Government Subsidies, Credit Allocation and the Investment Cycle

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Abstract

We present a model of banking in the presence of adverse selection and public guarantees. Instead of equilibrium credit rationing, state-ownership or guarantees over-ride banks' prudential incentives to screen borrowers, promote excessive lending and enhance incentives to evergreen poorly performing loans. Credit supply is directed to low-productivity, legacy projects at the expense of higher-productivity firms. Growing financial stability risk arising from a rising stock of non-performing loans is accompanied by falling productivity and investment growth. Applied to India, our results provide a complementary perspective on the investment slowdown over the last decade.

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I. Introduction

A. Motivation and Summary

Downturns pose a challenge to banks' solvency through multiple channels including, importantly, through pressure on loan quality. Banks that are undercapitalized face strong incentives to gamble for resurrection and engage in forbearance lending, including though loan restructuring and evergreening, to postpone taking large hits to earnings and capital. While for individual, non-systemic banks, effective banking supervision and resolution may nip such incentives in the bud, problems at systemic institutions or at the systemic level may sometimes require a more complex approach entailing assiduous supervisor-led processes.

This multi-player dialectic can be significantly further complicated when there is state-ownership of a material part of the banking system or when there are exemptions granted and special responsibilities assigned to state-owned banks. When such banks dominate the financial landscape, which is the case in several countries, these complexities will also be present at the level of the aggregate banking system. State-owned banks are a different kettle of fish. When the banking sector experiences a bad patch, the difference with respect to such banks is the prevalence of what may be called *intrinsic moral hazard*.[2] In the banking system, depositors face the moral hazard of bankers lending their money to doubtful projects that could make the bank illiquid, or at worst, insolvent. Bankers face the moral hazard of advances to firms being misappropriated because of the fungibility of credit, which would result in a rise in the banks' non-performing assets (NPAs). The difference in the case of state-owned banks is that it is not they that shoulder the costs of moral hazard, but an outside party—the government—which underwrites it. State-owned banks are also front, square and center of government programs promoting financial inclusion, priority sector lending and other special vehicles for targeted financial services provision. Moreover, in cyclical downturns, there is the expectation and pressure on state-owned banks to maintain or expand credit lines to borrowers who run into repayment problems. The end-result is intrinsic moral hazard of an insurance kind which manifests itself through-the-cycle.

In this paper, we present a framework to understand the implications of such intrinsic moral hazard for institutional risk management and the aggregate credit and investment cycles, particularly when public-sector banks (PSBs) own a significant share of the banking system.

We first present a static model that differentiates between PSBs and private banks on the basis of recovery rates that they can attain on NPAs reflecting the fact that, ceterius paribus, government ownership or guarantees would ensure that PSBs enjoy lower loss-given-default. This results in a departure from the traditional asymmetric information credit market equilibrium.[3] In that model, banks charge rates at which they attract a riskier pool of borrowers, which they respond to by rationing credit to limit losses emanating from adverse selection. In our model, government guarantees that cover PSBs' credit losses result in a tiering of the market, with excess lending by

[2] See D'Souza (2001) for a discussion.

[3] Stiglitz and Weiss (1981).

PSBs at lower rates to riskier borrowers relative to a competitive equilibrium. Private banks lend exclusively to low risk borrowers, such as high-productivity projects, at higher rates of interest. These high productivity firms constitute a residual share of the market; i.e., they may be rationed depending on the lending capacity of private banks and residual lending capacity of PSBs.

In order to link the equilibrium of the loans market to investment, productivity and output, we embed this static model into a dynamic economy. Banks can liquidate previously extended loans that have failed to perform and focus lending on newer projects with higher productivity, or restructure/evergreen the old loan and avoid taking an immediate hit on provisions, profits and capital. In order to focus solely on incentives generated by government subsidies enjoyed exclusively by PSBs, we focus on cases where privately-owned banks prefer to promptly liquidate NPAs given recovery rates and productivity differentials between new and old projects. We show that even in the absence of government compulsion or moral suasion, PSBs will be incentivized to prefer NPA evergreening at the cost of lower expected returns due to the government guarantee.

In the aggregate, this generates a dispersion between the loan portfolio composition of PSBs and private banks which increases over time. The share of non-performing, low productivity borrowers ("zombie firms") in PSBs' portfolios increases, and private banks finance an ever-growing share of the new, higher productivity investments. On the real side, investment and average productivity falls steadily over time as the share of zombie firms in bank credit rises. Eventually, if and as banks' credit limits are hit, high productivity firms begin to be rationed, and the fall in productivity, investment and output becomes faster and larger in magnitude.

Zombie lending leads to lower productivity, investment, and growth for two important reasons. First, because of the misallocation and rationing of credit. Firms face financial constraints and need access to credit markets to close their financing gaps while capital requirements constrain feasible levels and growth of credit supply by banks. More credit allocated to zombie firms results in a lower volume of loanable funds available to new, higher productivity ventures. This is important for real sector dynamics because zombie firms cannot allocate the same share of borrowed funds to productive investments since, over time, they build higher financial leverage (through evergreening) and need to divert an increasing share of borrowed funds to pay off interest-in-arrears, implying that they have less left over for investment and production. Consequently, increasing zombie lending would result in lower average productivity and investment. Second, the continuing presence of zombie firms in product and labor markets implies that there is less exit than desirable which increases congestion. In product markets, this results in lower output prices and average firm sales and in the labor market, in higher wages. This puts pressure on the so-called *creation margin* lowering the entry of new, higher productivity firms and projects.[4]

[4] Caballero and Hammour (1994, 1996).

B. Related Literature

The paper joins a large body of analytical work on zombie lending by weak banks and its investment and productivity implications.

The incentive for banks to underreport NPAs by rolling over bad loans lies in the fact that it saves them the trouble of increasing their loan loss reserves and having to deplete their already scarce bank capital. Rolling-over the NPA gives an opportunity to the borrower that is in the red to make interest payments and, in the process, allow the bank to avoid reporting an increase in NPAs. Banks, therefore, avoid a short-term outcome of lower net operating income which would have forced them to raise provisioning levels, increasing the likelihood of violating capital requirements, thereby inviting greater supervisory scrutiny. Peek and Rosengren (2005) found in their seminal study of the 1990s Japanese recession that firms were more likely to receive additional bank credit if they were in poor financial condition and that this evergreening was more prevalent among banks that were themselves in danger of violating regulatory constraints.[5]

Blattner et. al. (2019) assess the implications of a 2011 policy intervention by the European Banking Authority (EBA) that had the unintended effect of under-capitalizing a set of Portuguese banks. They find that exposed banks responded to higher capital requirements by cutting back lending and reallocating credit to distressed borrowers in their portfolio whose NPAs they had been underreporting. A recent paper by Acharya et. al. (forthcoming) finds that bank incentives for evergreening and NPA underreporting are likely to be strong in response to policy irrespective of its effect on capitalization during periods of market stress. They study the impact of the ECB's sovereign bond purchases via the Outright Monetary Transactions (OMT) program during the recent Euro Area financial crisis. Since the OMT increased the market value of sovereign bonds, banks from stressed Euro Area countries realized the highest gains from the policy intervention. These banks increased loan supply more than banks with lower gains from OMT. But, notably this increased credit outlay was exclusively directed to existing borrowers whose financial condition was weak and at interest rates below those being paid by the most credit worthy borrowers in Europe at that time.

Banks' incentives for bad loan management are similar to those generated by fair value accounting that forces them to mark down the value of trading book portfolios in the face of market volatility and crashes. Milbradt (2012) shows that banks find it optimal to respond by suspending trading in such assets in order to avoid taking mark-to-market hits. Begley et. al. (2017) report that banks significantly underreport the risk in their trading books when they are more leveraged and that this is especially frequent for banks with large trading positions during periods of elevated systemic risk.

