

## The Paradox of Global Thrift<sup>†</sup>

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*This paper describes a paradox of global thrift. Consider a world in which interest rates are low and monetary policy is constrained by the zero lower bound. Now imagine that governments implement prudential financial and fiscal policies to stabilize the economy. We show that these policies, while effective from the perspective of individual countries, might backfire if applied on a global scale. In fact, prudential policies generate a rise in the global supply of savings and a drop in global aggregate demand. Weaker global aggregate demand depresses output in countries at the zero lower bound. Due to this effect, noncooperative financial and fiscal policies might lead to a fall in global output and welfare. (JEL E21, E23, E43, E44, E52, E62, F32)*

The current state of the global economy is characterized by exceptionally low nominal interest rates. In recent years, indeed, policy rates have hit the zero lower bound in most advanced countries (panel A of Figure 1). Against this background a consensus is emerging suggesting that monetary policy, which is expected to be frequently constrained by the zero lower bound in the foreseeable future, should be complemented with prudential financial and fiscal policies. Limiting private and public debt accumulation during booms, the argument goes, will help stabilize the economy, respectively by reducing the risk of financial crises and by creating space for fiscal interventions during busts. According to this view, governments should employ prudential financial and fiscal policies as macroeconomic stabilization tools when the zero lower bound constrains monetary policy.<sup>1</sup>

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<sup>1</sup>These arguments have been formalized in two seminal papers: Farhi and Werning (2016) and Korinek and Simsek (2016). In this literature, which we describe in detail later on, the need for government intervention arises due to an aggregate demand externality, caused by the fact that atomistic agents do not internalize the impact of their financial decisions on aggregate spending and income.

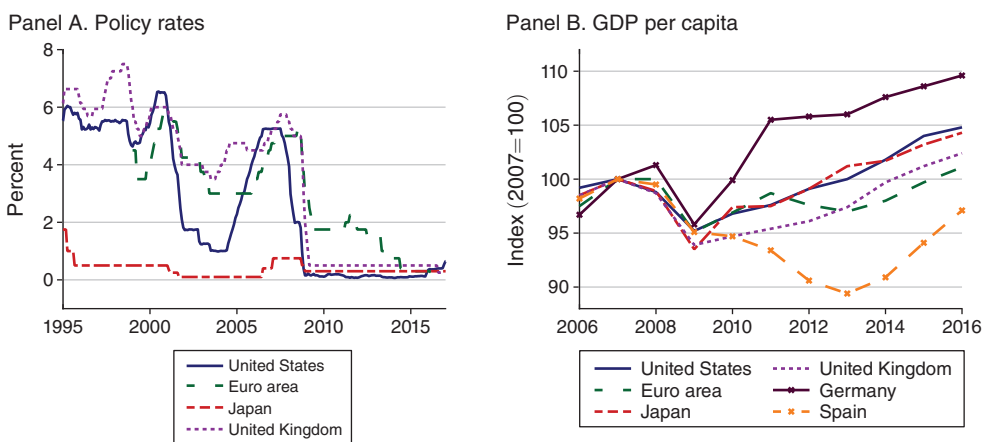


FIGURE 1. POLICY RATES AND REAL GROSS DOMESTIC PRODUCT PER CAPITA

Notes: Panel A shows the exceptionally low interest rates characterizing the post-2008 period. Panel B highlights the relatively fast recoveries from the 2009 recession experienced by the United States and Japan, and the slow recovery in the euro area and in the United Kingdom. The figure also shows the heterogeneity between fast-recovering core euro-area countries, captured by Germany, and the stagnation experienced by peripheral euro-area countries, captured by Spain. See online Appendix I for data sources.

But what happens if prudential policies are implemented on a global scale? In this paper we show that, as a result, the world may fall prey of a *paradox of global thrift*. In a financially integrated world, in fact, the implementation of prudential financial and fiscal policies increases the global supply of savings and lowers global aggregate demand. In turn, weaker global aggregate demand depresses output in countries whose monetary policy is constrained by the zero lower bound. Due to this effect prudential policies might completely backfire and, paradoxically, lead to a fall in global output and welfare.

To formalize this insight we develop a tractable framework of a financially integrated world, in which equilibrium interest rates are low and monetary policy is occasionally constrained by the zero lower bound. We study a world composed of a continuum of small open economies. Countries are hit by uninsurable idiosyncratic shocks. Because of this feature, there is heterogeneity in the demand and supply of savings across countries, and foreign borrowing and lending emerge naturally.

Due to the presence of nominal rigidities monetary policy plays an active role in stabilizing the economy. For instance, when a country experiences a fall in aggregate demand the central bank has to lower the policy rate to keep the economy at full employment. The zero lower bound, however, might prevent monetary policy from fully offsetting the impact of negative demand shocks on output. In this case, the country enters a recessionary liquidity trap. Importantly, if global rates are sufficiently low the world itself may get stuck in a *global liquidity trap*. This is a scenario in which a significant fraction of the world economy experiences a liquidity trap with unemployment.

