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 capital for entrepreneurs, potentially spurring productive investment; low interest rates, however, also induce entrepreneurs to lever up so as to increase payouts to equity. Whereas such leveraged payouts privately benefit entrepreneurs, they come at the social cost of reducing 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. We provide preliminary evidence consistent with the model's implications.

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Introduction

The Federal Reserve 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]

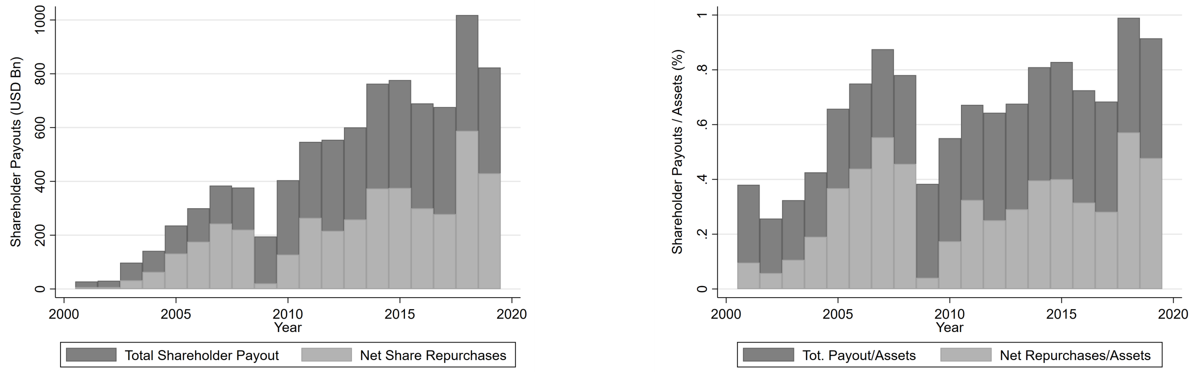
First, corporate leverage has significantly risen. Aggregate corporate debt to GDP has reached historically high levels, exceeding in particular those prevailing just before the global financial crisis. The share of corporate credit originated by non-banks—the so-called "shadow-banking" system—is also at an all-time high.

Second, this high 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 the past two decades that the aggregate importance of share repurchases has increased, especially so in the past decade. As Figure 1 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 more than $800 billion in 2018. 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.[3]

[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

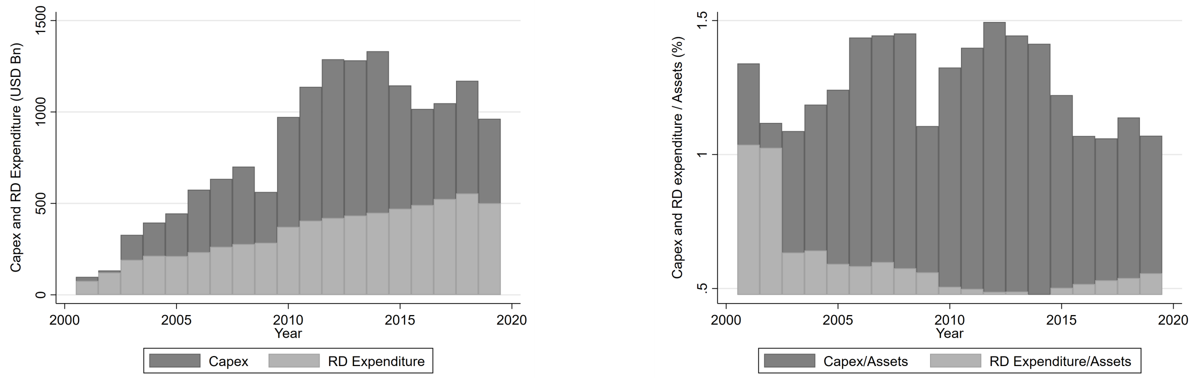
[3]The evolution of the US leveraged-loan market epitomizes these trends. This segment has doubled in size since 2010. Outstanding volumes now approach that of the high-yield bond market. The share of banks in their financing has plummeted to 8%. Nearly 70% of the proceeds fund "shareholder enhancements" such as dividends and buybacks, leveraged buyouts, or mergers and acquisitions.



(a) (b)

Figure 1: Total net share repurchases and shareholder payouts (defined as the sum of net share repurchases and dividend payouts). Panel (a) shows repurchases and payouts in levels, and panel (b) shows both repurchases and payouts normalized by firm assets in the prior quarter. Data from Compustat, 2001-2019 (inclusive).

Third, fixed business investment since the crisis remains below historical trends to date despite cheap funding, robust corporate profits and favorable tax reforms. Figures 2a and 2b show that while the level of investments has grown modestly over time, it has been relatively flat in absolute terms over the past decade; furthermore, the increase in capital and R&D expenditures have not been commensurate with firms' asset growth, as normalized investment has trended downwards over the last decade.



(a) (b)

Figure 2: Total capital and R&D expenditures. Panel (a) shows expenditures in levels, and panel (b) shows expenditures normalized by firm assets in the prior quarter. Data from Compustat, 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 investments or expanding payroll 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.[4] 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 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 leveraged buybacks.

