Constrained Credit Policies in Economies with Coordination Failures*

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Abstract

In this paper, I study constrained credit policies in economies with micro-level credit coordination failures. I develop a general equilibrium framework with heterogeneous productive projects where capital is indivisible and funded by several creditors. I first show that complementarities between creditors' lending decisions can lead to credit coordination failures at the micro-level, causing aggregate output losses by shifting credit from profitable to less profitable projects. Next, I show that credit policy can prevent credit coordination failures by eliminating complementarities between lending decisions. As a result, a sufficiently well-targeted credit policy could improve aggregate outcomes. In spite of this, the implementation of the policy depends on the amount of resources available for the policy. I find that a constrained policy can be subject to another form of coordination failure. Even for a very well-targeted policy which uses very few resources *in equilibrium*, creditors may induce the policy to be unfeasible if they don't believe the policy announcement will be fulfilled (i.e., aggregate coordination failure). Finally, I characterize the results in extended versions of the model that allow for self-financing and balance sheet effects, endogenous sovereign default, and dynamics.

Keywords: financial crises, coordination failures, sovereign debt

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"[...] the ECB is ready to do whatever it takes [...]. ***Believe me, it will be enough.*** *"* Mario Draghi, ECB President, 26 July 2012

"If you have a bazooka and people know you've got it, ***you may not have to take it out.*** *"* Henry Paulson, U.S. Secretary of the Treasury, July 15, 2008

1 Introduction

Many firms and productive projects in the economy depend on funding from multiple creditors. The decision of one creditor to invest in a firm or project can influence the decisions of others. For example, consider a productive project that needs at least $100,000 for implementation. If two creditors are willing to invest a maximum of $50,000 each, they will both commit to funding the project if they believe the other would do the same. Conversely, creditors may opt not to fund the project if they believe the other won't. Thus, credit coordination failures can happen when there are complementarities between creditors' lending decisions, i.e., the actions of one creditor depend on the actions of another. These coordination failures have been studied in the context of runs on financial intermediaries (Diamond and Dybvig, 1983), sovereign debt self-fulfilling crises (Cole and Kehoe, 2000), and funding of indivisible productive projects (Halac, Kremer and Winter, 2020).

The aggregate consequences of credit coordination failures have motivated several credit policies, such as lender of last resort policies, which have been proposed and implemented in many modern economies.[1] The rationale is that the government, by providing an alternative source of funding that doesn't rely on other creditors' choices, may preclude coordination failures and ameliorate their aggregate consequences. Despite this, it is commonly argued that these policies may have "side effects," such as greater misallocation due to poor targeting and moral hazard. However, one often overlooked aspect in the study of these policies, yet well acknowledged by policymakers (as evident in the statements of Draghi and Paulson), is that enough resources have to be committed, but not necessarily used, for these policies to be *credibly* implemented and sustained. Thus, in this paper, I focus on the implementation of credit policies designed to address credit coordination failures when the policy has limited funding.

The main result of the paper shows that in economies where there is misallocation due to micro-level (at the firm and productive project level) credit coordination failures, the

[1]For example, many central banks—such as the Fed—were originally created to preclude runs on financial intermediaries. In general, credit policies can take on both implicit and explicit forms, and their announcement may occur either during or outside recessions.

government can improve the allocation of resources by implementing a sufficiently well-targeted credit policy. However, this policy may be susceptible to another form of coordination failure. If the policy's available resources are sufficient *in equilibrium* but insufficient *off-equilibrium*—i.e., when agents don't believe the policy will be implemented—then the feasibility of the policy would depend on the private sector's conjectures. I argue that this result can explain, for example, how lower fiscal capacity may lead to the failure of lender-of-last-resort policies, pushing the economy into a worse equilibrium, such as a crisis, even when credit policies would not require any funding in equilibrium.[2]

The theoretical framework is a general equilibrium economy where entrepreneurs have productive projects with heterogeneous returns that require a certain threshold of capital to operate and produce a unique final good. Entrepreneurs raise funds from atomistic creditors, who draw funds from a given aggregate supply of capital and offer a borrowing rate to the entrepreneurs. The assumption of creditors' atomicity captures the complementarities between creditors' lending decisions. Furthermore, entrepreneurs cannot commit to implementing the projects. If an entrepreneur is unable to raise sufficient funds to operate their project, they must return the borrowed funds to the creditors.

Given the interest rate (cost of borrowing), productive projects with a high enough return would operate if they get the funding, but, due to the complementarities in lending decisions among creditors, some of these profitable projects are be subject to a coordination failure and are not be able to get the funding.[3] In case of multiplicity, to construct the project-level equilibrium, I assume a sunspot variable randomly determines which projects are subject to a credit coordination failure. Finally, the market clearing condition, total demand of funds for the projects has to equate the total supply of funds, pins down the equilibrium interest rate.[4] This setup captures, in a stylized fashion, a family of theories involving complementarities in lending decisions and multiplicity.