Our global liquidity trap has two key features. First, because of the presence of idiosyncratic shocks, during a global liquidity trap not all countries need to be constrained by the zero lower bound and experience a recession. Moreover, even among

those countries stuck in a liquidity trap there may be asymmetries in terms of the severity of the recession. The model thus captures situations such as the asymmetric recovery that has characterized advanced countries in the aftermath of the 2008 financial crisis (panel B of Figure 1). Second, a global liquidity trap is a persistent event, which is expected to last for a long time.<sup>2</sup> Hence, during a global liquidity trap countries experiencing a boom in the present anticipate that they might fall into a recessionary liquidity trap in the future.<sup>3</sup>

Throughout the paper we contrast two different policy regimes. The first one is a *laissez-faire* benchmark. In the second regime, benevolent, but domestically-oriented, governments actively intervene to influence private agents' financial decisions by means of financial or fiscal policies. While these policies can take a variety of forms, their common trait is that they affect the country's current account. Hence, we refer to them as *current account policies*.

We start by showing that during a global liquidity trap governments have an incentive to intervene on the current account for prudential reasons. This is due to the same domestic aggregate demand externality described by Farhi and Werning (2016) and Korinek and Simsek (2016). That is, governments perceive that private agents overborrow in times of robust economic performance, because they do not internalize the fact that increasing savings in good times leads to higher aggregate demand and employment in the event of a future liquidity trap. Hence, governments in booming countries implement financial and fiscal policies to increase national savings and to improve the country's current account.

The fundamental insight of the paper is that these policy interventions might trigger a paradox of global thrift, which is essentially an international and policy-induced version of Keynes' paradox of thrift.<sup>4</sup> By stimulating national savings and current account surpluses, governments in countries undergoing a period of robust economic performance increase the global supply of savings, depressing aggregate demand around the world. However, central banks in countries stuck in a liquidity trap cannot respond to the drop in global demand by lowering their policy rate. As a consequence, the implementation of prudential current account policies by booming countries aggravates the recession in countries experiencing a liquidity trap.<sup>5</sup> This effect, which can be interpreted as an international aggregate demand externality, can be strong enough so that well-intended prudential policy interventions might end up exacerbating the global liquidity trap rather than mitigating it.

<sup>2</sup>Though making predictions about the future is of course a challenging task, this feature of the model is consistent with the empirical analysis performed by Gourinchas and Rey (2017), suggesting that global rates are likely to remain low for a long time.

<sup>3</sup>Our global liquidity trap is then in line with the notion of secular stagnation as described by Hansen (1939) and Lawrence Summers, "The Age of Secular Stagnation," *Foreign Affairs*, February 15, 2016. Both authors, in fact, refer to a state of secular stagnation as a long-lasting period characterized by low global interest rates, and by countries undergoing frequent liquidity traps, followed by fragile recoveries.

<sup>4</sup>John Maynard Keynes, "From Keynes to Roosevelt: Our Recovery Plan Assayed," *New York Times*, December 31, 1933.

<sup>5</sup>Our model thus formalizes the view that the large current account surpluses that some countries, most notably Germany, have run in the aftermath of the 2008 financial crisis might have slowed down significantly the recovery in the rest of the world (see IMF 2014; Ben S. Bernanke, "Germany's Trade Surplus Is a Problem," *Brookings Institution*, April 3, 2015, <https://www.brookings.edu/blog/ben-bernanke/2015/04/03/germanys-trade-surplus-is-a-problem/>; Paul Krugman, "The Harm Germany Does," *New York Times*, November 1, 2013, <https://krugman.blogs.nytimes.com/2013/11/01/the-harm-germany-does/>).

This result sounds a note of caution on the use of prudential policies as stabilization tools. More precisely, our framework highlights three factors that make a paradox of global thrift likely to occur. First, the contractionary spillovers from prudential policies are stronger when the ability of the world economy to supply liquid assets is low. Hence, a paradox of global thrift is more likely to materialize when the global supply of liquid assets is scarce and inelastic. Second, in our model the contractionary spillovers from prudential policies arise during periods of weak global demand, that is when the zero lower bound constrains monetary policy. In fact, we show that prudential policies implemented during global booms, when monetary policy is not constrained by the zero lower bound, are likely to generate expansionary spillovers. Lastly, in our framework it is the lack of international cooperation that gives rise to a paradox of global thrift. Key to our results, indeed, is the fact that governments in booming countries do not take into account the negative international demand externalities that policies fostering national savings and current account surpluses impose on countries stuck in a liquidity trap. Our analysis, which resonates with the logic of Keynes' Plan of 1941, thus suggests that when global aggregate demand is scarce international cooperation is needed, to ensure that current account interventions by booming countries do not impart excessive negative spillovers on the rest of the world.<sup>6</sup>

*Related Literature.*—This paper is related to three literatures. First, the paper contributes to the emerging literature on secular stagnation in open economies (Caballero, Farhi, and Gourinchas 2015; Eggertsson et al. 2016). As in this literature, we study a world trapped in a global liquidity trap. This is a persistent state of affairs in which global rates are low and monetary policy is frequently constrained by the zero lower bound. Both Caballero, Farhi, and Gourinchas (2015) and Eggertsson et al. (2016) study two-country overlapping generations models, in which interest rates are low because of a global shortage of safe assets.<sup>7</sup> Compared to these two papers, a distinctive feature of our framework is that the shortage of safe assets driving down global rates emerges from the presence of financial frictions that limits agents' ability to insure against idiosyncratic country-specific shocks. This allows us to study prudential policies, which neither Caballero, Farhi, and Gourinchas (2015) nor Eggertsson et al. (2016) consider, that is policy interventions that governments implement during booms to mitigate future liquidity traps.

