Frost and Fire: A Tale of Two Crises

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Abstract

Financial crises are characterized by depressed asset prices, tight financial constraints, and misallocation of resources. Standard policy responses—such as asset purchases and low interest rates—are generally intended to alleviate these symptoms. This paper distinguishes between two types of crises that appear similar but differ fundamentally in mechanism and policy prescription: *fire-sale crises*, where productive firms are forced to sell assets; and *demand-freeze crises*, where productive firms are unable to purchase assets. While both lead to similar observable outcomes, they have contrasting general equilibrium effects and call for different policy interventions. Notably, conventional policies can be counterproductive in demand-freeze crises, as they may exacerbate financial constraints and further distort resource allocation. Empirical evidence on the pattern of capital reallocation among US firms suggests that demand-freeze crises are, in fact, more common.

Keywords: Financial crises, financial frictions, demand freezes, fire sales, asset purchases, monetary loosening, credit easing, capital reallocation, cleansing effects.

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Some say the world will end in fire,
Some say in ice.
From what I've tasted of desire
I hold with those who favor fire.
But if it had to perish twice,
I think I know enough of hate
To say that for destruction ice
Is also great
And would suffice.

— Robert Frost

1 Introduction

There is substantial evidence linking financial crises to severe misallocation of capital (Caballero and Hammour, 2005; Reis, 2013; Gopinath et al., 2017). A widely accepted narrative emphasizes the role of tightening financial constraints during such crises, which hinder the efficient allocation of capital to its most productive uses. This misallocation, in turn, contributes to declining asset prices, which further exacerbate financial constraints, deepening the downturn in a self-reinforcing cycle (Lorenzoni, 2008).

In response to these dynamics, conventional wisdom typically advocates for credit-easing interventions, such as reductions in interest rates and large-scale asset purchases. These measures are designed to stabilize or increase asset prices, thereby alleviating financial constraints and facilitating a more efficient allocation of capital. As stated by Isabel Schnabel, member of the ECB's Executive Board: *"After the outbreak of COVID-19...asset purchases...reduced systemic stress, prevented broader fire sales and thus averted an excessive tightening of financing conditions that could have threatened the stability of the financial system at large."*[1]

In this paper, we challenge the conventional narrative of financial crises by using a canonical model that links financial distress to capital reallocation dynamics. Our framework, in which financial crises arise due to a tightening of financial constraints, reveals that crises can take two distinct forms: *fire-sale crises*, in which productive firms are forced to sell assets under distress; and *demand-freeze crises*, in which productive firms are unable to purchase assets despite potential gains from doing so. Both crisis types align with the prevailing view in that they feature depressed asset prices, binding financial constraints, and a breakdown in the

[1]Speech by Isabel Schnabel, Member of the Executive Board of the ECB, at the 2024 BOJ-IMES Conference on "Price Dynamics and Monetary Policy Challenges: Lessons Learned and Going Forward", 28 May 2024

efficient reallocation of resources. As a result, both crises lower aggregate output and welfare.

Despite exhibiting many similar features, fire-sale and demand-freeze crises differ in a critical respect: namely, in the general-equilibrium effects of asset prices on resource allocation. We show that it is useful to think of the effects of tightening of financial constraints as being composed of two parts. A partial-equilibrium effect, which captures the change in output while keeping the price of capital constant, and a general-equilibrium effect, which captures the change in output that comes about from the induced change in the price of capital. In fire-sale crises, high productivity entrepreneurs are sellers of capital because they need resources to pay off their debts. Thus, the decline in the price of capital that takes place during the crisis hurts them – and thus the allocation of capital – by forcing them to liquidate even more capital. In demand-freeze crises, high-productivity entrepreneurs are instead buyers of capital, although they are not able to buy as much capital as they would like to. Thus, the decline in the price of capital that takes place during the crisis benefits them – and thus the allocation of capital – by allowing them to purchase more capital.

The distinction between both types of crises has significant implications for the design of policy responses. We show that – in line with the conventional wisdom – interest rate cuts and asset purchases are always effective in raising the price of capital during crises, regardless of their type. Asset purchases do so by directly increasing the demand for capital, while reductions in the interest rate do it by raising unconstrained entrepreneurs' valuation of future dividends. However, this increase in the price of capital has radically different implications for the reallocation of capital and thus output, depending on whether it takes place during a fire-sale or a demand-freeze crisis.

We show that a sufficient statistic to evaluate the effect of policy-induced price changes on efficiency and output is the covariance between entrepreneurs' marginal productivity and their net purchases of capital. In fire sale crisis, this covariance is positive: an increase in the price of capital, which naturally benefits sellers, helps productive entrepreneurs and improves the allocation of capital. In a demand-freeze crisis, this covariance is instead negative: an increase in the price of capital, which naturally hurts buyers, harms productive entrepreneurs and worsens the allocation of capital. Thus, the benefits of lower interest rates or asset purchases in terms of output are strengthened during fire-sale crisis but weakened during demand-freeze crises.

Our model sheds light on a widespread debate regarding policy interventions during crises. On the one hand, there is a *benign* view that policies such as asset purchases are necessary to sustain the net worth of market participants thereby mitigating the severity of the crisis. As Ben Bernanke states, *"The purpose of asset purchases is to ease financial conditions...these policies*

help allocate resources towards productive uses...". On the other hand, there is a *distortionary* view that this type of intervention may distort markets and prevent the allocation of resources to their most productive uses. For instance, Rajan claims that *"Central bank asset purchases can distort market signals and misallocate resources...".*[2] Through the lens of our theory, both views are equally valid but they apply in different circumstances: while the benign view applies to fire-sale crises, the distortionary view applies to demand-freeze crises.

Admittedly, real-world crises likely combine elements of fire-sales and demand-freezes. To analyze which type of crisis is more prevalent, we study the relationship between firms' marginal product of capital (MPK) productivity and capital reallocation in Compustat data. In particular, we assess whether it is low- or high-MPK firms that expand their capital stock the most, especially during crises. Consistent with existing evidence (e.g., Eisfeldt and Rampini (2006)), we find that capital reallocation is strongly procyclical, with impaired reallocation in bad times. Moreover, it is high-MPK firms that expand their capital stock the most, even during financial crises as measured through a high excess-bond premium. This should not be the case during fire-sale crises, where we should observe low-MPK firms expanding their capital stock significantly while high-MPK firms are forced to reduce theirs.

Literature review: Our paper builds on the extensive macroeconomic literature on the financial accelerator, which highlights the central role of asset prices in the propagation of financial crises and business cycles more broadly (e.g., Bernanke and Gertler (1989), Kiyotaki and Moore (1997), Krishnamurthy (2003), Brunnermeier and Sannikov (2014), Lorenzoni (2008)). We contribute to this literature by showing that the pattern of capital reallocation across firms is a central determinant of general equilibrium outcomes and plays a crucial role in shaping the effectiveness of policy interventions during crises. In particular, we find that the empirical patterns of asset reallocation among U.S. corporates suggest that standard policy prescriptions derived from this literature may be counterproductive.

Our paper is also closely related to the literature studying asset reallocation and its macroeconomic implications under financial frictions (Eisfeldt and Rampini, 2006; Kurlat, 2013; Fuchs et al., 2016; Bigio, 2015; Eisfeldt and Shi, 2018; Asriyan et al., 2019; Lanteri and Rampini, 2022; Asriyan et al., 2024). Among these, the closest to our approach are Lanteri and Rampini (2022) and Asriyan et al. (2024), who also emphasize general equilibrium effects of capital reallocation arising from the interaction of productivity heterogeneity and financial constraints. Distinctively, our contribution lies in characterizing how these reallocation effects influence the dynamics of financial crises, how they inform the design of corrective interventions, and in

[2]This view is also reminiscent of the work of Caballero and Hammour (2005), who argued that recessions have a "cleansing" effect by enabling resources to be redirected to the most productive market participants.

providing a "sufficient-statistic" approach to empirically infer these effects from firm-level data.

At a broader level, our normative analysis is informed by a body of work that highlights inefficiencies in the allocation of productive factors that arise in the presence of financial frictions. A common theme in this literature is that individual firms fail to internalize the general equilibrium effects of their factor demand on prices, leading to inefficient allocations under financial constraints. Examples of this work include Biais and Mariotti (2009), Ventura and Voth (2015), Martin et al. (2018), Asriyan et al. (2021) and Buera et al. (2021).

A key mechanism underlying our normative results is the presence of equilibrium heterogeneity across firms in the tightness of financial constraints—and therefore in their marginal productivity of capital—and the differential responsiveness of these firms to policy changes. In this respect, our work connects to a growing empirical literature documenting firm-level heterogeneity in responses to policy interventions, particularly monetary shocks (e.g., Anderson and Cesa-Bianchi (2020), Cloyne et al. (2018), Ottonello and Winberry (2020), Jeenas (2024)).

Finally, our focus on the micro-level details of financial crises as a basis for optimal policy design is shared by recent contributions such as Kurlat (2021) and Robatto (2025). Unlike our framework, these papers model crises as being uniformly driven by fire sales, where the most productive firms become net sellers of assets. Nevertheless, they show that policy responses can still diverge sharply from traditional prescriptions, particularly when fire sales arise from asymmetric information problems à la Akerlof (1970).

2 A Model of Financial Crises

2.1 Environment

We consider an economy that lasts for three periods: $t = 0, 1, 2$. There are two goods: a perishable consumption good and capital. The economy's capital stock is fixed and equal to $\bar{K} > 0$. There are two sets of agents, entrepreneurs and savers, each of unit mass, denoted by I^E and I^S respectively.

Preferences. The preferences of agent $i \in I^E \cup I^S$ are given by:

$$U^i = E_0[c_2^i],$$

where $c_2^i \geq 0$ is agent i's consumption at $t = 2$ and $E_0[\cdot]$ is the expectation operator at $t = 0$.

Endowments. Each entrepreneur is endowed with $w \geq 0$ units of the consumption good at $t = 0$, while each saver is endowed with $W \geq 0$ units of it plus $\bar{K}$ units of capital at $t = 0$.

Technology. All agents have access to storage technology with a gross return 1. In addition, entrepreneurs have access to a productive technology that uses capital to produce consumption goods. In particular, if entrepreneur $i \in I^E$ installs $k_0^i \geq 0$ units of capital at $t = 0$, she produces $y_1^i = \rho_1^i \cdot (k_0^i)^\alpha$ units of the consumption good at $t = 1$, where $\alpha \in (0, 1)$. Likewise, if she installs $k_1^i \geq 0$ units of capital at $t = 1$, she produces $y_2^i = \rho_2^i \cdot (k_1^i)^\alpha$ units of the consumption good at $t = 2$. The productivities $\rho_1^i > 0$ and $\rho_2^i > 0$ are idiosyncratic and potentially stochastic.

Markets. In any given period t, entrepreneurs and savers can trade capital in a competitive market at price q_t. To finance investment, entrepreneurs can also issue promises to savers in a competitive credit market. Promises are short-term and (*de jure*) non-contingent: a promise issued at t is a commitment to deliver one unit of the consumption good at $t+1$. We introduce a friction by assuming that an entrepreneur can abscond with a fraction $1 - \theta_t$ of her output at $t = 1, 2$. We focus throughout on the case in which $\theta_1 = 1$ and $\theta_2 = \lambda \leq 1$.

Uncertainty. There is both idiosyncratic and aggregate uncertainty. Idiosyncratic uncertainty refers to the productivities ρ_1^i and ρ_2^i, both of which are realized at $t = 1$.[3] Productivities are drawn independently across entrepreneurs from a common distribution: $(\rho_1^i, \rho_2^i) \sim^{\text{iid}} G$ with support $[\underline{\rho_1}, \bar{\rho_1}] \times [\underline{\rho_2}, \bar{\rho_2}]$. At $t = 1$, there are thus two sources of heterogeneity among entrepreneurs. First, entrepreneurs differ in the *realized* productivity, ρ_1^i, which captures differences in their cash flows or net worth. Second, entrepreneurs differ in the *expected* productivity, ρ_2^i, which captures differences in their investment opportunities going forward. To conserve on notation, we summarize the productivities of entrepreneur i by $s^i = (\rho_1^i, \rho_2^i)$. Aggregate uncertainty instead refers to the value of the parameter λ, which is also realized at $t = 1$, drawn from a distribution F with support $[0, 1]$. We think of λ as capturing credit-market conditions, where high realizations of λ reflect normal times whereas low realizations of λ reflect crisis times.

