Journal of Asian Economics 85 (2023) 101590

Contents lists available at ScienceDirect

Journal of Asian Economics

journal homepage: www.elsevier.com/locate/asieco

Full length article

Do NBFCs propagate real shocks?

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ARTICLE INFO

JEL classification:
E44
G23
G21
J64

Keywords:
NBFC
Bank-NBFC interaction
Search and matching unemployment

ABSTRACT

Notwithstanding a smaller share of total loans vis-à-vis commercial banks, we investigate a possible role of Non-banking financial companies (NBFCs) in propagating a real shock to the rest of the economy. Our two-sector model captures emerging economy characteristics such as NBFC borrowings from commercial banks, heterogeneities in financial constraints, and labour market friction faced by firms. Our theoretical and simulation results, using Indian parameters, indicate that an idiosyncratic shock (i.e., higher realization of the failed firms) and a sectoral productivity shock (in the sector financed by NBFCs) increase the interest rate charged by the banks, and the unemployment rate while reducing the real wages and per capita capital formation. However, the reverse happens given a structural shock, assumed as an increase in the average number of failed firms. Early detection of such shocks and quick policy intervention are required to provide a cushion for capital formation and job creation.

1. Introduction

Financial Stability Board (FSB) defined *shadow banking* as "credit intermediation involving entities and activities (fully or partly) outside of the regular banking system". In October 2018, the FSB announced its decision to replace the term shadow banking with the term Non-banking Financial Intermediation. Notwithstanding the nomenclature, these financial institutions are perennially involved in maturity, credit and liquidity transformation, without explicit access to the central bank's liquidity (Pozsar, Adrian, Ashcraft, & Boesky, 2010, 2013). In many countries, these intermediaries are not subjected to stringent banking regulations as they do not accept traditional deposits. Rather shadow banks borrow short-term, leverage themselves considerably and often lend to risky, illiquid and long-term assets (Acharya & Oncu, 2011). The Global Financial Crisis (GFC) of 2008 brought to the forefront the systemic risk of this sector as it became the target of rollover risk and asset–liability mismatches (ALM) during financial stress (Report on Currency and Finance, RBI, 2010).[3] Since then, the literature, both in academia and policy domain, considers the implications of financial shocks originating in the shadow banking sector, its implications on financial stability and macroeconomic real variables (Gennaioli, Shleifer, & Vishny, 2013; Gertler & Karadi, 2011; Meeks, Nelson, & Alessandri, 2017; Moreira & Savov, 2017). In contrast, in this paper, we confine our focus to comprehending the role the shadow banking system could play to percolate and propel the real shocks in the rest of the real economy through bank-shadow bank interactions.

We propose a hypothetical model which captures the interactions between financial institutions, *viz.* scheduled commercial banks (SCBs) and non-banking financial companies (NBFCs), and firms, keeping the Indian context in mind. Policy research on this part

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[1] This paper represents the opinions of the authors solely and not those of the Reserve Bank of India.

[2] Acknowledgement: We are sincerely grateful to the participants of the 16th Annual Conference on Economic Growth and Development in Indian Statistical Institute, Delhi for their valuable feedback. We are also indebted to the three anonymous referees and the editor for their valuable comments and suggestions which helped us to improve the paper significantly.

[3] https://rbi.org.in/Scripts/AnnualPublications.aspx?head=Report+on+Currency+and+Finance.

https://doi.org/10.1016/j.asieco.2023.101590
Received 20 May 2022; Received in revised form 6 December 2022; Accepted 6 February 2023
Available online 9 February 2023
1049-0078/

is limited, mainly on account of granular and long-time series data availability. We attempt to circumvent this problem using a theoretical model, which captures three salient features of the NBFC sector in India. First, NBFCs are financed by SCBs in our model since the major chunk of the NBFC sector is of non-deposit-taking type. Second, NBFCs venture into small and risky firm loans. It is costly for well-regulated SCBs to scrutinize the risk of each fragmented project and extend the loans to the small agents. That gap or the excess demand for the loan is fulfilled by the NBFCs (Acharya, Khandwala, & Öncü, 2013). The third important feature of the NBFC sector as evidenced in Section 3, is sectoral concentration. One particular set of NBFCs finance only to the certain sector(s) and do not spread their operation across all the sectors. This makes NBFCs exposed to high sectoral risk. However, since NBFCs are financed by SCB which has operations in varied sectors, the effect of NBFC's lending is spread across different sectors. Therefore, the sectoral risk faced by NBFCs affects the SCB's lending rate. We capture this crucial feature of NBFC elaborately in the extension of the baseline model (Section 6). Our findings suggest that higher realization of the failed firms leads to an increase in the interest rate charged by the banks, and the unemployment rate while reducing the real wages and per capita capital formation. In case of an increase in productivity risk for the entire sector (in the sector financed by NBFCs), the effect is similar to the previous case. However, as an increase in the average number of failed firms is realized the reverse happens.

We construct a two-sector model, sector 1 is a primitive sector and sector 2 is a capital good-producing large manufacturing sector. The former sector consists of many small firms that produce the intermediate good. The final consumable good of sector 1 is produced by bundling all the intermediate goods together. Small firms use labour as their means of production. The financial need of the small firms which emerge to finance the initial capital is fulfilled by the NBFCs. These firms cannot access commercial banks' loans. However, the second sector consists of big modern firms. These firms use labour and capital to produce capital goods and are financed by the commercial bank. We keep this fact of heterogeneous financial constraints as our central spirit to build our model, as this is widely observed in reality (Alberola & Urrutia, 2020; Khan, 2022). Especially in India, MSMEs bear the unfavourable brunt of financial constraints (Athaide & Pradhan, 2020; Bhandari & Pradeep, 2022; Choudhury & Goswami, 2019; Mittal & Raman, 2021) whereas large and modern firms get easier access to formal SCB credits. To bridge that credit demand gap NBFCs play an important role. In sector 2, firms face uncertainty in terms of hiring labour. Since we want to understand the effect of shocks in the NBFC sector on the unemployment rate also, it is required to explicitly model some degree of labour market friction and generate equilibrium unemployment. To do so, we use search and matching friction of Diamond–Mortensen–Pissarides (DMP) style to employ additional labour (we elaborate on this in Section 4.3).

The model argues that NBFCs' borrowing pattern from SCBs has an additional effect on the real interest rate of the scheduled commercial bank over and above the policy-determined interest rate. This relation plays a crucial role in our paper as we aim to understand how NBFCs can pass the real shocks of one sector to the other sectors. There are three types of shocks which are considered in this paper. First, the realization of the random variable, i.e., a number of failed firms is termed an idiosyncratic shock. Second, the change in the expected number of failed firms is considered a structural shock. Third, a change in the sector-wide productivity risk where NBFC operates is defined as a sectoral shock. We show that the shocks in the sector where (non-deposit taking) NBFC operates, affect the equilibrium number of firms. These intermediate firms of sector 1 play a crucial role in the model because they demand NBFC loans, but not all firms survive and repay the loans. Thus, the failed firms crowd the loan market, which drives the interest rate high for all the firms in sector 1. This alters the credit demand of the economy, as NBFCs are financed by the SCBs. Also, the shocks affect the expected loan recovery of NBFCs. Both these channels impact the interest rate charged by NBFCs and SCBs, which, in turn, influence capital formation. Interest rate and capital formation both are instrumental to determine the number of vacancies firms post which impacts the labour market tightness in the economy and thus, the job creation and unemployment rate. Since the wage is realized by the bargaining process under labour market friction, the real wage of sector 2 becomes a function of labour market tightness. Earning equivalence condition connects the wage rate of sector 1 and sector 2. Thus, shocks in the sectors where NBFC operates impact the economy-wide real variables. We use the mentioned channels and explain that different types of shocks have different bearings. Therefore, it is important to understand the nature of shocks to infer the real effect.[4] To counter the change in capital formation and job creation due to shocks, the model suggests proactive policies like moderating the policy interest rate and policy deposit rate.

The rest of the paper is organized as follows. Section 3 gives a brief description of the characteristics of the Indian NBFCs in the context of the present paper. Section 4 describes the baseline model. We characterize the equilibrium of the baseline model and report the comparative statics results in Section 5. We introduce sectoral risk to the baseline model and identify the impact of change in sectoral risk in Section 6. Section 7 contains the numerical illustration of the theoretical model. We summarize the results, discuss the possibilities of further extensions and conclude the paper in Section 8.

2. Literature

The financial and macro stability issues around NBFIs are widely deliberated in the literature. One strand of literature argues that the strength and efficiency of this interconnected financial system can affect real growth positively via a rise in savings and efficient capital allocation (Jappelli & Pagano, 1994; Levine, 2005). Additionally, Ahamed, Ho, Mallick, and Matousek (2021), after

[4] Our objective is to understand the heterogeneous effects of different kinds of shocks on the real variables via bank-NBFC linkage. In particular, sectoral shocks which literature considers as an important risk to the bank-NBFC linkage (Acharya et al., 2013), are cleanly identified using Melitz (2003) set-up. It enables us to compare two risk scenarios using the single crossing property of two probability distributions. While we follow this strategy in a partial equilibrium set-up for understanding the effects of bank-NBFC interlinkage on the real economic variables, other DSGE models, such as Gebauer and Mazelis (2019) and Meh and Moran (2010), do not capture the sectoral risk explicitly.

analysing 1740 banks across 86 countries, found that banks operating in an inclusive financial sector with NBFIs achieve higher operating efficiency. However, the findings of another strand of literature highlight a different picture. Ouyang and Wang (2022) flagged the concern that shadow banking activities may weaken the stability of the SCBs, too. After looking into the Chinese case where SCBs and NBFIs work as substitutes, the paper concludes that long-run wealth management products of shadow banks reduce the stability of SCBs. Acharya, Qian, Su, Yang, et al. (2021) also raised concerns about financial fragility in the case of the Chinese economy because of regulatory arbitrage and competition for deposit funding in presence of fiscal stimulus and wealth management products of shadow banks. Adding to the concerns, Chen, Ren, and Zha (2018) and Sanfilippo-Azofra, Torre-Olmo, and Cantero-Saiz (2019) observed shadow banking system, by avoiding the usual channels of credit, reduces the effectiveness of the monetary policy in moderating money supply. In a related topic, Meh and Moran (2010) developed a dynamic stochastic general equilibrium model to understand the role of banks to transmit the shock. It argues that the bank capital channel plays an important role to propagate business cycle fluctuations in terms of output, investment, and inflation. Given this background of the ambiguous effect of financial integration in the literature, we try to understand theoretically how three different types of real shocks to one sector can percolate to other real variables due to NBFC and SCB interaction in the context of India.

Besides the broad similarities with global shadow banks, certain features make Indian NBFCs unique. As pointed out by Acharya et al. (2013), NBFCs in India, unlike western shadow banks (Hanson, Shleifer, Stein, & Vishny, 2015), provide an alternative to conventional lending by SCB in India. While NBFCs stand third (after banks and mutual funds) and account for around 9 percent of the total assets of its domestic financial sector in 2014, its importance in the financial hierarchy is derived from its role in providing small and fragmented loans (Neelima & Kumar, 2017).[5] Moreover, most of the NBFCs in India do not accept deposits and depend on the external funds, like SCB credits, company paper etc.[6] Given these facts, Öncü (2013) argues it may be possible that the collective failure of NBFCs brings a systemic risk to the financial system even when individual NBFCs play a small part in the financial ecosystem, especially in light of their interaction with commercial banks. This raises concerns for better regulatory supervision to reduce the chance of regulatory arbitrage (Sherpa, 2013). Although, it is also argued that making too stringent a stance towards NBFCs may hurt the growth and capital formation of the economy as NBFCs serve as the financier of the vast section MSMEs in India (Awasthi & Shukla, 2022; Bhandari & Pradeep, 2022; Kannan, Shanmugam, & Bhaduri, 2019). However, due to the limited availability of data, research related to NBFCs in India is not ample. We attempt to incorporate the features of Indian NBFCs in our model to understand the role NBFCs play under different types of shocks.

3. NBFC characteristic in India

In India, there is a large number of NBFCs operating through an extensive network of branches and supply credit to many niche segments (Gandhi, 2014).[7] Among these non-deposit taking NBFCs, systemically important (asset size more than Rs.500 crore) NBFCs dominate the segment. In the fund disbursements, among 11 activity-wise classifications listed by Reserve Bank of India, *investment and credit to companies account* for the major share of NBFC credits in India (Fig. 1). Banks lend to NBFCs directly and through debentures and commercial papers (CPs) issued by these companies. In view of the vital role of NBFCs in fund allocation, RBI has also eased norms to allow the co-origination of priority sector loans by banks and NBFCs.[8] Considering its importance in financial stability, RBI publishes overall bank exposure to NBFCs, including their investment in CPs and debentures in its reports.[9] In this paper, we also focus on the bank-NBFC interlinkages (in Section 4) by taking into account the loans disbursed for the production purpose (abstracting from personal loans) and attempt to model the perturbations due to a negative productivity shock.

The bi-yearly Financial Stability Report by the Reserve Bank of India (RBI) publishes its finding on NBFC vulnerabilities and system-level stress tests. There are a few empirical studies relating to Indian NBFCs. Acharya et al. (2013) analyse the growth of a shadow banking system in India and argues that Indian NBFCs are quite different from their emerging market counterpart. They are relatively well-capitalized, but bank lending forms a significant part of NBFCs' liabilities[10] which is one of the key assumptions of our model too. Recently RBI (2020) highlighted the market financing conditions for NBFCs due to COVID-19-related disruptions and mentioned the role of policy interventions to ensure the flow of funds to small and medium-sized NBFCs to minimize systemic risks.