Our contribution is to show how, and the degree to which, the provision of government subsidies to PSBs increases these banks' incentive to underreport NPAs by continuing to evergreen bad loans. We show that even in situations where competitive equilibria entail banks preferring

[5] Andrews and Petroukalis (2017) find similar evidence for the Euro Area between 2001-14.

prompt NPA liquidation, such government sponsored incentives are strong enough to reverse preferences and promote evergreening.[6]

The real effects of zombie lending have been extensively documented also. In their seminal contribution focused on Japan, Caballero et. al. (2008) showed that an increased prevalence of zombie firms in an industry depressed investment and employment growth of higher productivity firms. This exerted a detrimental impact on aggregate productivity growth because zombie lending also widened the productivity gap between zombie firms and other firms. In their study of the efficiency of resource allocation in Japan during the 1990s, Kwon et. al. (2015) finds that resource reallocation in favour of zombie firms contributed negatively to aggregate productivity growth mainly due to inefficient labour reallocation to such firms, of which more than a third could be attributed to zombie lending. Adelet McGowan et. al. (2017) finds that maintaining pre-crisis levels of zombie lending in stressed Eurozone countries would have resulted in a gain of 0.7 to 1 percent in aggregate multifactor productivity. Tracey (2019) assesses the real effects of forbearance lending in the Euro Area following the commencement of the sovereign debt crisis in 2010 and finds that a cessation of such practices would have resulted in an output increase of 4.65 percent driven by aggregate investment and productivity gains of 8.44 percent and 0.76 percent respectively. These gains reflect a larger proportion of high-quality firms in the absence of forbearance lending that prevented low-quality firms from defaulting, thereby introducing a drag on investment, productivity and output.

C. The Indian Banking Story

We draw motivation for our work from trends in the banking sector and their association with capital expenditure, investment and growth in India over the last two decades. PSBs dominate India's banking system[7] and there is historical evidence that business model and portfolio differences appear to have an association with ownership-driven priorities and objectives. They are more likely to lend to the government,[8] their credit activities have been noted as being associated with the electoral cycle, and elections appearing to impinge adversely on loan repayments.[9]

Most importantly, India's banking sector performance, investment and growth, which took off spectacularly between 2003/04 and 2007/08 and deteriorated thereafter, matches our theoretical predictions and narrative closely. Bank asset quality and credit growth deteriorated steadily after

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[6] Absence of government intervention can be an equally powerful force in strengthening incentives for NPA underreporting and evergreening. Acharya et. al. (2018) argues that Eurozone governments with weaker public finances were more reluctant to recapitalize distressed banks during the global financial crisis (2007-09). In turn, insufficient recapitalization is linked by these authors to increased gambling-for-resurrection type behavior by the banks including through evergreening of loans to zombie borrowers.

[7] PSBs held 68 percent of bank deposits, with private banks having a share of 21 per cent and foreign banks a share of about 4 per cent of deposit at end-2018. Cooperative banks accounted for the remaining 7 per cent of bank deposits. See RBI (2018).

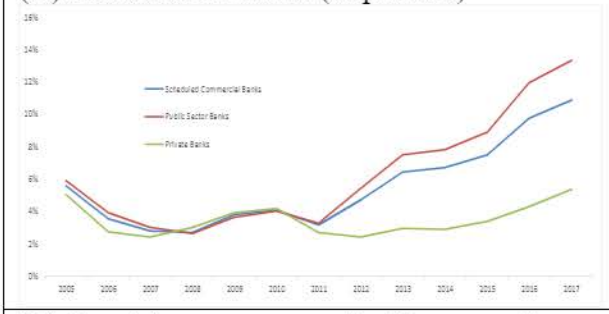
[8] Berger et. al. (2008).

[9] Cole (2009) found agricultural credit increasing by 5 to 10 percentage points in an election year but without having significant impact on agricultural output.

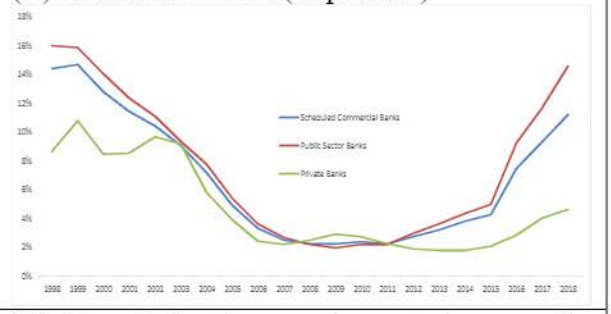
2008, much more so for PSBs (Figure 1, panels A and B). We also observe notable differences between PSBs and private banks in terms of their credit risk management between 2008-09 and the Reserve Bank of India's (RBI) asset quality review in March 2015. PSBs appear to have engaged in significantly greater bad loan restructuring than private banks. This is reflected in the much larger differential between stressed advances and NPAs for PSBs relative to private banks over this period, with the convergence between the two ratios for PSBs occurring only as late as 2015-18 after the RBI conducted an asset quality review and implemented follow-up measures. Private banks undertook defensive measures with much greater alacrity, as evidenced by their faster and greater increase in provisioning coverage of NPAs following the turn of the credit cycle (Figure 1, panel C).

Figure 1. Performance of Indian Banks, 2008—Present

(A) Stressed Advances (in percent)

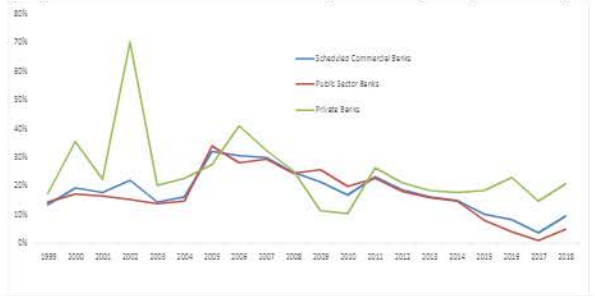


(B) Gross NPA ratio (in percent)



(C) Provision coverage ratio (in percent)

(D) Growth in advances (annual, in percent)



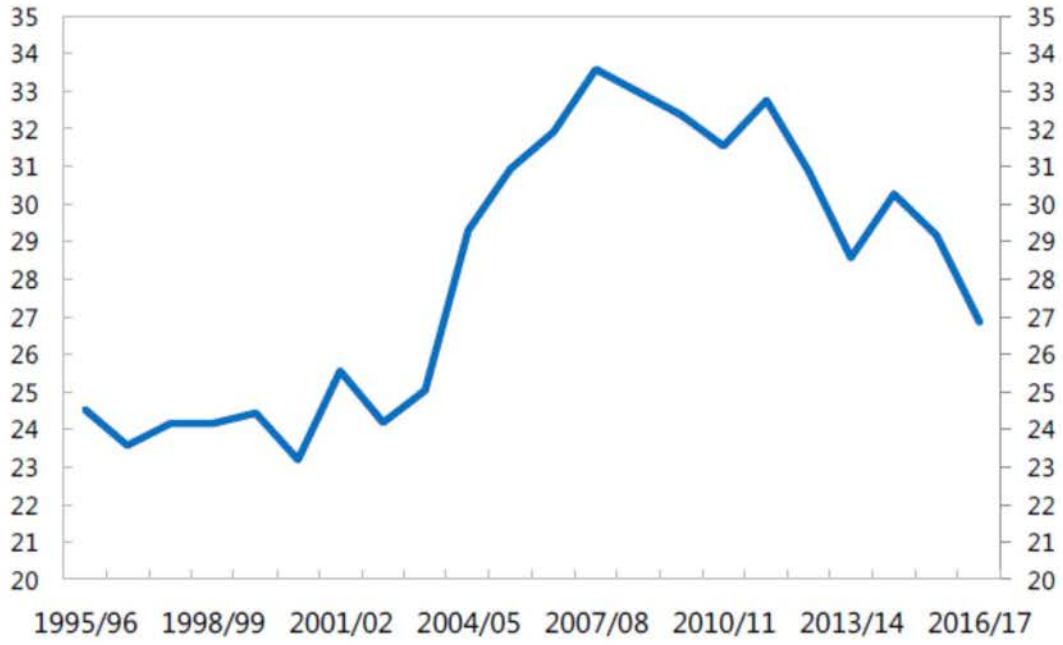
Sources: RBI and authors' calculations.

