Monetary Easing, Leveraged Payouts and Lack of Investment*

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Abstract

This paper studies a model in which a low monetary policy rate lowers the cost of capital for entrepreneurs, thereby spurring productive investment. Low interest rates also induce them 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 and productivity. In the presence of an unregulated shadow-banking system, the monetary authority has no choice but stimulating investment below first-best levels in order to contain such socially costly leveraged payouts.

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Introduction

The Federal Reserve has kept its policy rates at low levels since the 2008 crisis. The financial structure of US corporations has experienced three remarkable evolutions over the period.[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 nonbanks—the so-called shadow-banking system—is also at an all-time high. Second, this high leverage also owes to net equity issuances that have been significantly negative over the period due to payouts to shareholders, particularly in the form of share buybacks, that exceed high-water marks. Third, fixed business investment remains below historical trends to date despite robust corporate profits and favorable tax reforms.

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.

This 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 occurs only when the public sector is unable to regulate private leverage: an appropriate prudential regulation can restore the first-best investment level. Thus we offer an equilibrium relationship between several salient features of the current corporate credit

[1] These evolutions are described in details in, e.g., IMF (2017,2019) or Furman (2015).

cycle: the significant involvement of a large unregulated shadow-banking sector, important 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. 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 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 stochastically 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 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. 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 model of Holmström (1979), there is a tension between producing an output and borrowing against it here.

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. 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, the rise of corporate leverage, and that of leveraged payouts at the expense of capital expenditures. It has noteworthy implications for financial regulation and optimal monetary policy.

Implications for financial regulation. We also 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. Accordingly, our theory suggests that the existence of a large shadow-banking system may dramatically affect the transmission of monetary policy: We show that monetary easing entails more leveraged payouts at the expense of productive investment in the latter situation than in the former. Interestingly, as mentioned above, non banks have played an unprecedented central role in the 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. Whereas the central bank optimally restores the investment level of the flexible-price benchmark when it can regulate leverage, it optimally targets a strictly smaller second-best level in the presence of leveraged payouts. It is unclear however whether the interest rate that leads to to this second-best investment level should be lower or higher than the optimal rate under regulated leverage. We find that in the presence of small shocks, the second-best policy rate should be higher than the one that prevails when leverage can be regulated, whereas it has to be lower for sufficiently large shocks.

The paper is organized as follows. As a stepping stone, Section 1 presents a partial-equilibrium model of optimal investment and consumption-smoothing in the presence of moral hazard. Section 2 embeds it in a full-fledged equilibrium model and derives the main results. Section 3 presents concluding remarks.

Related literature

Our paper revisits the 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 payouts to this old idea of malinvestment.

Our paper also relates to two more recent strands of literature.

First, Bolton et al. (2016), Martinez-Miera and Repullo (2017) or Boissay et al. (2016) offer like us models in which a low cost of funds may be detrimental to incentives in the private sector. Whereas a low cost of capital are due to positive supply shocks in their setups, it stems from an optimal monetary-policy decision aimed at stimulating the economy after a negative shock in our setup.

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. Brunnermeier and Koby (2018) show that this may stem from eroded lending margins in an environment of imperfectly competitive banks. Coimbra and Rey (2017) study a model in which the financial sector is comprised of institutions with varying risk appetites. Starting from a low interest rate, further monetary easing may increase financial instability, thereby creating a trade-off with the need to stimulate the economy. A distinctive feature of our approach is that we jointly explain low investment and high corporate payouts.

1 Cost of capital, investment, and leveraged payouts

Consider an economy with a single consumption good and two dates indexed by $t \in \{0; 1\}$. An entrepreneur 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 the probability of success of his investment e at a private cost $e^2 f(I)/(2\pi)$ that is subtracted from his date-0 utility over consumption, where $\pi \in (0,1)$.[2] The entrepreneur is risk neutral over consumption at dates 0 and 1 and does not discount date-1 consumption at date 0. He has a large date-0 endowment of the consumption good $W > 0$. He can trade securities with counterparties that require a gross expected return $r > 0$.

The rest of this section solves for the entrepreneur's utility-maximization problem, discussing in turn the cases in which the entrepreneur's cost of capital r is larger or smaller than his (unit) discount rate.

