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Article

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Latin American Journal of Central Banking (LAJCB)

Provided in Cooperation with:

Center for Latin American Monetary Studies, Mexico City

Suggested Citation: Sánchez Serrano, Antonio (2022) : Loan renegotiation and the long-term impact on total factor productivity, Latin American Journal of Central Banking (LAJCB), ISSN 2666-1438, Elsevier, Amsterdam, Vol. 3, Iss. 4, pp. 1-20,
<https://doi.org/10.1016/j.latcb.2022.100074>

This Version is available at:

<https://hdl.handle.net/10419/336356>

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Loan renegotiation and the long-term impact on total factor productivity

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ARTICLE INFO

JEL codes:

D24
G21
G23
G32

Keywords:

Loan renegotiation
Non-performing loans
Total factor productivity
Loan forbearance

ABSTRACT

When a loan is close to becoming non-performing, banks have stronger incentives to renegotiate it in favourable conditions for the borrower (loan forbearance) rather than for recognising and resolving the non-performing loan. At the aggregated level and looking at borrowers (non-financial corporations), the preference for loan renegotiation may affect total factor productivity and aggregate productivity growth, as new entrants, typically using technologies that are more advanced, may be crowded out from bank funding by incumbent non-financial corporations (this would particularly be the case in the absence of well-developed financial markets). The empirical analysis finds that a wider use of loan renegotiation, seen through lower values of provisions to total loans, has a negative effect on the change of total factor productivity (in addition to the influence of consumption growth). These results provide useful insights when considering the resolution of non-performing loans and the long-term consequences on the real economy.

1. Introduction

As key financial institutions, banks channel deposits from savers and use them to provide credit to non-financial corporations to undertake their entrepreneurial activities. They have some comparative advantages in relation to other participants in financial markets, in particular in monitoring borrowers and enforcing contracts (Diamond, 1984; Gale and Hellwig, 1985; Kashyap et al., 2002; Donaldson et al., 2018). However, using bank lending to cover the funding needs of non-financial corporations may bring unintended consequences.

Although the exchange of information between the bank and the borrower has been documented as beneficial for both (see, among others, Petersen and Rajan, 1995; Elyasiani and Goldberg, 2004; Banerjee et al., 2021), if the borrower is in financial difficulties, it may lead to a preference towards loan renegotiation instead of resolving the loan (Bird et al., 2022). More generally, Laeven and Majnoni (2003) show that banks tend to recognise credit losses as late as possible, even if that leads to their recognition at the worst time of a financial crisis. Such delayed recognition of credit losses can reduce lending during a financial crisis, as Beatty and Liao (2011) document. In these circumstances, two main inquiries arise: (i) whether banks prefer to renegotiate the loan with the borrower or to recognise the non-performing loan immediately, and (ii) what the consequences are of that choice for the real economy.

The Japanese “lost decade” is a quasi-natural experiment addressing these questions, where academic evidence finds that banks played a negative role due to their close ties to non-financial corporations. According to Hoshi and Kashyap (2015), one of the mistakes of Japanese authorities was that they were not able (or willing) to clean-up the balance sheet of banks, which impaired credit allocation to the real economy. Watanabe (2010) shows that large decreases in the banks’ capital are directly related to a wider use of forbearance of borrowers. Related to credit allocation, Peek and Rosengren (2005) show that poor performing

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non-financial corporations are more likely to receive additional bank credit than better performing non-financial corporations are, due to the banks' interest to avoid loss recognition. Caballero et al. (2008) show how industries with large stocks of unresolved non-performing loans exhibit negative job dynamics, and lower productivity, extending this negative effect also to healthy non-financial corporations. Looking at a sample of OECD countries over the 2003–2012 period, Adalet McGowan et al. (2018) find similar negative effects of zombie corporations on the total corporate sector. They identify two channels through which zombie corporations limit output growth: investment and multi-factor productivity growth.

Regarding productivity growth, advanced economies have witnessed an important deceleration, particularly after the global financial crisis (Dieppe, 2020). Identifying the factors driving the total factor productivity growth has been on the research agenda for more than 50 years. Danquah et al. (2011) and Restuccia and Rogerson (2013) nicely summarise this research effort while Dieppe (2020) provides an extensive overview of productivity around the world. Danquah et al. (2011) discuss potential determinants of the total factor productivity growth, and they find particularly promising results for initial GDP, consumption share and trade openness. Looking at the relation between credit supply and productivity growth, Aghion et al. (2019) argue for a dual relationship between credit constraints and productivity because tighter access to credit makes it more difficult for entrepreneurs to invest and innovate, with negative effects on productivity over the long term. Furthermore, it drives less efficient incumbent firms out of the market, easing the entry of new innovators. Cecchetti and Kharroubi (2019) find that growth in finance negatively affects total factor productivity growth because finance tends to favour funding for low productivity projects or through highly collateralised loans.

Other contributions have recently looked empirically at the relation between bank credit and productivity, focused on European countries. Gopinath et al. (2017) find that potential misallocation of credit is one of the factors behind the decline in total factor productivity in Spain. Schmöller and Spitzer (2020) identify the decrease in the efficiency of R&D investment, particularly before 2008, and the increase in safe assets holdings after the global financial crisis as the main two factors explaining the slowdown in total factor productivity in the euro area. Hassan et al. (2017) consider banks' credit misallocation as one reason for the slowest productivity growth in Italy, and Mastromarco and Zago (2012) find that regional banking inefficiency has an important influence on total factor productivity growth rates in Italy. Still focused on Italy, Manaresi and Pierri (2018) estimate that the credit contraction between 2007 and 2009 could account for about a quarter of the observed decline in Italian total factor productivity growth. On the contrary, Schivardi et al. (2022) consider that misallocating credit modestly affected productivity growth in Italy during the European financial crisis.

In the aftermath of the global financial crisis, European banks showed high and persistent amounts of non-performing loans in their balance sheet due to numerous factors (Suarez and Sánchez Serrano, 2018), leading the Council of the EU to take action to reduce them (Council of the EU, 2017). In this context, some academics have looked at the effect of renegotiation and forbearance on banks. Homar et al. (2015) use data from the ECB Asset Quality Review and find that macro-economic factors, lax banking supervision and bank weakness mainly drive European banks' forbearance practices. Extending the sample to 69 banking crises around the world, Homar and van Wijnbergen (2017) identify bank recapitalisation as a key action against forbearance because it may lead to a quicker recovery. Other policy interventions, such as guarantees on bank liabilities or liquidity support, do not have a similar effect on forbearance practices. Using data on loan renegotiations in Brazil, Mourad et al. (2020) analyse the conditions under which loan forbearance is more likely to appear and find that larger loans, loans with previous forbearance measures and establishing higher provisions for forborne loans are important factors that explain how some loans are forborne and others are not. Faria-e-Castro et al. (2021) develop a model of relationship lending where banks have incentives to offer better conditions to less productive and more indebted corporations. They find that low-capitalised banks more often extend credit to these weak borrowers. In the aggregate, this practice of evergreening can result in lower interest rates, higher indebtedness and lower aggregative productivity. Looking at the syndicated loan market, Paligorova and Santos (2016) argue that non-banks' increasing role in that market negatively affects loan renegotiations.

Drawing from these findings, this article assesses whether the loan renegotiation practice can be one of the factors behind the sluggish growth of productivity in Europe in the last thirty years, considering it would prevent new entrants from easily finding bank funding. In this vein, Storz et al. (2017) conclude that providing incentives to banks to workout bad assets can contribute to deleverage in the corporate sector. My focus on new entrants, as opposed to incumbent non-financial corporations, is important. Decker et al. (2016) find a decline in new entrants across industrial sectors in the US in the last years, which are particularly important for productivity growth given their higher productivity. Gourio et al. (2016) find that a shock in the number of new entrants has significant and persistent effects on real GDP, productivity and population. Productivity growth depends not only on innovation and on technology investments at the non-financial corporation level, but also on the economy being able to reallocate resources from non-financial corporations with low productivity to those with higher productivity (Foster et al., 2006; Bloom, 2009; Acemoglu et al., 2018).

On a conceptual basis, the frontier between loan renegotiation and forbearance is blurred and the two terms have often been used interchangeably. According to the European Banking Authority (2014), forbearance occurs when the borrower is in financial difficulties (or expected to be in the short term) and the loan's terms and conditions are modified in way that the borrower is in a better position than it was with the previous loan or than it would be under a loan granted to another borrower with a similar risk profile. According to this definition, forbearance only affects troubled borrowers and arises in cases where the loan's new terms and conditions alleviate its financial burden. In the academic domain, Acharya et al. (2019) and Caballero et al. (2008) define forbearance as those situations where the borrower receives more favourable credit conditions than those prevailing in the market at that time. They also explain that interest rates below the market interest rates are the most obvious sign of forbearance. In this article, for simplicity, I will use the term 'loan renegotiation', even if it would be implicitly referring also to loan forbearance.

I first design a stylised model to understand banks' incentives towards loan renegotiation or resolving non-performing loans. In a second step, the model is expanded to understand the implications of the banks' decisions for incumbent non-financial corporations and for potential new entrants, considering how the banks' decision to renegotiate loans with incumbents in financial stress may affect productivity and technological development, in aggregated terms.

The stylised model shows the conditions under which loan renegotiation would be preferable for banks. In a straightforward calibration of the model, banks very close to the prudential capital requirement may not have the capacity to absorb losses from resolving non-performing loans, a trend that is exacerbated in a scenario of low interest rates. My results also show that the incentives towards loan renegotiation may hamper the real economy because new participants relying on bank funding may not enter the market, having, in turn, a negative (albeit relatively small) effect on aggregate productivity growth. In this regard, this article provides certain empirical evidence of a positive relation between the change in total factor productivity and the ratio of provisions for loans, which suggests that loan renegotiation (which occurs when provisions are low) has a negative effect on the change of total factor productivity. These results are novel to the extent that the existing literature on productivity growth has often considered the role of credit in relation to the existence of supply constraints, and the existing literature on banking and finance has seldom considered the implications for the real economy of widespread loan renegotiation (or forbearance) regarding technological development or productivity growth (exceptions being Caballero et al., 2008, and Adalet McGowan et al., 2018).

