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ABSTRACT

The Covid-19 crisis has lead to a reduction in the demand and supply of sectors that produce goods that need social interaction to be produced or consumed. We interpret the Covid-19 shock as a shock that reduces utility stemming from "social" goods in a two-sector economy with incomplete markets. We compare the advantages of lump-sum transfers versus a credit policy. For the same path of government debt, transfers are preferable when debt limits are tight, whereas credit policy is preferable when they are slack. A credit policy has the advantage of targeting fiscal resources toward agents that matter most for stabilizing demand. We illustrate this result with a calibrated model. We discuss various shortcomings and possible extensions to the model.

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1 Introduction

The Covid-19 pandemic is a quintessential macroeconomic shock. Large and unexpected, the shock has escalated so quickly that the self-stabilizing mechanisms of business cycles are likely not to work. Learning from the recent experiences of the Great Recession, central banks and fiscal authorities have responded with unprecedented speed and scale. An equally unprecedented amount of policy recommendations has been produced by the macroeconomics community, e.g. Brunnermeier et al. (2020), Gourinchas (2020), among many others. Calls for macroeconomic-stabilization have primarily focused on large scale transfer programs and central-bank open-market operations that facilitate bank credit. Both programs are geared toward expanding the amount of social insurance, while acting as a demand stabilizer.

In the case of the US, the combination of the CARES act setup by the US Treasury and the Main Street Lending Facility of the Federal Reserve offer amount to a combination of 1,902 billion US dollars in direct transfers, unemployment insurance, and credit to firms. A decomposition of this amount in this subset of programs is presented in Figure 1.

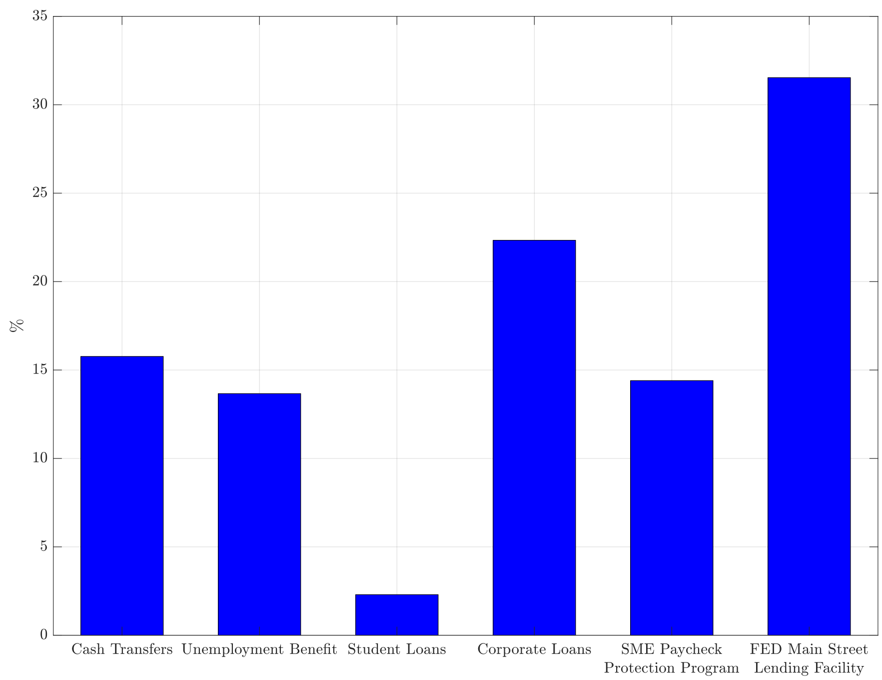


Figure 1: US Covid-19 Policy Response: Decomposition of Programs Directed to Consumers and Loans

Note: This figure reports the share of each component of a subset of the CARES act programs and the Main Street Lending Facility of the Federal Reserve. All figures are presented in current US Dollars: The Fed's Main Street Lending Facility amounts to 600 Billion. The CARES act assigns Cash Transfers for 300 Billion, 260 Billion in Unemployment Benefits and 43.7 Billions in Student Loans (as part of the Economic Impact Payments to American Households program), 274 Billion in loans to small business (as part of the Small Business Paycheck Protection Program) and 425 Billion in Corporate Loans. The figures are interpreted from statements from the U.S. Department of the Treasury: `https://home.treasury.gov/policy-issues/cares/preserving-jobs-for-american-industry`, and the classifications cross-checked with related articles: `https://messertodd.github.io/coronavirus-policy-response/Unconventional-MP.html`, and `https://www.npr.org/2020/03/26/821457551/whats-inside-the-senate-s-2-trillion-coronavirus-aid-package`.

Internationally, a recent report by UBS[1] claims that 3.7 percent, so far, of global GDP has been put forward in policies that vary in scale and target across countries. There is a striking difference between the response of developed economies, and other economies. Developed markets are usings 31 percent of fiscal expenditures on job retention schemes, 15 percent on business loans and grants, 15 percent on tax reliefs, 12 percent on direct cash payments, mostly driven by Japan where the share of direct transfers is 57 percent, and 10 percent on unemployment insurance. In emerging economies without China,[2] the figures on tax reliefs and unemployment insurance are comparable to those in developed economies, 18 percent and 10 percent, respectively. Nonetheless, emerging markets are relying more on direct cash payments (20 percent), but less on job retention schemes (13 percent) and business loans and grants (4 percent). These figures are subject to revisions and reclassification, and may change as the crisis evolves.

As policies are being refined on the spot, there is room for simple theories that assist this analysis. Here is one such environment. The paper presents a simple incomplete markets economy, which we use to frame the recent discussions regarding the macroeconomic trade-offs related to the policy responses during the Covid-19 crisis. The model is an extension of Bigio and Sannikov (2019), with two sectors. The economic forces are similar in spirit to Guerrieri et al. (2020). One sector produces social goods, which need social interactions to be consumed, whereas the other produces goods that can be consumed remotely. Households are subject to an unexpected shock that reduces the utility from consuming social goods. After the shock is announced, except for the idiosyncratic risk, the economy proceeds in a deterministic fashion. This reduction in utility is due to the fear of being infected, which induces a behavioral response of individuals during a pandemic.

The Covid-19 manifests as a discount factor shock in an equivalent representation of the model with one sector. If the elasticity of substitution between social and remote goods (ESBG) as well as the elasticity of intertemporal substitution (EIS) are greater than one (something we assume throughout the paper), the shock can be represented equivalently as a positive discount factor shock (less discounting). Since we assume labor is supplied inelastically and there is perfect reallocation of labor input across sectors, under the flexible prices benchmark, after the shock the remote good sector absorbs the fall in the social good sector. The unemployment rate remains at its natural level. Once we introduce rigid wages, if EIS is sufficiently high (or ESBG sufficiently small), a point made in Guerrieri et al. (2020), the unemployment rate adjusts to accommodate the decline in aggregate demand that results from the shock. This decline in consumption may manifest in both sectors, opening the door for macroeconomic stabilization. Inspired by the current policy debate, we study the effectiveness of lump-sum transfers versus a credit policy that generates the same path of government indebtedness.

We argue that the power of lump-sum transfers versus a credit subsidy policy critically depends on the level of financial development. Take two extremes. If we consider a natural borrowing limit, the Ricardian equivalence holds and lump-sump transfers are neutral. In this case, credit policy should be the preferred tool, and we show that it mitigates the recession. Now consider an economy with the borrow limit equal to zero. In this case, a credit policy is immaterial and lump-sum transfers are the preferred instrument. We also showcase an intermediate case. The choice of whether to go for transfers or credit

[1] "Global Economic Perspectives. Bubble, Bubble, Toil, and Trouble: which fiscal mix will work against Covid-19?," UBS Global Research Team, 21 April 2020.

[2] China is an outlier as its response to the crisis concerns mostly public investment, which according to the report represents 59 percent of total expenditures.

policy (or the optimal mix between them) depends crucially on how the lending channel is impaired due to Covid-19 crisis, captured here by some static comparative on the borrowing limit. A first lesson is that economies with a developed financial system should unleash credit. Developing economies should rely more on transfers. We also argue that a stringent debt limit amplifies the recession, at the same time that restricts the use of credit subsidy, perhaps the preferred instrument to target those households who really need support. We enrich this discussion presenting a numerical illustration where we compare both policies, for different levels of debt limits. To make policies comparable, we assume they produce the same path of real government liabilities.

This is a rudimentary environment that, being so, faces several limitations. An obvious limitation is the assumption of perfect labor reallocation across sectors, given that one feature of the crisis is that the actual mass of unemployed cannot be easily absorbed by the remote sector. The model assumes that a bar tender can work in grocery deliveries the next day. Yet, the lesson is valid: the goal of macroeconomic stabilization is to prevent the needed recession in social sectors to spill over to sectors that can be maintained active. Second, the policies themselves are very stark. For example, transfers are not directed to the poor, which are likely to contract their demand the most for precautionary reasons. Targeted transfers are part of social insurance in many countries and their effects in incomplete market economies are well understood (e.g. Berriel and Zilberman, 2011). However, the speed of the crisis limits the ability to setup transfers targeted to low wealth households rather than low income households. Thus, transfers can be targeted only in as much income is a proxy for wealth. The credit policy here is also stark because it targets individual debt only. In practice, governments are also attempting to target firm credit, as a means to keep workers in their jobs and avoid the social losses produced by inefficient unemployment spells. We explain how the model can be modified easily along those lines. Yet, we think that governments should attempt to stimulate credit card debt, a policy that has not being used as much as others. Third, the debt limits are exogenous. This is a key feature of the model that determines the relevance of the transfers versus credit subsidy, but clearly a credit program has to confront the reality of default risk and moral hazard. Finally, we leave aside the question of how these programs are financed. Temporary deviations from a Taylor rule allow, at least partially, the consolidated government to control the trajectory of real rates, and this can potentially introduce trade-offs.

A final important shortcoming is that the model is not tailored to speak to forced lockdowns (or any other containment policy). This could be simply accommodated by an ad-hoc restriction on the amount of social goods that can be consumed. The representation in terms of the discount factor would be the same as the one here, but the representation would be endogenous to policy. These are all issues that can be addressed in variations to this model. Despite these limitations, and the distance to reality, the model here is a good laboratory to think of policy implications in real time.

