Debt, Labor Markets and the Creation and Destruction of Firms*

Andres Almazan
University of Texas

Adolfo de Motta
McGill University

Sheridan Titman
University of Texas and NBER

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Abstract

We analyze the financing and liquidation decisions of firms that face a labor market with search frictions. In our model, debt facilitates the process of creative destruction (*i.e.*, the elimination of inefficient firms and the creation of new firms) but can also induce excessive liquidation and unemployment; in particular, during economic downturns. Within this setting we examine policy interventions that influence the firms' financing and liquidation choices. Specifically, we consider the role of monetary policy, which can reduce debt burdens during economy-wide downturns, and tax policy, which can influence the incentives of firms to use debt financing.

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1 Introduction

Economic forecasters and policymakers have long recognized that financial structure at the corporate and household level can influence macro-economic conditions. The 2008 economic crisis, which was triggered in part by the substantial leverage in the real estate and banking sectors, is perhaps the most visceral illustration of this point. While financial economists have produced a plethora of work that considers policy issues that relate to the leverage of financial institutions (*e.g.*, Brunnermeier 2009), the more general issue of the interaction between corporate financing choices and macro policy has received scant attention.

To examine the interaction between corporate financing choices and macro policy we incorporate a canonical corporate finance model, in which debt plays a fundamental role limiting agency problems within the firm, into a canonical model taken from the macro/search literature, in which production requires a suitable match between workers and firms. In particular, we combine the Hart and Moore (1995) argument that debt choices are made by investors to indirectly restrain managers who enjoy private benefits of control with a macro labor search model along the lines of Pissarides (2000). In the resulting framework, we explore how firms' capital structure choices, through their effects on liquidation, affect the tightness of labor markets in both booms and recessions, and how these effects can in turn affect the emergence of new firms.

Our model includes two generations of firms. The first generation are established firms that may subsequently be liquidated and the second generation are potential entrants that may hire the workers that leave the established firms that are liquidated. Firms of both generations interact in a labor market which is subject to search frictions. Established firms continue their operations only when they are able to retain their labor force, and entrants need to hire workers to produce. Thus there is an interaction between firms of different generations since firm entry (*i.e.*, creation) affects the demand for labor, and hence the ability of established firms to retain workers, and firm liquidation (*i.e.*, destruction) affects the labor supply, and hence the process of firm creation. Both choices affect and are affected by labor market conditions, and capital structure plays an important role in this interaction since debt choices by firms influence their liquidation decisions. Indeed, since firm liquidation decisions affect labor market conditions, there can be potential externalities associated with firms' debt obligations that affect workers as well as emerging new firms.

Within the context of this model we examine a number of policy issues that influence firms' capital structure choices. These include a tax policy that subsidizes the use of debt financing by firms,[1] and monetary policy which, by affecting the overall price level, can influence the real value of a firm's nominal debt obligations. We also examine how expectations about monetary policy affect the capital structure of firms and through this channel, how monetary policy influences the liquidation of established firms and the creation of new ventures.

Our analysis starts with the simplest form of our model that includes a fixed number of established firms and an unlimited number of *ex-ante* identical entrants that can potentially emerge. As we show, in this setting there is no externality associated with debt financing, so the optimal subsidy or tax on debt is zero. However, even within the context of this simple model there can be an important role for policies that influence firms' liquidation choices. Specifically, by generating inflation, a loose monetary policy can reduce the real value of debt during economy-wide downturns and, as a result, reduce bankruptcies in bad times, when liquidations are socially costly. In addition, since such a policy leads to higher *ex-ante* debt ratios, it increases bankruptcies in good times, when there would otherwise be too few liquidations.

We next consider a setting where the potential entrants are heterogeneous. When this is the case, capital structure choices are not in general socially optimal, and can lead to either too much or too little liquidation. The deviation from the social optimum arises because of negative externalities imposed on unemployed workers in the event of liquidation (*i.e.*, liquidation causes the unemployed to have more workers to compete with for jobs), positive externalities that benefit emerging new firms that need to hire labor, as well as pecuniary externalities imposed on existing firms. Depending on the

[1] The issue of the desirability of debt subsidies has been periodically raised in policy discussions. For instance during the Clinton and Bush administrations, the Congressional Budget Office (1997, 2005) considered proposals to eliminate the unequal treatment of debt and equity.

magnitude of these effects a social planner may want to use tax policy to tilt firms towards either more or less debt financing.

In addition to Hart and Moore (1995) and Pissarides (2000), which provide the basis for our model, our analysis is related to a number of papers in the literature. These include several theoretical contributions that consider potential negative spillovers created by debt financing. For instance, bankruptcy induced fire-sales (as discussed in Shleifer and Vishny 1992 and more recently Lorenzoni 2008) impose negative externalities on other firms by affecting their collateral constraints. In addition, our analysis of potential positive externalities of liquidations is related to Schumpeter's (1939) ideas on creative destruction, and to a number of more recent papers, e.g., Caballero (2007).[2] Also related is the study by Kashyap et al. (2008), which documents that the inability of Japanese banks to shut down failing firms in the 1990s discouraged the entry of healthy firms.[3] Finally, a contemporaneous paper by He and Matvos (2012) considers a case where debt facilitates firm exit when companies compete for survival in a declining industry and concludes that firms use less than the socially optimal amount of debt financing. To our knowledge, however, we are the first to consider the influence of debt in an economy where externalities can be imposed on workers as well as emerging new firms, and therefore the first to analyze the effects of policies that influence the real value of debt obligations and the incentives to use debt financing on labor markets and on the process of firm creation and destruction.

Our paper is also related to papers in the macro-labor literature that consider the interaction of labor market and capital market frictions. (See for instance, Wasmer and Weil, 2004, Chugh, 2009, Petrosky-Nadeau, 2009, and Jermann and Quadrini, 2012.) While their analysis of search costs in labor markets is similar to ours, our modeling of capital structure and the issues that we study are quite different. Specifically, the macro-labor literature tends to focus on the typical credit channel in which financial frictions

[2]In the finance literature, Almeida and Wolfenzon (2006) study the role of conglomerates in the process of creative destruction. In particular, they argue that internal capital markets allocate too much capital internally to mediocre projects, leaving less capital for higher NPV investments elsewhere in the economy.

[3]Chun et. al (2008) suggest that recent findings of more firm-specific performance variation in richer, faster growing countries, with more transparent accounting, better financial systems, and more secure property rights might partly reflect more intensive creative destruction in those economies.

(*e.g.*, asymmetric information or costly contract enforcement) create a wedge between the cost of different financing sources (*e.g.*, debt vs. equity), which in turn, leads to firms' financial structures that consist of the maximum amount of debt allowed by the external financing constraints.[4] In contrast, we consider a setting inspired by Hart and Moore (1995) where firms, which are subject to managerial agency problems, optimally choose between external debt and equity financing to influence the conditions under which managers liquidate in the future. Our framework emphasizes situations where firms fail to exit, and the effect that this has on labor reallocation to more productive entrants. This mechanism contrasts with the underinvestment effects stressed by the credit channel models in which external financial shocks affect firms' ability to obtain debt capital and thus invest and fill job vacancies. Considering a framework in which firms are financed with external debt and equity is essential to the central question addressed in our paper, namely whether or not the privately optimal debt-equity choices are also socially optimal.

Finally, there is also a finance literature that examines how capital structure affects the terms of trade between a firm and its employees. For example, in Titman (1984) the workers of more highly levered firms demand higher wages to compensate them for the costs that are imposed on them in the event that the firm goes bankrupt and liquidates. However, in these settings, as well as in our own, since the firm's debt choice internalizes the costs borne by its own workers when it liquidates, these is no wedge between the privately optimal and socially optimal debt choice. In contrast, in Perotti and Spier (1993) and Monacelli et al. (2011) by improving the firm's bargaining position and thus lowering wages, a firm can in fact choose more than the socially optimal amount of debt to extract surplus from its workers. As discussed below, this bargaining effect does not arise in our setting since we assume that firms pay their workers the expected wages up front which implies that the investors' choice of capital structure is not influenced by the ex-post desire to affect workers' wages.

The rest of the paper is organized as follows. Section 2 describes our framework. Section 3 studies the case in which there is an infinite number of identical potential

[4]One exception is Monacelli et al. (2011) which explores the role of capital structure in improving the firm's bargaining position with its workers as in Perotti and Spier (1993).

entrants (*i.e.*, homogenous entry case). Section 4 considers the policy implications that emanate from the homogenous entry case. Section 5 analyses the case in which potential entrants differ in their entry costs (*i.e.*, heterogeneous entry case). Section 6 concludes. Proofs and other technical derivations are relegated to the Appendix.

2 The model

We consider a risk-neutral economy in which the discount rate is normalized to zero. The economy consists of three periods: two productive periods $t = 1, 2$ and an interim period in which existing firms can be liquidated and new firms can be created. Next, we describe the agents, technology, contracting environment and labor market.

2.1 Agents: workers and two generations of firms

2.1.1 Established firms

The economy starts in the first productive period, $t = 1$, and is populated by a continuum of mass one of workers and established firms. Each firm employes one worker, produces in period 1 and, provided that it retains its worker, produces in period 2 as well. An established firm that fails to retain its worker is liquidated and obtains a liquidation value L which we normalize to zero.

An established firm i that produces in period t generates a cash flow r_{it} that can be decomposed as follows:

$$r_{it} = s_t + \varepsilon_i. \tag{1}$$

The first cash flow component s_t is an aggregate productivity shock in period t that is common to all firms. Formally $s_1 = \tilde{s}$, where $\tilde{s}$ is a binomial random variable such that

$$\tilde{s} = \begin{cases} s_h & \text{with prob. } p \\ s_l & \text{with prob. } 1-p \end{cases} \tag{2}$$

and

$$s_2 = \rho s_1 + (1-\rho)\,\tilde{s} \tag{3}$$

with $0 \leq \rho \leq 1$.[5]

The second cash flow component ε_i is a firm-specific shock, which is independent across firms, constant over time and drawn from a uniform distribution:

$$\varepsilon_i \sim U[-\bar{\varepsilon}, +\bar{\varepsilon}]. \tag{4}$$

2.1.2 Entrants

Entrants are firms that by incurring an entry cost enter the economy in the interim period, between production periods 1 and 2. We assume that there is a large set of potential *entrants* which are *ex-ante* identical except for their entry costs. In particular, potential entrants can be ordered according to their entry costs,

$$k(j) = k + \phi j, \tag{5}$$

where $k > 0$ is the minimum entry cost, $\phi \geq 0$ is a parameter that measures the difference in entry costs among potential entrants (*e.g.*, if $\phi = 0$ all entrants have the same entry cost), and $j \geq 0$ indexes entrants according to the magnitude of their entry costs.

After incurring the entry cost, an entrant j needs to hire a worker in a labor market with search frictions. If an entrant j succeeds in hiring a worker, it generates a cash flow r_{j2} at the end of period 2 where,

$$r_{j2} = s_2 + \varepsilon_j, \tag{6}$$

s_2 is the aggregate productivity shock in period 2 common to all firms (entrants and established firms), and ε_j is a firm-specific shock, independent across firms and uniformly distributed, *i.e.*, $\varepsilon_j \sim U[-\bar{\varepsilon}, +\bar{\varepsilon}]$. However, if entrant j fails to hire a worker, it loses its investment $k(j)$ and generates no cash flow.

2.2 Contracting environment

Firms are initially controlled by investors who subsequently transfer control to managers. Following Hart and Moore (1995), we assume that managers enjoy private benefits of control which makes them continue the firm's operations in period 2 as long as they have

[5] Note that ρ captures the correlation between s_1 and s_2, that is, if $\rho = 1$, s_1 and s_2 are perfectly correlated, and if $\rho = 0$ they are independent.

access to the necessary funds to retain their workers. For simplicity, we also assume that any funds available beyond those needed for worker retention are paid out to the investors. Furthermore, we ignore the effects of pecuniary compensation on managerial behavior, that is, we assume that the managerial control benefits are so strong that no feasible financial incentive payment can persuade the manager to liquidate the firm.

As in Hart and Moore (1995), before transferring control to the manager, investors set the firm's capital structure. Specifically, firm i issues short-term debt with a face value $d_i \geq 0$ that is due at the end of period 1, just after the cash flow r_{i1} is realized. We assume that the debt is a "hard claim" which cannot be renegotiated with creditors and, because of this, forces the manager to liquidate if the firm fails to meet its payment d_i. The debt market is accessible to firms in period 1, so if a firm cannot repay its debt from its period 1 cash flow r_{i1}, it may be able to cover the shortfall by borrowing funds against its period 2 cash flow, r_{i2}. We exclude any other financial contract (other than the residual equity owned by the investors) and in particular, we assume that debt cannot be made contingent on specific cash flow components $\{\varepsilon_i, s_t\}$.