2.2 Entrepreneurial investment and borrowing

We use b_t^i to denote the total (i.e., net of storage) promises of repayment at t made by entrepreneur $i \in I^E$ at $t - 1$. We assume that entrepreneur i can renegotiate promised repayments ex post, and that she has full bargaining power in renegotiation. Thus, repayments are *de facto* bounded by entrepreneurial collateral. Letting $\widetilde{b}_t^i$ denote the actual repayments made

[3]The assumption that ρ_2^i is realized at $t = 1$ is for simplicity. Our setting is isomorphic to the alternative specification where entrepreneur i receives a signal about ρ_2^i. E.g., if ρ_1^i and ρ_2^i are correlated, then the realization of ρ_1^i is itself a signal about ρ_2^i (see Section 3.3).

by entrepreneur $i \in I^E$ at time t, it follows that:

$$\widetilde{b}_1^i = \min\left\{\rho_1^i \cdot (k_0^i)^\alpha + q_1 \cdot k_0^i,\ b_1^i\right\}, \tag{1}$$

$$\widetilde{b}_2^i = \min\left\{\lambda \cdot \rho_2^i \cdot (k_1^i)^\alpha + q_2 \cdot k_1^i,\ b_2^i\right\}. \tag{2}$$

To streamline the analysis of the entrepreneurs' problem, we will make use of the following two observations. First, let R_t denote the market interest rate, i.e., the return on a non-contingent promise between periods t and $t+1$. Since there is neither consumption nor investment in the aggregate at $t = 0, 1$, storage must necessarily be used and, thus, in equilibrium:

$$R_t = 1 \text{ for } t = 0, 1. \tag{3}$$

Second, as capital is no longer useful after production at $t = 2$, we must have that in equilibrium:

$$q_2 = 0. \tag{4}$$

We are now ready to study entrepreneurial optimization, given asset prices. As is customary, we start with the entrepreneurs' problem at $t = 1$ and then analyze her problem at $t = 0$.

2.2.1 Optimization at $t = 1$

At $t = 1$, entrepreneur $i \in I^E$ has net worth:

$$w_1^i \equiv \rho_1^i \cdot \left(k_0^i\right)^\alpha + q_1(\lambda) \cdot k_0^i - \min\left\{\rho_1^i \cdot (k_0^i)^\alpha + q_1 \cdot k_0^i,\ b_1^i\right\}, \tag{5}$$

where the notation $q_1(\lambda)$ indicates that the price of capital depends on the aggregate state λ, and where we have used the expression for $\widetilde{b}_1^i$ in Equation (1). Entrepreneur $i \in I^E$ then solves:

$$V(w_1^i, s^i, \lambda) \equiv \max_{k_1^i, b_2^i}\ \rho_2^i \cdot (k_1^i)^\alpha + w_1^i - q_1(\lambda) \cdot k_1^i, \tag{6}$$

subject to her budget constraint:

$$q_1(\lambda) \cdot k_1^i \leq w_1^i + b_2^i, \tag{7}$$

and borrowing constraint:

$$b_2^i \leq \lambda \cdot \rho_2^i \cdot \left(k_1^i\right)^\alpha. \tag{8}$$

Note that we have imposed that $\widetilde{b}_2^i = b_2^i$, which is without loss of generality, since both ρ_2^i and $q_2 = 0$ are known at the time of borrowing at $t = 1$.

Optimization by entrepreneur $i \in I^E$ implies the following demand for capital:

$$k_1^i = k_1\left(w_1^i, s^i, \lambda\right) = \begin{cases} k_1^*\left(s^i, \lambda\right) & \text{if } w_1^i \geq w_1^*\left(s^i, \lambda\right) \\ x \text{ s.t. } q_1\left(\lambda\right) \cdot x = w_1^i + \lambda \cdot \rho_2^i \cdot x^\alpha & \text{otherwise} \end{cases}, \tag{9}$$

where:

$$w_1^*\left(s^i, \lambda\right) \equiv q_1\left(\lambda\right) \cdot k_1^*\left(s^i, \lambda\right) - \lambda \cdot \rho_2^i \cdot \left(k_1^*\left(s^i, \lambda\right)\right)^\alpha \tag{10}$$

denotes the level of net worth that enables entrepreneur $i \in I^E$ to undertake her efficient level of investment, $k_1^*\left(s^i, \lambda\right) \equiv \left(\frac{\alpha \cdot \rho_2^i}{q_1(\lambda)}\right)^{\frac{1}{1-\alpha}}$. The corresponding level of borrowing is then given by:

$$b_2^i = b_2\left(w_1^i, s^i, \lambda\right) = q_1\left(\lambda\right) \cdot k_1\left(w_1^i, s^i, \lambda\right) - w_1^i. \tag{11}$$

Equation (9) says that entrepreneur i's investment is efficient if her net worth exceeds the critical value $w_1^*\left(s^i, \lambda\right)$. When her net worth is below this critical value, entrepreneurial investment is inefficiently low. The lower bound on investment is equals to the amount of capital that the entrepreneur can purchase after debt renegotiation, using only what new borrowing she can obtain. This lower bound is:

$$\underline{k_1}\left(s^i, \lambda\right) \equiv k_1\left(0, s^i, \lambda\right) = \left(\frac{\lambda \cdot \rho_2^i}{q_1\left(\lambda\right)}\right)^{\frac{1}{1-\alpha}}. \tag{12}$$

Given optimal investment and borrowing decisions, it is useful to define the marginal value of wealth for an entrepreneur with net worth w_1^i in state (s^i, λ):

$$\nu^i = \nu(w_1^i, s^i, \lambda) \equiv \begin{cases} 1 & \text{if } w_1^i \geq w_1^*\left(s^i, \lambda\right) \\ \frac{(1-\lambda)\cdot\alpha\cdot\rho_2^i\cdot(k^i)_1^{\alpha-1}}{q_1(\lambda)-\lambda\cdot\alpha\cdot\rho_2^i\cdot(k_1^i)^{\alpha-1}} & \text{otherwise} \end{cases} \tag{13}$$

If the entrepreneur is unconstrained, Equation (13) says that the marginal value of wealth is one, which is the market interest rate at $t = 1$. If instead the entrepreneur is constrained, Equation (13) says that the marginal value of wealth is greater than one. The reason is that each unit of wealth enables the entrepreneur to purchase an additional $\left(q_1(\lambda) - \alpha \cdot \rho_2^i \cdot (k_1^i)^{\alpha-1}\right)^{-1}$ units of capital, and each raises final consumption by $(1 - \lambda) \cdot \alpha \cdot \rho_2^i \cdot (k_1^i)^{\alpha-1}$.

2.2.2 Optimization at $t = 0$

At $t = 0$, entrepreneur $i \in I^E$ chooses her investment k_0^i and debt level b_1^i to solve:

$$\max_{k_0^i, b_1^i} \int V(w_1^i, s^i, \lambda) \cdot dG(\rho_1^i, \rho_2^i) \cdot dF(\lambda), \tag{14}$$

subject to the budget constraint:

$$q_0 \cdot k_0^i = w + \int \min \left\{ \rho_1^i \cdot (k_0^i)^\alpha + q_1(\lambda) \cdot k_0^i,\ b_1^i \right\} \cdot dG(\rho_1^i, \rho_2^i) \cdot dF(\lambda). \tag{15}$$

where w_1^i satisfies Equation (5) and where we have replaced $\widetilde{b}_2^i$ in the budget constraint with its definition in Equation (1). The optimal choice of k_0^i is characterized by:

$$\begin{aligned} q_0 = & \int \left(\alpha \cdot \rho_1^i \cdot (k_0^i)^{\alpha-1} + q_1(\lambda) \right) \cdot dG(\rho_1^i, \rho_2^i) \cdot dF(\lambda) \\ & + \int_{w_1^i > 0} \frac{\nu(w_1^i, s^i, \lambda) - \gamma}{\gamma} \cdot \left(\alpha \cdot \rho_1^i \cdot (k_0^i)^{\alpha-1} + q_1(\lambda) \right) \cdot dG(\rho_1^i, \rho_2^i) \cdot dF(\lambda), \end{aligned} \tag{16}$$

where $\gamma \equiv \mathbb{E}\left[\nu(w_1^i, s^i, \lambda) \ | w_1^i > 0 \right]$ is the marginal value of entrepreneurial wealth at $t = 0$. Given k_0^i, optimal borrowing b_1^i follows from Equation (15).

Equation (16) states that, when choosing borrowing and investment at $t = 0$, the entrepreneur sets the marginal cost of investment, q_0, equal to its expected marginal benefit plus an *adjustment* term. The sign of this term depends on the correlation between the return to capital and the marginal value of net worth, ν. If the correlation is positive, capital hedges future shocks, as its payoff is high precisely in states where the marginal value of net worth is also high. All else equal, this amplifies entrepreneurial investment, k_0. By contrast, a negative correlation means means capital pays off the most in states where the marginal value of net worth is low, which dampens entrepreneurial investment. This case is most likely to be relevant in practice, as entrepreneurs are most likely to be constrained, i.e., ν is most likely to be high, in states in which the realized return to capital is low, i.e., ρ_1^i and $q_1(\lambda)$ are low.

2.3 Properties of equilibrium

We now formally define an equilibrium of the economy and discuss some of its key features.

Definition 1 *A competitive equilibrium consists of a vector of investment and borrowing decisions* $\{k_0^i, k_1^i, b_1^i, b_2^i\}$ *for each entrepreneur* $i \in I^E$ *and a vector of prices* $\{q_0, q_1(\lambda)\}$*, such*

that entrepreneurs' optimality conditions and budget constraints are satisfied in all states, i.e., Equations (5), (9)-(11), (15), *and* (16), *and the capital market clears in all states:*

$$k_0^i = \bar{K}, \tag{17}$$

and, for all λ*:*

$$\int k_1\left(w_1^i, s^i, \lambda\right) \cdot dG(\rho_1^i, \rho_2^i) = \bar{K}, \tag{18}$$

Given an equilibrium allocation of capital, aggregate output at $t = 2$ is given by:

$$Y_2(\lambda) = \int \rho_2^i \cdot k_1\left(w_1^i, s^i, \lambda\right) \cdot dG(\rho_1^i, \rho_2^i). \tag{19}$$

Since individuals only value consumption at $t = 2$, the social welfare in the aggregate state λ is in turn given by:

$$\mathcal{SW}(\lambda) = w + W + \int \rho_1^i \cdot \bar{K}^\alpha \cdot dG(\rho_1^i, \rho_2^i) + Y_2(\lambda). \tag{20}$$

Ultimately, aggregate consumption in this economy is equal to total endowment, $w + W$, plus whatever output is produced through investment. Since all entrepreneurs are ex-ante identical, output at $t = 1$ is mechanically equal to $\int \rho_1^i \cdot \bar{K}^\alpha \cdot dG(\rho_1^i, \rho_2^i)$, while $Y_2(\lambda)$ is determined endogenously and depends on how the capital stock is allocated at $t = 1$. This is our main object of interest.

It is useful at this point to establish a benchmark, which corresponds to the allocation that would obtain in the absence of financial constraints. Capital in this case is allocated efficiently at $t = 1$, which maximizes output at $t = 2$ and capital prices throughout.