Second, our paper is related to Farhi and Werning (2016) and Korinek and Simsek (2016), which develop theories of macroprudential policy interventions based on aggregate demand externalities. In particular, these papers study optimal financial market interventions in closed or small open economies in which monetary policy is constrained by zero lower bound.<sup>8</sup> One of the key insights of this literature is that benevolent governments should implement prudential financial and fiscal policies

<sup>6</sup>Eichengreen (2008, ch. 4) and Temin and Vines (2014, ch. 7) are two excellent sources on Keynes' Plan of 1941. In a nutshell, Keynes envisaged the need for international rules to contain excessive current account surpluses by booming countries, on the ground that these surpluses would depress global demand.

<sup>7</sup>Instead, Corsetti et al. (2019) studies secular stagnation in a single small open economy.

<sup>8</sup>In turn, these papers build upon Eggertsson and Krugman (2012) and Guerrieri and Lorenzoni (2017), which show that in closed economies negative financial shocks can trigger an episode of deleveraging and give rise to a recessionary liquidity trap. Benigno and Romei (2014) and Fornaro (2018), instead, study deleveraging and liquidity traps in open economies.

when they foresee that the zero lower bound will bind in the future.<sup>9</sup> We contribute to this literature by showing that, under certain conditions, in a financially integrated world prudential policies can backfire and give rise to a paradox of global thrift. Our results thus suggest that international cooperation is needed in order to fully exploit the stabilization benefits of prudential policies.

Third, our paper is related to the vast literature on international policy cooperation. For instance, Obstfeld and Rogoff (2002) and Benigno and Benigno (2003, 2006) study international monetary policy cooperation in models with nominal rigidities. In these frameworks, the gains from cooperation arise because individual countries have an incentive to manipulate their terms of trade at the expenses of the rest of the world. In our model, terms of trade are constant and independent of government policy, and hence terms of trade externalities are absent. Acharya and Bengui (2018) shows that there are gains from international cooperation in the design of capital control policies during a temporary liquidity trap. Their focus is on capital control policies that governments implement in order to manipulate the exchange rate during a liquidity trap.<sup>10</sup> Instead, we consider *ex ante* prudential policies, that is policies that governments implement to foster national savings and current account surpluses during booms, in order to mitigate future liquidity traps. Sergeyev (2016) studies optimal monetary and financial policy in a monetary union, and shows that gains from international cooperation arise because individual countries do not internalize the impact of liquidity creation by the domestic banking sector on the rest of the world. In his framework aggregate demand and pecuniary externalities interact, and fixed exchange rates constitute the fundamental constraint on monetary policy. Instead, in our model public interventions in the financial markets are purely driven by the presence of aggregate demand externalities, and our main result is that these policies can exacerbate the inefficiencies due to the zero lower bound constraint on monetary policy.

The rest of the paper is composed of five sections. Section I presents a simple baseline framework of an imperfectly financially integrated world with nominal rigidities. In Section II we characterize the *laissez-faire* equilibrium, and derive conditions under which the world ends up being stuck in a global liquidity trap. We then introduce, in Section III, current account policies and describe the paradox of global thrift. In Section IV we explore the conditions that make a paradox of global thrift more likely to occur. Section V concludes. The online Appendix contains all the proofs and derivations not included in the main text.

## I. Baseline Model

In this section we present the baseline model that we use in our analysis of the global implications of current account policies.<sup>11</sup> The model has two key elements.

<sup>9</sup>Farhi and Werning (2012, 2014, 2017) and Schmitt-Grohé and Uribe (2016) study optimal financial market interventions when the constraint on monetary policy is due to fixed exchange rates.

<sup>10</sup>The use of capital controls to manipulate the exchange rate during a liquidity trap is also discussed in Korinek (2017).

<sup>11</sup>Our framework builds on work by Schmitt-Grohé and Uribe (2016). However, their focus is on a single small open economy, while here we consider a multi-country world in which the world interest rate is endogenously determined. Moreover, in Schmitt-Grohé and Uribe (2016) monetary policy is constrained by participation in a

First, due to frictions on the credit markets, agents cannot perfectly insure against shocks, giving rise to fluctuations in aggregate demand. Second, the presence of nominal rigidities and of the zero lower bound constraint on monetary policy implies that drops in aggregate demand can generate involuntary unemployment.

In order to deliver transparently the key message of the paper, our baseline model is kept voluntarily stylized. In Section IV we present several extensions that allow for a variety of features ignored in the baseline model.

### A. Households

We consider a world composed of a continuum of measure one of small open economies indexed by  $i \in [0, 1]$ . Each economy can be thought of as a country. Time is discrete and indexed by  $t \in \{0, 1, \dots\}$ . Since the presence of risk is not crucial for our results, in our baseline model there is perfect foresight. We introduce uncertainty later on in Section IVC.

Each country is populated by a continuum of measure one of identical infinitely-lived households. The lifetime utility of the representative household in a generic country  $i$  is

$$(1) \quad \sum_{t=0}^{\infty} \beta^t \log(C_{i,t}),$$

where  $C_{i,t}$  denotes consumption and  $0 < \beta < 1$  is the subjective discount factor. Consumption is a Cobb-Douglas aggregate of a tradable good  $C_{i,t}^T$  and a nontradable good  $C_{i,t}^N$ , so that  $C_{i,t} = (C_{i,t}^T)^\omega (C_{i,t}^N)^{1-\omega}$  where  $0 < \omega < 1$ .