Owing to these vastly different approaches to deal with asset quality challenges, private banks were left with substantially larger room to maintain credit flows to the economy. So, while loan growth of PSBs fell continuously from 2008 onward, bottoming out at close to zero in 2017, it remained above 15 percent on an annualized basis for private banks between 2011-18 (Figure 1, panel D).[10]

[10] These differences echo Acharya's (2017) observation that weak banks "have capital only to survive, not to grow" and may focus on "high margins at the cost of high loan volumes".

On the real side, economic growth slowed substantially after weathering the impact of the global financial crisis very well— from a robust 9½ percent during 2009-11, real GDP growth halved within the next 3 years. This slowdown can be associated with the sputtering of the investment engine given the steep drop in the growth of gross fixed capital formation, from an annual average of 12 percent during 2001/02—2011/12 to 3½ percent during 2012/13—2016-17 (Figure 2).

Figure 2. India: Gross Fixed Capital Formation, 1995/96--Present



Source: Das and Tulin (2017).

The investment slowdown has several drivers, and it is not our contention that it owes solely to weak banks lending in excess to distressed corporates, thereby introducing a barrier to the entry of high productivity firms. Nonetheless, existing studies have consistently found that neither monetary policy nor structural supply factors nor heightened global and domestic uncertainties can fully explain the evolution of capital expenditure. Some studies have investigated the role of financial frictions focusing on the differential appetite for investment of firms depending on leverage, albeit do not directly confront cyclical incentives of banks that drive credit supply in India, particularly given the ownership and incentive structure of the domestic banking sector.

Anand and Tulin (2014) finds that monetary policy and a combination of other macro-financial variables fail to fully explain the investment slowdown. albeit adding a measure of policy uncertainty helps in partly closing the gap. Tokuoka (2012) finds a role for structural factors, specifically supply bottlenecks. Das and Tulin (2017) finds a clear association between financial frictions and investment rates, with highly leveraged firms and sectors experiencing the largest decreases in investment rates over the previous decade and firm-level investment being weakened by high financing burdens. Their results map coherently into the discussion in

Acharya (2017) and Acharya and Kulkarni (2012) and our formal analysis that links corporate leverage burdens to weak banks and incentives for zombie lending. In this context, we view our contribution as two-fold—providing a complementary narrative on the drivers behind the investment slump and to tease out the role played by government sponsored incentives for zombie lending by PSBs.

The rest of this paper is organized as follows. Section II describes and analyzes the static model of credit markets with adverse selection and government subsidies to PSBs. Section III embeds this model into a dynamic economy to analyze the differential implications for PSBs' and private banks' incentives to engage in zombie lending in such a setting and assesses the impact on productivity and output. Section IV concludes with a discussion on policy.

II. The Static Model

A. Borrowers

Consider a representative borrower framework where a firm (or a project owned by the firm) is described by (R, α), with R being the return in the good state which occurs with probability $\alpha \in (0,1)$. With probability $(1-\alpha)$, the firm / project produces nothing and loses a unit of collateral asset (whose price is normalized to 1).

The firm has access to the investment opportunity but does not have investible capital which it must borrow from a bank. If it borrows at a rate of interest r_L, then, assuming risk neutrality, it nets $\alpha(R - r_L) - (1-\alpha)$.[11] The firm will invest so long as this expected return exceeds its opportunity cost (given by rental return on the collateral asset, of $r \geq 0$); i.e., if and only if

$$\alpha(R+1) - (1+r) \geq \alpha r_L. \quad (1)$$

B. Banks

Banks raise funding via equity (E) and deposits (D) and lend out the funds so raised (L). The supply of deposits and equity is perfectly competitive, and it is assumed that the outside option for both equity and debt holders is the rental return (r).[12] A bank that lends to a project earns a return of r_L if the project succeeds (with probability α) and otherwise seizes collateral to recover $1 - l \in (0,1)$. Hence, the bank's profit from a balance-sheet size of L is:

$$(\alpha r_L - (1-\alpha)l - r)L \quad (2)$$

Public versus private banks. Besides privately-owned banks (PVBs) whose payoff function is described in (2), the economy also has public sector banks (PSBs) which are distinguished from PVBs by government subsidies that serve to enhance their recovery rates in the event of

[11] R, r_L, r are net returns and interest rates.

[12] Allowing for an equity risk premium complicates the algebra but does not affect the results.

borrower default. That is, up to some limit, $\bar{L}$, assumed to be sufficiently large, the government pays back the principal on the loan to the PSB. This translates into a recovery rate for PSBs on bad debt of the form:

$$(3) \qquad \begin{matrix} 1; up\ to\ L \leq \bar{L} \\ 1-l; beyond\ L > \bar{L} \end{matrix}$$

Using (3), we may rewrite (2) as:

$$(4a) \qquad \pi^{PV}(L) = (\alpha r_L - (1-\alpha)l - r)L \quad \text{(for PVBs)}$$

$$(4b) \qquad \pi^{PS}(L) = \begin{cases} (\alpha r_L - r)L; L \leq \bar{L} \\ (\alpha r_L - r)L - (1-\alpha)l(L-\bar{L}); L > \bar{L} \end{cases} \quad \text{(for PSBs)}$$

It follows that PVBs will lend if and only if

$$(5) \qquad r_L^{PV} \geq \frac{(1-\alpha)l+r}{\alpha}$$

PSBs are willing to supply credit up to loan amount $\bar{L}$ if and only if

$$(6) \qquad r_L^{PS} \geq \frac{r}{\alpha}.$$

C. Characterizing Equilibrium in the Loans Market

We begin with a key assumption; viz., $r < \frac{R}{2}$ which is necessary to obtain equilibria with positive credit allocation.

Then, combining (1) and (6), a necessary and sufficient condition for there to be bank financed investment in projects is:

$$(7) \qquad \frac{\alpha(R+1)-(1+r)}{\alpha} \geq \frac{r}{\alpha} \Leftrightarrow \alpha \geq \alpha^{PS} := \frac{2r+1}{R+1} \in (0,1),$$

where the bounds on α^{PS} derive from the assumption that $r < \frac{R}{2}$. Up to a scale of aggregate investment of $\bar{L}$, this characterizes the equilibrium with lending; i.e., credit demand up to this level can be completely satisfied by PSBs allocating loans at a rate $r_L^{PS} \in \left(\frac{r}{\alpha}, \frac{\alpha(R+1)-(1+r)}{\alpha}\right)$. Competitive credit supply would enable pinning down $r_L^{PS} = \frac{r}{\alpha}$.

Additional credit demand could be met by both PSBs and PVBs in combination, albeit at higher interest rates since the banks' participation constraints are now identical. However, since this participation constraint is tighter than PSBs' constraint up to a loan amount of $\bar{L}$, minimal project quality will generally need to be better than α^{PS}. Specifically, combining (1) and (5),

$$(8) \qquad \frac{\alpha(R+1)-(1+r)}{\alpha} \geq \frac{r+(1-\alpha)l}{\alpha} \Leftrightarrow \alpha \geq \alpha^{PV} := \frac{2r+(1+l)}{R+(1+l)} \in (\alpha^{PS}, 1)$$

where the bounds on α^{PV} derive from (7) and the assumption that $r < \frac{R}{2}$. Loans beyond the scale of aggregate investment of $\bar{L}$ can be extended by both PSBs and PVBs for projects meeting the quality constraint (8) at any rate $r_L^{PV} \in \left(\frac{r+(1-\alpha)l}{\alpha}, \frac{\alpha(R+1)-(1+r)}{\alpha}\right)$. Competitiveness of credit supply would enable pinning down r_L^{PV} at $\frac{r+(1-\alpha)l}{\alpha}$. We have established the following result:

Lemma 1. *In an economy with $\mathcal{B} < \bar{L}$ firms, where the quality of projects is sufficiently high ($\alpha > \alpha^{PS}$) and where outside investment options are sufficient poor ($r < \frac{R}{2}$), all firms will borrow from PSBs alone at a rate of interest $r_L^{PS} = \frac{r}{\alpha}$. If the economy has a larger number of firms than the government subsidy, $\mathcal{B} > \bar{L}$, then:*

*(a) $\bar{L}$ firms chosen randomly with probability $\frac{\bar{L}}{\mathcal{B}}$ each will borrow from PSBs at the rate r_L^{PS}, **and conditional on $\alpha > \alpha^{PV}$**, PSBs and PVBs will each serve half of the remaining $\mathcal{B} - \bar{L}$ firms at the rate $r_L^{PV} > r_L^{PS}$.*

(b) If, on the other hand, $\alpha \in (\alpha^{PS}, \alpha^{PV})$, the remaining $\mathcal{B} - \bar{L}$ firms will be rationed out of the credit market.