The primary challenge in analysing Indian NBFC data is the paucity of long, granular, high-frequency data. However, eyeballing the available data makes certain features of the NBFC sector quite evident. Fig. 1 demonstrates the sector-wise share of NBFC advances and indicates that most of the NBFC funds find their way to the industrial sector, which accounts for around 60 percent of total NBFC advances. All industrial segments (e.g. medium and small) receive credit flow from NBFCs. They also finance retail and services sectors, though their combined share is much lower than that of industry. Automobile loans, commercial real estate, trade, and transportation are some of the sectors in retail loans and services (Fig. 2). There are several other intermediate and

[5] https://rbidocs.rbi.org.in/rdocs/Bulletin/PDFs/01AR101017F2969F6115EB4B5992BD73976F9A905D.PDF.

[6] 8.5 times more non-deposit taking NBFCs (systematically important) exists than deposit taking NBFCs in India as July 2022 (https://rbi.org.in/Scripts/BS$_$NBFCList.aspx).

[7] https://rbidocs.rbi.org.in/rdocs/Bulletin/PDFs/04BSC080914.pdf.

[8] https://www.rbi.org.in/Scripts/NotificationUser.aspx?Id=11991&Mode=0.

[9] For instance, Table VI.8 reports Bank Lending outstanding to NBFCs in its Report on Trend and Progress (latest issue: https://rbi.org.in/scripts/PublicationsView.aspx?id=20272).

[10] In his speech Acharya (2017) mentioned this feature of Indian NBFCs too. https://rbidocs.rbi.org.in/rdocs/Bulletin/PDFs/01SP111217CBEF9077A25C48329B484120A3EF9B2F.PDF.

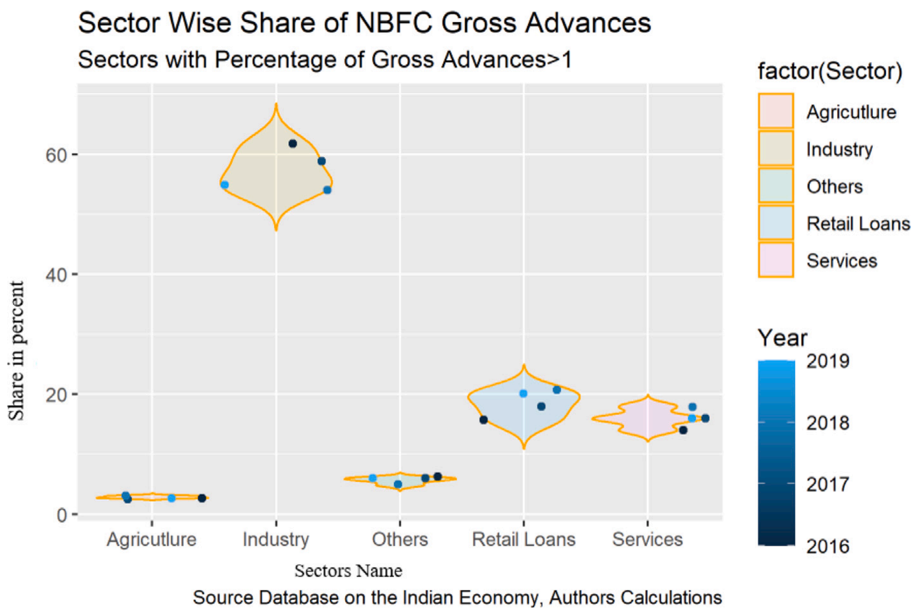

Fig. 1. NBFCs sectoral credit.

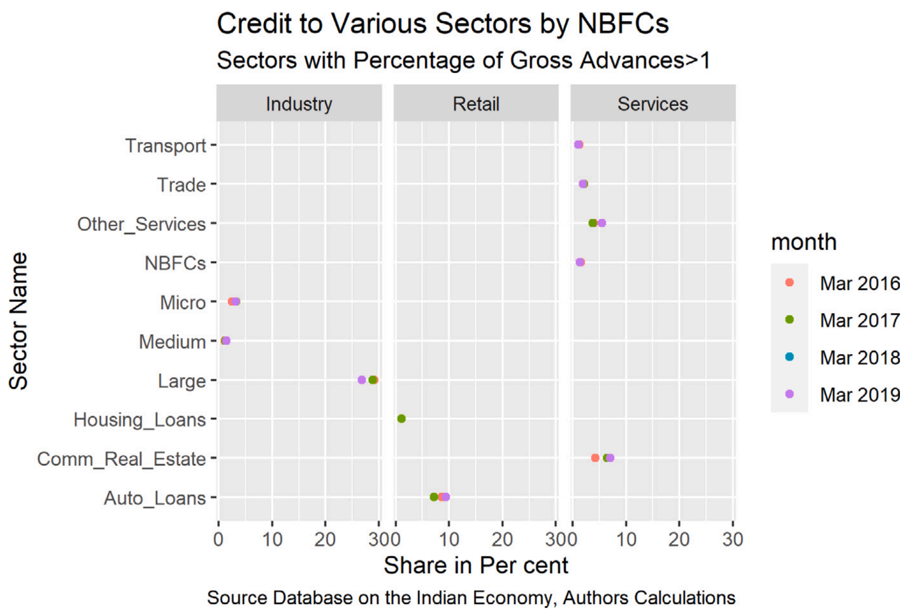

Fig. 2. NBFCs credit to different sectors.

consumer-good sectors that benefit from NBFC finances, albeit accounting for a small portion of total advances (Fig. 2). These figures support two important features of our model. First, the share of NBFC advances to different sectors has remained stable. Second, NBFC credit is a key source of funds for many medium, small and micro enterprises. An analysis of KLEMS (India) data indicates that these sectors are often labour intensive and generate considerable employment (Fig. 11).

Turning to the liability side of the NBFC balance sheet, the major heads include bank borrowings, debentures, and the issue of commercial papers (CPs). NBFCs in India are closely integrated with other entities in the financial sector. For instance, as noted in Acharya et al. (2013), banking credit plays an important role in the NBFC liability side, which accounts for around 20 percent of NBFC liabilities. Debentures, on the other hand, account for around 30 percent of NBFC liabilities which appears to be active during the period of muted economic activity. The third important source of NBFC funding in India is the CP market. NBFCs' CP issuance account for around a quarter of the total CP issuance and constitutes approximately 20 percent of NBFC liabilities. Though its share has declined significantly in 2020 the current year has seen aggressive fund rising by NBFCs through the CP routes. The

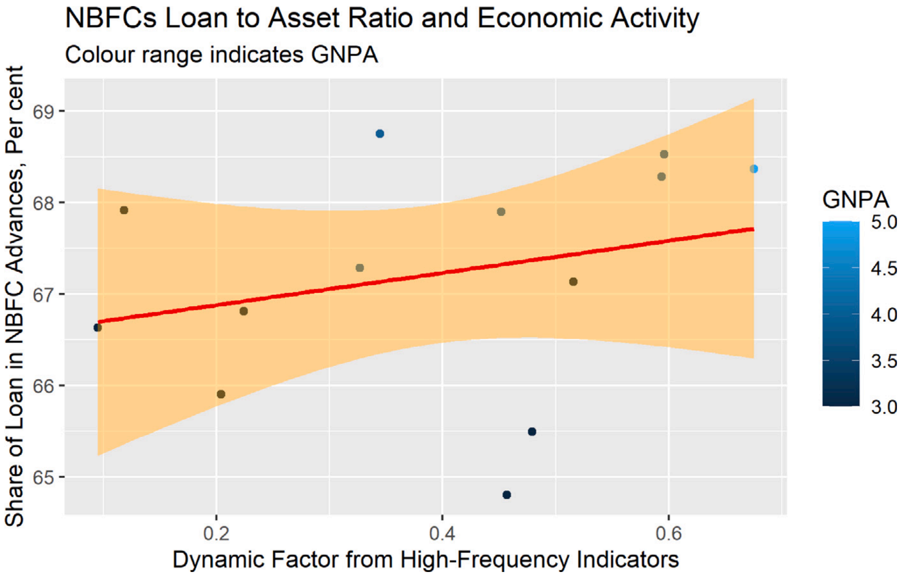

Fig. 3. NBFC-loans and economic activity.

Financial Stability Report (FSR) of the Reserve Bank of India discloses these features of NBFC liabilities on a half-yearly basis. FSR indicates that NBFCs are intertwined with Asset Management Companies - Mutual Funds (AMC-MF), Public Sector Banks, Insurance Companies, and Private Sector Banks.[11] These interlinkages point to the fact that if the impact of a negative productivity shock on the NBFC sector is not appropriately addressed, it may lead to a spillover through the financial system to the other sectors. This feature forms a crucial part of our model for evaluating the impact of a negative productivity shock through the banking channels. The inter-linkage is intertwined as the banking sector is linked through its deposits in the NBFCs. Mutual funds invest in non-convertible debt (NCDs) and debentures issued by NBFCs. Commercial banks also lend to NBFCs through CPs and debentures in India. A negative shock that impacts the cash flows (or incomes) of NBFCs could impact the banking sector, mutual funds, and CP markets. Instead of the relatively small share of NBFCs in total resource allocation, this inter-linkage could be a potential source of output and employment fluctuations.

NBFC credits are pro-cyclical with the economic activity of India. Fig. 3 indicates an increase in the share of NBFC loans during periods of the upturn in economic activity, which is in contrast with the general idea of the activity of shadow banks in the literature (Meeks et al., 2017).[12] Moreover, the gross non-performing assets also indicate a decline during the boom period.

Going further deep, we attempt to check the relation between the SCBs' contribution to NBFCs' liability and the cycle of economic activities. Fig. 4 plots banks' deposits as a percentage of NBFCs' liability goes up during high activity period.[13] These findings are consistent with the literature (Borio, Furfine, Lowe, et al., 2001) that credit is pro-cyclical in general and for India (RBI, Annual Report 2015, 2019).[14] However, the concern arises mainly because of the stance of literature which suggests a booming credit cycle or financial cycle could fuel an asset price bubble (Drehmann, 2013; Reinhart & Rogoff, 2009). Though we do not consider a financial bubble, a negative productivity shock could lead to defaults to certain NBFC loans, which may spill over through NBFC-bank interlinkages to the banking sector. This may not only adversely impact the credit-sensitive micro and small-scale industries but also large-scale industries that depend on bank credit.

4. The model

4.1. Description and timeline

This section presents a stylized partial equilibrium model to describe the link between dual-financial institutions and real sector outcomes. We consider two loan-providing financial institutions, namely scheduled commercial banks (SCB) and non-banking

[11] See Chapter II, Financial Stability Report 2019, Reserve bank of India (Chart 2.21, https://www.rbi.org.in/Scripts/PublicationReportDetails.aspx?UrlPage=&ID=952).

[12] As an economic activity indicator, a dynamic factor extracted from 15 high-frequency indicators representing industrial activities in India (Bhadury, Ghosh, & Kumar, 2020) is considered to represent non-agricultural sectors activity levels.

[13] Fig. 12 in Annex indicates the NBFCs dependence on debenture issuance goes up during the low economic activity period.

[14] (1) https://rbidocs.rbi.org.in/rdocs/AnnualReport/PDFs/0RBIAR2016CD93589EC2C4467793892C79FD05555D.PDF and (2) https://rbidocs.rbi.org.in/rdocs/AnnualReport/PDFs/0ANNUALREPORT2018193CB8CB2D3DEE4EFA8D6F0F6BD624CEDE.PDF.

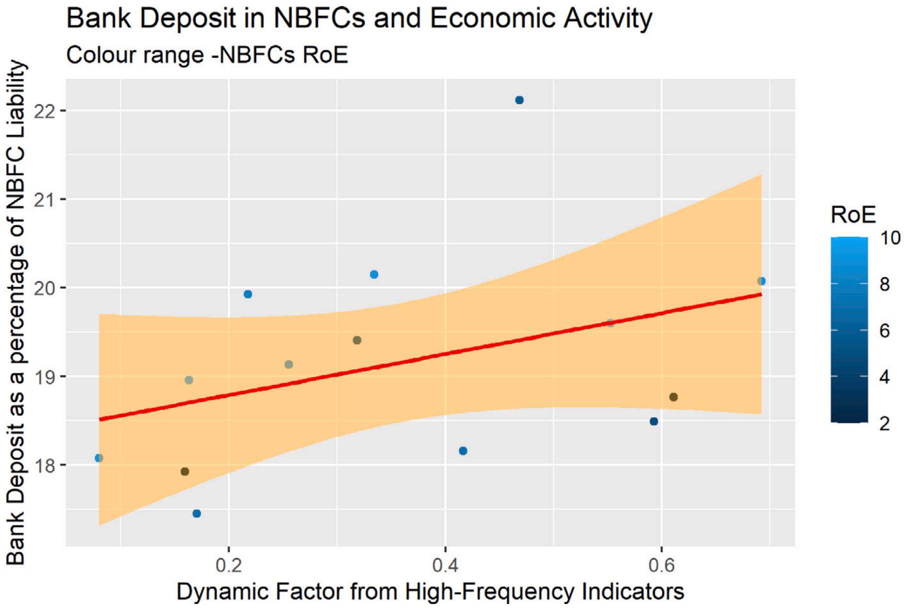

Fig. 4. Banks' deposit to NBFC. Fig. 4 uses data between 2016 and 2019.

financial institutions (NBFCs). SCB is a deposit-taking financial institution. It accepts deposits, provides loans and complies with banking regulations. Whereas, we model NBFC as a non-deposit-taking financial institution which borrows from SCB to lend money, and earns interest.[15] By assumption, SCB does not provide any small and fragmented loans, as small firms may lack the necessary collateral, or they may be exposed to risky and fragmented loans. NBFC provides loans to small firms but can charge a different interest rate than SCB. SCB lends to the large firm and the NBFC.