Each household is endowed with one unit of labor. There is no disutility from working, and so households supply inelastically their unit of labor on the labor market. However, due to the presence of nominal wage rigidities to be described below, a household might be able to sell only  $L_{i,t} < 1$  units of labor. Hence, when  $L_{i,t} = 1$  the economy operates at full employment, while when  $L_{i,t} < 1$  there is involuntary unemployment and the economy operates below capacity.

Households can trade in one-period real and nominal bonds. Real bonds are denominated in units of the tradable consumption good and pay the gross interest rate  $R_t$ . The interest rate on real bonds is common across countries, and  $R_t$  can be interpreted as the *world interest rate*. Nominal bonds are denominated in units of the domestic currency and pay the gross nominal interest rate  $R_{i,t}^n$ . Note that  $R_{i,t}^n$  is the interest rate controlled by the central bank, and thus can be thought of as the domestic policy rate.<sup>12</sup>

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fixed exchange rate regime. In our model, instead, monetary policy is constrained by the zero lower bound on the policy rate.

<sup>12</sup> Alternatively, we could allow households to trade nominal bonds denominated in foreign currencies. Given the structure of the economy, and in particular the fact that we are focusing on perfect-foresight equilibria, allowing households to trade foreign nominal bonds would not affect the equilibrium allocation of the model.



The household budget constraint in terms of the domestic currency is

$$(2) \quad P_{i,t}^T C_{i,t}^T + P_{i,t}^N C_{i,t}^N + P_{i,t}^T B_{i,t+1} + B_{i,t+1}^n = W_{i,t} L_{i,t} + P_{i,t}^T Y_{i,t}^T + P_{i,t}^T R_{t-1} B_{i,t} + R_{i,t-1}^n B_{i,t}^n.$$

The left-hand side of this expression represents the household’s expenditure. The terms  $P_{i,t}^T$  and  $P_{i,t}^N$  denote respectively the price of a unit of tradable and nontradable good in terms of country  $i$  currency. Hence,  $P_{i,t}^T C_{i,t}^T + P_{i,t}^N C_{i,t}^N$  is the total nominal expenditure in consumption. The terms  $B_{i,t+1}$  and  $B_{i,t+1}^n$  denote respectively the purchase of real and nominal bonds made by the household at time  $t$ . If  $B_{i,t+1} < 0$  or  $B_{i,t+1}^n < 0$  the household is holding a debt.

The right-hand side captures the household’s income. The variable  $W_{i,t}$  denotes the nominal wage, and hence  $W_{i,t} L_{i,t}$  is the household’s labor income. Labor is immobile across countries and so wages are country-specific. The variable  $Y_{i,t}^T$  is an endowment of tradable goods received by the household. Changes in  $Y_{i,t}^T$  can be interpreted as movements in the quantity of tradable goods available in the economy, or as shocks to the country’s terms of trade. The terms  $P_{i,t}^T R_{t-1} B_{i,t}$  and  $R_{i,t-1}^n B_{i,t}^n$  represent the gross returns on investment in bonds made at time  $t - 1$ .

There is a limit to the amount of debt that a household can take. In particular, the end-of-period bond position has to satisfy

$$(3) \quad B_{i,t+1} + \frac{B_{i,t+1}^n}{P_{i,t}^T} \geq -\kappa_{i,t},$$

where  $\kappa_{i,t} \geq 0$ . In words, the maximum amount of debt that a household can take is equal to  $\kappa_{i,t}$  units of tradable goods.

The household’s optimization problem consists in choosing a sequence  $\{C_{i,t}^T, C_{i,t}^N, B_{i,t+1}, B_{i,t+1}^n\}_t$  to maximize lifetime utility (1), subject to the budget constraint (2) and the borrowing limit (3), taking initial wealth  $P_0^T R_{-1} B_{i,0} + R_{i,-1}^n B_{i,0}^n$ , a sequence for income  $\{W_{i,t} L_{i,t} + P_{i,t}^T Y_{i,t}^T\}_t$ , and prices  $\{R_t, R_{i,t}^n, P_{i,t}^T, P_{i,t}^N\}_t$  as given. The household’s first-order conditions can be written as

$$(4) \quad \frac{\omega}{C_{i,t}^T} = R_t \frac{\beta\omega}{C_{i,t+1}^T} + \mu_{i,t},$$

$$(5) \quad \frac{\omega}{C_{i,t}^T} = \frac{R_{i,t}^n P_{i,t}^T}{P_{i,t+1}^T} \frac{\beta\omega}{C_{i,t+1}^T} + \mu_{i,t}$$

$$(6) \quad B_{i,t+1} + \frac{B_{i,t+1}^n}{P_{i,t}^T} \geq -\kappa_{i,t} \quad \text{with equality if } \mu_{i,t} > 0,$$

$$(7) \quad C_{i,t}^N = \frac{1 - \omega}{\omega} \frac{P_{i,t}^T}{P_{i,t}^N} C_{i,t}^T$$

where  $\mu_{i,t}$  is the nonnegative Lagrange multiplier associated with the borrowing constraint. Equations (4) and (5) are the Euler equations for, respectively, real and

nominal bonds. Equation (6) is the complementary slackness condition associated with the borrowing constraint. Equation (7) determines the optimal allocation of consumption expenditure between tradable and nontradable goods. Naturally, demand for nontradables is decreasing in their relative price  $P_{i,t}^N/P_{i,t}^T$ . Moreover, demand for nontradables is increasing in  $C_{i,t}^T$ , due to households' desire to consume a balanced basket between tradable and nontradable goods.