In this economy, the private equilibrium would be inefficient relative to the equilibrium without coordination failures. These failures preclude the implementation of some profitable projects, thereby reducing the equilibrium interest rate and allowing weaker

[2]This channel has been informally argued to be relevant in the context of large financial crises, such as several debt crisis episodes in Latin America in the 1980s and early 2000s (see, for example, Diaz-Alejandro (1985) andde Brun and Licandro (2006)).

[3]For greater clarity, in the basic model, I assume entrepreneurs have no internal funds, there is no uncertainty, and that creditors have perfect information regarding the returns of the projects given their implementation. The core results can be extended to much more general setup.

[4]The interest rate can be interpreted as the relative value of capital to the final good in this setup, I relax this and allow for balance sheet "effects" in an extension of the model.

projects to operate, ultimately diminishing aggregate income. This form of misallocation can motivate the government to intervene and provide credit to projects that can't be implemented due to coordination failures.

For the sake of clarity, I will first focus on the case in which the credit policy is perfectly targeted–i.e., it grants credit only to projects that would experience a coordination failure otherwise. The government announcement induces creditors to fund profitable projects. This is because profitable projects will be implemented independently of the private creditors' decisions to lend, effectively eliminating the coordination failure. Thus, the equilibrium with the perfectly targeted policy would be efficient, and, importantly, the government's credit facilities would remain unused in equilibrium.

Next, I extend the analysis to the policy can be constrained, i.e., the government has a finite amount of resources. If the announced policy requires more resources than are available, then it cannot be implemented (lacks commitment). Thus, creditors need to conjecture about, both, the implementation of the project they are funding (as before) and the policy implementation.

As described earlier, a perfectly targeted policy doesn't need any funds to be implemented *in equilibrium*, but creditors may conjecture that the announced policy will not be implemented. Thus, creditors will offer lending terms consistent with the equilibrium without policy. Consequently, the government will need funds to implement the policy since profitable projects under a coordination failure will borrow from the government's credit program. If the resources required *off-equilibrium*—i.e., the policy is implemented, but creditors conjectured incorrectly that it wouldn't be—are greater than those available, then the policy will not be implementable, as the creditors conjectured. Thus, there can be another coordination failure (macro) that may preclude the policy from being implemented, even if perfectly targeted and no funds are used in equilibrium.

[add extensions: balance sheet effects and self-financing; dynamics; sovereign debt]

Related Literature. The paper is closely related to the literature that studies credit coordination failures in macroeconomics and finance (see, for example, Diamond and Dybvig (1983) and Cole and Kehoe (2000)). Particularly, the theoretical framework is closely related to Halac *et al.* (2020) and Dovis and Kirpalani (2023). Halac *et al.* (2020) focuses on optimal unique private contracts with heterogeneous investors and Dovis and Kirpalani (2023) focuses in the optimal credit policy when the government has imperfect information regarding the project's quality. On the other hand, in this paper, I study the

aggregate consequences of coordination failures in general equilibrium and show that they would reduce aggregate output by creating misallocation, and focus on the credit policy when resources are limited, which can give rise to another form of aggregate multiplicity.

The paper is also related to other papers that study how limited resources can affect the credibility of credit policies. [5] Ennis and Keister (2009) studies a credible deposit insurance program in the Diamond and Dybvig (1983) model and Jeanne and Korinek (2020) studies ex-ante and ex-post policies. On the other hand, Bocola and Lorenzoni (2020) studies how credible are lender of last resort policies when the government is constrained. In that paper, the policy addresses an aggregate source of multiplicity that is created by the foreign currency borrowing, whereas in my paper, the policy is employed to prevent micro-level coordination failures.

2 Economy with Coordination Failures

In this section, I outline the basic model without government policy and show that coordination failures can create misallocation and reduce aggregate output. In the model, entrepreneurs hold heterogeneous productive projects, which they lack commitment to be implemented, and the complementarities in the lending decision between creditors, can lead to credit coordination failures.

2.1 Setup

The economy has $t \in \{0, 1\}$ periods, with two goods: capital and final goods. It is populated by a continuum of entrepreneurs and creditors. Each entrepreneur holds a productive project that requires at least k units of capital to be able to operate and produce $(1 + \tilde{r})k$ units of the final good at $t = 1$, where k is the same for all projects–i.e., they have the same scale. The distribution of the returns of the productive projects $\tilde{r}$ across entrepreneurs is $\phi(\tilde{r})$ such that $\int \phi(\tilde{r})\, \mathrm{d}\tilde{r} = 1$. I assume that there is no uncertainty regarding $\tilde{r}$ and it is known to creditors. Entrepreneurs don't have internal funds, so they have to borrow. Creditors allocate the supply of capital between the productive projects and a risk-free bond, which is in zero net supply and has return r. Creditors are identical, perfectly competitive, and atomistic relative to the project funding needs. Both, entrepreneurs and creditors get utility from the final good at $t = 1$. The aggregate supply of capital is fixed to $\mathcal{A}$.