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 an agent who values consumption at two dates 0 and 1 is endowed with an investment technology that converts date-0 consumption units into date-1 units with decreasing marginal returns to scale. The agent is price-taker in a bond market. As the required return on bonds decreases, the agent (i) invests more in her technology until its marginal return equates the return on bonds, and (ii) borrows more against the resulting date-1 output until so does her marginal rate of intertemporal substitution. We deem such borrowing for consumption against future output a "leveraged payout." A natural interpretation of this trade is indeed that the agent sets

[4]See, in particular, https://finance.yahoo.com/news/us-economys-recovery-coronavirus-could-191344712.html: Former Federal Reserve Chairwoman 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.

up a corporation that operates her investment, and that this corporation issues bonds, using the proceeds either to buy back shares from her or to pay her a special dividend.

Suppose now that the output from investment increases in costly private effort by the agent. Such moral hazard introduces a tension between investment and leveraged payouts as the interest rate decreases. On the one hand, the agent would like to enter into more leveraged payouts to front-load consumption. On the other hand, borrowing more against date-1 output reduces her incentives to increase this output, thereby making investment less profitable and thus smaller.[5] The agent sets her leverage at the level that optimally trades off consumption-smoothing and incentives. Very much like 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.

Such agents in our setup are entrepreneurs 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 entrepreneurs 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 by entrepreneurs. In the face of a lower rate, entrepreneurs optimally enter into more leveraged payouts at the expense of effort and investment. Whereas reduced effort and investment are deadweight social losses, entrepreneurs' 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.

It is important to stress that neither payouts nor risky corporate debt are problematic *per se* in our model. Rather, leveraged payouts affect the capital structure of firms, and this affects their real decisions as in any model in which frictions invalidate the Modigliani-Miller theorem. We show that even when some leverage is socially optimal, the incentive to undertake leveraged payouts implies that the privately optimal leverage is higher than

[5] 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.

the socially optimal one when the interest rate is sufficiently low.[6] We also show that our analysis applies in the presence of frictions other than hidden effort that invalidate Modigiliani-Miller, such as liquidity risk or adverse selection.

We provide preliminary evidence – descriptive and econometric – 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.

These 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 corporate leverage. We view the difference between a setting in which it can do so and one in which entrepreneurs 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—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

[6] 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 moral-hazard problem: "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."

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,[7] 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.

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 consumption-smoothing 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 – descriptive as well as econometric – for the model's implications. Section 5 presents concluding remarks.

1 Related literature

Our paper relates to three broad strands of theoretical 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, we argue in this paper that this relation between cost of capital and incentives 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

[7] 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.

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 low investment and high leveraged payouts by corporates.

Third, 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.

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.

In sum, 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 Cost of capital, investment, and leveraged payouts

2.1 Setup

Consider an economy with a single consumption good and two dates indexed by $t \in \{0; 1\}$. An entrepreneur is risk-neutral over consumption at dates 0 and 1 and discounts date-1 consumption at the gross rate $R > 1$. She has access to 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 entrepreneur controls e, the probability of success of her investment, at a private cost $e^2 f(I)/(2\pi R)$ that is subtracted from her utility over consumption at date 0, where $\pi \in (0, 1)$.[8] As is standard, this private cost stands for any time and resources that the insiders of a firm devote to maximizing value—e.g., through screening projects or mapping and hedging risks—instead of devoting them to tasks that they find more rewarding.

The entrepreneur has a large date-1 endowment of the consumption good $W > 0$. This endowment of a safe future cash flow W captures that the entrepreneur is the shareholder of a firm that starts out with existing, unlevered assets in place with payoff W that it can pledge in order to fund investment in the technology f or/and date-0 consumption. The entrepreneur can trade securities with risk-neutral counterparties that require a gross expected return $r > 0$ between dates 0 and 1.

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

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

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

[8] 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.

and invests I^{FB} *such that*

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

If $r \geq R$*, she borrows only* I^{FB} *at date 0, whereas she borrows* $(W + e^{FB} f(I^{FB}))/r > I^{FB}$ *if* $r < R$*.*

Proof. See Appendix A. ■

Proposition 1 highlights important features of the first-best. First, a decrease in the cost of capital r boosts the entrepreneur's output for two reasons. Holding effort fixed, investment size decreases in r from (2). 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 entrepreneur and her counterparts result from the latter having, unlike the former, investable funds at date 0. The entrepreneur borrows from them only to invest I^{FB}.[9] If $r < R$, the entrepreneur benefits from pledging her entire expected date-1 cash flow $W + e^{FB} f(I^{FB})$ to her counterparts at date 0. She invests I^{FB} with part of the proceeds and consumes the residual.

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

Suppose first that $r \geq R$. The entrepreneur in this case is not interested in frontloading consumption,[10] and she borrows only to fund the investment I in the technology f. Restricting the analysis to the case in which $W > rI$, so that she can issue a risk-free security, she selects the investment level I and the effort level e that solve

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

[9]The design of the claim issued by the entrepreneur is immaterial in the absence of moral hazard or risk-aversion.

[10]Unless $r = R$ in which case she is indifferent between frontloading or not.

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 the cost of capital 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 entrepreneur would like in this case to borrow not only to invest but also to frontload consumption. She optimally borrows against her entire risk-free endowment W. She also contemplates borrowing against the expected date-1 consumption that she can generate out of the technology f. In the presence of moral hazard, there is however a tension between doing so and retaining "skin in the game"— a date-1 stake in the output $f(I)$ in case of success that maintains the entrepreneur's incentives to exert effort.

More precisely, the entrepreneur solves the following problem. She 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 she retains— her "skin in the game." Investors purchase the claims to W and (in case of success) $(1-x)f(I)$. The entrepreneur uses the proceeds to invest I and consume, and then exerts private effort. The entrepreneur selects (e, I, x) that maximizes her expected utility subject to the effort level e being incentive-compatible. Formally, she solves

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

s.t.