2.3 Labor market

To complete the description of the economy, we need to characterize the reallocation of workers from established firms to entrants in the interim period. We provide the details of this reallocation next.

2.3.1 Labor market frictions

In the interim period, entrants face a labor market with search frictions, which implies that firms and workers do not always find a suitable match (*e.g.*, Pissarides 2000).[6] The labor market is formally described by a matching technology that specifies the likelihood of a match, and a sharing rule that determines how the matched parties share the surplus created by the newly formed relationship.

[6] Note that we consider an economy that starts with all workers employed by established firms at $t = 1$, but that features search frictions in the reallocation of workers from established firms to entrants in the interim period. The case in which established firms also face a labor market with search costs at $t = 1$ produces qualitatively similar results.

The matching technology is characterized by a constant-returns-to-scale Cobb-Douglas matching function:[7]

$$m(a, v) = \lambda a^{\alpha} v^{1-\alpha} \tag{7}$$

where m, the number of matches, is determined by a, the number of workers actively looking for jobs, and v, the number of entrants searching for workers. In this function, $0 < \alpha < 1$ is the elasticity of the number of matches to the number of workers looking for jobs and $\lambda > 0$ is a measure of the efficiency of the matching technology.

Following the search literature, we refer to the ratio of firms (*i.e.*, entrants) to workers, $\theta \equiv \frac{v}{a}$, as the "labor market tightness". Given this matching technology, $q(\theta) \equiv m(1, \theta)$ is the probability that a worker finds a suitable position, and $q(\theta)/\theta$ is the probability that an entrant hires a suitable worker.[8] Total employment, *i.e.*, the mass of workers that look for a job during the interim period but cannot find one, is $u \equiv a - m(a, v)$.

When there is a match between an entrant and a worker, the surplus they create, $E(r_2|s_1)$, is allocated according to a sharing rule. In particular, when matched with an entrant, a worker receives a wage

$$w_2 = \gamma + \beta E(r_2|s_1) \tag{8}$$

where $\gamma \geq 0$ and $\beta \in [0, 1]$, which implies that entrant's j expected cash flow, gross of its entry cost $k(j)$, is

$$E(r_2|s_1) - w_2 = (1 - \beta)E(r_2|s_1) - \gamma.$$

This specification encompasses the case in which $\beta = 0$, where workers receive a fixed wage, as well as the case in which $\gamma = 0$, where workers and firms share the surplus generated by their relation, with β being the workers' share of the surplus, *i.e.*, their bargaining power. We assume that $(1 - \beta)E(r_2|s_1) - \gamma > k$ so that entry by new firms can be profitable.[9]

[7] Petrongolo and Pissarides (2001) justify the use of a Cobb-Douglas function with constant returns to scale on the basis of its success in empirical studies.

[8] Since $m(a, v)$ is characterized by constant returns-to-scale, it follows that $q(\theta) \equiv \frac{m(a,v)}{a} = m(1, \theta)$ and $\frac{q(\theta)}{\theta} \equiv \frac{m(a,v)}{v} = m\left(\frac{1}{\theta}, 1\right)$. Also, we assume an interior solution, which requires that λ is small enough such that, in equilibrium, probabilities are well defined, *i.e.*, $m(a, v) < \min\{a, v\}$.

[9] As indicated above, this formulation assumes that wages are paid at the beginning of $t = 1$ before s_1 is realized. This is without loss of generality since agents are risk neutral.

2.3.2 Workers' retention costs

After period 1 an established firm must pay its worker his outside option to retain him. This payment corresponds to the expected compensation that the worker would receive if he quits his job and searches for an alternative job during the interim period, *i.e.*, $U(s_1) \equiv q(\theta_1)w_2$. Moreover, we assume that workers are *just* paid their outside option when retained by established firms, that is, any rents that workers receive from established firms are paid up front at the beginning of period 1. This assumption rules out that the investors' design of the firm's optimal capital structure be influenced by the desire to reduce worker rents in period 2 as in Perotti and Spier (1993) and Monacelli et al. (2011).

2.4 Timing of events

Next we summarize the relevant events. There are two production periods and an interim period in which firm destruction and creation as well as worker reallocation take place. Specifically:

Period 1 ($t = 1$): A continuum of mass one of established firms employ one worker each. At the beginning of the period, each established firm i issues short-term debt d_i, and then transfers the control of its operations to a manager. At the end of the period, firm i produces a cash flow r_{i1}, and its short-term debt d_i matures.

Interim period: Managers of established firms make their liquidation decisions and entrant j incur cost $k(j)$ to enter the market. Each entrant j attempts to hire an unemployed worker.

Period 2 ($t = 2$): Established firms that are not liquidated and entrants that find a match generate cash flows $\{r_{i2}\}$ and $\{r_{j2}\}$ respectively.

Period 1 (t=1)	Interim Period	Period 2 (t=2)
i) Established firms & workers set	i) Liquidation of established firms	i) Cash flows $\{r_{i2}\}$,$\{r_{j2}\}$
ii) Investors choose $\{d_i\}$	ii) Creation of entrants	
iii) Managers get control	iii) Entrants and workers match	
iv) Cash flows $\{r_{i1}\}$		

Figure 1: Timing of Events

3 Analysis of the model: Identical entrants

We start the analysis by considering the special case in which all potential entrants are identical in terms of their entry costs, *i.e.*, $\phi = 0$ so that $k(j) = k$ for all j. This case is particularly tractable because, as we show, the model can be solved recursively and produces many (but not all) of the results that are obtained from the analysis of the case with heterogeneous entry costs which we consider in Section 5.

The analysis starts in Section 3.1 with a characterization of the labor market conditions in the interim period assuming an exogenous number of job-seekers, *i.e.*, an exogenous labor supply. Then, in Section 3.2, we endogenize the labor supply by considering the firms' liquidation decisions in the interim period as a function of their debt choices in $t = 1$ (and taking into account the labor market effects derived in Section 3.1). Finally, in Section 3.3, we study the choice of debt by established firms at $t = 1$.

3.1 Labor market and entry

Consider the entry decision in the interim period $v(s_1)$ for a given labor supply $\bar{a} > 0$. Expressed in terms of market tightness, *i.e.*, $\theta_1 \equiv \theta(s_1) \equiv \frac{v(s_1)}{\bar{a}}$, the expected profit of each entrant is:

$$V(s_1) = -k + \frac{q(\theta_1)}{\theta_1} \left[(1-\beta) E(r_2|s_1) - \gamma \right], \tag{9}$$

where $\frac{q(\theta_1)}{\theta_1}$ is the probability of finding a worker and $[(1-\beta)E(s_2|s_1) - \gamma]$ is the expected cash flow retained by the firm. Setting $V(s_1) = 0$ (since new firms enter the market until their expected profit from entering is zero) and using the matching function (7) we obtain the following lemma:

Lemma 1 *In equilibrium the labor market tightness is* $\theta^*(s_1) = \left(\frac{\lambda[(1-\beta)E(s_2|s_1)-\gamma]}{k} \right)^{1/\alpha}$ *and the workers' reservation utility is*

$$U^*(s_1) = \lambda \theta^*(s_1)^{(1-\alpha)} \left(\gamma + \beta E(s_2|s_1) \right). \tag{10}$$

A number of implications follow from Lemma 1. Specifically, Lemma 1 indicates that market tightness, $\theta^*(s_1)$, increases with the efficiency of the matching technology

λ, and the expected surplus generated by a match $E(s_2|s_1)$, but decreases with the worker's share of this surplus (*i.e.*, decreases in both β and γ), and the fixed entry cost k. In addition, the workers' reservation utility, $U^*(s_1)$, increases with the efficiency of the matching technology λ, and the expected surplus $E(s_2|s_1)$, and decreases with the entry cost k. Parameters that affect worker's compensation conditioned on finding a job (*i.e.*, β and γ) do not have a monotonic effect on $U^*(s_1)$. Intuitively, β and γ can reduce the worker's outside option $U^*(s_1)$ since higher worker compensation reduces firm entry, which in turn decreases the worker's probability of finding a job.

It is worth stressing that Lemma 1 also indicates that $\theta^*(s_1)$ and $U^*(s_1)$ are independent of the labor supply $\bar{a}$. Since the labor demand $v(s_1)$ is perfectly elastic –there is an unlimited number of potential entrants with identical entry costs– labor supply shocks, *i.e.*, changes in $\bar{a}$, are fully offset by a corresponding change in firm entry until the equilibrium values $\theta^*(s_1)$ and $U^*(s_1)$ are achieved.

3.2 Liquidation decisions of established firms

So far we have characterized labor market tightness $\theta^*(s_1) \equiv \frac{v^*(s_1)}{\bar{a}}$ and workers' reservation utility $U^*(s_1)$ for a given labor supply $\bar{a}$. We now endogenize the labor supply $a(s_1)$ by noting that it corresponds to $l(s_1)$, *i.e.*, the number of workers whose firms are liquidated in the interim period:

$$a(s_1) = l(s_1). \tag{11}$$

Hence endogenizing $a(s_1)$ requires us to characterize the liquidation decisions of established firms, which in our setting are affected by managerial preferences. Specifically, since managers enjoy private benefits of control, an established firm is liquidated only when its manager is unable to retain the firm's worker. Worker retention, in turn, requires firms to pay the workers' outside option $U^*(s_1)$ with either internally generated or borrowed funds.[10]

[10]These observations illustrate the recursive nature of the model when $\phi = 0$. In this case liquidation decisions have no effect on labor market conditions (*i.e.*, $\theta^*(s_1)$ and $U^*(s_1)$ are independent of $a(s_1)$), but labor market conditions do affect the wages paid by established firms, and thus affect liquidation decisions (*i.e.*, $a(s_1)$ is affected by $\theta^*(s_1)$ and $U^*(s_1)$).

3.2.1 Managerial liquidation choices

Since an established firm i produces a period 1 cash flow $r_{1i} = s_1 + \varepsilon_i$ and a period 2 expected cash flow $E(r_{2i}|r_{1i}, s_1) = E(s_2|s_1) + \varepsilon_i$, the firm is liquidated when:[11]

$$G(\varepsilon_i, s_1, d_i) \equiv 2\varepsilon_i + s_1 + E(s_2|s_1) - d_i - U^*(s_1) < 0. \tag{12}$$

Hence, for a given amount of debt, d_i, and an aggregate shock, s_1, firm i is liquidated when its idiosyncratic shock ε_i is smaller than $\varepsilon^1_{d_i}$. This cut-off level, which makes $G(\varepsilon^1_{d_i}, s_1, d_i) = 0$, is explicitly defined by:

$$\varepsilon^1_{d_i} = \frac{1}{2}[d_i - s_1 - E(s_2|s_1) + U^*(s_1)]. \tag{13}$$

Since $\varepsilon_i \sim U[-\bar{\varepsilon}, +\bar{\varepsilon}]$, the probability that firm i is liquidated at $t = 1$ is

$$\Pr(\varepsilon_i < \varepsilon^1_{d_i}|s_1) = \frac{1}{2} + \frac{d_i - s_1 - [E(s_2|s_1) - U^*(s_1)]}{4\bar{\varepsilon}}. \tag{14}$$

Intuitively, managers only liquidate their firms when they cannot raise the necessary funds to retain their workers, which is more likely to occur when firms have more debt, when the aggregate shock is less favorable, and when the conditions in the labor market make worker retention more costly.

3.3 Debt choice of established firms

We now characterize the optimal capital structure, *i.e.*, the choice of debt, d_i, made by investors to maximize firm value. At the beginning of $t = 1$ firm i's investors solve the following convex problem:

$$\max_{d_i} \; p \int_{\varepsilon^h_{d_i}}^{\bar{\varepsilon}} \frac{\varepsilon_i + E(s_2|s_h) - U^*(s_h)}{2\bar{\varepsilon}} d\varepsilon_i + (1-p) \int_{\varepsilon^l_{d_i}}^{\bar{\varepsilon}} \frac{\varepsilon_i + E(s_2|s_l) - U^*(s_l)}{2\bar{\varepsilon}} d\varepsilon_i \tag{15}$$

where $\varepsilon^h_{d_i}$ and $\varepsilon^l_{d_i}$ correspond to $\varepsilon^1_{d_i}$ when $s_1 = s_h$ and $s_1 = s_l$.