Thus, this article contributes to two avenues of academic research. First, it can be framed within the academic stream that studies loan renegotiation and forbearance, and the possible adverse effects for the financial system and the real economy (Caballero et al., 2008; Homar et al., 2015; Homar and van Wijnbergen, 2017; Adalet McGowan et al., 2018; Mourad et al., 2020; Faria-e-Castro et al., 2021). Second, it contributes to the research avenue highlighting banking credit as a determining factor of productivity growth in advanced economies in the most recent years (Mastromarco and Zago, 2012; Hassan et al., 2017; Gospinath et al., 2017; Manaresi and Pierri, 2018). Finally, the COVID-19 pandemic seems to have intensified research efforts on unsustainable (or over-indebted) non-financial corporations, and this article indirectly contributes to that effort. Banerjee and Hofmann (2022) and Acharya et al. (2022) are two interesting and comprehensive contributions to this field.

This article is organised as follows. The following section presents the stylised model for a bank granting loans to non-financial corporations while the third section takes the perspective of an incumbent non-financial corporation and a potential new entrant. The fourth section provides empirical evidence of the model's main results. I then conclude with a special focus on potential policy applications of the article's results. Two appendixes propose an extension of the stylised model and provide complementary information to the empirical analysis.

2. A model of loan renegotiation in banks

Consider a bank whose only activity is to grant loans (L), for which it requires an interest r . The bank is funded through contributions from depositors and shareholders, who exercise discipline on the bank managers and require an adequate remuneration of their risk. For simplicity reasons, depositors and shareholders are not part of the model.

Similar to Homar and van Wijnbergen (2017), an stylised bank operates over three periods (Fig. 1):

- At $t = 0$, a loan is granted.
- At $t = 1$, the bank sees that, with a probability $(1-p)$, the loan is not going to be repaid and must decide whether to resolve it (for which, it could recover a proportion γ of the original loan) or whether to change the conditions of the loans under the expectation of being repaid in the next period (with a new interest rate, r'). With probability p , the loan is repaid and the bank decides to grant a new loan to the same or to another borrower.
- At $t = 2$, the loan is paid back with probability p' (if there was payment in the previous period), q (if the loan was refinanced) or q' (if the original loan was liquidated and a new loan was granted).

The key decision for the bank is taking place at $t = 1$ and involves recognising a loss equal to $((1-\gamma)L(1-p))$ or renegotiating the loan (namely, charging an interest rate r'), subject to a possible non-repayment in $t = 2$. I assume that the probability that the second loan is repaid (q) is lower than is the probability of the original loan's repayment (p).

Regarding interest rates, theory suggests that the interest rate of the renegotiated loan should be higher than the interest rate of the original loan because the related credit risk is higher in the second loan. However, this is not how loan renegotiation tends to occur in practice. Banks consider that a lower interest rate may facilitate the borrower's repayment, even if no improvement in its capacity to pay back the loan has been observed, and may be ready to sacrifice a small portion of profits to ensure that the loan is repaid (Faria-e-Castro et al., 2021; Acharya et al., 2022). In these conditions, the interest rate of the renegotiated loan (r') is lower than the interest rate of the original loan (r) is, even if the probability of the renegotiated loan's repayment is lower than the probability of the original loan's repayment ($q < p$). Therefore, loan renegotiation introduces a distortion in the pricing mechanism of credit through interest rates.

When creating a lending relationship, banks need to acquire information about the borrower, which generates costs for the bank. Theoretically, these costs should be incorporated into the loan's interest rate (Broecker, 1990; Freixas et al., 2007). For the sake of simplicity, these costs are not formally considered here.¹ A reference to them is made in Appendix 1, which discusses the alternative for new entrants to use bank loans, bonds or equity markets to fund their activities.

¹ The different interest rates charged to the renegotiated loan and to the potential new loan could also account for the costs of acquiring information about the new borrower.

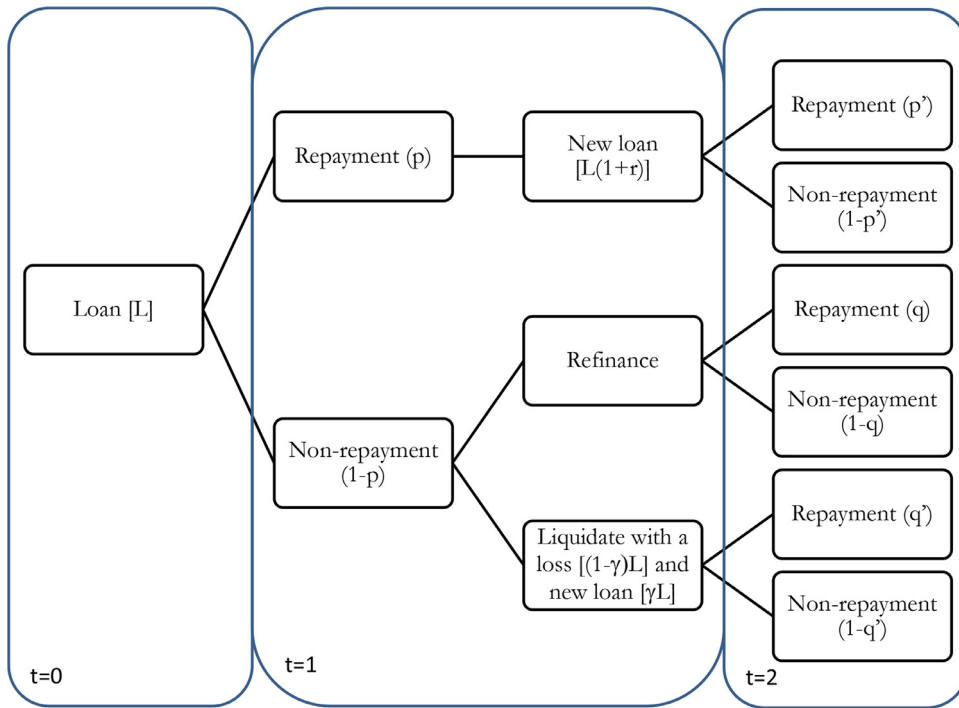


Fig. 1. Temporal evolution of a loan granted at $t = 0$.

2.1. Myopic bank manager

I start with the hypothesis of a myopic bank manager, who at $t = 1$ considers only the cash flows generated in that period, not future cash flows derived from their decision. In this setting, it would be optimal to resolve the non-performing loan if the recovered amount exceeded the expected value of the renegotiated loan to the troubled borrower. That would occur when:

$$\gamma L > Lq(1 + r') + \gamma' L(1 - q), \quad (1)$$

where q is the probability to repay the renegotiated loan, r' is the interest rate of the new loan, and γ and γ' are the amounts recovered from non-performing loans and from renegotiated loans in case they become non-performing and are resolved, respectively.

Operating and regrouping terms, Eq. (1) turns into the following:

$$\gamma > q + qr' - q\gamma' + \gamma'. \quad (2)$$

In these circumstances, the bank will resolve the non-performing loan depending on the amounts to recover, the probability of the renegotiated loan being repaid and that loan's interest rate.

Contrary to Homar and van Wijnbergen (2017), I consider that the bank can recover some value from the renegotiated loan when it becomes non-performing in the second period (in other words, $\gamma' \neq 0$). In principle, there would not be any reason why these recoveries should be smaller in normal times than those from non-performing loans are that have not been renegotiated.² Furthermore, the legal framework to which the bank and the borrower are subject (related, for example, to bankruptcy laws and the existence of a secondary market for non-performing loans) may determine the recovery amounts. The legal framework could exhibit certain stability over time.

It can be assumed that the renegotiated loan's recovered amounts should not differ (significantly) from those of the original loan, thus $\gamma = \gamma'$. As a result, Eq. (2) becomes:

$$0 > q(1 + r' - \gamma). \quad (3)$$

The expression in the parentheses above cannot be negative, so the myopic bank manager would not have any incentive to resolve the non-performing loan.

² In times of financial stress, there could be a simultaneous resolution of a large amount of non-performing loans, which could lower the recovered amounts. For example, in the case of exposures secured by real estate, banks' repossession collateral could generate fire sales and lower market prices.

2.2. Consideration of two periods

However, the decision of whether to renegotiate a non-performing loan also needs to consider expected cash flows in the second period. That would imply to abandon the previous hypothesis of a myopic manager and consider the interest income of the new loan in the case of resolving the non-performing loan. In this case, the relevant cash flows for the bank manager's decision would then be:

$$\gamma L(1+r)q' + \gamma L(1-q')\gamma > Lq(1+r') + \gamma' L(1-q). \quad (4)$$

Operating further, I obtain:

$$\gamma^2 - \gamma' + \gamma q'(1+r-\gamma) - q(1+r'-\gamma') > 0. \quad (5)$$

Contrary to Eq. (3), there may be (infrequent) situations in which the inequality above would hold. Therefore, a bank manager who considers the cash flows in the two periods will not always choose to refinance the loans because it may be desirable for the bank in terms of cash flows to resolve the non-performing loan and to grant a new loan (with, nonetheless, lower nominal). This would particularly be the case if the amount to be recovered from the non-performing loan was high enough, if the interest rate of the new loan was higher than the interest rate of the refinanced loan (in other words, interest rates increase between the two periods) and if the probability of the new loan being repaid was materially higher than the probability of the refinanced loan being repaid.

As above, assuming that $\gamma = \gamma'$, then:

$$(\gamma^2 - \gamma) + \gamma q'(1+r-\gamma) - q(1+r'-\gamma) > 0. \quad (6)$$

In these circumstances, there would be few cases where the inequality above would hold: the first and third expressions on the left-hand side are normally negative and the second one needs to be large enough to make the whole expression positive. Therefore, in general, even a non-myopic manager would often prefer to renegotiate the non-performing loan instead of resolving it.

2.3. The model with prudential capital requirements

Banks operate under a regulatory framework that requires them to hold a minimum amount of capital to absorb future unexpected losses. If one wants to incorporate prudential capital requirements into the model, one needs to go beyond the individual loan and consider the bank's whole loan portfolio.

I assume that the bank grants a number n of loans of equal principal L . The total balance sheet size of the bank is nL . On that basis, it retains knL units of capital, where $k > k^*$ (assumed to be the minimum prudential requirement) and $k < 1$. If k is lower than k^* , the breach of the prudential requirement leads to the bank's liquidation.

