 2010; Qiao et al., 2022; Yu et al., 2021).
- **Bad debts and zombie firms:** (Peek & Rosengren, 2005; Hoshi, 2006; Hoshi & Kashyap, 2010; Watanabe, 2011; Ueda, 2012).
- The **weakly capitalized banks and zombie lending:** (Hoshi & Kashyap, 2004; Peek & Rosengren, 2005).
- **Financial Constraints and innovation:** (Hall et al., 2016; Hall, 2005; Nanda & Nicholas, 2014; Tufano, 2003).

Motivation I

- In 2021, 13 per cent of the US-listed firms were zombies (Goldman Sachs).
- The share of zombie firms doubled between FY 2012 and FY 2022 from **4.9 per cent to 9.8 per cent in India** (Singh, 2023).
- Out of 500 listed firms in India, **10 per cent are zombie** firms (Pattanaik, 2022).
- Zombie firms: **depress market prices** and distort **credit allocation.**
- Hampers **investor confidence**.



Motivation II

I. **Low share of private R&D in India.**

II. **Credit misallocation due to zombie lending**: (Acharya et al., 2022; Jonghe et al., 2024; Song et al., 2019; Schivardi et al., 2020 Wang et al., 2021).

Zombie lending and innovation

- Banking policies have a measurable effect on innovation (Chava et al., 2013).
- **Institutional reforms that improve the efficiency of financial markets encourage innovation**. Provide evidence that relaxing credit constraints or direct subsidies particularly benefits less efficient firms and helps them remain longer in the market (Aghion et al., 2018).
- **Zombie lending hinders creative destruction**, as subsidised loans to unviable firms distort competition because resources are not allocated to the most efficient use, i.e., credit misallocation (Ahearne & Shinada, 2005; Caballero et al., 2008; Kane, 2000).

Forbearance policy and zombie lending

- Kane (1990) claims that **banks highly exposed to forbearance are already undercapitalised**.
- Forbearance policy with an interaction of undercapitalised banks, even after the end of the financial crisis that demands regulatory intervention, is likely to lead to a new lending distortion, resulting in a full-fledged banking crisis (Mannil et al., 2022; Ahearne & Shinada, 2005; Chari et al., 2022; Shen, 2002).
- Regulatory forbearance allows undercapitalised banks to spread (Acharya et al., 2022).
- GFCs had an impact for roughly two years on Indian economy, but the forbearance policy lasted for five years, which should have been ideally revoked (Mannil et al., 2022).

Forbearance is a temporary suspension of loan payments that normally lasts for a set period, usually given to overcome the impact of economic shocks.

- Regulatory forbearance on bank loans to poorly performing firms, distorts financial resources.
- Zombie firms with the backing of zombie lending tend to survive where they should ideally exit the market and crowd out the finances of healthy firms (McGowan & Andrews, 2017).
- Undercapitalised banks, taking advantage of the forbearance policy, continued to evergreen loans to distressed firms, which ultimately negatively affected the economy, including a decline in innovative output.
- When undercapitalised banks persist in lending to weak (zombie) firms even after the crisis, they use forbearance-led relaxed supervisory norms to create incentives for further lending distortions.

Research Gaps & Questions

Zombie firms impair innovation (McGowan et al., 2018 Geng et al., 2021; Qiao et al., 2022).

However, the specific mechanism through which innovation is stiffed has received less scholarly attention.

Research questions:

Does the innovation output of an industry decline if external funding is given more to zombie firms in the form of zombie lending?

Hypotheses

- Zombie firms can distort credit allocation and finance availability, a common factor in firm innovation activities.

- Zombie firms hinder creative destruction (Ahearne & Shinada, 2005; Caballero et al., 2008; Kane, 2000), and the relationship between zombie lending and firm innovation is worth investigating.

Hypothesis 1a: Zombie firm spillover impairs corporate innovation activities.
Hypothesis 1b: Zombie lending impairs corporate innovation activities.

Hypotheses

GFC Crisis: impacted the Indian economy for approximately two years, but forbearance policy was extended for five years (Mannil et al., 2022).

This paper examines:

- ❑ Prolonged extension of the **crisis-induced forbearance policy increased zombie lending**.

- ❑ **Undercapitalized banks continued evergreen loans to distressed firms**, which ultimately negatively affected the economy, including a decline in innovative output.

This scenario risks triggering a new full-fledged banking crisis (Mannil et al., 2022).

Hypothesis 2: Zombie lending impairs corporate innovation activities more during the forbearance policy.