[5] Bonfim and Santos (2023) provides empirical evidence regarding depositors' behavior and deposit insurance credibility. They find that during the Euro crisis deposits reallocate to banks backed by sovereigns with greater fiscal capacity.

Extensions. In Section 4, I discuss several extensions of the model related to self-financing and balance sheet-effects, different production technologies (e.g., divisible and indivisible capital, heterogeneous scale of production), and dynamics.

2.2 Productive Projects and Coordination Failures

For a project to be implemented the entrepreneur needs to get at least k initial funds. We assume the entrepreneur's outside option is 0 if the investment doesn't happen. Since each project requires that creditors provide them sufficient capital to be implemented, the entrepreneur cannot commit to implement a project, then individual creditors need to conjecture if the project is implemented or not–i.e., if other creditors will lend. In the case a creditor lends to the entrepreneur, but the project is not undertaken, for each unit of capital invested the creditors gets $(1+\alpha) \in [0,1]$ units of consumption. Conversely, if the project is undertaken the investor gets the contracted return $\hat{r}$. There is no risk, symmetric information, and creditors are perfectly competitive, then we trivially know that $\hat{r} = r$ for implemented projects.

Given the interest rate $r > \alpha$, a productive project is profitable if its return $\tilde{r} \geq r$ and the project is implemented if the entrepreneur is able to get k funds. The non-divisibility of the projects, combined with the atomicity of creditors, creates complementarities in the lending decision between creditors. Intuitively, if creditors conjecture that the entrepreneur gets k funds, they will lend and the entrepreneur gets the k funds to implement the project, as conjectured. On the contrary, if creditors conjecture that the entrepreneur is not able to get the funds, they expect to earn a return $\alpha < r$, then they don't invest in the productive project and the entrepreneur doesn't get the funds, as conjectured. The latter outcome, implies that a profitable project may not get the funding because of a coordination failure between creditors at the project-level (micro).

To construct the equilibrium, at the project-level, I will assume that a random sunspot variable ς iid across entrepreneurs is drawn from $\varsigma \sim U[0,1]$, at the beginning of $t = 0$, such that if $\varsigma < \eta$ the creditors fail to lend to the project.[6] The parameter $\eta \in [0,1]$ can be interpreted as the share of profitable productive projects in the economy that are subject to a coordination failure.

[6]The sunspot variable can be easily extended to be non-iid. For example, the draw of the sunspot variable could depend on the project scale, if projects had heterogeneous scales.

For an entrepreneur with states $(\tilde{r}, \varsigma)$ the cost of funding is:

$$\hat{r}\left(\tilde{r}, \varsigma\right) = \begin{cases} r & \text{if } \tilde{r} > r \text{ and } \varsigma > \eta \\ \infty & \text{otherwise.} \end{cases} \tag{1}$$

Finally, capital has to be sufficiently scarce for the coordination failures to exist in equilibrium. Assumption (1) is a sufficient for the equilibrium interest rate to be greater than the return conditional on no implementation–i.e., $r > \alpha$. Otherwise, the equilibrium could degenerate to a case in which $r = \alpha$ and all projects with $\tilde{r} \geq \alpha$ could be implemented in equilibrium, and a fraction of the supply of capital is unused or randomly allocated in equilibrium.

Assumption 1 (Capital Scarcity)**.** *Parameters* $\{\mathcal{A}, \eta, k\}$ *are such that* $\mathcal{A} < (1-\eta)k$ *and* $\tilde{r} > \alpha$ *for all* $\tilde{r}$ *with* $\phi(\tilde{r}) > 0$*.*

2.3 Equilibrium and Misallocation

2.3.1 Equilibrium

Definition. The competitive equilibrium is a set of investment choices, cost of financing $\hat{r}\left(\tilde{r}, \varsigma\right)$ schedule, initial distribution of entrepreneurs $\mu(\tilde{r}, \varsigma) = \phi(\tilde{r})h(\varsigma)$, aggregate supply of capital $\mathcal{A}$, and interest rate r such that:

1. Given the interest rate r and $\hat{r}\left(\tilde{r}, \varsigma\right)$, the entrepreneur's investment choice maximizes her profits $\pi = \max\left\{\left(\tilde{r} - \hat{r}\left(\tilde{r}, \varsigma\right)\right)k, 0\right\}$.