At $t = 1$, a proportion of all the loans becomes non-performing ($a < n$). If the bank decides to resolve the non-performing loans, the initial capital amount (knL) plus the interest received from the performing loans ($(n-a)$), minus the loss from liquidating the non-performing loans, minus dividends paid (which is expressed as a proportion of the total size of balance sheet, πnL) must still be higher than the minimum capital requirement, computed with the new balance sheet size:

$$knL + (n-a)Lr - (1-\gamma)aL - \pi nL > k^*[(1+r)L(n-a) + \gamma aL]. \quad (7)$$

Grouping terms and operating further, the equation turns into:

$$k > k^* + (1-k^*)\left(\frac{a}{n}(1-\gamma) - r\left(1 - \frac{a}{n}\right)\right) + \pi. \quad (8)$$

According to Eq. (8), it is possible that resolving non-performing loans leads to capital requirements that are below the prudential minimum. In these cases, the relative size of the paid dividends and the difference with the minimum capital requirement ($k - k^*$) emerge as the two most important factors. Other important variables to consider include the rate of non-performing loans, the amounts to be recovered from non-performing loans and the loan's interest rate.

If the loan is renegotiated, there is no loss to recognise in $t = 1$, thus the capital impact is substantially lower than in the case of resolving non-performing loans and so is the probability to breach the minimum capital requirement:

$$knL + (n-a)Lr - \pi nL > k^*[(1+r)L(n-a) + aL]. \quad (9)$$

As above, one can group similar terms to obtain the following equation:

$$k > k^* + (1-k^*)r\left(1 - \frac{a}{n}\right) + \pi. \quad (10)$$

It is assumed above that renegotiated loans did not generate interest income in the first period and that no loss related to them was recognised.

A comparison between Eqs. (8) and (10) reveals that resolving non-performing loans has higher costs regarding capital requirements, everything else equal, than renegotiating the loan does. That difference is equal to $(1-k^*)\left(\frac{a}{n}(1-\gamma)\right)$.

Beyond the unwillingness to breach regulatory minimum capital requirements, this also points to another incentive against resolving non-performing loans, considering bank managers may be unwilling to take the impact of the related loss on capital and the subsequent adverse reaction of existing shareholders and of market participants, in general. That would be consistent with the findings on income smoothing in the academic literature (see, among others, Copeland, 1968; Cheng et al., 2011; Kilic et al., 2013).

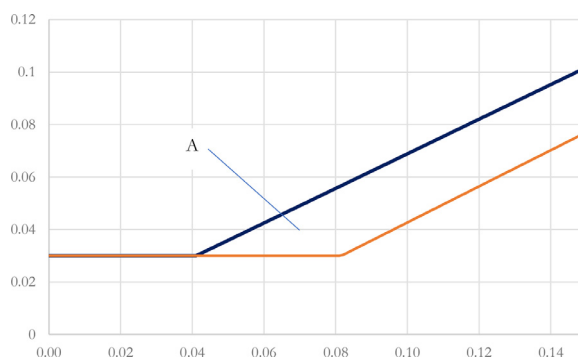


Fig. 2. Increases in non-performing loans and the banks' capacity to absorb losses from resolving non-performing loans.

Notes: each line represents the capital ratio above which a bank would have the capacity to resolve non-performing loans as absorbing the related losses without breaching the binding capital requirement of 3%. The blue line assumes interest rates at 3% and the orange line at 6%.

In sum, this section has shown that in the case that a loan is expected to become non-performing, there are strong incentives towards its renegotiation, based on expected cash flows and on the managers' wish to avoid deteriorating the bank's capital position. Besides, in some circumstances, resolving non-performing loans has higher costs also regarding regulatory capital and it could lead to a breach of prudential capital requirements. From the banks' perspective, thus, loan renegotiation prevails as the best option.

2.4. A small calibration of the model

Based on Eq. (8), I calibrate the model with prudential capital requirements to understand which variables may influence the banks' incentives towards resolving non-performing loans against the alternative of loan renegotiation, expressed in Eq. (10).

The calibration assumes a prudential (non-risk-weighted) prudential requirement of 3% (equity should be equal, at least, to 3% of total assets), following the leverage ratio requirement in Basel III, and that banks can recover 35% of the non-performing loans' value ($\gamma = 0.35$), in line with information from the European Banking Authority (2020). Finally, banks pay dividends equal to 0.2% of total assets ($\pi = 0.002$), a value that is slightly below the return on assets of European banks in the last years to allow for using profits to increase reserves (Basten and Sánchez Serrano, 2019).

The main point of interest is in the interaction of interest rates and the incentives for loan forbearance, given episodes of financial crisis of different intensity. Fig. 2 shows the combinations of increases in non-performing loans (x-axis) and the level of capital, which would imply a breach of the prudential capital requirement if the bank absorbs the losses from non-performing loans (y-axis), with interest rates set at 3% (area below the blue line) and at 6% (area below the orange line). The lines are truncated at the prudential minimum requirement of 3%.

It is clear how the resolution of non-performing loans is not a valid option for the bank in an environment of low interest rates, even when the capital ratio of the bank is above the minimum prudential requirement, compared to a situation in which the bank operates in an environment of higher interest rates. Therefore, for the hypothetical case of a bank with a capital ratio of 4% confronted with an increase in non-performing loans of 7% of total assets, the resolution of non-performing loans is not an option with interest rates at 3%, as point A in Fig. 2 is below the blue line. However, it is possible when interest rates are at 6% (point A in Fig. 2 is above the orange line).

A second interesting insight from Fig. 2 is that it requires a remarkable increase in non-performing loans for the bank not to be able to absorb the losses. In other words, the introduction of a prudential capital requirement at 3% allows the bank to absorb losses from non-performing loans when they increase moderately. Banks' capacity to resolve non-performing loans (and hence to avoid loan renegotiation) is impaired only when the increase of non-performing loans exceeds 5% of total assets, a rate last seen in some countries during the global financial crisis. Therefore, loan renegotiation becomes more widespread as an optimal solution when the crisis is more extreme.

The next section takes the perspective of the borrower and discusses the implications that the tendency of banks towards loan renegotiation can have for the real economy.

3. The perspective of non-financial corporations

Bank lending involves two counterparts; the previous section has covered one in detail: the lender. Concerning the second counterpart, the borrower, Fig. 3 displays the options faced by non-financial corporations. The main decision is whether to renegotiate the loan to the incumbent non-financial corporation in $t = 1$ or to liquidate it and use the available funds to grant a loan to a new entrant. An additional decision for new entrants is whether to ask for bank funding or to go for market-based funding through bond issuances (the latter two are described in detail in Appendix 1). I assume from here onwards that bank loans are the main funding source for the new entrant.

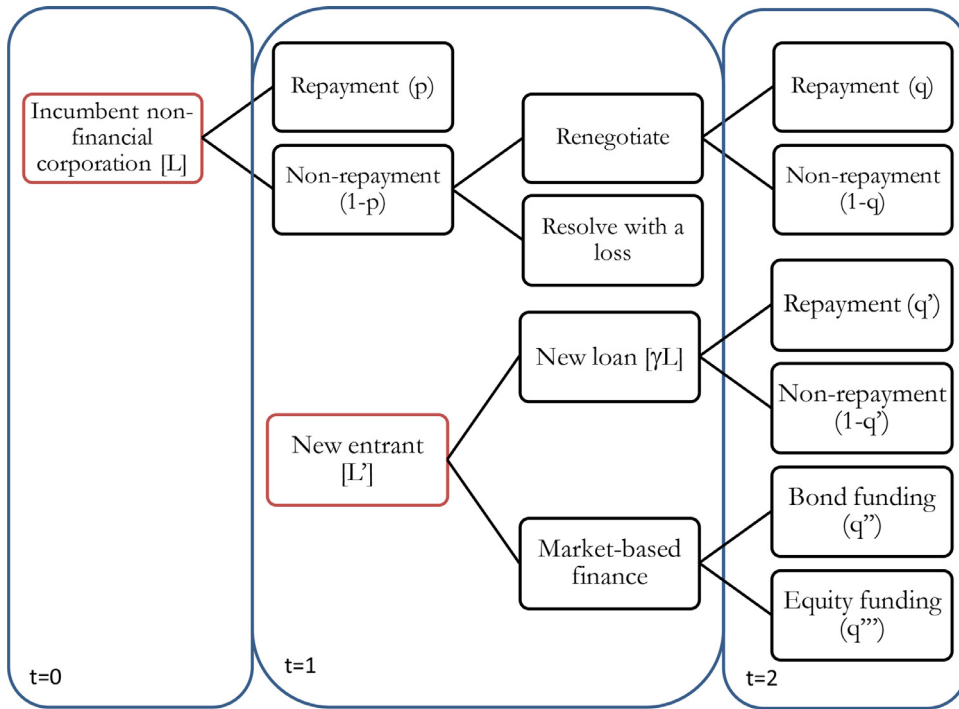


Fig. 3. Funding of an incumbent non-financial corporation and of a new entrant.

3.1. Incumbent and new non-financial corporations

I start with a representative (incumbent) non-financial corporation that operates under the following productivity function (similar to Caballero et al., 2008):

$$Y_t^i = A_t(1 + B + \varepsilon_t^i), \quad (11)$$

where Y represents productivity, i identifies the non-financial corporation as an incumbent, A is the state of technology at time t shared by all non-financial corporations, B is a possible shift in the use of technology that creates an aggregate productivity shock and ε_t^i is an idiosyncratic shock.

The costs of the incumbent non-financial corporation include a lineal function of its production and the cost from bank funding:

$$C_t^i = c_t^i N_t^i + L(1 + r), \quad (12)$$

where C are the total costs of the non-financial corporation, N is the volume of production and c refers to the unitary cost of production.

In normal circumstances, the level of reservation productivity and the costs would determine whether the incumbent non-financial corporation generates a profit in the period:

$$Y_t^i - C_t^i > 0, \quad (13)$$

$$A_t(1 + B + \varepsilon_t^i) - c_t^i N_t^i - L(1 + r) > 0. \quad (14)$$

Together with the incumbent non-financial corporation, it can be assumed that there is a new entrant looking for funding to enter the market segment with a higher level of technology. In this case, the productivity function would be equal to:

$$Y_t^n = A_t(1 + \theta + B + \varepsilon_t^n), \quad (15)$$

where n is used to refer to the new entrant and θ is a factor reflecting its superior technology.