Suppose first that $r \geq 1$. The entrepreneur in this case uses his own date-0 resources to fund the investment I in his technology f, and invests the residual $W - I$ in securities earning the expected return r. He selects the investment I and effort level e that solve

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

maximized at

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

In this case $r \geq 1$, the probability of success π does not depend on the cost of capital r. Both investment I and expected output $\pi f(I)$ decrease with respect to r.

Leveraged payouts. Consider now the case in which $r < 1$. Given his unit discount factor, the entrepreneur would like to borrow at the rate r against the date-1 consumption that he can generate out of his technology f. Such borrowing is akin to a leveraged payout, whereby the entrepreneur sets up a

[2]The linearity of effort cost with respect to output size plays no other role than simplifying the algebra.

firm that runs the investment in the technology f at date 0, and then lets this firm borrow against its expected future cash flows to buy back shares from the entrepreneur or pay him a special dividend.[3]

Such borrowing backed by future output however distorts the entrepreneur's incentives to exert effort. The entrepreneur optimally trades off early consumption and incentives by selecting an investment level I, an effort level e, and a leverage $1-x$ against his output, where $x \in [0,1]$ is the fraction of the output against which he does not borrow—the "skin in the game"—that solve

$$\max_{e,I,x}\left\{\frac{(1-x)ef(I)}{r}+W-I+\left(xe-\frac{e^2}{2\pi}\right)f(I)\right\} \tag{3}$$

s.t.

$$e=\arg\max_{y}\left\{xy-\frac{y^2}{2\pi}\right\}. \tag{4}$$

Condition (4) is the incentive-compatibility constraint. Simple algebra[4] yields the first-order conditions with respect to e, x, I:

$$e=\frac{\pi}{2-r}, \tag{5}$$

$$x=\frac{1}{2-r}, \tag{6}$$

$$\frac{\pi f'(I)}{2(2-r)}=r. \tag{7}$$

They imply that in this range, a lower cost of capital r induces an increase in leveraged payouts (a lower value of the skin in the game x). Furthermore,

[3]Dividends and share buybacks are equivalent in this environment that abstracts from tax considerations.

[4]See proof of Proposition 1 in the Appendix.

since a lower r induces both a lower probability of success $e = \pi/(2-r)$ and a higher investment $I = f'^{-1}(2r(2-r)/\pi)$, the overall impact of a reduction in r on expected output $ef(I)$ is ambiguous. Suppose for analytical simplicity that $f(I) = \gamma I^{1/\gamma}$, where $\gamma > 1$. We show in the appendix that the expected output actually increases in r for $r \in [2/(\gamma+1), 1]$, and decreases otherwise. The following proposition collects the above results.

Proposition 1. ***(Cost of capital, investment, and leveraged payouts)*** *Let $\overline{r}(r) = \min\{r; 1\}$. The entrepreneur chooses investment I, effort e, and skin in the game x such that*

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

Thus,

- *For $r \in (1, +\infty)$, a reduction in the cost of capital r is irrelevant for corporate leverage, payout policy, and incentives. It spurs investment and expected output.*
- *For $r < 1$, a reduction in the cost of capital r spurs leveraged payouts that reduce the entrepreneur's incentives and thus degrade asset quality. Investment is less sensitive to r than in the case $r > 1$. If $f(I) = \gamma I^{1/\gamma}$, expected output actually increases with respect to r if and only if $r \in [2/(\gamma+1), 1)$ when $f(I) = \gamma I^{1/\gamma}$.*

Proof. See the appendix. ■

The entrepreneur's linear preferences induce a sharp difference between the two cases discussed in Proposition 1. This permits a clear and simple exposition of the important intuition behind our results.[5] In the case $r > 1$,

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

fluctuations in the cost of capital only affect corporate investment I. When $r < 1$, by contrast, the cost of capital affects corporate leverage as well, even though the entrepreneur has all the internal liquidity W needed for investment. Leveraged payouts reduce incentives and thus shift the entire production function downwards, so much so that a reduction in the cost of capital actually comes with a reduction in expected output for $r \in (2/(\gamma + 1), 1]$.

The next section embeds this partial-equilibrium model with exogenous cost of capital into a model in which a central bank controls the real rate and thus firms' cost of capital in the presence 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 sticky prices.

2 Investment, leveraged payouts, and optimal monetary policy

2.1 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 at each date and do not discount future consumption. They are born with a large endowment W of the numéraire good.[6] Each entrepreneur born at date t is 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. Entrepreneurs control the probability of success e at a private cost $e^2 f(l)/(2\pi)$ that is subtracted from their utility when young.