2. Given the interest rate r, function $\hat{r}\left(\tilde{r}, \varsigma\right)$ is consistent with the creditors' non-profit condition–i.e., satisfy (1).

3. The demand of capital from the entrepreneurs has to equate the total supply of capital:

$$\mathcal{A} = (1-\eta)\int_{r} k\phi\left(\tilde{r}\right)\mathrm{d}\tilde{r} = (1-\eta)\left[1 - \Phi\left(r\right)\right]k, \tag{2}$$

where $\Phi(.)$ is the cdf of the projects' returns.

2.3.2 Misallocation

In the competitive equilibrium, aggregate output is determined by the projects that operate in equilibrium, i.e.,

$$Y = (1-\eta)\, k \int_r (1+\tilde{r})\, \phi(\tilde{r})\, \mathrm{d}\tilde{r}, \tag{3}$$

and since capital is fixed, there is no default in equilibrium, and consumption equates income, then the aggregate return is

$$\frac{C}{\mathcal{A}} = \frac{Y}{\mathcal{A}} = \frac{(1-\eta)\, k \int_r (1+\tilde{r})\, \phi(\tilde{r})\, \mathrm{d}\tilde{r}}{(1-\eta)\, k \int_r \phi(\tilde{r})\, \mathrm{d}\tilde{r}} = 1 + \mathbb{E}\left[\tilde{r} \mid \tilde{r} \geq r\right], \tag{4}$$

which is summarized by the conditional return of the projects implemented. Thus, a higher equilibrium interest rate (price of capital relative to the final good) implies greater aggregate consumption.

Proposition 1 indicates that coordination failures reduce aggregate output and consumption. A higher incidence of coordination failures, i.e., a higher η, implies that more profitable projects fail to secure financing. Thus, for a given interest rate, the demand for capital is lower. However, since the supply of capital is fixed, a decrease in the demand for capital results in a reduction of the equilibrium interest rate r. Consequently, a lower interest rate means that some projects, previously non-profitable at an interest rate consistent with lower levels of coordination failures, now become viable. Thus, a higher level of coordination failures creates misallocation by directing fewer funds to more productive projects and more to less profitable ones through a lower equilibrium interest rate.[7]

A lower scale of the projects (k) reduces output in a similarly way to an increment in coordination failures, but this has to do with the multiplicative form of the returns of each project. Intuitively, trivially greater scale implies greater returns in absolute value.

Proposition 1. *Under assumption (1), higher η implies a lower aggregate return and interest rate r.*

The change in the aggregate return, as indicated by equation (4), is summarized by the equilibrium interest rate. A lower interest rate reflects in poorer selection, resulting in reduced aggregate output and return. The inefficient allocation of capital, due to coordination failures, creates a motive to intervene and redirect the funds to the more

[7] This result is unchanged if I assume that to produce the firm needs divisible and indivisible capital.

productive projects.

3 Constrained Credit Policy

In this section, I introduce a credit policy that provides direct funding to productive projects. First, I demonstrate how a sufficiently well-targeted policy could improve aggregate outcomes. Next, I examine how limited resources could impact the feasibility of the policy, even when it has sufficient funds to be implemented *in equilibrium*. I find that credit policies, motivated by micro coordination failures, can be susceptible to an aggregate form of multiplicity (coordination failure) when the policy has limited resources.

3.1 Economy with Policy

The policy is announced at the beginning of $t = 0$, but it is implemented at the end of period $t = 0$, after creditors offer their lending terms. The policy consists of an arbitrary set of eligible productive projects $\mathcal{P}$ such that if a project $(\tilde{r}, \varsigma) \in \mathcal{P}$, the government can lend k funds at a rate $r^g(\tilde{r}, \varsigma)$. The policy is financed at $t = 0$ by borrowing B funds from the aggregate supply of capital at the market rate r and at $t = 1$ the net costs of the policy are lump-sum taxed T to the productive projects that operate. Thus, the government's budget constraint is simply $K^g (r - r^g) = T$, where K^g represents the funds entrepreneurs borrow from the program and r^g is the aggregate return of the lent funds.

