Monetary Easing, Leveraged Payouts and Lack of Investment*

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Abstract

We study a model in which a low monetary policy rate lowers the cost of corporate debt, potentially spurring productive investment; low interest rates, however, also induce firms to lever up so as to increase payouts to equity. Whereas such leveraged payouts privately benefit shareholders, leverage comes at the social cost of distorting their incentives thereby lowering productivity and discouraging investment. If leverage is unregulated (for example, due to the presence of a shadow-banking system), then the optimal monetary policy seeks to contain such socially costly leveraged payouts by stimulating investment in response to adverse shocks only up to a level below the first-best. The optimal monetary policy may even consist of "leaning against the wind," *i.e.*, not stimulating the economy at all, in order to fully contain leveraged payouts and maintain productive efficiency.

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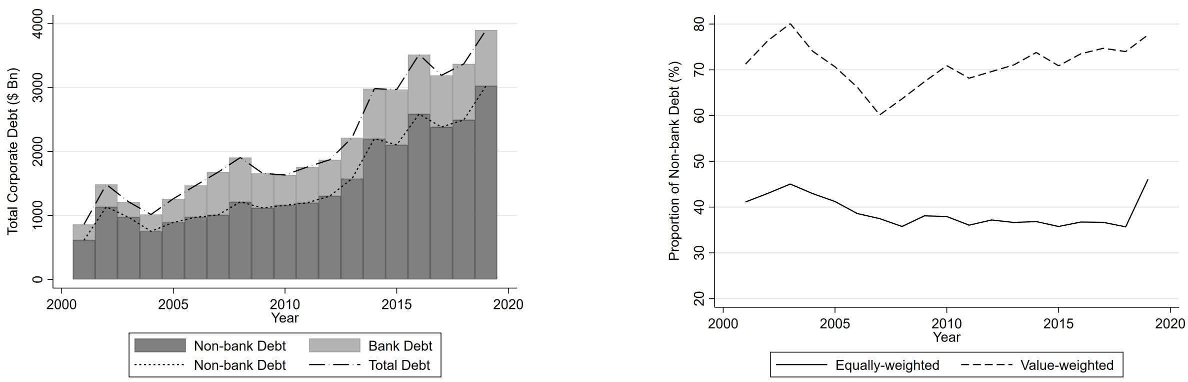
Introduction

The Federal Reserve (and central banks of several other advanced economies) has kept its policy rates at low levels following the 2008 global financial crisis. Since then, the financial structure of corporations in the United States (US) has experienced three remarkable evolutions.[1]

First, corporate leverage has significantly risen. Aggregate corporate debt, as shown in Figure 1 for the merged S&P Capital IQ and Compustat data, has reached historically high levels, exceeding in particular those prevailing just before the global financial crisis; the same conclusion can be reached for aggregate corporate debt relative to the GDP. As also shown in Figure 1, the share of corporate credit originated by non-banks—in particular, that originated by the so-called "shadow-banking" system—has also risen steadily since the crisis and reached its pre-crisis levels.



(a) (b)

Figure 1: Aggregate corporate debt: debt and non-bank financing. Panel (a) shows the aggregate value of bank and non-bank debt in levels (S&P Capital IQ variables *totbankdbt* and *nonbankdbt*. Panel (b) shows the fraction of non-bank debt. The solid line shows the average across all firms of firm-level non-bank debt to total debt ratio, and the dashed line shows aggregate non-bank debt as a share of aggregate corporate debt. Yearly data from Compustat merged with S&P Capital IQ summary capital structure information. The sample period is 2001-2019, inclusive.

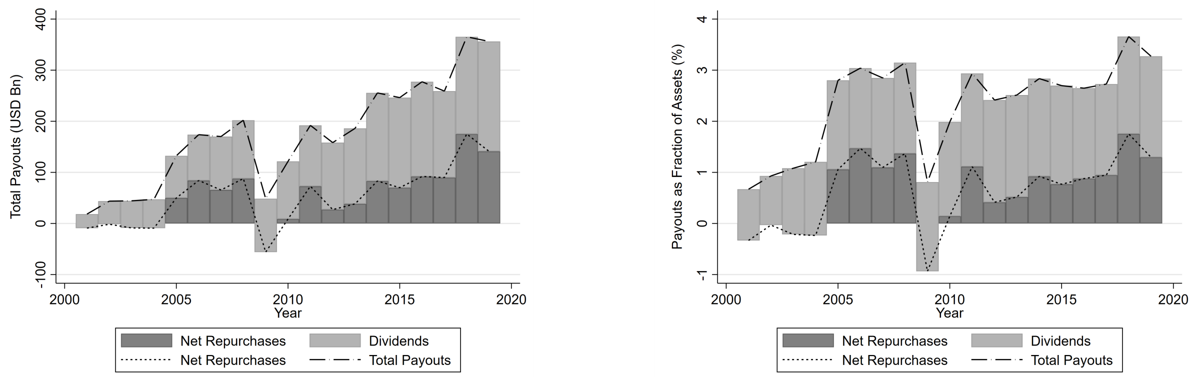
Second, the post-crisis high corporate leverage has been coincident with significantly large positive shareholder payouts, or in other words, negative net equity issuances, partly due to higher share buybacks (repurchases) than ever in the past.[2] Indeed, it was only in

[1] These evolutions are described in detail in, e.g., IMF (2017, 2019) or Furman (2015), and suggested to be side-effects of ultra-accommodative policy in Rajan (2013) and Stein (2013).

[2] In 1982, the Security and Exchange Commission liberalized open market repurchase operations for corporations in the United States. These require approval of the board of directors, and have to respect some volume and timing limitations in order to avoid any fraud liability. For more detail on SEC rules on repurchases: https://www.investopedia.com/terms/r/rule10b18.asp.

the past two decades that the aggregate importance of share repurchases has increased, especially so in the past decade. As Figure 2 shows, both net share repurchases and total shareholder payouts (the sum of net share repurchases and dividend payouts) have increased steadily since 2001 in absolute terms as well as relative to assets, reaching a peak of over $1 trillion in 2018.[3]

One favored explanation has been that this recent buyback and payout rally has been sustained by leverage due to the expansion in corporate bond markets. With yields at historically low levels, it has been inexpensive for companies to raise new leverage. The evolution of the US leveraged-loan market (per the IMF Global Financial Stability Report 2019) epitomizes these trends: This segment has doubled in size since 2010; outstanding volumes now approach that of the high-yield bond market; the share of banks in their financing has plummeted to 8%; and, nearly 70% of the proceeds fund "shareholder enhancements" such as special dividends, buybacks, leveraged buyouts, or mergers and acquisitions.



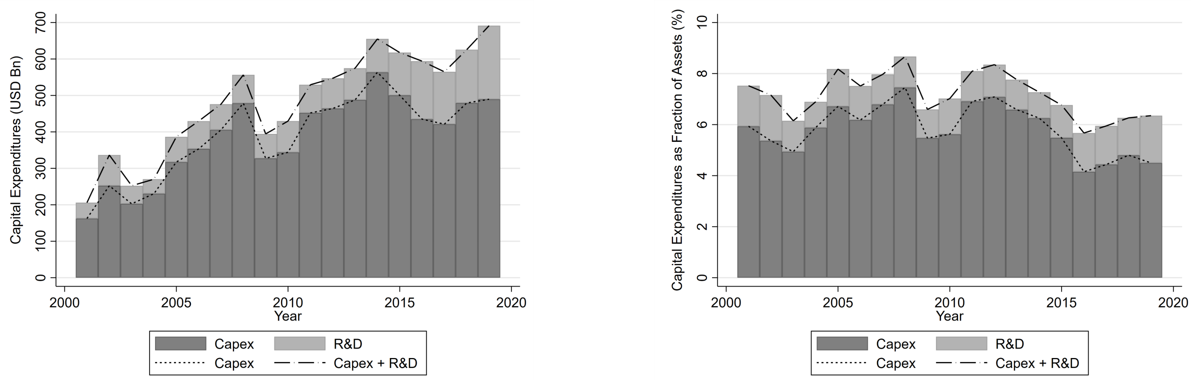
(a) (b)

Figure 2: Total net share repurchases and shareholder payouts. Net repurchases are calculated as purchase minus sale of common and preferred stocks (Compustat variables *prstkc* and *sstk*). Payouts are defined as the sum of net repurchases plus dividends (Compustat variable *dv*). Panel (a) shows repurchases and payouts in levels, and panel (b) shows both repurchases and payouts normalized by firm assets in the prior quarter. Yearly data from Compustat merged with S&P Capital IQ summary capital structure information. The sample period is 2001-2019, inclusive.

Third, fixed business investment—capital and R&D expenditures—since the crisis

[3]Data for firms' debt financing from S&P Capital IQ, which determines the sample of firms for Figures 1, 2, and 3, is not yet available for the full sample for 2020-2021. Appendix A uses data from all Compustat firms instead to produce Figures 7 and 8 that correspond respectively to Figures 2 and 3. It can be seen from Figure 7 that after the temporary decline in 2020 related to the Covid-19 pandemic, payout activity strongly recovered during the first half of 2021, consistent with expansionary monetary policy and large bond market issuance. Note also that using the data on all Compustat firms, overall shareholder payouts, in absolute and relative-to-asset terms, keep rising until 2018 (the year in which monetary easing was normalized by the Federal Reserve) and decline only thereafter.

remains below historical trends to date despite cheap funding, robust corporate profits and favorable tax reforms. Figure 3 shows that the absolute level of investments over the last decade has only grown modestly; and, relative to the firm assets, investments have trended downwards (during 2012 to 2016) or risen only gradually (2017 onwards), being by the end of 2019 below the pre-crisis levels.[4]



(a) (b)

Figure 3: Total capital and R&D expenditures (Compustat variables *capx* and *xrd*). Panel (a) shows expenditures in levels, and panel (b) shows expenditures normalized by firm assets in the prior quarter. Yearly data from Compustat merged with S&P Capital IQ summary capital structure information. The sample period is 2001-2019, inclusive.

Indeed, in the wake of the COVID-19 outbreak, former Federal Reserve Chairman Janet Yellen has acknowledged that enormous debt loads of non-financial corporations reflected excessive borrowing, much of which was not spent on productive purposes like investment but rather used for stock buybacks and to pay dividends to shareholders, and that the Federal Reserve did not have adequate tools to regulate such use of leverage in response to low interest rates.[5] This acknowledgement has lent weight to the possibility that the extraordinarily accommodative behavior of the Federal Reserve over the past decade has had a role in fueling the expansion of leveraged payouts. If true, this would

[4]Figure 8 in Appendix A which uses data on all Compustat firms shows that relative to the firm assets, investments have trended more uniformly and substantially downwards during 2012-2021.

[5]See https://finance.yahoo.com/news/us-economys-recovery-coronavirus-could-191344712.html: Former Federal Reserve Chair Janet Yellen said the high level of corporate debt across Wall Street – aided in part by historically low interest rates and a lack of regulatory oversight – could make it more difficult for the U.S. economy to recover from the coronavirus pandemic. Although the banking and financial sector entered the economic crisis brought on by the novel coronavirus outbreak in "generally good shape, Yellen said Monday during a video broadcast hosted by the Brookings Institution that enormous debt loads were an existing vulnerability. "But nonfinancial corporations entered this crisis with enormous debt loads, and that is a vulnerability, Yellen said. "They had borrowed excessively. Much of that borrowing, Yellen said, was not spent on productive purposes like investments or expanding payroll but rather used for stock buybacks and to pay dividends to shareholders. The borrowing spree happened because regulators had "few, if any tools to rein it in and because low interest rates made it easier for companies to borrow, according to Yellen, who led the U.S. central bank between 2014 and 2018.

imply that the target of monetary policy to sustain investment has possibly not been met, succeeding instead in raising dividend distributions in the form of shareholder payouts.[6]

Our paper offers a parsimonious model in which a low monetary policy rate leads to large leveraged payouts by firms that have a detrimental impact on capital expenditures, thereby leading to business investments that are too low from a social perspective. This adverse effect of low rates occurs only when the public sector is unable to regulate private leverage; conversely, an appropriate prudential regulation on leverage in combination with a low monetary policy rate can restore the first-best investment level. Thus we offer an equilibrium relationship between several salient features of the current corporate credit cycle: the significant involvement of a large unregulated shadow-banking sector, historically unprecedented levels of leveraged payouts, and disappointing capital expenditures.

Gist of the argument. Suppose that the shareholders of a firm value consumption at two dates 0 and 1. The firm owns a technology that converts date-0 investments into date-1 cash flows with decreasing marginal returns to scale. The firm is price-taker in a bond market. As the required return on bonds decreases, the firm maximizes shareholder value by (i) investing more in its technology until the marginal return equates the return on bonds, and (ii) borrowing more against the resulting date-1 cash flows to fund a date-0 payout—share buyback or special dividend, to shareholders until their marginal rate of inter-temporal substitution equates the bond return as well. A low interest rate thus both spurs investment and payout.

Suppose now that the output from investment (stochastically) increases in costly private effort by some active shareholders. Such moral hazard introduces a tension between investment and leveraged payouts as the interest rate decreases. On the one hand, shareholders would like the firm to enter into more leveraged payouts to front-load consumption. On the other hand, borrowing more against date-1 output reduces shareholders' skin in the game, thereby making investment less profitable and thus smaller.[7] The firm sets its leverage at the level that optimally trades off payouts and incentives. Very much like

[6] This sentiment has been echoed in the popular press, which also notes that many recipients of the Covid-19 bailout package (CARES) were those firms which borrowed heavily, helped by the low interest rate environment. In particular, many of these firms also issued shareholder payouts in excess of available cash reserves. See https://www.nytimes.com/interactive/2020/03/27/opinion/coronavirus-bailout.html.

[7] Unlike in the debt overhang problem of Myers (1977), debt is the optimal contract in this context as it maximizes incentives for a given raised amount of external funds.

there is a trade-off between eliciting incentives and smoothing consumption across states of nature in the canonical moral-hazard model of Holmström (1979), there is a tension here between producing an output and borrowing against it to fund early payouts.

Such firms in our setup are firms facing a (real) interest rate controlled by a benevolent central bank. The central bank aims at stimulating investment with a low interest rate in an economy in which rigid prices fail to send the proper signals to firms to invest. Whereas such monetary easing would seamlessly work in the absence of moral hazard, the above mentioned moral-hazard problem creates a wedge between privately and socially optimal leverage and investment decisions. In the face of a lower rate, shareholder-value maximizing firms optimally enter into more leveraged payouts at the expense of shareholders' effort and investment. Whereas reduced effort and investment are deadweight social losses, shareholders' private benefits from leveraged payouts at a distorted rate are a social wash because they must be paid for by other agents—in the form of taxes in our setup. In sum, our parsimonious model offers a clear connection between monetary easing and the rise of leveraged payouts at the expense of capital expenditures and productivity.