Lemma 1 *In the absence of financial constraints, i.e., when* $\lambda = 1$ *with probability one, equilibrium output and prices are given by:*

$$Y_2^\star \equiv \widetilde{\rho}_2 \cdot \bar{K}^\alpha, \tag{21}$$

and:

$$q_1^\star \equiv \alpha \cdot \widetilde{\rho}_2 \cdot \bar{K}^{\alpha-1} \text{ and } q_0^\star \equiv \alpha \cdot \int \rho_1^i \cdot dG(\rho_1^i, \rho_2^i) \cdot \bar{K}^{\alpha-1} + q_1^\star, \tag{22}$$

where:

$$\widetilde{\rho}_2 \equiv \left[\int (\rho_2^i)^{\frac{1}{1-\alpha}} \cdot dG(\rho_1^i, \rho_2^i)\right]^{1-\alpha}. \tag{23}$$

In the absence of financial constraints, aggregate productivity of capital at $t = 2$ is given by $\widetilde{\rho}_2$, which results from allocating the aggregate stock of capital $\bar{K}$ so as to equalize its marginal productivity among entrepreneurs. To analyze the competitive equilibrium with financial constraints and compare it to this benchmark, we make two parametric assumptions.

The first assumption guarantees that financial constraints are relevant, i.e., entrepreneurs are not so rich that the competitive equilibrium coincides with the benchmark in Lemma 1:

Assumption 1 *Entrepreneurial endowment w satisfies $w < \bar{w}$, where:*

$$\bar{w} \equiv \left(\alpha \cdot (\widetilde{\rho}_2)^{\alpha} \cdot (\bar{\rho}_2)^{1-\alpha} + \alpha \cdot \int \rho_1^i \cdot dG(\rho_1^i, \rho_2^i) - \underline{\rho_1} \right) \cdot \bar{K}^{\alpha}. \tag{24}$$

The second assumption guarantees that there are no states of nature in which *all* entrepreneurs renegotiate their debts. Besides capturing the empirically relevant case, this assumption also serves the technical purpose of ensuring that an equilibrium always exists:

Assumption 2 *Entrepreneurial endowment w satisfies $w > \underline{w}$, where:*

$$\underline{w} \equiv \left(\alpha \cdot \widetilde{\rho}_2 + \alpha \cdot \int \rho_1^i \cdot dG(\rho_1^i, \rho_2^i) - \bar{\rho}_1 \right) \cdot \bar{K}^{\alpha}. \tag{25}$$

Using these two assumptions, the following proposition establishes the existence of competitive equilibrium and compares it to the efficient benchmark in Lemma 1:

Proposition 1 *Suppose Assumptions 1 and 2 hold. Then, a competitive equilibrium exists. Moreover, there exists a $\lambda^{\star} \in (0, 1)$ such that:*

- *If $\lambda \geq \lambda^{\star}$, all entrepreneurs are unconstrained, $Y_2 = Y_2^{\star}$ and $q_1 = q_1^{\star}$.*
- *If $\lambda < \lambda^{\star}$, some entrepreneurs are constrained, $Y_2 < Y_2^{\star}$ and $q_1 < q_1^{\star}$.*

Using Proposition 1, we can partition the set of aggregate states into two subsets, which we respectively refer to as *normal* and *crisis* times. In normal times, $\lambda \geq \lambda^{*}$, the marginal product of capital is equalized across entrepreneurs, and Y_2 and q_1 are as in the efficient benchmark. In crisis times, instead, $\lambda < \lambda^{\star}$, financial constraints are tight, the marginal product of capital is not equalized across entrepreneurs, and Y_2 and q_1 are depressed relative to normal times.

3 A tale of two crises

In this section, we characterize the key properties of financial crises. As highlighted in Proposition 1, crisis times are marked by an inefficient allocation of capital, low output, and depressed

asset prices. Although this fits well with common narratives, it is unclear whether low asset prices exacerbate or alleviate the effects of financial crises. We now explore this question, and show that not all crises are alike.

3.1 Fire-sale and demand-freeze crises

We begin by characterizing the behavior of output Y_2 across different crisis states:

Proposition 2 *In equilibrium, the effect of an increase in $\lambda < \lambda^\star$ on output Y_2 is given by:*

$$\begin{aligned}\frac{dY_2}{d\lambda} &= \int \rho_2^i \cdot \alpha \cdot k_1\left(w_1^i, s, \lambda\right)^{\alpha-1} \cdot \frac{dk_1\left(w_1^i, s, \lambda\right)}{d\lambda} \cdot dG\left(\rho_1^i, \rho_2^i\right) \\ &= \underbrace{\mathbb{E}\left[(\nu^i - 1) \cdot \rho_2^i \cdot (k_1^i)^\alpha \mid \lambda\right]}_{\textit{Direct component}} + \\ &\quad \underbrace{-\mathbb{E}\left[(\nu^i - 1) \cdot (k_1^i - k_0^i \cdot \mathbb{1}_{w_1^i > 0}) \mid \lambda\right] \cdot \frac{dq_1}{d\lambda}}_{\textit{Indirect component}}. \end{aligned} \tag{26}$$

As the capital stock is fixed at $\bar{K}$, changes in λ only affect output through its effect on allocative efficiency, i.e., by reallocating capital across entrepreneurs. Proposition 2 decomposes this effect of λ into a direct and an indirect – i.e., general-equilibrium – component.

The direct component captures the effect of λ on capital allocation and output for a *given price of capital*. It represents the reallocation of capital from unconstrained to constrained entrepreneurs brought about by an increase in λ if the price of capital were fixed. Clearly, this direct component is always positive because $\nu > 1$ for constrained entrepreneurs.

The indirect component captures instead the effect of λ on capital reallocation that operates through the equilibrium price of capital q_1. The sign of this component is ambiguous and lies at the heart of our analysis: in particular, since q_1 is increasing in λ, its sign depends on whether productive entrepreneurs are on average *buyers* or *sellers* of capital.[4] If relatively productive (i.e., high ν) entrepreneurs are sellers of capital (i.e., $k_1 - k_0 \cdot \mathbb{1}_{w_1>0} < 0$), the indirect component of an increase in λ is positive and reinforces the direct component. Intuitively, a high value of λ raises the price of capital, which implies that productive entrepreneurs need to sell less units of capital, thereby boosting output. If relatively productive entrepreneurs are instead buyers of capital (i.e., $k_1 - k_0 \cdot \mathbb{1}_{w_1>0} > 0$), the indirect component of an increase in λ is negative and works against the direct component. Intuitively, a high value of λ raises the price of capital, which

[4]Throughout, we focus on equilibria in which q_1 is increasing in λ. Although there may also exist equilibria in which the opposite is true, these are unstable and lead to counter-intuitive results (e.g., an increase in the demand for capital leads to a fall in the equilibrium price of capital).

implies that productive entrepreneurs are able to buy less units of capital, thereby reducing output. Clearly, entrepreneurs that renegotiate their debts are buyers of capital, since their pre-existing capital stock, k_0, is fully appropriated by creditors.

Proposition 2 suggests that general-equilibrium forces play a key role in shaping the effects of financial crises, and that the direction of these forces depends on whether the most productive entrepreneurs are buyers or sellers of capital. Building on this insight, we distinguish between two types of crises:

Definition 2 *Define a financial crisis as a state in which $\lambda < \lambda^\star$, so that financial constraints bind, and output and asset prices are depressed. Then, in a crisis state λ:*

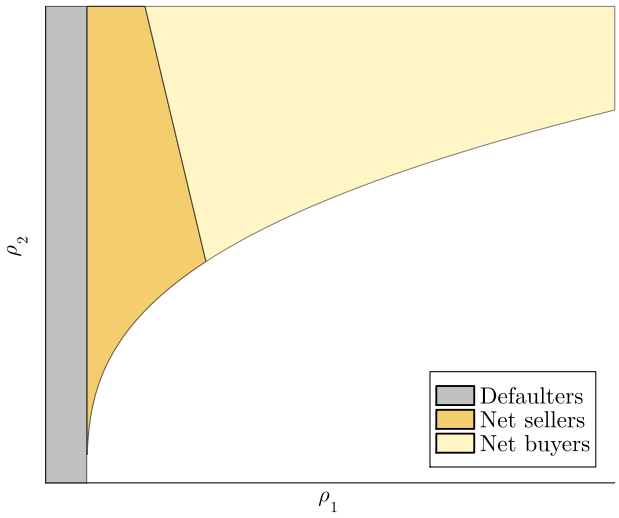
- *If $\mathbb{E}\left[(\nu^i - 1) \cdot (k_1^i - k_0^i \cdot \mathbb{1}_{w_1^i > 0}) \mid \lambda\right] < 0$, constrained (i.e., high ν) entrepreneurs are on average sellers of capital and we say there is a **fire-sale crisis**.*
- *If $\mathbb{E}\left[(\nu^i - 1) \cdot (k_1^i - k_0^i \cdot \mathbb{1}_{w_1^i > 0}) \mid \lambda\right] > 0$, constrained (i.e., high ν) entrepreneurs are on average net buyers of capital and we say there is a **demand-freeze crisis**.*

In what follows, we compare fire-sale and demand-freeze crises and draw out their policy implications. Before that, Panel (a) of Figure 1 characterizes the set of constrained entrepreneurs at $t = 1$, for given values of b_1 and λ. As the figure shows, entrepreneurs can be constrained either because they have low net worth – due to a low realization of ρ_1 – or because they have a high demand for capital – due to a high realization of ρ_2. The figure also shows that not all constrained entrepreneurs are alike. The shaded gray area depicts entrepreneurs that renegotiate their debts, i.e., with $\rho_1 \cdot \bar{K}^\alpha + q_1 \cdot \bar{K} < b_1$. The shaded red area depicts entrepreneurs that repay their debts in full and who are net sellers of capital, i.e., with $k_1 < k_0$. Finally, the shaded blue area depicts entrepreneurs that repay their debts in full and are net buyers of capital, i.e., with $k_1 > k_0$.

Figure 1 distinguishes among constrained entrepreneurs depending on their behavior, i.e., on whether they renegotiate their debts or whether they are net sellers or buyers of capital. It is also useful to distinguish among constrained entrepreneurs depending on whether they benefit from or are hurt by an increase in the price of capital.

Definition 3 *Consider a constrained entrepreneur i during a crisis, i.e., $\nu^i > 1$:*

- *If $k_1^i - k_0^i \cdot \mathbb{1}_{w_1^i > 0} < 0$, we say entrepreneur i is a fire seller.*
- *If $k_1^i - k_0^i \cdot \mathbb{1}_{w_1^i > 0} > 0$, we say entrepreneur i is a frozen buyer.*



(b) **Types of constrained entrepreneurs**

Figure 1: Illustrates the types of entrepreneurs during crises, depending on ρ_1^i and ρ_2^i.

Proposition 2 implies that the direction and strength of the indirect component depend on the share of constrained entrepreneurs and on their distribution between fire sellers and frozen buyers, as defined in Definition 3. This distribution is an endogenous object and is difficult to characterize in full generality. For this reason, we use two stylized economies to illustrate the key implications of the theory analytically, before studying these implications numerically in an empirically plausible, calibrated economy.

3.2 Two stylized economies

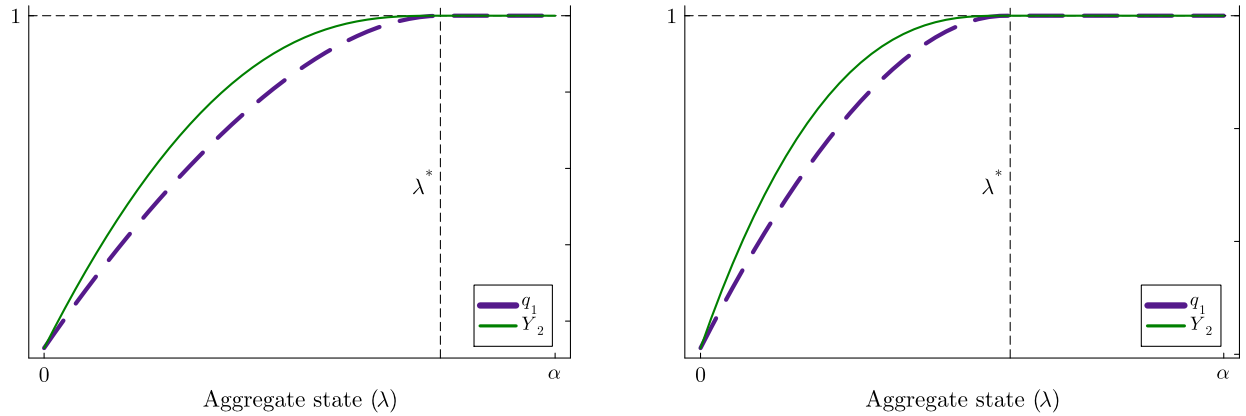
We use two stylized economies to illustrate the effects of financial crises, and to show that not all crises are alike. We define a **fire-sale economy** as one in which $\rho_1^i \sim U[0,2]$ and $\rho_2^i = 1$, for $i \in I^E$. We define a **demand-freeze economy** as one in which $\rho_1^i = 1$ and $\rho_2^i \sim U[0,2]$, for $i \in I^E$. In both economies, entrepreneurial endowment, w, is assumed to be large enough so as to rule out debt renegotiation in equilibrium.[5] As we shall see, a convenient implication of this setup is that the fire-sale economy suffers only from fire-sale crises, whereas the demand-freeze economy suffers only from demand-freeze crises (Definition 2).