The technology f features a lag between production and delivery of consumption services. This technology thus stands in our stylized model for the most interest-sensitive sectors of the economy such as durable-good, housing or capital-good sectors. We accordingly deem technology f the *capital-good sector*, and technology g the *consumption-good sector*.[7] We also term *investment* the resources spent to produce the capital good.

The functions f and g are twice differentiable and satisfy the Inada conditions.

Public sector. The public sector does not consume. It maximizes the sum of the utilities of agents in the private sector, discounting that of future generations with a factor arbitrarily close to 1.

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

Monetary policy. The public sector announces at each date an expected

[6] We could endogenize this endowment as labor income at some additional complexity and without gaining insights.

[7] A full-fledged model of f as a capital-good technology would require that the date-t investment be combined with labor at date $t+1$ in order to generate consumption. This would complicate the analysis without adding substantial insights.

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. On the other hand, 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.

Relationship to new Keynesian models. This setup can be described as a much simplified version of a new Keynesian model in which money serves only as a unit of account ("cashless economy") and monetary policy consists in enforcing the short-term nominal interest rate. Such monetary policy has real effects in the presence of nominal rigidities. We entirely focus on these real effects, and fully abstract from price-level determination by assuming extreme nominal rigidities in the form of a fixed price level for the consumption good. This will enable us to introduce ingredients that are typically absent from mainstream monetary models in a tractable framework in the following. Benmelech and Bergman (2012), Caballero and Simsek (2019) or Farhi and Tirole (2012) also focus on the financial-stability implications of monetary policy abstracting from price-level determination as we do.

2.2 Steady-state

We first study steady-states in which the public sector announces a constant gross interest rate r at each date. We suppose that the public sector offsets its net position in the bond market at each date with a lump-sum tax or rebate on current old workers. We denote $w \geq 0$ the steady-state wage, and $l \in [0, 1]$ the steady-state quantity of labor used by entrepreneurs. The steady-state associated with the policy rate r can then be characterized as follows.

Entrepreneurs. Each entrepreneur's problem is identical to that in Section 1.[8] As in Section 1, we denote x the skin in the game of an entrepreneur and $\overline{r}(r) = \min\{r; 1\}$. Each entrepreneur's objective is then

$$\max_{e,l,x} \left\{ (1 + r - \overline{r}(r)) \left[\frac{(1-x)ef(l)}{r} + W - wl \right] + \left(xe - \frac{e^2}{2\pi} \right) f(l) \right\} \tag{9}$$

s.t.

$$e = \arg\max_{y} \left\{ xy - \frac{y^2}{2\pi} \right\}. \tag{10}$$

Expression (9) for entrepreneurs' surplus subsumes (1) and (3). From Proposition 1, each entrepreneur chooses e, x, and l such that

$$x = \frac{1}{2 - \overline{r}(r)}, e = \pi x, \frac{\pi f'(l)}{2(2 - \overline{r}(r))} = rw. \tag{11}$$

Furthermore, taking into account that $x = 1$ whenever $r \geq 1$, one can write an entrepreneur's net position in the bond market when young as:

$$\mathbb{1}_{\{r \geq 1\}}(W - wl) - \frac{(1-x)ef(l)}{r}. \tag{12}$$

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

$$g'(1-l) = w. \tag{13}$$

[8] Up to the change of variable $I = wl$.

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

$$g(1-l)+wl \tag{14}$$

in the bond market thereby receiving a pre-tax income

$$r[g(1-l)+wl] \tag{15}$$

when old.

Public finances. The government balances its budget by rebating as a lump-sum to old workers the investment in public bonds by contemporaneous young workers and entrepreneurs net of the repayment of maturing bonds.

Equations (11) and (13) uniquely determine the steady-state values of (x, e, l, w) for a given interest rate r. The surplus of a given cohort is for such an interest rate:

$$\underbrace{(1+r-\overline{r}(r))\left(\frac{(1-x)ef(l)}{r}+W-wl\right)+\left(xe-\frac{e^2}{2\pi}\right)f(l)}_{\text{Entrepreneurs' surplus}}$$

$$+\quad \underbrace{rwl+rg(1-l)}_{\text{Old workers' pre-tax income}} \tag{16}$$

$$+\underbrace{(1-r)\left[\mathbb{1}_{\{r\geq 1\}}(W-wl)-\frac{(1-x)ef(l)}{r}+g(1-l)+wl\right]}_{\text{Rebate to old workers}} \tag{17}$$

$$=W+\left(e-\frac{e^2}{2\pi}\right)f(l)+g(1-l). \tag{18}$$

The entrepreneurs' surplus is given by expression (10) and old workers' pre-tax income by (15). The gross inflow in the government bond market is the sum of old workers' savings (14) and entrepreneurs' net position in the bond market (12). The net inflow is equal to the gross one minus the current bond repayments (equal to r times the gross inflow).[9]