Two important remarks are in order. First, neither share buybacks nor risky corporate debt are problematic *per se* in our model. Given the interest rate that they face, firms maximize total asset value (and shareholder value) by optimally trading off the costs and benefits of leveraged payouts in the presence of a friction that invalidates Modigliani-Miller. In particular, firms optimally split their proceeds from debt issuance between payouts and investment. Such privately optimal leveraged payouts become excessive from a social-welfare standpoint only when the central bank distorts the interest rate downwards to spur investment. In this case, leveraged payouts become excessive from a social standpoint because shareholders' gains from payouts are only a socially neutral transfer from financially repressed savers, whereas their gains from investment correspond to genuine social- value creation.[8]

Second, an important ingredient of the model is that a friction makes firms' financial policy relevant for total asset value and investment. We use a workhorse moral-hazard

[8]This view coincides with that of Cochrane in a recent blog post (https://johnhcochrane.blogspot.com/search?q=Airline+Bailouts+And+Capital+Regulation), although he focuses on a different form of rent extraction by shareholders: "Let's be clear. It is a myth that buybacks are bad because they reduce investment.(...). But buybacks do have a downside: they reduce equity and increase debt. Fine if you and the creditors are willing to take a bath in bad times. Not good if debt means taxpayers have to bail out in bad times. Too big to fail is spreading like a virus."

model to fix ideas, but the analysis does not live or die on this particular friction. It is important to stress that our basic insight carries over when assuming alternative frictions that invalidate Modigiliani-Miller, such as liquidity risk or adverse selection.[9]

Our results have noteworthy implications for financial regulation and optimal monetary policy.

Implications for financial regulation. We show that the central bank can implement the first-best despite moral hazard if it has a free hand at regulating private leverage, e.g., via the prudential regulation of financial institutions. We view the difference between a setting in which it can do so and one in which financial institutions lever up as they see fit as a stylized parallel between an economy in which corporate credit originates from regulated banks and one in which it also stems from non banks, in particular, from the "shadow-banking" sector. We show that monetary easing entails more leveraged payouts at the expense of productive investment in the latter situation than in the former. Accordingly, our theory suggests that the existence of a large shadow-banking system may dramatically affect the transmission of monetary policy. Interestingly, as mentioned above, non banks have played an unprecedented central role in the US corporate credit boom that followed the 2008 crisis. Leveraged payouts during this boom have reached record high volumes whereas business investment has remained disappointing.

Implications for optimal monetary policy. We show that when it cannot regulate leverage, the central bank optimally targets a strictly smaller investment level than when it can regulate leverage. Stimulating investment with low rates comes at the cost of inducing leveraged payouts, which reduce entrepreneurs' incentives and thus productive efficiency. A smaller investment target compared to the first-best optimally trades off scale and productive efficiency. If the pass-through from monetary policy to investment level is rather muted, as observed recently,[10] then the optimal monetary policy may even consist of "leaning against the wind," *i.e.*, not stimulating the economy at all, in order to fully contain leveraged payouts and maintain productive efficiency.

Although our contribution is primarily theoretical, we also provide some suggestive

[9] Section 2.2 develops such alternative models.

[10] Besides Furman (2015), see also the evidence presented for the United States by Wang (2019), who documents a weak pass-through of monetary policy to bank lending rates for the past two decades, especially so at low interest rates. See also the discussion and references in Wang (2019) for similar evidence of a weak pass-through of negative interest rates to the real economy in case of Europe and Japan.

evidence consistent with the model's implications by examining the behavior of shareholder payouts in the United States. First, we show that monetary accommodation leads to greater financing of payouts through the less-regulated (non-bank debt) versus regulated (bank debt) financial system. Second, we document that share repurchases tend to depress contemporaneous as well as subsequent real investment. The two results combined confirm the model's implication on the unintended consequence of monetary easing in the form of leveraged buybacks financed by shadow banking at the cost of corporate investments.

The paper is organized as follows. Section 1 discusses the related theoretical literature. As a stepping stone to our main model, Section 2 presents a partial-equilibrium model of optimal investment and payout policy in the presence of moral hazard. Section 3 embeds it in a full-fledged equilibrium model to determine the optimal monetary policy and derives the main results. Section 4 relates to the existing empirical literature and also presents evidence for the model's implications. Section 5 presents concluding remarks.

1 Related literature

Our paper relates to several strands of literature.

First, Bolton et al. (2016), Dell'Ariccia et al. (2014), or Martinez-Miera and Repullo (2017, 2020) study like us how low interest rates affect the risk-taking incentives of banks and corporations. We contribute to this literature on the risk-taking implications of low rates in two ways. First, this paper is the first to our knowledge to connect this question to that of the sizeable increase in share buybacks that has been a salient feature of the US economy since 2008. Second, in our model, the interest rate is an instrument that the central bank can (temporarily) control. This allows us to go one step further and offer policy implications regarding optimal monetary easing.

Second, this paper argues that the relation between cost of debt and leverage-induced frictions explains why low policy rates may fail to stimulate investment. Several recent contributions suggest alternative causes for this failure of monetary easing to spur investment. Brunnermeier and Koby (2018) show that this may stem from eroded lending margins in an environment of imperfectly competitive banks. Coimbra and Rey (2017) study a model in which the financial sector is comprised of institutions with varying risk appetites. Starting from a low interest rate, further monetary easing may increase financial instability, thereby creating a trade-off with the need to stimulate the economy. A distinctive feature of our approach is that we jointly explain monetary easing, low investment, and high leveraged payouts by corporates; these phenomena coincide with *low* borrowing rates for corporates in our model (as appears to be the case for borrowing from bond and leveraged loan markets), as distinct from models with intermediary balance sheet constraints which imply *high* borrowing rates for corporates.

Third, our model also relates to the recent papers that argue that corporate debt issuance is partly driven by firms' willingness to extract safety premia on their bonds. For instance, Mota (2021) writes down a model in which firms that are unconstrained and enjoy large safety premia issue debt that funds payouts rather than investment (as in our setup). Mota (2021) examines the time-series and the cross-section of safety premia and finds evidence that their dynamics impact firms' leverage. In our setup, risk-neutral investors view all securities as perfect substitutes, and this is the distortion of the real rate by monetary policy that drives leveraged payouts, including by risky firms (such as speculative-grade issuers of leveraged loans in practice).[11]

Fourth, corporate debt becomes riskier in our model following leveraged payouts, and this is our point of contact with the literature on the role of monetary easing in creating financial instability. In Farhi and Tirole (2012), the central bank faces a commitment problem which is that it cannot commit not to lower interest rates when financial sector's maturity transformation goes awry. In anticipation, the financial sector finds it optimal to engage in maturity transformation to exploit the central bank's "put." In Diamond and Rajan (2012), the rollover risk in short-term claims disciplines banks from excessive maturity transformation, but the inability of the central bank to commit not to "bailing out" short-term claims removes the market discipline, inducing excessive illiquidity-seeking by banks. They propose raising rates in good times taking account of financial stability concerns, but so as to avoid distortions from having to raise rates when banks are distressed. In contrast to these papers, in our model the central bank faces no commitment problem; lowering rates triggers inefficient leveraged payouts that negatively affect productive efficiency and, ultimately, investment.

[11] One interesting route towards unifying Mota (2021) and our paper would be a better understanding of how monetary policy shocks affect safety premia on corporate bonds in the time-series and in the cross-section.

Stein (2012) explains that the prudential regulation of banks can partly rein in incentives to engage in maturity transformation that is socially suboptimal due to fire-sale externalities; however, there is always some unchecked growth of such activity in shadow banking. Hence, in line with the policy implications from our model, he argues that monetary policy that leans against the wind can be optimal as it raises the cost of borrowing in all "cracks" of the financial sector.

Finally, and at a higher level, our paper revisits the old notion of "malinvestment" that has been prominent in Austrian economics (Hayek, 1931, for example). Malinvestment refers to the possibility that distortion of the real interest rate due to monetary easing subsidizes activities that are not socially desirable (but become privately profitable) at the expense of preferable investments. We are the first, to our knowledge, to connect the current fierce debate on the social optimality of leveraged share buybacks to this old idea of malinvestment.

2 Interest rate, investment, and leveraged payouts

2.1 Setup

In an economy with a single consumption good and two dates indexed by $t \in \{0; 1\}$, the shareholder of a firm is risk-neutral over consumption at dates 0 and 1 and discounts date-1 consumption at the discount rate $R > 1$. The firm owns an investment technology that transforms I date-0 consumption units into a number of date-1 units equal to $f(I)$ with probability e, and to zero with the complementary probability, where f satisfies the Inada conditions. The firm's shareholder controls the probability of success e at a private cost $e^2 f(I)/(2\pi R)$ that is subtracted from her utility over consumption at date 0, where $\pi \in (0, 1)$.[12] This private cost stands for any time and resources that the large shareholders of a firm (founders, institutional investors, activist funds, possibly top management,...) devote to maximizing value—e.g., through monitoring and screening projects or mapping and hedging risks—instead of devoting them to tasks that they find more rewarding. We could assume that this active incumbent shareholder shares the firm's ownership with small passive incumbent shareholders who free ride on her

[12]The term $1/R$ in effort cost is just a normalization. The linearity of effort cost with respect to output size $f(I)$ (as opposed to a more general dependence on I) plays no other role than simplifying the algebra.

governance effort without affecting our results. As shown in subsection 2.2, such hidden effort by a large shareholder could be replaced by other frictions such as liquidity risk or adverse selection, and this would lead to similar broad insights.

The firm also has a large date-1 endowment of the consumption good $W > 0$. This endowment W captures that the firm starts out with legacy assets with future cash flows W that it can pledge in order to fund investment in the technology f or/and date-0 payouts. The firm can trade securities with risk-neutral counterparties that require a gross expected return $r > 0$ between dates 0 and 1. We do not impose any restriction on the design of the securities that can be traded at this stage. Debt will arise endogenously.

The rest of this section solves for the firm's shareholder-value maximization problem. As a benchmark, we first solve for the first-best in which the firm's counterparties can observe the shareholder's effort e and thus contract on it.

Proposition 1. ***(First-best with observable effort)*** *Let $\bar{r}(r) = \min\{r; R\}$. The shareholder exerts effort*

$$e^{FB} = \frac{\pi R}{\bar{r}(r)} \tag{1}$$

and the firm invests I^{FB} such that

$$\frac{e^{FB} f'(I^{FB})}{2} = r. \tag{2}$$

If $r \geq R$, the firm raises only I^{FB} at date 0, whereas it raises $(W + e^{FB} f(I^{FB}))/r > I^{FB}$ and pays out the proceeds net of I^{FB} to the shareholder if $r < R$.

Proof. See Appendix B. ■

Proposition 1 highlights important features of the first-best. First, a decrease in the cost of capital r boosts the firm's output for two reasons. Holding the shareholder's effort fixed, investment size decreases in r from (2). This effort also decreases in r from (1), strictly so if and only if $r < R$.

If $r \geq R$, the only gains from trade between the firm and its counterparts result from the latter having, unlike the former, investable funds at date 0. The firm borrows from them only to invest I^{FB}.[13] If $r < R$, the firm maximizes shareholder value by

[13]In this first-best case without risk-sharing nor incentive concerns, the design of the claim issued by

pledging the entire expected date-1 cash flow $W + e^{FB} f(I^{FB})$ to its counterparts at date 0, investing I^{FB} with part of the proceeds, and using the residual for a date-0 payout to the shareholder.

In sum, in this first-best situation, when $r < R$, a decrease in r yields a surge in productive efficiency—measured by the probability that investment succeeds here, together with an increase in investment and in date-0 payout. We now show that the picture is dramatically different in the presence of moral hazard, that is, when outside investors cannot observe the effort that the shareholder exerts. We discuss in turn the cases in which the interest rate r is larger or smaller than her discount rate R.

Suppose first that $r \geq R$. The shareholder in this case is not interested in receiving a date-0 payout,[14] and the firm borrows only to fund the investment I in the technology f. Restricting the analysis to the case in which $W > rI$, so that the firm can issue a risk-free security, the investment level I and effort level e that maximize shareholder value solve

$$\max_{e,I} \left\{ \frac{\left(e - \frac{e^2}{2\pi}\right) f(I) + W - rI}{R} \right\}. \tag{3}$$

The objective is maximized at the first-best values $\left(e^{FB}, I^{FB}\right)$ such that

$$e^{FB} = \pi \quad \text{and} \quad \frac{\pi}{2} f'(I^{FB}) = r. \tag{4}$$

In this case $r \geq R$, as in the first-best, productive efficiency π does not depend on r. Both investment I^{FB} and expected output $\pi f(I^{FB})$ decrease with respect to r.

Suppose now that $r < R$. As in the first-best, the shareholder would like in this case the firm to borrow not only to invest but also to fund a date-0 payout. The firm optimally borrows against its entire risk-free endowment W. It also contemplates borrowing against the expected date-1 cash flows generated by the technology f. In the presence of moral hazard, there is however a tension between doing so and ensuring that the shareholder has sufficient "skin in the game"— a date-1 stake in the output $f(I)$ in case of success that maintains its incentives to exert effort.

More precisely, maximizing shareholder value boils down to solving the following

the firm against I^{FB} is immaterial, all that matters is that it commands the expected return r. Security design will matter in the presence of moral hazard (unobservable effort).

[14]Unless $r = R$ in which case she is indifferent between receiving one or not.

formal problem. The firm announces an investment level I, an effort level e, and the sale of a fraction $(1-x)$ of $f(I)$ in case of success, where $x \in [0,1]$ is the fraction of the output that the incumbent shareholder retains—her "skin in the game." Its counterparts purchase the claims to W and (in case of success) $(1-x)f(I)$. The firm uses the proceeds to fund investment I and its date-0 payout, and then the shareholder exerts private effort. The optimal (e, I, x) maximizes shareholder value subject to her effort level e being incentive-compatible, which corresponds to the program:

$$\max_{e,I,x} \left\{ \frac{W + (1-x)ef(I)}{r} - I + \left(xe - \frac{e^2}{2\pi} \right) \frac{f(I)}{R} \right\} \tag{5}$$

s.t.

$$e = \arg\max_{y} \left\{ xy - \frac{y^2}{2\pi} \right\}. \tag{6}$$

The date-0 payout is the sum of the present value of the legacy assets W/r net of investment I and of the present expected value of the fraction $(1-x)$ of output against which the firm borrows at the rate r. Date-1 expected cash flow to the shareholder is the expected retained output $xef(I)$. Condition (6) is the incentive-compatibility constraint, stating that the announced effort e must maximize the shareholder's utility net of effort costs.