This paper is one of the many research responses that study the positive and normative macroeconomic implications of the Covid-19 pandemic. One group of papers integrates epidemiology and macro models,[3] and study how the evolution of the pandemic interacts with the macroeconomy. Examples include Eichenbaum et al. (2020), Alvarez et al. (2020), Jones et al. (2020), Bethune and Korinek (2020), Krüger et al. (2020) and Kaplan et al. (2020). Another group interprets the Covid-19 shock by using the

[3] A description of the baseline epidemiology model and simulations concerning the Covid-19 pandemic can be found in Atkeson (2020) and Berger et al. (2020).

standard macroeconomics toolkit. In particular, the shock is interpreted as an unexpected shut down of part of the economy as a consequence of the pandemic shock and unmodeled sanitation measures. In Guerrieri et al. (2020), the shock is represented as a cap on labor employment. A key finding is that this supply shock only generates demand deficiency in a tow-sectors economy for a specific (but not restrictive) set of parameters. In Caballero and Simsek (2020), the large supply shock triggers a stock wealth decline of risk-tolerant agents, leading to a feedback loop that further decreases asset prices and output when the interest rate is constrained downward to accommodate the shock. In Buera et al. (2020), some of the firms in their model with heterogeneous entrepreneurs must shut down due to the shock. Our paper fits this branch of this emerging literature. We represent the Covid-19 shock as a shock that reduces the consumption of social goods. We interpret it as a decease in marginal utility of consuming such goods due to behavioral responses to the risk of being infected. Incidentally, this shock is more likely to be recessive for a specific set of parameters, similar to the set found by Guerrieri et al. (2020). Closely related is Faria-e Castro (2020), who studies policy responses to a similar shock in a two-sector model with two types of agents, borrowers and lenders. He finds that unemployment insurance is the preferred policy from the point of view of borrowers, while savers favor transfers. Finally, there is a third branch that studies empirically the macroeconomic consequences of early pandemics. For example, Barro et al. (2020), Correia et al. (2020), and Jordà et al. (2020). This literature is evolving fast, and these papers represent a rather incomplete list.

The paper is organized as follows. Section 2 presents the model. Section 3 discusses the results. Finally, Section 4 concludes.

2 Model

Time is continuous, $t \in [0, \infty)$. The economy is populated by ex-post heterogeneous households. There is a consolidated government, which is a combination of a Central Bank (CB) and fiscal authority. Banks intermediate between borrower and lender households, but since they make zero profits, they are simple pass through entities. The CB determines a common policy rate and conducts open market operations that translate into a credit subsidy. The fiscal authority makes/collects (lump sum) transfers/taxes to/from households and manages unemployment insurance. Households face idiosyncratic income shocks produced by unemployment spells. Households self-insure by borrowing and lending through banks.

There are two goods produced with a common input, labor. Due to wage rigidities, a shock aimed to capture the economic impact of the Covid-19 pandemics (i.e., a shock that reduces the consumption of goods that require social contact) generates unemployment beyond a natural level. This social inefficiency is amplified through debt constraints. The objective is to study the role of two specific policies aimed at stabilizing the economy after the shock. The policy options are either a credit policy that shows up as a lending subsidy or lump-sum direct transfers to households.

2.1 Preferences, technology, and the Covid-19 shock

To accommodate a Covid-19 shock, we consider two types of goods, one that can be consumed remotely, c_t^r, and another that requires social interactions, c_t^s. Let households instantaneous preferences be given by $U(x_t) \equiv \left(x_t^{1-\gamma} - 1\right) / (1-\gamma)$; the composite good x_t is given by

$$x_t = \left(\alpha^{1/\epsilon} c_t^{r\,1-1/\epsilon} + ((1-\alpha)\,\beta_t)^{1/\epsilon}\, c_t^{s\,1-1/\epsilon}\right)^{\epsilon/(\epsilon-1)}.$$

Here, γ is both the risk aversion parameter and the inverse of the intertemporal elasticity of substitution. For this version, the risk-aversion force is dominated by the elasticity of substitution. In turn, ϵ is the elasticity of substitution between goods, and α is the share of each type of good. Throughout the paper, we take a stance that social and remote goods are substitute, $\epsilon > 1$, such that the consumption of remote goods (at home, e.g., Netflix, Amazon, supermarket expenditures, etc) increases, whenever the consumption of social goods (e.g., movies, restaurants, etc) decreases.

We interpret $\beta_t \in [0,1]$ as a shock that reduces the utility from social goods due to the fear of the pandemic. Intuitively, individuals arguably experiment a lower degree of happiness whenever consuming certain goods that involve risk of being infected. In that sense, our model is capturing a behavioral response of individuals during a pandemic, rather than a proper containment policy that imposes social distance. Alternatively, we could impose an upper limit on the consumption of social goods, say $c_t^s \leq \bar{c}^s$, that would capture a policy that aims to limit social interactions, such as a lockdown. Both assumptions show up mathematically as a modification to the expenditure problem, but in the case of rationing, that representation would not be invariant to policy. We will study a quantity restriction in a new version of the paper. Utility flows are discounted accordingly with discount rate ρ, $\mathbb{E}\left[\int_0^\infty e^{-\rho t} U(x_t)\, dt\right]$.

Let c_t be total expenditures. For simplicity, we assume that both goods can be produced with the same production function, so their relative prices is one—we can relax this assumption without difficulty. The first-order conditions and simple algebra yield:

$$c_t^r = \frac{\alpha}{((1-\alpha)\,\beta_t) + \alpha} c_t; c_t^s = \frac{((1-\alpha)\,\beta_t)}{((1-\alpha)\,\beta_t) + \alpha} c_t; x_t = ((1-\alpha)\,\beta_t + \alpha)^{1/(\epsilon-1)}\, c_t.$$

Naturally, a decrease in β_t not only decreases (increases) the consumption of social (remote) goods, but if the elasticity of substitution is more than one, $\epsilon > 1$, for a given amount of expenditures, the consumption of the composite good decreases. For plausible assumptions on α and ϵ, conceptually we can reverse engineer β_t to deliver the path of c_t^s compatible with people fearing going out and staying at home for a given time, or the path desired by a containment policy $\bar{c}^s$ that limits consumption of social goods $c_t^s = \bar{c}^s$.

By substituting $x_t = ((1-\alpha)\,\beta_t + \alpha)^{1/(\epsilon-1)}\, c_t$ back into the households' objective function, and given that preferences are CRRA, one obtains

$$\mathbb{E}\left[\int_0^\infty e^{-\rho t} \xi_t U(c_t)\, dt\right],$$

where $\xi_t = ((1-\alpha)\,\beta_t + \alpha)^{(1-\gamma)/(\epsilon-1)}$.

For $(1-\gamma)/(\epsilon-1) < 0$, which is true, for instance, when both $\epsilon > 1$ and $\gamma > 1$, a Covid-19 shock that reduces the consumption of social goods, morphs into a negative discount factor shock (more discounting of the future). In the other case, in which $\epsilon > 1$ and $\gamma < 1$, the shock can be represented equivalently as a positive discount factor shock (less discounting) as agents do not gain much utility from current consumption. A positive discount factor shock, coupled with price rigidity, tends to generate a recession whenever the intertemporal elasticity of substitution is more than one, $IES = 1/\gamma > 1$, as agents are willing to substitute aggregate consumption intertemporally. Hence, we also assume throughout the paper that $\gamma < 1$, so our exercise can easily reproduce the feature that the Covid-19 shock is clearly recessive. Note that the assumption that $\epsilon > 1 > \gamma$ is consistent with the set of parameters for which Guerrieri et al. (2020) find that a supply shock in one of the sectors in their two-sectors model generates demand deficiency, something those authors calls a Keynesian supply shock—here we simply refer to the spill-over across sectors. Finally, note that the higher the share of social goods, $(1-\alpha)$, the more intense will be the propagation of the shock.

In addition, and for simplicity, we assume that production is a linear function of aggregate employment, $c_t^r + c_t^s = (1 - U_t)$, where U_t is the unemployment rate. Note that labor can be perfectly reallocated across sectors in response to the Covid-19 shock. This is a useful benchmark to show that, even under this assumption, the shock can induce a recession with a scope for policy response aimed at stabilizing output. Nonetheless, imperfect reallocation seems to be a key ingredient under the current crisis: given that the mass of unemployed cannot be easily absorbed by the essential sector, which would further increase the scope for policy to improve welfare.

Finally, there is no notion of payroll financing in this paper, as firms do not face frictions and always honor their wage bills. Although subsidizing firms is an important aspect of the current crisis, the focus here is on the trade-off between lump-sum transfers and credit subsidy to households, rather than firms. Nonetheless, we can easily modify this approach, by studying a subsidy policy to keep workers away from unemployment, but keeping them in a different pool of idle firms. The idea is that these workers could return to the workforce immediately, rather than going through the unemployment to employment process. We think this is a core policy response, but for now we abstract from it.

2.2 Households

The non-financial sector features a measure-one continuum of ex-ante identical households, that are ex-post heterogeneous. Heterogeneity follows from uninsurable idiosyncratic risk $z \in \{u, e\}$, where u stands for unemployed and e stands for employed. The stochastic process that governs this idiosyncratic risk is independent and identically distributed across households. Households transit from one state to another according to an instantaneous transition probabilities of $\Gamma_t^{eu} = \nu^{eu} + \phi_t^+$ and $\Gamma_t^{ue} = \nu^{ue} - \phi_t^-$, where $\{\nu^{ue}, \nu^{eu}\}$ are exogenous (or natural) transition rates, and ϕ_t is an endogenous employment-unemployment adjustment rate that occurs due to price rigidity. Namely, ϕ_t is positive (negative) when the rigidity constraint is binding and there is an excess supply (demand) of final goods under $\phi_t = 0$.

Households receive a flow of real income given by:

$$dw_t = y(z)\,dt + T_t dt,$$

where income w_t is the sum of direct transfers T_t (to be described below) and labor income (or unemployment insurance) $y(z)$. Note that, in equilibrium, the real wage rate is one. We assume that $y(e) = \left(1 - \tau^l\right)$, and thus, households are taxed with rate τ^l whenever they are employed, and $y(u) = b$, meaning that b is the replacement rate for unemployment insurance purposes.

Financial claims are nominal. Although all claims are nominal, the individual state variable is s_t, the stock of real financial claims—the distinction would matter only with long-term debt. Households store wealth in bank deposits, a_t^h, or currency, m_t^h, and borrow loans against banks, l_t^h. By convention, $\{a_t^h, m_t^h, l_t^h\} \geq 0$. Let real rates of return be $r_t^m \equiv i_t^m - \pi_t$ and $r_t^l \equiv i_t^l - \pi_t$, where i_t^m is the monetary policy rate, i_t^l is the rate on loans, and $\pi_t = \dot{P}_t / P_t$ is inflation. Note that the price of the composite good in terms of money is P_t. Currency does not yield nominal interest, and thus, its real return is $-\pi_t$. The law of motion for real wealth follows

$$ds_t = \left(r_t^m \frac{a_t^h}{P_t} - \pi_t \frac{m_t^h}{P_t} - r_t^l \frac{l_t^h}{P_t} - c_t \right) dt + dw_t, \tag{1}$$

and the balance-sheet identity is given by

$$\frac{a_t^h + m_t^h}{P_t} = s_t + \frac{l_t^h}{P_t}.$$

From a household's perspective, there is no distinction between holding deposits or currency beyond their rates of return. Hence, currency is only held when the nominal deposit rate is zero, and both assets yield the same return. This feature is introduced into the model only to articulate a zero lower bound as an implementation constraint. Another observation is that households do not hold deposits and loans if there is a positive spread between them. Combining these insights, (1) can be written succinctly as:

$$ds_t = \left(r_t(s_t) s_t - c_t \right) dt + dw_t, \tag{2}$$

where $r_t(s_t) = r_t^m$ if $s_t \geq 0$, and $r_t(s_t) = r_t^l$ if $s_t < 0$. Finally, households can borrow, but only up to a certain limit. For now, there is a fixed threshold $\bar{s} \leq 0$, such that $s_t \geq \bar{s}$. In this version of the paper, we abstract from default risk and moral hazard associated with incentives to repudiate debt. This is arguably a relevant feature of the current crisis. As we discuss below, the degree of slackness of such debt limit is the key determinant of policy design in response to the shock. Hence, exogenous debt limit is another feature of the model that is clearly restrictive.