The social costs of leveraged payouts. An important remark is in order before solving for the optimal steady-state interest rate. Note from expression (18) that the interest rate r affects social surplus only indirectly through its impact on the values of e and l that entrepreneurs choose in equilibrium. Entrepreneurs' surplus by contrast also directly depends on r from (10). In particular, when $r < 1$, entrepreneurs directly benefit from lower interest rates through higher leveraged payouts. Proposition 1 describes how they optimally trade off the benefits from such leveraged payouts with the negative impact of reduced incentives on their expected output. Expression (18) shows that this trade-off is privately but not socially optimal, however. Weaker incentives leading to a reduced expected output are social costs whereas early consumption from early payouts are only transfers from old workers towards young entrepreneurs that are neutral given the assumed social welfare function. If some agents (entrepreneurs) benefit from transferring consumption across dates at a rate different from one in the bond market, then other agents (workers here) have to pay for it. The impossibility to tax entrepreneurs implies indeed that their leveraged payouts must be financed by taxes on old workers. In short, leveraged payouts are in this model a form of inefficient rent extraction by entrepreneurs that is detrimental both to savers as it redistributes resources away from them, and to social welfare in the form of a reduced expected output. Notice that if their gains from leveraged payouts were compensated for by a lump-sum tax on entrepreneurs, then this would

[9]We assume for brevity throughout the paper that old workers' consumption (16)+(17) is always positive in the relevant range of the interest rate. It is easy to see that this is so as long as workers earn a sufficiently large amount of total income at each date. Acharya and Plantin (2019) study the situation in which positive consumption by old workers imposes a binding constraint on the policy rate.

eliminate the welfare-neutral redistribution from workers to entrepreneurs, yet this would leave the distortion in output unchanged.

We now solve for the optimal steady-state interest rate. Expression (18) implies that the public sector optimally seeks to implement (e^*, l^*) such that $e^* = \pi$ and $\pi f'(l^*)/2 = g'(1 - l^*)$. Given that profit maximization implies

$$g'(1 - l) = w \tag{19}$$

in the consumption-good sector and

$$\frac{\pi f'(l)}{2(2 - \overline{r}(r))} = rw \tag{20}$$

in the capital-good one, the public sector can reach (e^*, l^*) by setting the rate $r^* = 1$. The optimality of an interest rate equal to the (unit) growth rate of the population is of course akin to the "golden rule" maximizing steady-state utility in overlapping-generations models. Note that at this unit optimal rate, inflows and outflows in the bond market exactly offset each other so that the net rebate to old workers is zero.

2.3 Monetary easing

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 x units of labor into $\rho g(x)$ contemporaneous units of the consumption good, where $\rho \in (0, 1)$. We study in turn the implications of such time-varying productivity for optimal policy and welfare in three different contexts with incremental frictions:

1. The wage w 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.

2.3.1 Flexible-wage benchmark

Proposition 2. ***(Laissez-faire is optimal when the wage is flexible)*** *If the wage is flexible, the public sector implements the first-best by setting the interest rate at the steady-state level $r^* = 1$ at each date. At this rate there is no need to regulate leverage.*

The cohort born at date -1 subsidizes that born at date 0. There are no other transfers across cohorts.

Proof. Let us introduce $\rho_t = 1 + (\rho - 1)\mathbb{1}_{\{t=0\}}$. We use the subscripted notation $(e_t, x_t, l_t, w_t, r_t)$ to denote the values of (e, x, l, w, r) for the cohort born at date t out of the steady-state.

The social welfare function assigns the same weight to every unit of consumption no matter who consumes it and when, and to private costs of effort no matter when they are incurred. The first-best is thus reached when the output of cohort t net of effort costs

$$\left(e_t - \frac{e_t^2}{2\pi}\right) f(l_t) + \rho_t g(1 - l_t) \tag{21}$$

is maximum for all t, or

$$e_t = \pi, \rho_t g'(1 - l_t) = \pi f'(l_t)/2. \tag{22}$$

With a flexible wage, setting $r_t = 1$ for all t implements the first-best. This induces $x_t = 1$. Profit maximization in both sectors and labor-market clearing then imply

$$e_t = \pi, \tag{23}$$

$$\rho_t g'(1 - l_t) = w_t = r_t w_t = \pi f'(l_t)/2, \tag{24}$$

which characterizes the first-best from (22).