In the objective function (15), the first and second terms are the expected profits in period 2 when $s_1 = s_h$ and $s_1 = s_l$, respectively. These profits are affected by the debt

[11] Recall that for simplicity we have assumed that the firm pays the initial wage to the worker at the begining of the period.

choice because debt determines when the firm is liquidated, *i.e.*, it changes the liquidation cut-offs $\varepsilon^h_{d_i}$ and $\varepsilon^l_{d_i}$.

From (15) we can derive the following first order condition,

$$p[\varepsilon^{*h}_{d_i} + E(s_2|s_h) - U^*(s_h)] + (1-p)[\varepsilon^{*l}_{d_i} + E(s_2|s_l) - U^*(s_l)] = 0, \tag{16}$$

which can be rewritten as:

$$E[\varepsilon^{*1}_{d_i} + E(s_2|s_1) - U^*(s_1)] = 0. \tag{17}$$

Intuitively, as (17) indicates, the optimal amount of debt d_i^* is chosen so that the marginal firm that is liquidated has an expected value of zero. Using the definition of $\varepsilon^{*1}_{d_i}$ in (13) equation (17) can be rewritten as:[12]

$$d^* = E(s_1) - E\left[E(s_2|s_1) - U^*(s_1)\right]. \tag{18}$$

Intuitively, (18) illustrates that the optimal debt choice d^* increases with the expected cash flow in period 1, $E(s_1)$ since higher cash flows increase the ability of managers to continue operating the firm when doing so has a negative NPV. Furthermore, equation (18) also shows that d^* decreases with the expected value of the firm in period 2, $E\left[E(s_2|s_1) - U^*(s_1)\right]$, which reflects the debt overhang problem, i.e., the cost of forcing firms with positive continuation values to liquidate. In this setting, the continuation value is related to search frictions in the labor market, because of their effect on labor costs. Specifically, search frictions reduce labor costs, thereby improving continuation values, and hence, reducing firms' incentives to issue debt.

While (18) provides intuition on the economic forces in play, it can be further simplified to:

$$d^* = E\left[U^*(s_1)\right]. \tag{19}$$

This simplified expression (19) shows that on the net, since some of the above mentioned effects offset each other, the firm's optimal debt choice is purely related to the conditions in the labor market. In particular, an increase in the efficiency of the matching technology

[12] In equilibrium all firms choose the same amount of debt (*i.e.*, $d^* = d_i^*$ for all i) as each firm solves the same optimization problem (*i.e.*, equation 15).

λ or in aggregate productivity (i.e., higher s_h, s_l, or p), or a decrease in the entry cost k, increases the expected reservation wage of the workers $E\left[U^*(s_1)\right]$, and hence, the optimal amount of debt d^*. Furthermore, worker compensation parameters (i.e., β and γ) have an ambiguous effect on the optimal debt choice since, as discussed above, worker compensation has an ambiguous effect on the worker's reservation utility (i.e., $U^*(s_1)$). Proposition 1 summarizes these observations and states the main comparative statics relative to the optimal debt choice.

Proposition 1 *The optimal amount of debt d^* increases with the efficiency of the matching technology λ and with the aggregate cash flow component (i.e., s_l, s_h and p), and decreases with the entry cost, k. Furthermore, the effect of the worker compensation parameters (i.e., β and γ) on d^* is non-monotonic.*

Finally, notice that d^* determines ε_d^{*1}, which, in turn, determines the number of workers whose firms are liquidated at the end of the period:

$$l^*(s_1) = \Pr(\varepsilon_i < \varepsilon_d^{*1} | s_1) = \frac{1}{2} + \frac{d^* - s_1 - [E(s_2|s_1) - U^*(s_1)]}{4\bar{\varepsilon}}. \tag{20}$$

Specifically, the previous analysis generates a number of implications that relate to firms' debt choices and liquidation decisions. First, even under the optimal debt choice d^*, there are inefficiencies in firm liquidation. In particular, in good economic times, when $s_1 = s_h$, a number of negative NPV firms can continue operating, *i.e.*, $\varepsilon_d^{*h} + E(s_2|s_h) - U^*(s_h) < 0$. These firms generate enough cash flows in period 1 to meet their debt obligations and continue operating despite having a negative NPV in period 2. In contrast, during recessions when $s_1 = s_l$, the *ex-ante* optimal debt choice can force positive NPV firms to liquidate, *i.e.*, $\varepsilon_d^{*l} + E(s_2|s_l) - U^*(s_l) > 0$. Indeed, as shown in (16), the optimal debt choice, d^*, equates p times the value saved from liquidating the (unprofitable) marginal firm when $s_1 = s_h$, to $1-p$ times the value lost from liquidating the (profitable) marginal firm when $s_1 = s_l$. Second, the analysis also implies that there is refinancing activity by firms in recessions but not in good times. Specifically, in recessions, some positive NPV firms have insufficient funds to satisfy their debt obligations, d^*, but their future prospects allow them to borrow the necessary funds to pay d^*. In contrast, in good times, no additional borrowing occurs, since positive NPV firms have sufficient funds to repay d^* and negative NPV firms lack the ability to raise funds. The following proposition summarizes the previous observations:

Proposition 2 *The optimal debt policy implies that: (i) in recessions, i.e., $s_1 = s_l$, the marginal firm that is liquidated has a positive NPV, and several inframarginal firms refinance their debt obligations by borrowing additional funds; (ii) in good times, i.e., $s_1 = s_h$, the marginal firm liquidated has a negative NPV and no refinancing or additional borrowing occurs.*

The result that debt choices lead to excessive liquidation in recessions and insufficient liquidations in booms depends on the assumed relationship between the aggregate shocks in periods 1 and 2. According to (3) aggregate cash flows can either be uncorrelated when $\rho = 0$ or mean reverting when $0 < \rho \leq 1$, which implies that established firms have excessive cash flows relative to investment opportunities when $s_1 = s_h$ and insufficient cash flows relative to investment opportunities when $s_1 = s_l$.[13] It should also be noted that we are assuming that aggregate shocks affect the productivity of old and new firms equally. However, in unreported analysis we consider the case where technical progress –a positive aggregate shock– benefits new firms more than old firms. When this is the case, the tendency to get excessive liquidations in recessions and too few in booms is strengthened.[14]

We conclude this section by discussing how the two main elements of the model, namely the managerial agency conflict and labor market search frictions, interact to affect the liquidation decision of firms. In the absence of agency conflicts, search frictions reduce firms' incentives to liquidate in both recessions and good economic times (*i.e.*, $U(s_1)$ decreases with λ). Adding managerial agency problems does not affect the unconditional

[13]Notice that (17) implies that $sgn[\varepsilon_d^{*h} + E(s_2|s_h) - U^*(s_h)] = -sgn[\varepsilon_d^{*l} + E(s_2|s_l) - U^*(s_l)]$, and thus that (13) evaluated at (18) implies that $\varepsilon_d^{*h} + E(s_2|s_h) - U^*(s_h) > 0 > \varepsilon_d^{*l} + E(s_2|s_l) - U^*(s_l)$, if and only if: $s_h - E(s_2|s_h) + U^*(s_h) > s_l - E(s_2|s_l) + U^*(s_l)$. Since $U^*(s_h) > U^*(s_l)$, a sufficient condition for this relation to hold is that $s_h - E(s_2|s_h) > s_l - E(s_2|s_l)$, which is satisfied if $s_2 = \rho s_1 + (1-\rho)\widetilde{s} + K$ for any K.

[14]In models of embodied technological progress the productivity of firms created at time t depends on the state of technology at t and is unaffected by subsequent technological progress. See Solow (1960) for the original formulation and Aghion and Howitt (1994), Caballero and Hammour (1996), and Mortensen and Pissarides (1998) for more recent examples.

(*i.e.*, before s_1 is realized) probability of liquidation but changes the conditional one (*i.e.*, after s_1 is realized). In particular, because of the agency conflict there is a higher probability of liquidation during recessions when the labor market conditions are worse, and a lower probability of liquidation in good economic times when the labor market conditions are better, *i.e.*, $\theta^*(s_l) < \theta^*(s_h)$ and $U^*(s_l) < U^*(s_h)$. As a result, the use of debt by firms to address agency conflicts results in unemployment that is too high in recessions and too low in booms.[15]

4 Policy implications

The previous analysis considers the effect of debt on the creation and destruction of firms, and the resulting effect on the number of workers that are unemployed. Within this setting, we analyze two sets of questions that relate to policy implications. First, we examine *ex-ante* policy interventions that directly affect the amount of debt chosen by firms at $t = 1$. Second, we examine *ex-post* policy interventions that change the real value of firms' debt obligations in the interim period, after s_1 is realized.

In what follows, to evaluate the effect of policy interventions, we consider a social welfare function that includes the sum of firm profits and wages, but excludes the private benefits of managerial control.[16] It is worth noting that the policy that maximizes this social welfare function does not minimize unemployment. Since what matters is the sum of firm profits and wages, from the social point of view it may be more desirable to have fewer but more efficient firms even if this implies a higher level of unemployment.[17]

4.1 Ex-ante policy interventions: Corporate tax policy

We first consider whether social welfare can increase by changing incentives for the use of debt at $t = 1$, for instance, through corporate tax policy. We abstract from the potential

[15] As discussed above the labor market conditions are pinned down by the zero profit condition (and hence, they are independent of firms' debt choices and liquidation decisions). As we will see in Section 5, this is not the case when entry is not perfectly elastic, *i.e.*, $\phi > 0$.

[16] See Hart (1995) pp. 126-130 for an insightful discussion of the conditions in which ignoring managerial private benefits for the analysis of capital structure can be justified.

[17] Considering an alternative social welfare function that includes managerial private benefits and/or an additional exogenous social cost of unemployment would just reduce the socially desirable level of debt but does not fundamentally affect the main implications of the policy analysis.

implementation costs associated with this policy and focus exclusively on how incentives to use more or less debt financing affects total production. We start by stating the following result.

Proposition 3 *When entrants have identical entry costs, i.e., when $\phi = 0$, investors choose the socially optimal amount of debt to fund their firms at $t = 1$.*

Proposition 3 indicates that there is no need for *ex-ante* public interventions or, in other words, that any incentive or subsidies that distorts the use of debt financing by firms would reduce social welfare. This finding may appear somewhat surprising since, as already established in the search literature, privately optimal entry and liquidation decisions create externalities in the presence of search frictions which result in a labor market tightness that is in general either too high or too low from a social point of view.[18] However, in the case of identical entry costs, *i.e.*, $\phi = 0$, any public incentive that affects debt choice (and hence firm liquidation) is fully offset by changes in firm entry and does not affect labor market tightness θ_1^*. Put differently, while θ_1^* may be socially suboptimal, firms' leverage choices do not affect it and thus any policy that influences those choices is ineffective to affect labor market tightness. Moreover, since tax incentives on debt distort privately optimal firms' liquidation policies without affecting labor markets, such fiscal incentives reduce welfare relative to the case in which no incentives are provided. In summary, when $\phi = 0$ the (*ex-ante*) social and private choices of leverage coincide.

4.2 Ex-post policy interventions: Monetary policy

We now consider the possibility of "monetary" interventions that affect the real value of debt obligations after period 1. We abstract from institutional details of implementation and simply consider the social welfare implications of changes in the real value of the firms' debt obligations after s_1 is realized (but before the liquidation decisions are made).

We model monetary policy as a technology that modifies the real debt obligations

[18] As will be explained in detail in Section 5, a firm's liquidation creates a negative externality for unemployed workers and a positive externality for firms with vacancies.

from d to $d - \tau$ at the expense of a social cost $c(\tau)$:

$$c(\tau) = \begin{cases} \tau^2 & \text{if } \tau \geq 0 \\ \psi\tau^2 & \text{if } \tau < 0 \end{cases} \tag{21}$$

where $0 < \psi < 1$. We refer to the monetary policy as inflationary when $\tau > 0$ and as deflationary when $\tau < 0$. The parameter ψ characterizes the relative cost of inflationary and deflationary policies. In particular, our assumption that $0 < \psi < 1$ implies that the cost of an inflationary policy is smaller than the cost of an equivalent deflationary policy. This assumption is consistent with the observation that, generally, countries exhibit a moderate degree of inflation.