### B. Exchange Rates, Interest Rates, and Aggregate Demand

In our model, monetary policy affects the real economy through its impact on households' expenditure on nontradable goods. Before moving on, it is then useful to illustrate the channels through which the policy rate and the world interest rate affect demand for nontradables.

Let us start by establishing a link between demand for nontradable goods and the exchange rate. Since the law of one price holds for the tradable good we have that<sup>13</sup>

$$(8) \quad P_{i,t}^T = S_{i,t} P_t^T,$$

where  $P_t^T \equiv \exp(\int_0^1 \log P_{j,t}^T dj)$  is the average world price of tradables, while  $S_{i,t}$  is the effective nominal exchange rate of country  $i$ , defined so that an increase in  $S_{i,t}$  corresponds to a nominal depreciation.

To gain intuition let us now keep  $P_{i,t}^N$  and  $P_t^T$  constant, so that the nominal and the real exchange rate move together. Then equations (7) and (8) jointly imply that an exchange rate depreciation increases demand for nontradable goods. Intuitively, when the exchange rate depreciates the relative price of nontradables falls, inducing households to switch expenditure away from tradable goods and toward nontradable goods.

We now relate the exchange rate to the policy and the world interest rates. Combining (4) and (5) gives a no-arbitrage condition between real and nominal bonds,

$$(9) \quad R_{i,t}^n = R_t \frac{P_{i,t+1}^T}{P_{i,t}^T}.$$

This is a standard uncovered interest parity condition, equating the nominal interest rate to the real interest rate multiplied by expected inflation. Since real bonds are denominated in units of the tradable good, the relevant inflation rate is tradable price inflation. Combining this expression with (8) gives

$$R_{i,t}^n = R_t \frac{S_{i,t+1} P_{i,t+1}^T}{S_{i,t} P_{i,t}^T}.$$

<sup>13</sup>To derive this expression, consider that by the law of one price it must be that  $P_{i,t}^T = S_{i,t}^j P_{j,t}^T$  for any  $i$  and  $j$ , where  $S_{i,t}^j$  is defined as the nominal exchange rate between country  $i$ 's and  $j$ 's currencies, that is, the units of country  $i$ 's currency needed to buy one unit of country  $j$ 's currency. Taking logs and integrating across  $j$  gives  $P_{i,t}^T = S_{i,t} P_t^T$ , where  $S_{i,t} \equiv \exp(\int_0^1 \log S_{i,t}^j dj)$  and  $P_t^T \equiv \exp(\int_0^1 \log P_{j,t}^T dj)$ .



Taking everything else as given, this expression implies that a drop in  $R_{i,t}^n$  produces a rise in  $S_{i,t}$ . In words, a fall in the policy rate leads to an exchange rate depreciation, which induces households to switch expenditure out of tradable goods and toward nontradables. Through this channel, a cut in the policy rate boosts demand for nontradable goods. Conversely, a fall in the world interest rate  $R_t$  generates an exchange rate appreciation which, due to its expenditure switching effect, depresses demand for nontradables.

To capture these effects more compactly, it is useful to combine (7) and (9) into a single aggregate demand (AD) equation

$$(AD) \quad C_{i,t}^N = \frac{R_t \pi_{i,t+1}}{R_{i,t}^n} \frac{C_{i,t}^T}{C_{i,t+1}^T} C_{i,t+1}^N,$$

where  $\pi_{i,t} \equiv P_{i,t}^N / P_{i,t-1}^N$ . This expression is essentially an open-economy version of the New Keynesian aggregate demand block. As in the standard closed-economy New Keynesian model, demand for nontradable consumption is decreasing in the real interest rate  $R_{i,t}^n / \pi_{i,t+1}$  and increasing in future nontradable consumption  $C_{i,t+1}^N$ . In addition, changes in the consumption of tradable goods act as demand shifters. As already explained, a higher current consumption of tradable goods increases the current demand for nontradables. Instead, a higher future consumption of tradables induces households to postpone their nontradable consumption, thus depressing current demand for nontradable goods. Finally, due to the expenditure switching effect just discussed, a lower world interest rate is associated with lower demand for nontradable consumption.

### C. Firms and Nominal Rigidities

Nontraded output  $Y_{i,t}^N$  is produced by a large number of competitive firms. Labor is the only factor of production, and the production function is  $Y_{i,t}^N = L_{i,t}$ . Profits are given by  $P_{i,t}^N Y_{i,t}^N - W_{i,t} L_{i,t}$ , and the zero profit condition implies that in equilibrium  $P_{i,t}^N = W_{i,t}$ .