The proof that the only transfer across cohorts is that from the date-(-1) cohort towards the date-0 one is in the appendix. ■

When the wage is flexible, the steady-state unit interest rate $r^* = 1$ is unsurprisingly still optimal at all dates in the presence of time-varying productivity. From (24), 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_ρ and w_ρ this first-best date-0 employment level and the associated market wage in this case of a flexible wage.

Time-varying productivity only has a redistributive effect across the cohorts born at -1 and 0 that is immaterial given our social welfare function. The savings of agents born at date 0 and thus facing a less productive economy do not suffice to repay the bonds of old date-(-1) agents that are due at date 0, and so these latter old agents must pay a tax. Workers born at date 0 conversely receive a matching rebate once old at date 1, as savings from date-1 born agents are back to the higher steady-state value.[10]

[10] A public sector averse to intergenerational inequality (unlike ours) could of course smooth these transfers in an international capital market.

2.3.2 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.[11]

In preparation for our main result, we first suppose here that the public sector not only sets the interest rate at each date and taxes workers, but can also control entrepreneurs' leverage. The following proposition shows that in this case, the combination of a reduction in the date-0 interest rate and of a prudential regulation enforcing that entrepreneurs do not borrow at this date implements the first-best, albeit through higher transfers from cohort -1 to cohort 0 than under a flexible wage.

Proposition 3. ***(Monetary easing and prudential regulation implement the first-best)*** *The public sector implements the first-best outcome with the following policy:*

- *It sets $r^* = 1$ at all other dates than 0 (and thus need not regulate leverage at these dates)*
- *It sets $r_\rho = w_\rho/w < 1$ at date 0 and imposes $x_0 = 1$ to young date-0 entrepreneurs.*

[11] We could also assume a partial wage adjustment without affecting the analysis. Note also that the analysis would be similar if the date-0 productivity shock was permanent ("secular stagnation"). All that would matter in this case would be the number of periods it takes for the wage to adjust to the level that is optimal given the productivity shock.

The cohort born at date -1 *subsidizes that born at date 0, more so than under flexible wage. There are no other transfers across cohorts.*

Proof. First-order conditions for profit maximization (19) and (20) show that the capital-good sector is interest-rate sensitive whereas the consumption-good sector is not. The public sector can accordingly make up for the absence of appropriate price signals in the date-0 labor market by distorting the date-0 capital market. By setting the date-0 policy rate at

$$r_\rho = \frac{w_\rho}{w^*} < 1, \tag{25}$$

and imposing $x_0 = 1$ at date 0, the public sector implements the flexible-wage outcome in the labor market. Entrepreneurs hire up to the optimal level l_ρ since they face under this policy the same first-order condition as when the wage is flexible and $r^* = 1$:

$$\frac{\pi}{2} f'(l_\rho) = r_\rho w^* = w_\rho. \tag{26}$$

Each worker accommodates by applying in his own firm the residual quantity of labor that he cannot sell on the labor market at the disequilibrium wage w^*. He 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. ■

Note that the combination of date-0 monetary easing and leverage regulation maximizes the social welfare function, but that it implies more subsidy to date-0 entrepreneurs from date-(-1) workers. This owes to the fact that such young entrepreneurs, facing a rate $r_\rho < 1$, prefer to consume their endowment when young rather than save it, and the public sector must make up for this lower demand for bonds with higher date-0 taxes on old workers.

2.3.3 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 takes place in an unregulated shadow-banking system. The following proposition shows 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 4. ***(Rigid wage and unregulated leverage)***

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

2. *Surplus is strictly lower when leverage is unregulated 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 that born at date 0, more so than under rigid wage and regulated leverage. There are no other transfers across cohorts.*

Proof. See the appendix. ■

From (11), in the absence of leverage regulation, the skin in the game of an entrepreneur x and thus his effort e (strictly) increase in r for $r < 1$. 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 asset quality. 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. Finally, monetary easing is more anti-redistributive in the sense that date-0 leveraged payouts by young entrepreneurs lead to an issuance of corporate debt that crowds out public bonds and forces the public sector to raise more taxes on old workers than under regulated leverage.[12]

Overall, these results suggest that the rise of a large unregulated shadow-banking sector can significantly affect the impact of monetary easing on corporate leverage, payout, and investment, as well as on redistribution.