Figure 2 depicts the equilibrium price of capital, q_1, and output, Y_2, as a function of λ. Panels

[5]In the demand-freeze economy, this will be ensured by Assumption 2. In the fire-sale economy, it suffices to assume that entrepreneurial endowment satisfies:

$$w \geq 2 \cdot \alpha \cdot \bar{K} + \left(\frac{3}{4} \cdot \alpha^{\frac{2}{1-\alpha}}\right)^{\frac{1}{1-2\cdot\frac{\alpha}{1-\alpha}}} \cdot \bar{K}^{1-\frac{2}{1-2\cdot\frac{\alpha}{1-\alpha}}}.$$

(a) and (b) depict these variables for the fire-sale and the demand-freeze economies, respectively. Both economies are consistent with Proposition 1. There exists a threshold value $\lambda^\star$ such that, whenever $\lambda \geq \lambda^\star$, financial constraints do not bind at $t = 1$ and prices and quantities are as in the efficient benchmark. For levels of λ below $\lambda^\star$, however, financial constraints bind, thereby distorting the allocation of capital. Consequently, both asset prices and output fall relative to the efficient benchmark. Figure 2 suggests that financial crises in the fire-sale and demand-freeze economies are similar to each other and consistent with the conventional narrative. Namely, they are characterized by low asset prices and depressed output. However, this similarity masks a crucial difference regarding the source of the inefficient capital allocation.



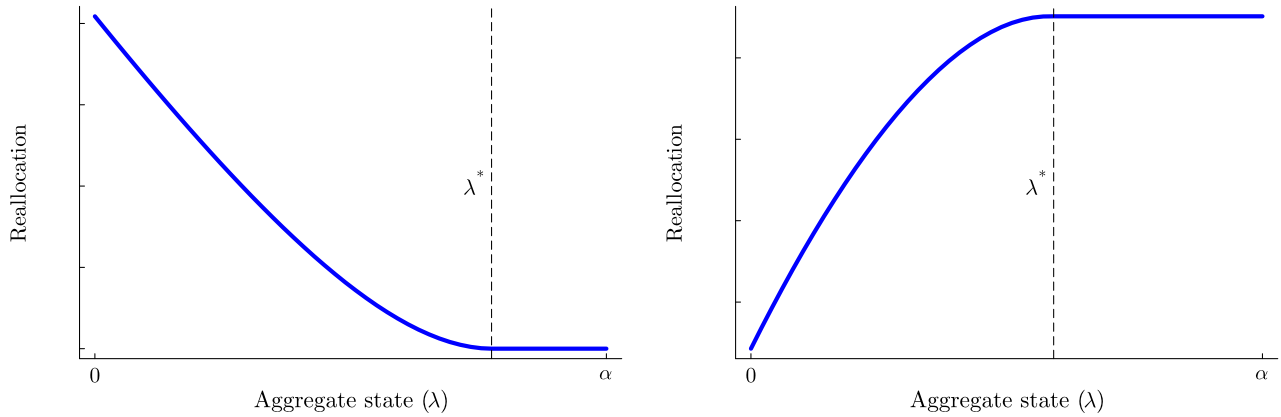
(a) **Fire-sale economy** (b) **Demand-freeze economy**

Figure 2: Illustrates output (Y_2) and the price of capital (q_1) across aggregate states (λ), relative to their counterparts, $Y_2^\star$ and $q_1^\star$, in the efficient benchmark (see Lemma 1).

In the fire-sale economy, entrepreneurs at $t = 1$ have the same productivity of investment going forward, ρ_2, but they differ in their net worth, w_1, due to heterogeneity in realized productivity, ρ_1. Thus, during a crisis, it is entrepreneurs with low ρ_1 who are constrained. In the terminology of Definition 3, these entrepreneurs are fire sellers: due to their low net worth and are forced to sell capital to repay their debts. In the demand-freeze economy, instead, entrepreneurs at $t = 1$ have the same net worth, w_1, as they coincide in the realized productivity, ρ_1, but they differ in the productivity of their investment going forward, ρ_2. Therefore, during a crisis, it is entrepreneurs with high ρ_2 who are constrained. In the terminology of Definition 3, these entrepreneurs are frozen buyers: due to binding financial constraints, they are unable to buy as much capital as they would like. This distinction has crucial implications for the role of capital reallocation during crises, for the sign and strength of the indirect component outlined in Proposition (2) and, ultimately, for the effective design of policy.

Consider first the behavior of capital reallocation during crises. In the fire-sale economy,

capital reallocation is counter-cyclical because crises are times of expanded trade. During normal times, there is no need to reallocate capital because all entrepreneurs have the same productivity of investment going forward. In crisis times, however, reallocation is high because entrepreneurs with low net worth are forced to sell part of their capital. In the demand freeze economy, capital reallocation is instead pro-cyclical because crises are times of restricted trade. In normal times, capital reallocation is high as entrepreneurs with a high realization of ρ_2 can borrow to purchase all the capital they desire. In crisis times, however, reallocation is low because financial constraints limit the amount of capital that these entrepreneurs can buy. This distinction between the two economies is illustrated in Figure 3, which depicts capital reallocation in both economies as a function of λ. We shall return to this distinction in Section 5, when we discuss the patterns of reallocation in the data.



(a) **Fire-sale economy** (b) **Demand-freeze economy**

Figure 3: Illustrates the share of capital that is traded, $\int (k_1^i - k_0^i)_+ \cdot dG(\rho_1^i, \rho_2^i)/\bar{K}$, across aggregate states (λ).

Consider next the direction of capital reallocation in the two economies, i.e., the types of entrepreneurs who buy and sell capital. In the fire-sale economy, it is entrepreneurs with a high marginal return to investment who sell capital during crises. These entrepreneurs have a low net worth and are forced to sell capital to repay their debts. Thus, as illustrated in Panel (a) of Figure 4, the covariance between ν and $k_1 - k_0$ is negative, constrained entrepreneurs are predominantly fire sellers, and – consequently – this economy only gives rise to fire-sale crises (Definition 2). In the demand-freeze economy, entrepreneurs with a high marginal return to investment are instead buyers of capital during crises. These entrepreneurs want to expand their capital holdings, but their ability to do so is limited by tight financial constraints. Thus, as illustrated in Panel (b) of Figure 4, the covariance between ν and $k_1 - k_0$ is positive, constrained entrepreneurs are frozen buyers and – consequently – this economy only gives rise to demand-

freeze crises.

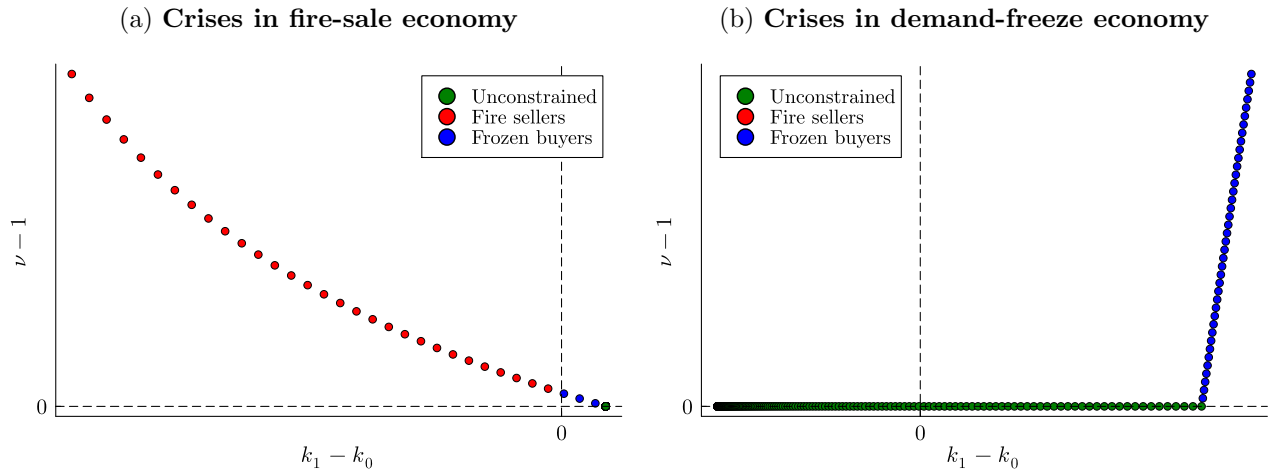


Figure 4: Illustrates the relationship between entrepreneurs' marginal value of net worth (ν) and their net demand for capital ($k_0 - k_1$).

The two stylized economies constructed here provide useful benchmarks to characterize fire-sale and demand-freeze crises. Crucially, in the fire-sale economy, the fall in the price of capital aggravates the crisis: since high-productivity entrepreneurs are net sellers of capital, low capital prices force them to sell even more capital to repay their debts. In the demand-freeze economy, the fall in the price of capital instead alleviates the crisis: since high-productivity entrepreneurs are net buyers of capital, low capital prices allow them to raise their investment. As we shall see in Section 4, this distinction is crucial for the effective design of policies.

Albeit pedagogical, these stylized economies are special in two respects. First, they are based on simplistic productivity processes, in which entrepreneurs differ only in their $t = 1$ or their $t = 2$ productivity. Second, they rely on a parametrization that rules out equilibrium debt renegotiation. We now extend our analysis to a more realistic, calibrated economy.

3.3 Crises in a "calibrated" economy

We assume that entrepreneurial productivity is well captured in logarithmic form by an AR(1) process:[6]

$$\log(\rho_1) \sim \mathcal{N}\left(\frac{a}{1-\gamma}, \frac{\sigma_\varepsilon^2}{1-\gamma^2}\right) \text{ with } a \text{ s.t. } E[\rho_1] = 1, \tag{27}$$

$$\log(\rho_2) = a + \gamma \cdot \log(\rho_1) + \varepsilon \quad \text{with} \quad \varepsilon \sim \mathcal{N}\left(0, \sigma_\varepsilon^2\right). \tag{28}$$

We set $\gamma = 0.9$ and $\sigma_\varepsilon = 0.1$ and consider a period to be a quarter [7]. This baseline value of γ as a quarterly persistence parameter is common in the firm-dynamics and the financial-frictions literature for the U.S. (e.g., Khan and Thomas (2013); Gilchrist et al. (2014); İmrohoroğlu and Tüzel (2014)). The standard deviation of the innovation is set to $\sigma_\varepsilon = 0.1$, which is in the middle of the range of values commonly used in the firm-dynamics literature.[8] We set $\alpha = 0.65$, a common value for the decreasing returns of firms' operating profits as a function of capital in the corporate finance literature (e.g., Hennessy and Whited (2007)). The level of entrepreneurial endowment w is set to deliver a debt-to-assets ratio of 0.65 at $t = 0$, following the mean ratio of liabilities to total assets for non-financial companies estimated by Kalemli-Ozcan et al. (2012). Finally, we assume a distribution $F(\lambda) = \lambda^\beta$ over the aggregate states and calibrate β to generate a 4% chance of a crisis (e.g., Jordà et al. (2017), Paul (2020)).