To gain intuition we analyze first the case where firms do not anticipate monetary interventions. Specifically, we examine the socially optimal monetary policy as a function of the realization of the aggregate shock s_1, *i.e.*, $\tau_1 \equiv \tau(s_1)$, taking as given the equilibrium debt choice d^*. Formally, for each $s_1 \in \{s_h, s_l\}$, the policymaker faces the following problem:

$$\max_{\tau} \int_{\varepsilon(\tau,s_1)}^{\overline{\varepsilon}} \frac{\varepsilon_i + E(s_2|s_1) - U^*(s_1)}{2\overline{\varepsilon}} d\varepsilon_i + U^*(s_1) - c(\tau_1) \tag{22}$$

$$\text{s.t.} \quad \varepsilon(\tau, s_1) = \frac{1}{2}[d^* - \tau_1 - s_1 - E(s_2|s_1) + U^*(s_1)], \tag{23}$$

whose solution is characterized by the next proposition.

Proposition 4 *When monetary policy is not anticipated, it is optimal to follow an inflationary monetary policy during recessions, i.e.,* $\tau_l < 0$, *and a restrictive policy during booms, i.e.,* $\tau_h > 0$.

As shown in Proposition 2, during economic booms there is less liquidation than would be socially desirable (due to the managerial desire for continuation which makes some negative NPV firms continue their operations) and during recessions there is more firm liquidation than would be socially optimal (due to debt overhang which forces managers to liquidate positive NPV firms). Thus, a policy that increases the real value of debt during booms and decreases it during recessions helps to make liquidation choices closer to the social optimum.

We now consider the case where firms anticipate an active monetary policy, and adjust their debt choices at $t = 1$ accordingly. Proposition 5 characterizes the optimal policy and how an anticipated monetary policy affects the firms' choice of debt at $t = 1$.

Proposition 5 *When monetary interventions are anticipated, the optimal policy* $\tau_1^* = \{\tau_l^*, \tau_h^*\}$*: (i) is inflationary during recessions and deflationary during booms, i.e.,* $\tau_l^* > 0 > \tau_h^*$*, (ii) has an inflationary bias i.e.,* $E(\tau_1^*) > 0$*; and (iii) is time consistent. Moreover, the optimal policy* τ_1^* *induces firms to choose the ex-ante socially optimal amount of debt* $d_{\tau^*}^*$ *which is higher than* d^**.*

From the previous proposition a number of observations arise.[19] First, as in the case in which monetary policy is unanticipated, τ_1^* is chosen to reduce liquidation induced by excessive debt in recessions, *i.e.*, $s_1 = s_l$, and promote additional liquidations due to insufficient debt in booms, *i.e.*, $s_1 = s_h$. Second, firms anticipating an active monetary policy adjust their debt choices at $t = 1$ in a socially optimal manner. To be more specific, whether firms end up increasing or decreasing their debt obligations depends on whether the government has an inflationary or deflationary bias in its monetary policy, which, in turn, depends on the relative cost of inflation and deflation. In our case, since $0 < \psi < 1$ for $\tau > 0$, firms increase their debt obligation to $d_{\tau^*}^* \geq d^*$ in anticipation of a policy that is biased toward inflation.

Proposition 5 also states that the optimal monetary policy is time consistent, *i.e.*, the government can carry out such a policy without committing to it in advance. Intuitively, the optimal policy is time consistent since, in this setting, liquidation decisions that maximize firm values also maximize social welfare. Roughly speaking, this implies that policymakers have no incentive to mislead firms when they announce their policy objectives, implying that policymakers' ability to commit is not necessary to implement the optimal policy. As we show in the analysis of Section 5, this is not the case when entrants can be heterogeneous.

[19] See the proof of Proposition 5 for a full characterization of the optimal policy τ_1^*, and firms' debt choices $d_{\tau^*}^*$.

We conclude this section by briefly discussing the assumption that debt cannot be made contingent on s_1, which provides the motive for having an active monetary policy. In general, as long as the shocks are not verifiable, there is a role for *ex-post* government intervention.[20] Indeed, notice that the optimal monetary policy would depend on the leverage of all firms in the economy rather than on the leverage of a single firm. Hence, if firms do not issue state contingent debt, then the government has the incentive to follow an active monetary policy which, in turn, discourages each firm from issuing state contingent debt. Therefore, any small cost of issuing state contingent securities (*e.g.*, if the government has a better technology to assess shocks and firms make mistakes in hedging) would lead toward an equilibrium in which firms do not issue state contingent debt and government follows an active monetary policy.

5 The general case

5.1 Debt choices with heterogeneous entrants

We now consider the case in which entrants differ in their entry costs, *i.e.*, $\phi > 0$. As in the case of identical entrants, *i.e.*, $\phi = 0$, solving the model requires us to characterize: (i) in period 1, the firms' debt choices $\{d_i\}$, which in equilibrium will be identical for all firms $d_i = d$; and (ii) in the interim period, for each $s_1 = \{s_l, s_h\}$, the labor market conditions, $\theta(s_1)$ and $U(s_1)$, and the firm creation and liquidation choices, $v(s_1)$ and $l(s_1)$. In particular, the equilibrium is characterized by the following conditions:

1. Firms enter the market until the *marginal* entrant is indifferent between incurring its entry cost and staying out. Hence, if there are $v(s_1)$ entrants, the zero profit condition for the marginal entrant implies that

$$k + \phi v(s_1) = \frac{q(\theta_1)}{\theta_1} \left[(1-\beta) E(r_2|s_1) - \gamma \right]. \tag{24}$$

2. Workers' outside option $U(s_1)$ is the probability of finding a job, *i.e.*, $\lambda\theta_1^{1-\alpha}$ times

[20] See Bolton and Rosenthal (2002) for a framework with a related policy analysis. In their setting, as in ours, *ex-post* policy interventions can be helpful since they contribute to complete debt contracts which otherwise cannot be made contingent on macroeconomic shocks.

the wage a worker receives when he finds one, *i.e.*, $(\gamma + \beta E(s_2|s_1)$, (as in eq. 10):

$$U(s_1) = \lambda\theta_1^{1-\alpha}(\gamma + \beta E(s_2|s_1)) \tag{25}$$

where $\theta_1 = \frac{v(s_1)}{l(s_1)}$.

3. Firm liquidation $l(s_1)$ depends on $U(s_1)$ and the debt chosen d in $t = 1$ (as in eq. 20):

$$l(s_1) = \frac{1}{2} + \frac{d - s_1 - E(s_2|s_1) + U(s_1)}{4\bar{\varepsilon}}. \tag{26}$$

4. In period 1, each firm's debt choice d depends on $U(s_1)$ (as in eq. 19):

$$d = E[U(s_1)]. \tag{27}$$

While (25), (26), and (27) describe the equilibrium conditions for $U(s_1)$, $l(s_1)$ and d in both cases (*i.e.*, with homogenous and heterogenous entrants) there is an important difference between the two cases. With homogenous entry the model is recursive (*i.e.*, $\theta(s_1)$ and $U(s_1)$ affect but are not affected by $v(s_1)$, $l(s_1)$ and d) whereas with heterogeneous entrants the model is not recursive (*i.e.*, all endogenous variables have effects on each other). Specifically, in the case of heterogenous entry, the zero profit condition (24) does not pin down $\theta(s_1)$ and instead equations, (24), (25), and (26) for $s_1 \in \{s_l, s_h\}$, and (27), must be solved simultaneously.[21] Thus, unlike contrast to the identical entrants case, with heterogenous entrants, debt choices influence labor market conditions, $\theta(s_1)$ and $U(s_1)$, and produce social welfare distortions. Therefore, with heterogeneous entrants, policies that influence firms' debt choices at $t = 1$ affect not only firm liquidation and unemployment but also social welfare. We discuss these policies next.

5.2 Policy implications

As in Section 4, we consider policy choices that either influence the firms' capital structures choices, *i.e.*, *ex-ante* interventions, or alternatively, affect the real value of debt

[21] As stated in Lemma 1 with identical entrants the free-entry condition, $V(s_1) = 0$, pinpoints $\theta(s_1)$.

obligation, *i.e.*, *ex-post* interventions. To examine the policy implications we begin by defining

$$\tilde{\beta}(s_1) \equiv \frac{w_2(s_1)}{E\left(s_2|s_1\right)} = \beta + \frac{\gamma}{E\left(s_2|s_1\right)}, \tag{28}$$

i.e., the worker's share of the surplus when the worker matches with a newly created firm. Notice that $\tilde{\beta}(s_1)$ depends on the aggregate shock s_1 (i.e., $\tilde{\beta}(s_l) < \tilde{\beta}(s_h)$) which is a fact that plays an important role in the policy analysis below.

5.2.1 The case without aggregate uncertainty

To gain intuition we start by considering the case without aggregate uncertainty, *i.e.*, $s_l = s_h = \bar{s}$, (and hence, $s_1 = s_2 = \bar{s}$). Without aggregate uncertainty, the analysis is simpler because: (i) firms (which are still exposed to idiosyncratic shocks) can perfectly foresee macroeconomic conditions including the conditions in the labor market and (ii) the worker's share of the matching surplus (which is obtained by setting $E\left(s_2|s_1\right) = \bar{s}$ in (28)) is a fixed amount $\bar{\beta} \equiv \beta + \gamma/\bar{s}$. Under these conditions, the following result holds:

Proposition 6 *Without aggregate uncertainty i.e., $s_l = s_h = \bar{s}$, there exists a debt choice $\bar{d}^*$ that implements the firms' privately optimal liquidation policy.*

To see why Proposition 6 holds notice that from (19) it follows that without aggregate uncertainty

$$\bar{d}^* = U^*(\bar{s}). \tag{29}$$

Intuitively, investors would set $\bar{d}^*$ to remove any funds in excess of those needed to undertake positive NPV investments at $t = 1$. Specifically, notice that a firm with an idiosyncratic shock ε' such that $\varepsilon' + E(s_2) = U^*(\bar{s})$ has a zero continuation value, *i.e.*, the cash flow from continuing operations equals the firm's labor costs. In contrast, the manager of firm i continues operations whenever firm i's idiosyncratic shock ε_i is such that $\varepsilon_i + E(s_2) \geq U^*(\bar{s}) - [\bar{s}_1 + \varepsilon_i - d_i]$, that is, whenever the cash flow from continuing operations is sufficient to cover labor costs net of the firm's first period cash flows, *i.e.*, $[\bar{s}_1+\varepsilon_i-d_i]$. Thus by setting $d_i = \bar{d}^* = \bar{s}_1-\varepsilon_i'$ investors allow firms with $\varepsilon_i > \varepsilon'$ to continue operations while forcing firms with $\varepsilon_i < \varepsilon'$ to liquidate. As stated in Proposition 6 this implies that firms' liquidation decisions are privately optimal (*i.e.*, there is no privately inefficient liquidation or continuation in the interim period).

The public policy question that remains is whether a firm's privately optimal debt choices $\bar{d}^*$ corresponds to the socially optimal firm debt choice $\bar{d}^*_W$, namely the firm's debt choice that maximizes social welfare. Proposition 7 shows that this is not generally the case:

Proposition 7 *With heterogeneous entrants, $\phi > 0$, and no aggregate uncertainty at $t = 1$, i.e., $s_l = s_h = \bar{s}$, private debt choices are generally socially suboptimal. Specifically, $\bar{d}^* < \bar{d}^*_W$ (resp. $\bar{d}^* > \bar{d}^*_W$) whenever $\bar{\beta} < \alpha$ (resp. $\bar{\beta} > \alpha$). Private debt choices are socially optimal, i.e., $\bar{d}^* = \bar{d}^*_W$, only when $\bar{\beta} = \alpha$.*

Proposition 7 states a central result of the analysis: with heterogenous entry private and social debt choices generally differ. Intuitively this occurs because with heterogenous entrants firm liquidations are not fully offset by firm entry and thus debt choices of established firms, which affect their liquidation decisions, have an effect on labor market tightness.