Corollary 1. *In the equilibrium characterized by lemma 1, PSBs have larger balance-sheets than PVBs and, where both are actively lending, PSBs charge a lower (weighted average) lending rate by lending to a subset of borrowers at a subsidized rate.*

D. An Economy with Differential Borrower Quality

We now embed this basic one-period model into an economy with two types of firms, differentiated by project quality. Specifically, it is assumed that $\alpha \in \{\alpha_L, \alpha_H\}$, where the quality types satisfy the constraints: $\alpha^{PS} < \alpha_L < \alpha^{PV} < \alpha_H$. Let $\mathcal{L}$ denote the measure of low quality projects in the firm population and $\mathcal{B} - \mathcal{L}$ the number of high quality projects.

It will be assumed that banks have no instruments other than the lending rate to separate the two types of borrowers. Under this assumption, the only modification to the analysis of the preceding section concerns the lower bound on the lending rate of PSBs given that they lend to both types of borrowers under the boundary value assumptions on α_L, α_H.

Define by $\omega_L := \frac{\mathcal{L}}{\mathcal{B}}$, the proportion of type L projects. Then, up to a limit of $\bar{L}$, PSBs are willing to lend at a rate that at least equals $\frac{r}{\omega_L\alpha_L+(1-\omega_L)\alpha_H}$. Since $\frac{r}{\omega_L\alpha_L+(1-\omega_L)\alpha_H} < \frac{r}{\alpha^{PS}}$, this implies from arguments establishing lemma 1 that both borrower types will wish to borrow from PSBs at the competitive lending rate of $r_L^{PS} := \frac{r}{\omega_L\alpha_L+(1-\omega_L)\alpha_H}$.

An extension of the previous result follows:

Lemma 2. *With competitive credit supply, a unique equilibrium with credit rationing exists wherein:*

(a) $\frac{\bar{L}}{\mathcal{B}}$ *percent of firms of both types borrow at the rate* r_L^{PS} *from PSBs.*

(b) All of the remaining $(\mathcal{B} - \mathcal{L})\frac{\mathcal{B}-\bar{L}}{\mathcal{B}}$ *firms with the high-quality projects borrow from PVBs and PSBs at a higher rate* $r_L^{PV} := \frac{r+(1-\alpha_H)l}{\alpha_H}$. *Of these firms,* $\frac{(\mathcal{B}-\mathcal{L})\frac{\mathcal{B}-\bar{L}}{\mathcal{B}}}{2}$ *each are served by PSBs and PVBs.*

(c) The remaining $\frac{\mathcal{B}-\bar{L}}{\mathcal{B}}\mathcal{L}$ *firms with low quality projects are rationed out of the credit market.*

Corollary 2. *The following observations are immediate consequences:*

(a) PSBs have a larger balance-sheet and lend at a lower weighted average lending rate than PVBs.

(b) The type-L borrowers who enjoy access to the loan market at cheaper borrowing rates would be rationed out altogether in the credit market equilibrium in the absence of implicit government guarantees that cover PSB losses in the event of their default.

E. Discussion

Credit rationing exists in equilibrium, reflecting adverse selection risk as in the standard model of credit markets with asymmetric information. It is high-risk borrowers that banks ration by setting lending rates that are too expensive, thereby achieving separation by effectively rationing such firms. However, the introduction of government subsidies significant alters the credit market relative to the standard model. Riskier firms procure access to credit from subsidized banks (PSBs) that are able to pass on the benefits of the government subsidy through credit provision at a cheaper, and therefore, affordable rate. As banks are unable to distinguish between borrower types if loans are priced cheap enough, both borrower types, low-risk firms and high-risk firms, benefit.

The intrinsic moral hazard of implicit government guarantees creates the image that less care need be taken. Depositors assume that the government guarantees safety and good conduct and banks judge that all they need to do is to obey specific aspects of the government's requirements. The government in effect has established an inefficient contract with PSBs. The implication of this sort of insurance system is quite different from that arising from models of lending where there is an asymmetry of information between borrowers and lenders. In the standard model, banks recognize that raising the loan interest rate or requiring higher collateral will only attract riskier borrowers and keep out the good ones. Given that loan repayments are strictly not enforceable due to incomplete contracting and weaknesses in the enforcement infrastructure, the standard intermediation model predicts that banks will restrict credit availability. Government guarantees change all this because they reduce the potential cost of default for PSBs which decreases their incentive to hike lending rates and ration credit. With PSBs secure in the knowledge that they have the protection of government that will recapitalize them when

required, there is a weakening of financial discipline on their part and as the threat of bankruptcy appears weak to them, they do not pursue efficient screening procedures which results in imprudent lending. The government assurance of recapitalizing the banking system results then in excess lending instead of credit rationing as traditional views on financial intermediation would have us believe. With PSBs dependent on government control and protection the ultimate risk of any credit extended to firms lies with the government and this passing on of the risk makes government shoulder the losses arising in the event of failure whilst these banks absorb the full returns from success and pass this on to government as dividends. The financial system thus suffers from moral hazard where public banks have a put option which is handed over to them free of cost.

III. Zombie Lending and the Real Sector

A. Incentives for Evergreening

We embed the one-period model with differentiated borrower quality into an intertemporal setting. In each period, a new population of firms (or, of projects) arrives, while, in the absence of evergreening, the earlier population of projects leaves the economy. To focus on the key issues, we will assume that the inflow of firms/projects is identical to that of the previous period. Specifically, $\mathfrak{M}_L$ new projects are of type L and $\mathfrak{M}_H$ new projects are of type H in each period.

Zombie projects. Projects (of either quality) that do not succeed can be kept alive by a bank if it chooses to evergreen them, in which case, these legacy projects will be called zombie projects. We assume that for a PSB, *this action is necessary for it to avail of the government subsidy that compensates for the loss*.[13] We first show that this makes it incentive compatible for PSBs to take up the subsidy whereas, if the relative likelihood of zombie projects succeeding is sufficiently low, then PVBs will not lend to such projects and prefer to initiate recovery by seizing collateral. This significantly simplifies the remainder of the analysis.

In what follows, it is assumed that once a project gets its loan evergreened and it enters zombie status, the bank will be unable to recover any value from the collateral.[14] On the other hand, since the zombie is attached to its existing lender, it cannot shop for better deals, hence, the terms on which it is provided credit may be more onerous; i.e., the interest rate charged may be higher than $r_L^j; j \in \{PS, PV\}$.

We begin by making ***two key assumptions***.

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[13] As in the preceding section, the subsidy remains unavailable to PVBs.

[14] This assumption serves to assist a clear assessment of the impact of incentives that often guide bank executives' decisions in reality; viz., when choosing to evergreen or restructure a poorly performing credit, the trade-off is between the potentially greater future loss due to larger loan exposure (evergreening) and depreciation of collateral security (both restructuring and evergreening), versus the gain from avoiding the steeper near-term loss that must be recognized if liquidation is chosen instead of evergreening. Given payoff continuity, weaker variants allowing for low, albeit positive recovery on collateral would suffice.