Contrary to the incumbent non-financial corporation, if one assumes that the new entrant is subject to fixed costs, its cost function would be:

$$C_t^n = c_t^n N_t^n + K + F^n, \quad (16)$$

where K represent the fixed costs of entry and F^n the funding costs of the new entrant, which are not necessarily through bank funding, as market-based funding can also be available.

The profit equation for the new entrant would then be given by:

$$Y_t^n - C_t^n > 0, \quad (17)$$

$$A_t(1 + \theta + B + \varepsilon_t^n) - c_t^n N_t^n - K - F^n > 0. \quad (18)$$

3.2. Dynamics of loan renegotiation

Based on Eq. (14), the incumbent non-financial corporation will not be able to pay back the loan (in $t = 1$, this occurs with a probability $1-p$) when:

$$A_1(1 + B + \varepsilon_1^i) - c_1^i N_1^i < L(1 + r), \quad (19)$$

where t has been replaced with 1.

This inequality may arise because either the productivity of the incumbent non-financial corporation is too low in comparison with its cost structure or, alternatively, that its production costs are too high in view of its productivity. Either would point to inefficiencies in the way the incumbent non-financial corporation operates.

In these circumstances, banks prefer to renegotiate the loan so that the incumbent non-financial corporation can pay it back in the next period ($t = 2$). That would entail that:

$$A_2(1 + B + \varepsilon_2^i) - c_2^i N_2^i > L(1 + r'). \quad (20)$$

If one assumes no (or limited) technological change ($A_1 \approx A_2$), no productivity shocks and similar levels of production ($N_1^i \approx N_2^i$), the incumbent non-financial corporation would only be in a position to pay back the loan if the interest rate of the loan were lower than the interest rate of the original loan ($r' < r$) and/or if it is able to undertake a strong cost reduction ($c_2^i < c_1^i$). Otherwise, the renegotiation of the loan would just end with a non-performing loan in $t = 2$.

Relaxing the assumptions above and allowing for technological change between $t = 1$ and $t = 2$ ($A_2 = A_1 + \Delta A$), the incumbent non-financial corporation would be able to pay back the renegotiated loan if:

$$(A_1 + \Delta A)(1 + B + \varepsilon_2^i) - c_2^i N_2^i > L(1 + r'). \quad (21)$$

To compare it with a situation in which a new entrant gets a loan, I subtract Eq. (14) from the equation above, and obtain:

$$(A_1 + \Delta A)(1 + B + \varepsilon_2^i) - c_2^i N_2^i - A_1(1 + B + \varepsilon_1^i) + c_1^i N_1^i > L(1 + r') - L(1 + r), \quad (22)$$

$$\Delta A(1 + B + \varepsilon_2^i) - c_2^i N_2^i + c_1^i N_1^i > L(r' - r). \quad (23)$$

In principle, the increase in productivity between the two periods, once production costs are taken into account, should be enough to overcome the difference in interest rates of the new loan and for loan renegotiation to lead to a positive outcome. That could be quite challenging, given the fact that the incumbent was not able to pay back the loan in the previous period. However, this trivial result reveals an important point: If the interest rate of the renegotiated loan is lower than the interest rate of the new loan, loan renegotiation would already make sense, even without a change in technology ($\Delta A = 0$) or production costs ($c_2^i N_2^i = c_1^i N_1^i$). In this case, the level of technology of a given sector may stagnate if loan renegotiation is a common practice, with incumbents having little interest to improve their productivity and cost structure.

However, in societal terms, consider a situation in which a new entrant only has access to funding via bank loans and that the amount of available credit in the whole economy is limited (in other words, loans to incumbents and to new entrants are substitutive). In this case, there would be a loss of technological progress, measured by the parameter θ (see Eq. 18), as the renegotiated loan would be at the expense of the potential loan to the new entrant.

In this vein, one can compare the circumstances in which the repayment of the renegotiated loan would seem more likely than the repayment of a loan granted to a new entrant. I do this by comparing the profit equations in $t = 2$ for the incumbent non-financial corporation and for the new entrant, assuming conditions under which the incumbent non-financial corporation may be in a position to generate higher profits than the new entrant:

$$A_2(1 + B + \varepsilon_2^i) - c_2^i N_2^i - L(1 + r') > A_2(1 + \theta + B + \varepsilon_2^n) - c_2^n N_2^n - K - \gamma L(1 + r). \quad (24)$$

Operating further, I obtain:

$$\theta A_2 - K - c_2^n N_2^n + c_2^i N_2^i + L(1 + r' - \gamma - \gamma r) < 0. \quad (25)$$

The last term in the left part of the inequality ($L(1 + r' - \gamma - \gamma r)$) will tend to be positive in most plausible cases. Given the smaller production of the new entrant ($N_2^n < N_2^i$), the term $-c_2^n N_2^n + c_2^i N_2^i$ in the equation above will typically be positive (unless unitary production costs are significantly higher for the new entrant: $c_2^i < c_2^n$). Therefore, a necessary condition for the probability of repayment of the renegotiated loan being higher than the probability of repayment of the loan to the new entrant is that the new entrant brings a minor improvement in technology that is not able to compensate for the fixed cost of entrance (K). That would be the case in sectors with certain barriers to entry (generating large fixed costs of entrance) or in which incumbent non-financial corporations already operate very close to the technological frontier.

It is important to note that renegotiating the loan to the incumbent non-financial corporation keeps the amount of credit and production constant in the economy. On the contrary, the available amount of bank credit for the new entrant after the resolution of the non-performing loan is smaller (γL) and so could be expected to reduce production in the most immediate periods (if successful, other competitors may increase the level of production). So, in addition to the trade-off of renegotiating or resolving the non-performing loan (see Section 2), there could be a second trade-off between maintaining the current level of production and incorporating the newest technology but with lower levels of production in the short term.

3.3. From technology to aggregated productivity growth

Section 2 has shown that banks have strong incentives to renegotiate loans, even under a prudential capital requirement. As a result, new entrants in a given industry may not get access to bank loans and could find themselves at a disadvantage against incumbent non-financial corporations, which would capture bank funding (Appendix 1 discusses briefly the consideration of having market and equity finance). This section shows how this behaviour at the individual level would influence the aggregate in terms of technological development, measured by the parameter θ in Eq. (10).

Following Blattner et al. (2019) and Petrin and Levinsohn (2012), I consider that the aggregated productivity growth (APG) in an economy at time t is equal to:

$$APG_t = \sum_{h=1}^H D_{h,t} \Delta Y_{h,t} + \sum_{h=1}^H D_{h,t} \sum_{k=1}^K W(k) \Delta X_{h,k,t}, \quad (26)$$

where h refers to a non-financial corporation, H to the total number of non-financial corporations (being the sum of incumbents and new entrants, $H = I + N$), D_h to a measure of the weight of non-financial corporation h on the total economy,³ Y to (total factor) productivity according to Eq. (11) and to Eq. (15), k to the inputs used in the production process, $W(k)$ to the primary input costs and $X(h, k, t)$ to a function of the primary inputs used by non-financial corporation h .

If one assumes two primary inputs in the production process, labour (L) and capital (K), Eq. (26) becomes:

$$APG_t = \sum_{h=1}^H D_{h,t} \Delta Y_{h,t} + \sum_{h=1}^H D_{h,t} W(L) \Delta X_{h,L,t} + \sum_{h=1}^H D_{h,t} W(K) \Delta X_{h,K,t}. \quad (27)$$

The second part is the contribution to labour and the third part the contribution of capital to aggregated productivity growth.

In broad terms, the first term of Eq. (27) can be seen as the change in total factor productivity, weighted by the size of non-financial corporations, and the second and third terms as the effect on productivity created by productive inputs.

I now focus on the first term of Eq. (27). Since the total number of non-financial corporations in an economy equals the new entrants (N) plus the incumbent non-financial corporations (I), the following expression for the change in total factor productivity can be derived:

$$\sum_{h=1}^H D_{h,t} \Delta Y_t = \sum_{i=1}^I D_{h,t} \Delta Y_t + \sum_{n=1}^N D_{h,t} \Delta Y_t. \quad (28)$$

Considering Eqs. (11) and (15), I obtain:

$$\sum_{h=1}^H D_{h,t} \Delta Y_t = \sum_{i=1}^I D_{i,t} \Delta A_t^i (1 + B + \varepsilon_t^i) + \sum_{n=1}^N D_{n,t} \Delta A_t^n (1 + \theta + B + \varepsilon_t^n). \quad (29)$$

Operating further:

$$\sum_{h=1}^H D_{h,t} \Delta Y_t = \sum_{h=1}^H D_{h,t} \Delta A_t^h (1 + B + \varepsilon_t^N) + \sum_{n=1}^N D_{h,t} \Delta A_t^n \theta. \quad (30)$$

And Eq. (27) becomes:

$$APG_t = \sum_{h=1}^H D_{h,t} \Delta A_t^h (1 + B + \varepsilon_t^N) + \sum_{n=1}^N D_{h,t} \Delta A_t^n \theta + \sum_{h=1}^H D_{h,t} W(L) \Delta X_{h,L,t} + \sum_{h=1}^H D_{h,t} W(K) \Delta X_{h,K,t}. \quad (31)$$

Therefore, the trend to renegotiate loans instead of recognising losses from non-performing loans has a direct impact on the number of new entrants in an economy (N) and on their weight on the total economy ($D_{h,t}$). Since these new entrants have higher technological capabilities, the fact that some of them are not able to enter into operation because of a lack of access to funding entails a loss in total factor productivity for the economy, which, in turn, also implies a loss in aggregated productivity growth. As in Baily et al. (1992) and Andersson (2006), this would signal the existence of a (non-dominant) relation between new entrants and the growth of total factor productivity.

To make that relation explicit, I further assume that non-financial corporations are all of the same size. As a result, Eq. (30) can be expressed as:

$$H D_{h,t} \Delta Y_t = H D_{h,t} \Delta A_t^h (1 + B + \varepsilon_t^N) + N D_{h,t} \Delta A_t^n \theta. \quad (32)$$

Operating further, one obtains:

$$\Delta Y_t = \Delta A_t^h (1 + B + \varepsilon_t^N) + \frac{N}{H} \Delta A_t^n \theta. \quad (33)$$

³ Petrin and Levinsohn (2012) and Blattner et al. (2019) use Domar weights, defined as revenue of the non-financial corporation divided by total gross value added. By construction, the sum of these weights is larger than 1.