In the real side of the economy, there are two goods: X_1, which is produced by intermediate inputs, and X_2 which is produced by labour and capital. The intermediate inputs, indexed as y_i, where $i = \{1, 2, \dots, n\}$ are produced by small firms in a monopolistically competitive market setup. To produce y_i, labour is the variable input, and the fixed input is capital good which is needed to initiate the production.[16] Small firms take a loan from NBFCs to finance the initial capital expenditure. X_2 is produced by large firms (Pissarides type), and its production process uses two variable inputs, namely labour and capital. Large firm's capital investment is financed by SCB. X_2 is used as the only capital good in this system. Whereas X_1 is purely a consumption good. The prices are P_1 and P_2 respectively. P_1 can be determined by the price index of the intermediate inputs and P_2 is treated as a numeraire.

Although this stylized model is a static model, there is a specific sequence of events. This sequence of events introduces the uncertainty in this otherwise standard model. There are two stages in the model. In the first stage, endogenous variables are determined for any n (number of intermediate input producing firms). In the second stage, the production process starts, and intermediate input producing firms of sector 1 face idiosyncratic shocks. Not all small and fragmented intermediate input producing firms can finish the production successfully (which we discuss in Section 4.2). Once a shock is observed, the number of successful firms is determined. Thus, by backward induction, the equilibrium values of all endogenous variables are realized.

4.2. Production in sector 1

The production function for producing X_1 is of standard CES form and is specified as the following,

$$X_1 = \left(\sum_{i=1}^{n} y_i^{\rho} \right)^{1/\rho} \tag{1}$$

where $0 < \rho < 1$. Each intermediate good producing firm needs α unit of initial fixed capital. Note that, capital good is produced in sector 2. Therefore, the cost of the initial capital is $P_2\alpha$. NBFCs give loans for this initial capital to the intermediate input producing firm. Each unit of y_i is produced by β/φ_i unit of labour, where $\varphi_i \in \{0, 1\}$. The interpretation of φ_i, which is a stochastic parameter, is crucial in this hypothetical economy. If φ_i realizes the value 1 then the firm can produce one unit of output using β unit of labour,

[15] For model simplicity, we refrain from considering other sources of liquidity to NBFC, such as commercial papers, in the basic structure for the model. The direction of the results should remain unaltered with that extension.

[16] The standard technique in the Dixit-Stiglitz type model is to introduce a fixed cost to clear the profit of the firms in a monopolistically competitive setup, such that the number of firms can be determined endogenously.

but if φ_i takes the value 0 then the firm needs an infinite amount of labour to produce one unit. In other words, if the firm receives an idiosyncratic adverse shock, then the firm has to leave the production process even after investing in the fixed cost of capital.

The demand for y_i is derived from Eq. (1) as

$$y_i = \frac{p_i^{-\sigma}}{\sum_{i=1}^{n} p_i^{1-\sigma}} P_1 X_1 \tag{2}$$

where $\sigma \equiv \frac{1}{1-\rho}$ and p_i is the price of ith intermediate input. Given the demand function represented in Eq. (2), the price elasticity of demand for y_i is σ. Therefore, the price of the intermediate input is determined as

$$p_i = \frac{\beta w_1}{\varphi_i} + \frac{p_i}{\sigma}, \tag{3}$$

where w_1 is the wage rate in sector 1. In case of an idiosyncratic negative shock, the marginal cost as well as the price of the ith intermediate input becomes prohibitively high (infinite), and otherwise, the price of the ith intermediate good is more than the marginal cost of production (as, $\rho < 1$). While the unit profit markup over unit cost is $\frac{p_i}{\sigma}$, the total profit, the firm i makes, is $\frac{y_i p_i}{\sigma}$. Since, any firm secures only zero profit in a monopolistically competitive market,

$$y_i = \varphi_i \frac{\rho\sigma}{\beta w_1} P_2 \alpha r_N. \tag{4}$$

r_N is the rent NBFC charges from the intermediate firms. Here, ith firm can produce non-zero output only if it does not receive a bad shock. Therefore, the labour demand is sector 1 is

$$L_1^d = \varphi \frac{\rho}{1-\rho} \frac{r_N}{w_1} P_2 \alpha. \tag{5}$$

where, $\varphi \equiv \sum_{i=1}^{n} \varphi_i$. Note that, φ takes the value n, if none of the firms faces negative shock, otherwise $\varphi = n - \tilde{s}$, where $\tilde{s}$ represents the number of the firms, which receive a negative productivity shock.

Given the real wage of the sector 1, which we solve in the later section, the labour market clearing condition for Sector 1 determines the number of intermediate input producing firms operating in the market.

$$n = \frac{1-\rho}{\rho} \frac{\frac{w_1}{P_2} L_1}{\alpha r_N} + \tilde{s} \tag{6}$$

The capital demand of the sector 1 is αn. The rent paid by the sector 1 firms is determined by the NBFCs' which is derived in Section 4.5.

4.3. Production in sector 2

Firms in sector 2 are of unit measure and produce capital good. Firms face a homogeneous of degree one production function where the factor inputs are capital and labour (expressed as, $F(K_2, L_2)$). Firms in this sector borrow from SCB for their capital expenditure and hire workers from a frictional labour market by posting costly vacancies. Once the firms are matched with workers, the wage is determined by Nash bargaining between worker and firm.[17]

The firm's nominal working profit per labour is,

$$\pi \equiv P_2 f(k) - w_2 - r_B P_2 k - \delta P_2 k \tag{7}$$

where, $k \equiv K_2/L_2$ is the per capita capital, w_2 is the wage paid by the firm in sector 2, r_B is the interest rate set by SCB and δ is the rate of depreciation. $f(k)$ is monotonically increasing, concave and follows the *Inada conditions*.

Our assumptions regarding the Production in sector 1 and 2 in a way relate to firms' size distribution, and they are influenced by two considerations. First, Hsieh and Klenow (2009) using Annual Survey of Industries Data documented the presence of a large number of small, medium and large size (in terms of value added) firms operating in India. Turning to an alternative dataset (Prowess dataset by CMIE), we define the size of the firms in terms of their average revenue, then the distribution of the firms is given in Fig. 5, which is in line with Hsieh and Klenow (2009)'s observations. Since there is a large number of firms in India, that are either small or medium-sized and located at different positions on a supply chain, a shock to these firms would eventually get transmitted to the larger entities as envisaged in our model, and therefore impact the overall economic variables.

4.3.1. Wage determination in sector 2

The labour market friction in Sector 2 hinders firms and workers to match readily. Each firm and worker enter sector 2 as a vacant firm and an unemployed worker, respectively. Given $\bar{L}_2$ is the total labour force available to sector 2, firms post $v\bar{L}_2$ vacancy to get the labour for the production (that is, v proportion of labour force of sector 2 is the posted vacancy in this sector). Similarly,

[17] Here, we introduce a stylized labour market friction, namely DMP style search and matching friction (Pissarides, 2000), because one of the aims of this paper is to understand the propagation effect of NBFCs on unemployment among other real variables.

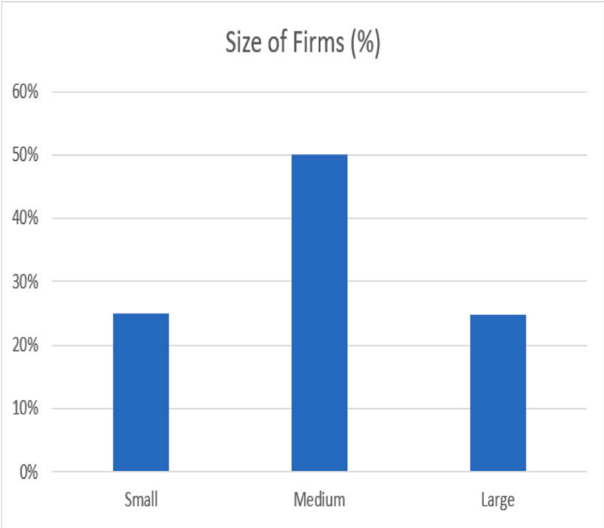

Fig. 5. Size distribution of indian firms.

u is the proportion of unemployed in the labour force of sector 2. Given v and u are the vacancy rate and unemployment rate, the matching function which describes the matches between firm and worker is given by,

$$m = m(u, v) \tag{8}$$

where m is increasing in each of its elements, concave and homogeneous of degree one.[18] The rate of getting a job by the worker is $m(1, \theta)$ and the rate of getting a worker by the firm is $m(\theta^{-1}, 1)$, where $\theta \equiv \frac{v}{u}$, is conventionally known is *market tightness*. After getting matched with the worker, the firm and worker set wage and start producing. The idiosyncratic job breaking rate is denoted as λ. Job arrival rate to the worker, worker arrival rate to the firm and job break rate follow the Poisson process. The value of a filled vacancy is J_F and the value of a vacant job is J_V. The following equations determine J_F and J_V in Bellman form.

$$r_B J_F = \pi - \lambda(J_F - J_V) \tag{9}$$

and

$$r_B J_V = -P_2 d + m(\theta^{-1}, 1)(J_F - J_V) \tag{10}$$

where d is the real cost of posting a vacancy. The firm in sector 2 does not need to borrow to finance this cost. $\left(J_F - J_V\right)$ shows the surplus generated by a filled job over a vacant job. Therefore, Eq. (9) shows that the return value from a filled job to a firm is operating profit from one worker minus the possible expected loss of surplus due to an idiosyncratic job break. Similarly, Eq. (10) describes that a vacant post incurs a cost of $-dP_2$, but it has an expected surplus from a productive match with a worker. 'Free entry and exit' of firms guarantees $J_V = 0$ in equilibrium. Therefore, from Eq. (10),

$$J_F = \frac{P_2 d}{m(\theta^{-1}, 1)}. \tag{11}$$

We rearrange Eq. (9) and use Eq. (7) to express J_F as the following,

$$(r_B + \lambda)J_F = P_2 f(k) - w_2 - P_2 k r_B - \delta P_2 k \tag{12}$$

The firm determines the desired level of k by maximizing J_F with respect to k. That results into the familiar first order condition of marginal product of per capita capital being equal to the marginal cost of it, plus the rate of depreciation. That is,

$$f'(k) = r_B + \delta \tag{13}$$

Clubbing Eq. (11) and Eq. (12) we get,

$$P_2\Big(f(k) - (r_B + \delta)k\Big) - w_2 - \frac{P_2 d}{m(\theta^{-1}, 1)}(r_B + \lambda) = 0 \tag{14}$$

Similar to the firm the value functions for employed workers and unemployed workers are denoted as V_E and V_U. A worker earns w_2 as flow income while employed and we assume the flow return while unemployed is a fraction $(0 < \tau < 1)$ of the wage

[18] These are standard assumptions of the matching function. See, Pissarides (2000).

of sector 1.[19] The surplus generated from a work is $\left(V_E - V_U\right)$. For the employed workers, the flow value of being employed thus consists of flow income minus the expected surplus loss from a possible job loss. Similarly, the flow value of being unemployed is w_2 plus the expected surplus gain from a possible productive match with the firm. Hence the Bellman forms of the value functions are expressed as,

$$r_B V_E = w_2 - \lambda(V_E - V_U) \tag{15}$$

and,

$$r_B V_U = \tau w_1 + m(1,\theta)(V_E - V_U). \tag{16}$$

Once the firm and worker match, the wage is set by Nash bargaining where both agents bargain over the surplus they generate from the match. Given $0 < \varrho < 1$ be the bargaining power of the worker w_2 is determined as,

$$w_2 = \arg\max_{w_2} \;\; (J_F - J_V)^{1-\varrho}(V_E - V_U)^{\varrho}. \tag{17}$$

The above maximization exercise with standard algebraic manipulation using Eqs. (11) and (15) finds the wage of sector 2 as the following,

$$w_2 = (1-\varrho)\tau w_1 + \varrho P_2\left(f(k) - (r_B + \delta)k + \theta d\right). \tag{18}$$

Eq. (18) is intuitively appealing. When the bargaining power of the worker is less, the wage in sector 2 becomes closer to sector 1 wage. On the other hand, if the bargaining power of the firm is limitingly zero, then almost the entire part of operating profit after interest payment goes to the worker as wage.