Entrepreneurs of projects eligible to the credit policy can choose to borrow from the private sector creditors and the government. The entrepreneur has no commitment to implement the project. As before, if the project is not implemented, lenders (government and private creditors) get back only a fraction $(1+\alpha) \in [0, 1]$ of the funds lent. Given taxes T, credit policy $\{\mathcal{P}, r_g(\tilde{r}, \varsigma)\}$, and private sector lending terms $\hat{r}(\tilde{r}, \varsigma)$, an entrepreneur that qualifies for the program–i.e., $(\tilde{r}, \varsigma) \in \mathcal{P}$–makes the investment choice and decides how to finance it, i.e.,

$$\pi = \max \left\{ \left(\tilde{r} - \min \left\{ \hat{r}(\tilde{r}, \varsigma), r^g(\tilde{r}, \varsigma) \right\} \right) k - T, 0 \right\}. \tag{5}$$

On the other hand, an entrepreneur that doesn't qualify for the policy solves

$$\pi = \max \left\{ \left(\tilde{r} - \hat{r}(\tilde{r}, \varsigma) \right) k - T, 0 \right\}. \tag{6}$$

Thus, for the project to be implemented, it is necessary that the after-tax profit is greater than 0. Notice that the financing choice is simple: entrepreneurs borrow from the cheapest

source of credit. Therefore, all entrepreneurs who qualify for the program and have a borrowing cost lower than that in the private sector opt for borrowing from the credit program. Formally, the measure of entrepreneurs that participate is

$$\mu^g(\tilde{r},\varsigma) = \mathbf{1}_{\{\hat{r}(\tilde{r},\varsigma)>r^g(\tilde{r},\varsigma)\}}\mathbf{1}_{\{(\tilde{r},\varsigma)\in\mathcal{P}\}}\mathrm{d}\mu(\tilde{r},\varsigma), \tag{7}$$

where the total funds borrowed from the credit program are denoted as K^g, given by $K^g = \int k, \mathrm{d}\mu^g(\tilde{r},\varsigma)$.

Due to the timing of the policy announcement and its implementation, creditors need to conjecture if the credit policy will be implemented. Proposition (2) characterizes how the credit cost offered by the creditors $\hat{r}(\tilde{r},\varsigma)$ are affected if they conjecture the credit policy is implemented.

Proposition 2. *Given the credit policy* $\{\mathcal{P}, r^g(\tilde{r},\varsigma)\}$ *the lending terms offered by the private creditors that conjecture the policy will be implemented in equilibrium are*

$$\hat{r}(\tilde{r},\varsigma) = \begin{cases} r & \text{if } \tilde{r} - \frac{T}{k} > r \text{ and } \varsigma > \eta \text{ and } (\tilde{r},\varsigma) \notin \mathcal{P} \\ r & \text{if } \tilde{r} - \frac{T}{k} \geq r^g(\tilde{r},\varsigma) \text{ and } (\tilde{r},\varsigma) \in \mathcal{P} \\ \infty & \text{otherwise.} \end{cases} \tag{8}$$

To illustrate how the policy can alter credit terms, let's consider an entrepreneur with a profitable project ($(\tilde{r}-r)k - T > 0$), but creditors won't lend to her due to a coordination failure ($\varsigma < \eta$). If the entrepreneur qualifies for the credit program and the cost of financing is sufficiently low such that the project is profitable if it is financed through the credit program (i.e., $r^g(\tilde{r},\varsigma) \leq \tilde{r} - \frac{T}{k}$), then the entrepreneur could borrow from the government and implement the project. In this scenario, since creditors anticipate that the credit policy ensures the project will be implemented, they are willing to lend independently of other creditors' decisions.

Furthermore, if government credit is more expensive than private credit in the absence of a coordination failure (i.e., $r^g(\tilde{r},\varsigma) \in [r, \tilde{r} - \frac{T}{k}]$), creditors will lend to the firm at a rate of r, and entrepreneurs will borrow from private creditors, even if $\varsigma < \eta$. Therefore, by eliminating the complementarity between creditors' lending decisions, the policy can prevent coordination failures between private creditors.

Equilibrium with Credit Policy. The competitive equilibrium with credit policy is a set of eligible projects and their respective lending terms $\{\mathcal{P}, r^g(\tilde{r}, \varsigma)\}$, lump-sum taxes T, funds lend by the government K^g, entrepreneurs' investment choices, cost of financing $\hat{r}(\tilde{r}, \varsigma)$ schedule, initial distribution of entrepreneurs $\mu(\tilde{r}, \varsigma) = \phi(\tilde{r})h(\varsigma)$, aggregate supply of capital $\mathcal{A}$, and interest rate r such that:

1. The policy announced is implemented.
2. Given the policy, taxes, and prices, the entrepreneur's investment choice solves (5).
3. Given the policy and prices, the creditors' satisfy the non-profit condition–i.e., consistent with Proposition (2).
4. The government budget constraint holds.
5. The entrepreneurs' demand of capital has to equate the total supply of capital $\mathcal{A}$ net of the credit program funds used (i.e., demand of capital equates $\mathcal{A} - K^g$).

(Lack of) Commitment. To focus on how the policy affects aggregate outcomes, I will assume the govern the government once it announces the policy, it commits to its implementation (i.e., first equilibrium condition). In the Section 3.2, I will relax this and assume the government may not implement the announced policy and show it can be relevant when the policies have limited resources for their implementation.