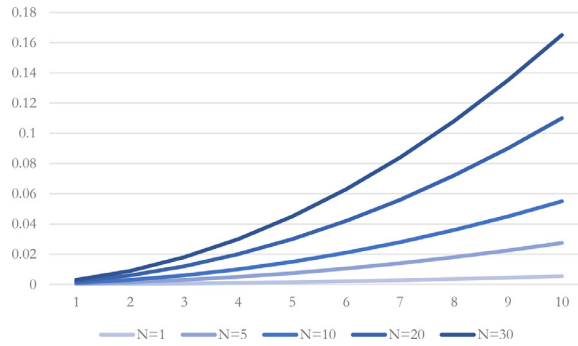


Fig. 4. Accumulated differential increase in total factor productivity under various numbers of new entrants in the economy, units.

Notes: Each line represents the difference between accumulated growth of total factor productivity at the end of each year, on the x-axis, under various numbers of new entrants and accumulated growth of total factor productivity at the end of each year with no new entrants ($N = 0$). The total number of corporations is set to 1,000.

If the rate of new entrants in the economy ($\dot{n}$) is defined as ($\dot{n} = \frac{N}{H}$), then the previous equation turns into:

$$\Delta Y_t = \Delta A_t^h (1 + B + \varepsilon_t^N) + \dot{n} \Delta A_t^n \theta. \quad (34)$$

According to Eq. (34), the share of new entrants in an economy could influence changes in total factor productivity, which, in turn, would affect the aggregated productivity growth of the economy, as per Eq. (27). Accordingly, the share of new entrants can be negatively related to the practice of loan renegotiation in the absence of other sources of funding.

3.4. A simplified parametrization to show new entrants' influence on productivity

Before proceeding into the empirical analysis, I use Eq. (30) to gauge the importance of the “loan renegotiation” channel in interaction between banking (credit) and productivity growth with a stylised example.

One can assume an economy operating in one sector of activity, with 1,000 incumbent non-financial corporations, and an increase in the state of technology of 1 unit per year ($\Delta A_t = 1$). There are no aggregate or idiosyncratic productivity shocks ($B = \varepsilon_t^i = 0$) and new entrants have a level of technology 10% higher than incumbents ($\theta = 0.1$). Fig. 4 shows the accumulated differential increase in total factor productivity ($\sum_{h=1}^H D_{h,t} \Delta Y_t$) over 10 years, with various numbers of new entrants in the economy. The increase of total factor productivity with no new entrants ($N = 0$) is used as a benchmark. An economy with no entrants would have accumulated growth of technological development equal to 10 after 10 years, while an economy with 3% of new entrants each year would have an accumulated technological growth of 10.165 at year 10 (at that time, 30% of the incumbents would have been new entrants over the past years). Therefore, the number of new entrants in the economy influences the increase of total factor productivity. As shown, the number of new entrants in an economy depends on their access to bank funding, which may be curtailed if other funding sources are not available and in cases of troubled incumbent non-financial corporations being favoured through loan renegotiation. While relatively small and subject to a very simplified framework in Fig. 4, this channel can be relevant when total factor productivity remains stable over time, as many advanced economies have experienced in recent years.

4. Empirical analysis

This section is focused on providing empirical evidence of the main result: banks' strong incentives to renegotiate loans may favour incumbent non-financial corporations at the expense of the entry of new entrants. In such a case, total factor productivity may be affected negatively (in the absence of sufficiently developed capital markets that can provide alternative sources of funding to the new entrants). The main objective is to find evidence of a negative relation between loan renegotiation and total factor productivity.

4.1. Identification strategy

My purpose is to explore the potential impact of loan renegotiation on the real economy in aggregated terms. Section 2 has developed a model establishing the microfoundations of banks' incentives to renegotiate troubled loans, and Section 3 has considered what it means for the productivity of corporations and the economy. Grouping the empirical factors with individual data of non-financial corporations would not make it possible to find evidence of the influence of loan renegotiation on the aggregated economy. Besides, granular corporate data is scarce and, in many cases, recent, so it would be difficult to build an adequately long time series.⁴

⁴ This remains a valuable stream of research to be pursued in the next years, once availability of granular data improves.

Eq. (34) formalises the relation between total factor productivity and the share of new entrants in the economy. Starting from there, I can assume that the share of new entrants takes a linear expression, as in the following:

$$\dot{n} = \beta_0 + \beta_1 EC + \beta_2 V - \beta_3 LR, \quad (35)$$

where EC refers to a variable related to the economic cycle in an economy (for example, consumption), V is a vector of structural economic-specific variables related, for instance, to entrepreneurial spirit or the openness of the economy, and LR is a measure of the extent of loan renegotiation.

Replacing $\dot{n}$ in Eq. (34) leads to the following equation:

$$\Delta Y_t = \Delta A_t (1 + B + \varepsilon_t^N) + (\beta_0 + \beta_1 EC + \beta_2 V - \beta_3 LR) \Delta A_t \theta. \quad (36)$$

Eq. (36) will be the basis of the empirical analysis, in which I try to find a statistically significant relation between the change in total factor productivity and a variable for loan renegotiation (LR).

Based on Eqs. (27) and (36), the regression equation is defined as follows:

$$\Delta TFP_{i,t} = TFP_{i,t} - TFP_{i,t-1} = \alpha + \beta_1 EC_{i,t} + \beta_2 V_{i,t} - \beta_3 LR_{i,t} + \gamma_i + \varepsilon_{i,t}. \quad (37)$$

where, in addition to variables defined above, $TFP_{i,t}$ represents the level of total factor productivity for country i in period t , γ_i are country-fixed effects and $\varepsilon_{i,t}$ is the error term.

The academic literature has often referred to the important role of country-level structural characteristics in the evolution of total factor productivity (Danquah et al., 2011; Dieppe et al., 2020). The introduction of country fixed effects in Eq. (37) is intended to capture these structural characteristics, which are broadly unchanged over time. Regarding period fixed effects, they should cover variables that remain constant across the cross-section of countries and that change over time. They should capture common global factors, such as the global financial cycle. However, the regression equation, Eq. (37), does not consider period fixed effects for two main reasons. First, the academic literature has not made a strong case for the role of common global factors in the evolution of total factor productivity at the country level. Besides, the sample comprises the main economies of the world, not encompassing the definition of small open economies for which the global financial cycle can be a strong factor in their macroeconomic performance. Second, assuming that period fixed effects capture the global financial cycle, it is worth noting that Eq. (37) already considers a variable to capture a country's economic cycle. As a result, the country-specific variable for the economic cycle may be highly correlated with the potential global factor. In any case, I introduce an independent variable for the global financial cycle in the empirical analysis to capture the potential impact of that global variable on country-specific changes in total factor productivity.⁵

Expressing all the variables in logarithms would allow for elasticities, showing the impact of each independent variable on the dependent variable. This specification (see Table A2 in Annex 3) is explored in Annex 3, but discarded it for two main reasons. First, the Durbin-Watson statistic could be seen as suggesting autocorrelation in residuals and endogeneity in the variables. Omitted variables could also be one possible explanation for autocorrelation in residuals. Second, the statistics for fitness-of-fit do not improve in comparison with a regression without logarithms. Even if the statistical significance of the variable used to capture loan renegotiation is the highest in Table A2, I have opted to continue the empirical analysis without logarithms in the variables.

4.2. Data

This empirical analysis is confronted with the difficulty of quantifying a relationship between two economic variables that have proven to be difficult to compute: loan renegotiation and total factor productivity (which can be seen as proxy for technological development). In Europe, supervisory data on loan renegotiation has been available quarterly only since 2015. As productivity is a long-term phenomenon, it cannot be fully captured with such a short time series. Therefore, I cannot use supervisory data and need to find a proxy to capture the degree of loan renegotiation in a banking system. On the other hand, data on total factor productivity of annual frequency is available for the major world economies over a relatively long period.

To approximate loan renegotiation, the ratio of loan provisions to total loans (also known sometimes as cost of risk) is used. The assumption is that, given the macroeconomic environment at a set time, including the rate of non-performing loans and economic growth, low ratio values would be associated with intense loan renegotiation, particularly in periods of crisis. Therefore, a positive relation between the ratio of loan provisions to total loans, and the change in total factor productivity can be expected.

The choice of loan provisions to total loans as an approximation of loan renegotiation does not come without issues. As documented by Betty and Liao (2014), loan provisions, which reflect the assessment of bank management on the evolution of credit quality in the loan portfolio in the near future, have been associated with practices of profit smoothening. Additionally, banks were applying various accounting approaches to loan provisions over the sample period (incurred losses or expected credit losses). However, as I am using country aggregates, the possible use of loan provisions for profit smoothening by individual banks should be diluted within the aggregate for the whole country. This issue is discussed again in the section on robustness checks.

The sample covers 23 countries, including European and non-European countries (Austria, Belgium, Canada, Switzerland, Czechia, Germany, Denmark, Estonia, Spain, Finland, France, Ireland, Italy, Japan, Luxembourg, Netherlands, New Zealand, Norway, Poland, Sweden, Slovakia, Slovenia and United States), for 1990 to 2019. Table 1 shows the descriptive statistics of these variables, with further details in Appendix 2.

⁵ On a more practical level, the introduction of period fixed effects also affects the degrees of freedom in the equations and leads to near-singular matrixes in many of the specifications later developed in the empirical analysis.

Table 1
Descriptive statistics.

Variable	N	Mean	Standard deviation	Q1	Q2	Q3
<i>Dependent variable</i>						
Total factor productivity	661	94.36	9.1996	89.95	97.20	100
Change of total factor productivity	638	0.7855	1.9273	-0.0353	0.7861	1.7489
<i>Independent variables</i>						
Provisions to total loans	653	0.0074	0.0137	0.0016	0.0044	0.0088
Consumption growth	643	0.0478	0.0488	0.0250	0.0397	0.0586
Exports to GDP	667	0.4978	0.3282	0.2917	0.4207	0.6265
Exports (index 1990 = 100)	667	5.5435	9.1852	1.6742	2.8857	4.3148

Notes: sample of 23 advanced economies starting in 1990 and finishing in 2019, with some breaks at the beginning and at the end of the time series. The change of total factor productivity is calculated as the difference between total factor productivity in two consecutive years. Provisions to total loans refers to the ratio of total provisions (or impairments) and total loans. The index of exports takes the value 100 in 1990, for each country separately.