4.3.2. Steady state factor demand of sector 2

The steady state unemployment rate in the DMP style model is defined as, the unemployment rate for which the outflow from unemployment and inflow into unemployment are equal (Pissarides, 2000). Therefore, the steady state unemployment rate is,

$$u^* = \frac{\lambda}{\lambda + m(1,\theta)}. \tag{19}$$

Thus, Eqs. (13), (14), (18) and (19) solve for per capita capital demand, wage in sector 2, market tightness and equilibrium unemployment rate in sector 2 *as a function of* r_B. Given the solution of u^*, the solution for the productive labour force in sector 2 is $(1-u^*)\bar{L_2}$. Therefore, aggregate capital demand for sector 2 is $k^*(1-u^*)\bar{L_2}$.

4.4. Interest rate determination of SCB

SCB lends to NBFCs and the firms of sector 2 and earns interest income. The SCB accepts deposits and is allowed to lend a given fraction (policy determined reserve ratio) of the deposit. To the deposit holders, SCB pays back interest which is in a way predetermined by central monetary authority.[20] There is a cost associated with running the operation of SCB and that is assumed as the quadratic function of the total lending amount by the SCB. The assumption about the structure of the banking market is as follows: (a) SCB cannot set a monopoly interest rate and (b) SCB is not allowed to charge discriminatory interest rates. Free entry and free exit are not allowed for the SCBs in this model. Therefore, it can preserve its profit but cannot be a "price setter". The interest rate that SCB charges to its borrowers, is derived from the profit maximizing exercise of SCB. Following is the optimization problem for SCB.

$$\text{Maximize } \pi_B = r_B P_2 K_B - \bar{r} D - \frac{\kappa}{2} P_2 K_B^2 \tag{20}$$

with respect to K_B and subject to

$$K_B = K_1 + K_2 \tag{21}$$

$$D = \psi P_2(K_1 + K_2). \tag{22}$$

where $0 < \bar{r} < 1$, $\psi > 1$ and $0 < \kappa < 1$. K_B is denoted as aggregate SCB lending. It is assumed that the credit market clears. The aggregate deposit that SCB collects is denoted as D, on which SCB pays $\bar{r}$ interest.

The above maximization problem solves for r_B as,

$$r_B = \bar{r}\psi + \kappa(K_1 + K_2). \tag{23}$$

As mentioned earlier, in our model banks cannot charge differentiated interest rates. This precludes them from directly lending to the risky and fragmented intermediate goods producing firms (sector 1). To circumvent this, banks lend to NBFCs, which extend credit to sector 1, and absorb risk. This augurs well with the NBFC sector, which has enough sectoral presence and has an information advantage in these niche areas.

[19] It can be seen in the following ways. The wage in sector 1 which has a competitive labour market, provides almost the subsistence level wage in a labour abundant country. Or, a labourer who appears for a sector 2 job, can always get a job in sector 1 because of free entry in sector 1 with an *iceberg* cost of movement. Hence, sector 1 wage plays as the base of outside flow income while not employed in sector 1.

[20] We assume that the SCB's interest rates on deposits are closely linked with central bank's policy rate and operating target.

4.5. Interest rate determination of NBFC

NBFCs borrow from the SCB and lend it to intermediate input producing firms of sector 1 to meet their initial capital requirement. The initial capital itself works as "hypothecation" or "mortgage" to NBFCs. The interest rate that NBFCs charge is announced before the commencement of any production activity. Therefore, NBFCs announce the interest rate in an uncertain environment, which arises due to possible negative shocks to the intermediate input producing firms.

It is assumed that NBFCs are operating in a perfectly competitive environment and making zero profit.[21] Given r_B is the commercial bank's rate of interest, NBFCs' have to pay back $(1+r_B)K_1$ to the bank, the cost borne by the NBFCs being $r_B K_1$. Here, K_1 is the aggregate demand of initial capital from sector 1 which is supplied by NBFCs. As we described in Section 4.1, $K_1 = P_2 \alpha n$.

However, due to idiosyncratic stochastic negative productivity shock to the intermediate input producing firms, few firms are not able to produce and sell the product. In that case, those firms will be unable to pay back the interest to NBFCs.[22] Keeping this uncertainty into consideration, NBFCs charge a premium over the cost of borrowing to break even. Thus, the zero profit condition of NBFCs results into,

$$r_N = \phi^e r_B \tag{24}$$

where $\phi^e \equiv E(\frac{n}{n-\tilde{s}}) \in [1,\infty)$. Here ϕ^e shows the expected ratio of total intermediate input producing firms to successful intermediate input producing firms. That ratio also indicates the inverse of the expected fraction of good loans out of the total number of loans provided by NBFCs. Clearly, r_N is higher than r_B. That is, NBFCs charge a higher interest rate than their cost of borrowing to hedge against the expected loss from uncertain cost recovery.

Using Eqs. (6) and (24), the number of productive firms in the intermediate input producing sector, $n-\tilde{s}$, can be expressed as,

$$n-\tilde{s} = \frac{1-\rho}{\rho}\frac{L_1}{\alpha\phi^e r_B}\frac{w_1}{P_2}. \tag{25}$$

Note that, the higher the markup NBFCs charge above the interest rate of SCB, the lesser the successful productive intermediate firms in the market. Earlier we defined ϕ^e as $E(\frac{n}{n-\tilde{s}})$. For ease of interpretation, we assume that $\tilde{s}$ can be expressed as the proportion of n.[23] That is, $\tilde{s} \equiv sn$, where s is a stochastic parameter with the bound of $[0,1)$. Therefore, ϕ^e becomes $E(\frac{1}{1-s})$. This says, the expected number of firms out of which one firm survives, is ϕ^e.

Now, we can rewrite the number of intermediate input producing firms as,

$$n = \frac{1-\rho}{\rho}\frac{L_1}{\alpha r_B}\frac{w_1}{P_2}\left[\frac{\frac{1}{1-s}}{E(\frac{1}{1-s})}\right]. \tag{26}$$

5. Equilibrium and comparative statics

The model closes with the two-sector earning equivalence condition, where the infinite present value of income stream for working in sector 1 equalizes to the infinite present value of being unemployed in sector 2. This is because, by assumption, everyone joins sector 2 as unemployed in contrast to sector 1, where one can readily get a job while entering. In notation, $\frac{w_1}{r_B} = V_U$. This equivalence condition expresses w_1/P_2 in terms of θ after some straightforward simplification. That is, the real wage in sector 1 can be written as,

$$(1-\tau)\frac{w_1}{P_2} = \frac{\varrho}{1-\varrho}\theta d \tag{27}$$

Now, the model is solvable for all the endogenous variables in terms of the given parameters.

Definition 1. An equilibrium in this model is a set of the solution $\{r_B^*, k^*\}$ which satisfies the demand for capital for the firms in sector 2 and maximizes the profit of the SCB given s, such that, for $\{r_B^*, k^*\}$, $\{n^*, r_N^*, \frac{w_1}{P_2}^*, \theta^*, u^*, \frac{w_2}{P_2}^*\}$ have non-zero positive equilibrium outcome and,

(i) $\{\theta^*, \frac{w_2}{P_2}^*\}$ solves the market tightness and the wage rate that maximizes the Nash bargaining surplus and satisfies the free entry condition for the firms in sector 2,

(ii) $\{u^*\}$ solves for the steady state unemployment rate in sector 2,

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[21] Besides being parsimonious and easy to explain, we use perfect competition because it jells well with the Indian scenario, where there is a large number of NBFCs. As of FY2022, 9467 non-deposit taking NBFCs operate in India (https://rbi.org.in/Scripts/BS$_$NBFCList.aspx). However, the perfect competition assumption can be relaxed without losing the spirit of our results. If we allow NBFCs to exploit monopoly power, the price of credit for sector 1 (r_N) becomes the sum of marginal cost and the monopolistic mark-up. The latter is a function of the elasticity of expected credit demand in sector 1 with respect to r_N. The strength of our results rather depends on the credit demand elasticity. That is, a high value of ρ will provide results with similar magnitude, as in the case of perfect competition. This can also be seen as a perfect insurance market among risk-neutral NBFCs: "gainers finance the loss of losers" and break even without seeking any extra rent.

[22] NBFCs do not have the "Lender of Last Resort" facility from the central bank.

[23] Relaxing this assumption does not defy the results of the paper but increase the complexity of computation to a large extent.

Table 1
Model summary.

Equation	(Definition)
$X_1 = \left(\sum_{i=1}^{n} y_i^{\rho}\right)^{1/\rho}$	(output of X_1)
$p_i = \frac{\beta}{\varphi_i} + \frac{w_1}{\rho}$	(price of intermediate input)
$K_1 = n\alpha$	(demand of capital in Sector 1)
$y_i = \frac{\varphi_i}{\varphi}\frac{L_1}{\beta}$	(output of intermediate input)
$X_2 = F(L_2, K_2) = L_2^{\vartheta} K_2^{1-\vartheta}$	(output of X_2)
$m = \frac{uv}{u+v}$	(matching function)
$k = \left(\frac{1-\vartheta}{r_B+\delta}\right)^{\frac{1}{\vartheta}}$	(per capita capital demand in sector 2)
$P_2\left(f(k) - (r_B+\delta)k\right) - w_2 - P_2 d(1+\theta)(r_B+\lambda) = 0$	(beverage curve)
$w_2 = (1-\varrho)\tau w_1 + \varrho P_2\left(f(k) - (r_B+\delta)k + \theta d\right)$	(wage in sector 2)
$u^* = \frac{\lambda}{\lambda + \frac{\theta}{1+\theta}}$	(steady state unemployment rate)
$K_2 = \left(\frac{1-\vartheta}{r_B+\delta}\right)^{\frac{1}{\vartheta}}(1-u^*)\bar{L}_2$	(*agg* demand for capital in sector 2)
$r_B = \psi\bar{r} + \kappa\left(n\alpha + k(1-u^*)\bar{L}_2\right)$	(interest rate of SCB)
$r_N = \phi^e r_B$	(interest rate of NBFC)
$\phi^e = E(\frac{1}{1-s})$	(inverse of expected fraction of successful loan)
$(1-\tau)\frac{w_1}{P_2} = \frac{\varrho}{1-\varrho}\theta d$	(earning equivalence condition)
$n = \left(\frac{1-\rho}{\rho}\frac{\varrho}{1-\varrho}\frac{L_1 d}{\alpha(1-\tau)}\right)\frac{\theta}{r_B}\left[\frac{\frac{1}{1-s}}{E(\frac{1}{1-s})}\right]$	(size of the intermediate input industry)

(iii) $\{n^*, \frac{w_1}{P_2}^*\}$ solves for the number of intermediate input producing firms and the wage rate which satisfies the zero profit condition for intermediate input producing firms in sector 1 and the earning equivalence condition between the two sectors, and,
(iv) $\{r_N^*\}$ solves for the interest rate charged by the NBFCs.

Table 1 summarizes the structure of the model. The simultaneous solution of the equations describes the equilibrium of this stylized model. We also specify the commonly used functional forms for the production function and the matching function.

Using the matching function mentioned in the Table 1, we solve w_2 and θ and hence, u^* as a function of k and r_B. Now, replacing n, $\frac{w_1}{P_2}$, u^* and θ, into the equation of "*interest rate of SCB*" (as mentioned in the Table 1), it can be expressed as a reduced form equation,

$$S^B\Big(\underset{-}{k}, \underset{+}{r_B};\ \underset{-}{\psi}, \underset{-}{\bar{r}}, \underset{-}{s}, E\big(\underset{+}{\frac{1}{1-s}}\big), \mathcal{A}\Big) = 0. \tag{28}$$

A detailed description of the algebraic steps to get the reduced form equation is provided in Appendix B. The sign below the variables and the parameters signifies the sign of the partial derivatives of the function S^B with respect to that particular variable or parameter. In Eq. (28) we explicitly specified the policy parameters, stochastic parameter, and the expectation of the stochastic parameter only, which are identified as parameters of interest. Where $\mathcal{A}$ is the set of all other parameters present in the reduced form Eq. (28).

We rearrange the equation of "*per capita capital demand in sector 2*" equation (as mentioned into the Table 1) and express that as,

$$D^k(\underset{+}{k}, \underset{+}{r_B}; \mathcal{B}) = 0. \tag{29}$$

As we specified the signs of the partial derivatives of Eq. (28), we mention the same for Eq. (29) too. $\mathcal{B}$ is denoted as the set of all the parameters present in the equation of "*per capita capital demand in sector 2*" that are neither the policy parameters nor the stochastic parameters.

The Eqs. (28) and (29) in (k, r_B) plane are represented as an upward sloping and a downward-sloping schedule, respectively. The intersection point of the two schedules which can be guaranteed by certain non-imposing parametric specifications shows the equilibrium of the model for a given realized value of s. We depict the equilibrium in Fig. 6 as (k^*, r_B^*).

5.1. Comparative statics results

5.1.1. Short term idiosyncratic shock

For a negative shock in the loan defaulter proportion among the intermediate input producing firms, that is, for a higher realized value of s, $S^B(\cdot) = 0$ curve in Fig. 6 moves upward to $S^{B\prime}(\cdot) = 0$. This causes a fall in equilibrium k (as $k^{*\prime}$) and a rise in equilibrium r_B (as $r_B^{*\prime}$). In our stylized model, this negative shock can be considered as the short term idiosyncratic shock.