Remarks on leveraged payouts. The risky (unless $x = 1$) security issued by the firm has payoffs $\{W; W + (1-x)f(I)\}$ against total assets with payoff $\{W; W + f(I)\}$. It thus admits a natural interpretation as risky debt. Section 2.2.3 shows that this optimal security actually generalizes as a standard debt contract under a more general stochastic structure with continuous payoff. The fraction of the proceeds from issuing risky debt that is paid out to the shareholder at date 0 is therefore akin to a leveraged payout, whereby the initially unlevered firm issues debt against its expected future cash flows not only to invest, but also to buy back shares or pay a special dividend. Dividends and share buybacks are equivalent in this environment that abstracts from any differential tax considerations relating to the two forms of payouts.

Simple algebra (see proof of Proposition 2 in Appendix B) yields the respective first-order conditions with respect to x, e, I:

$$\begin{aligned} x &= \frac{R}{2R-r}, \\ e = \pi x &= \frac{\pi R}{2R-r}, \\ \frac{\pi R f'(I)}{2(2R-r)} &= r. \end{aligned} \tag{7}$$

These conditions imply that in the case $r < R$, a lower r induces more leverage—a lower value of the skin in the game x. It also induces a higher investment $I = f'^{-1}(2r(2R-r)/(\pi R))$, although investment is less sensitive to r than under the first-best.

Unlike under the first-best, however, a reduction in r degrades productive efficiency: It induces a lower probability of success $e = \pi R/(2R-r)$. The overall impact of a reduction in r on expected output $ef(I)$ is therefore ambiguous. Suppose for example that $f(I) = I^{1/\gamma}$, where $\gamma > 1$. We show in Appendix B that the expected output increases in r for $r \in [2R/(\gamma+1), R]$, and decreases otherwise. The following proposition collects the above results, still using the notation $\overline{r}(r) = \min\{r; R\}$.

Proposition 2. ***(Interest rate, investment, and leveraged payouts)*** *The firm chooses skin in the game x, effort e, and investment I, such that*

$$x = \frac{R}{2R-\overline{r}(r)}, \quad e = \pi x = \frac{\pi R}{2R-\overline{r}(r)}, \quad \textit{and} \quad \frac{\pi R f'(I)}{2(2R-\overline{r}(r))} = r. \tag{8}$$

Thus,

- *For $r \in (R, +\infty)$, a reduction in r is irrelevant for payout policy and incentives. It spurs investment and expected output.*
- *For $r \le R$, a reduction in r spurs leveraged payouts that reduce the shareholder's incentives and thus degrade asset quality; investment is decreasing in r but less sensitive to it than in the case $r > R$.*

Proof. See Appendix B. ■

In the case $r > R$, moral hazard is immaterial. Shareholder value is at the first-best. Fluctuations in r only affect corporate investment I.

When $r < R$, by contrast, r affects leveraged payouts that reduce the shareholder's incentives and thus shift the entire production function downwards. The situation is therefore quite remote from the first-best as a decrease in r negatively affects productive efficiency, whereas Proposition 1 showed that in the absence of moral hazard, a lower rate boosts incentives and thus productive efficiency. This in turn implies that investment, while still decreasing in r, is less sensitive to it as the benefits from cheaper funds are partially offset by a reduction in productive efficiency.

Notice that when equilibrium effort is larger than 0.5, a marginal reduction in r not only reduces the mean of output but also raises its variance, as would be the case with an asset-substitution problem in lieu of a hidden-effort problem.

Section 3 embeds this partial-equilibrium model with exogenous interest rate into a model in which a central bank has control over the real rate because of nominal rigidities. The central bank seeks to maximize a standard social welfare function, and sets its policy rate so as to mitigate the distortions induced by a downward-rigid wage.

Before proceeding with this Section 3, we show in the following subsection that our central insights are robust to many extensions and alternative modellings. All that we need is a friction such that the Modigliani-Miller irrelevance fails to hold because leverage negatively affects total asset value, at least beyond some threshold. The following subsection offers examples of such frictions other than moral hazard. The reader interested in arriving at our main results may skip it in a first reading.

2.2 Alternative modelling choices

The ingredient provided by this partial-equilibrium model on which Section 3 will crucially rely is the fact that a friction introduces a tradeoff between leveraged payouts to a firm's shareholders and the firm's productive efficiency. Whereas they ease the exposition and offer tractability, many features of the above particular model are not important. The analysis in Section 3 carries over under the alternative formulations that this Section 2.2 offers, albeit (sometimes) at the cost of additional complexity.

First, we show that assuming as above that the firm's legacy future cash flows W are sufficiently large that investment (but not payouts) can be funded with safe debt is only meant to simplify the analysis. All insights hold if both investment and payouts must be financed with risky debt. Second, we show that other frictions than hidden effort by an active shareholder deliver the same tradeoff. Third, an extension of our model to continuous payoffs shows that the firm optimally raises external funds by issuing a standard debt contract.

We posit in this section that $W = 0$ and, for brevity, $f(I) = 2\sqrt{I}$.

2.2.1 Only risky debt

The main model posits that W is sufficiently large that firms can fund their investments (but not their payouts) with the issuance of risk-free claims. The analysis is modified as follows when this is not the case because $W = 0$.

Proposition 3. ***(Always risky corporate debt)***

- *If $r \geq 2R/3$, then the firm borrows againt future output only to invest, with $x = 3/4$ and $\sqrt{I} = 3\pi/(8r)$.*
- *If $r < 2R/3$, then the firm borrows to finance a date-0 payout as well. As in the case $W > 0$, $x = R/(2R - r)$, and $\sqrt{I} = \pi R/[2(2R - r)r]$.*
- *In both cases, effort e satisfies $e = \pi x$.*

Proof. See Appendix B. ■

As in the main model, the firm borrows only to fund investment until the interest rate falls below a threshold, in which case it also borrows to fund a payout at date 0 even though this puts a further dent on the shareholder's incentives. This is all that is needed for our main results in Section 3 to hold. Unlike in the main model, the first-best is always out of reach since $x \leq 3/4 < 1$, and the threshold for payouts is $2R/3$ instead of R.

2.2.2 Alternative frictions

Here we show that our results carry over when the hidden-effort friction is replaced either with rollover risk or with adverse selection.

Rollover risk

Suppose that the firm's project succeeds with probability $e = 1$ at date 1 at no cost (e.g., $\pi = +\infty$). Suppose however that the firm incurs rollover risk when borrowing. It borrows at the rate r between $t = 0$ and an interim date $t = 0.5$. At this interim date, it must refinance its loan with risk neutral investors who do not discount date-1 cash flows. The firm has access to this interim market with probability q only. If excluded from the market, it must liquidate all or part of its assets to repay debt and this comes at a deadweight loss equal to a fraction $\eta \leq 0.5$ of the liquidated assets. We have in this case:

Proposition 4. ***(Rollover risk, investment, and leveraged payouts)***

- *If* $r \geq (1-q\eta)^2[1-\eta(1-q)]R/(1-\eta)$, *then the firm issues risk-free debt and invests the proceeds* $[(1-\eta)/[1-\eta(1-q)]r]^2$.
- *Otherwise the firm issues risky debt, raising* $2(1-q\eta)^2/r^2$, *invests* $[(1-q\eta)/r]^2$, *and pays out the residual.*

Proof. See Appendix B. ■

If r is above a threshold, the firm borrows only to fund investment, in which case asset liquidation following market exclusion is only partial and debt is risk-free. For lower values of r, the firm prefers to borrow against its entire future cash flows to fund a date-0 payout as well. Debt becomes risky, and leveraged payouts have a negative impact on productive efficiency as they entail liquidating the entire assets when rollover risk materializes.

Adverse selection

Suppose that there is no moral hazard in the baseline model: The probability of success of a project e is exogenously given, and there is no cost of effort ($\pi = +\infty$). The firm's investment technology may be of two types, "good" or "bad". A good technology succeeds almost surely ($e = 1$) whereas a bad one almost surely fails ($e = 0$). The shareholder privately observes the project's type. Outside financiers share the prior belief that a technnology is good with probability q. The equilibrium is as follows:

Proposition 5. ***(Adverse selection, investment, and leveraged payouts)***

- *If* $r \geq q^2R$, *then the firm borrows and invests* $I = 1/r^2$ *if good, and 0 if bad.*
- *If* $r < q^2R$, *then the firm, regardless of its type, borrows* $2q^2/r^2$, *invests* q^2/r^2, *and pays out the residual to the shareholder.*

- *Debt is safe in the former case and subject to default with probability $1 - q$ in the latter one.*

Proof. See Appendix B. ■

A good firm may borrow only to invest, in which case a bad one does not mimic it and refrains from borrowing as it cannot benefit from investment. A good firm may alternatively borrow beyond its investment needs in order to fund a date-0 shareholder payout. In this case a bad firm mimics it, and so the good firm incurs a lemons spread. If the interest rate is sufficiently low, however, the good firm does prefer to borrow for a payout despite this spread. Overall, as in the moral-hazard case again, lower rates trigger leveraged payouts, and debt becomes riskier because it is backed by a pool of assets of lower quality. Furthermore, average productive efficiency decreases as improductive firms borrow.

2.2.3 Optimal security design with continuous payoffs

Suppose that instead of succeeding with probability e, an investment I delivers a payoff $lf(I)$ when the firm invests I and the shareholder exerts effort e, where l admits a p.d.f. $\psi(e, l)$ over $[0, 1]$. We can w.l.o.g. write the security sold to outside financiers as $s(l)f(I)$. We restrict the security to be such that s is increasing with $0 \leq s(l) \leq l$.

Proposition 6. ***(Continuous output distribution and standard debt contract)*** *If $(\partial\psi/\partial e)/\psi$ exists and is increasing in l, then the firm optimally issues a standard debt contract, that is, a claim of the form $min(l, d)f(I)$ for given d, I.*

Proof. See Appendix B. ■

In his pioneering work on security design, Innes (1990) shows that the same assumption of monotonicity of both the likelihood ratio ψ_e/ψ and the security s lead to the optimality of the standard debt contract, as is the case here.

3 Investment, leveraged payouts, and optimal monetary policy

3.1 Setup

Time is discrete. There is a single consumption good that serves as numéraire. There are two types of private agents, workers and entrepreneurs, and a public sector.

Workers. At each date, a unit mass of workers are born and live for two dates. They derive utility from consumption only when old, and are risk-neutral over consumption at this date. Each worker supplies inelastically one unit of labor when young in a competitive labor market. Each worker also owns a technology that transforms l units of labor into $g(l)$ contemporaneous units of the consumption good.

Entrepreneurs. At each date, a unit mass of entrepreneurs are born and live for two dates. Entrepreneurs are essentially identical to the representative shareholder in the previous section. They are risk-neutral over consumption when young and old, and discount future consumption at $R > 1$. They receive a large endowment W of the numéraire good when old. Each entrepreneur born at date t is also endowed with a technology that transforms l units of labor at date t into $f(l)$ consumption units at the next date $t + 1$ with probability e, and zero units with the complementary probability.[15] Entrepreneurs control the probability of success e at a private cost $e^2 f(l)/(2R\pi)$ that is subtracted from their utility when young.

The technology f, unlike g, features a one-period lag between production and delivery of consumption services. This technology thus stands in our stylized model for the most interest-sensitive sectors of the economy such as durable-good, housing or capital-good sectors. We accordingly deem technology f the *capital-good sector*, and technology g the *consumption-good sector*. We also term *investment* the resources spent to produce the capital good. A full-fledged model of f as a capital-good technology would feature that the date-$t + 1$ capital resulting from date-t investment be combined with labor at date $t + 1$ in order to generate the consumption good. This would complicate the analysis without adding substantial insights. The functions f and g satisfy the Inada conditions and f is twice continuously differentiable.

[15] The joint distribution of entrepreneurs' outcomes conditional on their effort levels is immaterial for most of the analysis. We posit conditional independence for simplicity.

Bond market. There is a competitive market for one-period bonds denominated in the numéraire good.

Public sector. The public sector implements monetary and fiscal policies.

- Monetary policy: The public sector announces at each date an expected rate of return at which it is willing to trade arbitrary quantities of bonds;

- Fiscal policy: The public sector can tax workers as it sees fit. It can in particular apply lump-sum taxes. However, it cannot tax entrepreneurs.

This latter assumption is made stark in order to yield a simple and clear exposition of our results. As detailed below, all that matters is that the public sector does not have a free hand at regulating entrepreneurs' behavior with appropriate tax schemes. In particular, it cannot use taxation as a substitute for prudential regulation. One possible reason entrepreneurs cannot be taxed is that they can operate in a different jurisdiction.

Social welfare function. The public sector seeks to maximize the sum of the present values of aggregate consumption net of effort costs at each date discounted at the rate R.

Relationship to new Keynesian models. This setup can be viewed as a much simplified version of the new Keynesian framework, as it shares the following features with it: i) Money serves only as a unit of account ("cashless economy"), ii) the monetary authority controls the short-term nominal interest rate, and iii) sticky prices imply that it can affect real interest rates by doing so.

Assuming extreme nominal rigidities in the form of a fixed price level as we do enables us to abstract from price-level determination and to introduce ingredients that are typically absent from such mainstream monetary models.[16]

No model of monetary policy is complete without specifying how the central bank interacts with the fiscal authority: Monetary and fiscal policies are in general interdependent as they both contribute to shape the budget constraint of the government (e.g., Woodford 2001). In this paper, fiscal policy only serves to accommodate monetary policy ("Ricardian fiscal policy"), and we will see that it does so in a welfare-neutral fashion.

[16] In somewhat related setups, Benmelech and Bergman (2012), Caballero and Simsek (2019), Diamond and Rajan (2012), and Farhi and Tirole (2012) also abstract from price-level determination as we do. Their focus is, however, on the financial-stability implications of monetary policy.

3.2 Characterization of the first-best

Date-t aggregate consumption is equal to date-t aggregate income. Thus, denoting e_t the effort exerted by entrepreneurs born at date t and l_t the quantity of labor that they hire, date-t aggregate consumption net of effort costs reads:

$$\underbrace{W + e_{t-1} f(l_{t-1})}_{\text{Income generated by old entrepreneurs}} \quad + \quad \underbrace{g(1 - l_t)}_{\text{Income generated by young workers}} \quad - \quad \underbrace{\frac{e_t^2 f(l_t)}{2\pi R}}_{\text{Young entrepreneurs' effort}} \quad . \tag{9}$$

Social welfare viewed from date-t, S_t, is then

$$S_t = W + e_{t-1} f(l_{t-1}) + \sum_{t' \geq t} \frac{1}{R^{t'-t}} \left[\frac{W}{R} + g(1 - l_{t'}) + \left(e_{t'} - \frac{e_{t'}^2}{2\pi} \right) \frac{f(l_{t'})}{R} \right] \tag{10}$$

Differentiating with respect to $e_{t'}$ and $l_{t'}$ yields:

Proposition 7. ***(First-best)*** *The first-best is such that for all t,*

$$e_t = \pi, \tag{11}$$

$$\frac{\pi f'(l_t)}{2R} = g'(1 - l_t). \tag{12}$$

Proof. See discussion above. ■

Optimality conditions (11) and (12) are straightforward: The marginal effort cost must equate the resulting marginal expected increase in output, and labor must yield the same marginal return in both sectors.