Proposition 7 can be directly related to several results in the search literature that consider whether firm liquidation and exit affects social welfare by creating externalities on either unemployed workers or on entrants. In particular, in a market with search frictions, a firm's exit imposes a negative externality on job-seekers (*i.e.*, a "thick market externality") and a positive externality on other potential employers (*i.e.*, a "congestion externality"). Hence, in a setting like ours, in which debt choices determine firms' exits, the optimal trade-off between these two externalities is directly connected to debt choices. Notice that when $\bar{\beta} = \alpha$, these two externalities offset each other, and hence, private debt choices become socially optimal. (This is the familiar Hosios condition.) Intuitively, in equilibrium, firms enter until the marginal benefits of entry, which depend on their share of the profits, equals their entry cost. Hence, if the firm's share $(1-\bar{\beta})$ is too low, entering firms get too little of the surplus and, as a result, too few firms tend to enter. Conversely, if $(1 - \bar{\beta})$ is too high, entering firms get too much of the surplus, which leads to excessive entry. Hosios (1990) shows that the socially optimal value of $(1-\bar{\beta})$ equals the elasticity of the matching function with respect to number of vacancies $(1-\alpha)$.[22]

a) Ex-ante interventions: Corporate tax policy

Having established the conditions that relate private and social debt choices, we now discuss the *ex-ante* tax policy interventions that can affect firms' capital structure choices. An immediate corollary from Proposition 7 is the following:

Corollary 1 *Under the conditions of Proposition 7 the socially optimal corporate tax policy should promote (discourage) debt financing whenever $\bar{\beta} < \alpha$ (resp. $\bar{\beta} > \alpha$).*

Intuitively, given the conditions stated in Proposition 7, the policymaker would set a liquidation level and thus vacancies such that the marginal benefit in terms of additional matches to new firms equals the costs imposed on the unemployed workers.[23] Specifically, the thick market and congestion externalities exactly offset each other only when the Hosios condition is satisfied, that is, when the worker's share of the surplus $\bar{\beta}$ is equal to the elasticity of the matching function with respect to unemployment α.[24]

Given the relation between the workers' share of the surplus, $\bar{\beta}$, and aggregate productivity Corollary 2 can be stated:

Corollary 2 *Under the conditions of Proposition 7, an increase in future productivity $E(s_2|\bar{s})$ increases the socially optimal amount of debt, $\bar{d}_W^*$.*

An increase in the expected aggregate productivity $E(s_2|\bar{s}) = \bar{s}$, decreases $\bar{\beta}$, and tends to make the labor market too tight from the social point of view. This occurs because, when there are real wage rigidities, increases in $\bar{s}$ do not translate into a proportional wage increase $w_2(\bar{s})$. Thus real wage rigidities tend to make the labor market

[22] See chapter 8 in Pissarides (2000) and pp. 101-104 in Caballero (2007) for a discussion of the Hosios condition and of efficiency in search models.

[23] We abstract from implementation issues and simply assume that the policy maker can "force" firms to change their debt choices with revenue neutral tax policies. In practice the policy instruments usually employed to affect the firms' debt choices (e.g., debt subsidies or taxes) have an effect on the government's tax revenues. However, by offseting these revenues with a corresponding lump-sum tax or subsidy to any firm affected by these policies the revenue neutrality of these interventions would be restored.

[24] It is also worth noting that the Hosios condition does not depend on the number of entrants, $v(\bar{s})$, and thus on the entry cost. That is $v(\bar{s})$ affects both the market tightness in equilibrium and the socially optimal market tightness but not whether one is smaller or larger than the other.

too tight during periods of expected economic prosperity (that is, there are too many firms looking for workers relative to the number of unemployed workers) and too loose during periods of lousy economic prospects (that is, too many unemployed workers looking for jobs relative to the number of job vacancies). As stated in Corollary 2, when good economic times are expected at $t = 2$, *i.e.,* when $\bar{s}$ is high, the positive externalities that liquidation creates on new firms looking for workers are greater than the negative externalities that liquidation has on other unemployed workers and therefore debt should be promoted at $t = 1$. When bad economic times are expected, however, firms can easily find workers, and hence, additional liquidations do not help these firms much while it hurts the unemployed workers who already a small probability of finding a job. Thus when $\bar{s}$ is low, public policy should discourage the use of debt in firms' capital structures at $t = 1$.

b) Ex-post policy interventions

We now discuss the effects of *ex-post* interventions throughout an active (and anticipated) monetary policy. We start by describing the results when monetary policy is the only policy tool (*i.e.*, when an active corporate tax policy at $t = 1$ is not available) and later consider the optimal mix of monetary and tax policy.

Proposition 8 *With no aggregate uncertainty at $t = 1$, i.e., $s_l = s_h = \bar{s}$, and heterogenous entrants $\phi > 0$, anticipated monetary interventions τ_1^* generate costly inflation when $\bar{\beta} > \alpha$ and costly deflation when $\bar{\beta} < \alpha$, and lead to worse outcomes relative to the case in which policymakers commit not to intervene.*

With heterogenous entry costs policymakers face the problem of time inconsistency in monetary policy interventions (as described by Kydland and Prescott, 1977). This time inconsistency problem arises from the differences in the social and private benefits of liquidation. If policymakers prefer that firms have lower (*higher*) debt obligations they will choose to inflate (*deflate*) *ex-post.* However, this gives firms an incentive to choose a higher (*lower*) debt obligation *ex-ante.* In the absence of aggregate uncertainty, these choices lead to high (*low*) nominal debt obligations and high inflation (*deflation*) which make policy interventions both socially costly and ineffective.

From the previous discussion two main conclusions follow. First, when monetary interventions have a social cost, the government would like to commit to not use monetary interventions to offset capital structure choices. Second, when both corporate tax policy and monetary interventions are available, the optimal policy will rely exclusively on tax policy interventions. This conclusion, which depends on the assumption that tax policy interventions have no social cost, would need to be qualified if social costs of taxes are considered. With social tax policy costs then the optimal policy mix would consider tax policy and monetary interventions. In this case, monetary interventions, which would still be time inconsistent, would lead to additional social costs by inducing costly monetary adjustments and by interfering with the optimal provision of tax incentives to corporate debt.

5.2.2 The general case with aggregate uncertainty

We now consider the general case with both aggregate uncertainty and heterogenous entry.[25] As shown below, there are additional externalities in this case that can arise when liquidation choices affect the tightness of the labor market $\theta(s_1)$, and consequently the wage that firms need to pay to retain their workers, $U(s_1)$.

To facilitate the presentation, we first consider the social efficiency of firms' liquidation decisions in the absence of managerial agency problems. In this case, liquidation decisions are *ex-post* privately efficient, that is, firm i continues at the end of period 1 if and only if $\varepsilon_i + E(s_2|s_1) \geq U(s_1)$. However, as in Section 5.2.1, the social optimality of the liquidation decisions is determined by the Hosios conditions.[26] That is, if $\tilde{\beta}(s_1) > \alpha$, there is too little liquidation and, alternatively, if $\tilde{\beta}(s_1) < \alpha$, there is too much liquidation from the social point of view. Note also that in the presence of real wage rigidities, i.e., when $\gamma > 0$, whether private incentives lead firms to have too many or too few liquidations can depend on the state of the economy. Specifically, since $\tilde{\beta}(s_1)$ decreases with $E(s_2|s_1)$, there is a tendency to have too few liquidations during booms and too many liquidations

[25] Equations, (24), (25), and (26) for $s_1 \in \{s_l, s_h\}$, and (27) make up the seven equation system that solve for the seven endogenous variables $\{U(s_h), U(s_l), v_h, v_l, l_h, l_l, d\}$.

[26] Note that the case without managerial agency problems is similar to the one without aggregate uncertainty of Section 5.2.1. Indeed, in the absence of aggregate uncertainty, investors choose *ex-ante* an amount of debt that makes liquidation decisions *ex-post* privately efficient.

during recessions.[27]

Consider now the case in which managers have private incentives to never liquidate and only do so in the event of bankruptcy. As discussed above, the privately optimal choice of debt is given by equation (19) and trades-off the (privately) excessive liquidation during recessions against the excessive continuation during booms. While this trade-off is the same as the one in Section 3 (*i.e.*, the case with identical potential entrants) now the debt choice imposes externalities that can cause the *ex-ante* privately optimal choice to deviate from the social optimum. In particular, in addition to the earlier described search externalities that liquidation imposes on unemployed workers and new entrants, there is a pecuniary externality that is generated because liquidation choices affect wages, $U(s_1)$.

This pecuniary externality arises since firms ignore the effect of their debt choices at $t = 1$ on market tightness $\theta(s_1)$ and on the retention wage $U(s_1)$. The effect of debt on $U(s_1)$ is relevant since firms are more likely to liquidate at the end of period 1 if wages are higher. This general equilibrium effect was absent in the homogenous entry case described in Section 3, because in that case firms' liquidation decisions do not affect market tightness $\theta(s_1)$, which is pinned down by the free-entry condition. The effect is also absent in the case without aggregate uncertainty of Section 5.2.1 because investors' choice of debt made liquidation decisions *ex-post* privately efficient (see Proposition 6). In fact, the pecuniary externality happens because the liquidation decisions in period 1 are not *ex-post* privately efficient but rather determined by the constraint that debt imposes on managers, which is needed to mitigate their reluctance to liquidate. We formally state this result in the following proposition:

Proposition 9 *With heterogeneous entrants $\phi > 0$ and aggregate uncertainty at $t = 1$, private debt choices are generally socially suboptimal even when $\tilde{\beta}(s_1) = \alpha$.*

The previous discussion identifies the two reasons why, in general, firms will not choose the socially optimal amount of debt in the general case: search and pecuniary externalities. Similar to the search effect, the pecuniary externality can lead to private

[27] This effect is distinct from the effect illustrated in Section 3 that was related to the presence of a free-cash flow problem during booms and a debt overhang problem during recessions.

choices that generate too much or too little debt relative to the social optimum. Intuitively, the pecuniary externality tends to ameliorate the effect of too much debt in recessions and too little debt during booms, and thus tends to reduce the need for an active monetary policy. This tendency can be illustrated in the special case in which the Hosios condition is satisfied. In that case an increase in the amount of debt will tend to decrease the market tightness $\theta(s_1)$ and hence $U(s_1)$, which in turn allows managers to continue operations more often. This feedback effect is helpful during recessions (since firms suffer from a debt overhang problem) but harmful during booms (since firms suffer from a free cash flow problem). Whether firms choose too much or too little debt from a social point of view depends on which of these two forces dominate.

From an *ex-post* point of view, there are now two reasons to increase (*reduce*) the value of debt during good economic times, that is to resolve the free cash flow (*debt overhang*) problem and to increase (*decrease*) the tightness of the labor market. Finally, it should be noted that the analysis suggests complementary roles for tax and monetary policies. Specifically, policymakers can use taxes and subsidies to induce firms to choose the socially optimal debt ratio *ex-ante*, and then use monetary policy to accommodate the realization of the aggregate shock in the interim period.

6 Concluding remarks

Since the seminal work of Modigliani and Miller (1958), economists have examined the costs and benefits of financial leverage from the perspective of firms seeking financing. In this paper, we extend this analysis and examine how corporate financing choices influence the aggregate economy. In particular, we consider a setting where financial leverage can increase the probability of a firm liquidating following economic shocks, and within this setting we consider potential externalities. For example, corporate liquidations can have negative externalities during economic recessions, if they contribute to excess slack in the labor markets. In contrast, liquidations may have positive externalities during economic booms, if they facilitate the emergence of more productive startup companies.

The framework we develop provides intuition about the economic effects of policies that influence the magnitude of firm debt obligations. In particular, we consider monetary policy, which affects the real value of existing debt obligations, and show that in some situations an active policy that decreases debt obligations during economy-wide downturns can improve ex ante firm values. In addition, we identify conditions under which welfare can be improved with subsidies or taxes that alter the firms' use of debt financing.

With the intention of keeping the model tractable we have made a number of assumptions that should be relaxed in future research. In particular, we assume that firms are all identical in two important respects. The first is that the cash flows of firms are equally sensitive to the aggregate shock. The second is that there is just one type of labor, so we effectively ignore the possibility that workers can offer their services in segmented labor markets with different characteristics. When these assumptions are relaxed it is clear that there will be cross-industry differences in the tightness of their labor markets, implying that the tax policies and monetary policies that optimize labor markets for one industry are not necessarily optimal for other industries.

There are a number of policy choices that may be particularly relevant in a setting with heterogeneous industries that can be evaluated by extending our existing framework. For example, the U.S. government provides subsidized debt for emerging industries that may create positive externalities, like renewable energy, as well as for failing industries, like automobiles, that might otherwise create negative spillovers. Since a primary motivation for these initiatives is to create and save jobs, a model, such as ours, that explicitly considers the effect of financing on the labor market is likely to be relevant.

There are a number of important aspects of our analysis that merit further attention. In addition to considering the study of a richer set of policy tools, future research should also extend the scope of the model. While our current model focuses on how capital structure policies affect firm exit choices, an analysis of how these policies influence the creation of new firms is also warranted. For example, if mature firms are better able to benefit from the debt tax shield, such a policy will put incumbents at an advantage relative to new entrants. In contrast, in addition to fostering firm creation, providing subsidized debt to emerging new firms may also contribute to their future failures.