We introduce nominal rigidities by assuming, in the spirit of Akerlof, Dickens, and Perry (1996), that nominal wages are subject to the downward rigidity constraint

$$W_{i,t} \geq \gamma W_{i,t-1},$$

where  $\gamma > 0$ . This formulation captures in a simple way the presence of frictions to the downward adjustment of nominal wages, which might prevent the labor market from clearing. In fact, equilibrium on the labor market is captured by the condition

$$(10) \quad L_{i,t} \leq 1, \quad W_{i,t} \geq \gamma W_{i,t-1} \quad \text{with complementary slackness.}$$

This condition implies that unemployment arises only if the constraint on wage adjustment binds.

### D. Monetary Policy and Inflation

We describe monetary policy in terms of targeting rules. In particular, we consider central banks that target inflation of the domestically-produced good. More formally, the objective of the central bank is to set  $\pi_{i,t} = \bar{\pi}$ , where  $\bar{\pi}$  is the central bank's inflation target. Throughout the paper we focus on the case  $\bar{\pi} > \gamma$ , so that when the inflation target is attained the economy operates at full employment (i.e.,  $\pi_{i,t} = \bar{\pi}$  implies  $L_{i,t} = 1$ ). Hence, monetary policy faces no conflict between stabilizing inflation and attaining full employment, thus mimicking the divine coincidence typical of the baseline New Keynesian model (Blanchard and Galí 2007).<sup>14</sup>

The central bank runs monetary policy by setting the nominal interest rate  $R_{i,t}^n$ , subject to the zero lower bound constraint  $R_{i,t}^n \geq 1$ .<sup>15</sup> Monetary policy can then be captured by the following monetary policy (MP) rule:<sup>16</sup>

$$(MP) \quad R_{i,t}^n \begin{cases} \geq 1 & \text{if } Y_{i,t}^N = 1 \text{ and } \pi_{i,t} = \bar{\pi} \\ = 1 & \text{if } Y_{i,t}^N < 1 \text{ and } \pi_{i,t} = \gamma, \end{cases}$$

where we have used (10) and the equilibrium relationships  $W_{i,t} = P_{i,t}^N$  and  $L_{i,t} = Y_{i,t}^N$ . The (MP) equation captures the fact that unemployment ( $Y_{i,t}^N < 1$ ) arises only if the central bank is constrained by the zero lower bound ( $R_{i,t}^n = 1$ ). As we show in online Appendix D, this policy is also constrained efficient as long as the central bank operates under discretion, and faces an arbitrarily small cost from deviating from its inflation target.<sup>17</sup>

In what follows we will focus on the limit  $\gamma \rightarrow \bar{\pi}$ . This corresponds to an extremely flat Phillips curve, such that deviations of economic activity from full employment do not generate significant drops in inflation below target. While this assumption is by no means crucial for our results, it allows us to streamline the exposition and simplifies the derivation of some of the results that follow.

<sup>14</sup>Since only the nontradable good is produced, we are in practice assuming that the central bank follows a policy of producer price inflation targeting. This is a common assumption in the open economy monetary literature. Another option is to consider a central bank that targets consumer price inflation. We have experimented with this possibility, and found that the results are robust to this alternative monetary policy target. The analysis is available upon request.

<sup>15</sup>We provide in online Appendix C some possible microfoundations for this constraint. In practice, the lower bound on the nominal interest rate is likely to be slightly negative. In this paper, with a slight abuse of language, we will refer to the lower bound on  $R_{i,t}^n$  as the zero lower bound. It should be clear, though, that conceptually it makes no difference between a small positive or a small negative lower bound.

<sup>16</sup>One could think of the central bank as setting  $R_{i,t}^n$  according to the rule

$$R_{i,t}^n = \max\left(\bar{R}_{i,t}^n \left(\frac{\pi_{i,t}}{\bar{\pi}}\right)^{\phi_\pi}, 1\right),$$

where  $\bar{R}_{i,t}^n$  is the value of  $R_{i,t}^n$  consistent with  $\pi_{i,t} = \bar{\pi}$ . In the baseline model we focus on the limit  $\phi_\pi \rightarrow \infty$ . This means that the inflation target can be missed only if the zero lower bound constraint binds.

<sup>17</sup>Deviating from the inflation target could be costly for the central bank due to institutional reasons, capturing the price stability mandate characterizing central banks in most advanced countries. Alternatively, one could assume, as in the standard New Keynesian model, that deviations of inflation from target are costly because they distort relative prices.

E. Market Clearing and Definition of Competitive Equilibrium

Since households inside a country are identical, we can interpret equilibrium quantities as either household or country specific. For instance, the end-of-period net foreign asset position of country  $i$  is equal to the end-of-period holdings of bonds of the representative household,  $NFA_{i,t} = B_{i,t+1} + B_{i,t+1}^n / P_{i,t}^T$ . In our baseline model, which features perfect foresight, the composition of the net foreign asset position between real and nominal bonds is not uniquely pinned down in equilibrium. Throughout, we resolve this indeterminacy by focusing on equilibria in which nominal bonds are in zero net supply, so that

$$(11) \quad B_{i,t}^n = 0,$$

for all  $i$  and  $t$ . This implies that the net foreign asset position of a country is exactly equal to its investment in real bonds, i.e.,  $NFA_{i,t} = B_{i,t+1}$ .