Should monetary easing be more or less aggressive in the presence of shadow banking? Interestingly, whether the optimal date-0 interest rate r_u—the one that leads entrepreneurs to choose l_u—is lower or higher than the optimal date-0 rate in the presence of regulated leverage, r_ρ, is unclear. On the one hand, investment is less sensitive to the interest rate when leverage is unregulated, which implies setting a lower interest rate when leverage is unregulated than when it is in order to reach a given target level for l.[13] We just stated on the other hand that the target for employment in the capital-good sector should be lower in the absence of leverage regulation—$l_u < l_\rho$, which goes in the direction of setting $r_u > r_\rho$ as less stimulation is needed. The following proposition shows that the latter effect is dominant in the case of small productivity shocks (large values of ρ) whereas the former one prevails for large shocks, provided f is not too concave.

Proposition 5. ***(Optimal policy rate in the presence of shadow banking)***

1. *If ρ is sufficiently close to 1 other things being equal then $r_u = 1 > r_\rho$.*

[12]In the presence of an international capital market, this deficit could of course be financed with debt issuance rather than with current higher taxes on workers.

[13]In the absence of leverage regulation l is reached by setting r such that $\pi f'(l) = 2w^* r(2-r)$ whereas r is such that $\pi f'(l) = 2rw^*$ for $x = 1$.

2. Suppose $f(l) = \gamma l^{1/\gamma}$ where $\gamma > 1$. If ρ and γ are sufficiently small other things being equal then $r_u < r_\rho$.

Proof. See the appendix. ■

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 consists in leaning against the wind this way, and setting $r_u = 1$.

In the presence of very large shocks however, it may be preferable to bite the bullet and tolerate a massive amount of anti-redistributive leveraged payouts. The following quote by Andrew Sorkin (2018) reflecting on the monetary remedies to the 2008 crisis epitomizes this[14]:

"It doesn't help that the economic medicine used by policymakers after a crisis exacerbates those feelings of anger. The most efficient fix—lowering interest rates—helps the wealthy because they end up with cheaper mortgages and enjoy the benefits that low rates have on corporate growth. Those lower on the economic ladder, on the other hand, get little in interest on their savings. The gap between the haves and the have-nots widens. But that approach actually works, pulling everyone along with it, even if it is uneven and there are greater beneficiaries than others."

[14]https://www.nytimes.com/2018/09/10/business/dealbook/financial-crisis-trump.html

3 Discussion

Shadow banking

We interpret the respective polar cases of regulated (Section 2.3.2) and unregulated (Section 2.3.3) leverage as respectively the situation in which the financial sector is mostly comprised of banks subject to prudential regulation and that in which a large shadow-banking sector operates. An interesting route for future research consists in studying the intermediate situation in which the regulation of leverage can only be imperfectly enforced, and examining the interplay of such imperfect enforcement with the crowding out of investment by financial risk taking highlighted here.[15]

Taxing entrepreneurs

Whereas we assume that entrepreneurs cannot be taxed at all for expositional simplicity, our results rely only on the assumption that the public sector does not have a free hand at taxing them. If this were the case, it would be easy to deter socially inefficient leveraged share buybacks, for example through the taxation of date-0 consumption by entrepreneurs or that of corporate debt. An interesting route for future research consists in studying the situation in which such taxation is distortive or/and can only be imperfectly enforced.[16]

Zero lower bound and asset purchases

In the face of a zero lower bound (ZLB) on policy rates, the Federal Reserve has responded to the 2008 crisis with unconventional policies that include

[15] Plantin (2015) develops a model of leverage regulation under imperfect enforcement.

[16] Landier and Plantin (2017) offer a model of optimal capital taxation under imperfect enforcement.

the purchase of private claims such as mortgage-related securities. Suppose that the public sector is subject to a similar ZLB in our setup: It cannot set the date-0 rate below $r^* = 1$.[17] The public sector can still enter into asset purchases, swapping date-0 entrepreneurs' claims to their date-1 output with public bonds akin to remunerated excess reserves. Such swaps spur investment at date 0: If the public sector trades $1/r_0$ bonds for each date-1 consumption unit, then this amounts to grant a lower interest rate to date-0 entrepreneurs. Such asset purchases however have the same adverse implications for incentives as interest-rate reductions because they reduce entrepreneurs' skin in the game in the very same way.