3.1.1 Credit Policy Trade-Offs

I specialize the policy and show there is a potential trade-off between precluding coordination failures and subsidizing credit to weak projects when the policy is imperfectly targeted. Moreover, for a reasonably well targeted policy I show the policy could improve aggregate outcomes.

There is no source of risk in the economy, then I will assume that $r^g(\tilde{r}, \varsigma) = r$ for all $(\tilde{r}, \varsigma) \in \mathcal{P}$, where r is the equilibrium interest rate with policy.[8] Intuitively, this policy tries to implement as much projects as possible, but without offering cheaper credit than the market (for profitable projects). Since $\mathcal{P}$ is an arbitrary set of projects, only those that are not profitable will borrow from the government funds. This implies that the funds used are $K^g = \int \mathbf{1}_{\left\{\tilde{r} - \frac{T}{k} - r < 0\right\}} \mathbf{1}_{\{(\tilde{r}, \varsigma) \in \mathcal{P}\}} k, \mathrm{d}\mu(\tilde{r}, \varsigma)$, and the aggregate return of the

[8] This forms of policies can be described as market-based interventions (see, for example, Dovis and Kirpalani (2023)).

credit program is $r^g = \alpha$.[9] Thus, the policy budget constraint and capital market clearing condition are

$$\frac{T}{k} = \Phi\left(r + \frac{T}{k}\right)\Psi_2\left(\{\mathcal{P}\}, r, T\right)(r - \alpha) \tag{9}$$

$$\begin{aligned}\frac{\mathcal{A}}{k} = {} & (1-\eta)\left(1 - \Phi\left(r + \frac{T}{k}\right)\right) + \eta\left(1 - \Phi\left(r + \frac{T}{k}\right)\right)\Psi_1\left(\{\mathcal{P}\}, r, T\right) \\ & + \Phi\left(r + \frac{T}{k}\right)\Psi_2\left(\{\mathcal{P}\}, r, T\right),\end{aligned} \tag{10}$$

respectively, where $\Psi_1\left(\{\mathcal{P}\}, r, T\right) \in [0,1]$ is the share of profitable productive projects which qualify to the credit program but would not get the funds in absence of the policy, and $\Psi_2\left(\{\mathcal{P}\}, r, T\right) \in [0,1]$ is the share of non-profitable productive projects which qualify to the credit program.[10] Then, it follows that the total return of the economy is

$$\begin{aligned}\frac{C}{\mathcal{A}} = 1 + \frac{k}{\mathcal{A}}\Bigg\{ & (1-\eta)\left(1 - \Phi\left(r + \frac{T}{k}\right)\right)\mathbb{E}\left[\tilde{r} \mid \tilde{r} - \frac{T}{k} \geq r\right] \\ & + \eta\left(1 - \Phi\left(r + \frac{T}{k}\right)\right)\Psi_1\left(\{\mathcal{P}\}, r, T\right)\mathbb{E}\left[\tilde{r} \mid \tilde{r} - \frac{T}{k} \geq r,\ \varsigma < \eta,\ (\tilde{r}, \varsigma) \in \mathcal{P}\right] \\ & + \Phi\left(r + \frac{T}{k}\right)\Psi_2\left(\{\mathcal{P}\}, r, T\right)\alpha\Bigg\},\end{aligned} \tag{11}$$

The first line corresponds to the aggregate return of the private sector projects which are not subject to a coordination failure, the second line corresponds to the return of profitable projects which would not be implemented in absence of the credit program, and the third line corresponds to the return of the projects which the government financed in equilibrium. The aggregate return is the weighted average of these three terms.

3.1.2 Perfectly Targeted Policy

From Definition 1 it is straightforward that in equilibrium taxes are $T = 0$, and the shares $\Psi_1 = 1$ and $\Psi_2 = 0$. Then, the equilibrium is identical to the one in which $\eta = 0$ and there is no misallocation of productive resources due to credit coordination failures. As I discussed before, by removing the misallocation the policy improves aggregate outcomes.

Definition 1. *A perfectly targeted policy is* $\{\mathcal{P}, r_g(\tilde{r}, \varsigma)\}$ *such that* $(\tilde{r}, \varsigma) \in \mathcal{P}$ *if* $\tilde{r} > r + T/k$ *and* $\varsigma < \eta$*, and lending terms are* $r^g(\tilde{r}, \varsigma) = r$ *with* r *the equilibrium interest rate.*

The perfectly targeted policy serves as a useful benchmark, as it improves aggregate

[9] Non-profitable projects receive funds, but are not implemented.