The Hamilton-Jabobi-Bellman (HJB) equation associated with the household's problem is:

Problem 1 *[Household's Problem] The household's value and policy functions are the solutions to:*

$$\begin{aligned}
\rho V(z, s, t) &= \max_{\{c\}} \xi_t U(c) + V'(z, s, t) \left[r_t^m(s) s - c + y(z) + T_t \right] \\
&\quad + \Gamma_t^{zz'} \left[V(z', s, t) - V(z, s, t) \right] + \dot{V}(z, s, t),
\end{aligned}$$

subject to $s \geq \bar{s}$.

2.3 Unemployment, inflation, and the Phillips curve

In standard Real Business Cycle models, prices adjust to ensure market clearing, whereas in standard New Keynesian (NK) models prices are rigid but firms produce and supply goods to meed their demand. Here, we follow the NK tradition, but instead of assuming monopolistic competition and a price adjustment process, we simply postulate that prices are rigid in a way that makes inflation evolve according to a classic forward-looking version of the Phillips curve:

$$\dot{\pi}_t = \rho\left(\pi_t - \pi_{ss}\right) - \kappa\left(U_{ss} - U_t\right),$$

where the subscript ss denote steady-state levels. In particular, inflation increases (decreases) whenever unemployment U_t is below (above) its natural rate U_{ss}, or inflation π_t is above (below) its long-run expected inflation-target π_{ss}, implemented by the CB interest-rate policy. Different from a NK model, steady-state inflation does not have consequences for efficiency.

By solving the equation forward, one obtains the following integral solution for inflation at time t,

$$\pi_t = \pi_{ss} + \kappa \int_0^\infty \exp\left(-\rho s\right)\left(U_{ss} - U_t\right) ds.$$

Importantly, π_t is not pre-determined, as it depends on path of future unemployment. Inflation is boosted at intensity κ, as unemployment falls below steady state. When unemployment is below steady state, the economy experience wage pressures. In that case, nominal wages tend to increase. Similarly, the economy features deflation as the unemployment rate rises above steady state.

In this model, as anticipated above, we assume that the endogenous component ϕ_t of employment-unemployment transitions adjusts to ensure market clearing. In particular, the law of motion of unemployment is given by

$$\dot{U}_t = \left[\nu^{eu} + \phi_t^+\right]\left(1 - U_t\right) - \left[\nu^{ue} - \phi_t^-\right] U_t. \tag{3}$$

If demand is insufficient, and prices cannot adjust downwards, the unemployment rate responds.

2.4 Intermediation and implemenation of credit spread with open-market operations

Financial intermediation is carried out by a competitive fringe of intermediaries. In the paper, these are simple pass through entities. In particular, banks choose their supply of nominal deposits, a_t, nominal loans, l_t, and reserve holdings, m_t.[4] Free entry and perfect competition yield zero expected profits. Deposits and reserves earn corresponding rates $i_t^a = i_t^m$, where i_t^m is the policy target set by the CB. Due to the credit policy, the interest rate on loans, i_t^l, differs from the policy rate.

To implement the credit policy, we assume that the CB branch of the consolidated government conducts a policy that targets a given loan subsidy, $\sigma_t > 0$. This subsidy is induced by a combination of interest on reserves and open-market operations as explained below. Due to competition, i_t^l must be such that expected returns satisfy $i_t^l + \sigma_t = i_t^m$. In real terms, let interest rates be expressed as r_t^a, r_t^m and r_t^l. Given that $i_t^a = i_t^m = i_t^l + \sigma_t$, any composition of banks' balance sheet, such that $l_t + m_t = a_t$, is consistent with optimal behavior. The aggregate supply of deposits and loans, and holdings of reserves are denoted by A_t^b, L_t^b, and M_t^b, respectively, and of course, must satisfies $L_t^b + M_t^b = A_t^b$.

To explain how the CB implements a negative spread, we work with the continuous time limit of a discrete time implementation. To implement a spread σ_t, the CB purchases a fixed allotment of loans

[4] Banks operate without equity. The introduction of a role for bank equity (via restrictions like capital requirements or limited participation) would produce bank profits and would make equity an aggregate state variable. For simplicity, we abstract away from this dimension in this paper. In practice, alleviating capital requirements is essential to expand credit.

L_t^f. Loans are purchased at a random auction at a pre-specified price $q_t \equiv 1 + \Delta\sigma_t \cdot \frac{L_t^b}{L_t^f}$ for a small time interval Δ. Since the price is greater than one, all loans participate in the auction. Winners in the auction earn an arbitrage $(q_t - 1)$ per time interval. The probability of selling a loan is $\Theta = L_t^f / L_t^b \Delta$ per interval of time. Taking the interval to zero, then the bank earns an arbitrage of

$$\sigma_t \equiv \lim_{\Delta \to 0} (q_t - 1) \cdot \Theta_t,$$

per instant of time.

2.5 Consolidated government

Throughout the paper, we consider the consolidated government budget constraint, which combines budget constraints associated with the Central Bank (CB) and the branch of the government responsible for fiscal policies, and use the terms CB and (consolidated) government interchangeably.

Budget constraint. The CB has a nominal net asset position, E_t, defined as:

$$E_t \equiv L_t^f - M_t.$$

The net-asset position is the difference between loans held by the CB, L_t^f, and the CB liabilities, i.e., the monetary base, M_t. The monetary base is divided into the aggregate holdings of reserves by banks M_t^b and the household's currency holdings, $M0_t$. The monetary base is always positive. The CB can issue or purchase loans L_t^f: when negative L_t^f is understood to be a stock of government bonds, when positive, it is understood to be the loan purchases of the CB.[5] An open market operation is a simultaneous increase or decrease in M_t and L_t^f without altering net asset positions.[6]

There are two "active" fiscal policies available to the government, lump-sum transfers T_t and the credit subsidy σ_t. The parameter b is important to control the degree of insurance in the economy and endow the unemployed with some income. We assume that the employment insurance is not necessarily balanced, leaving a deficit of $w_t b U_t - w_t \tau^l (1 - U_t)$. Considering the consolidated budget, the nominal fiscal surplus without transfers is given by:

$$\Pi_t^f = i_t^m L_t^f - i_t^m (M_t - M0_t) - P_t T_t - \sigma_t L_t^b + w_t \tau^l (1 - U_t) - w_t b U_t, \tag{4}$$

where the sources of income are given by the nominal interest on loans and labor taxes, whereas the sources of expenses are reserve remunerations, transfers, the credit subsidy and unemployment insurance. The net asset position of the consolidated government evolves according to

$$dE_t = d\Pi_t^f = \underbrace{dL_t^f - dM_t}_{\text{unbacked transfers}}.$$

[5]There is no distinction between private and public loans. In fact, whenever $L_t^f < 0$, an increase in L_t^f is interpreted as a conventional open market operation (OMO). Instead, when $L_t^f > 0$, an increase L_t^f is an unconventional OMO. The assumption is that government bonds are as illiquid as private loans from the point of view of banks.

[6]The model is rich enough to accommodate a "helicopter drop" through an increase in M_t, without a counterpart increase in L_t^f.

The government accumulates a nominal claim on the private sector as undistributed income. The net asset position decreases with the difference between the monetary base and the loan purchases of the CB. In real terms, the CB's net asset position is $\mathcal{E}_t \equiv E_t/P_t$ and its loan holdings are $\mathcal{L}_t^f \equiv L_t^f/P_t$. Let $\mathcal{W}_t$ denote the real wage, and $f(z,s,t)$ the density associated with the joint distribution of savings s and employment status z. The next proposition exploits this observation to express the law of motion of the real net asset position $\mathcal{E}_t$ in real terms.

In real terms, $\mathcal{E}_t$ satisfies:

$$\dot{\mathcal{E}}_t = r_t^m \mathcal{E}_t + (\sigma_t - \pi_t) \int_{\bar{s}}^{0} s\left[f(e,s,t) + f(u,s,t)\right] ds + \mathcal{W}_t \left(\tau^l (1-U_t) - bU_t\right) - \tau_t \mathcal{E}_t,\ \mathcal{E}_0 \text{ given.} \quad (5)$$

where transfers are given by $T_t = \tau_t \mathcal{E}_t$. The first term in (4) is the portfolio income earnings (losses) of the CB which equal the real rate times the net asset position. The second term captures the losses from the CB's subsidy. The third term is the outcome of income taxation and unemployment insurance policy. Finally, transfers are subtracted from the real asset position. A policy path is constrained by solvency conditions. An important restriction is a long-run solvency constraint for the CB. In particular, there is a limit $lim_{t\to\infty}\mathcal{E}_t \geq \underline{\mathcal{E}}$ for some minimum $\underline{\mathcal{E}}$ that guarantees that the CB can raise enough revenues and satisfy $d\underline{\mathcal{E}} = 0$. It must be the case that at $\underline{\mathcal{E}}$ discount window revenues cover any balance sheet costs. This condition is equivalent to assuming that the CB's liabilities are not worth zero in equilibrium. The model features a Laffer curve for CB revenues. Although we do not solve for $\underline{\mathcal{E}}$ explicitly, in the exercises we analyze in the following section, we impose that all policy paths lead to a convergent stable government net asset position and $lim_{t\to\infty} d\mathcal{E}_t = 0$. Another restriction in the opposite direction is that $\mathcal{E}_t \leq -\bar{s}$, which is equivalent to saying that the CB claim on the public cannot exceed the public's debt limit.

Taylor rule. To set the interest **instensivelyon** reserves, the CB works with a Taylor rule that allows for a discretionary component that is triggered by the shock, but also follows a standard Taylor rule that captures commitment for the long-run. This feature is important. Without a Taylor rule, the model is unstable, so we need the long-run component. At the same time, we want to capture the idea that monetary policy responds to economic conditions. For that, we specify the following rule:

$$i_t^m = i_\infty^m + \eta \cdot (\pi_t - \pi_{ss}), \quad (6)$$

where $\eta > 1$ is the parameter that governs the response of nominal interest rate to inflationary pressures. In addition, i_∞^m is chosen to guarantee an inflation target π_{ss}.