Innovation and competition

- Positive correlation between innovation activities and product market competition showing an inverted U-shaped relationship (Aghion et al., 2005)
- Zombie firms can restrict competition within industries (Ascani & Nair, 2025), thereby reducing firms' post-innovation rents and restraining incumbents from pursuing innovation, especially in laggard industries.
- The congestion effect caused by zombie firms reduces industry competition, leading to lower levels of industrial innovation (Carreira et al., 2022; Geng et al., 2021; Qiao et al., 2022; Yu et al., 2023).
- Lower competition leads to more innovation, with empirical evidence that indicates the opposite—that increased competition spurs innovation (Aghion et al., 2005).
- This hampers economic growth by constraining the expansion of more productive firms, ultimately leading to lower productivity growth.

Hypothesis 3: Capital misallocation created by zombie firms and weekly capitalised banks affects industrial competitiveness and innovation activities.

Setting of the study

The study uses sample of Indian manufacturing firms. The calculation of zombie lending is based on the year of GFCs forbearance i.e., August 2008.

Analysis

1. Trace the firms which are doing R&D and patenting in Indian manufacturing sector.
2. Identifying the weakly capitalized banks based on their capital asset ratio (Caballero et al., 2008, Hoshi & Kashyap, 2010, and Chari et al., 2022).
3. Match weakly capitalized banks with their borrowing firms in an industry at NIC four-digit.
4. Construct the variable of zombie lending in an industry.
5. Examine the impact of zombies on innovation.
6. Examine the impact of zombie lending on industrial innovation.

Data

Descriptive statistics

- Time period: 2000-2019
- Firm level and R&D: CMIE prowess
- Bank level: DBIE (RBI)
- Patent: Patseers

Study variables

Variables	Variable definition	Data source
Innovation activities		
ln(R&D Expenditure)	Research and development expenditure of firms in an industry	CMIE
ln(R&D stock)	Log transformed R&D stock	CMIE
Patent Application	Total number of patent applications filed by firms in an industry	PatSeer
ln(Patent stock)	Log transformed Patent stock	PatSeer
Zombie lending		
LowCap Bank	If a bank is undercapitalised, the variable takes the value one, 0 otherwise.	DBIE
Zshare	Sales-weighted share of zombie firm in an industry	CMIE
Industry controls		
ln(ROA)	A ratio of total returns to total fixed assets	CMIE
ln(Tangibility)	A ratio of fixed assets to total assets	CMIE
TFP	The total factor productivity of firms in an industry is calculated using the L-P method.	CMIE
Size	An average size of firms in an industry based on sales	CMIE
Age	The average age of firms in an industry	CMIE
HHI	Herfindahl–Hirschman Index is the "sum of squares of the individual firm's market shares in an industry.	CMIE

Institutional framework

- Undercapitalised (weakly capitalised bank)- If the total capital ratio of the bank at the end of March 2008 i.e., before the GFCs period, is in the lowest quartile of the distribution (Acharya et al., 2022; Chari et al., 2022).

- Our analysis includes 27 public sector banks and 22 private sector banks. Foreign banks are excluded from the study because their capital requirements differ and are not sensitive to local forbearance measures or provisioning requirements. Foreign banks get external funding from their parent company or banks. Moreover, their share in the total loan market is approximately 7 per cent. Hence, it will have an insignificant impact.

- When a firm borrows from more than one bank in the year, the bank names are recorded in Prowess in the order in which they appear in the firm's financial statements. In multiple banking relationships, we retain the first bank as it likely corresponds to the firm's lead bank (Chari et al., 2022).

- We construct an industry-level measure describing the extent to which sectors depend on weak banks.

- We aggregate the firm-level weak bank indicator to the industry level by averaging across all firms in the same NIC-four-digit industry and label the variable as zombie lending.

Empirical strategy

- We classify **under-capitalized banks if their total capital ratio is in the lowest quartile of the distribution** (Acharya et al., 2022; Chari et al., 2022) and call them weak banks. We then identify firms in a borrowing relationship with the under-capitalized banks.
- Weakly capitalized banks + recapitalization => zombie lending
  - Europe: Acharya et al. (2018); Carpinelli et. Al (2017); Japan: Caballero et. Al (2008); US: Gropp et. Al (2008)
  - India: Chari, Jain, and Kulkarni (2019).
  - Study forbearance introduced in 2008-2013: Provisioning for "restructured assets" same as standard assets.
  - Subsequently, removed in May 2013 (effective April 2015).
- We then construct an industry-level measure that describes the extent to which sectors depend on weak banks as of 2009.
- We **aggregate the firm-level weak bank indicator to the industry level by averaging across all firms in the same NIC-four-digit industry and label the variable as zombie lending** (Caballero et al., 2008).
- We use two proxies to measure the industry's innovation: (1) **R&D stock** and (2) **Patent stock** (Lac, 1995; Bloom et al., 2016).