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

Date-0 consumption is the sum of the present value of the endowment W/r net of investment I and of the present expected value of the fraction $(1-x)$ of output against which the entrepreneur borrows at the rate r. Date-1 expected consumption is the expected retained output $xef(I)$. Condition (50) is the incentive-compatibility constraint, stating that the announced effort e must maximize the entrepreneur's date-1 consumption net of effort costs.

Interpretation as leveraged payouts. The risky (unless $x = 1$) security issued by the entrepreneur has payoffs $\{W; W + (1-x)f(I)\}$ against an asset with payoffs $\{W; W + f(I)\}$. It thus admits a natural interpretation as risky debt.[11] The fraction of the proceeds from issuing risky debt that the entrepreneur consumes at date 0 is therefore akin to a leveraged payout, whereby the initially unlevered firm owned by the entrepreneur issues debt against its expected future cash flows not only to invest, but also to buy back shares from the entrepreneur or pay her a special dividend.[12]

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

$$x = \frac{R}{2R - r}, \tag{7}$$

$$e = \pi x = \frac{\pi R}{2R - r}, \tag{8}$$

$$\frac{\pi R f'(I)}{2(2R - r)} = r. \tag{9}$$

These conditions imply that in the case $r < R$, a lower cost of capital 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 A 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 $\overline{r}(r) = \min\{r; R\}$.

[11] Section 2.2.3 shows that the optimal security generalizes as a standard debt contract under a more general stochastic structure with continuous payoff.

[12] Dividends and share buybacks are equivalent in this environment that abstracts from any informational or differential tax considerations relating to the two forms of shareholders' payouts.

Proposition 2. ***(Cost of capital, investment, and leveraged payouts)*** *The entrepreneur chooses skin in the game x, effort e, and investment I, such that*

$$x = \frac{R}{2R - \overline{r}(r)}, \quad e = \pi x = \frac{\pi R}{2R - \overline{r}(r)}, \quad and \quad \frac{\pi R f'(I)}{2(2R - \overline{r}(r))} = r. \tag{10}$$

Thus,

- *For $r \in (R, +\infty)$, a reduction in the cost of capital r is irrelevant for payout policy and incentives. It spurs investment and expected output.*
- *For $r \leq R$, a reduction in the cost of capital r spurs leveraged payouts that reduce the entrepreneur'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 A. ■

The entrepreneur's linear preferences induce a sharp difference between the two cases discussed in Proposition 2. This permits a clear and simple exposition of the important intuition behind our results.[13] In the case $r > R$, moral hazard is immaterial. The entrepreneur reaches the first-best. Fluctuations in the cost of capital only affect corporate investment I.

When $r < R$, by contrast, the cost of capital affects leveraged payouts that reduce 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. This in turn implies that investment, while still decreasing in the cost of capital, 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 the cost of capital 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 cost of capital 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.

[13]The broad qualitative insights would carry over under strict concavity.

Before proceeding with this Section 3, we show in the following subsection that our central insights are robust to many extensions and alternative modellings. 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 that Section 3 will crucially rely on 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, and the analysis in Section 3 carries over under alternative formulations that we describe here, albeit (sometimes) at the cost of additional complexity.

First, we show that assuming entrepreneur's wealth W to be sufficiently large that investment 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 deliver the same tradeoff. Third, a standard extension of our model to continuous payoffs shows that the entrepreneur optimally issues 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 entrepreneurs have enough safe collateral W to fund investment. The analysis is modified as follows when $W = 0$.

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

- *If $r \geq 2R/3$, then the entrepreneur borrows againt future output only to invest, with $x = 3/4$ and $\sqrt{I} = 3\pi/(8r)$.*

- *If $r < 2R/3$, then the entrepreneur borrows for consumption as well. As in the case $W > 0$, $x = R/(2R - r)$, and $\sqrt{I} = \pi R/[2(2R - r)r]$.*

Proof. See Appendix A. ■

As in the main model, the entrepreneur borrows only to fund investment until the cost of capital falls below a threshold, in which case she also borrows to consume at date

0 even though this puts a further dent on incentives. This is all that is needed for our main results 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 entrepreneur's project succeeds with probability $e = 1$ at date 1 at no cost. Suppose however that the entrepreneur incurs rollover risk when borrowing. She borrows at the rate r between $t = 0$ and an interim date $t = 0.5$. At this interim date, she must refinance her loan with risk neutral investors who do not discount date-1 cash flows. The entrepreneur has access to this interim market with probability q only. If excluded from the market, she must liquidate all or part of her 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 entrepreneur issues risk-free debt and invests the proceeds* $[(1 - \eta)/[1 - \eta(1 - q)]r]^2$*.*
- *Otherwise the entrepreneur issues risky debt, raising* $2(1 - q\eta)^2/r^2$*, invests* $[(1 - q\eta)/r]^2$*, and consumes the residual.*

Proof. See Appendix A. ■

If the cost of capital is above a threshold, the entrepreneur borrows only to fund investment, in which case asset liquidation following market exclusion is only partial and debt is risk-free. As in the baseline model with moral hazard, for lower costs of capital, the entrepreneur prefers to borrow against its entire future output to consume early. 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 entrepreneur may be of two types, "good" or "bad". A good entrepreneur's project succeeds almost surely whereas that of a bad entrepreneur almost surely fails. The entrepreneur privately observes her type. Her counterparts share the prior belief that she is good with probability q. All entrepreneurs' actions are publicly observed. The equilibrium is as follows:

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

- *If $r \geq q^2 R$, then the entrepreneur borrows and invests $I = 1/r^2$ if good, and 0 if bad.*
- *If $r < q^2 R$, then the entrepreneur, regardless of her type, borrows $2q^2/r^2$, invests q^2/r^2, and consumes the residual.*
- *Debt is safe in the former case and subject to default with probability $1 - q$ in the latter one.*

Proof. See Appendix A. ■

A good entrepreneur may borrow only to invest, in which case a bad one does not mimic her and refrains from borrowing as she does not benefit from investment. The good entrepreneur may alternatively borrow beyond her investment needs in order to consume against future output. In this case a bad entrepreneur mimics her, and so the good entrepreneur incurs a lemons discount. If the interest rate is sufficiently low, however, the good entrepreneur does prefer to borrow for consumption despite this discount. 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 entrepreneurs 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 entrepreneur invests I and 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 by the entrepreneur 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 entrepreneur 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 A. ■

In his pioneering work on security design, Innes (1990) shows that the same assumption of monotonic likelihood ratio ψ_e/ψ and 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 that in the previous section. They are risk-neutral over consumption when young and old, and discount future consumption at the rate $R > 1$. 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.[14] 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

[14]The joint distribution of entrepreneurs' outcomes is immaterial.

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.

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.[15]

[15]In somewhat related setups, Benmelech and Bergman (2012), Caballero and Simsek (2019), Diamond

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.

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:

$$\underbrace{W + e_{t-1} f(l_{t-1})}_{\text{Income generated by old entrepreneurs}} + \underbrace{g(1 - l_t)}_{\text{Income generated by young workers}} - \underbrace{\frac{e_t^2 f(l_t)}{2\pi R}}_{\text{Young entrepreneurs' effort}} . \tag{11}$$

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

$$S_t = W + e_{t-1} f(l_{t-1}) + \sum_{t' \geq t} \frac{1}{R^{t'-t}} \left[\frac{W}{R} + g(1 - l_{t'}) + \left(e_{t'} - \frac{e_{t'}^2}{2\pi} \right) \frac{f(l_{t'})}{R} \right] \tag{12}$$

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

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

$$e_t = \pi, \tag{13}$$

$$\frac{\pi f'(l_t)}{2R} = g'(1 - l_t). \tag{14}$$

Proof. See discussion above. ■

Optimality conditions (13) and (14) 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, where future output is discounted at R in both cases.

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.

3.3 Laissez-faire

We solve for the competitive equilibrium of this economy in the case in which the public sector is inactive.[16] 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 again 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.

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,

$$r_t = R. \tag{15}$$

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

$$g'(1-l_t) = w_t. \tag{16}$$

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

$$g(1-l_t) + w_t l_t \tag{17}$$

in the bond market, thereby receiving an income

$$R(g(1-l_t) + w_t l_t) \tag{18}$$

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

[16] 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.

repay (18) to old workers. From (4), optimal investment then implies:

$$e_t = \pi, \tag{19}$$

$$\frac{\pi}{2} f'(l_t) = r_t w_t = R w_t. \tag{20}$$

In sum, there exists a unique competitive equilibrium such that

$$(r_t, e_t, x_t, l_t, w_t) = (R, \pi, 1, l^*, w^*), \tag{21}$$

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

$$\frac{\pi}{2R} f'(l^*) = g'(1 - l^*) = w^*, \tag{22}$$

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

Social welfare under laissez-faire. From Proposition 7, relations (19) and (22) ensure that laissez-faire implements the first-best. Date-t aggregate income (11) is split into consumption for the various agents as follows:

$$W + g(1 - l_t) + e_{t-1} f(l_{t-1}) - \frac{e_t^2}{2\pi R} f(l_t) = \tag{23}$$

$$\underbrace{g(1 - l_t) + w_t l_t - w_t l_t - \frac{e_t^2}{2\pi R} f(l_t)}_{\text{Young entrepreneurs' consumption net of effort cost}} \tag{24}$$

$$+ \underbrace{e_{t-1} f(l_{t-1}) + W - r_{t-1}(g(1 - l_{t-1}) + w_{t-1} l_{t-1})}_{\text{Old entrepreneurs' consumption}} \tag{25}$$

$$+ \underbrace{r_{t-1}(g(1 - l_{t-1}) + w_{t-1} l_{t-1})}_{\text{Old workers' consumption}} \tag{26}$$

Young entrepreneurs' consumption (24) 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 (22). 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

$$S_t = W + e_{t-1}f(l_{t-1}) + \sum_{t' \geq t} \frac{1}{R^{t'-t}} \left[W + g_{t'}(1 - l_{t'}) + \left(e_{t'} - \frac{e_{t'}^2}{2\pi} \right) \frac{f(l_{t'})}{R} \right], \tag{27}$$

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

$$g'_{t'}(1 - l_{t'}) = \frac{\pi f'(l_{t'})}{2R}. \tag{28}$$

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

$$g'_{t'}(1 - l_{t'}) = w_{t'}, \tag{29}$$

$$\frac{\pi f'(l_{t'})}{2} = R w_{t'}. \tag{30}$$

At all dates $t \neq 0$, $g_t = g$, and wage and labor supply to entrepreneurs are w^* and l^* solving (22). Since $g_0 = \rho g < g$, (29) and (30) 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 $w_\rho < w^*$ the first-best date-0 employment level in the capital-good sector and the 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.[17]

In preparation for our main result, we first suppose here that the public sector not only sets the interest rate at each date, but can also control entrepreneurs' leverage. It does so by imposing a prudential regulation on entrepreneurs that consists of a maximum fraction λ of their expected cash flows that entrepreneurs can pledge in the bond market.