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[17] For example, because the private sector can secretly store with a unit gross return.

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Appendix

Proof of Proposition 1

The case $r \geq 1$ is straightforward and derived in the body of the paper. In the case $r < 1$, in order to derive the conditions in (7), notice first that (4) implies $e = \pi x$. Plugging this into (3), the objective becomes

$$\frac{\pi x[2-(2-r)x]}{2r} f(I) + W - I, \tag{27}$$

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

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

$$ef(I) = \gamma \left(\frac{\pi}{2-r}\right)^{\frac{\gamma}{\gamma-1}} \left(\frac{1}{2r}\right)^{\frac{1}{\gamma-1}}, \tag{28}$$

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

Proof of Proposition 2

The only result that is not established in the body of the paper regards transfers across cohorts. For any t, in the absence of leverage regulation, the surplus of a date-t cohort is

$$\begin{aligned}
&(1 + r_t - \overline{r}(r_t)) \left[\frac{(1-x_t)e_t f(l_t)}{r_t} + W - w_t l_t\right] + r_t w_t l_t + r_t \rho_t g(1-l_t) + \\
&\mathbb{1}_{\{r_{t+1} \geq 1\}}(W - w_{t+1} l_{t+1}) - \frac{(1-x_{t+1})e_{t+1} f(l_{t+1})}{r_{t+1}} + w_{t+1} l_{t+1} + \rho_{t+1} g(1-l_{t+1}) \\
&- r_t \left[w_t l_t + \rho_t g(1-l_t) + \mathbb{1}_{\{r_t \geq 1\}}(W - w_t l_t) - \frac{(1-x_t)e_t f(l_t)}{r_t}\right]
\end{aligned} \tag{29}$$

The first line in (29) is the consumption of entrepreneurs plus old workers' pre-tax income. The next two lines are the lump-sum rebated to old workers, comprised of the net savings of the next cohort (second line) minus the repayment of outstanding bonds to the private sector (third line).

From (29), straightforward computations show that under the optimal policy, the surplus of each cohort born at any date $t \notin \{-1; 0\}$ is given by

$$W + \frac{\pi f(l^*)}{2} + g(1 - l^*), \tag{30}$$

whereas that of cohort -1 is

$$W + \frac{\pi f(l^*)}{2} + \rho g(1 - l_\rho), \tag{31}$$

and that of cohort 0 equals

$$W + \frac{\pi f(l_\rho)}{2} + g(1 - l^*). \tag{32}$$

Comparing the surpluses of cohorts 0 and -1 with their respective outputs shows that cohort -1 pays a subsidy equal to $g(1-l^*) - \rho g(1-l_\rho)$ to cohort 0. ■

Proof of Proposition 3

From (29), and accounting for leverage regulation, straightforward computations show that the surplus of each cohort born at any date $t \notin \{-1; 0\}$ is given by

$$W + \frac{\pi f(l^*)}{2} + g(1 - l^*), \tag{33}$$

whereas that of cohort -1 is

$$w^* l_\rho + \frac{\pi f(l^*)}{2} + \rho g(1 - l_\rho), \tag{34}$$

and that of cohort 0 equals

$$W + \frac{\pi f(l_\rho)}{2} + g(1 - l^*) + W - w^* l\rho. \tag{35}$$

Cohort -1 thus pays a subsidy equal to $g(1 - l^*) - \rho g(1 - l_\rho) + W - w^* l_\rho$ to cohort 0, larger than under flexible wage. This is due to the fact that young date-0 entrepreneurs are unwilling to save $W - w^* l_\rho$ at the rate $r_\rho < 1$, and prefer instead to consume this when young. This forces the public sector to collect this additional amount from old date-0 workers. ■

Proof of Proposition 4

Proof of points 1. and 2. Setting $r_t = 1$ maximizes (21) for all $t \neq 0$. Regarding the date-0 cohort, the optimal rate $r \leq 1$ maximizes

$$\Sigma(r) = \left(e(r) - \frac{e(r)^2}{2\pi} \right) f\left(l(r)\right) + \rho g(l(r)), \tag{36}$$

where relations (11) implicitly define $e(r)$ and $l(r)$. These functions are obviously differentiable with respect to r, respectively increasing and decreasing, and straightforward computations yield:

$$\Sigma'(r) = \frac{\pi(1 - r) f(l(r))}{(2 - r)^3} + \left[\frac{\pi(3 - 2r) f'(l(r))}{2(2 - r)^2} - \rho g'(1 - l(r)) \right] l'(r). \tag{37}$$