3.3 Laissez-faire

We solve for the competitive equilibrium of this economy in the case in which the public sector is inactive.[17] The competitive equilibrium is characterized by a sequence $(r_t, e_t, x_t, l_t, w_t)$ where e_t and l_t are entrepreneurs' effort and hired labor, x_t is the skin in the game of the entrepreneurs born at date t, w_t the date-t wage, and r_t the expected (gross) return on bonds due at date $t + 1$. Such a sequence characterizes an equilibrium if it is such that private agents optimize and markets clear.

[17] As will be clear, laissez-faire may alternatively be interpreted as a monetary policy that consists in announcing an official rate R and a passive fiscal policy.

Equilibrium interest rate. The bond market clears if entrepreneurs optimally borrow the amount saved by workers. Given their linear preferences, this requires that for all t,

$$r_t = R. \tag{13}$$

Workers. Young workers' income is comprised of labor income in the capital-good sector $w_t l_t$, labor income in the consumption-good sector $w_t(1 - l_t)$, and profits from the consumption-good sector $g(1 - l_t) - w_t(1 - l_t)$. These latter profits are maximum when

$$g'(1 - l_t) = w_t. \tag{14}$$

Since they consume only when old, young workers invest the resulting total income

$$g(1 - l_t) + w_t l_t \tag{15}$$

in the bond market, thereby receiving an income

$$R(g(1 - l_t) + w_t l_t) \tag{16}$$

when old.

Entrepreneurs. Up to the change of variable $I = w_t l_t$, each entrepreneur's problem is identical to that in Section 2. Since $r_t = R$, each entrepreneur is happy to borrow against her date-1 endowment W any amount above the investment $w_t l_t$ required to produce $e_t f(l_t)$, and sets $x_t = 1$. For brevity we suppose that W is always sufficiently large to repay (16) to old workers. From (4), optimal investment then implies:

$$e_t = \pi, \tag{17}$$

$$\frac{\pi}{2} f'(l_t) = r_t w_t = R w_t. \tag{18}$$

In sum, there exists a unique competitive equilibrium such that

$$(r_t, e_t, x_t, l_t, w_t) = (R, \pi, 1, l^*, w^*), \tag{19}$$

the wage w^* and labor supply to entrepreneurs l^* solve

$$\frac{\pi}{2R} f'(l^*) = g'(1 - l^*) = w^*, \tag{20}$$

and workers lend $g(1 - l^*) + w^* l^*$ to entrepreneurs.

Social welfare under laissez-faire. From Proposition 7, relations (17) and (20) ensure that laissez-faire implements the first-best. Date-t aggregate income (9) is split into consumption for the various agents as follows:

$$W + g(1 - l_t) + e_{t-1} f(l_{t-1}) - \frac{e_t^2}{2\pi R} f(l_t) = \tag{21}$$

$$\underbrace{g(1 - l_t) + w_t l_t - w_t l_t - \frac{e_t^2}{2\pi R} f(l_t)}_{\text{Young entrepreneurs' consumption net of effort cost}} \tag{22}$$

$$+ \underbrace{e_{t-1} f(l_{t-1}) + W - r_{t-1}(g(1 - l_{t-1}) + w_{t-1} l_{t-1})}_{\text{Old entrepreneurs' consumption}} \tag{23}$$

$$+ \underbrace{r_{t-1}(g(1 - l_{t-1}) + w_{t-1} l_{t-1})}_{\text{Old workers' consumption}} \tag{24}$$

Young entrepreneurs' consumption (22) is comprised of workers' loans net of wages paid and effort cost. Old entrepreneurs consume their output and endowment net of workers' loan reimbursement, which old workers in turn consume. The following proposition collects these results.

Proposition 8. ***(Laissez-faire)*** *There exists a unique laissez-faire equilibrium in which the return on bonds is R. The wage w^* and labor supply to entrepreneurs l^* solve (20). There are no leveraged payouts, $e^* = \pi$, and workers lend $g(1-l^*)+w^*l^*$ to entrepreneurs. Laissez-faire implements the first-best.*

Proof. See discussion above. ■

Assuming a social welfare function that discounts aggregate consumption and effort at the "natural" rate of the economy R is not crucial to our results. It only has the convenient implication that laissez-faire is optimal in this benchmark model, and so any public intervention will solely result from the additional frictions that we now inject in this economy.

3.4 Monetary easing

Productivity shock. Suppose now that one cohort of workers — the one born at date 0, say — has a less productive technology than that of its predecessors and successors. Unlike the other cohorts, their technology transforms y units of labor into $\rho g(y)$ contemporaneous units of the consumption good, where $\rho \in (0, 1)$.

Interpretation of the shock. This simple shock has two important features. First, it makes labor overall less productive at date 0, which will depress the wage if it is flexible. Second, the capital-good technology becomes relatively more appealing than the consumption-good one at this date. A natural interpretation of this shock is as follows. If the date-t consumption-good technology was explicitly combining capital produced before t with date-t labor, then past poor investments would lead to a reduction in the date-0 productivity of the consumption-good technology. Date-0 investment would then be important to replace/upgrade such low-productivity assets. The simple asymmetric shock ρ captures this in our simplified model of the capital-good sector.

We study in turn the implications of such a negative (perfectly anticipated) productivity shock for optimal policy and welfare in three different contexts with incremental frictions:

1. The wage is flexible.

2. The wage is downward rigid and the public sector can regulate private leverage.

3. The wage is downward rigid and the public sector cannot regulate private leverage.

3.4.1 Flexible-wage benchmark

Proposition 9. ***(Laissez-faire is optimal when the wage is flexible)*** *If the wage is flexible, laissez-faire implements the first-best.*

Proof. The analysis in Section 3.3 carries over when the consumption-good technology is a time-dependent one $g_t(l)$. The welfare function reads in this case

$$S_t = W + e_{t-1} f(l_{t-1}) + \sum_{t' \geq t} \frac{1}{R^{t'-t}} \left[W + g_{t'}(1 - l_{t'}) + \left(e_{t'} - \frac{e_{t'}^2}{2\pi} \right) \frac{f(l_{t'})}{R} \right], \tag{25}$$

and is thus maximal when $e_{t'} = \pi$ and

$$g'_{t'}(1 - l_{t'}) = \frac{\pi f'(l_{t'})}{2R}. \tag{26}$$

This latter first-order condition is satisfied under laissez-faire because the equilibrium wage and labor supply solve

$$g'_{t'}(1 - l_{t'}) = w_{t'}, \tag{27}$$

$$\frac{\pi f'(l_{t'})}{2} = Rw_{t'}. \tag{28}$$

At all dates $t \neq 0$, $g_t = g$, and wage and labor supply to entrepreneurs are w^* and l^* solving (20). Since $g_0 = \rho g < g$, (27) and (28) imply that the date-0 wage adjusts to a level $w_0 < w^*$ such that the employment level in the capital-good sector l_0 is above l^*.

For the remainder of the paper, we respectively denote $l_\rho > l^*$ and $w_\rho < w^*$ these first-best date-0 employment level in the capital-good sector and associated date-0 market wage that arise in this case of a flexible wage. ■

3.4.2 Rigid wage and regulated leverage

We introduce for the remainder of the paper an additional friction in this economy in the form of a rigid wage:

Assumption. ***(Downward-rigid wage)*** *The wage cannot be smaller than the steady-state wage w^* at date 0.*

In other words, we suppose that the wage is too downward rigid to track the transitory negative productivity shock that hits the date-0 cohort, and that the public sector cannot regulate it in the short run.[18]

Public regulation of private leverage. In preparation for our main result, we first suppose here that the financing of entrepreneurs by workers is intermediated by financial institutions that the public sector can regulate. More precisely, we posit that an entrepreneur must set up a financial institution if she wants to collect workers' savings. To do so, the entrepreneur creates an entity that she fully owns and capitalizes by transfer of all or part of her net assets. This entity is entitled to issue savings vehicles that workers

[18] We could also assume a partial wage adjustment without affecting the analysis.

can invest in, and it can use the proceeds as it sees fit. The public sector can enforce a prudential regulation of these financial institutions. It can impose that the value of their liabilities towards workers is smaller than λ times their assets, where $\lambda \in [0, 1]$. The case $\lambda = 1$ corresponds to the situation in which financial institutions face no prudential constraint. The assumption that entrepreneurs must set up such institutions to collect savings is moot in this case $\lambda = 1$.

The following proposition shows that the combination of a reduction in the date-0 interest rate and of a prudential regulation of private leverage implements the first-best allocation despite a downward-rigid wage.

Proposition 10. ***(Monetary easing and prudential regulation implement the first-best.)*** *The public sector reaches the first-best by:*

- *being inactive (or equivalently announcing a policy rate equal to R) at all other dates than 0;*
- *announcing a date-0 rate $r_\rho < R$ and imposing a prudential regulation λ_ρ on date-0 financial institutions, where (r_ρ, λ_ρ) solves:*

$$\pi \left(\frac{1/2 - \lambda_\rho}{R} + \frac{\lambda_\rho}{r_\rho} \right) f'(l_\rho) = w^*, \tag{29}$$

$$\frac{\lambda_\rho}{r_\rho}(\pi f(l_\rho) + W) = \rho g(1 - l_\rho) + w^* l_\rho. \tag{30}$$

Proof. See Appendix B. ■

An inspection of first-order conditions (14) and (18) shows that the capital-good sector is interest-rate sensitive whereas the consumption-good sector is not. The public sector can therefore make up for the absence of appropriate price signals in the date-0 labor market by distorting the date-0 capital market and spur investment with a low interest rate: $r_0 < R$. Section 2 suggests however that this comes at the cost of a lower productive efficiency because it also spurs leveraged payouts, and we will see below that this is detrimental to social welfare. Proposition 10 shows that the joint use of a low interest rate and of a sufficiently tight prudential regulation—a sufficiently low λ_ρ—enables the public sector to implement the first-best.

It is interesting and worth highlighting that a very simple cap on the liabilities of financial institutions as a fixed fraction of their total assets warrants this result. In particular, there is no need to introduce a regulation that caps firms' dividends nor to more generally restrict what firms can do with the proceeds from the loans that they obtain. The intuition for this result is as follows. By investing, that is, by producing assets, entrepreneurs relax the prudential constraints of financial institutions as they can endow them with more capital. In other words, prudential regulation creates an additional marginal benefit from investment over date-0 payouts—relaxing leverage constraints—that in turn tilts entrepreneurs' use of funds away from payouts and towards investment. The resulting lower ratio of payouts over investment implies that it is possible to induce them to fund the first-best level of investment by issuing only risk-free claims.

Equation (29) states that (r_ρ, λ_ρ) are set so that entrepreneurs optimally demand the socially optimal labor l_ρ, and (30) ensures that they borrow sufficiently on top of $w^* l_\rho$ to absorb date-0 workers' savings. Each worker accommodates by applying in her own firm the residual quantity of labor that she cannot sell on the labor market at the disequilibrium wage w^*. She does so at a marginal return below wage ($\rho g'(1-l_\rho) = w_\rho < w^*$), and produces at the socially optimal level by doing so.

3.4.3 Rigid wage and unregulated leverage

As mentioned in the introduction, bank loans have been a shrinking fraction of corporate financing over the past two decades. This reflects, among other things, the rise of a large unregulated shadow-banking system. In the language of our model, this means that the maximum leverage that the public sector can impose on financial institutions—at least on a subset of them—has increased. This section captures this in a stark way by assuming that the public sector cannot regulate leverage at all. Financial institutions set by entrepreneurs are practically irrelevant in this case and we can ignore them. Suppose that the public sector seeks to stimulate investment by date-0 entrepreneurs by setting $r_0 < R$. From Section 2, each date-0 entrepreneur solves

$$\max_{e,l,x} \left\{ \frac{W + (1-x)ef(l)}{r_0} - w^* l + \left(xe - \frac{e^2}{2\pi} \right) \frac{f(l)}{R} \right\} \tag{31}$$

s.t.

$$e = \arg\max_y \left\{ xy - \frac{y^2}{2\pi} \right\} \tag{32}$$

yielding

$$x_0 = \frac{R}{2R - r_0} < 1, \tag{33}$$

$$e_0 = \pi x_0 = \frac{\pi R}{2R - r} < \pi, \tag{34}$$

$$\frac{\pi R f'(l_0)}{2(2R - r_0)} = r_0 w^*. \tag{35}$$

Such behavior by date-0 entrepreneurs has two implications: disequilibrium in the bond market and socially suboptimal effort.

Disequilibrium in the bond market. Entrepreneurs find it optimal to borrow against W, issue risky debt, and thus borrow a total amount

$$\frac{W + (1 - x_0)ef(l_0)}{r_0} \tag{36}$$

larger by assumption than workers' savings,

$$\rho g(1 - l_0) + w^* l_0. \tag{37}$$

The public sector absorbs this excess private supply of bonds by taxing date-0 old workers to raise the differential amount $[W + (1-x_0)ef(l_0)]/r_0 - (\rho g(1-l_0) + w^* l_0)$.[19] Conversely, date-1 old workers receive a corresponding rebate out of the repayment from these bonds. Appendix A details the resulting subsidies from workers born at date -1 to entrepreneurs and workers born at date 0 when $r_0 < 1$ and leverage is unregulated.[20] Note that these subsidies are welfare-neutral given the assumed social-welfare function.

Socially suboptimal effort. Second, and more important, reduced skin in the game ($x_0 < 1$) implies in turn that date-0 entrepreneurs exert an effort level below π that is not socially optimal from Proposition 7. The resulting lower productive efficiency implies

[19] We assume here that date-0 old workers can afford such a tax. See Section 3.4.4 for alternative financing of the excess date-0 bond supply.

[20] See proof of Proposition 11.

that they invest less than they would in the absence of moral hazard.

In sum, Proposition 2 describes how entrepreneurs facing $r_0 < 1$ optimally trade off the benefits from leveraged payouts with the negative impact of the resulting reduced incentives on their expected output. This trade-off is privately optimal, but not socially optimal. The reduced expected output due to weaker incentives is not only a private but also a social loss whereas the value that entrepreneurs extract from leveraged payouts holding effort fixed stems from a (welfare-neutral) transfer from old date-0 workers.