Fiscal rule. To allow comparisons among policies, lump-sum transfers and credit policies, we setup a path for government debt as a policy target. During the crisis, we allow debt to expand and then shrink it back. We assume the following rule

$$\mathcal{E}_t = \underbrace{\mathcal{E}_\infty}_{\text{long-run target}} + \underbrace{(\mathcal{E}_d - \mathcal{E}_\infty) \cdot \exp\left[-\gamma^{LR} t\right]}_{\text{long-run deviation}} + \underbrace{(\mathcal{E}_{t^-} - \mathcal{E}_d) \cdot \exp\left[-\gamma^{SR} t\right]}_{\text{short-run deviation}}. \quad (7)$$

The term $\mathcal{E}_\infty$ is a long-run target. The term $\mathcal{E}_d$ is an attraction point of net asset position. The rate $\mathcal{E}_{t^-}$ is the government net asset position the instant before a shock. Finally, the term $\exp\left(-\gamma^{SR}t\right)$ captures the speed of expansion of government debt and $\exp\left(-\gamma^{LR}t\right)$ the speed of reversal of the discretionary policy to the long-run target. We further discuss this rule in the Appendix A, where we argue that by assuming $\gamma^{LR} < \gamma^{SR}$, the net asset position (debt) decreases (increases) and then increases (decreases) during and after the crisis to accommodate the stabilizing policies. Since the path of net asset position is pinned down, we obtain the possible mix of transfers and credit policy as a residual as follows. Take derivatives with respect to time to obtain:

$$\dot{\mathcal{E}}_t = -\left[\gamma^{LR}\left(\mathcal{E}_d - \mathcal{E}_\infty\right) \cdot \exp\left[-\gamma^{LR}t\right] + \gamma^{SR}\left(\mathcal{E}_{t^-} - \mathcal{E}_d\right) \cdot \exp\left[-\gamma^{SR}t\right]\right]. \tag{8}$$

And thus, all policies that combine paths for transfers T_t and credit subsidy σ_t satisfying

$$T_t = r_t^m \mathcal{E}_t + \left(\sigma_t - \pi_t\right) \int_{\bar{s}}^{0} s\left[f\left(e,s,t\right) + f\left(u,s,t\right)\right] ds + \mathcal{W}_t\left(\tau^l\left(1 - U_t\right) - bU_t\right) - \dot{\mathcal{E}}_t, \tag{9}$$

they also imply the same path for debt and, thus, they are comparable.

We consider two types of policy. First, a pure transfers policy, for which we set $\sigma_t - \pi_t = 0$, and thus solve for the path of lump-sum transfers that is consistent with the expansion of debt in (7). In this case,

$$T_t = r_t \mathcal{E}_t + \mathcal{W}_t\left(\tau^l\left(1 - U_t\right) - bU_t\right) - \dot{\mathcal{E}}_t.$$

In addition, we consider an active credit policy for which we set the path credit subsidy according to:

$$\sigma_t = \underbrace{\sigma_\infty}_{\text{long-run target}} + \underbrace{\left(\sigma_d - \sigma_\infty\right) \cdot \exp\left[-\psi^{LR}t\right]}_{\text{long-run deviation}} + \underbrace{\left(\sigma_{t^-} - \sigma_d\right) \cdot \exp\left[-\psi^{SR}t\right]}_{\text{short-run deviation}}, \tag{10}$$

and transfers are backed as a residual from (9). This subsidy rule is akin to the evolution of debt in (7), in which the value σ_∞ plays to role of the long-run target. Again, the term σ_d is an attraction point of the subsidy policy, and the rate $\sigma_{t^-}^m$ is the credit policy the instant before a shock. As regarding the law of motion to debt, the term $\exp\left(-\psi^{SR}t\right)$ captures a degree of responsiveness to the shock: the speed at which the discretionary policy kicks, whereas $\exp\left(-\psi^{LR}t\right)$ the speed of reversal of the discretionary policy, to the long-run target. Again, we further discuss this rule in the Appendix A. In this case, we assume that $\psi^{LR} > \psi^{SR}$such that the credit subsidy σ_t first increases, and then decreases toward its long-run target.

One important aspect of macroeconomic stabilization policy is the speed of the implementation. The Covid-19 shock has evolved faster than ever. Arguably, a credit policy is faster to implement, given that monetary operations do not require the bureaucratic burden of a sending checks. We can control the speed of the policy responses via the parameters $\left\{\psi^{SR}, \gamma^{SR}\right\}$. Another critical aspect, is that we do not consider targeted transfers. Thus, the transfer program wastes budgetary resources distributing resources to wealthy individuals. Although in practice, transfers have been assigned to low-wage earners, the misallocation of transfers is still a problem. There are many low wage earners that have years of savings, and many high wage earners that are in deep debts. Without appropriately observing wealth, the effectiveness of the policy faces clear implementation constraints.

Finally, we could enrich the model to evaluate different schemes to finance those policies. For instance, by introducing short-run deviations of the Taylor rule that imply a lower path for the interest i_t^m, the debt evolution is mitigated, but this can potentially introduce trade-offs. Hence, the model can also provide insights on the welfare implications of the fiscal-monetary interactions needed to finance the debt implied by policies.

2.6 General equilibrium

Distribution of wealth and employment status. The mass of agents sums to one. At each instant t, there is a distribution $f(z,s,t)$ of real financial wealth across households given their employment status z. The law of motion of this distribution satisfies a Kolmogorov-Forward Equation (KFE). The KFEs are given by:

$$\begin{aligned}\frac{\partial}{\partial t}f(e,s,t) &= -\frac{\partial}{\partial s}\left[\mu(e,s,t)f(e,s,t)\right]-\Gamma_t^{eu}f(e,s,t)+\Gamma_t^{ue}f(u,s,t) \text{ and}\\ \frac{\partial}{\partial t}f(u,s,t) &= -\frac{\partial}{\partial s}\left[\mu(u,s,t)f(u,s,t)\right]-\Gamma_t^{ue}f(u,s,t)+\Gamma_t^{eu}f(e,s,t).\end{aligned} \tag{11}$$

Note that a fraction $U_t=\int_{\bar{s}}^{\infty}uf(u,s,t)\,ds$ is unemployed, whereas a mass $1-U_t$ is active in the workforce. The mass of unemployed evolves according to the law of motion in (3).

Markets. Recall that $m_t^h(z,s)$, $a_t^h(z,s)$ and $l_t^h(z,s)$ are the demand for currency, deposits and loans, respectively, at instant t by a household with employment status z and savings s. Outside money is held as bank reserves or currency. The aggregate currency stock is

$$M0_t \equiv \int_{\bar{s}}^{\infty}\left[m_t^h(e,s)f(e,s,t)+m_t^h(u,s)f(u,s,t)\right]ds.$$

Naturally, households only hold currency at a zero-lower bound. Equilibrium in the outside money market is:

$$M0_t+M_t^b=M_t. \tag{12}$$

The credit market has two sides: a deposit and a loans market. In the deposit market, households hold deposits supplied by banks. In the loans market, households obtain loans supplied by banks and the CB. The distinction between the loans and deposits is that they clear with different interest rates. The deposit market clears when:

$$A_t^b=\int_0^{\infty}\left[a_t^h(e,s)f(e,s,t)+a_t^h(u,s)f(u,s,t)\right]ds, \tag{13}$$

whereas the loans market clears when:

$$L_t^b + L_t^f = \int_{\bar{s}}^{0} \left[l_t^h(e,s) f(e,s,t) + l_t^h(u,s) f(u,s,t) \right] ds, \tag{14}$$

whereL_t^b and L_t^f are loans purchases by banks and the CB, respectively. Note that household deposit demand is given by $a_t^h(z,s) \equiv P_t s - m_t^h(z,s)$ for positive values of s whereas demand for loans by $l_t^h(z,s) \equiv -P_t s$ for negative values of s.

Finally, the goods market clears when:

$$(1 - U_t) \equiv Y_t = C_t \equiv \int_{\bar{s}}^{\infty} \sum_{z \in \{e,u\}} \left(c_t^r(z,s) + c_t^s(z,s) \right) f(z,s,t)\, ds, \tag{15}$$

where $c_t^r(z,s)$ and $c_t^s(z,s)$ represent the demands for remote and social goods, respectively, at instant t by a household with employment status z and savings s. The definition of the perfect foresight equilibrium is standard.

Equilibrium computation. The real equilibrium deposit rate solves a single clearing condition (Bigio and Sannikov, 2019):

$$-\int_{\bar{s}}^{0} s \left[f(e,s,t) + f(u,s,t) \right] ds = \int_{0}^{\infty} s \left[f(e,s,t) + f(u,s,t) \right] ds + \mathcal{E}_t \text{ for } t \in [0,\infty). \tag{16}$$

If we obtain the real deposit rate, we also obtain the real value of loans and deposits as well as the evolution of wealth. By Walras Law, if (16) holds, then the goods market clearing condition (15) also holds.

3 Policy responses and trade-offs

3.1 Two insights

We state here two insights to guide the discussion below. First, consider the case in which the borrowing limit is the natural one. Since this borrowing limit is never binding, and except for the initial unexpected shock there is not aggregate risk, the Ricardian equivalence holds meaning that debt and lump-sum transfers are equivalent to finance expenditures—see Ljungqvist and Sargent (2012) for a textbook treatment. Hence, if the economy eventually returns to the same steady-state, any path of transfers is neutral as it will be consistent with a path in which transfers are set to zero all time. This insight showcases an extreme economy where one of the policies we evaluate has muted effects. Second, consider the other opposite case, an economy where debt limits are severe, as in Werning (2015) and Guerrieri et al. (2020). In particular, let the borrowing limit be zero. By construction, any credit subsidy is immaterial as there is not credit to be subsidized.

This discussion showcases that the effectiveness of policy critically depends on the extent of borrowing limits. In one extreme, when credit is ample, transfers are useless. In the other case, when credit is restricted, a credit policy is useless. These insights might be important for ongoing policy debates, as it means that in developed economies, with ample credit limits, transfer policies are more likely to to be neutral, whereas in emerging economies, with low credit limit, credit subsidy might not have a bite. These insights seem to be guiding policies to some extent: as we noted in the introduction, developing countries are relying more intensively on transfer programs, developed economies on credit programs.