The impact of a rise in s is the fall in $\frac{n-\tilde{s}}{n}$, that is, a decrease in the share of firms who have successfully repaid the borrowing amount from NBFCs. This implies the borrowing amount taken from SCB by NBFCs is larger than the repayment to NBFCs. Given the

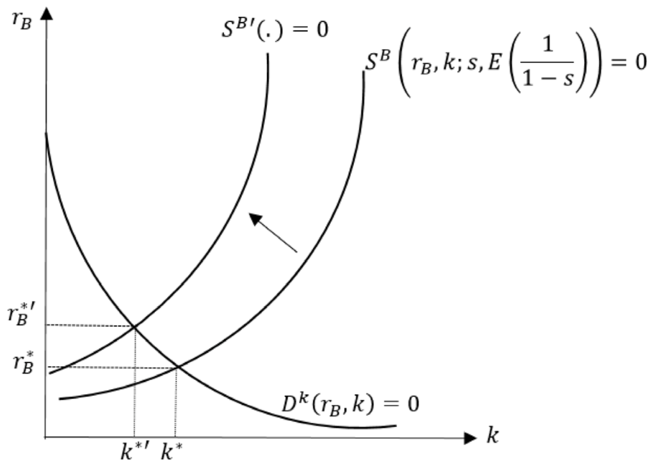

Fig. 6. Equilibrium solution for r_B and k.

larger capital demand from sector 1 as compared to repayment, the price of a loan, that is r_B, increases. That causes the fall in k and the rise in r_N. This implies a shrink, both in the size of sector 1 and sector 2. That has an obvious negative impact on employment and real wages. Equilibrium market tightness in sector 2 (θ^*) depends positively on k^* and negatively on r_B^* (See Appendix A for the mathematical expression). Therefore, a negative NBFC shock leads to a fall in θ^* due to a lack of vacancy postings (in other words, job creation). That causes a rise in the unemployment rate in sector 2 and a fall in the real wage of both sectors 1 and 2. Additionally, due to a rise in the interest rate and a fall in market tightness, there is a second round contractionary effect on n, that is, the number of intermediate input-producing firms. So, a short term idiosyncratic NBFC shock can have a real sector impact via the interest rate channel of the SCB, and more importantly, that can transmit into capital formation, unemployment, and wage rate of the two sectors.

Proposition 1. *A random negative idiosyncratic shock in the loan recovery of NBFCs' leads to*
(i) rise in real interest rate of both SCB and NBFCs,
(ii) fall in the capital input of sector 2 and the real wage of both the sectors,
(iii) increase in unemployment, and,
(iv) fall in output of both sectors.

5.1.2. Structural shock

The difference between short term idiosyncratic shock and structural shock is, in the case of short term idiosyncratic shock we considered a change in the observed value of the random parameter, s, whereas, for the structural shock, the expected value of the random parameter is changed. That is, in the context of the present model, we change ϕ^e to see the effect of structural change. As it is explained in Section 4.5, ϕ^e is the expectation of the total number of loans to good loans ratio provided by NBFCs. If this ratio increases then it implies structurally the return is less in the sector where NBFCs operate.

In Fig. 6, $S^B(.) = 0$ curve shifts down for an increase in $\phi^e (\equiv E(\frac{1}{1-s}))$ for any given observed value of s. That leads to a reduction in equilibrium r_B^* and an increase in equilibrium k^*, for any given observed value of s. As r_B^* falls and k^* rises, market tightness in sector 2 and real wage in both sectors go up. Since these results are true for any observed value of s, that implies the expected values of θ, w_1/P_2 and w_2/P_2 also increase.

The difference between the interest rate charged by NBFCs and SCBs increases, because NBFCs are now operating in a market where the inherent return is less. If r_N increases n falls. That reduces NBFCs' borrowing from SCBs. Hence, r_B also decreases due to the lesser demand for the loan from sector 1. Moreover, due to less r_B, the equilibrium per capita capital in sector 2 increases causing more job creation in sector 2. The unemployment rate falls. As a second round effect, the drop in n is moderated by the decrease of r_B and the increase in θ.

5.1.3. Policy intervention

Intuitively the effects of policy decisions are straightforward in this hypothetical model. The reduction in policy rate $\bar{r}$ has a positive impact on k and a negative impact on u. Therefore, to counter an increase in s, policy maker may go in the line of reducing the policy rate. We explain the effect of the policy shock in light of this hypothetical model. The policy interest rate ($\bar{r}$) and the SCB's lending interest rate (r_B), are positively related. That implies, credit flow to both sector 1 and sector 2 rises following a reduction in $\bar{r}$. Also, the decrease in r_B reduces the cost of production in both sectors and thereby encourages production. As a result number of firms in sector 1 increases and so does the number of vacancies in sector 2. However, the policy rate transmission is an issue to ponder upon. In this model, the first-round rate transmission depends positively on another policy variable, ψ, that is a proxy of the inverse of the reserve requirement. Therefore, a lower (higher) value of ψ escalates the policy transmission when the policymaker wants to reduce (increase) the market interest rate (r_B and r_N) (see, Eq. (23)). The intuition behind this is, the lower (higher) the value of ψ, the lesser (greater) the unused fraction of the deposit which SCB can (cannot) lend. Thus, both $\bar{r}$ and ψ play an important role as policy instruments. However, as a second round effect, the decrease (increase) in r_B becomes moderated by the rise (fall) in k, n and $(1-u^*)$, which increases the credit demand. The extent of the moderation in r_B depends crucially on the magnitude of κ, which is a proxy for the marginal cost of lending (*mclr*) for SCB. The moderation in the change in r_B can be amplified by a higher κ as it increases the cost of lending to SCB.

6. Model extension: Sectoral risk and transmission

The sectoral concentration of operation is a distinct characteristic of Indian NBFCs.[24] This serves the purpose of filling up the capital deficiency of particular sectors. However, if the sector as a whole faces a shock, then that translates to the banking system. In the baseline model described above, we dealt with the idiosyncratic shocks to the small firms that are associated with NBFCs. The interest rate charged by NBFCs is internalizing that risk, and therefore, charging a higher interest rate as compared to r_B. This was ensuring the repayment mechanism to SCBs remains unaffected. Here, we extend the baseline model and consider sectoral risk, which all intermediate input-producing small firms are subject to.

We introduce the sectoral shock in sector 1 using Melitz (2003) framework in our baseline model. The intermediate input producing firms incur a sunk cost, f, before learning about the sectoral productivity. We can understand f as an entry cost. Firms finance that cost by borrowing from the NBFCs. As in our baseline model, firm i uses $\frac{\beta}{\psi_i}$ units of labour, where β is the same for all firms, but the realization of ψ_i is firm-specific. However, in this extension, β is also a stochastic parameter, defined over a non-zero, continuous and bounded domain (*e.g.* $\mathcal{B} \equiv [\underline{\beta}, \overline{\beta}]$, where $\underline{\beta} \geq 0$ and $\overline{\beta} > 0$), and realizes its value from a probability distribution G. Firms find the realized value of β after entering the market. Otherwise, the production process remains the same as earlier. That is, firms incur a fixed cost α in terms of capital good (X_2) to produce the output which is covered by borrowing from NBFCs. Therefore, the total cost of producing y_i unit of intermediate good is $P_2\alpha r_N + w_1\frac{\beta}{\varphi}y_i$. The production technology for producing X_1 also remains unaltered as described in Eq. (1). Thus, the demand for y_i is the same as in Eq. (2) and price determination for intermediate input producing firms also remain unchanged as mentioned in Eq. (3). Now, the profit of intermediate input producing firm i after making y_i unit of output is, $\pi^I_{1i} \equiv \frac{p_i y_i}{\sigma} - P_2\alpha r_N$. Since, price, p_i, depends on β (see Eq. (3)), therefore, π^I_{1i} is also a function of β. If $\pi^I_{1i}(\beta) \geq 0$ then firms can finish the production. Hence, the cut-off β^* is such that,

$$\pi^I_{1i}(\beta^*) = 0. \tag{30}$$

The effective probability density function for the labour intensity of the intermediate input producing firms, thus, becomes, $\tilde{g}(\beta) = \frac{g(\beta)}{G(\beta^*)}$ for $\beta \leq \beta^*$, and $\tilde{g}(\beta) = 0$, otherwise. That is, if β remains below the cut-off β^*, then the firms generate positive profit and continue production. However, if the realized value of β is higher than the cut-off β^*, then the profit of the firms go below zero and no firms commence production. We name the states as a "bad season" if $\beta > \beta^*$ and "good season" if otherwise.

In this version of the model, we specify the price of X_1, which takes the standard form as in the literature. That is,

$$P_1^{1-\sigma} = \sum_{i=1}^{n}\left(\int_{\beta\in\mathcal{B}} p_i(\beta)^{1-\sigma}\tilde{g}(\beta)d\beta\right). \tag{31}$$

All the successful firms (that is, for which $\varphi = 1$) sets equivalent price because they are all homogeneous and faces the same value of β. Following the same notation mentioned in the baseline model, the number of successful firms is $(n-\tilde{s})$. Therefore, we rewrite the price expression specified in Eq. (31) after making a few straightforward simplifications as,

$$P_1 = (n-\tilde{s})^{\frac{1}{1-\sigma}}\frac{w_1}{\rho}\tilde{\beta}. \tag{32}$$

where, $\tilde{\beta}^{1-\sigma} \equiv \int_{\beta\in\mathcal{B}}\beta^{1-\sigma}\tilde{g}(\beta)d\beta$. Here, $\tilde{\beta}$ can be interpreted as an index of labour intensity. Since good 1 is sold in a competitive product market, the revenue has to be exhausted among its factor inputs if production takes place. In other words, the market clearing condition is, $P_1X_1 = w_1L_1 + (n-\tilde{s})(P_2\alpha + P_2 f)r_N$. Note that, the sunk cost was incurred in capital goods and hence, that good itself can be used as the mortgage. The cost of f is financed by NBFCs. Therefore, firms have to make the interest payment to NBFCs in case of successful completion of production. Now, we can express π^I_{1i} in terms of parameters and factor prices, but independent of i. Using Eqs. (2), (3) and (32) into the expression of π^I_{1i} for the successful firms (that is, $\varphi = 1$), we get

$$\pi^I_1(\beta) = \left(\frac{\beta}{\tilde{\beta}}\right)^{1-\sigma}\frac{w_1L_1 + (n-\tilde{s})(P_2\alpha + w_1 f)r_N}{\sigma(n-\tilde{s})} - P_2\alpha r_N. \tag{33}$$

The free entry condition ensures,

$$G(\beta^*)\int_{\beta\in\mathcal{B}}\pi^I_1(\beta)\tilde{g}(\beta)d\beta = P_2 f r_N. \tag{34}$$

[24] Section 3 and Acharya et al. (2013) provide evidence of the sectoral concentration of NBFCs' operations. This feature of the NBFC operation exposes them to sectoral risk.

The above two equations are crucial for solving cut-off productivity, β^*, as defined by Eq. (30). Given r_N and $\frac{w_1}{P_2}$, we reach the following equation which implicitly solves the β^* after a few algebraic manipulations.

$$G(\beta^*)\left[\left(\frac{\beta^*}{\tilde{\beta}}\right)^{\sigma-1}-1\right]=\frac{f}{\alpha},$$
$$\Rightarrow \int_{\underline{\beta}}^{\beta^*}\left(\left(\frac{\beta^*}{\beta}\right)^{\sigma-1}-1\right)g(\beta)d\beta=\frac{f}{\alpha} \tag{35}$$

Eq. (35) solves the β^*. The left-hand side of Eq. (35) is positively related to β^* because $\sigma > 1$ and the right-hand side of that equation does not vary with respect to β^*. Note that, β^* has a negative relation with the fixed cost, α and has a positive relationship with the sunk cost. We will discuss the effect of G on β^* later.

In addition to β^*, another variable of interest that we need to characterize is n. Combining Eqs. (33) and (34), we determine the equilibrium number of intermediate input producing firms, n in terms of given parameters and $\frac{w_1}{P_2}$, r_N and β^*.

$$n=\frac{\frac{w_1}{P_2}L_1}{\left[f\left(\frac{\sigma}{G(\beta^*)}-1\right)+\alpha(\sigma-1)\right]r_N}+\tilde{s} \tag{36}$$

In this model extension, we get Eq. (36) in place of Eq. (6) of the baseline model.[25] If we set f equals to zero and then we get back the exact formulation of Eq. (6). It is intuitive that lesser *chance* of realizing lower marginal cost (i.e., lower value of $G(\beta^*)$) causes a lesser number of firms to enter the market. Eq. (36) also indicates the same. Even for same β^*, a riskier sector 1 would attract a lesser number of intermediate input producing firms. This feature was absent in the baseline model as explained in the previous subsections.[26] This is a the standard (Melitz, 2003) type result. The interest rate charged by NBFCs, r_N, brings the only departure from the Melitz-type setup. In the next section, we characterize r_N in this changed model formation and understand additional channels that are impacting n due to the operation of NBFCs.

6.1. Interest rate determination

In this subsection, we explain the determination of the equilibrium interest rate of both NBFC and SCB in the context of this extension. The model structure for loan recovery is kept unchanged. That is, the assumption for the perfect insurance market among NBFCs remains intact. This holds for both sectoral risk and firm-wise idiosyncratic risk in sector 1. Broadly, the major results remain unchanged even if we introduce a certain level of financial friction.[27]

As the baseline model, SCB lends to NBFCs and the large firm of sector 2. In a "bad season", NBFCs finance only the sunk cost to intermediate input producing firms, because none of the intermediate input producing firms in sector 1 can commence production. Otherwise, NBFCs finance both the sunk cost and the fixed cost. Since it is unknown beforehand whether the *season* is "good" or "bad", NBFCs arrange the entire fund from SCB to finance all the seasons irrespective of its state. Thus, borrowing from SCB for sector 1 is not state-dependent. The cost of creating a loan also remains the same as in the baseline model. because the entire fund in terms of provisioning SCB has to make the entire fund (independent of *state*) available for loan.