First, that zombie projects are less likely to succeed (equivalently, in a risk neutral setting, they have lower productivity) than both, type L and type H projects; i.e., $\alpha_z \in (0, \alpha^{PS})$.[15, 16]

Second, we assume that $r < l$; i.e., the outside option rate of return (on rental, deposits and equity) is less than the loss-given-default on the collateral should the bank declare the bad loan as non-performing and attempt recovery via collateral.[17]

From the perspective of a PSB, the choice it faces in period $t \geq 1$ is as follows. It can continue its relationship with a failed borrower by evergreening the loan and hence, avoid taking the hit on the recovery rate while earning a lower expected rate of return on the project. Or, alternatively, it can lend to a new project with higher likelihood of success but a higher immediate hit to recovery on this failed borrower. Since the same problem is repeated each period no matter what the outcome of this period's decision, the same choice will be repeated in the next period as was made in this period. This simplifies the dynamic choice problem. Denoting by $V^{PS}_{t+1,NEW}$ and $V^{PS}_{t+1,Z}$, the value functions corresponding to the discounted present value of the inter-temporal stream of payoffs resulting from (re)allocation of the exposure on this credit account into the future in the events of success and failure of the project between periods t and $(t+1)$, the PSB will prefer to lend to a zombie firm if an only if:

$$\alpha_z\left(r^{PS}_{L,z} + \beta V^{PS}_{t+1,NEW}\right) + (1-\alpha_z)\beta V^{PS}_{t+1,Z} > -l + \alpha_N\left(r^{PS}_{L} + \beta V^{PS}_{t+1,NEW}\right) + (1-\alpha_N)\beta V^{PS}_{t+1,Z}, \tag{9}$$

where $\alpha_N := \omega_L\alpha_L + (1-\omega_L)\alpha_H$ and $\beta \in (0,1)$ is the PSBs' discount factor. Exploiting the recursive structure of this problem and, using the fact that $\alpha_N r^{PS}_L = r$ (from lemma 2), we may rewrite (9) as:

$$\sum_{t=0}^{\infty}\beta^t(1-\alpha_z)^t\alpha_z\left(r^{PS}_{L,z} + \beta V^{PS}_{t+1,NEW}\right) > (r-l) + \alpha_N\beta V^{PS}_{t+1,NEW} + (1-\alpha_N)\beta\sum_{t=0}^{\infty}\beta^t(1-\alpha_z)^t\alpha_z\left(r^{PS}_{L,z} + \beta V^{PS}_{t+1,NEW}\right)$$

$$\Leftrightarrow \alpha_z r^{PS}_{L,z}\left(1-\beta(1-\alpha_N)\right) + (l-r)\left(1-\beta(1-\alpha_z)\right)$$

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[15] Setting $\alpha_z < \alpha^{PS}$ does not violate the zombie projects' participation constraint as choosing not to evergreen their loan would result in at most, a zero return which is always lower than trying again with a fresh loan.

[16] Assuming lower productivity for zombie firms irrespective of vintage of the NPA corresponds to stylized facts in the Indian case. Firm-level data confirms a negative relationship between investment rates and financial leverage and high leverage is concentrated in those sectors with the lowest investment rates as demonstrated by Anand and Tulin (2014). The reasons for zombie firms to have higher leverage and lower investment rates were noted in the introduction. Assuming a uniformly lower productivity for zombie firms irrespective of their vintage in the NPA pool likely understates relative productivity differential for older vintages since these firms will tend to have higher leverage levels and lower investment rates making them less productive.

[17] Whether this is true or not is an empirical issue. Nonetheless, given returns on equity and private loans and recovery rates on emerging markets NPAs, we feel confident making this assumption.

$$> \beta V_{t+1,NEW}^{PS}\left(\alpha_N\left(1-\beta(1-\alpha_z)\right)-\left(1-\beta(1-\alpha_N)\right)\right),$$

where the left-hand side is positive due to positivity of $l-r$ (from the second of our assumptions). Moreover, the right-hand side of the inequality is dominated by:[18]

$$\beta V_{t+1,NEW}^{PS}\left(\left(1-\beta(1-\alpha_z)\right)-\left(1-\beta(1-\alpha_N)\right)\right)=\beta^2 V_{t+1,NEW}^{PS}(\alpha_z-\alpha_N)<0.$$

This proves that (9) always holds, and hence, PSBs always prefer to take up the government subsidy and evergreen a loan to a zombie project conditional on failure in the preceding period.

From the perspective of a PVB, there is no subsidy for evergreening a bad loan and since there is zero recovery from collateral under a repeat default, it must charge substantially higher than r_L^{PV} (up to a maximum of *R*) in order it to compensate for the lower productivity of a zombie project relative to a new type-*H* project. Since, in either case, the choice next period will lead to the same expected value, V_{t+1}^{PV}, the PVB will choose to close out a bad loan over evergreening a zombie if and only if:

$$\begin{aligned}-1+\alpha_z\left(r_{L,z}^{PV}+\beta V_{t+1,H}^{PV}\right)+(1-\alpha_z)\beta\left(-l+V_{t+1,H}^{PV}\right)\\ <-l+\alpha_H\left(r_{L,z}^{PV}+\beta V_{t+1,H}^{PV}\right)+(1-\alpha_H)\beta\left(-l+V_{t+1,H}^{PV}\right)\end{aligned}$$

$$(10)\quad \Leftrightarrow \alpha_z r_{L,z}^{PV} < r+(1-\alpha_H)l+(1-l)+\beta l(\alpha_H-\alpha_z).$$

In deriving (10), we have used the fact that under the maintained hypothesis, a PVB prefers liquidating a failed loan, collecting on the collateral and issuing a new loan at a rate at which only type-*H* borrowers find it profitable to borrow, and, given the stationary and recursive structure of the choice problem, the same holds in future periods also. Noting that: (i) $r_{L,z}^{PV} < R$; (ii) $\frac{\partial lhs(10)}{\partial \alpha_z} > 0 > \frac{\partial rhs(10)}{\partial \alpha_z}$; (iii) $lhs(10)=0<rhs(10)$, when evaluated at $\alpha_z=0$; (iv) $\alpha_z < \alpha^{PV} := \frac{2r+1}{R+1}$; and (v) $\frac{\partial rhs(10)}{\partial \alpha_H} < 0$, a sufficient condition for (10) to hold is:

$$\alpha^{PV}(R+\beta l) < r+1-l(1-\beta),$$

which in turn holds if $l < \frac{1}{R+1}$. Hence, a sufficient condition for PVBs to prefer liquidation of failed projects and issuing loans to new type-*H* projects if that the loss-given-default be bounded above by a quantity that decreases in the expected return on the project conditional on it being successfully completed.

We have established:

Lemma 3. *If zombie projects enjoy sufficiently low productivity; i.e., $\alpha_z < \alpha^{PS}$ and loss-given-default on bad loans exceeds the return on bank funding, then under the government subsidies offered to PSBs, (but not PVBs):*

[18] The proof follows from the fact that $V_{t+1,NEW}^{PS} \geq 0$.

(a) defaulting borrowers always prefer to evergreen their existing bad loans.

(b) PSBs always prefer to evergreen bad loans over lending to new borrowers notwithstanding productivity differentials. They may charge any rate $r_{L,z}^{PS} \in (r_L^{PS}, R)$ *on such loans.*

(c) If the loss-given-default on bad loans satisfies $l < \frac{1}{R+1}$*, then no feasible interest rate (i.e., less than or equal to R), can induce PVBs to prefer evergreening bad loans and creating zombie projects over lending to new high productivity borrowers. PVBs will prefer evergreening only if this condition is violated.*

Discussion.

1. The import of the arguments yielding lemma 3 is that government subsidies constitute a powerful incentive mechanism. Not only do they lower underwriting standards by incentivizing banks to extend loans to borrowers that would otherwise be financially excluded under a competitive equilibrium, but banks which enjoy the subsidy have strong and robust incentive to evergreen the loans over lending to new clients with higher productivity.

2. In contrast, it appears that lacking subsidies, PVBs would only be incentivized to evergreen loans under a limited set of circumstances. We note that the sufficient condition specified in lemma 3(c) is not tight. As growth acceleration slows as an upswing matures, peaks and a downturn commences, one would expect real returns on projects (R) to decline and the loss-given-default on NPAs being liquidated (l) to rise. Hence, even as the sufficiency condition for PVBs to prefer liquidation over evergreening tightens due to falling recovery rates on collateral, it relaxes because of lower returns in the event that the project recovers.[19]

3. In the rest of this paper, we will maintain the assumption that $l < \frac{1}{R+1}$. There are two reasons for this. First, in the Indian context, the long-run average annual return on equity is less than 16 percent, taking this as an upper bound for R would result in this condition holding for average loss-given-default on NPAs of up to 86 percent which is quite high even in emerging market contexts.[20] Second, the dynamic inefficiency we explore in the paper would be exaggerated if, under a violation of this constraint, PVBs also have an incentive to evergreen NPAs over liquidating them. By precluding that possibility, we are able to provide a clearer analysis of the impact of government subsidies on the rate of (growth in) evergreening and in the portfolio of zombie loans held by the banking sector, and ultimately, therefore, for productivity and investment.