Leveraged payouts thus are in this model a form of inefficient rent extraction by entrepreneurs that is detrimental both to old date-0 workers, as it redistributes resources away from them, and to social welfare, as it results in a reduced expected output. Notice that if entrepreneurs' gains from leveraged payouts were compensated for by a lump-sum tax on them rather than on old workers, then this would eliminate the welfare-neutral redistribution from workers to entrepreneurs, yet this would leave the socially costly distortion in output unchanged.

The following proposition, where we employ the subscript u to denote outcomes under the rigid-wage and unregulated-leverage case, details this insight that monetary easing in this case not only induces leveraged payouts but also a lack of investment that puts the first-best out of reach.

Proposition 11. ***(Rigid wage and unregulated leverage)***

1. *The optimal interest rates are $r^* = R$ at all dates other than 0 and $r_u \leq R$ at date 0.*

2. *Social welfare is strictly lower when leverage is not regulated than when it is because date-0 investment is strictly lower: Entrepreneurs hire a quantity of labor l_u strictly smaller than the first-best one l_ρ.*

3. *The cohort born at date -1 subsidizes the cohort born at date 0.*

Proof. See Appendix B. ■

In the absence of leverage regulation, the skin in the game of an entrepreneur x and thus her effort e (strictly) increase in r for $r < R$. As a result, attempts at spurring investment/employment in the capital-good sector with a reduction in the date-0 interest rate boost leveraged payouts and degrade productive efficiency. This unintended consequence of monetary easing implies that social surplus is maximized at a lower date-0 use of labor in the capital-good sector l_u than in the presence of a prudential regulation imposing $x = 1$: $l_u < l_\rho$. In this sense, lack of investment relative to the first-best is part of a second-best policy in the absence of a strict prudential regulation.

The following proposition details how the size of the shock $1 - \rho$ affects monetary policy when leverage is unregulated.

Proposition 12. ***(Shock size and optimal interest rate)*** *There exists $\bar{\rho} \in [0, 1)$ such that*

- *If, ceteris paribus, $\rho \geq \bar{\rho}$, then it is optimal to ignore the shock ρ and leave the date-0 interest rate at its steady-state value: $r_u = R > r_\rho$. Investment is strictly below the first-best level but productive efficiency is at the first-best ($l_u < l^*$ but $e^* = \pi$).*

- *If $\bar{\rho} > 0$, then for $\rho \in (0, \bar{\rho})$ the optimal monetary policy is accommodative: $r_u < R$. Investment and productive efficiency are both strictly below their first-best levels ($l_u < l^*$ and $e^* < \pi$).*

Proof. See Appendix B. ■

Proposition 12 shows how the optimal interest rate trades off productive efficiency e and scale l in the capital sector. If ρ is sufficiently large (the shock is small), it is always optimal to avoid any leveraged payout by leaving the rate at $r^* = R$, thereby preserving productive efficiency $e^* = \pi$ at the cost of investing at a scale smaller than the first-best. It may be that this policy is actually optimal for all possible shocks (case $\bar{\rho} = 0$). Consider for example the limiting case in which the function f is constant. In this case, a reduction in the interest rate has only an adverse effect on productive efficiency and no impact on scale. It is thus undesirable to cut the interest rate no matter the size of the shock.

Stein (2012) argues that in the presence of some unchecked credit growth in the shadow-banking system, a monetary policy that leans against the wind can be optimal as it raises the cost of borrowing in all "cracks" of the financial sector. This resonates with our result that the optimal policy response to sufficiently small productivity shocks—and possibly for all shocks— consists in "leaning against the wind" this way, and setting $r_u = R$.

The proof of Proposition 12 offers formal examples in which $\bar{\rho}$ is either equal to zero or strictly positive. In this latter case, as ρ becomes smaller than $\bar{\rho}$, it becomes preferable to spur l even though this comes at a cost for productive efficiency. In this case, there is aggressive monetary easing that still has a limited impact on investment, and generates instead a surge in leveraged payouts, that in turn induce degrade productive efficiency.

3.4.4 Alternative financing of corporate debt at date 0

We have posited that the excess supply of corporate bonds induced by a date-0 policy rate smaller than R is picked up by the public sector, which funds its investment with taxes on old workers. We could alternatively assume that deep-pocketed investors, non-residents for example, would be willing to supply the savings that clear the bond market at the rate set by the central bank as the date-0 shock occurs, because these investors are short of better options to store their liquidity at this time. This alternative sheds interesting light on the importance of a large demand for "storage assets" issued by corporations for leveraged payouts to rise. Mota (2021) writes down such a model in which leveraged payouts arise in times of strong demand for assets perceived as safe (even though they need not be safe). Interestingly, the scenario in which these purchases of corporate bonds are intermediated by the public sector resembles unconventional monetary policies. Such policies have been implemented by all major monetary authorities. They consist in the issuance of public liabilities (remunerated reserves) reinvested in part in private securities.

4 Empirical evidence

Although the contribution of this paper is mostly theoretical, we offer in this section three types of empirical results that are consistent with our theory. We first summarize the literature suggesting that share buybacks are increasingly financed by debt issuance, particularly so during accommodative monetary policy shocks. We then carry out our own simple empirical analysis. We find evidence that (i) the link between monetary easing and leveraged payouts is particularly strong for firms that rely on non-bank debt; and, (ii) aggressive payout behavior is detrimental to contemporaneous and subsequent investment.

4.1 Related empirical literature

The linkages implied by our model between leveraged payouts, monetary policy and business investment have not yet been fully or rigorously established in the empirical literature on payouts and buybacks, which has primarily focused on issues relating to managerial private information and signaling, market timing across debt and equity markets, earnings management to meet analyst forecasts, and compensation practices.[21] Three recent inquiries, however, establish the marked growth in payouts over the past two decades, attempt to understand how they are financed, and analyze the impact of payout behavior on firm performance, especially in times of monetary policy accommodation.

Kahle and Stulz (2020) show that aggregate real payouts are meaningfully higher in the 2000s relative to 1971-1999, with substantial growth in the last decade. The authors show that the increase in aggregate real payouts over the 2000s is driven by both changing characteristics (firms are older, larger, and have more free cash flow) and a higher *propensity* for payouts. Further, firm payout rates are more sensitive to firm characteristics after 2000, though the mechanism behind this finding remains unclear. The authors also find that capital expenditures fall similarly for firms with positive and zero payouts, though R&D growth for payers lag those of nonpayers. Specifically, the ratio of R&D to lagged assets grows from 2.07% to 3.03% from pre- to post-2000 for payers, but grows from 5.80% to 14.08% for non-payers. Hence, we consider both capital expenditures and the sum of capital expenditures and R&D in our analysis to provide a holistic picture of investment outcomes.

Farre-Mensa, Michaely, and Schmalz (2020) study corporate payouts between 1989 to 2019. The authors break down the total payout of firms in two components: the non-discretionary component, which is the minimum of regular dividends in the current and the prior year, and the discretionary component, which is equal to the sum of regular dividend increases, special dividends and share repurchases. They document that firms which pay discretionary payouts also raise funds during the same year, mostly in the form of debt, and that cash flows generated by the firms' operations are not sufficient to

[21]See, in particular, Brav, John, and Campbell, Michaely (2005), Ikenberry, Lakonishok, Vermaelen (1995), Peyer and Vermaelen (2009), Brockman and Chung (2001), Vermaelen (1981) on private information and signaling; Baker and Wurgler (2002), Ma (2019) on market timing; Bens et al (2003), Hribar, Jenkins, and Johnson (2006), Almeida, Vyacheslay, and Kronlund (2016) on earnings management to meet analyst forecasts; and, Farre-Mensa, Michaely, and Schmalz (2020) on compensation and management incentives. Dittmar and Dittmar (2008) document evidence that buybacks happen in coordinated waves over the time-series; however, a convincing explanation for the cycle of buybacks is still missing.

sustain the observed level of payouts. The authors emphasize that debt is by far the most important source of payout financing, noting that 30% of aggregate payouts are linked to firms which also raised net debt in the same year, and payouts account for 41% of net debt proceeds for these firms.

Elgouacem and Zago (2019) examine the relationship between share buybacks, monetary policy and the cost of debt over the period 1985 to 2016.[22] They find that net repurchases are correlated with net debt issuances and lower investment. In order to measure the *causal* effect of monetary policy on repurchases, the authors employ a regression discontinuity design, inspired by Hribar, Jenkins, and Johnson (2006) and Almeida, Vyacheslay, and Kronlund (2016). In particular, they exploit the fact that firms who expect to be right below the Earnings Per Share (EPS) forecast by analysts tend to repurchase shares more frequently than those who expect to meet or exceed analyst forecasts. They document that a fall in a firm's bond yields (instrumented with monetary policy shocks) results in higher repurchases among firms who would have otherwise failed to meet consensus estimates. They also find that investments and employment fall with a drop in yields only for firms who would have underperformed consensus forecasts, suggesting that share repurchases may crowd out real activity.

Together, Farre-Mensa, Michaely, and Schmalz (2020) and Elgouacem and Zago (2019) suggest that share buybacks and discretionary payouts are increasingly financed by leverage; accommodative monetary policy shocks drive this behavior in part; and, such leveraged buyback activity is not coincident with investments in spite of monetary accommodation.[23] Our model provides a theoretical rationale for these results. It also derives a novel implication: the source of leveraged buybacks at low interest rates should be the unregulated financial system (for example, bond financing) rather than regulated finance (bank debt). Next, we present evidence supporting this implication.

The empirical analysis consists of two parts. First, we document that monetary easing triggers repurchasing activity especially for firms that rely on non-bank financing. Second, we employ the identification strategy used in Elgouacem and Zago (2019) to

[22]The authors define "repurchases" as in Ma (2014) as the firm's net position in the equity market. This is the difference between the value of the shares repurchased and the value of the newly issued shares normalized by total assets in the previous period.

[23]In addition to these papers, Lazonic (2014) underlines the potentially harmful consequences of buybacks on investment, employment and human capital formation, and Almeida, Vyacheslay, and Kronlund (2016) also provides suggestive evidence that buybacks crowd out investment and employment growth, but these papers do not focus on issues related to leverage.

show that aggressive payout behavior is detrimental for real activity as measured by contemporaneous and subsequent capital expenditures.

4.2 Monetary policy, bank debt, and stock repurchases

In this section, we test whether the sensitivity of repurchases to monetary policy is more pronounced for firms which rely on financing from the unregulated portion of the credit market. We use data on firm fundamentals from Compustat North America, and merge this to debt composition data from Capital IQ. Our panel of firms is at a quarterly frequency from 2000-Q1 to 2019-Q4. Finally, we use monetary policy shocks as defined in Kuttner (2000) (see Appendix D for more details on the construction of shocks).

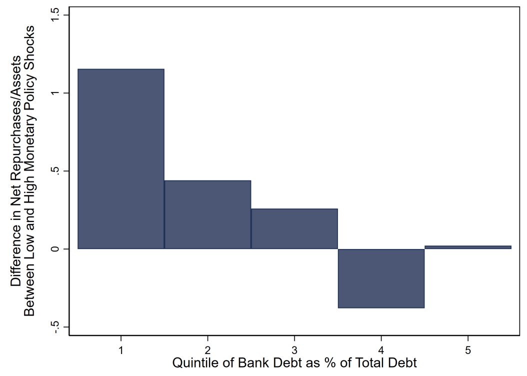
Throughout what follows, the Net Repurchases variable is defined as: purchases of common and preferred stock (Compustat variable *prstkc*) minus sale of common and preferred stock (Compustat variable *sstky*) divided by total assets (Compustat *at*) lagged by one quarter. We also consider total shareholder payouts, defined as net repurchases plus cash dividends (Compustat *dv*) normalized by assets.[24] Following the literature, we focus on *net* (rather than gross) repurchases, as share repurchases which are coincident with equity issuances do not result in any additional resources for the firm's shareholders and do not enable the moral hazard we highlight in our model.

Figure 4 displays the difference in net repurchases between periods of contractionary (high shock) and accommodative (low shock) monetary policy, for firms with differential reliance on bank financing.

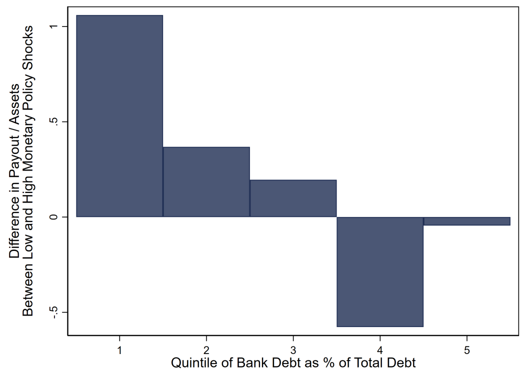
A monetary policy shock is considered 'low' when the Kuttner shock is in the first quartile of all shocks in the time series, and 'high' when it falls in the fourth quartile. Quarters when shocks are low are considered periods of accommodative policy, while quarters when shocks are high are considered periods of contractionary policy.

As shown in binned scatter plots 4c and 4d, net repurchases are consistently larger during periods of accommodative monetary policy. This is in line with our conjecture that firms may be financing repurchases with debt issuances; as the cost of debt decreases, net repurchases can be more readily financed using leverage raised from weakly regulated parts of the financial system. Indeed, we observe in Figures 4a and 4b that the difference between easing and tightening quarters decreases (conversely, increases) for firms that

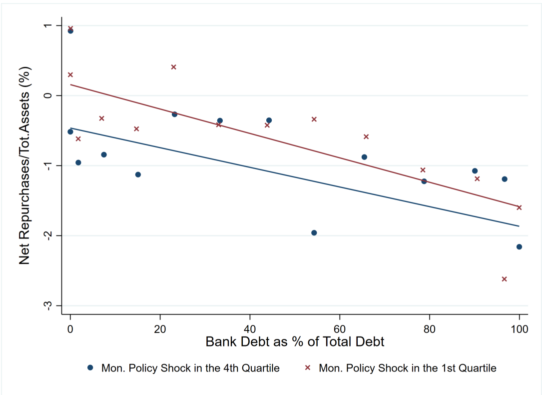
[24]In Compustat symbols: $(prstkc_t - sstky_t + dv_t)/at_{t-1}$.