The combination of the interactions between incumbent firms and new entrants, which is considered in our model, with the dual effects of capital structure policy on entry as well as exit, which is not considered in our model, suggests that future research should extend the limited dynamics incorporated in our model. In addition to taking into account the influence of capital structure policy on entry as well as exit, a more dynamic (and more complicated) setting can potentially help us think more carefully about how financial policies contribute to business cycles and economic growth. These are challenging issues that we will leave to future work.

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APPENDIX

Proof of Lemma 1

Note that $E(r_2|s_1) = E(s_2|s_1)$ and hence, the free-entry condition, *i.e.*, $V(s_1) = 0$, implies that

$$\theta_1^* = \left(\frac{\lambda[(1-\beta)E(s_2|s_1) - \gamma]}{k} \right)^{1/\alpha} \tag{A.1}$$

and

$$U^*(s_1) = q(\theta_1^*)(\gamma + \beta E(s_2|s_1)) = \lambda (\theta_1^*)^{1-\alpha} (\gamma + \beta E(s_2|s_1)) \blacksquare \tag{A.2}$$

Proof of Proposition 1

From equation (19) the optimal amount of debt is:

$$d^* = E[U^*(s_1)]. \tag{A.3}$$

From equations (A.1) and (A.2) it follows that

$$\begin{aligned} \frac{\partial U^*(s_1)}{\partial \lambda} &> 0 \; ; \; \frac{\partial U^*(s_1)}{\partial k} < 0 \; ; \; \frac{\partial U^*(s_1)}{\partial \beta} \gtrless 0 \; ; \; \frac{\partial U^*(s_1)}{\partial \gamma} \gtrless 0 \\ \frac{\partial U^*(s_h)}{\partial s_h} &> 0 \; ; \; \frac{\partial U^*(s_l)}{\partial s_l} > 0 \; ; \; \frac{\partial E[U^*(s_1)]}{\partial p} > 0. \end{aligned}$$

and hence that

$$\begin{aligned} \frac{\partial d^*}{\partial \lambda} &> 0 \; ; \; \frac{\partial d^*}{\partial k} < 0 \; ; \; \frac{\partial d^*}{\partial \beta} \gtrless 0 \; ; \; \frac{\partial d^*}{\partial \gamma} \gtrless 0 \\ \frac{\partial d^*}{\partial s_h} &> 0 \; ; \; \frac{\partial d^*}{\partial s_l} > 0 \; ; \; \frac{\partial d^*}{\partial p} > 0 \blacksquare \end{aligned}$$

Proof of Proposition 2

Firm i should be liquidated when its expected cash flow in period 2, $E(r_{i2}|r_{i1}, s_1)$, is lower than the workers' outside option, $U^*(s_1)$. Let $H(\varepsilon_i, s_1)$ be the difference between $E(r_{i2}|r_{i1}, s_1)$ and $U^*(s_1)$:

$$H(\varepsilon_i, s_1) \equiv E(r_{i2}|r_{i1}, s_1) - U^*(s_1) = \varepsilon_i + E(s_2|s_1) - U^*(s_1). \tag{A.4}$$

From equation (13), the marginal firm liquidated is

$$\varepsilon_d^{*1} = \frac{1}{2}[d^* - s_1 - E(s_2|s_1) + U^*(s_1)], \tag{A.5}$$

which implies that:

$$H(\varepsilon_d^{*1}, s_1) = \frac{1}{2}[d^* - s_1 + E(s_2|s_1) - U^*(s_1)]. \tag{A.6}$$

There is too much liquidation in recessions if the marginal firm liquidated in a recession is positive NPV (that is, if $H(\varepsilon_d^{*l}, s_1) > 0$). Symmetrically, there is too little liquidation during booms if the marginal firm liquidated during a boom is negative NPV (that is, if $H(\varepsilon_d^{*h}, s_1) < 0$). From equation (16), the optimal amount of debt satisfies the following f.o.c.:

$$pH(\varepsilon_d^{*h}, s_1) + (1-p)\, H(\varepsilon_d^{*l}, s_1) = 0 \tag{A.7}$$

which implies that $H(\varepsilon_d^{*l}, s_1) > 0$ and $H(\varepsilon_d^{*h}, s_1) < 0$ if and only if $H(\varepsilon_d^{*h}, s_1) < H(\varepsilon_d^{*l}, s_1)$, that is, if and only if

$$s_h - E(s_2|s_h) + U^*(s_h) > s_l - E(s_2|s_l) + U^*(s_l). \tag{A.8}$$

Since $U^*(s_h) > U^*(s_l)$, and since $s_h - E(s_2|s_h) \geq s_l - E(s_2|s_l)$, it follows that $H(\varepsilon_d^{*l}, s_1) > 0$ and $H(\varepsilon_d^{*h}, s_1) < 0$■

Proof of Proposition 3

The social planner solves the following optimization problem:

$$\max_d E[\int_{\varepsilon_d^1}^{\overline{\varepsilon}} \frac{\varepsilon_i + E(s_2|s_1) - U^*(s_1)}{2\overline{\varepsilon}} d\varepsilon_i] + E\left[U^*(s_1)\right] \tag{A.9}$$

s.t.

$$\varepsilon_d^1 = \frac{1}{2}[d - s_1 - E(s_2|s_1) + U^*(s_1)] \quad \text{for } s_1 \in \{s_l, s_h\}. \tag{A.10}$$

From Lemma 1, the tightness of the labor market θ_1^* and the reservation utility $U^*(s_1)$ are pinned down by the free-entry condition and hence do not depend on firms' liquidation decisions or the amount of debt. (Intuitively, since there is an unlimited number of identical potential entrants, changes in liquidation decisions are fully offset by a corresponding change in firm entry until the equilibrium values of θ_1^* and $U^*(s_1)$ are achieved.)

Since $U^*(s_1)$ does not depend on d neither does $E[U^*(s_1)]$ and the solution to the above program is

$$d^* = E\left[U^*(s_1)\right], \tag{A.11}$$

which coincides with the solution to the firm's optimization problem, *i.e.*, equation (19)■

Proof of Proposition 4.

The social planner solves the program in equations (22) and (23), that is, for each $s_1 \in \{s_l, s_h\}$ it solves:

$$\max_{\tau} \int_{\varepsilon(\tau,s_1)}^{\overline{\varepsilon}} \frac{H(\varepsilon_i, s_1)}{2\overline{\varepsilon}} d\varepsilon_i + U^*(s_1) - c(\tau_1) \tag{A.12}$$

$$\text{s.t.:} \quad \varepsilon(\tau, s_1) = \frac{1}{2}[d^* - \tau - s_1 - E(s_2|s_1) + U^*(s_1)] \tag{A.13}$$

where, $H(\varepsilon_i, s_1)$ is defined as in equation (A.4), *i.e.*,

$$H(\varepsilon_i, s_1) \equiv \varepsilon_i + E(s_2|s_1) - U^*(s_1).$$

This convex problem yields the following f.o.c.:

$$\frac{1}{4\overline{\varepsilon}} H(\varepsilon(\tau_1, s_1), s_1) - c'(\tau_1) = 0. \tag{A.14}$$

Consider first the case in which $s_1 = s_h$. If $\tau_h = 0$, then $\varepsilon(0, s_h) = \varepsilon_d^{*h}$ (as defined in A.5), and from the proof of Proposition 2 above we know that $H(\varepsilon_d^{*h}, s_1) < 0$. In that case, since $c'(0) = 0$, the f.o.c. evaluated at $\tau_h = 0$ has a negative sign, and hence, there are incentives to decrease τ_h below 0 when $s_1 = s_h$.

Consider now the case in which $s_1 = s_l$. If $\tau_l = 0$, then $\varepsilon(0, s_l) = \varepsilon_d^{*l}$ (as defined in A.5), and from the proof of Proposition 2 we know that $H(\varepsilon_d^{*l}, s_1) > 0$. In that case, since $c'(0) = 0$, the f.o.c. evaluated at $\tau_l = 0$ has a positive sign, and hence, there are incentives to increase τ_l above 0 when $s_1 = s_l$■

Proof of Proposition 5

First we show that $d_\tau^* > d^* \Leftrightarrow E(\tau_1) > 0$:

At $t = 1$, before s_1 is realized, each firm i solves for its optimal debt choice under a conjectured monetary policy $\tau_1^c = \{\tau_l^c, \tau_h^c\}$:

$$\max_d E[\int_{\varepsilon(\tau_1^c)}^{\overline{\varepsilon}} \frac{\varepsilon_i + E(s_2|s_1) - U^*(s_1)}{2\overline{\varepsilon}} d\varepsilon_i] + E[U^*(s_1)] \tag{A.15}$$

$$\text{s.t.: } \varepsilon(\tau_1^c) = \frac{1}{2}[d - \tau_1^c - s_1 - E(s_2|s_1) + U^*(s_1)] \quad \text{for } s_1 \in \{s_l, s_h\}. \tag{A.16}$$

Since firms are infinitesimally small, each firm i chooses its debt firms taken τ_1^c as given (*i.e.*, τ_1^c depends on the debt choice of all firms but the debt choice of an individual firm does not affect τ_1^c). The f.o.c. from the previous convex problem characterizes firm's i optimal debt choice given conjecture $\tau_1^c = \{\tau_l^c, \tau_h^c\}$:

$$d_{\tau^c}^* = E(\tau_1^c) + E[U^*(s_1)]. \tag{A.17}$$

[Notice that that the debt choice is the same for all firms, i.e., $d_{\tau^c}^{i*} = d_{\tau^c}^*$, as firms are *ex-ante* identical and face the same optimization problem. Note also that in any rational expectations equilibrium all firms must have identical conjectures about monetary policy.]

Taken firms' debt choices as given $d_{\tau^c}^*$, the policy maker solves for the policy $\tau_1^* = \{\tau_l^*, \tau_h^*\}$ that maximizes welfare. Thus, in each state $s_1 \in \{s_l, s_h\}$, the policy maker solves:

$$\max_\tau \int_{\varepsilon(\tau, s_1)}^{\overline{\varepsilon}} \frac{\varepsilon_i + E(s_2|s_1) - U^*(s_1)}{2\overline{\varepsilon}} d\varepsilon_i + U^*(s_1) - c(\tau_1) \tag{A.18}$$

$$\text{s.t.: } \varepsilon(\tau, s_1) = \frac{1}{2}[d_{\tau^c}^* - \tau - s_1 - E(s_2|s_1) + U^*(s_1)] \tag{A.19}$$

which yields

$$\frac{d_{\tau^c}^* - \tau_1^* - s_1 + E(s_2|s_1) - U^*(s_1)}{4\overline{\varepsilon}} - c'(\tau_1^*) = 0. \tag{A.20}$$

In a rational expectations equilibrium $\tau_1^c = \tau_1^*$ and thus the equilibrium choices, $(\tau_1^*, d_{\tau^*}^*)$, are obtained by imposing $\tau_1^c = \tau_1^*$ and solving equations (A.17) and (A.20) simultaneously.

Comparing eq. (A.17) to eq. (19) from the main text, notice that $d_\tau^* = E(\tau_1) + d^*$ and hence, as stated in Proposition (5), $d_\tau^* > d^* \Leftrightarrow E(\tau_1^*) > 0$.

Next we show that $\tau_l^* > 0 > \tau_h^*$*:*

Equating eq. (A.20) for $s_1 = s_h$ to eq. (A.20) for $s_1 = s_l$, we obtain

$$\frac{\tau_h^* + s_h - E(s_2|s_h) + U^*(s_h)}{4\bar{\varepsilon}} + c'(\tau_h^*) = \frac{\tau_l^* + s_l - E(s_2|s_l) + U^*(s_l)}{4\bar{\varepsilon}} + c'(\tau_l^*), \tag{A.21}$$

and since $s_h - E(s_2|s_h) > s_l - E(s_2|s_l)$ and $U^*(s_h) > U^*(s_l)$ then it follows that

$$\frac{\tau_h^*}{4\bar{\varepsilon}} + c'(\tau_h^*) < \frac{\tau_l^*}{4\bar{\varepsilon}} + c'(\tau_l^*). \tag{A.22}$$

Taking expectations in eq. (A.20) and using eq. (A.17) we obtain

$$E[c'(\tau_1^*)] = pc'(\tau_h^*) + (1-p)c'(\tau_l^*) = 0. \tag{A.23}$$

Note that eq. (A.22) implies that $\tau_h^* = \tau_l^* = 0$ cannot be a solution (*i.e.*, $0 \not> 0$). Since $c'(\tau) > 0$ if $\tau > 0$ and $c'(\tau) < 0$ if $\tau < 0$, and since τ_h^* and τ_l^* cannot be both zero, eq. (A.23) implies that either $\tau_h^* > 0 > \tau_l^*$ or $\tau_l^* > 0 > \tau_h^*$. Finally, $\tau_h^* > 0 > \tau_l^*$ violates eq. (A.22), *i.e.*, if $\tau_h^* > 0 > \tau_l^*$ then

$$\frac{\tau_h^*}{4\bar{\varepsilon}} + c'(\tau_h^*) > \frac{\tau_l^*}{4\bar{\varepsilon}} + c'(\tau_l^*), \tag{A.24}$$

this implies that $\tau_l^* > 0 > \tau_h^*$.