Table 2
Results of the regressions using panel least squares.

Dependent variable: change in total factor productivity				
	(I)	(II)	(III)	(IV)
Constant	-0.1143 (0.1570)	-0.1505 (0.2645)	-0.1243 (0.1691)	0.0149 (0.2628)
Consumption growth	20.3336*** (1.9929)	21.8772*** (2.4996)	20.5804*** (2.0403)	19.9036*** (2.2145)
Exports to GDP (t-1)	-0.1849 (0.2331)	-0.2985 (0.4322)	-0.1902 (0.2494)	-0.6372 (0.0045)
Provisions to total loans (t-1)	9.1405* (5.4307)	11.5492* (6.1013)	9.5171* (5.5025)	20.4336*** (6.3954)
Country fixed effects	No	Yes	No	Yes
Cross-section weights	No	No	No	Yes
Random fixed effects	No	No	Yes	No
Number of observations	616	616	616	616
R-squared	0.1480	0.1839	0.1480	0.1787
Durbin-Watson	1.6574	1.7182	1.6555	1.7131
Sum of squared residuals	1974.674	1891.352	1974.738	1903.456
F-statistic	35.4362	5.3198	34.8335	6.3492
Prob (F-statistic)	0.0000	0.0000	0.0000	0.0000

Notes: ***, ** and * denote statistical significance at 0.01, 0.05 and 0.1 levels. For the columns with random fixed effects and with cross-section weights, R-squared, Durbin-Watson and the sum of squared residuals are unweighted.

Missing observations are recurrent in this time series and have been linearly extrapolated when possible. When missing values occur at the beginning of the time series, linear extrapolation is not possible, resulting in a slightly different number of observations for each variable.

Data has annual frequency, which still captures short-term movements over the business cycle. To exclude these movements and focus on the structural (long-term) relation between loan renegotiation and total factor productivity, one could take 10-year (or five-year) moving averages. However, as the dataset covers a relatively short period of time (in principle, from 1990 to 2019, but with some countries starting only in 1995 or later), I keep annual data and control for the business cycle using crisis dummies and an independent variable for the global financial cycle.

4.3. Results

The empirical analysis may be subject to the endogeneity problem, mainly in relation to two particular conditions: (i) omitting relevant variables and (ii) the simultaneity of loan renegotiation and total factor productivity. The second issue is addressed by considering provisions to total loans lagged one year, as it would naturally take time before loan renegotiation could restrict access of new entrants to certain activities in non-financial corporations, affecting ultimately total factor productivity. The other stock variable in the regression (exports to GDP) is also lagged. For the omission of relevant variables, I conduct tests of omitted variables (likelihood ratio) and look at the distribution of the residuals (Jarque-Bera test for normality).

The results of the regression using panel least squares are shown in Table 2.

Column (I) follows the main findings in Danquah et al. (2011) and use consumption growth, (lagged) exports to GDP and (lagged) provisions to total loans as independent variables. Provisions to total loans are statistically significant, but only at the 10% level, and with the expected positive sign. This positive sign should be read as a negative impact of loan renegotiation on the change of total

Table 3

Results of the regressions using panel least squares with independent variables to capture global effects.

Dependent variable: change in total factor productivity				
	(I)	(II)	(III)	(IV)
Constant	-0.3378 (0.2658)	-0.1479 (0.2590)	-0.0777 (0.2606)	0.0644 (0.2557)
Consumption growth	21.0873*** (2.4784)	19.4348*** (2.2118)	22.2330*** (2.4588)	20.3803*** (2.2024)
Crisis dummy			-1.7830*** (0.3858)	-1.2577*** (0.2593)
Exports to GDP (t-1)	0.0192 (0.4348)	-0.3355 (0.4316)	-0.3449 (0.4251)	-0.6408 (0.4286)
Global financial cycle	0.2966*** (0.0761)	0.2343*** (0.0507)		
Provisions to total loans (t-1)	11.4995* (6.0292)	18.5187*** (6.3914)	10.8900* (6.0003)	17.1478*** (6.2693)
Country fixed effects	Yes	Yes	Yes	Yes
Cross-section weights	No	Yes	No	Yes
Number of observations	616	616	616	616
R-squared	0.2045	0.2372	0.2125	0.2070
Durbin-Watson	1.7069	1.7252	1.7964	1.7680
Sum of squared residuals	1843.798	1854.134	1825.153	1837.844
F-statistic	5.8225	7.0434	6.1134	7.1722
Prob (F-statistic)	0.0000	0.0000	0.0000	0.0000

Notes: ***, ** and * denote statistical significance at 0.01, 0.05 and 0.1 levels. For the columns with cross-section weights, R-squared, Durbin-Watson and the sum of squared residuals are unweighted.

factor productivity. The associated coefficient is approximately half of that for consumption growth, signalling its lower importance in determining the path of total factor productivity. Regarding consumption growth and as discussed earlier, consumption may play a dual role in relation to total factor productivity: More consumption and economic activity should induce productivity gains, but more consumption may come at the expense of savings and affect investment in the economy, making a negative contribution to total factor productivity. Finally, exports to GDP are not statistically significant in the results.

Column (II) introduces country fixed effects to account for the strong national component in productivity (Danquah et al., 2011; Dieppe, 2020). The coefficient associated with provisions to total loan increases in consideration of country fixed effects. Having country fixed effects, which can correlate with the explanatory variables, seems more appropriate than using random fixed effects, as in column (III). In both cases, the growth of consumption continues to show a positive coefficient, around twice the size of the coefficient associated with provisions to total loans. Column (IV) returns to country-fixed effects and introduce cross-section weights to account for possible cross-section heteroskedasticity. This results in an increase in the coefficient associated with provisions to total loans, which now equals the coefficient of consumption growth and its statistical significance.

As previously discussed, the regressions in Table 2 do not consider period fixed effects, which would account for unobservable factors that change over time but are constant across countries, such as the global financial cycle. As an alternative for introducing period fixed effects, Table 3 brings these global factors into the regression in two different ways. First, it considers the global financial cycle, as computed by Miranda-Agrippino and Rey (2020), as an additional independent variable in the regression expected to enter with a positive sign. Second, a closer look at the sample period (1990-2019) reveals that the most important event that could affect productivity is the global financial crisis of 2007-2009. However, the global financial crisis did not affect all countries included in the dataset at the same time, and there were other countries in crisis in different periods. Using the identification of systemic banking and currency crises in Laeven and Valencia (2020), Fig. 5 shows that only 12 out of the 23 countries reported a crisis in 2008, with the US reporting a crisis in 2007. This finding is in line with existing evidence on heterogeneity in business and financial cycles globally (A'Hearn and Woitek, 2001; Schüler et al., 2020). Therefore, instead of introducing period fixed effects, I prefer to use a dummy variable for those crisis years identified by Laeven and Valencia (2020). A negative value for the associated coefficient can be expected, as years of crisis (equal to 1 in the dummy variable) should lead to negative changes in total factor productivity.

Table 3 shows the results of these regressions, with and without cross-section weights. The new variables for the global financial cycle and for the crisis dummy enter with the expected positive and negative signs, respectively, and are statistically significant. The statistical significance of the other independent variables as well as the size of their associated coefficient do not vary much in comparison with the regressions reported in Table 2, although there seems to be a small improvement in the fitness-of-fit indicators. Consumption growth continues to be the main factor driving changes in total factor productivity, with the lagged ratio of provisions to total loans contributing approximately half of it.

This analysis provides evidence of a long-term positive relationship between the one-year lagged ratio of provisions to total loans, which is used as an approximation of loan renegotiation, and the change of total factor productivity, which is taken as the main variable indicating technological progress in an economy. According to it, a wide use of loan renegotiation should lead to a less intense recognition of credit losses from non-performing loans, which in turn contributes negatively to the growth of total factor

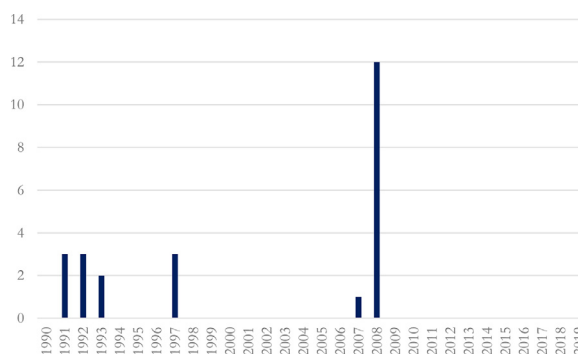


Fig. 5. Number of crises reported in Laeven and Valencia (2020).

Notes: Each bar represents the number of countries in the sample reporting a systemic banking or currency crisis in Laeven and Valencia (2020).

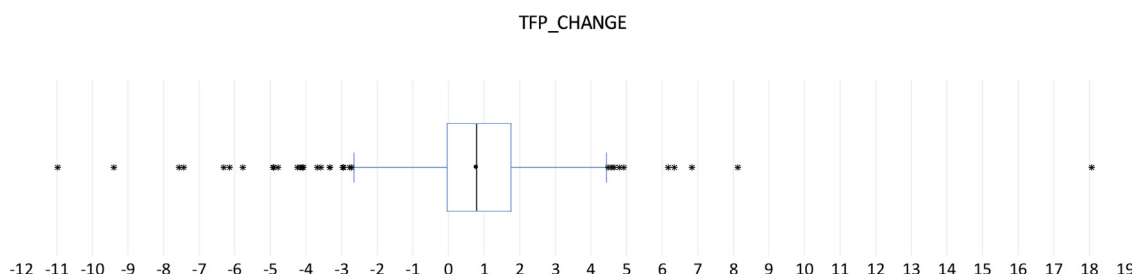


Fig. 6. Distribution of observations for change in total factor productivity.

Notes: The figure represents the range of values taken by the change in total factor productivity. Each dot represent a value taken outside the 5th and 95th percentile. The box shows the interquartile range with the median highlighted with a black line. The mean is shown as a black dot.

productivity in the economy in the next year. This relation complements the strong influence of consumption growth on total factor productivity.