Therefore, the SCB's profit-maximizing interest rate remains the same as in the baseline model, described in Eq. (23). Following is the relevant equation for this extension,

$$r_B=\bar{r}\psi+\kappa\left[(\alpha+f)n+(1-u^*)\bar{L_2}k\right]. \tag{37}$$

Now, consider the interest determination of NBFCs. If $\beta > \beta^*$ then intermediate input producing firms borrow only the sunk cost from the NBFCs and as we assumed a perfect insurance market, firms meet the repayment obligations too. The free entry condition in Eq. (34) ensures the repayment of the sunk cost even in the *bad season*. Given $\beta \leq \beta^*$ the intermediate input producing firms start production and hence, incur both sunk cost and the fixed cost of production which are financed by NBFCs. Analogous to the baseline model, due to idiosyncratic shocks $\tilde{s}$ firms fail to complete the production. As discussed in Section 6, keeping the model in line with the baseline model we assume $\tilde{s}$ firms face idiosyncratic shock and do not repay the loans. Therefore, whatever be the state, *good or bad*, n firms take the loan to finance the sunk cost and $(n-\tilde{s})$ firms make the repayment. However, in *good season* (i.e. $\beta \leq \beta^*$) firms take an additional loan to finance the fixed cost as well, and $(n-\tilde{s})$ firms repay the loan. As we discussed earlier in Section 4.1, NBFCs declare the interest rate at the beginning of the period, before getting the information about the actual number of failed intermediate input producing firms. Therefore, they consider the expected ratio of successful firms (or, failed firms) to total firms. Thus, ensuring zero profit in the competitive NBFC sector, the interest rate, r_N, charged by NBFCs becomes,

$$r_N=E\left[\frac{1}{1-s}\right]r_B\frac{\alpha+f}{\alpha G(\beta^*)+f}>E\left[\frac{1}{1-s}\right]r_B>r_B. \tag{38}$$

[25] Note that $\sigma-1=\frac{\rho}{1-\rho}$.

[26] If $G_1(\beta^*)\leq G_0(\beta^*)$ for all β^* and $G_1(\beta^*)<G_0(\beta^*)$ at least for one β^* then we define, that sector 1 is riskier which faces the labour intensity distribution, G_1.

[27] Interested readers can contact the authors for an online appendix where we introduce a certain degree of financial friction and present another version of this extended model. There we assume that in case of "bad season" NBFCs fail to return the loan to SCB and SCB carries the entire burden of loan default in "bad season". However, the broad understanding and the results of the model hold the same.

If we set $G(\beta^*) = 1$ (i.e. if there is no "bad season"), the zero-profit ensuring interest rate charged by NBFCs of this model extension matches exactly with the baseline model. Interestingly, here r_N is higher than the baseline model for any given r_B. Eq. (38) shows that an increase in α causes a rise in r_N, but in the case of f the relation is inverse. Also, *ceteris paribus*, a fall in $G(\beta^*)$ induces a rise in r_N.

6.2. Equilibrium and results

The extension of the baseline model, now, has a system of equations, and a simultaneous solution that guarantees the equilibrium of the model. We did not alter the model setup of sector 2 such that we can align the model with its previous version. However, the possibility of incorporating sectoral shock in sector 2 without tampering with the model in great deal is discussed in Section 8. The Definition 1 as a description of the equilibrium remains almost the same with a minor addition. In this extension, the solution of β^* must exist such that all other characteristics of the Definition 1 hold.

The general strategy we use to guarantee the solution of the model is as follows. We describe an implicit solution for $\{r_B^*, k^*\}$ such that all four conditions mentioned in the Definition 1 are satisfied, given any value of β^*. Then, we argue that Eq. (35) has a solution for β^* given the equilibrium $\{r_B^*, k^*\}$ as explained in Appendix B.[28] We write that equation in an implicit structural form describing the relation with the variables and parameters as follows.

$$S_1^B\left(\underset{-}{k}, \underset{+}{r_B};\ \underset{-}{\psi}, \underset{-}{\bar{r}}, \underset{-}{s}, E\left(\frac{1}{1-\underset{+}{s}}\right), \mathcal{A}_1\right) = 0. \tag{39}$$

Structurally, Eq. (39) is similar to Eq. (28). We use subscript "1" to distinguish the functional form of the latter equation from the former. $\mathcal{A}_1$ contains the set of parameters which constitutes of $G(\beta^*)$ and f in addition to the baseline model parameters. Since we keep the model formation of sector 2 intact, Eq. (29) remains unaltered. The intersection of Eqs. (39) and (29) in $\{k, r_B\}$ plane gives the solution of $\{k^*, r_B^*\}$ which satisfies the definition of the model equilibrium 1, given any β^*. Therefore, the equilibrium value of all the endogenous variables can now be expressed in terms of β^*. Since, in this version of the model Eq. (35) is independent of $\{k, r_B\}$, β^* can be solved only in terms of exogenous parameters. Thus, the solution of β^* from Eq. (35) completes the characterization of the equilibrium of this model extension.

6.2.1. Effects of sectoral risk

The main aim of extending the baseline model is to understand the impact of the change in sectoral risk. Let us consider another labour intensity ($\beta \in \mathcal{B}$) distribution $G_1(\beta)$ for the intermediate input producing firms in sector 1. The relation between $G(\beta)$ and $G_1(\beta)$ is as follows: (i) the mean labour intensities are the same (i.e. $\int_{\beta\in\mathcal{B}} G(\beta)d\beta = \int_{\beta\in\mathcal{B}} G_1(\beta)d\beta$) and, (ii) there exists a $\hat{\beta} \in (0, B)$[29] such that $G_1(\beta) \leq (\geq) G(\beta)$ when $\beta \leq (\geq) \hat{\beta}$. This implies the distribution G_1 is generated from G by shifting the probabilities towards the right tail labour intensity, keeping the mean constant. In other words, G and G_1 satisfy the single crossing properties with the same mean. This suggests if $\beta^* < \hat{\beta}$ then the risk of encountering a "bad season" is higher if intermediate input producing firms in sector 1 faces the productivity distribution G_1 as opposed to G.[30]

The Eq. (35) is the equation of interest in this analysis. LHS of Eq. (35) shifts downward in β^* plane, if $G_1(\beta) \leq G(\beta)$, given the same mean. Since the RHS of Eq. (35) is independent of β^*, the new cut-off labour intensity for $G_1(\beta)$, β_1^*, becomes greater than the initial β_0^* (the initial equilibrium cut-off productivity of the intermediate input producing sector is defined as β_0^*, considering G as the productivity distribution).

Despite the above analysis showing that higher sectoral risk for sector 1 results into a rise in cut-off labour intensity, β^*, the resultant effect on $G(\beta^*)$ is ambiguous. Given $\beta_0^* < \beta_1^*$, if $G(\beta_0^*) < G_1(\beta_1^*)$ then number of equilibrium intermediate firms increases. Combining larger $G_1(\beta_1^*)$ and higher n^* we get higher r_B^* and lesser k^*, thus, causing a higher equilibrium unemployment and lower real wages in both sector 1 and sector 2. Yet, given $\beta_0^* < \beta_1^*$, if $G(\beta_0^*) > G_1(\beta_1^*)$ holds then the resultant equilibrium number of intermediate firms, n^* falls. These two leads to a fall in r_B^* and an increase in k^*. As a result equilibrium unemployment falls and real wages in both sectors increase. Therefore, given $\tilde{\beta}^* \equiv G_1^{-1}\left(G(\beta_0^*)\right)$, if $\beta_1^* < \tilde{\beta}^*$, then r_B^* decreases and k^* increases. On the other hand, if $\beta_1^* \in [\tilde{\beta}^*, \beta_0^*)$, then r_B^* rises and k^* falls. That is, when NBFCs operate in a riskier sector, then adverse real effects are observed only if the equilibrium cut off productivity falls above $\tilde{\beta}$.

Proposition 2. *If NBFCs operate in riskier sectors, then, for a given* s,
(i) cut-off productivity for the intermediate input producing firms rises (i.e. $\beta_0^* < \beta_1^*$*),*
(ii) equilibrium interest rate charged by SCB and unemployment increase and, per-capita capital in sector 2 and real wages of both the sectors fall, given $\beta^* > \tilde{\beta}^*$*. Reverse happens if* β_1^* *remains within* $[\underline{\beta}, \tilde{\beta}^*]$.

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[28] In this version of the model, since Eq. (35) is independent of any other endogenous variables, except β^*, the sequence of solving the model is not particularly important. However, this definition of equilibrium is useful for any other involved extension of this model.

[29] For the purpose of specificity let the $\mathcal{B}$ is defined as $(0, B)$.

[30] Although, the single crossing property fails to satisfy the transitivity assumption, however, for our purpose, it is sufficient to compare between two distributions, discretely. Additionally, since, our objective is to analyse the effect of an increase in sectoral risk, we do not consider the case when $\beta^* > \hat{\beta}$. The effective result is the same. If $\beta^* > \hat{\beta}$, then G depicts riskier situation than G_1. So, we consider only the case when $\beta^* \leq \hat{\beta}$.

Table 2
Parameter summary.

Parameter	Value	Definition	(Source)
σ	1.2	Price elasticity of demand for intermediate input	Christiano, Eichenbaum, and Evans (2005)
α	0.582	Initial capital requirement for intermediate input	Schmitt-Grohé and Uribe (2004)
β	0.8	Labour intensity of sector 1	Gabriel, Levine, Pearlman, and Yang (2012)
δ	0.03	Rate of depreciation of capital in sector 2	(KLEMS India)
ϑ	0.74	Labour elasticity of producing capital good	(KLEMS India)[a]
κ	0.074	Marginal cost of lending	(SBI[b] 1 year MLCR)
ψ	1.37	SCB's deposit to credit ratio	(RBI NSDP Release)
$\bar{r}$	0.035	Interest rate to depositors	(Saving account interest rate, RBI NSDP Release)
λ	0.15	Rate of firing of job in sector 2	(ASI data. See Banerjeea and Mazumderb (2019)),
d	0.213	Cost of posting vacancy	Hall (2017)
ϱ	0.4	Bargaining power of the labour in sector 2	Gomes (2015)
τ	0.13	Ratio of unemployment benefit in sector 2 and wage in sector 1	(ASI data and MGNREGA wage)[c]
L_1	0.7	Proportion of labour force available in sector 1	(PLFS data)[d]

[a] 5 year average capital share of Auto-industry.

[b] State Bank of India.

[c] Annual Survey of Industries (ASI) reported wage for the contractual worker of India is 325.81 per man day on 2014. We consider 4.5% inflation rate as the growth rate of the wage for last 6 years because India has moved to an inflation targeting economy with a target band of 2% to 6%. Then we make it as the annual wage of the contractual worker as INR 1,32,378.28 for 2020–21. MGNREGA wage which is a famous employment guarantee programme of India, is set as INR 182 for 2020 March (we did not consider the relief package announced due to Covid-19 crisis). This programme's upper bound of job days is 100. Therefore, annual maximum guaranteed wage is INR 18 200. This we will consider as the base wage or the unemployment benefit. Therefore, our estimated τ is 0.13 for India.

[d] We use the quarterly data of Periodic Labour Force Survey (PLFS) of India from 2017–18 to 2021–22 to estimate the proportion of labourer employed in the informal sector where the credit penetration of NBFCs for production purpose is higher. The average employment share of the informal sector over 16 quarters is 70%. We adopt the official definition of the informal sector provided by the Ministry of Statistics and Programme Implementation (MOSPI).

7. Numerical illustration

In this section, we take the theoretical model to numerical estimation. The points of interest are mainly to identify the magnitude of the change in the real sector due to different shocks. Four kinds of shocks are under consideration: idiosyncratic and structural shocks in line with NBFC repayment, policy shocks, and sectoral shock.

7.1. Short-term idiosyncratic shock

The Table 2 describes all the parametric specifications taken for the calibration exercise. Since we motivate our theoretical model by providing a background of the NBFC scenario of India, the majority of the parametric specifications are taken from Indian perspective. While of the parameters are taken from the literature. Each of the sources of the parametric specifications is described in the "source" column of Table 2. Given the parametric specification, the model is solvable.[31] We consider the proportion of firms that are unable to repay to NBFCs (s) following Beta(0.5, 5) distribution. We create 10 000 observations of s from the Beta(0.5, 5) distribution. The mean of that random variable is 0.09 and the standard deviation is 0.12. First we estimate the effect of the shocks in NBFC repayment to other real sector variables according to the present hypothetical model. If the proportion of firms who are unable to repay to NBFC raise by 1% (we assume the increase is from 9% to 10% in s) which we call as a negative idiosyncratic shock, then the interest rate charged by SCB increases by 0.08%. Market tightness (θ) in the capital good producing sector 2 decreases by 0.18%. The unemployment rate (u) increases by 0.04% in sector 2. Per capita capital in sector 2 drops by 0.51%. Real wages in sector 1 and sector 2 reduce by 0.30% and 0.18%, respectively. Given the probability distribution of s, the distribution of other variables is endogenously determined within the model. Fig. 7 summarizes the histograms of the distributions of the endogenous random variables. Lower s causes higher k and higher real wages in both sectors. In case of r_B and u, the relation with s is direct. That is higher values of s cause higher interest rates charged by SCB and higher unemployment. So, given the distribution of s is left-skewed, the distribution of k, W_1/P_2 and W_2/P_2 are right skewed and the distribution of r_B and u are left skewed. This numerical finding supports our Proposition 1.