[10] Explicitly, these functions are $\Psi_1\left(\{\mathcal{P}\}, r, T\right) = \left[\eta\left(1 - \Phi\left(r + \frac{T}{k}\right)\right)\right]^{-1}\int_{r+\frac{T}{k}}^{\eta}\mathbf{1}_{\{(\tilde{r},\varsigma)\in\mathcal{P}\}}\phi\left(\tilde{r}\right)\mathrm{d}\varsigma\mathrm{d}\tilde{r}$ and $\Psi_2\left(\{\mathcal{P}\}, r, T\right) = \left[\Phi\left(r + \frac{T}{k}\right)\right]^{-1}\int\mathbf{1}_{\left\{\tilde{r} - \frac{T}{k} - r < 0\right\}}\mathbf{1}_{\{(\tilde{r},\varsigma)\in\mathcal{P}\}}\mathrm{d}\mu\left(\tilde{r}, \varsigma\right)$.

outcomes and abstracts from standard issues studied in the literature concerning policy targeting (as discussed earlier) or moral hazard.[11] In the next Section, I will show that even an perfectly targeted policy could be subject to an aggregate form of multiplicity when the resources available are limited.

3.2 Constrained Credit Policy

Previously, I assumed that the policy could always be implemented and show that, if the policy was sufficiently well-targeted, aggregate outcomes could improve without incurring significant fiscal costs. In this section, I study the equilibrium where the government is constrained and has a limited level of resources available for the policy. I show that when the policy is constrained, another potential form of coordination failure could emerge. Under certain conditions, a well targeted policy that has enough resources in equilibrium may not be implementable.

3.2.1 Constrained Policy and Aggregate Multiplicity

Recall the timing of the policy was such that the announcement happened before the lending terms are offered by the creditors, but the implementation of the policy happens afterwards. Then, creditors need to conjecture if the policy will be implemented or not.

Previously, I assumed that creditors always conjecture that the policy was implemented, and the government consistently implements it. Now, I will relax this assumption and allow for creditors to conjecture otherwise, and assume that the government policy is constrained, meaning it may not be feasible (implemented).

The policy is constrained by an exogenous parameter $\bar{B}$, which is expressed in terms of capital, restricting the amount of debt the government can borrow at $t = 0$, i.e., $B \leq \bar{B}$. The credit program's debt limit captures in a reduced form limitations to the resources available to the government can deploy for this policy, for example, political economy constraints to lender of last resort policies and limited international debt access.

Equilibrium with Constrained Policy. The competitive equilibrium with a constrained credit policy is a set of eligible projects and their respective lending terms $\{\mathcal{P}, r^g(\tilde{r}, \varsigma)\}$, lump-sum taxes T, funds lend by the government K^g, entrepreneurs' in-

[11] For example, if the government has imperfect information the policy may be poorly targeted, or in a dynamic environment the policy may encourage projects to become exposed to coordination failures. The idea of imperfect targeting and moral hazard related to credit policies, such as lender of last resort policies, dates back to Bagehot (1873).

vestment choices, cost of financing $\hat{r}(\tilde{r}, \varsigma)$ schedule, initial distribution of entrepreneurs $\mu(\tilde{r}, \varsigma) = \phi(\tilde{r})h(\varsigma)$, aggregate supply of capital $\mathcal{A}$, interest rate r, and debt limit $\bar{B}$ such that:

1. The policy announced is implemented if $K^g \leq \bar{B}$, otherwise the equilibrium is the one with no policy $\{\emptyset, r^g(\tilde{r}, \varsigma)\}$.

2. Given the policy, taxes, and prices, the entrepreneur's investment choice solves (5).

3. Given the policy and prices, the creditors' satisfy the non-profit condition–i.e., consistent with Proposition (2).

4. The government budget constraint holds.

5. The entrepreneurs' demand of capital has to equate the total supply of capital $\mathcal{A}$ net of the credit program funds used (i.e., demand of capital equates $\mathcal{A} - K^g$).

Aggregate Multiplicity. To compute the equilibrium, first, we assume the policy is implementable (as in the previous section) and check if the policy is feasible ($K^g \leq \bar{B}$). If the policy is feasible, then this means that the resources are enough for the policy to be implemented *in equilibrium*. Next, we need to check whether the policy is feasible *off-equilibrium*. Creditors could conjecture the policy is not feasible, then the lending terms offered by the creditors are consistent with the no policy equilibrium $\hat{r}(\tilde{r}, \varsigma; \{\emptyset, \mathbf{r}^g\})$ (as in Section 2.3), but the policy is implemented anyways and $\{\mathcal{P}, r^g(\tilde{r}, \varsigma)\}$ are the same as announced. This implies *off-equilibrium* resources K^g_{off} are needed for the policy to be implemented even if creditors conjectured otherwise.