Innovation measures

- Innovation measures: (1) R&D stock, which is input, and (2) Patent stock, which is output-based (Ambrammal & Sharma, 2016; (Lac, 1995; Bloom et al., 2016).

R&D stock: we calculate the average growth of R&D at 5 per cent per year in real terms (Ambrammal et al., 2014; Basant & Fikkert, 1996; Hall, 1992). Furthermore, we assumed the depreciation rate to be 15 per cent and calculated R&D stock using the perpetual inventory method.

Patent stock:

Due of the time lag between innovation and the time of application, we compute the growth of an industry's patent stock as a measure of innovation activity using a perpetual inventory method with a depreciation rate ($\boldsymbol{\delta}$) of 15 per cent in the first year with available PatSeer information on patent filing (Dhanora et al. (2020) and Lach (1995)).

$$PatentStock_{j,t} = Patents_{j,t} + (1 - \delta).\ PatentStock_{j,t-1}$$

Where $Patents_{j,t}$ is the total number of patent applications. The patent stock growth rate is the log change in patent stock between periods. δ is the depreciation rate, i.e., 15 per cent. The analysis is done taking the lead of the patent stock, as it takes a time lag for the investment made in R&D to convert into patentable output.

Neck-to-neck Vs Laggard Industries

- we split the industry into neck-to-neck and laggard industries based on industry differences in total factor productivity (TFP) -Aghion et al. (2005).

we compute the technological gap on the firm level by identifying the frontier firm with the largest TFP within each industry, calculating the difference to all other firms in the same industry, and scaling it with the frontier's TFP.

$$\text{Technological Gap}_{i,2009} = \frac{\text{Max TFP}_j - \text{TFP}_i}{Max\ TFP_j}$$

we compute the average technological gap_i for each industry, where a low/high value corresponds to the small/large technological gap, indicating neck-to-neck and laggard industries, respectively. We further split the industries based on the median value of the industry-level technological gap and ran separate regression for the two groups. We have made our estimates of TFP using the Levinsohn-Petrin method (Levinsohn & Petrin, 2003) based on the Gross output method, which further attempts to overcome the simultaneity bias in production function estimation.

Empirical framework

we utilize a panel fixed effect model, for which we build the following equation:

- **To capture whether zombie spillover impairs corporate innovation, the following models are built:**

$$Innovation_{jt} = \alpha + \beta 1\ Zshare_{jt-1} + \beta 2\ X_{jt-1} + \lambda_{\ j} + \delta_t + \epsilon_{jt} \quad \text{(I)}$$

- **To capture whether zombie lending impairs corporate innovation, the following models are built:**

$$Innovation_{jt} = \alpha + \beta 1\ Zombie\ lending_{jt-1} + \beta 2\ X_{jt-1} + \lambda_{\ j} + \delta_t + \epsilon_{jt} \quad \text{(II)}$$

$$Innovation_{jt} = \alpha + \beta 1\ Zombie\ lending_{jt-1} + \beta 2\ Forbearance_t + \beta 3\ LowCapbank_{t-1} + \beta 4\ Forbearance_t * Zombie\ lending_{jt-1} + \beta 5\ X_{jt-1} + \lambda_j + \delta_t + \epsilon_{jt} \quad \text{(III)}$$

Where $_i$ represents the firm, $_j$ represents the industry, and $_t$ is the year. The dependent variable $Innovation_{ij}$ refers to innovation measures: R&D and patent stocks at industry $_j$ at time $_t$. $Zshare_{ij}$ refers to the sales-weighted share of zombies out of total firms in industry $_j$ at a time $_t$. $Zombie\ lending_{jt}$ variable is created by the interaction of low-capitalized banks in industry $_j$ at time $_t$ with the zombie share in an industry; it is created as a proxy to capture zombie lending in an industry. χ is a vector of the control variables that may influence firm innovation (Qiao et al., 2022). At the firm level, we control for Firm age (natural log of one plus the number of years that the firm has been in operation) and firm size (the natural log of total sales of the firms). At the industry level, we control the HHI (Herfindahl-Hirschman Index at the industry level) for each industry. In addition to the control variables discussed above, we also control for industry λ_j and year δ_t fixed effects.