To be sure, such a prudential regulation applies to banks, not to non-financial firms, in practice. We could accordingly split the capital-good sector into firms and financial intermediaries. Firms would by assumption have to borrow from financial intermediaries that would fund in turn their loans with workers' savings. It would be sufficient to subject such intermediaries to a prudential regulation in this case.

The following proposition shows that the combination of a reduction in the date-0 interest rate and of a prudential regulation 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 entrepreneurs, where (r_ρ, λ_ρ) solves:*

$$\pi\left(\frac{1-\lambda_\rho}{R}+\frac{\lambda_\rho}{r_\rho}\right)f'(l_\rho)=w^*, \tag{31}$$

$$\frac{\lambda_\rho}{r_\rho}(\pi f(l_\rho)+W)=\rho g(1-l_\rho)+w^* l_\rho. \tag{32}$$

Proof. See Appendix A. ■

An inspection of first-order conditions (16) and (20) 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. Equation (31) pins down the investment l chosen by an entrepreneur facing a prudential constraint λ_ρ and a cost of external funds

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

r_ρ. The term $[(1-\lambda_\rho)/R + \lambda_\rho/r_\rho]$ represents the inverse of her weighted cost of funds, increasing in allowed leverage λ_ρ when external funds are cheaper than internal ones ($r_\rho < R$). Equation (31) states that (r_ρ, λ_ρ) are set so that entrepreneurs optimally demand the socially optimal labor l_ρ. 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.

From Section 2, unregulated entrepreneurs would issue risky debt at such a cost $r_\rho < R$, thereby exerting a privately optimal effort level below the first-best π. The role of prudential regulation is to curb this behavior and ensure that entrepreneurs only issue sufficient risk-free debt to absorb young date-0 workers' savings $\rho g(1-l_\rho) + w^* l_\rho$, as formalized in (32). This way they exert the socially optimal effort level.

3.4.3 Rigid wage and unregulated leverage

Suppose now that the public sector no longer has the ability to regulate entrepreneurs' leverage. This corresponds to an economy in which a significant fraction of credit activity can be considered to take place in an unregulated shadow-banking system.

Suppose that the public sector seeks to stimulate investment by date-0 entrepreneurs by setting $r_0 < R$. From Section 2, date-0 entrepreneurs solve

$$\max_{e,l,x} \left\{ \frac{W + (1-x)ef(l)}{r_0} - w^* l + \left(xe - \frac{e^2}{2\pi} \right) \frac{f(l)}{R} \right\} \tag{33}$$

s.t.

$$e = \arg\max_{y} \left\{ xy - \frac{y^2}{2\pi} \right\} \tag{34}$$

yielding

$$x_0 = \frac{R}{2R - r_0} < 1, \tag{35}$$

$$e_0 = \pi x_0 = \frac{\pi R}{2R - r} < \pi, \tag{36}$$

$$\frac{\pi R f'(l_0)}{2(2R - r_0)} = r_0 w^*. \tag{37}$$

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

$$\frac{W + (1 - x_0) e f(l_0)}{r_0} \tag{38}$$

larger by assumption than workers' savings,

$$\rho g(1 - l_0) + w^* l_0. \tag{39}$$

The public sector absorbs this excess private supply of bonds by taxing date-0 old workers to raise the differential amount $[W + (1 - x_0) e f(l_0)]/r_0 - (\rho g(1 - l_0) + w^* l_0)$.[18] Conversely, date-1 old workers receive a corresponding rebate out of the repayment from these bonds. Appendix A details the subsidies from workers born at date -1 to entrepreneurs and workers born at date 0 when $r_0 < 1$ and leverage is unregulated.[19] Note that these subsidies are welfare-neutral.

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 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

[18]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.

[19]See proof of Proposition 11.

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 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.[20]

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 use 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 A. ■

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.

[20] 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 unchanged the socially costly distortion in output.

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 A. ■

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 below one 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 an important 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 entrepreneurs' debt

We have posited that the excess supply of bonds induced by leveraged payouts was financed by a tax on old workers. We could alternatively assume that deep-pocketed investors, non-residents for example, would be willing instead to supply the savings that clear the bond market at the rate set by the central bank. Interestingly, the scenario in which the public sector issues liabilities bought by these outside investors and purchases entrepreneurs' bonds with the proceeds 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.

Alternatively, these outside investors may directly invest in the securities issued by firms. This alternative sheds interesting light on the importance of a large demand for "storage assets" issued by entrepreneurs for leveraged payouts to rise. In the absence of such a strong demand for assets perceived as safe—although they are not that safe in our setup, entrepreneurs cannot borrow at the rate at which the central bank would like them too.

4 Empirical evidence

4.1 Related empirical literature

The linkages implied by our model between leveraged payouts, monetary policy and real 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.

[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.

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 capital during the same year, mostly in the form of debt, and that cash flows generated by the firms' operations are not sufficient to 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

[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.

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 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 C 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

[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.

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]

Figure 3 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 3c and 3d, 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 3a and 3b that the difference between easing and tightening quarters decreases (conversely, increases) for firms that rely more (less) on bank debt relative to market debt.