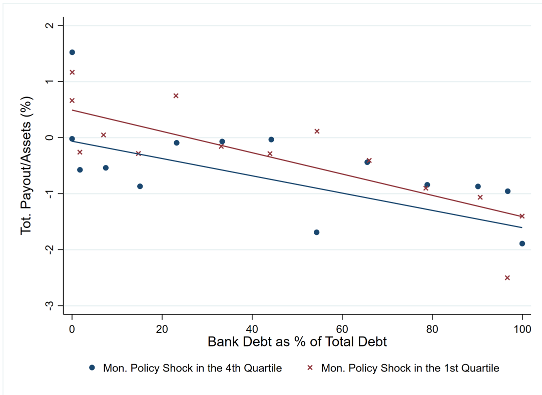
(a) Difference in net repurchases / assets (%) conducted during low and high monetary policy shocks.



(b) Difference in total payouts / assets (%) conducted during low and high monetary policy shocks.



(c) Binscatter of net repurchases / assets (%) against bank debt as a proportion of total debt, by low and high monetary policy shocks.



(d) Binscatter of total payout/assets (%) against bank debt as a proportion of total debt, by low and high monetary policy shocks.

Figure 4

rely more (less) on bank debt relative to market debt.

In order to investigate this relationship econometrically, we analyze the link between reliance on bank debt and a firm's net repurchases normalized by assets in a regression setting. The baseline specification is the following:

$$\text{Net Repurchases}_{i,t} = \theta \text{ Below-Median Shock}_t + \gamma \text{ Bank Debt/Total Debt}_{i,t} + \beta \text{ Below-Median Shock}_t \times \text{Bank Debt/Total Debt}_{i,t} + X_{i,t} + \rho_d + \epsilon_{i,t}$$

where Net Repurchases$_{i,t}$ are net repurchases normalized by assets for firm i during quarter t, Below-Median Shock$_t$ is an indicator equal to 1 if the monetary policy shock during quarter t is below the median[25], Bank Debt/Total Debt$_{i,t}$ is firm i's bank debt as a per-

[25]Note that the median Kuttner shock is very close to zero (-1×10^{-8}), so shocks which are below the median are almost always coincident with negative Kuttner shocks.

centage of their total debt during quarter t, $X_{i,t}$ are firm-quarter controls, and ρ_d is an industry fixed effect. Specifically, $X_{i,t}$ includes net income and total debt (both normalized by assets), log(assets), and Tobin's Q. Column 1 in Table 1 shows our results from the baseline specification above, column 2 uses firm fixed effects in place of the industry fixed effects, and column 3 uses firm and quarter fixed effects.

The coefficient of interest is β, which represents the marginal impact of additional bank debt on repurchasing behavior, given a particular interest rate shock. Table 1 shows that β is negative for our baseline specification, and remains so with the usage of more granular fixed effects.[26] Using the results from our tightest specification in column 3, moving from a completely bank-debt financed firm to a fully bond-financed firm would shift a firm from being a median net repurchaser to the 75th percentile in net repurchasing activity.

While far from being conclusive, this evidence is consistent with our model's novel implication that looser monetary policy leads firms to increase leveraged share repurchases funded by non-bank debt, such as debt raised from bond markets or from the lightly regulated parts of the financial system. In additional robustness checks, we find three pieces of evidence which suggest low interest rates increase net repurchases through non-bank debt. First, the dampening effect of bank debt reliance on net repurchases is economically larger and of greater statistical significance after the Great Financial Crisis. Increased regulation and lower bank capital during this period likely lead to tighter bank loan-supply; therefore, firms with higher reliance upon bank debt are relatively more constrained in their ability to conduct leveraged share repurchases. Secondly, we also see a stronger dampening effect of bank debt reliance on net repurchases for firms which do not have S&P debt ratings. Unrated firms likely face more difficulties in switching from bank to non-bank sources of debt, which in turn constrains the extent to which they can conduct leveraged share repurchases. Thirdly, we split firms into four groups based on the proportion of total debt funded by banks. We find that the impact of monetary policy on net repurchases is progressively lower for firms with progressively higher levels of bank debt. Our sample size is somewhat limited and statistical power of tests low after the appropriate sample splits, so we omit a presentation of these regression tables in the text.

[26]We note that a higher reliance on bank debt has a positive effect on net repurchases in our baseline specification, but that it is no longer statistically significant once we include firm fixed effects.

Table 1: Impact of Bank Debt on Net Repurchases

	Net Repurchases			Payouts		
	(1)	(2)	(3)	(4)	(5)	(6)
Bank Debt %	0.0075**	0.0037	0.0031	0.0075**	0.0040	0.0034
	(0.0033)	(0.0043)	(0.0043)	(0.0033)	(0.0042)	(0.0043)
Below-Median Shock	0.1687	0.0118		0.1363	-0.0249	
	(0.1775)	(0.1716)		(0.1783)	(0.1719)	
Below-Median Shock × Bank Debt %	-0.0097**	-0.0080**	-0.0073*	-0.0099**	-0.0079*	-0.0072*
	(0.0041)	(0.0040)	(0.0040)	(0.0041)	(0.0040)	(0.0040)
N	26,380	26,380	26,380	26,380	26,380	26,380
Industry FE	Y	N	N	Y	N	N
Firm FE	N	Y	Y	N	Y	Y
Quarter FE	N	N	Y	N	N	Y

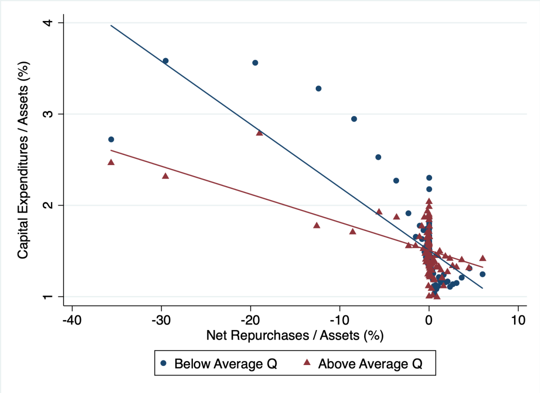
This table shows the effect of bank debt on firms' net repurchasing and payout behavior. The outcome variable in columns (1)-(3) is repurchases normalized by assets for firm i during quarter t; the outcome variable in columns (4)-(6) is payouts normalized by assets for firm i during quarter t. Below-Median shock is an indicator equal to 1 if the monetary policy shock is below the median during quarter t, (Bank Debt/Total Debt)$_{i,t}$ is firm i's bank debt as a percentage of their total debt during quarter t. Additional controls include net income and total debt (both normalized by assets), log(assets), and Tobin's Q. Column (1) shows our baseline specification, column (2) uses firm fixed effects rather than industry fixed effects, and column (3) uses firm and quarter fixed effects. Standard errors are clustered at the firm level, and * denotes 10% significance, ** denotes 5% significance, *** denotes 1% significance.

4.3 Repurchasing activity and real investments

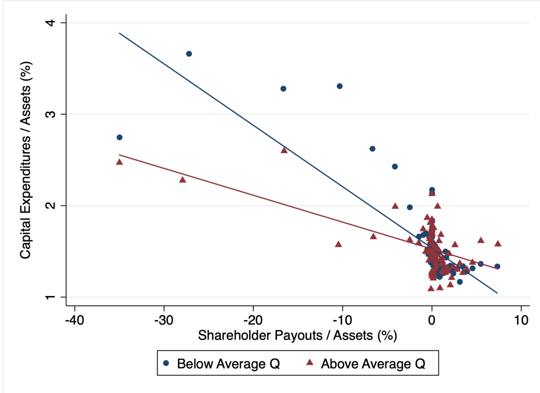
Thus far, we have provided evidence that loose monetary policy leads to increased net repurchases. This section focuses on the investment outcomes which result from these net repurchase and payout policies.

We control for investment opportunities using Tobin's Q, defined as the market value of assets over their replacement value. We proxy for this value by assuming that the market value of debt and assets are equal to their respective book values.

Figure 5 shows binned scatter plots of capital expenditures against net repurchases (Figure 5a) and total shareholder payout (Figure 5b), where all variables are normalized by firm assets in the prior quarter. The negative relationship in Figure 5 suggests that net repurchases (and shareholder payouts) may detract from capital expenditures, and further that this relationship holds for both low and high Q firms. A similar trend emerges if we include R&D expenditures in our metric of real investments (results available upon request).



(a) Binscatter of capital expenditures against net repurchases for firms with below and above average Q. Both capex and repurchases are normalized by assets in the prior quarter.



(b) Binscatter of total shareholder payouts against net repurchases for firms with below and above average Q. Both capex and shareholder payouts are normalized by assets in the prior quarter.

Figure 5

Next, we provide econometric support to the negative impact of repurchasing behavior on firm investments.

The endogeneity of repurchasing behavior is the main empirical challenge. For instance, high repurchases may be a symptom of low investment opportunities, and hence be related to low capital expenditures. In order to draw a causal link between net repurchases and investment, we use a regression discontinuity design first documented in Hribar, Jenkins, and Johnson (2006), and subsequently adopted by Elgouacem and Zago (2019).

Firms whose earnings per share (EPS) are below consensus forecasts are more prone to repurchase shares, in order to boost EPS and avoid disappointing market expectations. By repurchasing shares, firms forego some interest earnings on the cash used to finance the repurchase, but also lower the number of shares outstanding. If the foregone earnings is small enough, a lower number of outstanding shares will increase a firm's EPS. Usually, this is only feasible when the EPS is very close to the consensus forecast, as the funds needed to generate an increase in EPS of more than several cents is typically prohibitively high.[27]

[27]As a simple example, suppose a firm begins quarter t with a consensus forecast EPS of \$1. The firm repurchases 1 million shares during the period, and ends the quarter with 50 million shares and a realized EPS of \$1, implying total earnings of \$50 million and meeting market expectations. We observe that the firm spent a total of \$20 million on the repurchase, so their foregone earnings are equal to the interest the firm could have earned by putting this quantity into a savings account at $r = 2\%$, net of taxes ($\tau = 35\%$), equal to 20(0.02)(1-0.35), or \$0.26 million. This allows us to calculate a counterfactual EPS, where counterfactual earnings are the reported earnings at the end of the period, plus foregone earnings (\$50.26 million), divided by the outstanding shares at the beginning of the quarter (51 million),

Using firm data from Compustat and analyst estimates from IBES, we construct the counterfactual EPS for each firm every quarter, and keep only observations where the counterfactual EPS is within ±\$0.02 of consensus forecasts. Figure 6 shows a sharp increase in the likelihood of repurchases when a firm's counterfactual EPS would have underperformed vis-à-vis analyst expectations.

We use the following baseline specification to test for the causal impact of repurchases on capital expenditures[28]:

$$\text{Capital Expenditures}_{i,t} = \beta \text{ Net } \widehat{\text{Repurchases}}_{i,t} + X_{i,t} + \rho_d + \epsilon_{i,t}$$

where Capital $\text{Expenditures}_{i,t}$ is the capital expenditure (normalized by assets) for firm i in quarter t and Net $\widehat{\text{Repurchases}}_{i,t}$ is firm i's net repurchases in quarter t, instrumented by an indicator $\mathbb{1}(\text{Distance} < 0)$ set equal to 1 if the firm's counterfactual EPS is below consensus estimates. Additionally, we control for net income and total debt (both scaled by assets), log(assets), Tobin's Q, as well as $\text{Capex}_{i,t-1}$, which address some differences in firm characteristics for firms above and below consensus estimates (see Table 4 in Appendix C).

In Panel A of Table 2, columns 1 and 5 shows that net repurchases have a negative impact on capital expenditures when we consider all firms across the entire sample period. Columns 2 and 6 shows that this negative relationship remains when we restrict to the substantially smaller subset of firms whose counterfactual EPS is within \$0.02 of consensus estimates. Thus far, these OLS regressions demonstrate the negative relationship between net repurchasing behavior on contemporaneous and subsequent capital expenditures, but do not yet address the main endogeneity issue.

We show our baseline specification in column 3 of Panel A, which estimates the causal impact of net repurchases on capital expenditures, which is meaningfully larger than the estimates in columns 1 and 2. The effect persists if we replace industry with firm fixed effects. Based on our baseline results, a one standard deviation increase in normalized net repurchases leads to approximately one-fifth of a standard deviation decrease in nor-

equal to \$0.99, just under consensus forecasts.

[28]We differ from Elgouacem and Zago (2019) in examining the impact of net repurchases on the level of capital expenditures, rather than focusing on the impact of net repurchases on the *growth* in capital expenditures over the subsequent four quarters after a negative EPS surprise induced repurchase, relative to capital expenditures during the prior four quarters.

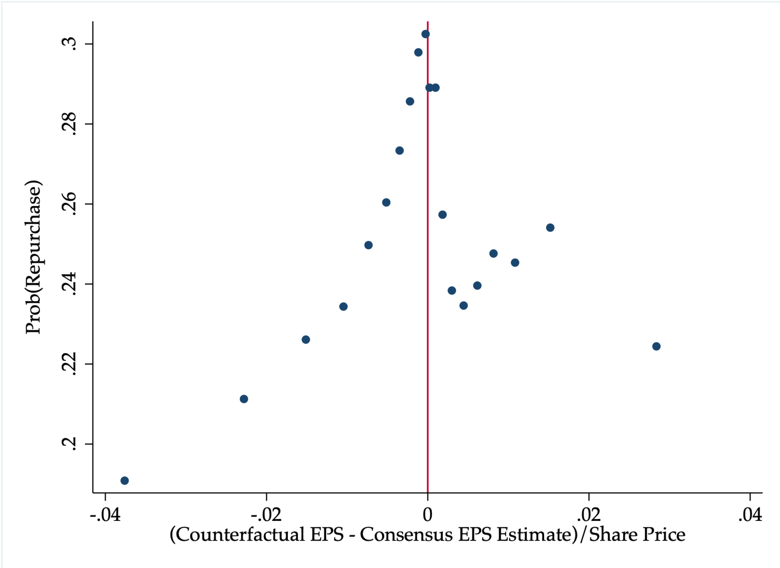


Figure 6: Probability of a positive net repurchase as a function of the difference between the counterfactual EPS and the consensus EPS estimate, normalized by the end of period share price. Firms that would have marginally underperformed relative to consensus estimates are more likely to repurchase shares compared to those that met expectations.

malized capital expenditures. These negative effects are not transitory—columns 5-8 of Table 2 repeat the exercise of columns 1-4, where the outcome variable is cumulative capital expenditures over the next four quarters (normalized by assets at $t-1$) and shows that the negative effect of net repurchases on capital expenditures persists over several quarters.

In Panel B of Table 2, we include R&D expenditures as part of firm investment and examine the sum of capital expenditures and R&D expenditures (normalized by previous quarter assets) as the outcome variable. The results in Panel B are consistent with the patterns outlined above—in particular, that there is a negative causal relationship between net repurchases and firm investment, and that the negative impact of net repurchases is persistent over time.

Considering our empirical results as a whole, we conclude that firms relying on non-bank financing tend to increase payouts aggressively in periods of monetary easing, and that an increase in payouts occurs at the expense of real investment, suggesting an unintended consequence of monetary easing.