Identification of zombie firms

As per our definition, a firm is categorized as a zombie if:

(a) **its ICR<1,**

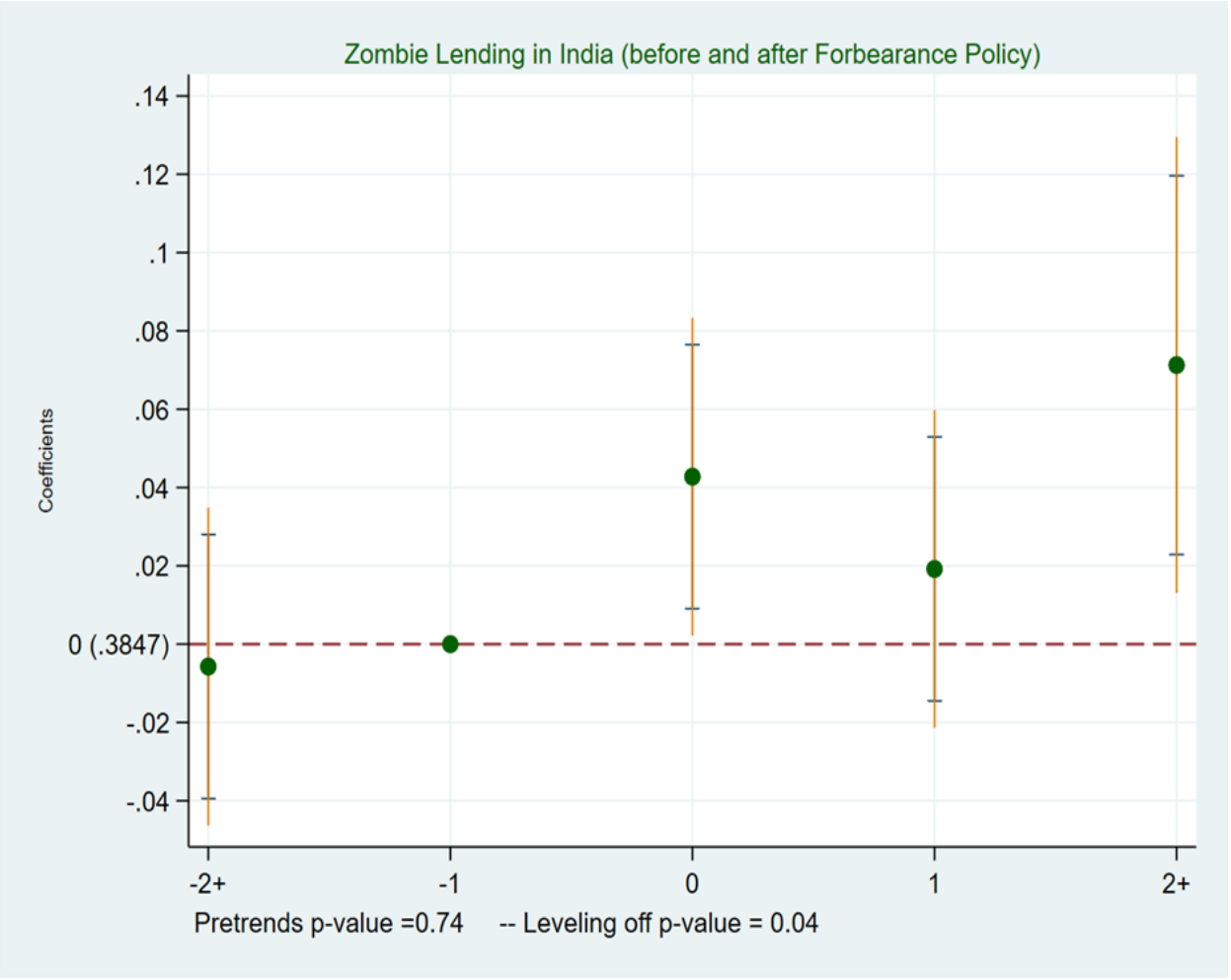
(b) **the leverage of the firm is greater than the median leverage (at four-digit NIC code), and**

(c) **the growth of debt is positive** (Pattanaik et al., 2022).

- Definition shows the ability of the firm to fulfil its external obligations.
- The rationale of this definition is that it identifies those debt-ridden firms that cannot service their debt and are likely on the edge of exit unless their creditor(s) sustain their continuation.