Next we show that $E(\tau_1^*) > 0$ *iff* $\psi < 1$*:*

Since $\tau_l^* > 0 > \tau_h^*$, using the definition of $c(\tau)$ and eq. (A.23) we obtain:

$$p\tau_h^* + (1-p)\psi\tau_l^* = 0 \tag{A.25}$$

which can be rewritten as

$$E(\tau_1^*) = (1-p)(1-\psi)\tau_l^*. \tag{A.26}$$

Since $\tau_l^* > 0$ then $E(\tau_1^*) > 0$ iff $\psi < 1$.

Finally we show that private debt choices are ex-ante socially optimal and that monetary policy is time consistent:

The socially optimal debt choices and monetary policy are obtained by solving for $\{d, (\tau_h, \tau_l)\}$ in a simultaneous and coordinated manner:

$$\max_{\{d,\tau_1\}} E[\int_{\varepsilon(\tau,s_1)}^{\overline{\varepsilon}} \frac{\varepsilon_i + E(s_2|s_1) - U^*(s_1)}{2\overline{\varepsilon}} d\varepsilon_i] + E[U^*(s_1)] - E[c(\tau_1)]$$

$$\text{s.t.} \quad : \quad \varepsilon(\tau_1, s_1) = \frac{1}{2}[d - \tau_1 - s_1 - E(s_2|s_1) + U^*(s_1)] \quad \text{for } s_1 \in \{s_l, s_h\}. \tag{A.27}$$

The previous problem yields the following first order conditions:

$$d = E(\tau_1) + E[U^*(s_1)] \tag{A.28}$$

$$\frac{d - \tau_1 - s_1 + E(s_2|s_1) - U^*(s_1)}{4\overline{\varepsilon}} - c'(\tau_1) = 0 \quad \text{for } s_1 \in \{s_l, s_h\}. \tag{A.29}$$

Notice that conditions (A.28) and (A.29) are identical to the conditions that characterized the decentralized private optimum (*i.e.*, conditions A.17 and A.20) which implies that the choice of debt by firms is socially optimal and that monetary policy is time consistent.■

Proof of Proposition 6

Follows from main text after Proposition 6.■

Proof of Proposition 7

For a given $\overline{s}$(i.e., there is not aggregate uncertainty) the social planner solves the following problem

$$\max_{d} \int_{\varepsilon^1_{d_i}}^{\overline{\varepsilon}} \frac{\varepsilon_i + E(s_2|\overline{s}) - U(\overline{s})}{2\overline{\varepsilon}} d\varepsilon_i + U(\overline{s}) +$$

$$+ \underbrace{v(\overline{s})\frac{q(\theta_1)}{\theta_1}[(1-\beta)E(s_2|\overline{s}) - \gamma]}_{\text{(Total) Entrants cash flows}} - \underbrace{[kv(\overline{s}) + \phi\frac{v^2(\overline{s})}{2}]}_{\text{(Total) Entry costs}} \tag{A.30}$$

s.t.

$$\varepsilon^1_{d_i} = \frac{1}{2}[d - \overline{s} - E(s_2|\overline{s}) + U(\overline{s})] \tag{A.31}$$

$$l(\overline{s}) = \Pr(\varepsilon_i < \varepsilon^1_d|\overline{s}) = \frac{1}{2} + \frac{d - \overline{s} - E(s_2|\overline{s}) + U(\overline{s})}{4\overline{\varepsilon}} \tag{A.32}$$

$$k+\phi v(\overline{s})=\frac{q(\theta_1)}{\theta_1}\left[(1-\beta)E(r_2|\overline{s})-\gamma\right] \tag{A.33}$$

$$U(\overline{s})=\lambda\theta_1^{1-\alpha}\left[\gamma+\beta E(s_2|\overline{s})\right] \tag{A.34}$$

[Note: Since $s_h = s_l = \overline{s}$, then $s_2 = \overline{s}$ and hence $E(s_2|\overline{s}) = \overline{s}$. Throughout, we do not substitute $E(s_2|\overline{s})$ for $\overline{s}$ for clarity, as it allows to distinguish in the expressions between $t = 1$ and $t = 2$ cash flows.]

Note that equation (A.31) is the cut-off level below which established firms are forced to liquidate, and hence, (A.32) is the number of established firms that are liquidated. (These correspond to equations 13 and 26 in the main text.); Equation (A.33) is the zero profit entry condition (*i.e.*, equation 24); Equation (A.34) defines the worker's outside option (*i.e.*, equation 25). Note also that (*i*) by definition $\frac{q(\theta_1)}{\theta_1} = \lambda\theta_1^{-\alpha}$ and $\theta_1 = \frac{v(s_1)}{l(s_1)}$; and (*ii*) in equation (A.30) there is no need to take expectations w.r.t. s_1 as we are considering the case in which there is no aggregate uncertainty, *i.e.*, $s_1 = \overline{s}$; (*iii*) Unlike the case of homogenous entrants in which all entrants make zero profits, now all entrants except the marginal one make a profit (this is capture by the last two terms in the social planner's objective function A.30).

The derivative of the social planner's objective function (SPOF) w.r.t. the debt is:

$$\begin{aligned}\frac{\partial \text{SPOF}}{\partial d} &= \frac{-1}{4\overline{\varepsilon}}\left(\varepsilon_d^1+E(s_2|\overline{s})-U(\overline{s})\right)\left(1+\frac{\partial U(\overline{s})}{\partial d}\right)+\\ &+\underbrace{\left(1-\Pr\left(\varepsilon_i\geq\varepsilon_d^1\right)\right)}_{l(\overline{s})}\frac{\partial U(\overline{s})}{\partial d}+\\ &+\lambda\frac{\partial\theta_1^{-\alpha}}{\partial d}v(\overline{s})\left[(1-\beta)E(s_2|\overline{s})-\gamma\right]+\\ &+\frac{\partial v(\overline{s})}{\partial d}\underbrace{\left[\frac{q(\theta_1)}{\theta_1}(1-\beta)E(s_2|\overline{s})-\gamma-k-\phi v(\overline{s})\right]}_{=0\text{ from the zero profit entry condition (A.33).}}\end{aligned} \tag{A.35}$$

[Note that, unlike individual firms, the social planner internalizes the effect that debt choices have on θ_1, $U(s_1)$, and $v(s_1)$.]

From equation (A.34)

$$\frac{\partial U(\overline{s})}{\partial d}=(1-\alpha)\lambda\theta_1^{-\alpha}\frac{\partial\theta_1}{\partial d}\left[\gamma+\beta E\left(s_2|\overline{s}\right)\right] \tag{A.36}$$

so we can rewrite $\frac{\partial \text{SPOF}}{\partial d}$ as:

$$\begin{aligned}\frac{\partial \text{SPOF}}{\partial d} &= \frac{-1}{4\bar{\varepsilon}}(\varepsilon_d^1 + E\left(s_2|\bar{s}\right) - U(\bar{s}))\left(1+\frac{\partial U(\bar{s})}{\partial d}\right) \\ &\quad + l(\bar{s})\lambda\theta_1^{-\alpha}\frac{\partial \theta_1}{\partial d}\left[(1-\alpha)\left[\gamma+\beta E\left(s_2|\bar{s}\right)\right] - \alpha\left[(1-\beta)E\left(s_2|\bar{s}\right)-\gamma\right]\right]\end{aligned}$$

At the private optimum the choice of debt is determined by equation (27), which in the case with no uncertainty about s_1 can be written as

$$\overline{d}^* = U(\overline{s}) \tag{A.37}$$

and hence, from eq. (A.31), at the private optimum the cut-off level below which established firms are forced to liquidate is

$$\overline{\varepsilon}_d^{1*} = \frac{1}{2}[\overline{d}^* - \overline{s} - E\left(s_2|\overline{s}\right) + U(\overline{s})] = U(\overline{s}) - E\left(s_2|\overline{s}\right). \tag{A.38}$$

Hence evaluating $\frac{\partial \text{SPOF}}{\partial d}$ at the private optimum (PO):

$$\left|\frac{\partial \text{SPOF}}{\partial d}\right|_{\text{PO}} = l(\overline{s})\lambda\theta_1^{-\alpha}\left|\frac{\partial \theta_1}{\partial d}\right|_{\text{PO}}\left[(1-\alpha)\left[\gamma+\beta E\left(s_2|\overline{s}\right)\right] - \alpha\left[(1-\beta)E\left(s_2|\overline{s}\right)-\gamma\right]\right] \tag{A.39}$$

[Note: We use $|\circ|_{\text{PO}}$ to denote that the expression is evaluated at the private optimum.]

Next we show that an increase in debt decreases the tightness if the labor market, *i.e.*, $\frac{\partial \theta_1}{\partial d} < 0$:

From $\theta_1 = \frac{v(s_1)}{l(s_1)}$ it follows that

$$\frac{\partial \theta_1}{\partial d} = \frac{1}{\left(l(s_1)\right)^2}[l(s_1)\frac{\partial v(s_1)}{\partial \theta_1}\frac{\partial \theta_1}{\partial d} - v(s_1)\frac{\partial l(s_1)}{\partial d}], \tag{A.40}$$

[Note that from the zero profit entry condition, equation A.33, $v(s_1)$ depends on d only through θ_1.]

Operating and using equations (A.32) and (A.36) we obtain

$$\begin{aligned}\frac{\partial \theta_1}{\partial d}\frac{1}{\theta_1}[l(s_1) - \frac{\partial v(s_1)}{\partial \theta_1}] &= -\frac{\partial l(s_1)}{\partial d} = \frac{-1}{4\bar{\varepsilon}}\left(1+\frac{\partial U(s_1)}{\partial d}\right) = \\ &= \frac{-1}{4\bar{\varepsilon}}\left[1+(1-\alpha)\lambda\theta_1^{-\alpha}\frac{\partial \theta}{\partial d}\left[\gamma+\beta E\left(s_2|s_1\right)\right]\right],\end{aligned}$$

and then solving for $\frac{\partial \theta_1}{\partial d}$,

$$\frac{\partial \theta_1}{\partial d} = \frac{-1}{\frac{4\bar{\varepsilon}}{\theta_1}[l(s_1) - \frac{\partial v(s_1)}{\partial \theta_1}] + (1-\alpha)\lambda\theta_1^{-\alpha}\left[\gamma+\beta E\left(s_2|s_1\right)\right]} < 0. \tag{A.41}$$

[Note that the zero profit entry condition, *i.e.*, equation A.33, implies that $\frac{\partial v(s_1)}{\partial \theta_1} < 0$ as $\frac{q(\theta_1)}{\theta_1} = \lambda \theta_1^{-\alpha}$.]

Finally, since $\frac{\partial \theta_1}{\partial d} < 0$, equation (A.32) implies that

$$\left|\frac{\partial \text{SPOF}}{\partial d}\right|_{\text{PO}} > 0 \Leftrightarrow (1-\alpha)\left[\gamma + \beta E\left(s_2|\overline{s}\right)\right] - \alpha\left[(1-\beta)E\left(s_2|\overline{s}\right) - \gamma\right] < 0$$
$$\Leftrightarrow (1-\alpha)\overline{\beta}E\left(s_2|\overline{s}\right) - \alpha(1-\overline{\beta})E\left(s_2|\overline{s}\right) < 0 \Leftrightarrow \overline{\beta} < \alpha, \tag{A.42}$$

which corresponds to the well-known Hosios condition.■

Proof of Proposition 8

At $t = 1$, given $s_1 = \overline{s}$ each firm i solves for its optimal debt choice under the conjectured monetary policy τ^c:

$$\max_d \int_{\varepsilon(\tau^c)}^{\overline{\varepsilon}} \frac{\varepsilon_i + E\left(s_2|\overline{s}\right) - U\left(\overline{s}\right)}{2\overline{\varepsilon}} d\varepsilon_i \tag{A.43}$$

$$\text{s.t.} \quad : \quad \varepsilon\left(\tau^c\right) = \frac{1}{2}\left[d - \tau^c - \overline{s} - E\left(s_2|\overline{s}\right) + U\left(\overline{s}\right)\right]. \tag{A.44}$$

Since firms are infinitesimally small, each firm i chooses its debt firms taken τ^c as given (*i.e.*, τ^c depends on the debt choice of all firms but the debt choice of an individual firm does not affect τ^c). The f.o.c. from the previous convex problem characterizes firm's i optimal debt choice given conjecture τ^c:

$$\overline{d}^*_{\tau^c} = \tau^c + U\left(\overline{s}\right). \tag{A.45}$$

[Notice that that the debt choice is the same for all firms, i.e., $\overline{d}^{i*}_{\tau^c} = \overline{d}^*_{\tau^c}$, as firms are ex-ante identical and face the same optimization problem.]