Table 2: Impact of Net Repurchases on Firm Investment

	Panel A: Impact of Net Repurchases on Capital Expenditures							
	Capex_t				$\text{Capex}_{t+1,t+4}$			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Net Repurchases	-0.0301***	-0.0124**	-0.1127***	-0.0626*	-0.1367***	-0.0836***	-0.6964***	-0.2331*
	(0.0075)	(0.0049)	(0.0336)	(0.0331)	(0.0150)	(0.0239)	(0.1611)	(0.1394)
N	285,864	8,561	8,561	8,561	219,662	8,561	8,561	8,561
Industry FE	Y	Y	Y	N	Y	Y	Y	N
Firm FE	N	N	N	Y	N	N	N	Y
	Panel A: First Stage Regression							
1(Negative EPS Surprise)			0.7566***	0.7750***			0.7566***	0.7750***
			(0.0748)	(0.0827)			(0.0748)	(0.0827)
F			102	88			102	88

	Panel B: Impact of Net Repurchases on Capital Expenditures and R&D							
	Capex_t + $\text{R\&D}_t$				$\text{Capex}_{t+1,t+4}$ + $\text{R\&D}_{t+1,t+4}$			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Net Repurchases	-0.0584***	-0.0061	-0.1996***	-0.0898**	-0.3069***	-0.0554**	-1.0270***	-0.3557**
	(0.0091)	(0.0058)	(0.0483)	(0.0408)	(0.0162)	(0.0251)	(0.2118)	(0.1568)
N	269,164	8,394	8,394	8,394	210,480	8,394	8,394	8,394
Industry FE	Y	Y	Y	N	Y	Y	Y	N
Firm FE	N	N	N	Y	N	N	N	Y
	Panel B: First Stage Regression							
1(Negative EPS Surprise)			0.7722***	0.7826***			0.7722***	0.7826***
			(0.0748)	(0.0824)			(0.0748)	(0.0824)
F			107	90			107	90

This table shows the causal effect of repurchases on firm investment. The outcomes in Panel A are $\text{Capex}_{i,t}$ and $\text{Capex}_{i,(t+1,t+4)}$, normalized by assets for firm i during quarter $t-1$. The outcomes in Panel B are $\text{Capex}_{i,t}$ + $\text{R\&D}_{i,t}$ and $\text{Capex}_{i,(t+1,t+4)} + \text{R\&D}_{i,(t+1,t+4)}$, normalized by assets for firm i during quarter $t-1$. Where missing, we set R&D expenditures equal to zero. Additional controls include net income and total debt (both scaled by assets), log(assets), Tobin's Q, as well as $\text{Capex}_{i,t-1}$ in Panel A and $\text{Capex}_{i,t-1} + \text{R\&D}_{i,t-1}$ in Panel B. Columns (1) and (5) show the impact of net repurchases on firm investment for the entire panel of Compustat firms over our sample period. Columns (2)-(4) and (6)-(8) show the causal impact of net repurchases on firm investment, which restricts the sample to firms whose counterfactual EPS are within $0.02 of consensus estimates, resulting in a vastly reduced set of observations. Standard errors are clustered at the firm level, and * denotes 10% significance, ** denotes 5% significance, *** denotes 1% significance.

5 Concluding remarks

We developed a model of the interest-rate channel of monetary policy in which low official rates aim at spurring investment. Firms take advantage of such low rates in two ways. They borrow to invest, but also to fund payouts to their shareholders. If a standard friction (moral hazard, adverse selection, or rollover risk) creates a tension between leveraged payouts and productive efficiency, then firms undertake a privately optimal tradeoff. Their choice is socially suboptimal though, as reduced efficiency is a social loss whereas payouts are a welfare-neutral transfer. Controlling overall leverage in the private sector suffices to restore the first-best, but is out of reach in the presence of a large unregulated financial sector. We provide preliminary evidence that is in line with our prediction that leveraged payouts in response to monetary easing are funded in the least regulated (non-bank) corners of the financial system and occur at the expense of real investment.

There are several promising directions along which our model can be extended. While low interest rates are associated with a growth in unregulated leverage or shadow banking, this growth can also have equilibrium effects on the nature of risks undertaken by banks and other regulated entities. Modelling the impact of monetary easing with risk heterogeneity across firms and featuring co-existence of regulated and unregulated leverage appears to be an interesting line of research for further inquiry.

Another possibility is to extend the model to understand how monetary easing affects and is affected by corporate debt maturity (see, for example, the evidence in Fabiani et al, 2021; Jungherr et al, 2021; and, Foley-Fisher et al, 2016). In this vein, the recently witnessed fallout of the pandemic begs the question as to how leveraged payouts interact with shocks to firm profitability to create rollover risk. Answering this question requires extending our framework to aggregate risks with embedding of fire-sale externalities, which would create a tension between ex-post measures such as the lender-of-last-resort policies of a central bank and its ex-ante decision whether to accommodate in order to stimulate investment.

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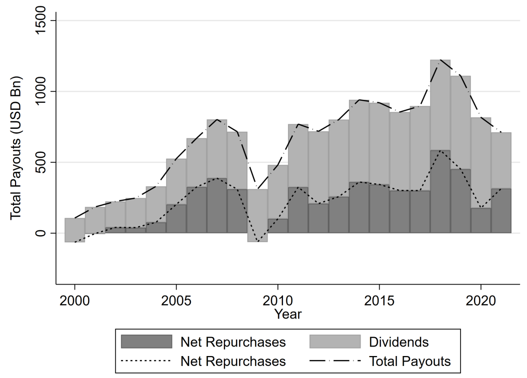
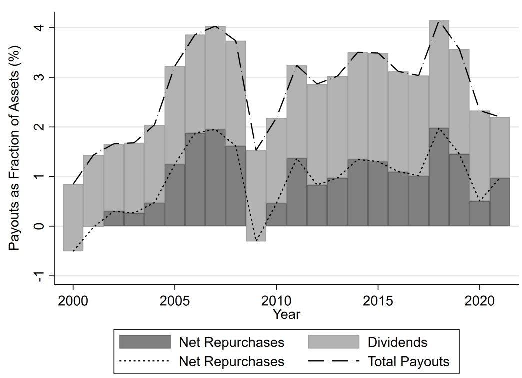
Appendix A Aggregate Charts

This section replicates Figures 2 and 3 using a larger sample consisting of all firms in the Compustat database. The data are yearly for the period 2000 to 2020; for 2021, we show the year-to-date sum of all quarterly data present at the time of writing (Dec 2021).

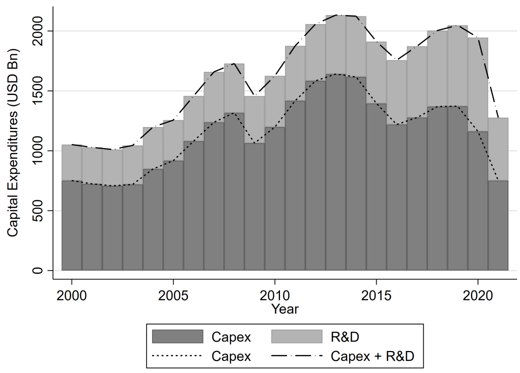


(a)

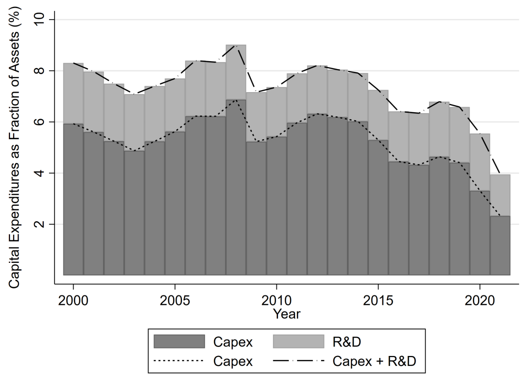


(b)

Figure 7: Total net share repurchases and shareholder payouts. Net repurchases are calculated as purchase minus sale of common and preferred stocks (Compustat variables *prstkc* and *sstk*). Payouts are defined as the sum of net repurchases plus dividends (Compustat variable *dv*). Panel (a) shows repurchases and payouts in levels, and panel (b) shows both repurchases and payouts normalized by firm assets in the prior quarter. Yearly data from Compustat, 2000-2021 (inclusive).



(a)



(b)

Figure 8: Total capital and R&D expenditures (Compustat variables *capx* and *xrd*). Panel (a) shows expenditures in levels, and panel (b) shows expenditures normalized by firm assets in the prior quarter. Yearly data from Compustat, 2000-2021 (inclusive).

The total number of firms in Compustat has decreased over the sample period. The increasing trend in total payouts is more marked if we plot only the firms that were present during the whole sample period.

Appendix B Proofs

Proof of Proposition 1

Suppose $r \geq R$. In this case, the firm raises funds at date 0 only to invest the proceeds I. In the absence of moral hazard or risk aversion, the exact claim sold to its counterparts is irrelevant as long as its expected value is rI. The optimal effort e and investment I solve:

$$\max_{e,I} \left\{ \frac{\left(e - \frac{e^2}{2\pi}\right) f(I) - rI}{R} \right\} \tag{38}$$

leading to

$$e = \pi, \pi f'(I) = 2r. \tag{39}$$

Suppose $r < R$. In this case, the firm sells its entire date-1 cash flows $ef(I) + W$ at date 0 to invest I and pay out the residual to its shareholder. Shareholder-value maximization boils down to:

$$\max_{e,I} \left\{ \frac{ef(I)+W}{r} - I - \frac{e^2 f(I)}{2\pi R} \right\} \tag{40}$$

leading to

$$re = R\pi, \pi R f'(I) = 2r^2. \tag{41}$$

■

Proof of Proposition 2

The case $r \geq R$ is straightforward and derived in the body of the paper. In the case $r < R$, in order to derive the conditions in (7), notice first that (6) implies $e = \pi x$. Plugging this into (5), the objective becomes

$$\pi x \left(\frac{1-x}{r} + \frac{x}{2R} \right) f(I) + \frac{W}{r} - I, \tag{42}$$

and first-order conditions with respect to x and I yield the two remaining conditions in (7).

Suppose $f(I) = I^{1/\gamma}$. When $r < R$, the expected output is

$$ef(I) = \left(\frac{\pi R}{2R - r} \right)^{\frac{\gamma}{\gamma-1}} \left(\frac{1}{2\gamma r} \right)^{\frac{1}{\gamma-1}}, \tag{43}$$

and standard derivation yields its variations with respect to r. ■

Proof of Proposition 3

The firm solves

$$\max_{e,I,x} \left\{ \frac{(1-x)ef(I)}{r} - I + \left(xe - \frac{e^2}{2\pi} \right) \frac{f(I)}{R} \right\} \tag{44}$$

s.t.

$$\frac{(1-x)ef(I)}{r} \geq I, \tag{45}$$

$$e = \arg\max_{y} \left\{ xy - \frac{y^2}{2\pi} \right\}. \tag{46}$$

If (45) is not binding, it must be that $r \leq R$, and the solution is given by conditions (8) with $f(I) = 2\sqrt{I}$, yielding the expressions in the proposition. Writing that (45) binds with I and x as such functions of r yields that it binds for $r \geq 2R/3$.

In this binding case, it is still the case that $e = \pi x$, and I given x results from the binding condition (45). Injecting this value for I in the objective and maximizing it over x yields $x = 3/4$. ■

Proof of Proposition 4

If the firm borrows only to invest, assuming it can always repay the debt in full, shareholder value $[f(I) - [1 - q + q/(1-\eta)]rI]/R$ is maximum at $I = [[1-\eta]/[1-\eta(1-q)]r]^2$ and equal to $[1-\eta]/[[1-\eta(1-q)]Rr]$. Furthermore, $\eta \leq 1/2$ ensures that debt is indeed risk-free, as straightforward algebra shows that $(1-\eta)f(I) \geq rI$ as soon as $\eta \leq 1/[2(1-q)]$. If the firm borrows against its entire future cash flows, shareholder value is $(1-\eta q)f(I)/r - I$, maximum at $I = [(1-q\eta)/r]^2$, equal in this case to $[(1-q\eta)/r]^2$, which yields the results. ■

Proof of Proposition 5

If a good firm borrows only to invest, shareholder value $(f(I) - rI)/R$ is maximum at $I = 1/r^2$, equal to $1/(Rr)$, whereas if it borrows against its entire output it is $qf(I)/r - I$, maximum at $I = q^2/r^2$ and equal in this case to q^2/r^2, which yields the results. ■

Proof of Proposition 6

Suppose $r < R$. Ignoring the constraints on $s(.)$, the shareholder-value maximization problem reads:

$$\max_{e,I,s(.)} \left\{ \frac{W + f(I) \int_0^1 s(l)\psi(e,l)dl}{r} - I + \left(\int_0^1 (l - s(l))\psi(e,l)dl - \frac{e^2}{2\pi} \right) \frac{f(I)}{R} \right\} \tag{47}$$

s.t.

$$e = \arg\max_y \left\{ \int_0^1 (l - s(l))\psi(y,l)dl - \frac{y^2}{2\pi} \right\}, \tag{48}$$

which yields a Lagrangian:

$$\frac{W + f(I) \int_0^1 s(l)\psi(e,l)dl}{r} - I + \left(\int_0^1 (l - s(l))\psi(e,l)dl - \frac{e^2}{2\pi} \right) \frac{f(I)}{R} \\ + \mu \left(\int_0^1 (l - s(l)) \frac{\partial \psi(e,l)dl}{\partial e} - \frac{e}{\pi} \right). \tag{49}$$

Pointwise optimization over $s(.)$ shows that s is maximum for l below a threshold then minimum. Given the monotonicity restriction, it must be a standard debt contract. The case $r \geq R$ is very similar.