Market clearing for the nontradable consumption good requires that in every country consumption is equal to production,

$$(12) \quad C_{i,t}^N = Y_{i,t}^N.$$

Instead, market clearing for the tradable consumption good requires

$$(13) \quad C_{i,t}^T = Y_{i,t}^T + R_{t-1} B_{i,t} - B_{i,t+1}.$$

This expression can be rearranged to obtain the law of motion for the stock of net foreign assets owned by country  $i$ , that is, the current account

$$NFA_{i,t} - NFA_{i,t-1} = CA_{i,t} = Y_{i,t}^T - C_{i,t}^T + B_{i,t}(R_{t-1} - 1).$$

As usual, the current account is given by the sum of net exports,  $Y_{i,t}^T - C_{i,t}^T$ , and net interest payments on the stock of net foreign assets owned by the country at the start of the period,  $B_{i,t}(R_{t-1} - 1)$ .

Finally, in every period the world consumption of the tradable good has to be equal to world production,  $\int_0^1 C_{i,t}^T di = \int_0^1 Y_{i,t}^T di$ . This equilibrium condition implies that bonds are in zero net supply at the world level,

$$(14) \quad \int_0^1 B_{i,t+1} di = 0.$$

We are now ready to define a competitive equilibrium.

**DEFINITION 1:** A competitive equilibrium is a path of real allocations  $\{C_{i,t}^T, C_{i,t}^N, Y_{i,t}^N, B_{i,t+1}, B_{i,t+1}^n, \mu_{i,t}\}_{i,t}$ , policy rates  $\{R_{i,t}^n\}_{i,t}$  and world interest rate  $\{R_t\}_t$ , satisfying (4), (6), (11), (12), (13), (14), (AD), and (MP) given a path of endowments  $\{Y_{i,t}^T\}_{i,t}$ , a path for the borrowing limits  $\{\kappa_{i,t}\}_{i,t}$ , and initial conditions  $\{R_{-1} B_{i,0}\}_i$ .

## F. Some Useful Simplifying Assumptions

We now make some simplifying assumptions that allow us to solve analytically the baseline model. We will discuss how our results are affected by relaxing these assumptions in Section IV.

We consider a world in which the global supply of saving instruments is limited, and in which borrowing constraints are tight. The simplest way to formalize this idea is to focus on a zero liquidity economy, in the spirit of Werning (2015). We thus assume that  $\kappa_{i,t} = 0$  for all  $i$  and  $t$ , so that households cannot take any debt. This situation can be thought of as a limiting case of extreme scarcity in liquidity, with very limited borrowing and small asset values. Later on, in Section IV, we will relax this assumption and introduce positive amounts of liquidity.

We also focus on a specific process for the tradable endowment. Following Woodford (1990), we consider a case in which there are two possible realizations of the tradable endowment: high ( $Y_h^T$ ) and low ( $Y_l^T < Y_h^T$ ). We assume that one-half of the countries receives  $Y_h^T$  in even periods and  $Y_l^T$  in odd periods. Symmetrically, the other half receives  $Y_l^T$  during even periods and  $Y_h^T$  during odd periods. From now on, we will say that a country with  $Y_{i,t}^T = Y_h^T$  is in the high state, while a country with  $Y_{i,t}^T = Y_l^T$  is in the low state. As we will see, this endowment process generates in a tractable way asymmetric business cycles across countries.

Finally, we study stationary equilibria in which the world interest rate and the net foreign asset distribution are constant. We will thus assume that the initial asset position satisfies  $B_{i,0} = 0$  for every country  $i$ .<sup>18</sup> Moreover, we focus on minimum state space Markov equilibria, in which all the countries with the same tradable endowment behave symmetrically. Hence, with a slight abuse of notation, we will sometime omit the  $i$  subscripts, and denote with an  $h$  ( $l$ ) subscript variables pertaining to countries in the high (low) state.

## II. Equilibrium under Laissez-Faire

In this section we characterize the equilibrium under laissez-faire. This will serve as a benchmark against which to contrast the equilibrium with government intervention through fiscal and financial policy. We start by solving for the path of tradable consumption and deriving the equilibrium world interest rate. We then turn to the market for nontradable goods.

### A. Tradable Consumption and World Interest Rate

Solving for the path of tradable consumption is straightforward. Intuitively, households seek to smooth tradable consumption by borrowing in the low-endowment state and saving in the high-endowment state. But savers in high-state countries can only save by lending to borrowers in low-state countries, and borrowing is ruled out. Hence, in equilibrium the allocation of tradable consumption corresponds to

<sup>18</sup>We briefly discuss transitional dynamics in online Appendix E.

the financial autarky one, so that every country consumes exactly its endowment of tradable goods ( $C_{i,t}^T = Y_{i,t}^T$  for all  $i$  and  $t$ ).

Since the borrowing constraint binds in low-state countries, the equilibrium world interest rate adjusts to ensure that countries in the high state do not want to save. This happens when<sup>19</sup>

$$(15) \quad R \leq R^{lf} \equiv \frac{Y_l^T}{\beta Y_h^T}.$$

Any interest rate below  $R^{lf}$  ensures that the international credit market clearing condition (14) holds. As a consequence, the equilibrium world interest rate is potentially not uniquely pinned down. However, as highlighted by Werning (2015), interest rates strictly below  $R^{lf}$  are not robust to the introduction of small amounts of liquidity. In fact, with positive but vanishing levels of liquidity in equilibrium the borrowing constraint cannot bind in high-state countries. This implies that the Euler equation (4) in high-state countries must hold with equality, requiring  $R = R^{lf}$ . We adopt this equilibrium refinement throughout the paper.