If the resources $K^g_{\text{off}} < K^g < \bar{B}$ then the policy is always implementable. This case will be typically associated with a policy that is very ill targeted and needs more resources in equilibrium than off equilibrium. The most economically interesting case is when $K^g_{\text{off}} > K^g$. Now there are three regions: first, $\bar{B} > K^g_{\text{off}} > K^g$ the policy is always implementable since even if creditors conjecture the policy is not feasible the government will be able to implement it; second, $K^g_{\text{off}} > K^g > \bar{B}$ the policy is never implementable, no matter the conjecture of the creditors; lastly,

$$K^g_{\text{off}} > \bar{B} > K^g \tag{12}$$

the policy will be implemented depending on the creditors' conjectures. If creditors belive the policy will be implemented then the policy is feasible and implemented as conjectured. On the other hand, if creditors believe the policy is not feasible then the policy cannot be implemented as conjectured. This is an aggregate source of multiplicity, that again comes from coordination failures among creditors.

Finally, I will define a *credible* policy as one that is implemented independently of the creditors' conjectures.

Definition 2. *A credible policy is a credit policy* $\{\mathcal{P}, r_g(\tilde{r}, \varsigma)\}$ *such that*

$$\max\left\{K^g, K^g_{off}\right\} \leq \bar{B}. \tag{13}$$

3.2.2 Illustrative Example: Perfectly Targeted Policy

Without loss of generality, I study the policy when is perfectly targeted (see Definition 1).[12] From Section 3.1.2, we know that the resources required to implement this policy are $K^g = 0$, but off-equilibrium creditors will not lend to the firms that are subject to a coordination failure thus some entrepreneurs may use the credit policy funds. This suggests that the resources needed off-equilibrium may be greater than those in equilibrium.

Denote $\check{r}$ the equilibrium interest rate where there is no policy (formally, $\{\emptyset, \mathbf{r}^g\}$) and r the one with the perfectly targeted policy. We know $\check{r}$ is smaller than the interest rate r with the perfectly targeted policy (see Proposition 1), then the government credit is more expensive than the private one (for those entrepreneurs that can access to funds). Thus, the only entrepreneurs that will use the funding from the government will be those with $\tilde{r} > r$ and $\varsigma < \eta$, so the funds required to implement the policy off-equilibrium are

$$K^g_{\text{off}} = k\eta\left(1 - \Phi\left(r\right)\right) > 0.$$

Therefore, a perfectly targeted policy will be credible, in the sense provided by Definition 2, if $\bar{B} > k\eta\left(1 - \Phi\left(r\right)\right)$.

Comparative Statics. A lower debt limit $\bar{B}$ makes the policy closer to the region of multiplicity $\bar{B} \in (0, k\eta\left(1 - \Phi\left(r\right)\right)]$. One potential interpretation of a lower $\bar{B}$ may have to do with the government having lower access to international credit, or low level of inter-

[12] The mathematical expressions are more complicated if the policy is not perfectly targeted, but the mechanism studied is the same.

national reserves, which may jeopardize its lender of last resort policies and trigger runs (coordination failures) among financial intermediaries that need to rollover their liabilities. This transmission mechanism from weaker government finances to the real economy doesn't rely on, for example, financial firms holding government bonds, as it is commonly studied in the literature (see, for example, Farhi and Tirole (2018)). Furthermore, it can explain crises episodes where there are runs over the sovereign debt and the financial system simultaneously, as it is frequent in several emerging economies sudden stop episodes.

Also a larger incidence of coordination failures η can expose the policy to multiplicity and make the policy not credible. Higher η can be interpreted as a higher contingent liability for the government (off-equilibrium liabilities), since the policy needs to rescue several projects in the case that creditors are pessimistic and believe the policy will not be implemented. Now the transmission mechanism is slightly different, the government finances may look fine, but increasing pessimism implies greater (off-equilibrium) contingencies can make the policy not credible and create a systemic run over the financial system (private sector).

4 Extensions

[add extensions: balance sheet effects and self-financing; dynamics; sovereign debt]

5 Conclusions

In this paper, I have developed a tractable general equilibrium model where capital is indivisible and financed by multiple creditors. The complementary between lending decisions can create micro-level coordination failures, leading to misallocation and aggregate output losses. The government can improve equilibrium outcomes by implementing a well-targeted credit policy, but the government policy may not be credible if resources are limited. I find that if creditors are pessimistic regarding the credit policy implementation, the credit policy may not be implementable even if the resources needed in equilibrium are low (i.e., fail to coordinate).

The notion formalized in this paper aligns with the perspectives of several policymakers attempting to implement credit policies during a crisis. It also presents an alternative channel through which fiscal policy capacity can influence the real economy. A potential avenue for future research is to understand better the interaction between the contingent liabilities, such as credit policies, and the government fiscal capacity when this is

endogenous to the policies.

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