The standard deviation of per capita capital and market tightness in the sector 2 register a high variance due to the fluctuations in NBFC shock (s). Since in Section 5 we introduce only random fluctuation in repayment to NBFCs the entire variation or spread in other endogenous variables comes only through that channel. That implies, given no other shock, NBFC shocks can create relative volatility in r_B, k, u, W_1/P_2 and W_2/P_2 by 4.62%, 4.78%, 1.47%, 3.03% and 1.77%, respectively.[32]

[31] Matlab codes are available on request.

[32] Reported numbers are coefficient of variation.

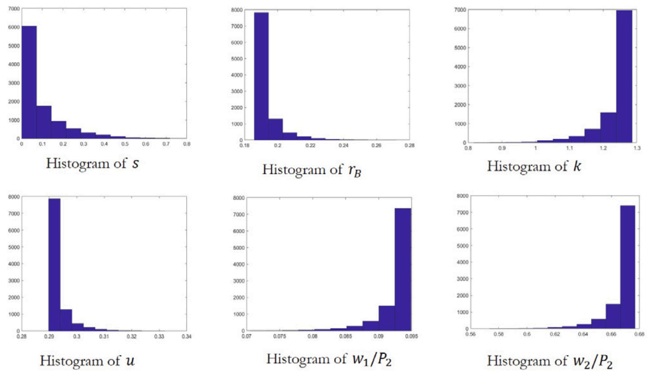

Fig. 7. Distribution of the endogenous variables.

Table 3
Effect of change in policy parameters on the endogenous random variables.

Variables	$\frac{\Delta\mu_j}{\Delta\bar{r}}$	$\frac{\Delta\sigma_j}{\Delta\bar{r}}$	$\frac{\Delta\mu_j}{\Delta\psi}$	$\frac{\Delta\sigma_j}{\Delta\psi}$
r_B	0.60**	−0.01	0.02**	0.00
k	−4.71**	−0.43**	−0.12**	−0.01
θ	−1.27**	−0.07**	−0.03**	0.00
u	0.29**	0.00	0.01**	0.00
w_1/P_2	−0.21**	−0.01**	−0.01**	0.00
w_2/P_2	−0.87**	−0.05**	−0.02**	0.00

7.2. Effect of policy intervention

Table 3 describes the effect of policy intervention on endogenous random variables. We perform Kolmogorov–Smirnov test for each of the variables. That is, we test the null hypothesizes: "after the policy shock, variable j is generated from same distribution as the initial distribution of j". The null hypothesizes are rejected for both 5% and 1% level for all the variables. To check whether the reported mean values are statistically the same or not, we perform t-test (Welch's t-test for those whose variances are not statistically significantly same). Similarly, for comparing the variance, F-test is performed for each of the variables. Both of these two tests are performed at 95% confidence interval. In the Table 3, the double asterisk sign signifies that the change in parameters is statistically significant compared to its initial parameter characteristics. We find all the deviations in the mean for a change in policy parameter(s) are statistically significant.

For a drop in $\bar{r}$ keeping ψ same, the average interest rate charged by SCB and unemployment rate fall. A similar effect with lesser magnitude on average r_B and u can be seen for a fall in ψ keeping $\bar{r}$ constant. The effect of change in $\bar{r}$ and ψ on average per capita capital in sector 2, market tightness in sector 2, and real wages of both sectors is inverse. However, the Table 3 suggests that the effect of a fall in $\bar{r}$ is higher than the effect of a fall in ψ on all the endogenous variables. The standard deviations of k, θ, w_1/P_2 and w_2/P_2 increase as an effect of reduction in the policy parameter, $\bar{r}$, whereas, standard deviations of r_B and u remain statistically same.

Proposition 3. *Given the distribution of the random proportion of the loan recovery of NBFCs' as Beta(0.5,5), reduction in $\bar{r}$ or ψ causes*

(i) fall in the average interest rate charged by SCB and average unemployment rate, leaving no significant impact on their standard deviations, and

(ii) the rise in the average per capita capital input of sector 2 and the average real wage of both the sectors with a small increase in standard deviation.

7.3. Structural shock

As mentioned in Section 5.1.2 we investigate the effect of structural shock in this section using a numerical exercise. Table 4 describes the characteristic of the variables given the distribution of s is changed from Beta(0.5,5) to Beta(1,5). We perform the Kolmogorov–Smirnov test for all the listed variables to check the null hypothesis: "variables are generated from same distribution". For each of the variables, the null hypothesizes are rejected with 5% and 1% statistical significance. The difference in the mean and the variance of the random variables listed in the Table 4 are statistically different too, for 95% confidence interval.

Note that the mean value of s increases by 0.079 according to the Table 4. We confirmed that the mean of $\frac{1}{1-s}$ also rises. Therefore, by changing the distribution of s we move to a structurally more risky situation for NBFCs repayment than earlier (revisiting discussion of Section 5.1.2 numerically). The increase in the expected number of intermediate input producing firms

Table 4
Effect of structural change.

Variables	$\frac{\Delta\mu_j}{\Delta E\left(\frac{1}{1-s}\right)}$	$\frac{\Delta\sigma_j}{\Delta E\left(\frac{1}{1-s}\right)}$
r_B	−0.003**	0.021**
k	0.037**	0.152**
θ	0.008**	0.043**
u	−0.001**	0.010**
w_1/P_2	0.320**	0.116**
w_2/P_2	0.001**	0.007**

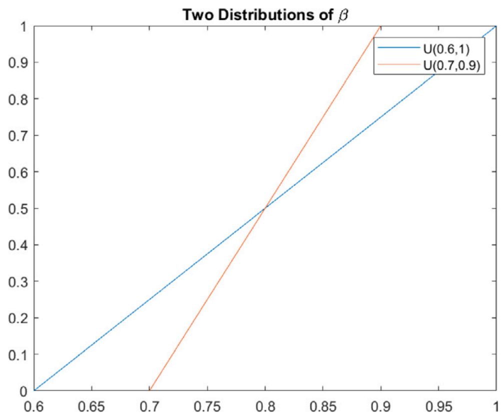

Fig. 8. Distributions of β.

per successful intermediate input firm (i.e. rise in $E\left(\frac{1}{1-s}\right)$), causes a drop in the average interest rate charged by SCBs and increase in average k with higher standard deviation. The average real wage rate in sectors 1 and 2 both go up and the average unemployment rate drops. Due to this structural change, the volatility in all the variables goes up. In the case of k, the spread is highest when the environment is riskier. However, the rise in average k is also the highest.

7.4. Sectoral risk

This subsection numerically displays the results after incorporating the sectoral risk in our baseline model (i.e. numerical example for the results derived in Section 6.2.1). To make this extension we need to assume a distribution function for β (i.e. $G(\beta)$) and the value of the sunk cost (f). We assume the sunk cost at 0.001. The initial distribution for β is assumed as Uniform(0.6, 1). Therefore, the average labour intensity remains the same at 0.8, as the baseline model assumption declared in Table 2. This helps us to compare the baseline model with this extension. We retain all other parameter-choices as mentioned earlier in the Table 2. Given this distribution of β, the solution for β^*, the cut-off labour intensity, is 0.67. Correspondingly the probability of a "good season", $G(\beta^*)$, is 0.17. The distribution of the proportion of the failed firms, s, remains as earlier and follows $Beta(0.5, 5)$. As described in Section 7.1, endogenous variables become stochastic because of s. In this extension as compared to the baseline model, the average r_B and u increase, and k, $\frac{w_1}{P_2}$ and $\frac{w_1}{P_2}$ go down.

We define the higher sectoral risk in Section 6. Here we use a numerical example to demonstrate a higher sectoral risk scenario. Let, the new distribution of β be Uniform(0.7,0.9). Note that the mean remains the same as earlier. That is, the average labour intensity is still 0.8. However, for all $\beta < 0.8$, $G_1(\beta) < G(\beta)$, where G_1 stands for Uniform(0.7,0.9) and G stands for Uniform(0.6,1). Therefore, Uniform(0.7,0.9) depicts a riskier sector 1 (see Fig. 8).

The new solution for β_1^* is 0.75 and $G_1(\beta_1^*) = 0.25$, given Uniform(0.7,0.9). Note that, in this case $\tilde{\beta}^*$ (defined in Section 6.2.1) is equal to 0.73 which is less than β_1^*. That is, in this example, $\beta_1^* > \tilde{\beta}^*$. Now, we compare the two situations with respect to the endogenous variables. The following figure (Fig. 9) shows the change in the distribution of the endogenous variables given the increase in sectoral risk in that sector where NBFC operates. Or, in other words, if NBFC operates in a higher-risk sector then the distribution of the endogenous variables changes in the following way (Fig. 9).

The distributions for r_B, n and u shift to right, and opposite happen for k, $\frac{w_1}{P_2}$, $\frac{w_2}{P_2}$ and θ when sector 1 is riskier. This result resembles the Proposition 2. The change in the moments of the endogenous variables is listed in the following table corresponding to the change in $G(\beta^*)$, when the β^*, due to a change in the distribution of β, is higher than $\tilde{\beta}^*$.

Table 5 shows that the change in average r_B, u and n with respect to change in $G(\beta^*)$ (given, $\beta_1^* > \tilde{\beta}^*$) are positive and the magnitude of increase for one unit rise in $G(\beta^*)$ is higher for n as compared to other two variables. On the contrary, the mean per capita capital in sector 2, market tightness, and real wages shrink for one unit change in $G(\beta^*)$. In terms of magnitude, the drop is highest in average k. The change in standard deviations of the endogenous variables is small but statistically significant. It shows that the variability of all the variables, barring k, inflates due to a rise in the sectoral risk of sector 1.

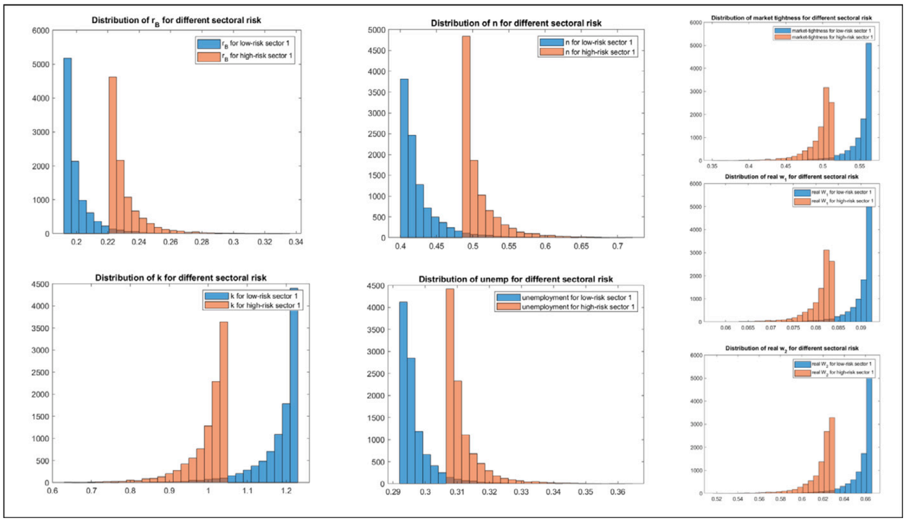

Fig. 9. Effect of higher sectoral risk on the distribution of endogenous variables.

Table 5
Effect of change in sectoral risk.

Variables	$\frac{\Delta\mu_j}{\Delta G(\beta^*)}$	$\frac{\Delta\sigma_j}{\Delta G(\beta^*)}$
r_B	0.36***	0.024***
k	−2.17***	−0.082***
θ	−0.67***	0.004***
u	0.18***	0.013***
W_1	−0.11***	0.001***
W_2	−0.46***	0.005***
n	0.98***	0.010***

Table 6
Correlation matrix.

	NBFCs' credit	*SCB's credit*	*GVA_Industry*	*GDP (MP)*	*Formal Emp*	*Informal Emp*
NBFCs' credit	1					
SCB's credit	0.39	1				
GVA_Industry	0.30	0.50	1			
GDP (MP)	0.19	0.49	0.84	1		
Formal Emp	0.14	0.18	0.51	0.59	1	
Informal Emp	0.25	0.34	0.30	0.30	0.28	1

7.5. Empirical observations

As mentioned in the earlier sections, one of the major challenges with research related to the NBFC sector in the context of India is the unavailability of long-time series data. It is therefore difficult to verify the predictions of the theoretical model with the appropriate empirical framework. However, based on the available data since 2016,[33] we calculate the flow of NBFCs' credit, banks' credit, and sequential changes in quarterly GDP. In Fig. 10, the pie-diagram indicates that the NBFCs have a sectoral presence with most of their funds directed towards small enterprises in the manufacturing sector, retail loans, and services sector. We, therefore, consider the manufacturing sector GVA to identify the association between NBFCs' credit and economic activities.