Panel (a) of Figure 5 depicts the price of capital, q_1, and output, Y_2, in the calibrated economy as a function of λ. As in the fire-sale and demand-freeze benchmarks, financial crises are times of low asset prices and output. Panel (b) of the figure depicts the share of the total capital stock that is reallocated across entrepreneurs. As in the demand-freeze economy of the previous section, the volume of reallocation in the calibrated economy is lower during crises than in normal times.

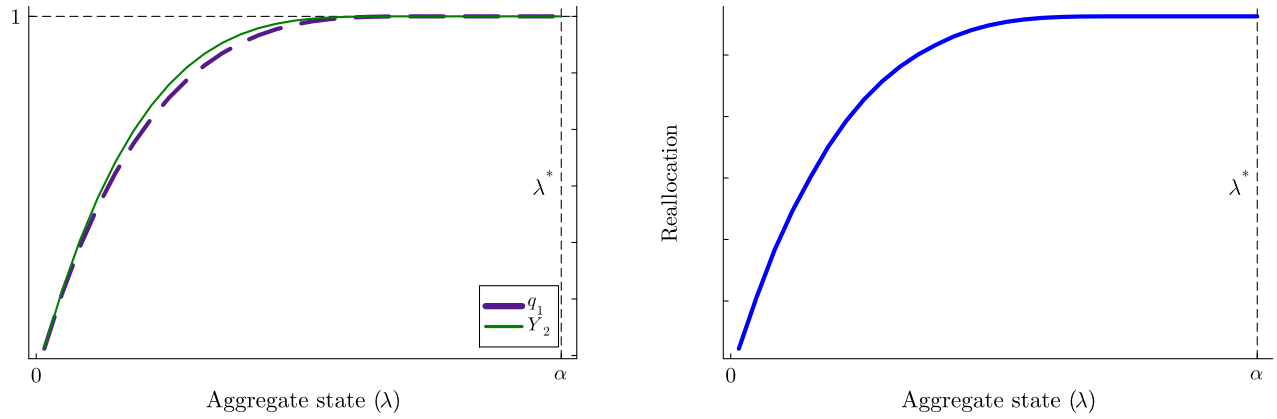
To illuminate the nature of financial crises in the calibrated economy, Panel (a) of Figure 6 plots a random sample of 20,000 entrepreneurs in (ρ_1, ρ_2)-space for a crisis with $\lambda = 0.1$. The yellow region marks combinations of (ρ_1, ρ_2) at which entrepreneurs are financially constrained. Most constrained entrepreneurs are net buyers of capital (blue), with a smaller share being net sellers (red).[9] In this respect, the calibrated economy echoes the demand-freeze benchmark:

[6] Given that the implied support of the distribution $G(\rho_1, \rho_2)$ is $(0, \infty) \times (0, \infty)$, it is straightforward to check that Assumptions 1 and 2 are satisfied in the calibrated economy.

[7] In the Appendix, we extend the analysis to $\gamma = 0.65$ and consider a period to be a year

[8] E.g., Gilchrist et al. (2014) or İmrohoroğlu and Tüzel (2014) would suggest $\sigma_\varepsilon \approx 0.15$. Khan and Thomas (2013) use a value consistent with a quarterly $\sigma_\varepsilon \approx 0.065$.

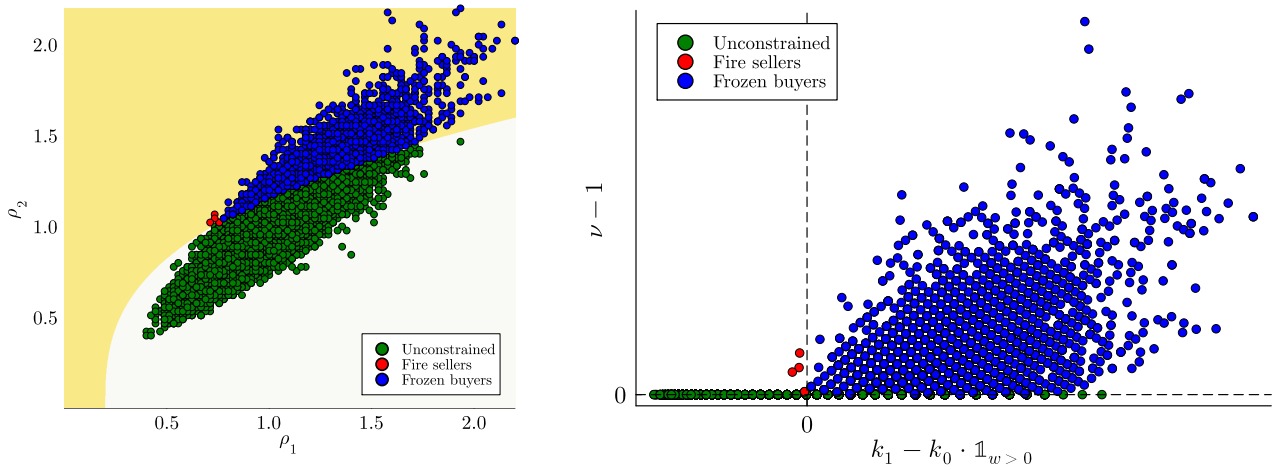
[9] Entrepreneurs who renegotiate their debt—those with ρ_1 sufficiently close to zero—are part of the equilib-



(a) **Asset prices and output** (b) **Reallocation**

Figure 5: Illustrates the behavior of asset prices, output and capital reallocation as a function of λ.

during crises, most constrained agents are frozen buyers, expanding but less than desired. The mechanism is the interplay of persistent productivity and concave technology. Entrepreneurs with higher net worth (high ρ_1) tend to have higher future productivity (high ρ_2); because concavity makes desired investment rise more than proportionally with ρ_2, the highest productivity types—those with high (ρ_1, ρ_2)—are precisely the ones most likely to hit financial constraints.



(a) **Types of constrained entrepreneurs** (b) **Capital reallocation and productivity**

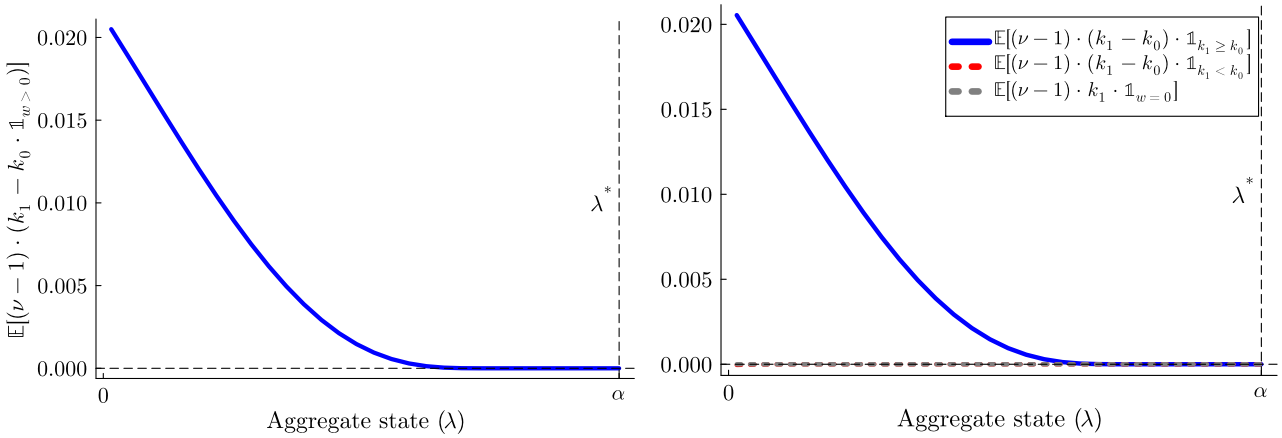
Figure 6: Characteristics of financial crises in the calibrated economy.

Panel (b) of Figure 6 depicts entrepreneurs' marginal value of net worth, ν, against their net purchases of capital, $k_1 - k_0 \cdot \mathbb{1}_{w_1>0}$, during the crisis. The correlation between the two variables is once again reminiscent of the demand-freeze economy depicted in Panel (b) of Figure 4.

rium but do not appear in the simulated sample because the renegotiation probability is extremely small (about 10^{-11}).

Unconstrained entrepreneurs adjust their capital stock until their marginal value of net worth equals one. Constrained entrepreneurs, who have a high marginal value of net worth, are largely net buyers of capital but their ability to expand is limited by the financial constraint. Unlike the stylized demand-freeze economy, there is now some variation in entrepreneurs' marginal value of wealth for each level of capital purchases: the reason is that, given the calibrated productivity process, entrepreneurs differ in both ρ_1 and ρ_2.

This discussion suggests that, in line with Definition 2, $\mathbb{E}\left[(\nu^i - 1) \cdot (k_1^i - k_0^i \cdot \mathbb{1}_{w_1^i > 0}) \mid \lambda\right] > 0$ in the calibrated Economy. Figure 7 confirms this to be the case. Panel (a) shows that the expectation term is positive *for all* $\lambda < \lambda^\star$: namely, in the calibrated economy, all crises are demand-freeze crises. Panel (b) decomposes the expectation term into the contributions by net buyers, net sellers, and entrepreneurs who renegotiate their debts. As the figure shows, the expectation term is driven solely by the prevalence of net buyers: in the calibrated economy, neither debt renegotiation nor fire sellers are common. Interestingly, the expectation terms becomes larger as the crisis becomes more severe, i.e., for smaller values of λ, since low asset prices during severe crises increases entrepreneurs' desire to expand.



(a) **Expectation term of indirect component** (b) **Expectation term, decomposition**

Figure 7: Expectation term of the indirect component of $\frac{dY}{d\lambda}$ in the calibrated economy.

In sum, once the economy is calibrated to an empirically disciplined productivity process and allows for equilibrium debt renegotiation, financial crises primarily take the form of demand freezes. Asset prices and output fall, capital reallocation is muted, and constrained entrepreneurs—those with a high marginal value of net worth—are net buyers of capital. Consequently, in the calibrated economy the indirect (general-equilibrium) component of changes in λ identified in Proposition 2 dampens, rather than amplifies, crisis effects: lower asset prices during crises facilitate the reallocation of capital toward constrained entrepreneurs. As we now

show, this has first-order implications for policy design.

4 Policy implications

We now turn to policy design for financial crises, focusing on "credit easing"—reductions in policy rates and large-scale asset purchases—which, under conventional wisdom, help mitigate crisis costs.

4.1 Crisis interventions

We focus throughout on the ex-post effect of policies, i.e., on the effects of crisis interventions at $t = 1$. We can interpret our analysis as applying to policies in a given state $\lambda < \lambda^\star$, which does not affect entrepreneurial choices at $t = 0$ because any such state has a zero probability of occurring from an ex-ante perspective.

We model interest-rate policies as taxes or subsidies to the use of storage at $t = 1$. Letting τ denote the tax rate imposed on storage at $t = 1$, it follows that $R_1 = 1-\tau$ in equilibrium. Thus, we henceforth use R_1 directly to capture the policy. To model asset purchases, we assume that the government can purchase K^g units of capital at $t = 1$ and use them to produce output at $t = 2$ according to a public technology:

$$Y_2^g = \rho^g \cdot K^g. \tag{29}$$

We assume that the costs and/or revenues generated by either policy are transferred lump-sum to savers.