3.2 Numerical illustrations

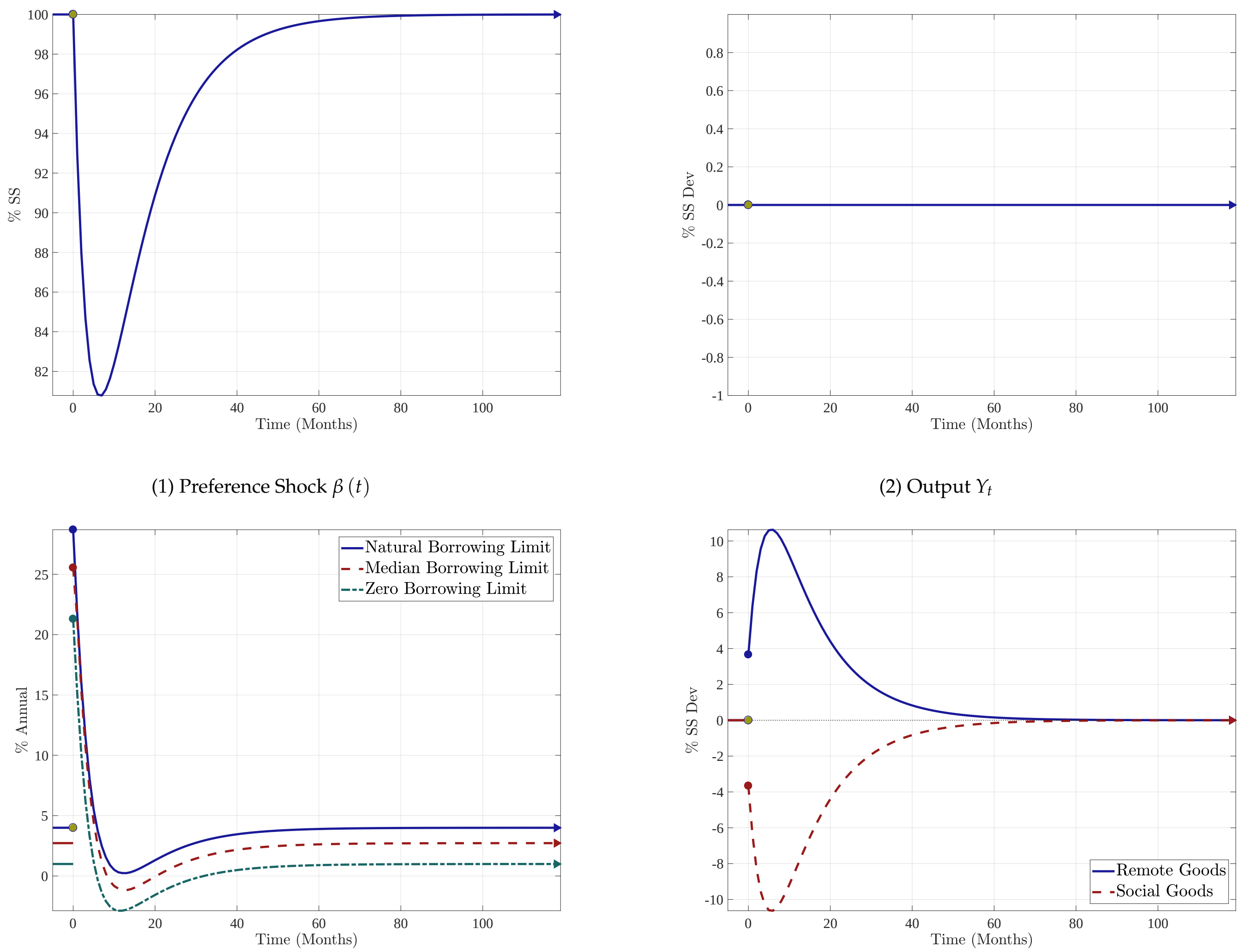
To evaluate the model, we present a simple calibration for illustrative purposes. As explained above, we assume that $\epsilon = 1.8$ and $\gamma = 0.5$, such that the shock in the marginal utility of social consumption is associated with less discounting, and thus, due to $IES > 1$ and rigid prices, it generates a recession. Also, we assume a low degree of substitutability, which is in line with the idea that some substitution occurs (e.g., going to the movies for online streaming), but given the nature of goods that requires social interactions, we doubt they can be largely substituted for goods that can be consumed at home.

We assume the economy is initially in the steady-state. Then, we solve the model for a time-varying path of β_t, which governs the evolution of behavioral responses due to the infection risk of Covid-19. Eventually, the economy converges back to steady-state. We assume β_t follows an inverse-hump-shape path (see Figure 2, left-top panel), which becomes perfectly foreseen once the unforeseen Covid-19 shock hit the economy.

We consider a few exercises. First, we analyze the model dynamics in an environment with fully flexible prices. Second, we compare the model dynamics in an environment with rigid prices under three different scenarios: no policies at all (laissez-faire), a pure transfers policy in which the credit subsidy is set to zero, and an active credit subsidy in which lump-sum transfers are computed as a residual. Finally, we experiment with different degrees of borrowing limits. We consider the natural borrowing limit, in which transfers are immaterial due to arguments related to the Ricardian equivalence, so credit subsidy is the preferred policy. We also consider a zero borrowing limit, in which a credit subsidy by construction cannot do anything, so lump-sum transfers are the preferred one. And, finally, an intermediate borrowing limit in which trade-offs between the use of both policies emerge.

3.2.1 Benchmark: flexible prices

To set the stage, in this section, we report results under a flexible prices benchmark, which we obtain by setting the parameter κ to infinity. Figure 2 displays four plots. The top-left panel displays the evolution of β_t, the shock governing the marginal utility of consuming social goods. Under the assumption that $\epsilon > 1$ and $\gamma < 1$, this shock affects the economy as if there is less discounting of the future. Market clearing implies that consumption equals output, which is not affected by the shock since labor flows are exogenous. As the bottom panels reveal, output is constant and households simply reallocate consumption from social goods, affected by the negative marginal utility shock, toward remote goods. The price margin that adjusts is the real interest rate. Regarding the path of the interest rate, this path first increases at the time the shock arrives unexpectedly. Intuitively, given that households anticipate a fall in the the marginal utility of consumption of social goods as the shock escalates, they would like to anticipate consumption and, thus, interest rate must increase at the very beginning of the transition path. As the shock evolves in a perfect foreseen fashion, interest rate follows an inverse hump shape, remaining temporarily below its steady-state level, given the incentives households face to postpone consumption to the future. Finally, given that output is constant, and consumption paths for social and remote goods depend mostly on γ and ϵ, the borrowing limit does not affect these paths. It affects only the path of interest rate which moves downwards as the borrowing limit becomes tighter and reduces the demand for loans.



(1) Preference Shock $\beta(t)$

(2) Output Y_t

(3) Real Interest Rates

(4) Consumption C_t^r and C_t^s

Figure 2: Transition paths under flexible prices.

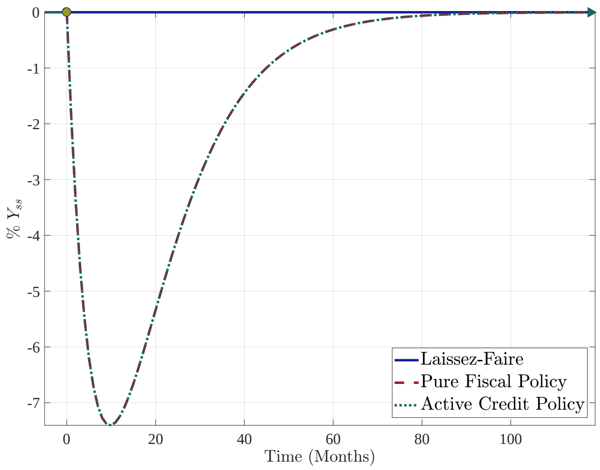
Note: The figure reports the paths of preference shock, total output, real interest rate and consumption of social goods and remote goods under flexible prices after an unforeseen Covid-19 shock. In panel (1), the preference parameter of social goods consumption β_t is expressed in the percentage of steady-state value. In panels (2) and (4), the total output and consumption of social goods and remote goods are expressed in percentage deviations from the steady-state values. In panels (3), the real interest rates are expressed in annual percentages under three levels of borrowing limit: natural borrowing limit, zero borrowing limit, and a moderate borrowing limit where $\bar{s} = -0.1b$.

This is a stark economy. Labor reallocation is perfect and instantaneous, meaning that a bar tender can become a UPS driver or a nurse the next day. This assumption is at odds with reality, but still, showcases that that some segments of the economy should absorb resources not employed in sectors that have to be avoided. The next sections address the points that with wage rigidity, remote sectors can be dragged down by the recession in social sectors.

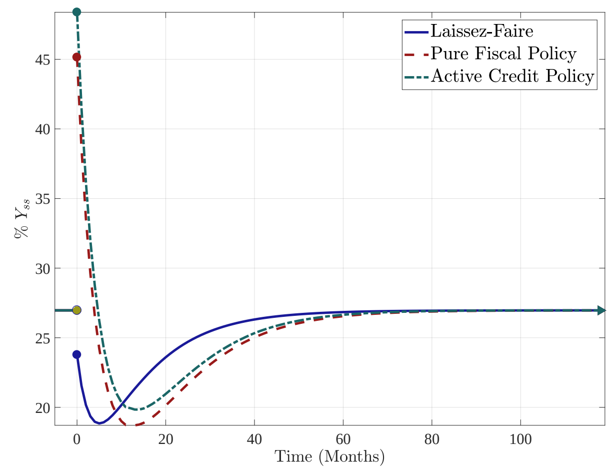
3.2.2 Rigid prices, pure transfers and active credit policy

Under the assumption of price rigidity, $\kappa < \infty$, output drops in a persistent way, enhancing the role of potential policies to mitigate the impact of the shock. In the next sections, we consider scenarios without policy interventions (laissez-faire), with pure lump-sum transfers, and with an active credit policy where transfers adjust as a residual. To make policies comparable, we assume they generate the same path of the consolidated government's position in the latter two cases. We report results for three different degrees of borrowing limits. First, we consider the natural borrowing limit, in which transfers are innocuous. Second, we consider a zero borrowing limit in which credit subsidy is immaterial. Finally, an intermediate borrowing limit that illustrates the trade-off between using both policies.

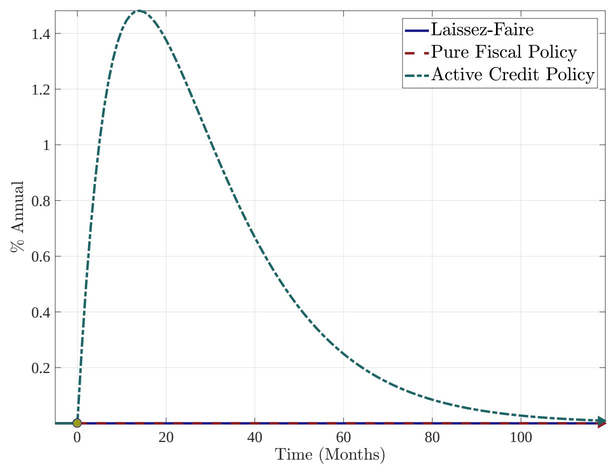
Natural borrowing limit. Figure 3 considers the policy interventions, whereas Figure 4 displays output, consumption and interest rate paths. Compared to laissez-faire (full blue line), dashed red lines (dash-dotted green lines) represent the paths that take into account transfers policy (active credit policy) right after the shock, when the Government instantaneously implements them. Policies are designed to generate the same path of debt, as illustrated in the first panel of Figure 3. The second and third panels plot paths of transfers and credit policy, respectively. In the later case, transfers adjust residually as illustrated by the seconde panel.