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[19] In general, the cyclical behavior of incentive constraints is difficult to underpin since the (relative) likelihood of non-performance on the loan of new and zombie borrowers also may change over the cycle, albeit, we would conjecture that so long as zombie borrowers' likelihood of success falls faster than new borrowers, the sufficiency condition associated with (10) would not tighten.

[20] Reliable estimates of recovery rates on bank NPAs are not available for India. Based on the workout methodology, Ghosh and Newar (2008) provided an estimate of l at 79 percent based on a limited sample of corporate loan accounts.

B. Zombie Lending, Depressed Productivity and Investment Slumps

Loan portfolio composition of PSBs and PVBs. Let $\mathfrak{M}_L$ and $\mathfrak{M}_H$ denote the inflow of new type L and type H projects in each period. The total lending capacity of the banking sector in each period is: $\bar{\mathcal{L}} = \bar{\mathcal{L}}^{PS} + \bar{\mathcal{L}}^{PV}$. We assume that $\bar{\mathcal{L}}^{PS} \in (\mathfrak{M}_L, \mathfrak{M}_L + \mathfrak{M}_H)$ and $\bar{\mathcal{L}}^{PV} < \mathfrak{M}_H$; i.e., PSBs do not have the capacity to cover investment / credit demand of all (new) projects and PVBs do not have capacity to cover credit demand of all new type H borrowers. Following lemma 3, under government subsidies, PSBs will serve all new borrowers (of type L and H) at the same rate of interest r_L^{PS} and evergreen zombie projects at some fixed, yet arbitrary $r_{L,z}^{PS} \in (r_L^{PS}, R)$. PVBs have a tighter participation constraint will only serve new customers willing to borrow at the higher rate of r_L^{PV} and hence serve new type H clients exclusively.

As in Lemma 2, non-zombie borrowers, irrespective of their type, will prefer to do so from PSBs, and given the limits on balance-sheet capacity, we impose the rationing rule as in the previous section; i.e., each borrower has an equal chance of availing of credit at a PSB. Hence, with $\boldsymbol{Z}$ zombies, applying the law of large numbers (LLN), PSBs will have a loan portfolio with types (Z, L, H) in the following proportions: [21] $\left(\frac{Z}{\bar{\mathcal{L}}^{PS}}, \omega_L^{PS}\frac{\bar{\mathcal{L}}^{PS}-Z}{\bar{\mathcal{L}}^{PS}}, (1-\omega_L^{PS})\frac{\bar{\mathcal{L}}^{PS}-Z}{\bar{\mathcal{L}}^{PS}}\right)$; where $\omega_L^{PS} := \frac{\mathfrak{M}_L}{\mathfrak{M}_L+\mathfrak{M}_H}$ is the share of new type L borrowers in the non-zombie loan portfolio. PVBs will then serve the remaining $\mathfrak{M}_H - (1-\omega_L^{PS})(\bar{\mathcal{L}}^{PS} - Z)$ type H borrowers up to their lending limit, $\bar{\mathcal{L}}^{PV}$.

The zero-profit condition on r_L^{PV}, combined with the law of large numbers, guarantees that $(\forall t); \pi_t^{PV} = 0$. Hence, assuming no fresh external investment in PVB equity, we have a constant balance-sheet capacity to meet demand for credit from new type H borrowers: $(\forall t); \bar{\mathcal{L}}_t^{PV} = \bar{\mathcal{L}}_0^{PV} = \bar{\mathcal{L}}^{PV}$. We will assume that PVBs have enough balance-sheet capacity to cover credit demand of type H projects not funded by PSBs in period 0 (when no zombie projects are on the latters' balance-sheets), but they cannot cover lending to all type H projects on their own: $(1-\omega_L^{PS})\bar{\mathcal{L}}^{PS} \equiv (1-\omega_L^{PS})\bar{\mathcal{L}}_0^{PS} < \bar{\mathcal{L}}^{PV} < \mathfrak{M}_H$.

The dynamics of the loan portfolio, aggregate productivity and investment

Period 0

In $t = 0$, the quantum of PSB loans that do not perform, and hence, equivalently, the potential number of zombie projects generated to be served in period 1 is:

$$Z_0 = \left((1-\alpha_L)\omega_L^{PS} + (1-\alpha_H)(1-\omega_L^{PS})\right)\bar{\mathcal{L}}_0^{PS}.$$

It is assumed that the per period subsidization capacity, $\bar{L}$ is large, and hence, this entire amount of bad loans is evergreened in period 1 and this is also the volume of zombie loans.

[21] There are well known technical difficulties involved in applying the LLN to a continuum of random variables. However, as in Fong and Szentes (2005) and references cited therein, our interest is in the case of the LLN applied to a large number of, but finitely many, firms, with an appropriate version of the law for which these problems do not arise.

Next, define the average =productivity of bank financed projects (per unit lent) as:[22]

(***for PVBs***) $AP_0^{PV} = \alpha_H R.$
(***for PSBs***) $AP_0^{PS} = (\omega_L^{PS}\alpha_L + (1-\omega_L^{PS})\alpha_H)R$
(***banking sector***) $AP_0 = \frac{\mathfrak{M}_H}{\bar{\mathcal{L}}_0^{PS}\omega_L^{PS}+\mathfrak{M}_H} AP_0^{PV} + \frac{\bar{\mathcal{L}}_0^{PS}\omega_L^{PS}}{\bar{\mathcal{L}}_0^{PS}\omega_L^{PS}+\mathfrak{M}_H}\alpha_L R$

Period 1

As a result of having to lend Z_0 to zombie projects, PSBs lending capacity to new projects is reduced to $\bar{\mathcal{L}}_1^{PS} = \bar{\mathcal{L}}_0^{PS} - Z_0$.

PSBs loan portfolios in period 1 can be described by:

$$\begin{cases} \frac{Z_0}{\bar{\mathcal{L}}_0^{PS}}\% \ \rightarrow zombies;\ [\alpha_z \in (0, \alpha^{PS})]; \\ \omega_L^{PS}\frac{\bar{\mathcal{L}}_1^{PS}}{\bar{\mathcal{L}}_0^{PS}}\% \ \rightarrow new\ type\ L;\ [\alpha_L \in (\alpha^{PS}, \alpha^{PV})]; \\ (1-\omega_L^{PS})\frac{\bar{\mathcal{L}}_1^{PS}}{\bar{\mathcal{L}}_0^{PS}}\% \ \rightarrow new\ type\ H;\ [\alpha_H \in (\alpha^{PV}, 1)] \end{cases}$$

PVBs' loan portfolio in period 1 is: $min\{\mathfrak{M}_H - (1-\omega_L^{PS})\bar{\mathcal{L}}_1^{PS}, \bar{\mathcal{L}}^{PV}\}$ of new type H borrowers.

The potential number of zombie projects generated at the end of period 1, is, therefore:

$$\begin{aligned} Z_1 &= (1-\alpha_z)Z_0 + \Big((1-\alpha_L)\omega_L^{PS} + (1-\alpha_H)(1-\omega_L^{PS})\Big)\bar{\mathcal{L}}_1^{PS} \\ &= \Big((1-\alpha_z) - (1-\alpha_L)\omega_L^{PS} - (1-\alpha_H)(1-\omega_L^{PS})\Big)Z_0 \\ &\quad + \Big((1-\alpha_L)\omega_L^{PS} + (1-\alpha_H)(1-\omega_L^{PS})\Big)\bar{\mathcal{L}}_0^{PS} \\ &> \Big((1-\alpha_L)\omega_L^{PS} + (1-\alpha_H)(1-\omega_L^{PS})\Big)\bar{\mathcal{L}}_0^{PS} = Z_0, \end{aligned}$$

where the last inequality is a simple consequence of $(1-\alpha_z) > (1-\alpha_L) > (1-\alpha_H)$. Hence, credit demand from failed borrowers increases relative to the preceding period.