In the presence of crisis interventions, aggregate output can be expressed as:

$$Y_2(\lambda, R_1, K^g) = \int \rho_2^i \cdot k_1\left(w^i, s^i, \lambda\right)^\alpha \cdot dG(\rho_1^i, \rho_2^i) + \rho^g \cdot K^g, \tag{30}$$

where:

$$k_1\left(w^i, s^i, \lambda\right) \equiv \min\left\{\left(\frac{\alpha \cdot \rho_2^i}{q_1(\lambda, R_1, K^g) \cdot R_1}\right)^{\frac{1}{1-\alpha}}, x\right\} \tag{31}$$

for $x \geq 0$ that satisfies:

$$q_1\left(\lambda, R_1, K^g\right) \cdot x = w_1^i + \frac{\lambda \cdot \rho_2^i \cdot x^\alpha}{R_1}. \tag{32}$$

Finally, the marginal value of net worth for entrepreneur i is now given by:

$$\nu(w_1^i, s^i, \lambda) \equiv \frac{(1-\lambda)\cdot\alpha\cdot\rho_2^i\cdot k_1\left(w^i, s^i, \lambda\right)^{\alpha-1}}{q_1(\lambda, R_1, K^g)\cdot R_1 - \lambda\cdot\alpha\cdot\rho_2^i\cdot k_1\left(w^i, s^i, \lambda\right)^{\alpha-1}}\cdot R_1. \tag{33}$$

The notation $Y_2(\lambda, R_1, K^g)$ and $q_1(\lambda, R_1, K^g)$ makes it explicit that output and asset prices now also depend on policies R_1 and K^g. Equations (31)-(33), in turn, generalize the capital demand and the marginal value of net worth of Equations (9) and (13) to the case where the interest rate may not equal the technological return to storage, i.e., $R_1 \neq 1$. Lastly, the price of capital must clear the market for capital:

$$\int k_1\left(w^i, s^i, \lambda\right)\cdot dG(\rho_1^i, \rho_2^i) + K^g = \bar{K}. \tag{34}$$

Equations (30)-(34) can be used to characterize the effects of policy interventions on output and welfare, where the latter is as before given by Equation (20).

It is immediate that a decline in R_1 boosts the demand for capital of all entrepreneurs and, hence, raises the equilibrium price of capital q_1. To analyze the overall effect of the policy on output, it is once again useful to decompose it into a direct and an indirect component, where the indirect component operates through the equilibrium price of capital.

Proposition 3 *Consider a competitive equilibrium in a crisis state $\lambda < \lambda^\star$ absent policy intervention. The effect of a small increase in the interest rate on output Y_2 is given by:*

$$\frac{dY_2}{dR_1} = \underbrace{-\mathbb{E}\left[\left(\nu^i - 1\right)\cdot\lambda\cdot\rho_2^i\cdot\left(k_1^i\right)^\alpha \;|\lambda\right]}_{\textit{Direct component}} \underbrace{-\mathbb{E}\left[\left(\nu^i-1\right)\cdot\left(k_1^i - k_0^i\cdot\mathbb{1}_{w_1^i>0}\right)|\lambda\right]\cdot\frac{dq_1}{dR_1}}_{\textit{Indirect component}}. \tag{35}$$

The direct component in Equation (35) captures the effect of the interest rate on the allocation of capital and output for a *given price of capital*. It is unambiguously negative: a lower rate relaxes financial constraints, thereby promoting reallocation from unconstrained to constrained entrepreneurs (who have the higher marginal value of net worth).

The indirect component in Equation (35) captures instead the effect of the interest rate on capital reallocation that operates through the equilibrium price of capital q_1. Its sign hinges on the nature of the crisis at hand. In a fire-sale crisis, $\mathbb{E}\left[\left(\nu^i-1\right)\cdot\left(k_1^i - k_0^i\cdot\mathbb{1}_{w_1^i>0}\right)|\lambda\right] < 0$, so the indirect component reinforces the expansionary effect of an interest-rate cut. By raising q_1, a lower rate reduces the need for productive entrepreneurs to liquidate capital to repay debts. In a demand-freeze crisis, $\mathbb{E}\left[\left(\nu^i-1\right)\cdot\left(k_1^i - k_0^i\cdot\mathbb{1}_{w_1^i>0}\right)|\lambda\right] > 0$, so the indirect component

attenuates the expansion from a rate cut. By raising q_1, a lower rate limits the ability of productive entrepreneurs to purchase capital.

The effects of asset purchases can likewise be expressed as the sum of a direct and an indirect component.

Proposition 4 *Consider a competitive equilibrium in a crisis state $\lambda < \lambda^\star$ absent policy intervention. The effect of a small increase in asset purchases on output Y_2 is given by:*

$$\frac{dY_2}{dK^g} = \underbrace{\rho^g - q_1}_{\textit{Direct component}} \underbrace{- \mathbb{E}\left[(\nu^i - 1) \cdot (k_1^i - k_0^i \cdot \mathbb{1}_{w_1^i > 0}) \mid \lambda\right] \cdot \frac{dq_1}{dK^g}}_{\textit{Indirect component}}. \tag{36}$$

The direct component in Equation (36) captures the effect of asset purchases on output for a *given price of capital*. Since asset purchases reallocate capital towards the public technology, the sign of the direct component depends on the marginal productivity of capital in the public sector ρ^g relative to its marginal productivity in the private sector q_1.

The indirect component in in Equation (36) captures instead the effect of asset purchases that operates through the equilibrium price of capital q_1. Once again, its sign hinges on the nature of the crisis at hand. In a fire-sale crisis, $\mathbb{E}\left[(\nu^i - 1) \cdot (k_1^i - k_0^i \cdot \mathbb{1}_{w_1^i > 0}) \mid \lambda\right] < 0$, so the indirect component is expansionary. By raising q_1, asset purchases reduce the need for productive entrepreneurs to liquidate capital. In a demand-freeze crisis, $\mathbb{E}\left[(\nu^i - 1) \cdot (k_1^i - k_0^i \cdot \mathbb{1}_{w_1^i > 0}) \mid \lambda\right] > 0$, so the indirect component is contractionary. By raising q_1, asset purchases limit the ability of productive entrepreneurs to purchase capital.

In sum, both interest-rate cuts and asset purchases raise the equilibrium price of capital q_1. The resulting price increase can mitigate a fire-sale crisis (by easing deleveraging) but worsen a demand-freeze crisis (by pricing out constrained buyers). As we show next, this indirect channel can be sizable and may even dominate the direct effect. We begin by quantifying both policies in stylized fire-sale and demand-freeze economies, and then turn to the calibrated benchmark.

4.2 Two stylized economies: redux

We return to the stylized benchmarks of Section 3.2. In the fire-sale economy, entrepreneurs differ only in ρ_1; in the demand-freeze economy, they differ only in ρ_2. Throughout, entrepreneurial net worth is assumed to be sufficiently high to rule out debt renegotiation in equilibrium.

Figure 8 illustrates the effects of interest-rate policy and asset purchases in the fire-sale economy during a crisis ($\lambda = 0.1$). In this setting, the indirect channel reinforces policy stimulus. Accordingly, Panel (a) shows that rate cuts raise both the capital price q_1 and output. Panel

(b) reports the effects of asset purchases: they initially lift output for the same reason, but can turn contractionary as the productivity wedge between the private and public sector, $q_1 - \rho^g$, widens.

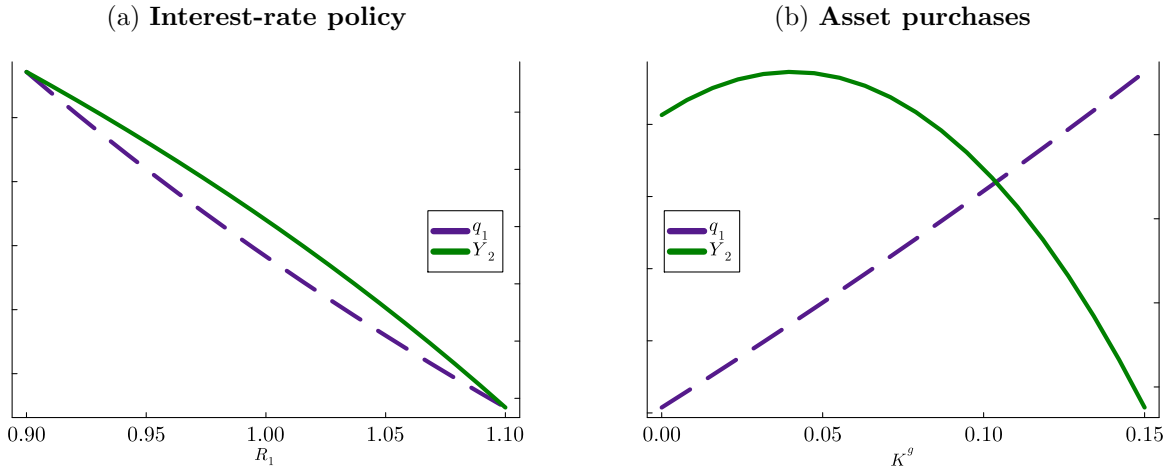


Figure 8: Fire-sale economy: Y_2 and q_1 as a function of R_1 and K^g in crisis state ($\lambda = 0.1$)

Figure 9 illustrates instead the effects of interest-rate policy and asset purchases in the fire-sale economy during a crisis ($\lambda = 0.1$). In this setting, remember that the indirect channel weakens policy stimulus. In the case of interest-rate cuts, as Panel (a) shows, the indirect component is dominant! Thus, rate cuts raise the capital price q_1 but they reduce output. Panel (b) reports the effects of asset purchases. In the demand-freeze economy, they are always contractionary, as they reduce output both through the direct component, i.e., by reallocating capital towards the less productive public sector, and through the indirect component, i.e., by reducing the ability of constrained entrepreneurs to purchase capital.

Although the fire-sale and demand-freeze economies share key crisis features—depressed asset prices and heightened misallocation—the policy prescriptions differ materially. In the fire-sale economy, instruments that raise the capital price q_1—policy rate cuts and asset purchases—operate through both the direct and indirect channels to increase output (with asset purchases turning contractionary only when the public–private productivity wedge is sufficiently large). By contrast, in the demand-freeze economy the indirect channel dominates: higher q_1 impedes reallocation toward constrained buyers and can more than offset the direct effect, so rate cuts reduce output and asset purchases are contractionary.

(a) **Interest-rate policy** (b) **Asset purchases**

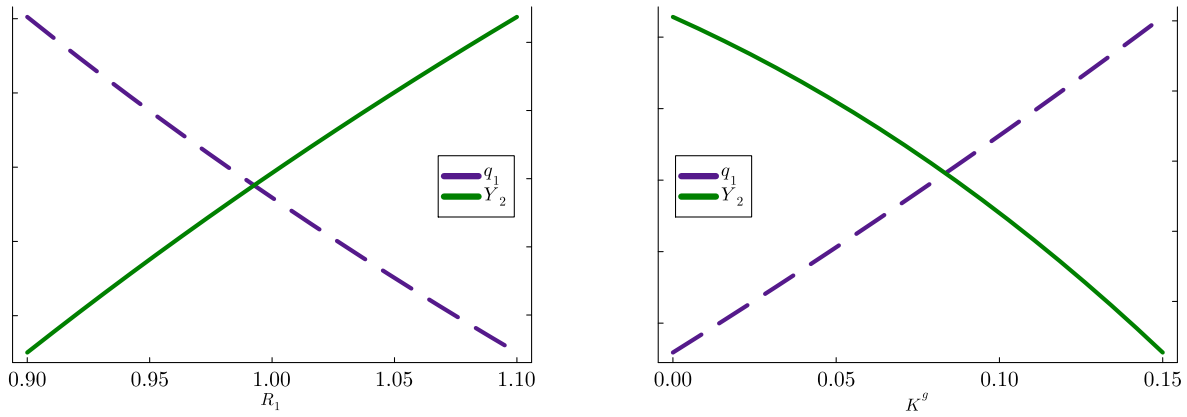


Figure 9: Demand-freeze economy: Y_2 and q_1 as a function of R_1 and K^g in crisis state ($\lambda = 0.1$)

4.3 Policy in the calibrated economy

We now turn to the effects of policy in the calibrated economy. Panels (a) and (b) in Figure 10 respectively illustrate the effects of interest-rate policy and asset purchases in the calibrated economy. The figure depicts the effect of policies when $\lambda = 0.1$ and the marginal productivity of capital in the public sector, ρ^g, is equal to its productivity in the private sector in the absence of policy.