(1) Real Net Asset Position $\mathcal{E}_t$



(2) Real Fiscal Transfer

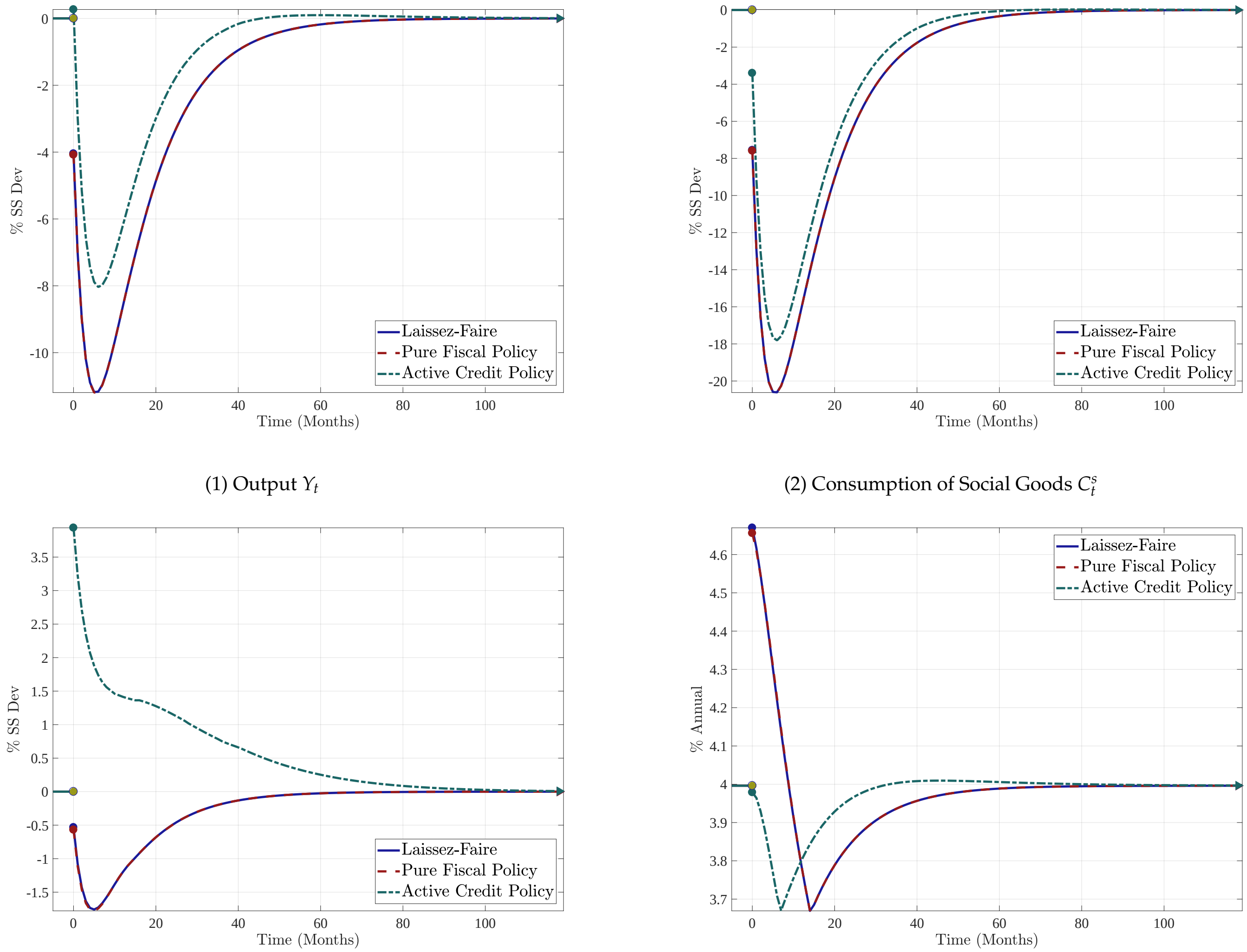


(3) Real Credit Subsidy $\sigma_t - \pi_t$

Figure 3: Nominal rigidity and policy variables (natural borrowing limit).

Note: The figure reports the paths of real net asset position, real fiscal transfer and real credit subsidy in the following scenarios of policy interventions after an unforeseen Covid-19 shock: laissez-faire, pure lump-sum trasnfer and active credit policy. In panels (1) and (2), the net asset position and fiscal transfers are expressed in percentage terms of the steady-state output. In panels (3), the real credit subsidity rate is expressed in annual percentage. The pure fiscal transfer policy and active credit policy follow the same path of net asset position, and the credit subsidy rates in laissez-faire and pure fiscal transfer policy are equal to zero. Given the paths of net asset position and credit subsidy rate, the paths of fiscal transfers are computed as residuals from equation (9). In all figures the households' borrowing limit is set at the natural borrowing limit level, such that the mass of population constrained at the limit is zero along the whole path of transition.

With nominal rigidity, and no policy interventions (blue full-lines in Figures 3 and 4), the output drops in a persistent way. As we explained earlier, this responds to the inability of the remote sector to absorb the slack of the social sector. There are more job separations which implies larger unemployment, and is captured by the slope of the output path. Micro uncertainty increases, meaning that precautionary savings should increase. This reinforces the negative effect on interest rates due to "less discounting" and $IES < 1$, or a more willingness to substitute intertemporally rather than intratemporally. Hence, as opposed to the flexible prices benchmark, consumption of remote goods does not absorb perfectly the fall in the consumption of social goods. There is scope for macroeconomic stabilization, a policy analysis we pursue next.



(1) Output Y_t

(2) Consumption of Social Goods C_t^s

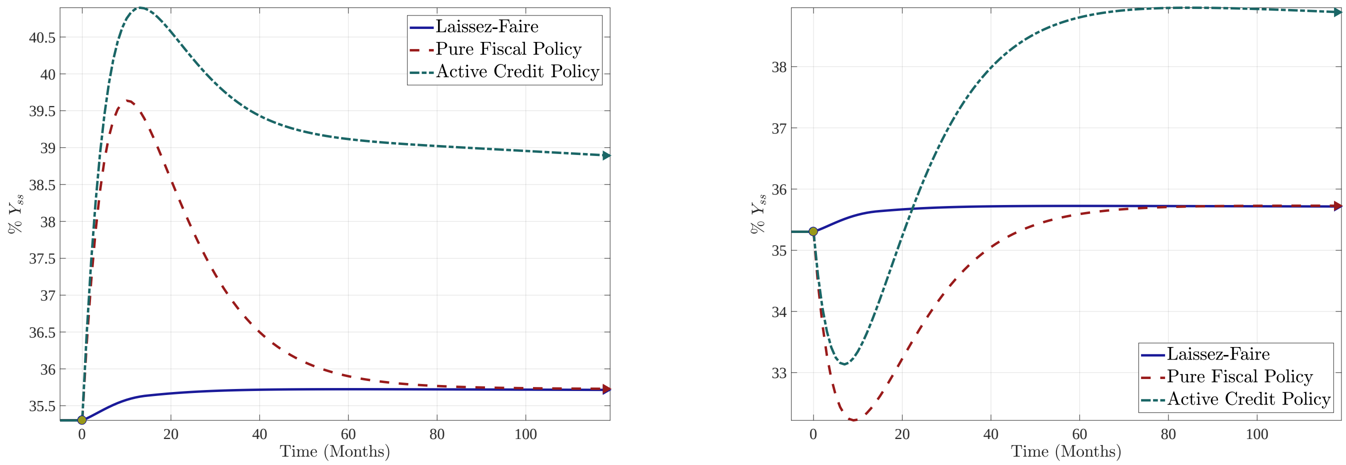
(3) Consumption of Remote Goods C_t^r

(4) Real Interest Rates

Figure 4: Nominal rigidity and real variables (natural borrowing limit).

Note: The figure reports the paths of total output, consumption of social goods and remote goods, and real interest rate in the following scenarios of policy interventions after an unforeseen Covid-19 shock: laissez-faire, pure lump-sum trasnfer and active credit policy. In panels (1), (2) and (3), the total output and consumption of social and remote goods are expressed in percentage deviations from the steady-state values. In panels (4), the real interest rates are expressed in annual percentages. In all figures the households' borrowing limit is set at the natural borrowing limit level, such that the mass of population constrained at the limit is zero along the whole path of transition. The paths of policy interventions follow Figure 3.

Due to arguments related to the Ricardian equivalence, except for approximation errors, the output, consumption and interest rate paths under laissez-faire and pure transfers overlap perfectly as portrayed in Figure 4. In contrast, if a credit policy is implemented by reducing the path of transfers, the fall in output is mitigated due to a boom in the consumption of remote goods. Due to the absence of any containment policy in our model, perhaps undesirably, the decline in the consumption of social goods is also mitigated. In addition, we do not see an initial increase in the interest rate any more, whose path follows an inverse hump shape, with the valley occurring before than in the laissez-faire economy. Intuitively, the incidence of a credit subsidy implies a lower rate that debtors must honor, but a higher rate that remunerates depositors. Hence, both paths of bank deposits and bank loans increase with respect to an economy where transfers are innocuous, as illustrated by Figure 5.



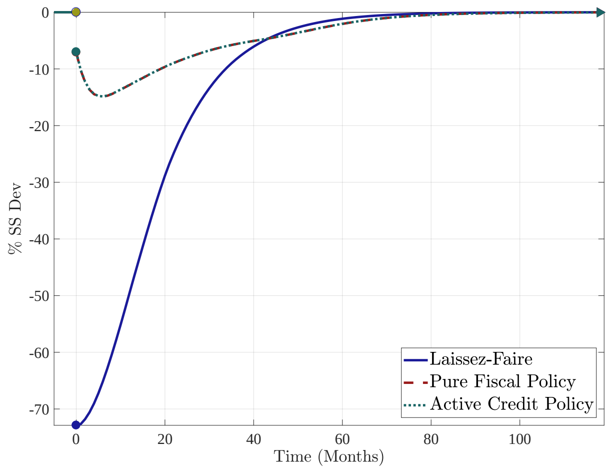
(1) Bank Deposits A_t (2) Bank Loans L_t

Figure 5: Nominal rigidity and banking variables (natural borrowing limit).