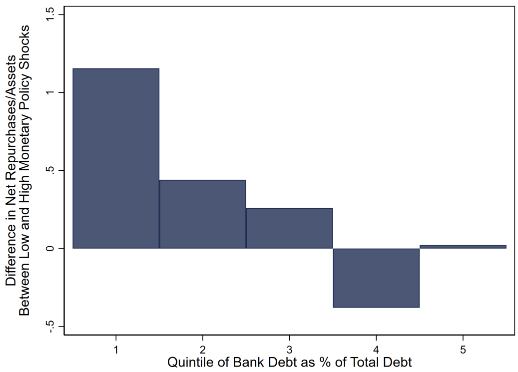
In order to investigate this relationship econometrically, we analyze the link between reliance on bank debt and a firm's net repurchases normalized by assets in a regression setting. The baseline specification is the following:

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

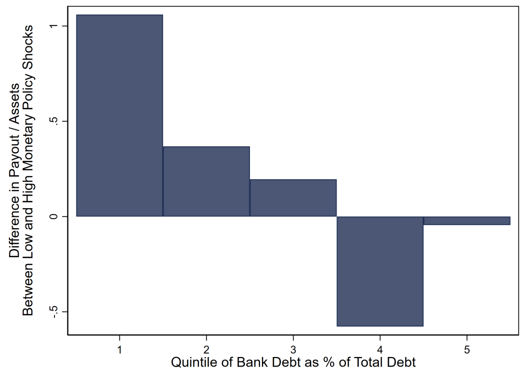
where Net Repurchases$_{i,t}$ are net repurchases normalized by assets for firm i during quarter t, Below-Median Shock$_t$ is an indicator equal to 1 if the monetary policy shock during quarter t is below the median[25], Bank Debt/Total Debt$_{i,t}$ is firm i's bank debt as a percentage of their total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

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

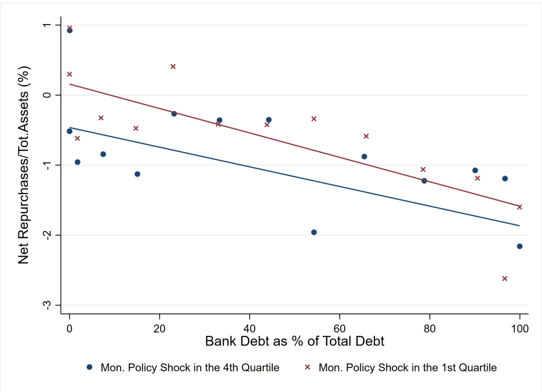
[25] Note that the median Kuttner shock is very close to zero (-1×10^{-8}), so shocks which are below the median are almost always coincident with negative Kuttner shocks.



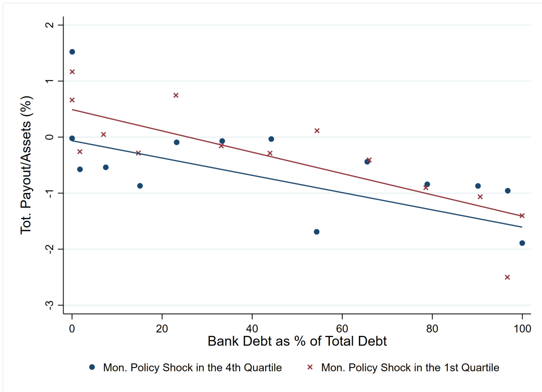
(a) Difference in net repurchases / assets (%) conducted during low and high monetary policy shocks.



(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 3

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.[27]

[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.

[27]In additional robustness checks, we find two 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. 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.

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	Y	Y	N	Y
Firm FE	N	Y	Y	N	Y	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.

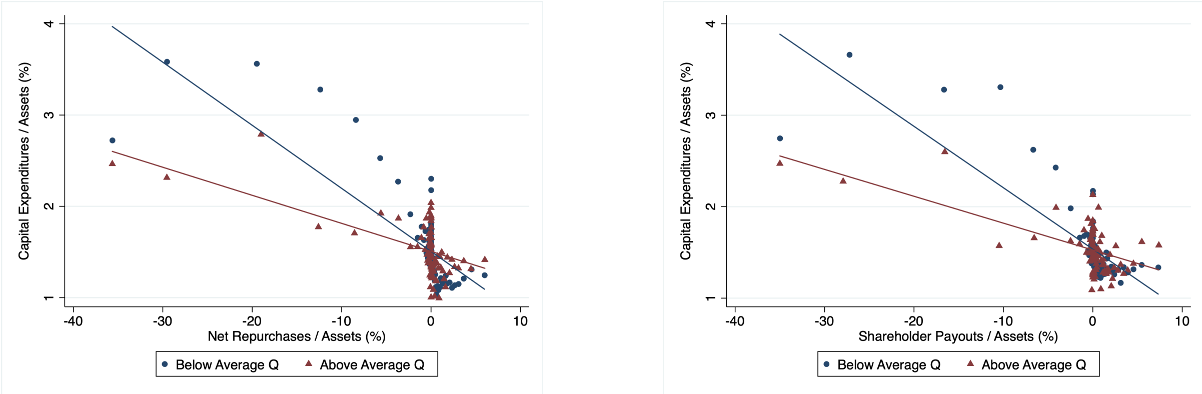
4.3 Repurchasing activity and real investments

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 4 shows binned scatter plots of capital expenditures against net repurchases (Figure 4a) and total shareholder payout (Figure 4b), where all variables are normalized by firm assets in the prior quarter. The negative relationship in Figure 4 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).

Next, we provide econometric support to the negative impact of repurchasing behavior



(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 4

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.[28]

[28] 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), equal to \$0.99, just under consensus forecasts.