(a) **Interest-rate policy** (b) **Asset purchases**

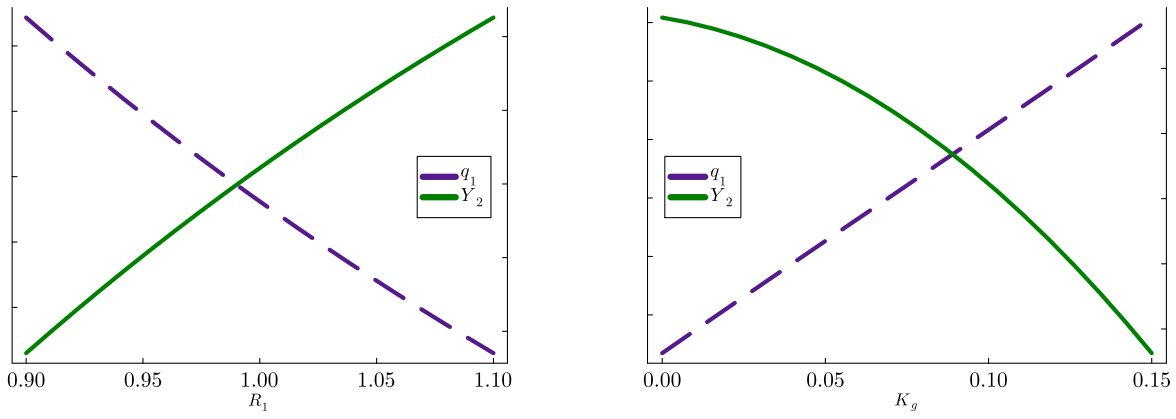


Figure 10: Calibrated economy: Y_2 and q_1 as a function of R_1 and K^g in crisis state ($\lambda = 0.1$)

Once again, due to the combination of persistent productivity and a concave technology, the calibrated economy features demand-freeze crises. Panel (a) shows that, in fact, the indirect

channel of interest-rate cuts is not only positive but it dominates the direct channel. Consequently, cuts in the interest rate are contractionary in the calibrated economy. Panel (b) shows that asset purchases are also contractionary. The direct channel of asset purchases is increasingly negative as the marginal productivity of capital in the private sector rises above ρ^G, and the indirect channel is also negative because – given the demand-freeze nature of the crisis – higher asset prices prevent the reallocation of capital towards constrained entrepreneurs.

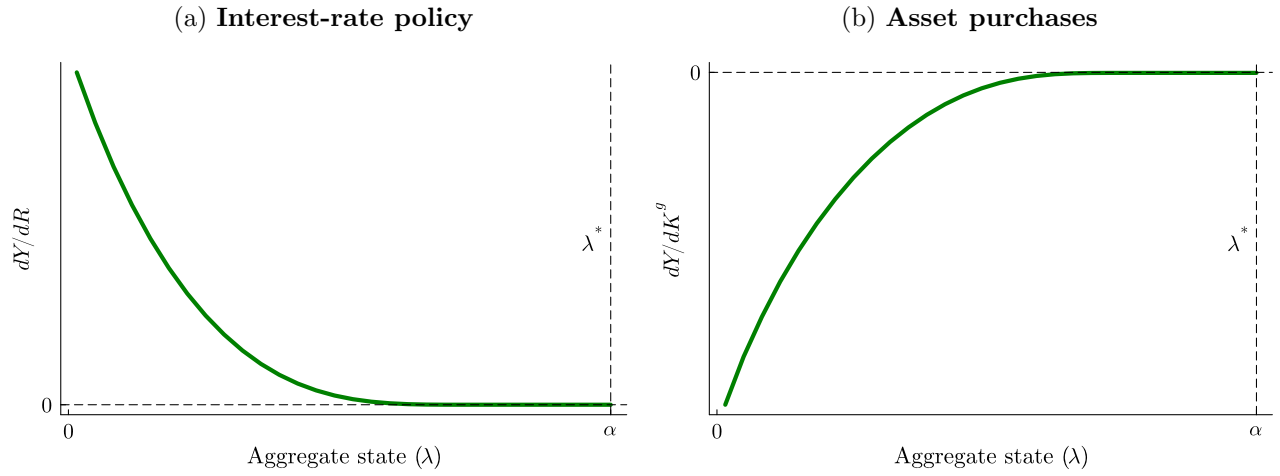


Figure 11: Calibrated economy: effect of policy interventions on output, across aggregate states (λ)

Figure 11 extends these results beyond the illustrative case $\lambda = 0.1$. Starting from the non-intervention equilibrium, Panel (a) reports the marginal effect of the interest rate on output across values of λ. The derivative is positive for all $\lambda < \lambda^\star$, implying that—in the calibrated economy—an interest-rate cut is contractionary in every crisis state. Moreover, the contractionary impact is strongest in the most severe crises, because the direct component vanishes as $\lambda \to 0$ (see Equation (35)). Panel (b) shows the marginal effect of asset purchases on output across λ: asset purchases are likewise contractionary throughout, and increasingly so as the crisis intensifies.

While the theory allows for ambiguity—policy effects hinge on general-equilibrium feedback through q_1—the quantitative results indicate that this is not a mere theoretical possibility. The indirect channel is pivotal in the economy calibrated to match the joint evolution of firm-level productivity and leverage. Taken together, the theory and the numerical exercise point to a central insight: policy effectiveness depends critically on the correlation between entrepreneurs' productivity and their net demand for capital (buyers vs. sellers). We next examine this correlation in the data.

5 Reallocation in the data

Real-world crises likely combine aspects of both fire-sales and demand-freezes. In the following, we use the predictions of our model to motivate a reduced-form analysis of the patterns of capital reallocation over the business cycle, both in the aggregate and across firms, in U.S. data.

To do so, note that we can express the expectations-term in the indirect component as follows:

$$\begin{aligned}\mathbb{E}\left[(\nu^i-1)\cdot(k_1^i-k_0^i\cdot\mathbb{1}_{w_1^i>0})\mid\lambda\right] &= \mathbb{COV}\left(\nu^i,k_1^i-k_0^i\mid\lambda\right)+\mathbb{E}\left[(\nu^i-1)\cdot k_0^i\cdot\mathbb{1}_{w_1^i=0}\mid\lambda\right]\\ &\geq \mathbb{COV}\left(\nu^i,k_1^i-k_0^i\mid\lambda\right), \qquad (37)\end{aligned}$$

where the last inequality follows because the product of $\nu-1$ and k_0 is weakly positive.

Equation (37) says that the expectations term in the indirect component is bounded below by the covariance between ν and net capital purchases, k_1-k_0. This has important conceptual and empirical implications. Conceptually, it yields a sufficient statistic for detecting a demand-freeze crisis: if $\mathbb{COV}\left(\nu^i,k_1^i-k_0^i\mid\lambda\right)>0$, the crisis must be of the demand-freeze variety.[10] Practically, this covariance is directly measurable using firm-level data by relating the marginal product of capital to net investment. In what follows, we implement this test using Compustat.

5.1 Data

As the firm-level dataset we use the quarterly Compustat universe of publicly listed U.S. incorporated firms, during the period 1983Q3–2019Q3. Our central measure of firm i's overall (gross) capital accumulation ($I_{i,t}$) is its reported *Capital Expenditures* in quarter t (denoted as $Capx_{i,t}$), net of *Sale of Property Plant, and Equipment* ($Sale_{i,t}$). When constructing investment rates, we take its ratio relative to the book value of tangible capital stock $k_{i,t-1}$, in place at the end of quarter $t-1$, measured as the Compustat item *Property, Plant, and Equipment (Net)*.[11] To more directly study the reallocation of *existing* capital, we also consider only focusing on the proxies for the sale of existing capital by $Sale_{i,t}$, and the purchases of existing capital with the *Acquisitions* item ($Acq_{i,t}$). This follows conventional approaches in the literature on capital reallocation (e.g., Eisfeldt and Rampini, 2006). As $Capx_{i,t}$ does not include the capital obtained through acquiring other firms, we also consider an acquisitions-augmented gross investment

[10] It also yields a necessary statistic for detecting a fire-sale crisis. If a crisis is of the fire-sale variety, the covariance must be negative.

[11] See Appendix A.1 for further detail on sample selection and variable construction.

measure $I^a_{i,t} \equiv Capx_{i,t} - Sale_{i,t} + Acq_{i,t}$.

As the proxy for firm i's (log) marginal revenue product of capital in quarter t ($\text{MRPK}_{i,t}$), we employ its (log) average revenue product of capital ($\text{ARPK}_{i,t}$). The justification for this is that all our panel regressions include detailed (SIC2) industry fixed effects, so as long as $\text{ARPK}_{i,t}$ is proportional to $\text{MRPK}_{i,t}$ conditional on industry-specific capital shares, the between-firm variation in $\log(\text{ARPK}_{i,t})$ is identical to that of $\log(\text{MRPK}_{i,t})$, as the industry fixed effects control for the industry-specific capital shares.

Our estimated panel regressions also include a variety of other firm-level observables as controls. As the measure of a firm's leverage we employ its total debt divided by its total assets, both measured at book values. We measure firms' balance sheet liquidity (or, *liquidity ratio* for short) as the ratio of cash and short-term investments to total assets. As the measure of firms' size we employ (log) total book assets. We measure Tobin's q as the market-to-book ratio of total assets. We discuss further details on the sample selection and the construction of other variables used in Appendix A.1.

5.2 The cyclicality of capital reallocation in the aggregate

We first provide evidence that capital reallocation activity is procyclical, as already found in existing work, e.g., by Eisfeldt and Rampini (2006). To do so, we construct aggregate turnover measures based on acquisitions and sales to proxy for capital reallocation. While our data is quarterly, we construct these measures over an annual horizon in order to eliminate any effects of seasonality over quarters. Moreover, micro-level acquisitions and capital sales can be lumpy and erratic, making it potentially difficult to precisely detect systematic responses in investment over shorter horizons. Also, for comparability with Eisfeldt and Rampini (2006) who use the annual Compustat database, we compute a generic measure of turnover over a given year $[t, t+3]$ as the ratio of the sum of all observed firms' acquisitions and/or capital sales during the interval, relative to the sum of their total assets (or tangible capital) in place at the end of quarter $t-1$.

Table 1 reports the correlations between the time series of various aggregate turnover measures during the year implied by quarters $[t, t+3]$, and either real GDP growth between $t-1$ and $t+3$ or – to proxy for financial crises – the Gilchrist and Zakrajšek (2012) excess bond premium (EBP) measured in quarter t. The correlations indicate that capital turnover activity is procyclical in the aggregate – higher whenever real GDP growth is high or when the EBP is low. The correlations are statistically significantly different from zero for a majority of cases. Through the lens of our model, this procyclicality of reallocation activity is the first stylized

fact that hints towards the U.S. economy being more likely prone to demand-freeze, rather than fire-sale crises.

Table 1: Cyclicality of aggregate reallocation measures in Compustat

	Correlation	
Turnover rate	Real GDP growth	EBP
$\frac{\text{Acq.+Sale}}{\text{Assets}_{t-1}}$	0.2421***	-0.2707***
$\frac{\text{Acq.+Sale}}{\text{PP\&E}_{t-1}}$	0.0528	-0.2640***
$\frac{\text{Sale}}{\text{Assets}_{t-1}}$	0.3647***	-0.0693
$\frac{\text{Sale}}{\text{PP\&E}_{t-1}}$	0.3488***	-0.1158
$\frac{\text{Acq.}}{\text{Assets}_{t-1}}$	0.1630*	-0.2740***
$\frac{\text{Acq.}}{\text{PP\&E}_{t-1}}$	0.0051	-0.2516***

5.3 Capital investment and reallocation in the cross-section

In the following, we study how capital accumulation and sales behavior varies in the *cross-section* of firms, and whether these cross-sectional relations change during times of financial turmoil, as measured by the EBP. To do so, we estimate simple panel regressions of the following specification type:

$$y_{i,t} = \alpha_i + \delta_{s,t} + \beta \log(\text{ARPK}_{i,t+1}) + \gamma \log(\text{ARPK}_{i,t+1}) \times s_t^{EBP} + \zeta X_{i,t-1} + u_{i,t} \qquad (38)$$

where $y_{i,t}$ is generic notation for the capital accumulation or sale activity for firm i during quarter t. α_i and $\delta_{s,t}$ denote firm and time×industry (SIC2) fixed effects, respectively. $\text{ARPK}_{i,t+1}$ is measured as the ratio of firm i's revenues in $t+1$ to the capital stock in place in t. Note that this is the relevant timing of interest implied by the indirect component in our model, i.e., whether the covariance of investment activity in t positively or negatively related to the marginal productivity of capital in $t+1$.