The correlation coefficients reported in Table 6 broadly support our theoretical model conclusions. The correlation between GVA Industry and NBFCs' credit remains positive, which captures the direct impact. The indirect impact, on the other hand, works through the positive association between banks' credit and GVA Industry (or GDP at Market Prices). Here the positive correlation between banking credit and GVA coupled with a positive correlation between NBFC Credit and Banks' credit could indicate the transmission channels highlighted in our model. Finally, as a factor input, we also consider formal and informal sector employment.[34] In the anticipated lines, the correlation between informal employment and NBFC credit is found to be positive (and higher than formal sector employment), which supports our model findings.

[33] Sourced from different volumes of 'The Report on Trend and Progress of Banking', DBIE and 'Financial Stability Reports'.

[34] Sourced from unit level Periodic Labour Force Survey data published by MOSPI, GoI.

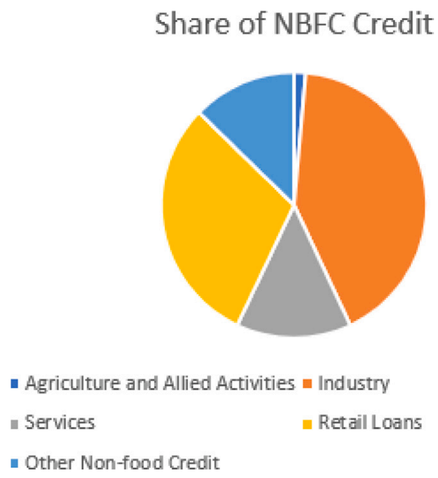

Fig. 10. NBFCs' credit and overall economic indicators.

8. Discussion and conclusion

Even though shadow banks contribute a small fraction of the entire global loan portfolio, shadow banks are the focal point of financial stability discussions in the post-global financial crisis period, mainly because of their interlinkage with the broad financial markets. However, in many emerging countries the paucity of long time series data on shadow banks stifles the scope of adequate empirical research. Considering NBFCs' systemic importance and taking a cue from the Indian experience of shadow banks, we develop a simple two-sector theoretical model. That enables us to identify and understand how a shock in the sectors financed by NBFCs percolated and propelled to other real variables, such as real interest rate, per capita capital formation, unemployment rate, and real wage rate. The uncertainties faced by the NBFCs influence other sectors of the economy through the banking channels because most of the NBFCs are non-deposit taking and SCBs park a fraction of the deposits with them. Our paper is equipped to distinguish the impacts of idiosyncratic shock, structural shock, and sectoral shock. We believe, the virtue of the uncomplicated structure of the model would be helpful to understand the interactions of different variables without losing out on the robustness of the results. The theoretical and simulation results of the model suggest an idiosyncratic negative shock or a sectoral shock in the sector where NBFCs predominantly operate inducing an upward spike in the interest rate charged by SCBs, leading to a drop in per capita capital formation. Consequently, the unemployment rate rises and drags down the real wages in the economy. However, a negative structural shock reduces the interest rate charged by SCBs. This is because in our model NBFCs determine the interest rate based on the average default rate and there is a positive relationship between the two. Therefore, a higher average default rate, in turn, increases NBFCs' interest rate and discourages firms to enter the market. This dampens the demand for loans and the interest rate charged by the SCBs, resulting in a fall in the unemployment rate, an increase in real wages, and per capita capital formation. Therefore, the change in the loan demand by NBFCs drives the major results of this paper. This model provides a basic setup for several possible extensions. For instance, the baseline model can be extended by the introduction of uncertainty in the repayment of loans by NBFCs to the SCBs. Secondly, the model framework provides enough scope to bend the assumption of one section facing sectoral risk while the other does not. One simple way to do that is to introduce endogenous job destruction in sector 2 and then, compare the effect of sectoral risks. While we recognize the richness of these extensions, this paper keeps the attention directed to understanding the role NBFCs play to propel the different shocks to the rest of the economy.

The central policy highlight of this paper is that the systemic risk of NBFCs could propagate through NBFC-SCB interlinkages to unemployment and output. Under such shocks, the reduction in policy rate may provide a cushion in terms of a positive boost to capital formation and job creation. We, therefore, underline the need for early identification of the nature of shocks and quick policy intervention to dampen any spillover at an early stage. We also emphasis the need for frequent data dissemination relating to the NBFC sector for continuous risk evaluation and vigil.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A

We explain the algebraic solution of the baseline model in.

We mentioned the maximization problem of the firm in the sector 2 in Eq. (13). The solution of the per capita capital (k) demand is expressed in the Table 1. Taking these two together and replacing w_1 mentioned in the Table 1 in Eq. (18), the wage rate of the sector 2 is determined as,

$$\frac{w_2}{P_2} = \frac{\varrho\theta d}{1-\tau} + b\vartheta k^{1-\vartheta}. \tag{40}$$

Note that, $f(k) - (r_B + \delta)k = \vartheta k^{1-\vartheta}$, and, $m(\theta^{-1}, 1) = \frac{1}{1+\theta}$.

Therefore, Eq. (14) can be rewritten as,

$$\frac{w_2}{P_2} = \vartheta k^{1-\vartheta} - d(1+\theta)(r_B + \lambda). \tag{41}$$

Combining Eqs. (40) and (41) we solve for θ.

$$\theta = \frac{(1-\varrho)\vartheta k^{1-\vartheta} - d(r_B+\lambda)}{\varrho + (1-\tau)(r_B+\lambda)}. \tag{42}$$

Hence, the solution for the real wage in sector 2, $\frac{w_2}{P_2}$, is

$$\frac{w_2}{P_2} = \varrho\vartheta k^{1-\vartheta} + \frac{\varrho d}{1-\tau}\Big(\frac{(1-b)\vartheta k^{1-\vartheta} - d(r_B+\lambda)}{\varrho + (1-\tau)(r_B+\lambda)}\Big). \tag{43}$$

So, from Eqs. (42) and (43) it is clear that both θ and $\frac{w_2}{P_2}$ can be solved in terms of k and r_B. Using the mentioned matching function (see the Table 1), in Eq. (19) the steady state $u^* = \frac{\lambda(1+\theta)}{\lambda+\theta(1+\lambda)}$. Given that, we found θ in terms of k and r_B, u^* can also be expressed in terms of the same.

Now, replacing n (mentioned in Table 1), u^* and θ in the equation for *"interest rate of SCB"* (mentioned in Table 1) we get,

$$\begin{aligned} &r_B - \psi\bar{r} - \kappa\alpha\Big(\frac{1-\rho}{\rho}\frac{\varrho}{1-\varrho}\frac{L_1 d}{\alpha(1-\tau)}\Big)\Big[\frac{\frac{1}{1-s}}{E(\frac{1}{1-s})}\Big]\frac{1}{r_B}\frac{(1-\varrho)\vartheta k^{1-\vartheta} - d(r_B+\lambda)}{\varrho+(1-\tau)(r_B+\lambda)} \\ &\quad -\kappa\bar{L}_2 k\frac{(1-\varrho)\vartheta k^{1-\vartheta} - (r_B+\lambda)d}{(1-\varrho)(1+\lambda)\vartheta k^{1-\vartheta} + (r_B+\lambda)(\lambda(1-\tau) - d(1+\lambda)) + \lambda\varrho} = 0. \end{aligned} \tag{44}$$

The left hand side of Eq. (44) is the explicit form of $S^B\Big(\underset{+}{k}, \underset{+}{r_B};\ \underset{-}{\psi}, \underset{-}{\bar{r}}, \underset{-}{s}, \underset{+}{E}\big(\frac{1}{1-s}\big), \mathcal{A}\Big)$, mentioned in Section 5.

Consider, the equation of "*per capita capital demand in sector 2*", mentioned in Table 1,

$$k - \Big(\frac{1-\vartheta}{r_B+\delta}\Big)^{\frac{1}{\vartheta}} = 0. \tag{45}$$

The left hand side of the above equation was mentioned as $D^k(\underset{+}{k}, \underset{+}{r_B}; \mathcal{B})$, in Section 5.

Solving Eqs. (44) and (45), we can get equilibrium r_B^* and k^*. Now, for an observed value of s, we can solve θ^*, u^*, $\frac{w_1}{P_2}^*$, $\frac{w_2}{P_2}^*$, n^* and $r^*{}_N$ by putting the solution of $\{k^*, r_B^*\}$. This solves the equilibrium of the model as described in Definition 1.

Appendix B

The strategy of solving the model for the extension of the baseline model described in Section 6 is as follows. As in case of the baseline model, we solve θ^*, $\frac{w_1}{P_2}$ and $(1-u^*)$ in terms of r_B and k (described below).

Eq. (42) gives the solution of θ in terms of r_B and k. Using that we get the solution of $\frac{w_1}{P_2}$ as follows from Eq. (27),

$$\frac{w_1}{P_2} = \frac{1}{1-\tau}\frac{\varrho d}{1-\varrho}\frac{(1-\varrho)\vartheta k^{1-\vartheta} - d(r_B+\lambda)}{\varrho+(1-\tau)(r_B+\lambda)}. \tag{46}$$

We plug those in Eq. (37). Similarly, we can express n in terms of r_B and k from Eqs. (36). Using these we, thus, express Eq. (37), completely in terms of r_B and k, given the exogenous parameters, and β^*. After the substitution, now, we get a positive relation between r_B and k, similar to Eq. (28). Therefore, for an increase in r_B, k also increases to satisfy Eq. (37).

Now to see the explicit form of Eq. (39) we plug n, r_N and $1-u^*$ in Eq. (37) and we get,

$$\begin{aligned} &r_B - \bar{r}\psi - \frac{(1-\varrho)\vartheta k^{1-\vartheta} - (r_B+\lambda)d}{(1-\varrho)(1+\lambda)\vartheta k^{1-\vartheta} + (r_B+\lambda)(\lambda(1-\tau) - d(1+\lambda)) + \lambda\varrho}\kappa\bar{L}_2 k \\ &\quad -\left(\frac{\frac{1}{1-s}}{E\left[\frac{1}{1-s}\right]}\right)\frac{\alpha G(\beta^*) + f}{(\sigma-1)\alpha + f(\frac{\sigma}{G(\beta^*)} - 1)}\frac{\kappa}{r_B}\frac{w_1}{P_2}L_1 = 0 \end{aligned} \tag{47}$$

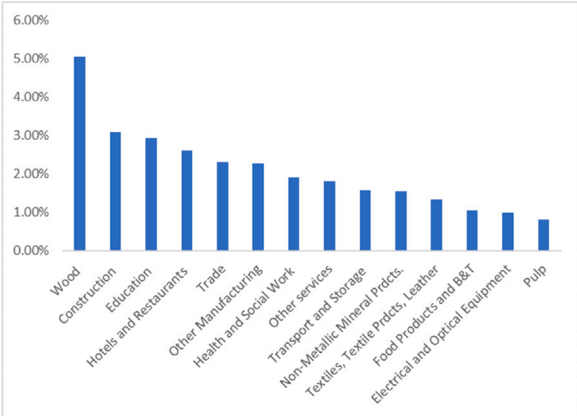

Fig. 11. Labour intensity, sector-wise classification .
Source: KLEMS, India data base and authors calculation.

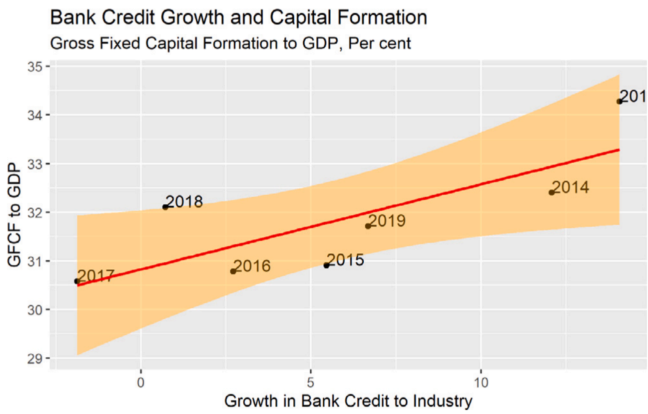

Fig. 12. Bank credit growth and capital formation.

In other words, the profit maximizing r_B and k for SCB can be expressed as a positively slopped relation, similar to the baseline model. If we use the expression $\frac{w_1}{P_2}$, as showed in Eq. (46), in the above equation we can rewrite it as:

$$r_B - \bar{r}\psi - \frac{(1-\varrho)\vartheta k^{1-\vartheta} - (r_B+\lambda)d}{(1-\varrho)(1+\lambda)\vartheta k^{1-\vartheta} + (r_B+\lambda)(\lambda(1-\tau) - d(1+\lambda)) + \lambda\varrho}\kappa \bar{L}_2 k - \left(\frac{\frac{1}{1-s}}{E\left[\frac{1}{1-s}\right]}\right)\frac{\alpha G(\beta^*)+f}{(\sigma-1)\alpha + f\left(\frac{\sigma}{G(\beta^*)}-1\right)}\left(\frac{1}{1-\tau}\frac{\varrho d}{1-\varrho}\frac{(1-\varrho)\vartheta k^{1-\vartheta} - d(r_B+\lambda)}{\varrho+(1-\tau)(r_B+\lambda)}\right)\frac{\kappa}{r_B}L_1 = 0 \tag{48}$$

This equation is the explicit representation of Eq. (39).

Annex C

See Figs. 11 and 12.

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