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 5 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[29]:

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

where Capital 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 Capex$_{i,t-1}$, which address some differences in firm characteristics for firms above and below consensus estimates (see Table 4 in Appendix B).

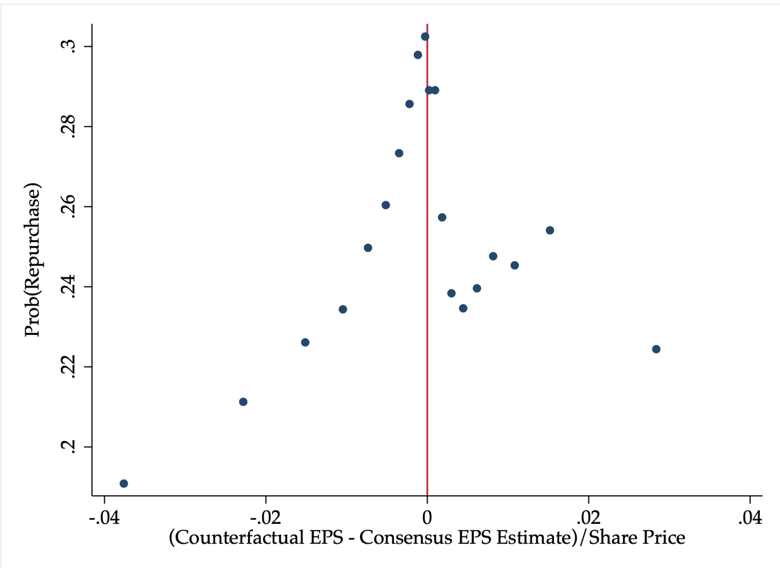


Figure 5: Probability of a positive net repurchase as a function of the difference between the counterfactual EPS and the consensus EPS estimate, normalized by the end of period share price. Firms that would have marginally underperformed relative to consensus estimates are more likely to repurchase shares compared to those that met expectations.

[29]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.

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 normalized 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.

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

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.

ways. They invest, but also frontload consumption by means of leveraged payouts. 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 early consumption is 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 shadow-banking 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.

Similarly, 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 Proofs

Proof of Proposition 1

Suppose $r \geq R$. In this case, the entrepreneur 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 her counterparts is irrelevant as long as its expected value is rI. The optimal effort e and investment I solve:

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

leading to

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

Suppose $r < R$. In this case, the entrepreneur sells its entire date-1 cash flows $ef(I)+W$ at date 0 to invest I and consume the residual. She solves

$$\max_{e,I} \left\{ \frac{ef(I) + W}{r} - I - \frac{e^2 f(I)}{2\pi R} \right\} \tag{42}$$

leading to

$$re = R\pi, \pi R f'(I) = 2r^2. \tag{43}$$

■

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 (9), notice first that (50) implies $e = \pi x$.

Plugging this into (49), the objective becomes

$$\pi x \left(\frac{1-x}{r} + \frac{x}{2R} \right) f(I) + \frac{W}{r} - I, \tag{44}$$

and first-order conditions with respect to x and I yield the two remaining conditions in (9).

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

$$ef(I) = \left(\frac{\pi R}{2R - r} \right)^{\frac{\gamma}{\gamma-1}} \left(\frac{1}{2\gamma r} \right)^{\frac{1}{\gamma-1}}, \tag{45}$$

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

Proof of Proposition 3

The entrepreneur solves

$$\max_{e,I,x} \left\{ \frac{(1-x)ef(I)}{r} - I + \left(xe - \frac{e^2}{2\pi} \right) \frac{f(I)}{R} \right\} \tag{46}$$

s.t.

$$\frac{(1-x)ef(I)}{r} \geq I, \tag{47}$$

$$e = \arg\max_{y} \left\{ xy - \frac{y^2}{2\pi} \right\}. \tag{48}$$

If (47) is not binding, it must be that $r \leq R$, and the solution is given by conditions (10) with $f(I) = 2\sqrt{I}$, yielding the expressions in the proposition. Writing that (47) 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 (47). Injecting this value for I in the objective and maximizing it over x yields $x = 3/4$. ■

Proof of Proposition 4

If the entrepreneur borrows only to invest, assuming she can always repay her debt, her utility $[f(I) - [1 - q + q/(1-\eta)]rI]/R$ 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 entrepreneur borrows against her entire output her utility 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 entrepreneur borrows only to invest, her utility $(f(I) - rI)/R$ is maximum at $I = 1/r^2$, equal to $1/(Rr)$, whereas if she borrows against her entire output her utility 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 entrepreneur solves

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

s.t.

$$e = \arg\max_y \left\{ \int_0^1 (l - s(l))\psi(y,l)dl - \frac{y^2}{2\pi} \right\}, \tag{50}$$

which yields a Lagrangian:

$$\begin{aligned} &\frac{W + f(I)\int_0^1 s(l)\psi(e,l)dl}{r} - I + \left(\int_0^1 (l - s(l))\psi(e,l)dl - \frac{e^2}{2\pi} \right) \frac{f(I)}{R} \\ &+ \mu \left(\int_0^1 (l - s(l)) \frac{\partial \psi(e,l)dl}{\partial e} - \frac{e}{\pi} \right). \end{aligned} \tag{51}$$

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:

$$\max_{B,l} \left\{ c_0 + \frac{c_1}{R} \right\} \tag{52}$$

s.t.