Finally, we show that average productivity of bank-financed projects decreases from period 0 to period 1:

(***for PVBs***) $AP_1^{PV} = \alpha_H R = AP_0^{PV}$
(***for PSBs***) $AP_1^{PS} = \left(\frac{Z_0}{\bar{\mathcal{L}}_0^{PS}}\alpha_z + (\omega_L^{PS}\alpha_L + (1-\omega_L^{PS})\alpha_H)\frac{\bar{\mathcal{L}}_1^{PS}}{\bar{\mathcal{L}}_0^{PS}}\right)R < AP_0^{PS}$
where the inequality follows from $\alpha_z < \alpha_L < \alpha_H$.

[22] The productivity doesn't account for the loss of collateral value. However, it should be noted that it is the market recovery value of collateral, l, that is lower than its depreciated value of $1-\delta$. Hence, the market value loss beyond depreciation does not count so long as the collateral can be reused in later periods, which we assume is the case. The productivity values reported above are gross of collateral depreciation.

(***for the banking sector***) assuming, for convenience, that $\mathfrak{M}_H - (1-\omega_L^{PS})\bar{\mathcal{L}}_1^{PS} < \bar{\mathcal{L}}^{PV}$, we have:[23]

$$\begin{aligned} AP_1 &= \frac{\mathfrak{M}_H}{\omega_L^{PS}\bar{\mathcal{L}}_0^{PS} + Z_0(1-\omega_L^{PS}) + \mathfrak{M}_H} AP_0^{PV} + \frac{\omega_L^{PS}\bar{\mathcal{L}}_1^{PS}}{\omega_L^{PS}\bar{\mathcal{L}}_0^{PS} + Z_0(1-\omega_L^{PS}) + \mathfrak{M}_H}\alpha_L R \\ &\quad + \frac{Z_0}{\omega_L^{PS}\bar{\mathcal{L}}_0^{PS} + Z_0(1-\omega_L^{PS}) + \mathfrak{M}_H}\alpha_z R \\ &< \frac{\mathfrak{M}_H}{\bar{\mathcal{L}}_0^{PS}\omega_L^{PS} + \mathfrak{M}_H} AP_0^{PV} + \frac{\bar{\mathcal{L}}_0^{PS}\omega_L^{PS}}{\bar{\mathcal{L}}_0^{PS}\omega_L^{PS} + \mathfrak{M}_H}\alpha_L R = AP_0, \end{aligned}$$

where the inequality follows from the fact that $AP_0^{PV} > \alpha_L R > \alpha_z R$ and the weights on AP_0^{PV} and $\alpha_L R$ are lower in AP_1 than in AP_0.

Period *t*

We now establish by induction that the increase in zombie lending and resulting decrease in productivity that prevail in the economy between periods 0 and 1 will persist into any arbitrary period *t* so long as it does so through period *t — 1*. By this time, PSBs' lending capacity will have reduced to: $\bar{\mathcal{L}}_t^{PS} = \bar{\mathcal{L}}_0^{PS} - Z_{t-1} < \bar{\mathcal{L}}_0^{PS} - Z_{t-2} = \bar{\mathcal{L}}_{t-1}^{PS}$, where the inequality follows from the induction step assumption of $Z_{t-1} > Z_{t-2}$.

PSBs loan portfolios in period *t* can be described by:

$$\begin{cases} \dfrac{Z_{t-1}}{\bar{\mathcal{L}}_0^{PS}}\% \ \rightarrow zombies;\ [\alpha_z \in (0, \alpha^{PS})]; \\ \omega_L^{PS}\dfrac{\bar{\mathcal{L}}_t^{PS}}{\bar{\mathcal{L}}_0^{PS}}\% \ \rightarrow new\ type\ L;\ [\alpha_L \in (\alpha^{PS}, \alpha^{PV})]; \\ (1-\omega_L^{PS})\dfrac{\bar{\mathcal{L}}_t^{PS}}{\bar{\mathcal{L}}_0^{PS}}\% \ \rightarrow new\ type\ H;\ [\alpha_H \in (\alpha^{PV}, 1)] \end{cases}$$

PVBs' loan portfolio in period 1 is: $min\{\mathfrak{M}_H - (1-\omega_L^{PS})\bar{\mathcal{L}}_t^{PS}, \bar{\mathcal{L}}^{PV}\}$ of new type *H* borrowers.

The potential number of zombie projects generated at the end of period *t*, is, therefore:

$$\begin{aligned} Z_t &= (1-\alpha_z)Z_{t-1} + \Big((1-\alpha_L)\omega_L^{PS} + (1-\alpha_H)(1-\omega_L^{PS})\Big)\bar{\mathcal{L}}_t^{PS} \\ &= \Big((1-\alpha_z) - \Big((1-\alpha_L)\omega_L^{PS} + (1-\alpha_H)(1-\omega_L^{PS})\Big)\Big) Z_{t-1} \\ &\quad + \Big((1-\alpha_L)\omega_L^{PS} + (1-\alpha_H)(1-\omega_L^{PS})\Big)\bar{\mathcal{L}}_0^{PS} \end{aligned}$$

[23] The other case, where there is rationing of type *H* borrowers in period 1 will involve lower average productivity than this case so it suffices to consider this one.

$$> \left((1-\alpha_z) - \left((1-\alpha_L)\omega_L^{PS} + (1-\alpha_H)(1-\omega_L^{PS})\right)\right) Z_{t-2}$$
$$+ \left((1-\alpha_L)\omega_L^{PS} + (1-\alpha_H)(1-\omega_L^{PS})\right)\bar{\mathcal{L}}_0^{PS} = Z_{t-1},$$

where the last inequality is a consequence of combining the induction step assumption of $Z_{t-1} > Z_{t-2}$. Hence, credit demand from failed borrowers increases in period *t* relative to the preceding period.

Finally, we show that average productivity of bank-financed projects decreases from period *t--1* to period *t*:

(***for PVBs***) $AP_t^{PV} = \alpha_H R = AP_0^{PV}$

(***for PSBs***) $AP_t^{PS} = \left(\frac{Z_{t-1}}{\bar{\mathcal{L}}_0^{PS}}\alpha_z + (\omega_L^{PS}\alpha_L + (1-\omega_L^{PS})\alpha_H)\frac{\bar{\mathcal{L}}_t^{PS}}{\bar{\mathcal{L}}_0^{PS}}\right) R < AP_{t-1}^{PS}$

where the inequality follows from $\alpha_z < \alpha_L < \alpha_H$.

(***for the banking sector***) assuming, for convenience, that $\mathfrak{M}_H - (1-\omega_L^{PS})\bar{\mathcal{L}}_t^{PS} < \bar{\mathcal{L}}^{PV}$, we have:

$$\begin{aligned} AP_t &= \frac{\mathfrak{M}_H}{\omega_L^{PS}\bar{\mathcal{L}}_0^{PS} + Z_{t-1}(1-\omega_L^{PS}) + \mathfrak{M}_H} AP_0^{PV} + \frac{\omega_L^{PS}\bar{\mathcal{L}}_t^{PS}}{\omega_L^{PS}\bar{\mathcal{L}}_0^{PS} + Z_{t-1}(1-\omega_L^{PS}) + \mathfrak{M}_H}\alpha_L R \\ &\quad + \frac{Z_{t-1}}{\omega_L^{PS}\bar{\mathcal{L}}_0^{PS} + Z_{t-1}(1-\omega_L^{PS}) + \mathfrak{M}_H}\alpha_z R \\ &< \frac{\mathfrak{M}_H}{\omega_L^{PS}\bar{\mathcal{L}}_0^{PS} + Z_{t-2}(1-\omega_L^{PS}) + \mathfrak{M}_H} AP_0^{PV} \\ &\quad + \frac{\omega_L^{PS}\bar{\mathcal{L}}_t^{PS}}{\omega_L^{PS}\bar{\mathcal{L}}_0^{PS} + Z_{t-2}(1-\omega_L^{PS}) + \mathfrak{M}_H}\alpha_L R + \frac{Z_{t-2}}{\omega_L^{PS}\bar{\mathcal{L}}_0^{PS} + Z_{t-2}(1-\omega_L^{PS}) + \mathfrak{M}_H}\alpha_z R \\ &= AP_{t-1}, \end{aligned}$$

where the induction step assumption of $Z_{t-1} > Z_{t-2}$ ensures that the inequality follows from the fact that $AP_0^{PV} > \alpha_L R > \alpha_z R$ and the weights on AP_0^{PV} and $\alpha_L R$ are lower in AP_t than in AP_{t-1}.