Findings

- Forbearance: Compared to good banks, lending by stressed banks to low-solvency firms increased- zombie lending.
- Zombie firms hinder undercapitalized banks through financial constraints and credit misallocation.
- This intensity further increases during the financial crisis (Schmidt et al., 2020)- showing the effects of the ultraloose monetary policy due to the forbearance scheme.



Note: t=0 corresponds to the year 2008 when the forbearance policy was introduced.

Findings: zombie spillover

- Significant decline in R&D stock in industries with a high share of zombie firms.
- A **1 per cent increase in the zombie share**, on average, results in a **1.354 per cent decrease in the industry's R&D stock**.
- We find a delayed effect of zombie spillover on patent stock.
- We see the impact after three years in patent stock.
- With a **1 per cent increase in zombie share**, the **patent stock** in the year in t+3 years **decreases by 1.024 per cent**.

Table 2: Regression result of the impact of zombie spillover on innovation activities

	ln (R&D stock$_{j,t}$)				ln (Patent stock$_{j,t+3}$)			
VARIABLES	Spec I	Spec II	Spec III	Spec IV	Spec I	Spec II	Spec III	Spec IV
Zshare	-1.354*	-1.354*	-1.759**	-1.759**	-1.024*	-1.024*	-0.684	-0.684
	(0.73)	(0.73)	(0.813)	(0.813)	(0.53)	(0.53)	(0.6)	(0.6)
Constant	0.352	0.352	0.655	0.655	4.466***	4.466***	1.433	1.433
	(0.986)	(0.986)	(1.38)	(1.38)	(0.897)	(0.897)	(1.038)	(1.038)
Industry Controls	YES	YES	YES	YES	YES	YES	YES	YES
Observations	2,039	2,039	2,039	2,039	2,039	2,039	2,039	2,039
R-squared	0.274	0.274	0.392	0.392	0.027	0.027	0.249	0.249
Number of industries	111	111	111	111	123	123	123	123
Industry FE	NO	YES	NO	YES	NO	YES	NO	YES
Year FE	NO	NO	YES	YES	NO	NO	YES	YES

Notes: Table shows results for regression relating proxies for zombie share in industry to innovation activities in the industry. The dependent variables are measured as the natural logarithm R&D stock and Patent stock value. The primary variable of interest is Zshare, the share of zombie firms (sales-weighted) out of the total firms in an industry. Industry controls include- sales, ROA, Tangibility, age, and HHI, as well as interaction between the controls and Zshare. All variables are logged and transformed. While interpretating the results, note that all independent variables are lagged by one period. Industry and year-fixed effects are included when indicated. *** p<0.01, ** p<0.05, * p<0.1 indicates statistical significance at 1 per cent, 5 per cent and 10 per cent respectively. Robust standard errors are in parentheses.

Findings: zombie lending

❑Credit misallocation created by zombie firms and undercapitalised banks delays innovation activities.

❑ **1 per cent increase in zombie lending**, the **R&D stock of an industry declines by 1.21 per ce**nt. Meanwhile, **patent stock was reduced by 0.39 per cent.**

❑ 1 per cent increase in zombie lending during the forbearance period reduces R&D stock by 3.84 per cent- suggesting that the adverse impact of zombie lending intensified during the crisis-induced forbearance period (Acharya et al., 2021).

Table 3: Regression results of the impact of zombie lending on innovation activities of an industry.

	ln(R&D stock)			ln(Patent stock)		
VARIABLES	Spec. I	Spec. II	Spec. III	Spec. I	Spec. II	Spec. III
Zombie lending	-1.210**	-1.210**	-0.539	-0.432**	-0.394*	-0.493**
	(0.574)	(0.574)	(0.682)	(0.212)	(0.207)	(0.232)
Forbearance		0.983***	0.973***		0.0884**	0.0808**
		(0.157)	(0.157)		(0.0411)	(0.0390)
Forbearance # Zombie lending			-3.840*			1.629
			(2.211)			(2.196)
Constant	0.561	0.561	0.700	3.035***	3.074***	3.077***
	(1.298)	(1.298)	(1.307)	(0.727)	(0.721)	(0.721)
Industry controls	YES	YES	YES	YES	YES	YES
Observations	2,039	2,039	2,039	3,139	3,139	3,139
R-squared	0.390	0.390	0.394	0.151	0.154	0.155
Number of Industries	111	111	111	182	182	182
Industry FE	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES

Notes: Table shows results for regression relating proxies for zombie lending to innovation activities in the industry. Lowcapj is the fraction of firms in industry j that have a lending relationship with a weakly capitalised bank as of 2009. The dependent variables are measured as the natural logarithm R&D stock and Patent stock value. The main variable of interest is the Zombie lending. industry, and year-fixed effects are included when indicated. Industry controls are the same as in previous Table. *** p<0.01, ** p<0.05, * p<0.1 indicates statistical significance at 1 per cent, 5 per cent and 10 per cent respectively. Robust standard errors are in parentheses.