$$c_0 + w^* l \leq B, \tag{53}$$
$$c_1 + rB \leq \pi f(l) + W, \tag{54}$$
$$rB \leq \lambda(\pi f(l) + W), \tag{55}$$
$$c_0 \geq 0. \tag{56}$$

Inequalities (53) and (54) clearly bind at the optimum, and so does (55) since $r < R$. Injecting these equalities in the objective and differentiating w.r.t. l yields a first-order condition:

$$\pi \left(\frac{1-\lambda}{R} + \frac{\lambda}{r} \right) f'(l) = w^*. \tag{57}$$

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:

$$\pi \left(\frac{1-\lambda}{R} + \frac{\lambda}{r} \right) f'(l_\rho) = w^*, \tag{58}$$
$$\frac{\lambda}{r}(\pi f(l_\rho) + W) = \rho g(1 - l_\rho) + w^* l_\rho. \tag{59}$$

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:

$$\Sigma_\rho(r) = \left(e(r) - \frac{e(r)^2}{2\pi}\right)\frac{f\left(l(r)\right)}{R} + \rho g(1 - l(r)), \tag{60}$$

where relations (36) and (37) 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:

$$\Sigma_\rho'(r') = \underbrace{e'(r')\left(1 - \frac{e(r')}{\pi}\right)}_{>0}\frac{f\left(l(r')\right)}{R} + \underbrace{l'(r')}_{<0}\underbrace{\left[\left(e(r') - \frac{e(r')^2}{2\pi}\right)\frac{f'\left(l(r')\right)}{R} - \rho g'(1 - l(r'))\right]}_{<0} > 0. \tag{61}$$

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)

$$W + \pi f(l^*) + \rho g(1 - l_u) - \frac{e_0^2 f(l_u)}{2\pi R} \tag{62}$$

  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)

$$W + e_0 f(l_u) + g(1 - l^*) - \frac{\pi^2 f(l^*)}{2R} \tag{63}$$

  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

$$\frac{\pi R f'(l(r))}{2(2R-r)} = r w^* \tag{64}$$

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

$$l'(r) = \frac{4w^*(R-r)}{\pi R f''(l(r))}, \tag{65}$$

and so one can write

$$\Sigma'_\rho(r) = (R-r)\left[\underbrace{\frac{\pi f(l(r))}{(2R-r)^3}}_{A} + \frac{4w^*}{\pi R f''(l(r))}\left[\underbrace{\frac{\pi(3R-2r)f'(l(r))}{2(2R-r)^2} - \rho g'(1-l(r))}_{B}\right]\right] \tag{66}$$

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 (64) 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

$$\frac{d\Sigma_\rho}{d\rho} = g(1 - l_u). \tag{67}$$

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

$$\frac{\pi f(l^*)}{2R} + \rho g(1 - l^*). \tag{68}$$

Expression (68) 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 (64). 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

$$\frac{\pi R f'(l_u)}{2(2R - r_u)} = r_u w^*, \tag{69}$$

$$\frac{\pi f'(l_\rho)}{2} = \frac{R w_\rho}{w^*} w^*, \tag{70}$$

implying

$$r_u(2R - r_u) = \frac{R^2 w_\rho}{w^*} \left(\frac{l_u}{l_\rho}\right)^{\frac{1}{\gamma}-1}. \tag{71}$$

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 (71) yields

$$\frac{Rw_\rho}{w^*} \simeq r_u \left(2 - \frac{r_u}{R}\right), \tag{72}$$

and this implies

$$r_u < \frac{Rw_\rho}{w^*} < R. \tag{73}$$

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

We have

$$\Sigma'_\rho(r) = (R - r)\left[\frac{2Rg'(0.5)l^{1/\gamma}}{(2R-r)^3} - \frac{2w^*(3R-2r)\gamma}{R(2R-r)^2(\gamma-1)}l + \frac{\rho g'(1-l)\gamma^2 2w^*}{g'(0.5)(\gamma-1)R^2}l^{2-1/\gamma}\right] \tag{74}$$

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 B 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 C 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 6 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.

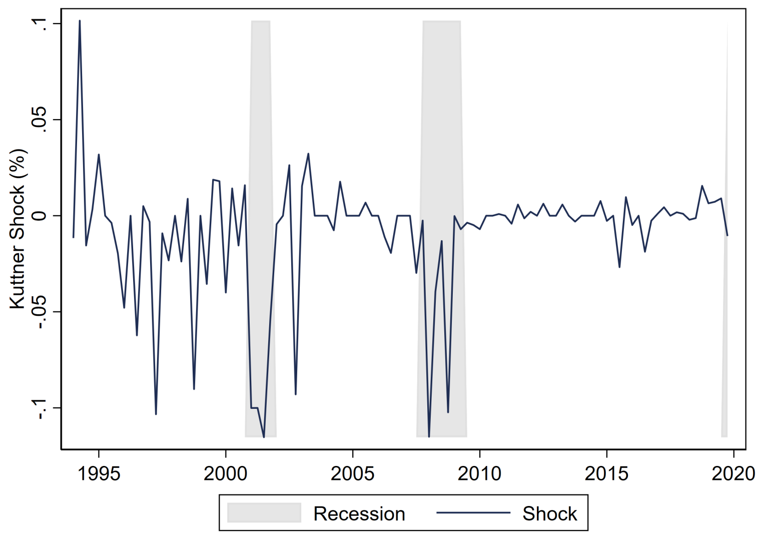

Figure 6: Kuttner shocks, 1994 - 2019 (inclusive).

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.