$X_{i,t}$ is a vector of firm-level controls, measured as of quarter t. In our baseline, $X_{i,t}$ includes the firm's leverage, liquidity ratio, Tobin's Q and log total assets. s_t^{EBP} denotes an indicator of financial turmoil in quarter t, as calculated based on EBP_t. We consider both a continuous specification, with $s_t^{EBP} = EBP_t$, and dummy-specifications, with s_t^{EBP} being an indicator

variable of whether EBP_t is above a certain percentile of the observed $\{EBP_t\}$ series during the sample period. $u_{i,t}$ are regression error terms. We drop extreme observations of firm-level variables to control for outliers (see Appendix A.1.1) and consider standard errors clustered two-way at the time×industry (SIC3) and firm levels.

In our benchmark specification, $y_{i,t} = 100 \times I_{i,t}/k_{i,t-1}$, meaning i's gross investment rate (net of capital sale) in quarter t. Table 2 presents the corresponding estimates of β and γ. The first column corresponds to a specification in which $s_t^{EBP} = 1$ whenever EBP_t is above the median observed EBP value in our sample. The positive coefficient of $\hat{\beta}$ says that at times of low EBP, meaning "normal times" (when $s_t^{EBP} = 0$), more productive firms accumulate relatively more capital. Quantitatively, a 10% higher $ARPK_{i,t+1}$ predicts a 0.081 pp higher investment rate. The negative estimate of $\hat{\gamma}$ says that in times of financial turmoil, this positive cross-sectional relation between productivity and investment weakens. However, since $|\hat{\gamma}| < |\hat{\beta}|$, the relation between productivity and investment *remains* positive even when EBP is high. Moreover, as we increase the cutoff for "high EBP", and thus focus on the most severe 10% observations of EBP, this weakening of reallocation towards high-productivity firms becomes more pronounced. But again, the cross-sectional relationship between productivity and investment remains positive.

Table 2: Panel regressions for investment rates in "normal" and "crisis" times

	High EBP_t cutoff:			
Dep. var.: $100 \times I_{i,t}/k_{i,t-1}$	p50	p75	p90	Cont.
$\log(ARPK_{i,t+1})$	0.8056***	0.7713***	0.7637***	0.7534***
	(12.61)	(12.88)	(13.15)	(13.05)
$\log(ARPK_{i,t+1}) \times High\ EBP_t$	-0.1333**	-0.1176**	-0.2036***	
	(-2.49)	(-1.97)	(-2.67)	
$\log(ARPK_{i,t+1}) \times EBP_t$				-0.1435***
				(-3.67)
Observations	319,563	319,563	319,563	319,563
Controls	✓	✓	✓	✓
Firm FE	✓	✓	✓	✓
Time-Industry FE	✓	✓	✓	✓

Table 3 in Appendix A.2 shows that the same results hold for the acquisitions-augmented investment rates. Moreover, Tables 4–6 in Appendix A.2 show that analogous takeaways apply when we focus separately on reported capital expenditures, or the acquisition of existing firms or likelihood of selling physical capital.[12] More productive firms spend more on capital expenditures, engage more actively in acquisitions and are less likely to sell existing capital in normal

[12]When considering sale of capital as a standalone variable, we focus on the extensive margin indicator of

times. In crisis times, these relations with productivity weaken quantitatively, but there is no evidence that they change sign.

Thus, also in the cross-section of firms, we uncover patterns of capital reallocation that are reminiscent of an economy more likely prone to demand-freeze crises: on average, capital reallocation goes in the "right" direction, but simply less so in times of financial crises.

6 Conclusions

This paper has used a canonical model of financial crises to distinguish between two seemingly similar but fundamentally different types of crises: fire-sale and demand-freeze crises. Although both are characterized by depressed asset prices and impaired capital reallocation, they diverge sharply in their general equilibrium implications and in the policy interventions they warrant. In fire-sale crises, productive firms are distressed sellers, making asset price support via credit-easing policies not only benign but actively beneficial. Conversely, in demand-freeze crises, productive firms are constrained buyers, so the same policies can perversely worsen resource misallocation by inflating asset prices and limiting productive firms' access to capital. Our theoretical framework establishes the sign of the covariance between firms' marginal productivity and net capital purchases as a sufficient statistic to identify demand-freeze crises, and thus to assess the appropriateness of policy interventions.

Empirical evidence drawn from U.S. firm-level data further supports the relevance of the demand-freeze perspective. We find that capital reallocation is procyclical, and that even during times of financial distress, firms with higher marginal productivity tend to expand their capital stock more than others—contrary to what would be expected in a fire-sale environment. This insight has significant policy implications: standard responses such as interest rate cuts or asset purchases may be ill-suited—or even counterproductive—during crises dominated by demand freezes. Recognizing the nuanced nature of financial crises and adapting policy accordingly is therefore essential for promoting efficient capital allocation and mitigating the long-run economic costs of downturns.

whether a firm is selling capital or not, due to the high prevalence of zeros and missing observations in this variable in Compustat.

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A Data Appendix

A.1 Compustat data for firm-level analysis

In this Appendix we outline the steps taken to construct the variables and select the sample of Compustat firm-quarters that we use in the empirical analysis of Section 5.

A.1.1 Sample selection

We follow conventional sample selection criteria from the literature. We exclude all firms that are not incorporated in the United States and that are in the financial industry (SIC code between 6000 and 6999), utilities (SIC between 4900 and 4999), or quasi-governmental sectors (SIC code between 9000 and 9999), or for which no SIC industry code is available. In addition, we drop all firm-quarters for which measurements of *Total assets* (Compustat data

item 44, $ATQ_{i,t}$), *Property, Plant and Equipment (Net)* (item 42, $PPENTQ_{i,t}$), *Sales* (item 2, $SALEQ_{i,t}$) are negative.

In addition to these sample selection criteria, when estimating the panel regressions specifications such as (38), we drop observations of specific firm-level variables in given firm-quarters identified as outliers which might significantly affect the estimates. We drop the individual firm-quarter observations of $ARPK_{i,t}$ above and below the 1st and 99th percentiles within each SIC1-quarter-cell. For the controls in $X_{i,t-1}$, we drop the individual firm-quarter observations of the liquidity ratio, leverage and Tobin's q for which the observation is above the 99th percentile of the corresponding variable's quarter t cross-section. As for the outcome variables in the panel regression specifications, i.e., investment rates or acquisitions-to-assets rates, we drop the observations below the 1st and above the 99th percentile. We do this separately within each quarter t.

A.1.2 Construction of variables and summary statistics

We construct the key variables employed in Section 5 as follows.

1. As the measure of firms' *fixed capital stocks* in place at the end of quarter t, we employ the Compustat $PPENTQ_{i,t}$, and denote it as $k_{i,t}$.

2. We measure *gross investment* for firm i in quarter t as the quarterly *Capital Expenditures* ($Capx_{i,t}$) constructed based on the Compustat reported *Year-to-date Capital Expenditures* (item 90, $CAPXY_{i,t}$).

3. As the measure of sales of existing capital we use the quarterly sale of property, plant, and equipment, inferred from the Compustat Year-to-Date variable *Sale of Property, Plant, and Equipment* (item 83, $SPPEY_{i,t}$).

4. As the measure of purchases of existing capital (and other productive assets) we use the quarterly acquisitions, inferred from the Compustat Year-to-Date variable *Acquisitions* (item 94, $AQCY_{i,t}$).

5. As the measure of firm *Size*, we employ *Total Assets* $ATQ_{i,t}$.

6. We define *Leverage* as total debt divided by $ATQ_{i,t}$, with total debt computed as the sum of *Debt in Current Liabilities* (item 45, $DLCQ_{i,t}$) and *Total Long-Term Debt* (item 51, $DLTTQ_{i,t}$).

7. We measure the *Liquidity ratio* as *Cash and Short-Term Investments* (item 38, $CHEQ_{i,t}$) divided by $ATQ_{i,t}$.

8. We construct Tobin's q, as the book value of total assets ($ATQ_{i,t}$), plus the difference between the market value of common equity ($PRCCQ_{i,t} \times CSHOQ_{i,t}$) and the book value of *Common Equity – Total* (item 59, $CEQQ_{i,t}$), all scaled by $ATQ_{i,t}$.

A.2 Additional empirical results

Table 3: Panel regressions for acquisitions-augmented investment rates in "normal" and "crisis" times

	High EBP_t cutoff:			
Dep. var.: $100 \times I^a_{i,t}/k_{i,t-1}$	p50	p75	p90	Cont.
$\log(ARPK_{i,t+1})$	1.9242***	1.7735***	1.7688***	1.7479***
	(11.76)	(11.77)	(11.95)	(12.04)
$\log(ARPK_{i,t+1}) \times High\ EBP_t$	-0.448***	-0.2608	-0.5552***	
	(-3.27)	(-1.62)	(-2.79)	
$\log(ARPK_{i,t+1}) \times EBP_t$				-0.4724***
				(-4.49)
Observations	311,288	311,288	311,288	311,288
Controls	✓	✓	✓	✓
Firm FE	✓	✓	✓	✓
Time-Industry FE	✓	✓	✓	✓

Table 4: Panel regressions for gross investment rates in "normal" and "crisis" times

	High EBP_t cutoff:			
Dep. var.: $100 \times Capx_{i,t}/k_{i,t-1}$	p50	p75	p90	Cont.
$\log(ARPK_{i,t+1})$	0.8319***	0.8043***	0.7925***	0.7832***
	(14.62)	(15.28)	(15.4)	(15.41)
$\log(ARPK_{i,t+1}) \times High\ EBP_t$	-0.1245***	-0.1288**	-0.1987***	
	(-2.68)	(-2.56)	(-2.96)	
$\log(ARPK_{i,t+1}) \times EBP_t$				-0.14***
				(-4.11)
Observations	399,075	399,075	399,075	399,075
Controls	✓	✓	✓	✓
Firm FE	✓	✓	✓	✓
Time-Industry FE	✓	✓	✓	✓

	High EBP_t cutoff:			
Dep. var.: $100 \times Acq_{i,t}/k_{i,t-1}$	p50	p75	p90	Cont.
$\log(ARPK_{i,t+1})$	0.9641***	0.896***	0.8851***	0.8798***
	(11.28)	(11.29)	(11.72)	(11.92)
$\log(ARPK_{i,t+1}) \times High\ EBP_t$	-0.2143***	-0.1414	-0.2292*	
	(-2.77)	(-1.52)	(-1.93)	
$\log(ARPK_{i,t+1}) \times EBP_t$				-0.225***
				(-3.58)
Observations	381,522	381,522	381,522	381,522
Controls	✓	✓	✓	✓
Firm FE	✓	✓	✓	✓
Time-Industry FE	✓	✓	✓	✓

Table 5

Table 6: Panel regression estimates for capital sale indicator in "normal" and "crisis" times

	High EBP_t cutoff:			
Dep. var.: $\mathbf{1}[Sale_{i,t} > 0]$	p50	p75	p90	Cont.
$\log(ARPK_{i,t+1})$	-0.0101***	-0.0112***	-0.0119***	-0.0117***
	(-4.91)	(-5.62)	(-6.03)	(-5.93)
$\log(ARPK_{i,t+1}) \times High\ EBP_t$	-0.0034**	-0.0024	0.0006	
	(-2.35)	(-1.41)	(0.28)	
$\log(ARPK_{i,t+1}) \times EBP_t$				-0.0017
				(-1.4)
Observations	326,350	326,350	326,350	326,350
Controls	✓	✓	✓	✓
Firm FE	✓	✓	✓	✓
Time-Industry FE	✓	✓	✓	✓