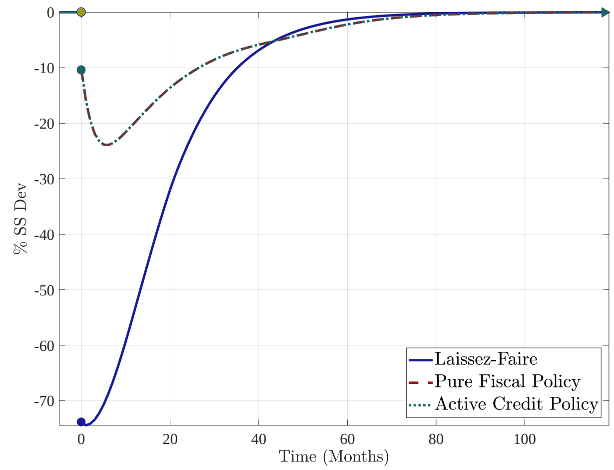
Note: The figure reports the paths of bank deposits and loans in the following scenarios of policy interventions after an unforeseen Covid-19 shock: laissez-faire, pure lump-sum trasnfer and active credit policy. The bank deposits and loans are expressed in percentages of the steady-state output. In all figures the households' borrowing limit is set at the natural borrowing limit level, such that the mass of population constrained at the limit is zero along the whole path of transition. The paths of policy interventions follow Figure 3.

We do not analyze an economy with credit against future taxes. But the result is instructive: if borrowing limits are very large, then how much we vary the limit with transfers will not have a large impact on the allocation.

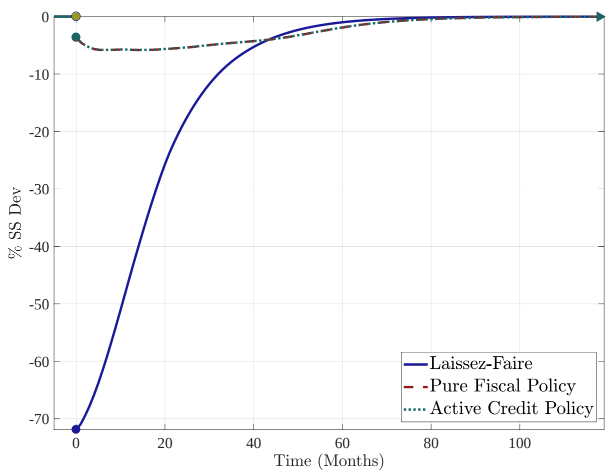
Zero borrowing limit. Now we move to the opposite extreme. Consider Figures 6 and 7 that are the counterparts of Figures 4 and 5 for the case in which we assume no borrowing at all (we omit the paths of policies since they carry a similar message to the previous case in Figure 3). In the zero borrowing limit case, the credit policy is innocuous, and since transfers adjust residual to deliver the same expansion of debt as in the pure fiscal policy exercise, the paths under both policies (dashed red lines and dash-dotted green lines) overlap. This means that the marginal impact of the credit policy is muted here. Figure 6 reveals that, under the zero borrowing limit and laissez-faire, the same shock generates a recession nearly seven times larger than under the natural debt limit, which makes policy even more urgent. In other words, a stringent debt limit amplifies a lot the recession, at the same time that restrict the use of credit subsidy, perhaps the preferred policy tool to target those households who really need support. Once transfers kick in, the recession (as well as the fall in the consumption of social and remote goods) is mitigated substantially. As expected, the remote sector accommodates better the effect of transfers.



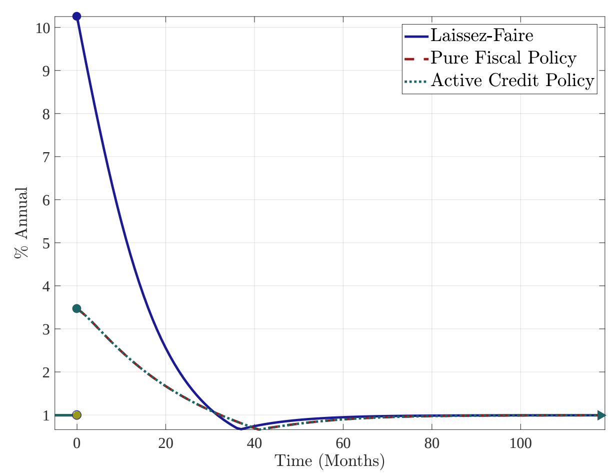
(1) Output Y_t



(2) Consumption of Social Goods C_t^s



(3) Consumption of Remote Goods C_t^r

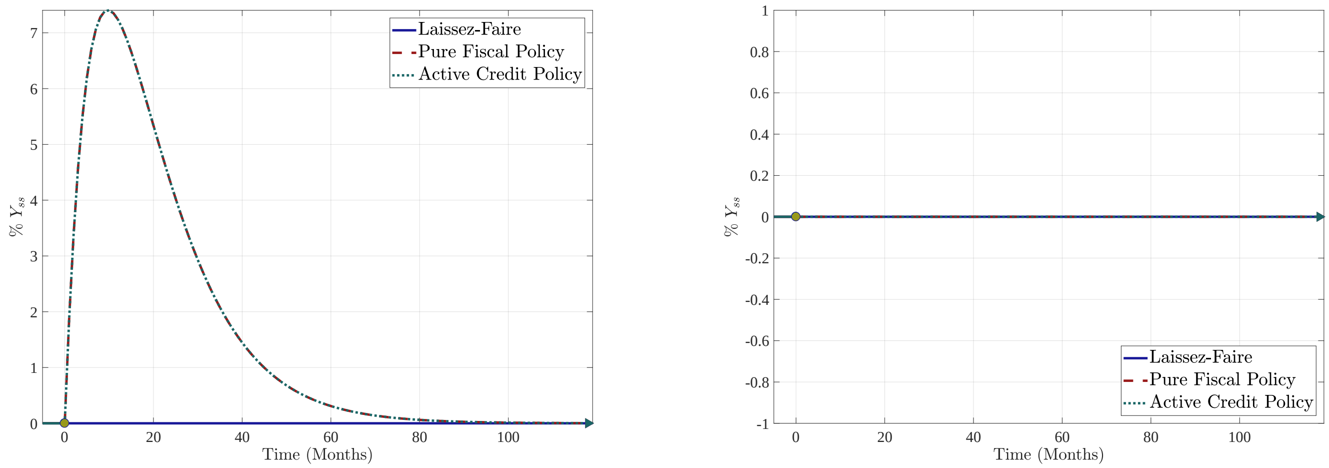


(4) Real Deposit Rate

Figure 6: Nominal rigidity and real variables (zero borrowing limit).

Note: The figure reports the paths of total output, consumption of social goods and remote goods, and real interest rate in the following scenarios of policy interventions after an unforeseen Covid-19 shock: laissez-faire, pure lump-sum trasnfer and active credit policy. In panels (1), (2) and (3), the total output and consumption of social and remote goods are expressed in percentage deviations from the steady-state values. In panels (4), the real interest rates are expressed in annual percentages. In all figures the households' borrowing limit is set at the zero borrowing limit level, i.e., $\bar{s} = 0$. The paths of net asset position and credit subsidy rate follow Figure 3 and the paths of lump-sum transfers are computed as residuals from equation (9).

Under the zero borrowing limit and laissez-faire, interest rate initially increases abruptly as agents are willing to borrow to smooth the shock but the zero borrowing limit impedes so. Once transfers are implemented, as illustrated in Figure 7, part of it becomes deposits mitigating such increase in the interest rate.



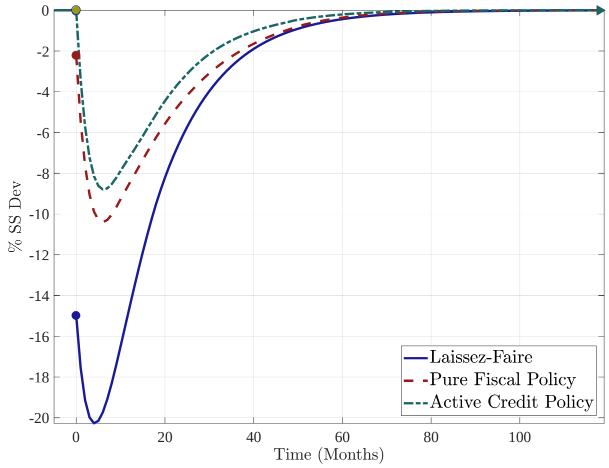
(1) Bank Deposits A_t

(2) Bank Loans L_t

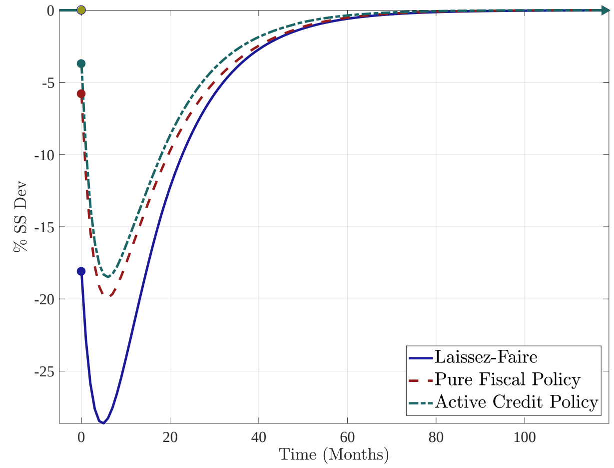
Figure 7: Nominal rigidity and banking variables (zero borrowing limit).

Note: The figure reports the paths of bank deposits and loans in the following scenarios of policy interventions after an unforeseen Covid-19 shock: laissez-faire, pure lump-sum trasnfer and active credit policy. The bank deposits and loans are expressed in percentages of the steady-state output. In all figures the households' borrowing limit is set at the zero borrowing limit level, i.e., $\bar{s} = 0$. The paths of net asset position and credit subsidy rate follow Figure 3, and the paths of lump-sum transfers are computed as residuals from equation (9).

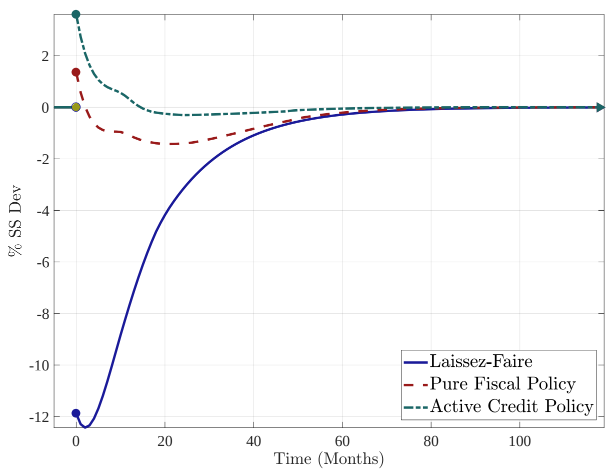
Moderate borrowing limit. Finally, we consider the moderate borrowing limit. We calibrate $\bar{s}$ such that 10 percent of households are at the borrowing limit, $s_t = \bar{s}$, in the steady-state, which implies that 29 percent of them are indebted, $s_t \in [\bar{s}, 0)$. Figures 8 and 9 are the counterparts of Figures 4 and 5, and again we do not report the policy paths for conciseness. Recall that a pure fiscal policy (dashed red lines) means that transfers are set to match a given path of debt. As in the case with natural borrowing limit, under this policy, the fall in output and consumption of both social and remote goods is mitigated with respect to the laissez-faire benchmark. Nonetheless, with an intermediate level of borrowing limit, if the government uses part of its fiscal resources to implement an active credit policy rather than solely pure transfers, it can further improves outcomes. Indeed, output and consumption paths move further upward (dashed-dot green lines), with a expansion in the remote good sector.