We have established:

Proposition 1. *In any equilibrium with lending of the dynamic economy where investment is financed by the banking sector, government subsidies result in:*

(a) an increasing accumulation of zombie projects/ firms with access to credit markets via evergreening of loans by their incumbent PSB lenders.

(b) since this increase in zombies comes at the expense of lending to new investment projects with higher productivity, such zombie lending results in a decrease in average productivity and investment in the economy.

(c) in general, government subsidies to PSBs results in lending to projects that would otherwise be economically unviable.

It is immediately clear from the structure of this economy that total investment in the economy itself falls since new type L firms are rationed due to the growth of zombie lending by the PSBs. New type H firms would initially find themselves borrowing at a higher average interest rate due to zombies forcing more of their number to migrate to borrowing from PVBs. Eventually, if the dynamics above continue unabated, the banking sector's capacity to finance high-productivity firms may itself begin to be squeezed and the credit supply to them will be rationed. In such cases, the subsequent fall in productivity and investment will be much faster and larger.

What is critical is the balance between lending capacity of the PVBs, who eventually come to dominate credit supply to high-productivity firms, and the residual credit demand that they face. If the latter grows faster than the former, or equivalently, if the rate of growth of zombie firms in the economy outstrips that of PVBs' lending capacity for long enough, this outcome will transpire.

This is formalized in:

Proposition 2. *If* $\bar{\mathcal{L}}^{PV} < \left(1 - \frac{\bar{\mathcal{L}}^{PS}}{\mathfrak{M}_L + \mathfrak{M}_H}\left(1 - \frac{\omega^f}{\alpha_z + \omega^f}\right)\right)\mathfrak{M}_H$, *then* $(\exists!)(T < \infty); (\forall)(t \geq T); LD_t^{PV} > \bar{\mathcal{L}}^{PV}$.

In the statement of the proposition, $\omega^f \coloneqq (1 - \alpha_L)\omega_L^{PS} + (1 - \alpha_H)(1 - \omega_L^{PS})$, is the ex-ante probability of failure assigned to any new firm that borrows funds from PSBs, and $LD_t^{PV} \coloneqq \mathfrak{M}_H - (1 - \omega_L^{PS})\bar{\mathcal{L}}_t^{PS}$, is the loan demand going to PVBs from high-productivity firms in period *t*.

The result implies that as long as PVB lending capacity is sufficiently bounded, the growth of zombie lending eventually results in high-productivity firms being rationed out the credit market altogether. This means that from this point onward, the number of new firms obtaining credit falls.

Proof. Noting that we may rewrite $LD_t^{PV} \coloneqq \mathfrak{M}_H\left(1 - \frac{\bar{\mathcal{L}}_t^{PS}}{\mathfrak{M}_L + \mathfrak{M}_H}\right)$, we note that loan demand facing PVBs increases over time since $\bar{\mathcal{L}}_t^{PS}$ decreases in *t*. By definition,

$$\bar{\mathcal{L}}_t^{PS} = \bar{\mathcal{L}}^{PS} - Z_{t-1} = \bar{\mathcal{L}}^{PS}(1 - \omega^f) - Z_{t-2}(1 - \alpha_z - \omega^f)$$

$$= \bar{\mathcal{L}}^{PS}\left(1 - \omega^f \sum_{s=0}^{t-2}(1 - \alpha_z - \omega^f)^s\right) - Z_0(1 - \alpha_z - \omega^f)^{t-1}$$

Noting that $\alpha_z < \alpha_L < \alpha_H \Rightarrow 1 - \alpha_z - \omega^f \in (0,1)$, this implies that

$$lim_{t\to\infty}\bar{\mathcal{L}}_t^{PS} = \bar{\mathcal{L}}^{PS}\left(1 - \frac{\omega^f}{\alpha_z + \omega^f}\right)$$

and hence, $LD_t^{PV} < \mathfrak{M}_H\left(1 - \frac{\bar{\mathcal{L}}^{PS}}{\mathfrak{M}_L + \mathfrak{M}_H}\left(1 - \frac{\omega^f}{\alpha_z + \omega^f}\right)\right) < \mathfrak{M}_H$, which completes the proof. ‖

IV. Reflections on Policy

We do not formally address cyclical issues in this paper, but these are worth dwelling on at this point. The government guarantees that are the focus of our study reinforce an impressionistic view among the public regarding the relatively robust health and resilience to stress of PSBs compared to private banks, with this perception triggering behavior that vindicates this view when the banking sector comes under pressure. Specifically, PSBs have implicit insurance from the government that their stability will be maintained and this imparts greater confidence in them by their creditors and the public—they do not worry about the non-marketable, idiosyncratic loans made by these banks. As argued by Acharya and Kulkarni (2012), this explains why, in the Indian context, there was a "flight-to-safety" during the global financial crisis wherein private banks experienced deposit withdrawals with the beneficiary PSBs being able to increase credit at cheaper rates. Neither this phenomenon, nor the markedly greater increase in wholesale funding costs of the largest private Indian bank compared to the largest PSB can be explained by differences in fundamentals.

In such a context, it becomes easy to make the erroneous argument that if banks do not roll over bad loans, they would necessarily be contributing to deteriorating economic conditions that typically accompanies the rise of NPAs. PSBs are especially prone to be sensitive to such criticism and are more likely to respond by evergreening loans. But, in the process they continue to finance firms susceptible to unsustainable returns and having low productivity.

As we have demonstrated, even from a purely financial perspective, incentives for postponing the enforcement of debt contracts are significantly greater for PSBs. This is because government subsidies increase the option value of restructuring and evergreening bad loans in the hope that a sufficiently favorable outcome in the near-future wipes out the existing stock of NPAs. This is why in comparison to private banks, a stressed environment tends to make PSBs' asset quality poorer and credit risk management more deficient, lowering profitability and constraining their ability to maintain healthy rates of credit growth.

The painful consequences of this are felt in the corporate sector and reflected at the aggregate level in the real sector, since loans evergreened by PSBs to firms that have run into difficulties restricts the availability of finance for newly emerging sectors and high productivity projects, weighing on investment, and eventually, impeding the growth (potential) of the economy. As financial stability risks rise with growth in banking sector NPAs, the momentum of the real economy itself falters because of this crowding out of high productivity firms, increasing downside risks to the economic outlook and potentially squeezing room for policy to respond effectively in the face of exogenous shocks.

The scope for banking supervision to impinge upon banks' ability to act on these incentives is, therefore, vitally important. In India, where the RBI has these powers in its supervision of private-sector banks, it has used them effectively in successfully guiding the alignment of incentives with economically desirable actions. In comparison, limits on the scope of the RBI's supervisory sanction vis-à-vis PSBs appear to have adversely affected the its ability to undertake

necessary and effective action. Unlike the case of privately-owned banks, the RBI does not have the power to revoke the license of a PSB, nor to commence liquidation or resolution of a failing PSB, nor to even compel the merger of such a bank with another bank. It is the central government that has these powers which were conferred on it at the time of bank nationalization. Moreover, the RBI is prohibited by the Banking Regulation Act of 1949 from levying personal fines on PSB board members and has limited powers to hold PSB officials accountable, being only able to recommend their removal but without the power to implement such recommendation.

Given the potentially significant impact on growth and welfare, there are clear benefits of putting the prudential supervision of PSBs and private banks should be put on an even footing along all of these dimensions. In the Indian case, the results of our study underscore the importance of putting the RBI's supervisory and resolvability powers vis-à-vis the PSBs on par with those applicable to private banks. This also puts greater onus on the government to bolster PSBs' corporate governance as their exclusive shareholder. Potential strategies that can assist with this deserve further study.

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