Findings: neck-to-neck Vs laggard industries

- Zombie spillover affects more in the laggard industries compared to neck-to-neck industries.
- For every **1 per cent rise in zombie share** in an industry, the **R&D stock of laggard industries gets impaired by approximately 1.7 per cen**t.
- A **1 per cent rise in zombie share in a laggard industry**, the **patent stock declines approximately by 0.08 per cent**.
- **The greater impact of increasing zombie shares on laggard industries** can be due to-
  - Zombie firms reduce competition among firms in laggard industries (Mosel, 2011), allowing inefficient firms to survive longer.
  - Reduces the incentives for other firms to innovate or enhance productivity.
  - Neck-to-neck industries are more dynamic and resilient, mitigating the negative effects of zombie spillover through stronger competition and high innovation incentives.
  - Zombie firms are less likely to exit industries with a high share of undercapitalised banks, they result in negative spillover effects on healthy and new-entrant firms.

result

Findings

- **1 per cent increase in zombie lending in an industry, the R&D stock reduces by approximately 1.074 per cent** in regular times, and this impact further increases to 5.127 per cent during the times of forbearance policy.
- **1 per cent rise in zombie lending in an industry, patent stock reduces by approximately 0.559 per cent.**
- Laggard industries' patent stock is negatively impacted by zombie lending; in contrast, zombie lending has an insignificant impact on patent outcomes within neck-to-neck industries.
- Many frontier firms in India also utilise internal funding for innovation (Sasidharan et al., 2014). By diversifying funding sources, neck-to-neck industries enhance their resilience and reduce vulnerability to zombie lending. Moreover, neck-to-neck industries engage in innovative activities owing to high competition, which may mitigate the negative impact of zombie lending.
- In contrast, laggard industries suffer from resource misallocation, heavily depend on external financing, and are less innovative.

result

Conclusion

- Approximately **9 per cent of manufacturing firms are zombies**.
- A bank-borrower relationship exists between weakly capitalised banks and zombie firms- zombie lending.
- Decline in R&D and patent stock in industries with a high share of zombie firms and weak bank presence.
- The combination of ultra-loose monetary policy and forbearance during the economic shock raises the chances of zombie lending (Jafarov & Minnella, 2023).
- The effects are more apparent in laggard industries facing technological progress and productivity enhancement challenges.
- Our empirical results are in line with the existing literature (Liang, 2017; Yu et al., 2023), i.e., zombie lending impacts innovation in two ways:
  i. by direct financing repeatedly by the weakly capitalised banks to the unviable firms (Misra, 2021), and
  ii. another possible explanation can be that in industries with a high number of undercapitalised banks and high zombie shares, banks get more aware and extend the credit carefully or demand collaterals from firms, which can include healthy firms as well (Bittner et al., 2023).

Key takeaway

- **Phased and timely withdrawal of the forbearance policy**. This is critical because regulatory forbearance during a crisis increases evergreen lending, and its extension will worsen the zombie lending issue. **Tighten credit standards, increase supervisory role during times of crisis,** and make the best out of forbearance policy.
- **Loan monitoring and lending transparency** can help reduce zombie lending activities. Additionally, **bankruptcy reforms and credit programs** that encourage industry-specific innovation ecosystems are needed to prevent zombie lending and optimise resource allocation.
- **Laggard industries require specific governmental responses**. The research found that zombie lending impacts industries, impeding their capacity to catch up with the neck-to-neck industries. Zombie firms may hinder innovation
- **Credit schemes** must also be investigated to create an industry-specific innovation ecosystem.

Thank you!