4.4. Robustness checks

This section assesses the robustness of the results obtained in the empirical analysis by slightly amending the econometric approach used.

I start with a regression of Eq. (37) using robust least squares to account for large outliers that may have an excessive weight on the results, as reported in Table 2. Fig. 6 shows the presence of some large outliers in the distribution of the dependent variable (change in total factor productivity).

Table 4 reports the results of the regressions using robust least squares. In a comparison with the results of the regressions reported in Table 2, a decrease in the coefficient associated with consumption growth is observed, while the coefficient of provisions to total loans remains at similar levels. The statistical significance of provisions to total loans increases in robust least squares, confirming the influence of certain outliers in the results obtained using panel least squares.

Second, methodological concerns may arise for the convenience of using the ratio of loan provisions to total loans as an approximation to the intensity of loan renegotiation. Beatty and Liao (2014) document that banks could be using loan provisions to smooth profits over the cycle, thus introducing some bias into that approximation. To explore how best to capture the intensity of loan renegotiations, despite the potential use of loan provisions to smooth profits, one could construct a variable as the multiplication of GDP growth and provisions to total loans. However, it is worth noting that the change in total factor productivity and GDP growth are correlated by construction (total factor productivity is computed assuming a production function). Indeed, the correlation between GDP growth and the change in total factor productivity is 0.85 in the sample.

Instead, I use the variable for the global financial cycle, taken from Miranda-Agrippino and Rey (2020), and multiply it by provisions to total loans. The variable is introduced with a time lag into the regression equation. Higher values would then be associated with a more intense recognition of profits during periods when the cycle is moving upwards, suggesting either income smoothing or a lower use of loan renegotiation, or with intense recognition of provisions in periods of downturns (no loan renegotiation). This new variable is expected to appear with a positive coefficient in the regression.

Table 5 below shows the results of these regressions with country fixed effects. Columns (III) and (IV) also consider the dummy variable for the identified crisis periods for each country taken from Laeven and Valencia (2020). The new variable to capture loan renegotiation is statistically significant at the highest level with the expected positive sign across the four columns in Table 4. In

Table 4

Results of the regressions using robust least squares (M-estimation).

Dependent variable: change in total factor productivity			
	(I)	(II)	(III)
Constant	0.1953* (0.1146)	0.1171 (0.1124)	0.2482* (0.1124)
Consumption growth	14.5752*** (1.4544)	13.2231*** (1.4258)	14.7446*** (1.4212)
Crisis dummy			-1.3936*** (0.2784)
Exports to GDP (t-1)	-0.1457 (0.1701)	0.0126 (0.1665)	-0.1759 (0.1662)
Global financial cycle		0.2977*** (0.0540)	
Provisions to total loans (t-1)	9.7330** (3.9632)	9.3210** (3.8488)	8.8734** (3.8757)
Number of observations	616	616	616
R-squared	0.0950	0.1228	0.1168
Rw-squared	0.1702	0.2182	0.2102
Sum of squared residuals (non-robust)	2006.264	1960.644	1949.341
Rn-squared statistic	104.7520	136.7419	135.8855
Prob (Rn-squared statistic)	0.0000	0.0000	0.0000

Notes: ***, ** and * denote statistical significance at 0.01, 0.05 and 0.1 levels. Robust least squares do not allow for cross-section or period random and fixed effects.

Table 5

Results of the regressions using panel least squares with an alternative variable for loan renegotiation.

Dependent variable: change in total factor productivity				
	(I)	(II)	(III)	(IV)
Constant	-0.0585 (0.2495)	0.3481 (0.2359)	0.0011 (0.2446)	0.3318 (0.2259)
Consumption growth	20.5784*** (2.4124)	16.8412*** (2.1892)	21.0130*** (2.3634)	17.5359*** (2.1568)
Crisis dummy			-1.9743*** (0.3836)	-1.6038*** (0.2569)
Exports to GDP (-1)	-0.2842 (0.4282)	-0.8764** (0.4204)	-0.3185 (0.4193)	-0.8048** (0.3997)
Global financial cycle (-1) * provisions to total loans (-1)	26.7595*** (7.6077)	31.4526*** (6.5440)	31.0057*** (7.4940)	39.7537*** (6.4547)
Country fixed effects	Yes	Yes	Yes	Yes
Cross-section weights	No	Yes	No	Yes
Number of observations	616	616	616	616
R-squared	0.1959	0.2255	0.2305	0.2770
Durbin-Watson	1.6793	1.6370	1.7532	1.8013
Sum of squared residuals	1863.755	1851.617	1783.525	1762.649
F-statistic	5.7480	6.8719	6.7848	8.6886
Prob (F-statistic)	0.0000	0.0000	0.0000	0.0000

Notes: ***, ** and * denote statistical significance at 0.01, 0.05 and 0.1 levels. For the column with cross-section weights, the values of R-squared, Durbin-Watson, sum of squared residuals and F-statistics are weighted.

terms of size, its associated coefficient is significantly larger than the coefficient associated with growth in consumption, particularly when cross-section weights are included in columns (II) and (IV). This new configuration maintains the previous result of a relation between the change in total factor productivity and loan renegotiation.

Third, neoclassical growth models consider that growth is dynamic. Translating that into the regression per Eq. (37), this would imply that lagged TFP change should be included as an additional independent variable. Table 6 presents the results of these regressions, with country fixed-effects, a variable for the global financial cycle and a crisis dummy. While the lagged TFP change is not statistically significant in any of the six columns of Table 6, there is an improvement in fitness-of-fit indicators (R-squared, sum of squared residuals) as well as a higher value of the Durbin-Watson statistic, alleviating concerns about autocorrelation in the residuals. Only in column (V) are the variable provisions to total loans not statistically significant. In the other columns, its associated coefficient is similar in size to the one of consumption growth when cross-section weights are included. The results of the regressions in Table 6 tend to confirm the existence of a relation between loan renegotiation and the change in total factor productivity.

I have conducted three robustness checks of my results. These checks suggest the existence of a relation between total factor productivity and loan renegotiation. Here, it is important to mention again that data on loan renegotiation is scarce, and I have not been able to find any variable to serve as approximation other than the ratio of provisions to total loans. Supervisory information on

Table 6

Results of the regressions using panel least squares with lagged dependent variable.

Dependent variable: change in total factor productivity	(I)	(II)	(III)	(IV)	(V)	(VI)
Constant	−0.3207 (0.2742)	−0.0556 (0.2702)	−0.5109* (0.2758)	−0.2142 (0.2676)	0.3166 (0.2439)	0.4704** (0.2308)
TFP change (−1)	0.0362 (0.0419)	0.0397 (0.0400)	0.0569 (0.0418)	0.0437 (0.0397)	−0.0062 (0.0367)	−0.0085 (0.0341)
Consumption growth	25.2493*** (2.9736)	22.5310*** (2.4898)	23.7453*** (2.9675)	21.6088*** (2.5064)	17.9766*** (2.6508)	17.0142*** (2.2822)
Crisis dummy					−3.3296*** (0.2482)	−2.6167*** (0.1749)
Exports to GDP (t−1)	−0.2619 (0.4396)	−0.7692* (0.4551)	0.0795 (0.4441)	−0.4326 (0.4462)	−0.2057 (0.3836)	−0.6947* (0.3768)
Global financial cycle			0.2908*** (0.0776)	0.2100*** (0.0518)		
Provisions to total loans (t−1)	14.7117** (6.2146)	23.8774*** (6.3814)	14.7257** (6.1448)	21.6486*** (6.4143)	5.3778 (5.4673)	11.6315** (5.5071)
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Cross-section weights	No	Yes	No	Yes	No	Yes
Number of observations	598	598	598	598	598	598
R-squared	0.1997	0.2394	0.2189	0.2550	0.3917	0.4471
Durbin-Watson	1.7643	1.7368	1.7799	1.7591	1.7593	1.7513
Sum of squared residuals	1809.411	1793.108	1765.896	1746.869	1375.303	1326.873
F-statistic	5.4786	6.9131	5.9164	7.2253	13.5924	17.0713
Prob (F-statistic)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Notes: ***, ** and * denote statistical significance at 0.01, 0.05 and 0.1 levels. For the columns with cross-section weights, R-squared, Durbin-Watson and the sum of squared residuals are unweighted.

loan renegotiation (forbearance) for European banks is available since 2015, and soon the time series could be long enough for use as input in Eq. (33).

5. Conclusions

When confronted with a loan turning into non-performing in the near future, the most likely response of banks is to renegotiate, not to resolve it. In the absence of well-developed financial markets, this could then impede the access to finance for new entrants, potentially having long-lasting effects over economic development. These effects are driven by a newly identified channel, operating through total factor productivity and aggregate productivity growth. Moreover, loan renegotiation does not guarantee that loans would be repaid later, so it may just delay the necessary recognition of credit losses in the economy.

My results are relevant for the policy challenges that policymakers face in the realm of non-performing loans. For example, in 2017, the Council of the EU launched an action plan with a range of measures to address the large stock of non-performing loans (Council of the EU, 2017). One of the objectives was to increase the recovery amount of non-performing loans ($\gamma' > \gamma$, following the notation of the model) as a way to incentivise their resolution.⁶ However, the model shows that, in the short-term, the likely impact of this measure is to increase the incentives toward loan renegotiation, just contrary to the intended effect. Indeed, expectations of future higher recovery rates make resolving non-performing loans less attractive. Ideally, such action should be announced sufficiently in advance and with strict requirements related to its entry into force.

For policy-makers, resolving non-performing loans entails a trade-off (Suarez and Sánchez Serrano, 2018). In the short-term, simultaneously resolving a large amount of non-performing loans may threaten the solvency of banks, as the related sizable losses may make banks breach their minimum prudential capital requirements. On the other hand, favouring incumbent non-financial corporations, through loan renegotiation and a delayed recognition and resolution of non-performing loans, may be costly in terms of technological and productivity growth, over the long-term.

The article offers novel insights into the interaction between total factor productivity and loan renegotiation. Recent research efforts have pointed out the role of credit supply constraints in the dynamics of productivity in European economies in the last years. This article adds another channel through which lending can affect productivity: loan renegotiations. Further research efforts could focus on investigating the interaction between credit and productivity, exploiting granular datasets such as credit registers. Such research could offer important insights when policymakers are confronted with difficult trade-offs arising from a large increase in non-performing loans. Ensuring that the banking system positively contributes to growth in the real economy should be a priority for policymakers, particularly in view of the significant macroeconomic challenges ahead.