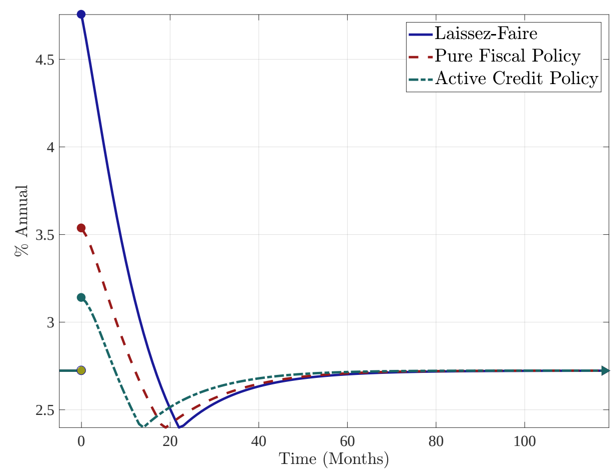
(1) Output Y_t



(2) Consumption of Social Goods C_t^s



(3) Consumption of Remote Goods C_t^r

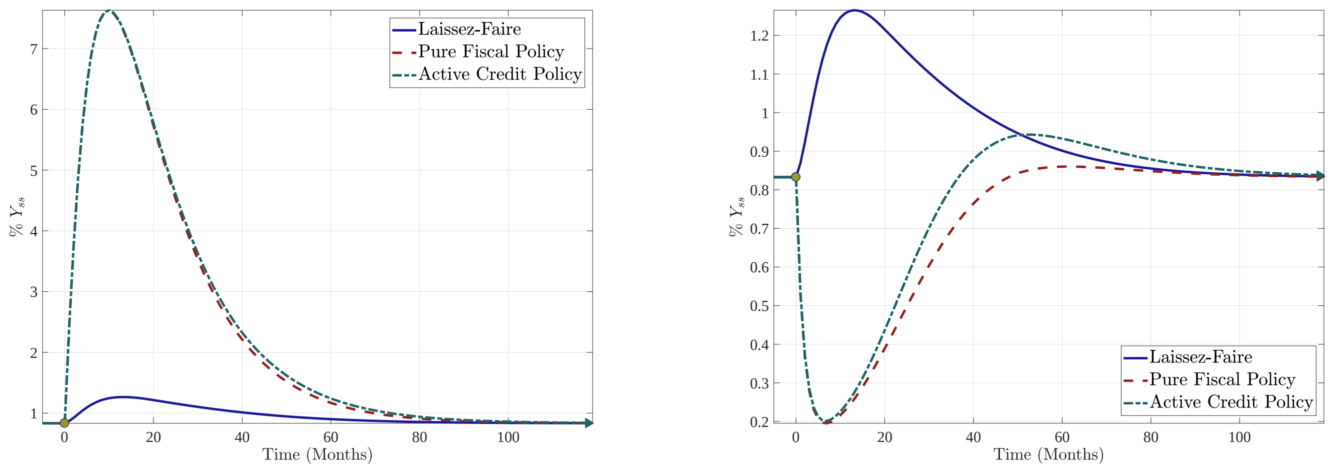


(4) Real Deposit Rate

Figure 8: Nominal rigidity and real variables (moderate borrowing limit).

Note: The figure reports the paths of total output, consumption of social goods and remote goods, and real interest rate in the following scenarios of policy interventions after an unforeseen Covid-19 shock: laissez-faire, pure lump-sum trasnfer and active credit policy. In panels (1), (2) and (3), the total output and consumption of social and remote goods are expressed in percentage deviations from the steady-state values. In panels (4), the real interest rates are expressed in annual percentages. In all figures the households' borrowing limit is set at a moderate level, i.e., $\bar{s} = -0.1b$. The paths of net asset position and credit subsidy rate follow Figure 3, and the paths of lump-sum transfers are computed as residuals from equation (9).

In addition, due to this mitigation in output and consumption once policies are implemented, interest rates do not increase as much as they do in the laissez-faire case to induce market clearing. The timing when rates fall below their steady-state level are anticipated once policies are implemented. With a moderate borrowing limit, transfers further increase deposits as part of the households save their transfers, but loans also fall as transfers to another part of the households weak precautionary needs at the same time that they can be used to anticipate consumption. Government debt absorbs such difference, affecting the path of interest rate in the aforementioned way. Under the credit policy, which stimulates both deposits and loans as illustrated by Figure 9, the interest rate increases less right after the shock, just to follow the same inverse hump-shape path towards the steady-state.



(1) Bank Deposits A_t (2) Bank Loans L_t

Figure 9: Nominal rigidity and banking variables (moderate borrowing limit).
Note: The figure reports the paths of bank deposits and loans in the following scenarios of policy interventions after an unforeseen Covid-19 shock: laissez-faire, pure lump-sum trasnfer and active credit policy. The bank deposits and loans are expressed in percentages of the steady-state output. In all figures the households' borrowing limit is set at a moderate level, i.e., $\bar{s} = -0.1b$. The paths of net asset position and credit subsidy rate follow Figure 3, and the paths of lump-sum transfers are computed as residuals from equation (9).

4 Final remarks

All the examples above are illustrative of the mechanism. The key message is that the best use of the mix between lump-sum transfers and active credit policy depends crucially on the extent of the borrowing limit. In the next versions of the paper, we aim to explore more this trade-off under a proper calibration and extensions that consider default risk and endogenize the borrowing limit. This is important to asses possible moral-hazard constraints. In addition, we aim to compare other types of policies, such as unemployment insurance and job retention schemes.

Next versions of the paper aim also to relax the assumption on perfect reallocation of labor input across sectors, to study an ad-hoc restriction on the amount of social goods that can be consumed so we can simulate containment policies, and to allow temporary deviations from the Taylor rule so the consolidated government can tame the debt path with a lower interest rate.

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Appendix

A Properties of policy rules

This section discusses the class of policy rules used in the draft. We specify rules of the form: :

$$x_t = x_\infty + (\bar{x}_0 - \bar{x}_\infty) \cdot \exp\left(-\mu^{LR} t\right) + (x_{0^-} - \bar{x}_0) \cdot \exp\left(-\mu^{SR} t\right).$$

In this rule, the value $\bar{x}_\infty$ is a long-run target. The term $\bar{x}_0$ is an attraction point of the policy rate in the short-run, after a shock. The rate x_{0^-} is the policy variable the instant before a shock. The term $\exp\left(-\mu^{SR} t\right)$ captures a degree of responsiveness to the shock to its short-run attraction point—the speed at which the discretionary policy kicks in, whereas $\exp\left(-\mu^{LR} t\right)$ the speed of reversal of the discretionary policy, to the long-run target. In what follows we assume $\mu^{LR} < \mu^{SR}$. This functional form has several natural properties:

1. First, observe that for any finite pair $\left\{\mu^{SR}, \mu^{LR}\right\}$ we have the following:

$$\lim_{t \to \infty} x_t = \bar{x}_\infty.$$

2. Consider that for any finite pair $\left\{\mu^{SR}, \mu^{LR}\right\}$ we have the following:

$$\lim_{t \to 0^+} x_t = x_{0^-}.$$

3. Consider that for any finite pair $\left\{\mu^{LR}\right\}$ we have the following:

$$\lim_{t \to 0^+} \lim_{\mu^{SR} \to \infty} x_t = \bar{x}_0,$$

meaning that the adjustment is immediate.

4. Consider that for any finite pair $\left\{\mu^{SR}\right\}$ we have the following:

$$\lim_{t \to \infty} \lim_{\mu^{LR} \to \infty} x_t = \bar{x}_0,$$

meaning that the attraction point is the discretionary point.

5. Consider the limit, $\mu^{LR}/\mu^{SR} \to \infty$, then speed of responsiveness is immediate and the

$$\begin{aligned}
\lim_{t \to \infty} \lim_{\mu^{SR}/\mu^{LR} \to \infty} x_t &= \lim_{t \to \infty} \lim_{\mu^{SR}/\mu^{LR} \to \infty} \bar{x}_\infty + \exp\left(-\mu^{SR} t\right) \left[(\bar{x}_0 - \bar{x}_\infty) \cdot \exp\left(-\left(\mu^{LR} - \mu^{SR}\right) t\right) + (x_{0^-} - \bar{x}_0)\right] \\
&= \bar{x}_\infty + (\bar{x}_0 - \bar{x}_\infty) \lim_{t \to \infty} \lim_{\mu^{SR}/\mu^{LR} \to \infty} \exp\left(-\mu^{SR} t\right) \left[\exp\left(-\left(\mu^{LR} - \mu^{SR}\right) t\right)\right] \\
&= \bar{x}_\infty + (\bar{x}_0 - \bar{x}_\infty) \lim_{t \to \infty} \lim_{\mu^{SR}/\mu^{LR} \to \infty} \exp\left(-\mu^{SR} t\right) \left[\exp\left(\mu^{SR}\left(1 - \mu^{LR}/\mu^{SR}\right) t\right)\right] \\
&= \bar{x}_0,
\end{aligned}$$

where the last line follows by L'Hospital rule.

6. Monotonicity of x_t. Let's assume $x_\infty > \bar{x}_0$ and $x_{0^-} > \bar{x}_0$, which is the scenario in our simulations. If $\mu^{LR} < \mu^{SR}$, then

$$\frac{\partial x_t}{\partial t} \gtreqless 0 \text{ iff } t \gtreqless \frac{1}{\mu^{SR} - \mu^{LR}} \ln\left(\frac{\mu^{SR}}{\mu^{LR}} \cdot \frac{x_{0^-} - \bar{x}_0}{x_\infty - \bar{x}_0}\right),$$

which means that the path of $\bar{x}_t$ first decreases over time from x_{0^-}, then increases back to x_∞, which is our parametrization for the evolution of real net position, $\mathcal{E}_t$, after the shock to represent the fiscal space available for stabilizing policies. If instead, $\mu^{LR} > \mu^{SR}$, then

$$\frac{\partial \bar{x}_t}{\partial t} \gtreqless 0 \text{ iff } t \lesseqgtr \frac{1}{\mu^{LR} - \mu^{SR}} \ln\left(\frac{\mu^{LR}}{\mu^{SR}} \cdot \frac{x_\infty - \bar{x}_0}{x_{0^-} - \bar{x}_0}\right),$$

which means that the path of $\bar{x}_t$ first increases over time from x_{0^-}, then decreases back to $\bar{x}_\infty$, which is our choice whenever we study an active credit subsidy σ_t.