Appendix

	Laggard industries				Neck-to-neck industries			
Dependent variable: ln(R&D stock)	Spec I	Spec II	Spec III	Spec IV	Spec I	Spec II	Spec III	Spec IV
Zshare	-1.576*	-1.576*	-1.706*	-1.706*	-2.403	-2.403	-0.854	-0.854
	(0.889)	(0.889)	(0.964)	(0.964)	(5.302)	(5.302)	(5.456)	(5.456)
Constant	1.625	1.625	1.102	1.102	-0.746	-0.746	0.185	0.185
	(1.443)	(1.443)	(1.756)	(1.756)	(1.15)	(1.15)	(1.706)	(1.706)
Industry controls	YES	YES	YES	YES	YES	YES	YES	YES
Observations	928	928	928	928	1,111	1,111	1,111	1,111
R-squared	0.192	0.192	0.374	0.374	0.328	0.328	0.407	0.407
Number of industries	106	106	106	106	109	109	109	109
Industry FE	NO	YES	NO	YES	NO	YES	NO	YES
Year FE	NO	NO	YES	YES	NO	NO	YES	YES
F-Stat	14.02	14.02	11.67	11.67	13.06	13.06	9.134	9.134
Prob > F	0	0	0	0	0	0	0	0

back

	Laggard industries				Neck-to-neck industries			
VARIABLES Dependent variable: ln(Patent Stock)	Spec I	Spec II	Spec III	Spec IV	Spec I	Spec II	Spec III	Spec IV
Zshare	-0.0844*	-0.0844*	-0.0177	-0.0177	-0.529	-0.529	0.602	0.602
	(0.0482)	(0.0482)	(0.0606)	(0.0606)	(1.633)	(1.633)	(2.022)	(2.022)
Constant	1.018***	1.018***	0.234	0.234	4.015***	4.015***	-0.858	-0.858
	(0.212)	(0.212)	(0.252)	(0.252)	(1.221)	(1.221)	(1.061)	(1.061)
Industry controls	YES	YES	YES	YES	YES	YES	YES	YES
Observations	1,954	1,954	1,954	1,954	1,202	1,202	1,202	1,202
R-squared	0.005	0.005	0.085	0.085	0.018	0.018	0.230	0.230
Number of industries	178	178	178	178	115	115	115	115
Industry FE	NO	YES	NO	YES	NO	YES	NO	YES
Year FE	NO	NO	YES	YES	NO	NO	YES	YES
F-Stat	1.638	1.638	1.815	1.815	2.119	2.119	3.723	3.723
Prob > F	0.127	0.127	0.0131	0.0131	0.0470	0.0470	6.15e-07	6.15e-07

VARIABLES	Laggard industry			Neck-to-neck industry		
Dependent variable: ln(R&D stock)	Spec. I	Spec. II	Spec III	Spec. I	Spec. II	Spec. III
Zombie lending	-1.074**	-1.074**	-0.364	-4.200	-4.200	-5.571
	(0.480)	(0.480)	(0.586)	(4.924)	(4.924)	(5.162)
Forbearance		1.770***	1.897***		1.135***	1.1978***
		(0.199)	(0.249)		(0.300)	(0.326)
Forbearance # Zombie lending			-5.128*			-4.103
			(2.833)			(3.261)
Constant	1.022	1.022	0.456	0.169	0.169	1.340
	(1.742)	(1.742)	(1.002)	(1.620)	(1.620)	(1.453)
Industry controls	YES	YES	YES	YES	YES	YES
Observations	928	928	928	1,111	1,111	1,111
R-squared	0.374	0.374	0.386	0.408	0.408	0.498
Number of Industries	106	106	106	109	109	109
Industry FE	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES

back

VARIABLES	Laggard industry			Neck-to-neck industry		
Dependent variable: ln(Patent stock)	Spec. I	Spec. II	Spec. III	Spec. I	Spec. II	Spec. III
Zombie lending	-0.551***	-0.559***	2.065	-0.596***	2.089	2.915
	(0.186)	(0.192)	(2.345)	(0.188)	(2.335)	(2.928)
Forbearance	0.0970***	0.0963***			0.0145	-0.00754
	(0.0333)	(0.0337)			(0.0720)	(0.0700)
Forbearance # Zombie lending		0.190				3.971
		(0.497)				(4.476)
Constant	2.612***	2.610***	1.618	2.603***	1.638	1.769
	(0.564)	(0.565)	(1.693)	(0.573)	(1.699)	(1.705)
Industry controls	YES	YES	YES	YES	YES	YES
Observations	1,937	1,937	1,202	1,937	1,202	1,202
R-squared	0.142	0.142	0.228	0.137	0.228	0.230
Number of Industries	178	178	115	178	115	115
Industry FE	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES

Robustness test: zombie share

VARIABLES	ln(R&D stock)			ln(Patent stock)		
	Spec. I	Spec. II	Spec. III	Spec. I	Spec. II	Spec. III
Zshare	-2.926***	-2.926***	-1.349***	5.444	5.444	44.04
	(0.812)	(0.812)	(0.349)	(4.720)	(4.772)	(4.723)
Forbearance		1.037***	0.287		0.353	0.365
		(0.230)	(0.354)		(0.519)	(0.521)
Forbearance#Zshare2			-12.05			-21.85**
			(2.345)			(4.823)
Constant	2.495***	2.495***	-0.228	-1.465	-1.465	-1.465
	(0.669)	(0.669)	(1.058)	(1.719)	(1.719)	(1.715)
Observations	1,587	1,587	1,492	651	651	651
R-squared	0.156	0.156	0.142	0.169	0.169	0.171
Number of Industries	104	104	101	81	81	81
Industry FE	YES	YES	YES	YES	YES	YES
Year	YES	YES	YES	YES	YES	YES

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Robustness test: zombie lending

VARIABLES	ln(R&D stock)			ln(Patent stock)		
Zombie lending	-7.756**	-7.756**	-7.743**	-17.34	-17.34	-18.83
	(2.992)	(2.992)	(3.032)	(9.832)	(9.832)	(9.830)
Forbearance		0.262	0.263		0.337	0.336
		(0.333)	(0.337)		(0.64)	(0.64)
Forbearance # Zombie lending			-1.257			-1.412
			(2.42)			(9.203)
Constant	-0.162	-0.162	-0.163	-1.472	-1.472	-1.476
	(1.060)	(1.060)	(1.060)	(1.725)	(1.725)	(1.728)
Observations	1,492	1,492	1,492	651	651	651
R-squared	0.145	0.145	0.145	0.171	0.171	0.171
Number of Industries	101	101	101	81	81	81
Industry FE	YES	YES	YES	YES	YES	YES
Year	YES	YES	YES	YES	YES	YES

Robust standard errors are in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Endogeneity test

Variables	The first stage Zombie lending	The second stage ln(R&D Stock)
ln(NPA)	-6.219***	-
	0.884	
Zombie lending	-	-0.019**
		0.006
Controls	YES	YES
Constant	12***	12.5***
	1.015	1.001
Year (FE)	YES	YES
Industry (FE)	YES	YES
F-value	246.09	
R2	0.807	0.509
Observations	1609	1609

Notes: This table shows IV regression results. ***, **, * represent significance at the 1 per cent, 5 per cent, and 10 per cent, respectively. Standard errors are given in parentheses.

Descriptive statistics

Variables	Obs.	Mean	Std. dev	Min	Max
Dependent Variables					
Innovation activities					
ln(R&D stock)	2,048	5.222	2.523	-2.416	12.259
ln(Patent stock)	3,377	0.745	1.383	0	7.114
Independent Variables					
Zshare	3,156	0.026	0.136	0	1
Zombie lending	3,055	.010522	.0474262	0	1
Control Variables					
ln(ROA)	3,340	2.763	2.010	-7.109	8.783
ln(Tangibility)	3,347	1.555	1.751	-5.718	9.062
TFP	3,377	6.867	20.248	-59.279	256.108
Size	3,307	9.557	3.001	-2.302	16.827
Age	3,377	22.96	9.957	1	101
HHI	3,377	3624.212	3219.612	0	10000

back

Back

- *Reason for Manufacturing Sector Selection*

Whenever there is a crisis in an economy, we often witness a significant decrease in demand in the manufacturing industry (Baldwin & Tomiura, 2020). Therefore, the focus of the forbearance policy is on the manufacturing sector. This situation can enable zombie lending within the manufacturing sector. Literature also focuses on the correlation between reduced operating efficiency and innovation and the concentration of zombie loans, particularly compared to other industries (Shen & Chen, 2017). Moreover, the preliminary analysis found that most zombie firms are in the manufacturing sector. Hence, considering the abovementioned discussion, we empirically investigate the impact of zombie lending on the innovation capacity of the manufacturing sector.

- *Reason for the time-period Selection*

The setting of this study is from 2000 to 2019, including the forbearance policy introduced in August 2008. The sample period ends in March 2019 to avoid potential confounding effects from the bank mergers and privatisations in India that year (Rai & Pandey, 2022). Additionally, this timeframe was chosen to prevent the results from being influenced by the economic slowdown caused by the COVID-19 pandemic.