Proof of Proposition 10

At all dates other than 0, the rigid wage w^* coincides with the flexible one, and so laissez-faire is optimal. At date 0, suppose first that effort is observable, and so $e_0 = \pi$. Facing a prudential regulation $\lambda \in [0, 1)$ and $r \leq R$, a date-0 entrepreneur borrows B and hires l that solve:

$$\max_{B,l} \left\{ c_0 + \frac{c_1}{R} - \frac{\pi f(l)}{2R} \right\} \tag{50}$$

s.t.

$$c_0 + w^* l \leq B, \tag{51}$$

$$c_1 + rB \leq \pi f(l) + W, \tag{52}$$

$$rB \leq \lambda(\pi f(l) + W), \tag{53}$$

$$c_0 \geq 0. \tag{54}$$

Condition (53) reflects the prudential constraint of the entrepreneur's financial institution. The maximum amount rB that a financial institution can promise to savers is equal to λ times its total assets equal to its loan to the entrepreneur rB plus the net assets transferred by the entrepreneur, that is, the net value from her operating firm $\pi f(l) + W - rB$. Notice that (53) posits that debt is risk-free, which holds if W is sufficiently large as assumed. Inequalities (51) and (52) clearly bind at the optimum, and so does (53) since $r \leq R$. Injecting these equalities in the objective and differentiating w.r.t. l yields a first-order condition:

$$\pi \left(\frac{1/2 - \lambda}{R} + \frac{\lambda}{r} \right) f'(l) = w^*. \tag{55}$$

Ensuring that $l = l_\rho$ and that date-0 entrepreneurs can borrow sufficiently to absorb workers' savings $\rho g(1 - l_\rho) + w^* l_\rho$ yields two equations that uniquely define λ_ρ and r_ρ:

$$\pi \left(\frac{1/2 - \lambda}{R} + \frac{\lambda}{r} \right) f'(l_\rho) = w^*, \tag{56}$$

$$\frac{\lambda}{r}(\pi f(l_\rho) + W) = \rho g(1 - l_\rho) + w^* l_\rho. \tag{57}$$

If date-0 entrepreneurs find it optimal to issue only safe debt under (λ_ρ, r_ρ) in the absence of moral hazard, then they find it a fortiori desirable when their effort is not observable; this is because moral hazard only adds an incentive-compatibility constraint to their problem that reduces the benefits from issuing risky debt. ■

Proof of Proposition 11

Proof of points 1. and 2. Laissez-faire is optimal for all $t \neq 0$ because the wage is at its flexible level. Regarding the date-0 cohort, the optimal rate $r \leq 1$ maximizes:

$$\Sigma_\rho(r) = \left(e(r) - \frac{e(r)^2}{2\pi}\right)\frac{f\left(l(r)\right)}{R} + \rho g(1-l(r)), \tag{58}$$

where relations (34) and (35) implicitly define $e(r)$ and $l(r)$, which are obviously differentiable with respect to r, respectively increasing and decreasing. For r' such that $l(r') = l_\rho$, we have:

$$\Sigma_\rho'(r') = \underbrace{e'(r')\left(1 - \frac{e(r')}{\pi}\right)}_{>0}\frac{f\left(l(r')\right)}{R} + \underbrace{l'(r')}_{<0}\underbrace{\left[\left(e(r') - \frac{e(r')^2}{2\pi}\right)\frac{f'\left(l(r')\right)}{R} - \rho g'(1-l(r'))\right]}_{<0} > 0. \tag{59}$$

The last negative sign stems from the fact that by definition of l_ρ, $\pi f'(l(r'))/2R = \rho g'(1-l(r'))$ and $e(r') < \pi$. Then, the fact that surplus is strictly increasing at r' such that $l(r') = l_\rho$ implies in turn points 1. and 2. in the proposition ($l_u < l_\rho$).

Proof of point 3. Aggregate income is split as follows across agents at dates 0 and 1 .

- Date-0 aggregate income (net of effort cost)

$$W + \pi f(l^*) + \rho g(1-l_u) - \frac{e_0^2 f(l_u)}{2\pi R} \tag{60}$$

  is split into the consumptions of

  - Old workers: $R(g(1-l^*) + w^* l^*) - \left[\frac{W+(1-x_0)e_0 f(l_u)}{r_u} - \rho g(1-l_u) - w^* l_u\right]$
  - Old entrepreneurs: $\pi f(l^*) + W - R(g(1-l^*) + w^* l^*)$
  - Young entrepreneurs: $\frac{W+(1-x_0)e_0 f(l_u)}{r_u} - w^* l_u - \frac{e_0^2 f(l_u)}{2\pi R}$

- Date-1 aggregate income (net of effort cost)

$$W + e_0 f(l_u) + g(1-l^*) - \frac{\pi^2 f(l^*)}{2R} \tag{61}$$

  is split into the consumptions of

  - Old workers: $r_u(\rho g(1-l_u) + w^* l_u) + [W + (1-x_0)e_0 f(l_u) - r_u(\rho g(1-l_u) + w^* l_u)]$

– Old entrepreneurs: $x_0 e_0 f(l_u)$

– Young entrepreneurs: $g(1-l^*) + w^* l^* - w^* l^* - \frac{\pi^2 f(l^*)}{2R}$

Overall, old date-0 workers are taxed $[W + (1-x_0)e_0 f(l_u)]/r_u - \rho g(1-l_u) - w^* l_u$, allowing young entrepreneurs to consume the equivalent amount on top of what they receive from young workers ($\rho g(1-l_u) + w^* l_u$). Date-1 old workers in turn receive a rebate of $[W + (1-x_0)e_0 f(l_u) - r_u(\rho g(1-l_u) + w^* l_u)]$ on top of the proceeds from their loans to entrepreneurs. The difference between the tax on date-0 workers and the value of this rebate to date-1 workers discounted at R accrues to date-0 entrepreneurs. ■

Proof of Proposition 12

Step 1. It is optimal to set $r_u = R$ for ρ sufficiently large.

Differentiating

$$\frac{\pi R f'(l(r))}{2(2R-r)} = r w^* \tag{62}$$

w.r.t. r for $r \in (0,1)$ yields

$$l'(r) = \frac{4w^*(R-r)}{\pi R f''(l(r))}, \tag{63}$$

and so one can write

$$\Sigma'_\rho(r) = (R-r)\left[\underbrace{\frac{\pi f(l(r))}{(2R-r)^3}}_{A} + \frac{4w^*}{\pi R f''(l(r))}\left[\underbrace{\frac{\pi(3R-2r)f'(l(r))}{2(2R-r)^2} - \rho g'(1-l(r))}_{B}\right]\right] \tag{64}$$

We have $\lim_{r\to R} l(r) = l^*$, and so for (ρ, r) sufficiently close to $(1, R)$, term B becomes arbitrarily close to 0 from the first-best condition $\pi f'(l^*)/(2R) = g'(1-l^*)$. Term A on the other hand stays bounded away from 0 for (ρ, r) in the neighborhood of $(1, R)$, and thus $\Sigma' > 0$ in this neighborhood. Furthermore, a standard continuity argument implies that $\lim_{\rho\to 1} r_u = R$. As a result, $\Sigma'(r_u)$ must be strictly positive for ρ sufficiently close to 1, implying that (r_u, l_u) is actually equal to (R, l^*) for ρ sufficiently close to 1.

Step 2. Existence of $\bar{\rho}$.

Let $\underline{r}$ denote the value of r such that (62) yields $l(\underline{r}) = 1$. Let Ω denote the subset of values of $\rho \in (0,1)$ such that the maximum of $\Sigma_\rho(r)$ over $r \in [\underline{r}, R]$ is interior, that is, such that it is reached at some $r \in (\underline{r}, R)$. We know from Step 1 that $r_u = R$ for ρ sufficiently large. This implies that $\Omega \neq (0,1)$, and therefore that $\bar{\rho}$, if it exists, is strictly smaller than 1.

If $\Omega = \emptyset$, this means that $\Sigma_\rho(r)$ is maximum at $r = R$ for every $\rho \in (0,1)$ because Σ'_ρ is strictly positive in the right-neighborhood of $\underline{r}$ (in turn because $g'(1 - l(r))$ is unbounded in this neighborhood) and thus the maximum of Σ_ρ, if not interior, cannot be at $\underline{r}$. It must therefore be at $r = R$. This implies that $\bar{\rho}$ exists and is equal to 0 in this case.

Suppose otherwise that $\Omega \neq \emptyset$. We show that Ω must be of the form $(0, \bar{\rho})$. To see this, notice that for any $\rho \in \Omega$, the envelope theorem implies that

$$\frac{d\Sigma_\rho}{d\rho} = g(1 - l_u). \tag{65}$$

The output net of effort costs of the date-0 cohort when the interest rate is $r_u = R$ reads:

$$\frac{\pi f(l^*)}{2R} + \rho g(1 - l^*). \tag{66}$$

Expression (66) is linear in ρ, with a slope $g(1 - l^*)$ larger than $g(1 - l_u)$ since $l_u > l^*$ when $r_u < R$ from (62). This means that if $\rho \in \Omega$, then the left-neighborhood of ρ is also within Ω because Σ_ρ admits a local extremum that is strictly larger than its value for r in the neighborhood of R. This establishes that Ω is an interval of the form $(0, \bar{\rho})$.

Step 3. Examples such that $\bar{\rho} = 0$ and $\bar{\rho} > 0$.

Suppose that $f(l) = \frac{2Rg'(0.5)}{\pi} l^{\frac{1}{\gamma}}$ for $\gamma > 1$.

We have

$$\frac{\pi R f'(l_u)}{2(2R - r_u)} = r_u w^*, \tag{67}$$

$$\frac{\pi f'(l_\rho)}{2} = \frac{R w_\rho}{w^*} w^*, \tag{68}$$

implying

$$r_u(2R - r_u) = \frac{R^2 w_\rho}{w^*}\left(\frac{l_u}{l_\rho}\right)^{\frac{1}{\gamma}-1}. \tag{69}$$

l_u and l_ρ remain bounded and bounded away from 0 for as $\gamma \to 1$ because they are smaller than 1 and larger than l^* which tends to 0.5 as $\gamma \to 1$. Thus, letting $\gamma \to 1$ in (69) yields

$$\frac{R w_\rho}{w^*} \simeq r_u\left(2 - \frac{r_u}{R}\right), \tag{70}$$

and this implies

$$r_u < \frac{R w_\rho}{w^*} < R. \tag{71}$$

Note that we have actually established that $\lim_{\gamma \to 1} \bar{\rho} = 1$.

We have

$$\Sigma'_\rho(r) = (R - r)\left[\frac{2Rg'(0.5)l^{1/\gamma}}{(2R-r)^3} - \frac{2w^*(3R-2r)\gamma}{R(2R-r)^2(\gamma-1)}l + \frac{\rho g'(1-l)\gamma^2 2w^*}{g'(0.5)(\gamma-1)R^2}l^{2-1/\gamma}\right] \tag{72}$$

There exists l^0 sufficiently small such that the first term dominates the second one for all values of $(r, l) \in [0, R] \times (0, l^0)$ for γ sufficiently large. The third term dominates the second term for γ sufficiently large and all $(r, l) \in [0, R] \times (l^0, 1)$. Thus $\Sigma'_\rho > 0$ for γ sufficiently large which implies $\bar{\rho} = 0$. ■

Appendix C Summary Statistics

Table 3: Summary Statistics

	Q1	Median	Mean	Q3	SD
Assets	65.097	421.163	3350.135	2506.385	8789.241
Cash / Assets	2.486	8.406	24.931	25.008	35.000
Total Debt / Assets	10.391	21.646	24.341	35.026	17.648
Bank Debt %	12.526	64.205	57.001	100.000	40.679
Net Repurchases / Assets	-0.061	0.000	-1.265	0.009	11.610
Capex / Assets	0.272	0.714	1.609	1.615	3.838
Current Ratio	3.877	12.509	1266.409	53.693	83342.445
Interest Coverage Ratio	-1.837	3.416	7.484	12.270	404.377

Summary statistics for observations used in Table 1. Observations are at the firm-quarter level, 2000-2019 (inclusive). Current ratio is short term assets / short term liabilities; interest coverage ratio is operating income / interest expense. Note that all stock variables (cash, total debt) are normalized by current period assets, and all flow variables are normalized by prior quarter assets (net repurchases, capital expenditures)

Table 4: Difference in Firm Characteristics for Firms Above and Below Consensus Forecasts

	(1)	(2)	(3)	(4)	(5)	(6)
	Log(Assets)	Total Debt	Interest Coverage Ratio	Current Ratio	ROA	Tobin's Q
Difference	0.128***	0.559	-21.407	36.154	-0.002***	-0.176***
	(0.044)	(0.485)	(18.800)	(250.265)	(0.001)	(0.035)

This table shows the difference in various firm characteristics between firms who are marginally below consensus expectations (the counterfactual EPS under no repurchases was below analyst forecasts, but by no more than $0.02) and those who are marginally above consensus expectations. We control for industry fixed effects in each case when comparing the difference in means for each characteristic. Firms who marginally underperform are relatively larger, slightly less profitable, and have a lower Q value of investment. These are included as control variables in all regression specifications.

Appendix D Monetary Policy Shocks

For the results in the paper, we exploit the methodology from Kuttner (2000) to construct monetary policy shocks. The magnitude of the shocks determines which quarters are considered to be of monetary easing or tightening. The need to use such shocks arises from the fact that the level of nominal interest rates also embeds other factors – notably, aggregate market conditions – which can affect the likelihood of share repurchases.

Figure 9 displays the shocks' time series. The way they are computed is based upon the movement in the Fed Funds futures. The idea is to capture the unexpected component of the rate change decided by the Fed's Federal Open Market Committee. Given a monetary policy committee meeting on date t, the day $t-1$ futures embed the expected change in interest rates on, or after, date t. Therefore, any deviation from this expectation on the day of the meeting represents the 'surprise' in the monetary policy change, i.e., a shock. Shocks are then averaged to a quarterly frequency.

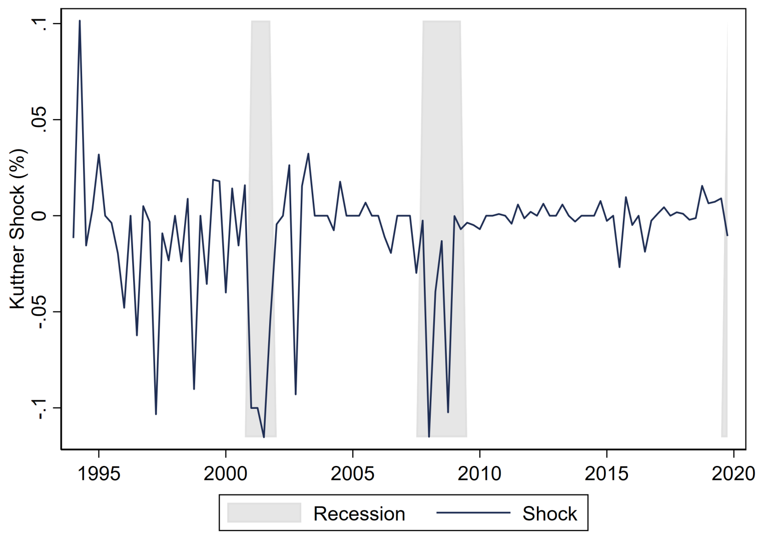


Figure 9: Kuttner shocks, 1994 - 2019 (inclusive).

For robustness, we replicated our exercise using alternative shocks following the Romer and Romer (2004) methodology. Results are similar, although data availability limits the sample period for these shocks only until year 2012.