For r'_ρ such that $l(r'_\rho) = l_\rho$, we have by definition of l_ρ that $\pi f'(l(r'_\rho))/2 = \rho g'(1 - l(r'_\rho))$, which implies

$$\Sigma'(r'_\rho) = \frac{\pi(1 - r'_\rho) f(l(r'_\rho))}{(2 - r'_\rho)^3} - \frac{\pi}{2} \left(\frac{1 - r'_\rho}{2 - r'_\rho} \right)^2 f'(l(r'_\rho)) l'(r'_\rho) > 0, \tag{38}$$

implying in turn points 1. and 2. in the proposition ($l_u < l_\rho$).

Proof of point 3. From (29), straightforward computations show that the surplus of each cohort born at any date $t \notin \{-1; 0\}$ is given by

$$W + \frac{\pi f(l^*)}{2} + g(1 - l^*), \tag{39}$$

whereas that of cohort -1 is

$$w^* l_u + \frac{\pi f(l^*)}{2} + \rho g(1 - l_u) - \frac{\pi(1 - r_u) f(l_u)}{r_u (2 - r_u)^2}, \tag{40}$$

and that of cohort 0 equals

$$W + \frac{\pi f(l_\rho)}{2} + g(1 - l^*) + W - w^* l_u + \frac{\pi(1 - r_u) f(l_u)}{r_u (2 - r_u)^2}. \tag{41}$$

Cohort -1 thus pays a subsidy equal to $g(1 - l^*) - \rho g(1 - l_u) + W - w^* l_u + \pi(1 - r_u) f(l_u)/[r_u (2 - r_u)^2]$ to cohort 0, larger than under rigid wage and regulated leverage. This is due to the fact that young date-0 entrepreneurs consume an additional $\pi(1 - r_u) f(l_u)/[r_u (2 - r_u)^2]$ when young borrowed against their date-1 output, which forces the public sector to collect this additional amount from old date-0 workers. ■

Proof of Proposition 5

Proof of point 1. Using

$$l'(r) = \frac{4w^*(1-r)}{\pi f''(l(r))}, \tag{42}$$

one can write

$$\Sigma'(r) = (1-r)\left[\underbrace{\frac{\pi f(l(r))}{(2-r)^3}}_{A} + \frac{4w^*}{\pi f''(l(r))}\left[\underbrace{\frac{\pi(3-2r)f'(l(r))}{2(2-r)^2} - \rho g'(1-l(r))}_{B}\right]\right] \tag{43}$$

For (ρ, r) sufficiently close to $(1,1)$, B becomes negligible relative to A and so $\Sigma' > 0$ over $[r,1)$. Furthermore, standard continuity arguments imply that $\lim_{\rho\uparrow 1}(r_u, l_u) = (1, l^*)$. That $\Sigma'(r_u)$ must therefore be strictly positive for ρ sufficiently close to 1 implies that (r_u, l_u) is actually equal to $(1, l^*)$ for ρ sufficiently close to 1.

Proof of point 2. If $f(l) = \gamma l^{1/\gamma}$ then $f''(l) = (1/\gamma - 1)l^{1/\gamma - 2}$. Thus, for any fixed $(r, l) \in (0,1)^2$, there exists γ sufficiently close to 1 and ρ sufficiently close to 0 such that

$$\frac{\pi f(l)}{(2-r)^3} + \frac{4w^*}{\pi f''(l)}\left[\frac{\pi(3-2r)f'(l)}{2(2-r)^2} - \rho g'(1-l)\right] < 0. \tag{44}$$

It is easy to see that this implies that l_u must become arbitrarily close to 1 for ρ and γ sufficiently small. It is also clearly the case that l_ρ is arbitrarily close to 1 for ρ and γ sufficiently small. We have

$$\frac{\pi f'(l_u)}{2(2-r_u)} = r_u w^*, \tag{45}$$

$$\frac{\pi f'(l_\rho)}{2} = r_\rho w^*, \tag{46}$$

and so it must also be that $r_u < r_\rho$ for ρ and γ sufficiently small. ■