⁶ Other policies referred to the improvement of information provided to potential buyers of non-performing loans or measures to lighten judiciary procedures linked to the recoverability of collateral values.

Disclaimer

The views expressed in this article are those of the author and do not necessarily represent the views of the European Systemic Risk Board (ESRB), any of its member institutions or the ESRB Secretariat. Comments received from two anonymous referees are gratefully acknowledged. All remaining errors are the author's.

Declaration of Competing Interests

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 1. Introducing market and equity finance for the new entrant

Sections 2 and 3 have shown how myopic bank managers may opt for loan renegotiation, leaving new entrants without the funding they need to enter the market. Even if the assumption of myopic bank managers is lifted up, loan renegotiation seems to be very often the optimal response. This appendix considers that new entrants can also take their necessary funding from financial markets.

Considering first bond markets and following Bolton and Freixas (2000), I assume that new entrants (and non-financial corporations, in general) can issue bonds, under an interest rate of r'' . In the case of liquidation of the non-financial corporation, bondholders would be able to recover an amount γ'' , which would be nonetheless lower than the amount recovered in case of a bank loan ($\gamma'' < \gamma$), to reflect the more efficient skills of banks to recover value in liquidation (Freixas et al., 2007; Donaldson et al., 2018).

Investors would then be ready to acquire a bond of the new entrant under the following zero-profit condition:

$$B = q''B(1 + r'') + (1 - q'')\gamma''B \quad (A1)$$

$$1 = q''(1 + r'') + (1 - q'')\gamma'' \quad (A2)$$

where B represents the nominal amount of the bond and q'' the probability of repayment. The investors' appetite for these bonds would be a function of the probability of repayment, so that lower probabilities of repayment would require higher interest rates.

I assume that the new entrant incurs some issuance costs, related to the provision of information to potential investors. In comparison with incumbent non-financial corporations, these costs would be higher for new entrants, as market participants do not know them and must therefore devote intense effort to the task.

These costs (C_B) would then be incorporated into the equation of the productivity for the new entrant (supplier of information) and into the zero-profit condition of the investor as C_I , as they require some effort to acquire that information:⁷

$$A_2(1 + \theta + B + \varepsilon_2^N) - c_2^N N_2^N - K - C_B > B(1 + r'') \quad (A3)$$

$$1 = q''(1 + r'') + (1 - q'')\gamma'' - C_I \quad (A4)$$

Eq. (A4) shows that, in comparison with bank lending, the new entrant must absorb now two fixed costs: the fixed cost of entering into the market segment and the fixed cost for the provision of information to potential investors.

As a result and with all else being equal, the probability of repayment of the bond is lower than the probability of repayment of the bank loan ($q'' < q'$), as the new entrant needs to face additional costs. Besides, the lower recovery amounts by bondholders in the event of default imply that the new entrant would need to offer higher interest rates than those it could obtain from bank lending.

Therefore, in some cases, it would be possible that, being left outside bank funding, a new entrant is not able to start its operations because bond funding is too expensive. That result would be in line with the findings of Diamond (1984 and 1991) according to which, when monitoring is efficient, investment is profitable and investors are small, bank funding dominates over market funding. On the other hand, it has been shown how bank funding tends to prioritise incumbent non-financial corporations, making them better in terms of welfare—as they would benefit from the lower competition and would not be pressed by new entrants with a higher level of technology. However, society might be worse-off due to the missed higher level of technology.

It can also be further assumed that the new entrant can receive equity finance, in the form of shares, which would require a proportional part of yearly profits to be paid as dividends to the shareholders. In this case, the new entrant's level of profits would define funding costs. This would imply that:

$$A_2(1 + \theta + B + \varepsilon_2^N) - c_2^N N_2^N - K - C_E > \pi^N [A_2(1 + \theta + B + \varepsilon_2^N) - c_2^N N_2^N - K - C_E] \quad (A5)$$

$$[A_2(1 + \theta + B + \varepsilon_2^N) - c_2^N N_2^N - K - C_E](1 - \pi^N) > 0 \quad (A6)$$

⁷ The implicit assumption here is that the information costs of banks and potential investors in relation to incumbent non-financial corporations are zero. Alternatively, it could be seen as potential investors entering into higher information costs regarding new entrants only, as there is considerable uncertainty about the success of the new entrant, and incumbent non-financial corporations have already been operating for some years. Both banks and potential investors may have internalised the information.

where C_E is the cost of informing potential investors in equity and π^N is the proportional part of benefits required by investors. Shareholders do not obtain anything in case the new entrant does not generate any profit; thus, they have a strong incentive for getting enough information about the prospects of the new entrant. One can then assume that $C_E > C_B$.

Dividends paid to shareholders can also be interpreted as a return for their investment, in a similar way that the interest of a bond would reward the risk taken by bondholders. That would generate the following zero profit equation for equity investors:

$$1 = q'''(1 + \pi^N) - C_I \quad (A7)$$

where q''' represents the probability of the new entrant to generate profits and, thus, pay a dividend. I implicitly assume that when the new entrant does not generate profits, nothing is distributed to shareholders. In this regard, equity markets seem less interesting for new entrants than bonds, to the extent that the return required by potential shareholders will exceed the rates of possible bonds. However, they may also help new entrants to attract the required capital if they are able to ensure a certain level of profits in the medium-term.

The academic literature has extensively discussed the optimal financial architecture in terms of the balance between credit and financial markets (bond and equity markets). For the purposes of this article, there is no need to go deeper into the results, and I refer the interested reader to the existing academic literature. [Allen and Gale \(1995\)](#) and [Boot and Thakor \(1997\)](#) are two basic references in this area.

Appendix 2. Methodological information about data used in the empirical analysis

[Table A1](#) shows further details on the variables used for empirical analysis:

Table A1

Sources and methodology of the data used in the empirical analysis.

Variable	Main data source	Comments
Total factor productivity	AMECO (European Commission)	Index of total factor productivity, with 2015 = 100. The change of total factor productivity is calculated as the difference between the value of total factor productivity in a given year and the value of the previous year.
Provisions to total loans	OECD and ECB Consolidated Banking Data	Provisions on loans (or when not available net provisions) divided by total loans as reported to the OECD Banking Database. The OECD Banking Database was discontinued in 2010 and the last observation is 2009 for the majority of countries. Exceptions are: Canada (no use of OECD data), Czechia (last observation from OECD is 2007), Japan (last observation from OECD is 2002), Norway (last observation from OECD is 2002), Switzerland (last observation from OECD is 1996), New Zealand (last observation from OECD is 1991) and US (no use of OECD data). For the subsequent periods, data taken from the ECB Consolidated Banking Data for EU countries, as impairments to total assets (for domestic banks) and the inverse of total loans and advances to total assets. For Canada, allowance for credit losses divided by total mortgages (source: Bank of Canada and Haver Analytics). For Japan, provision of allowance for loan losses divided by loans and bills discounted (source: Japanese Bankers Association and Haver Analytics). For Norway, average of bank loan losses to total lending to households and to non-financial corporations (source: Norges Bank and Haver Analytics). For the US, allowances for losses loans and leases divided by total loans and leases (source: FDIC). For New Zealand, total impaired assets expenses divided by total lending (source: Reserve Bank of New Zealand). For Switzerland, changes to provisions and other value adjustments and losses divided by mortgage loans plus total staggered consumer credit (source: Swiss National Bank).
Consumption growth	AMECO (European Commission) and World Bank	Yearly growth rate for the final consumption expenditure of households and NPISH in national currency, at current prices. Data is taken from the World Bank for Austria, Canada, Czechia, Ireland, Luxembourg and New Zealand.
Exports to GDP	World Bank	Exports of goods and services as a percentage of gross domestic product.
Exports index	AMECO (European Commission)	Index of exports of goods and services at current prices in national currency, with 1990 = 100.
Global financial cycle	Miranda-Agrippino and Rey (2020)	Please refer to Miranda-Agrippino and Rey (2020) for further details.

Appendix 3. Further regressions

[Table A2](#) presents the results of expressing the dependent and independent variables in [Eq. \(37\)](#) in logarithms.

Table A2

Results of the regressions using panel least squares, dependent and independent variables expressed in logarithms.

Dependent variable: change in total factor productivity (logs)						
	(I)	(II)	(III)	(IV)	(V)	(VI)
Constant	0.0409*** (0.0056)	0.0584*** (0.0107)	0.0462*** (0.0066)	0.0582*** (0.0074)	0.0595*** (0.0105)	0.0550*** (0.0073)
Consumption growth	0.0062*** (0.0010)	0.0079*** (0.0013)	0.0068*** (0.0011)	0.0066*** (0.0009)	0.0082*** (0.0013)	0.0066*** (0.0009)
Crisis dummy					−0.0202*** (0.0043)	−0.0116*** (0.0026)
Exports to GDP (t-1)	0.0002 (0.0013)	0.0047 (0.0048)	0.0007 (0.0019)	0.0031 (0.0032)	0.0041 (0.0047)	0.0024 (0.0032)
Provisions to total loans (t-1)	0.0020*** (0.0007)	0.0035*** (0.0010)	0.0025*** (0.0008)	0.0046*** (0.0007)	0.0035*** (0.0010)	0.0040*** (0.0007)
Country fixed effects	No	Yes	No	Yes	Yes	Yes
Cross-section weights	No	No	No	Yes	No	Yes
Random fixed effects	No	No	Yes	No	No	No
Number of observations	536	536	536	536	536	536
R-squared	0.0727	0.1600	0.0705	0.1551	0.1955	0.1857
Durbin-Watson	1.2628	1.4089	1.2620	1.4151	1.4820	1.4528
Sum of squared residuals	0.1821	0.1649	0.1824	0.1658	0.1579	0.1598
F-statistic	13.8145	3.8854	13.9102	6.3562	4.7572	6.8522
Prob (F-statistic)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Notes: ***, ** and * denote statistical significance at 0.01, 0.05 and 0.1 levels. For the columns with random fixed effects and with cross-section weights, R-squared, Durbin-Watson and the sum of squared residuals are unweighted.

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