Taken firms' debt choices $\overline{d}^*_{\tau^c}$ as given, the policy maker solves for the policy τ that maximizes welfare. Thus, the policy maker solves:

$$\max_\tau \int_{\varepsilon(\tau,\overline{s})}^{\overline{\varepsilon}} \frac{\varepsilon_i + E(s_2|\overline{s}) - U(\overline{s})}{2\overline{\varepsilon}} d\varepsilon_i + U(\overline{s}) - c\left(\tau\right)$$
$$+ \underbrace{v(\overline{s})\frac{q(\theta_1)}{\theta_1}\left[(1-\beta)E(s_2|\overline{s}) - \gamma\right]}_{\text{(Total) Entrants cash flows}} - \underbrace{\left[kv(\overline{s}) + \phi\frac{v^2(\overline{s})}{2}\right]}_{\text{(Total) Entry costs}} \tag{A.46}$$

$$\text{s.t.: } \varepsilon(\tau, \overline{s}) = \frac{1}{2}[\overline{d}^*_{\tau^c} - \tau - \overline{s} - E(s_2|\overline{s}) + U(\overline{s})] \quad \text{(A.47)}$$

$$l(\overline{s}) = \frac{1}{2} + \frac{\overline{d}^*_{\tau^c} - \tau - \overline{s} - E(s_2|\overline{s}) + U(\overline{s})}{4\bar{\varepsilon}} \quad \text{(A.48)}$$

$$k + \phi v(\overline{s}) = \frac{q(\theta_1)}{\theta_1}[(1-\beta)E(r_2|\overline{s}) - \gamma] \quad \text{(A.49)}$$

$$U(\overline{s}) = \lambda\theta_1^{1-\alpha}[\gamma + \beta E(s_2|\overline{s})] \quad \text{(A.50)}$$

Notice that program (A.30)-(A.34) is similar to program (A.46)-(A.50). That is, choosing τ in program (A.46)-(A.50) determines $\overline{d}^*_{\tau^c} - \tau$, and hence, it is as choosing d in program(A.30)-(A.34) except for the cost of the monetary policy, $c(\tau)$. Note also that the privately optimal debt choice net of inflation is equal to the privately optimal debt choice in the absence of monetary policy, that is, from equations (A.37) and (A.45), in equilibrium

$$\overline{d}^* = \overline{d}^*_{\tau^*} - \tau^*. \quad \text{(A.51)}$$

From the proof of Proposition 7, we know that the policy maker has incentives to increase (*decrease*) the amount of debt beyond the private optimum $\overline{d}^*$ if $\overline{\beta} < \alpha$ (*if* $\overline{\beta} > \alpha$). This means that in program (A.46)-(A.50), at the private optimum, *i.e.*, $\overline{d}^*_{\tau^*} = \overline{d}^* + \tau^*$, if $\overline{\beta} < \alpha$ (*resp.* $\overline{\beta} < \alpha$), the policy maker has incentives to follow a deflationary (*resp. inflationary*) monetary policy in an attempt to increase (*resp. decrease*) $\overline{d}^*_{\tau^*} - \tau^* = \overline{d}^*$. This costly monetary policy (*i.e.*, $c(\tau^*) > 0$), however, does not change the real value of the debt obligations as, in equilibrium, firms will increase $\overline{d}^*_{\tau^*}$ by $\tau^*$to keep $\overline{d}^*_{\tau^*} - \tau^*$ constant at $\overline{d}^*$. That is, if $\widetilde{\beta} < \alpha$ ($\widetilde{\beta} > \alpha$) the policy maker is trapped in following a socially costly deflationary (*inflationary*) policy which in equilibrium will be ineffective as firms will counteract the policy by adjusting their debt choices.■

Proof of Proposition 9

The social planner solves the following problem to determine the socially optimal amount of debt:

$$\max_d E[\int_{\varepsilon^1_{d_i}}^{\overline{\varepsilon}} \frac{\varepsilon_i + E(s_2|s_1) - U(s_1)}{2\overline{\varepsilon}} d\varepsilon_i] + E(U(s_1)) +$$
$$+\underbrace{E\left[v(s_1)\frac{q(\theta_1)}{\theta_1}\left[(1-\beta)E(s_2|s_1) - \gamma\right]\right]}_{\text{Expected (total) entrants cash flows}} - \underbrace{E[kv(s_1) + \phi\frac{v^2(s_1)}{2}]}_{\text{Expected (total) entry costs}} \tag{A.52}$$

subject to equations (A.31), (A.32), (A.33), and (A.34) from the proof of case without aggregate uncertainty, *i.e.*, proof of Proposition (7). [Note that the only difference with case without aggregate uncertainty is that in equation (A.52), unlike in equation (A.30), we need to take expectations over s_1 when solving for d and that equations (A.31), (A.32), (A.33), and (A.34) hold for each $s_1 \in \{s_h, s_l\}$.]

Deriving the social planner's objective function (SPOF) w.r.t. debt:

$$\begin{aligned} \frac{\partial \text{SPOF}}{\partial d} &= -E[\frac{\varepsilon^1_d + E(s_2|s_1) - U(s_1)}{4\overline{\varepsilon}}(1 + \frac{\partial U(s_1)}{\partial d})] + E[l_1 \frac{\partial U(s_1)}{\partial d}] \\ &\quad + E[\lambda \frac{\partial \theta_1^{-\alpha}}{\partial d} v_1((1-\beta)E(s_2|s_1) - \gamma)] \\ &\quad + E[\frac{\partial v_1}{\partial d}\underbrace{(\frac{q(\theta_1)}{\theta_1}(1-\beta)E(s_2|s_1) - \gamma - k - \phi v_1)}_{=0 \text{ from the zero profit entry condition (A.33)}}] \end{aligned} \tag{A.53}$$

[Note that unlike individual firms the social planner internalizes the effect that debt choices have on θ_1, $U(s_1)$, and $v_1(\equiv v(s_1))$.]

From equation (A.34) we obtain equation (A.36):

$$\frac{\partial U(s_1)}{\partial d} = (1-\alpha)\lambda\theta_1^{-\alpha}\frac{\partial \theta_1}{\partial d}\left[\gamma + \beta E(s_2|s_1)\right]$$

so we can rewrite expression as (A.53):

$$\begin{aligned} \frac{\partial \text{SPOF}}{\partial d} &= -E\left[\frac{\varepsilon^1_d + E(s_2|s_1) - U(s_1)}{4\overline{\varepsilon}}(1 + \frac{\partial U(s_1)}{\partial d})\right] + \\ &\quad + E\left[l_1\lambda\theta_1^{-\alpha}\frac{\partial \theta_1}{\partial d}E(s_2|s_1)[(1-\alpha)\widetilde{\beta}(s_1) - \alpha(1-\widetilde{\beta}(s_1)]\right] \end{aligned} \tag{A.54}$$

At the private optimum the debt choice satisfies the following equation (see eq. 17):

$$E[\varepsilon^1_d + E(s_2|s_1) - U(s_1)] = 0, \tag{A.55}$$

and hence evaluating (A.54) at the private optimum yields:

$$\left|\frac{\partial \text{SPOF}}{\partial d}\right|_{\text{PO}} = -E\left[\frac{\varepsilon_d^1 + E(s_2|s_1) - U(s_1)}{4\overline{\varepsilon}}\left|\frac{\partial U(s_1)}{\partial d}\right|_{\text{PO}}\right] + \\ +E\left[l_1\lambda\theta_1^{-\alpha}\left|\frac{\partial \theta_1}{\partial d}\right|_{\text{PO}} E(s_2|s_1)\left[(1-\alpha)\widetilde{\beta}(s_1) - \alpha(1-\widetilde{\beta}(s_1))\right]\right] \tag{A.56}$$

[Note: As before, we use $|\circ|_{\text{PO}}$ to denote that the expression is evaluated at the private optimum.] Hence there are two effects determining if at the private optimum the social planner has incentives to increase or decrease the amount debt, that is, whether $\left|\frac{\partial \text{SPOF}}{\partial d}\right|_{\text{PO}}$ is greater or smaller than zero depends on the signs and magnitude of the *pecuniary externality* (first line in eq. A.56) and the *search externality* (second line in eq. A.56).

(1) *Pecuniary externality*:

$$-E\left[\frac{\varepsilon_d^1 + E(s_2|s_1) - U(s_1)}{4\overline{\varepsilon}}\left|\frac{\partial U(s_1)}{\partial d}\right|_{\text{PO}}\right] \tag{A.57}$$

When firms choose their debt, they do not take into account that it affects $U(s_1)$ and hence ε_d^1. The marginal firm destroyed in good times has a value

$$\varepsilon_d^h + E(s_2|s_h) - U_2(s_h), \tag{A.58}$$

and the marginal firm destroyed in bad times has a value

$$\varepsilon_d^l + E(s_2|s_l) - U_2(s_l). \tag{A.59}$$

Since d affects $U(s_1)$ and hence ε_d^1 the net effect depends on whether at the private optimum d moves $U(s_1)$ more in good or in bad times (i.e., $\frac{\partial U(s_h)}{\partial d}$ vs. $\frac{\partial U(s_l)}{\partial d}$) times the value of the marginal firm destroyed in good (*i.e.*, $\varepsilon_d^h + E(s_2|s_h) - U_2(s_h)$) and bad times (*i.e.*, $\varepsilon_d^l + E(s_2|s_l) - U_2(s_l) > 0$), respectively.

[Notice that the pecuniary externality is not present in the case without aggregate uncertainty as the privately optimal amount of debt makes the marginal firm liquidated a zero NPV firm. (See eq. A.38)]

(2) *Search externality*:

$$E\left[l_1\lambda\theta_1^{-\alpha}\left|\frac{\partial \theta_1}{\partial d}\right|_{\text{PO}} E(s_2|s_1)\left[(1-\alpha)\widetilde{\beta}(s_1) - \alpha(1-\widetilde{\beta}(s_1))\right]\right] \tag{A.60}$$

Since $\frac{\partial \theta_1}{\partial d} < 0$ (see equations A.40, A.41, and A.41 in the proof of the case without aggregate uncertainty), the sign of the search externality depends on the sign of

$$(1-\alpha)\widetilde{\beta}(s_1) - \alpha(1-\widetilde{\beta}(s_1)) \text{ for } s_1 \in \{s_h, s_l\}. \tag{A.61}$$

For instance consider in the case in which $\widetilde{\beta}(s_h) < \widetilde{\beta}(s_l) < \alpha$, the search externality would tend to make socially desirable to increase the privately optimal amount of debt as at the private optimum labor markets would be too tight (*i.e.*, too many entrants v_1 relative to the number of workers looking for jobs l_1). Conversely, if $\alpha < \widetilde{\beta}(s_h) < \widetilde{\beta}(s_l)$, the search externality would push towards decreasing debt. Finally, if $\widetilde{\beta}(s_h) < \alpha < \widetilde{\beta}(s_l)$ the search externality would push towards increasing debt in good times and decreasing debt in bad times, and hence, *ex-ante*, the search externality can induce an increase or decrease in debt depending on which of these two effects dominates. Notice that if $\gamma = 0$ and $\alpha = \beta$ then $\widetilde{\beta}(s_l) = \widetilde{\beta}(s_h) = \alpha$ and there would be no search externalities. (This is the Hosios condition.)

The above explained pecuniary and search externalities make private debt choices generally socially suboptimal. (Note that even if the Hosios condition is satisfied, *i.e.*, $\gamma = 0$ and $\alpha = \beta$, and hence there are no search externalities, the pecuniary externality will generally cause the privately and socially optimal amount of debt to defer.)■