Expression (15) relates the world interest rate to the fundamentals of the economy. Naturally, a higher discount factor  $\beta$  leads to a higher demand for bonds by saving countries, and thus to a lower world interest rate.<sup>20</sup> Moreover, the world interest rate is decreasing in  $Y_h^T/Y_l^T$ , because a higher volatility of the endowment process increases the desire to save to smooth consumption for countries in the high state. We collect these results in the following lemma.

LEMMA 1: *In a laissez-faire equilibrium with vanishing liquidity  $C_{i,t}^T = Y_{i,t}^T$  and  $R = R^{lf} \equiv Y_l^T/(\beta Y_h^T)$ .*

### B. Nontradable Consumption and Output

We now turn to the market for nontradable goods. Equilibrium on this market is reached at the intersection of the (AD) and (MP) equations, which we rewrite here for convenience:<sup>21</sup>

$$(AD) \quad Y_{i,t}^N = \frac{R\bar{\pi}}{R_{i,t}^n} \frac{C_{i,t}^T}{C_{i,t+1}^T} Y_{i,t+1}^N,$$

$$(MP) \quad R_{i,t}^n \begin{cases} \geq 1 & \text{if } Y_{i,t}^N = 1 \\ = 1 & \text{if } Y_{i,t}^N < 1, \end{cases}$$

where we have imposed the equilibrium condition  $C_{i,t}^N = Y_{i,t}^N$ .

<sup>19</sup>This expression is obtained by combining the Euler equation (4) characterizing households in high-state countries, with the equilibrium relations  $C_{h,t}^T = Y_h^T$  and  $C_{h,t+1}^T = Y_{t+1}^T$ .

<sup>20</sup>The demand for bonds by countries in the high state  $B_h$  is given by

$$B_h = \max \left\{ \frac{\beta}{1 + \beta} \left( Y_h^T - \frac{Y_l^T}{\beta R} \right), 0 \right\}.$$

To derive this expression we have combined the Euler equation (4) with the resource constraint (13) and the equilibrium condition  $B_l = 0$ .

<sup>21</sup>Recall that we are focusing on the limit  $\gamma \rightarrow \bar{\pi}$ .

The key observation is that when aggregate demand is sufficiently weak monetary policy ends up being constrained by the zero lower bound ( $R_{i,t}^n = 1$ ), and the economy experiences a liquidity trap with output below potential ( $Y_{i,t}^N < 1$ ). Combining the (AD) and (MP) equations and using  $R = R^{lf}$  and  $C_{i,t}^T = Y_{i,t}^T$ , one can see that a liquidity trap occurs if

$$(16) \quad R^{lf} \bar{\pi} \frac{Y_{i,t}^T}{Y_{i,t+1}^T} Y_{i,t+1}^N < 1.$$

Notice that, since  $Y_h^T > Y_l^T$ , the zero lower bound is more likely to bind in the low state compared to the high state. Intuitively, changes in tradable consumption act as demand shifters. When a country transitions from the high to the low state the associated drop in tradable consumption gives rise to a fall in aggregate demand for nontradable goods.

Throughout the paper we focus on equilibria in which liquidity traps can happen, but they have finite duration.<sup>22</sup> Given our focus on two-period stationary equilibria, this is the case if fundamentals are such that liquidity traps can arise only when a country is in the low state. We thus make the following assumption.

**ASSUMPTION 1:** *The parameters  $\beta$ ,  $Y_l^T$ ,  $Y_h^T$ , and  $\bar{\pi}$  are such that  $R^{lf} \bar{\pi} > 1$ .*

Assumption 1 guarantees that in the laissez-faire equilibrium the zero lower bound does not bind in the high state, so that  $R_h^n > 1$  and  $Y_h^N = 1$ , where we have removed time subscripts to simplify notation. We provide a discussion of the case  $R^{lf} \bar{\pi} \leq 1$  in online Appendix F.

Turning to the low state, there are two possible scenarios to consider. First, if aggregate demand is sufficiently strong low-state countries operate at full employment ( $Y_l^N = 1$ ). This happens if<sup>23</sup>

$$(17) \quad R^{lf} \geq R^* \equiv (\bar{\pi} \beta)^{-\frac{1}{2}}.$$

Otherwise, if  $R^{lf} < R^*$ , in low-state countries the zero lower bound binds ( $R_l^n = 1$ ) and production of nontradable goods is

$$(18) \quad Y_l^N = (R^{lf} / R^*)^2 < 1.$$

The following proposition summarizes these results.<sup>24</sup>

<sup>22</sup>This is the case considered traditionally by the literature on liquidity traps (Krugman 1998; Eggertsson and Woodford 2003; Werning 2011), as well as by the literature on macroprudential policies and aggregate demand externalities (Farhi and Werning 2016, Korinek and Simsek 2016). See Caballero, Farhi, and Gourinchas (2015) and Eggertsson et al. (2016) for open-economy models in which permanent liquidity traps are possible.

<sup>23</sup>To obtain this condition, combine (15) holding with equality and (16).

<sup>24</sup>Using these equilibrium conditions and equation (7), one can also recover the behavior of tradable price inflation. For instance, it is easy to see that in a stationary equilibrium the average world price of tradables evolves according to

$$\frac{P_t^T}{P_{t-1}^T} = \exp\left(\int_0^1 \log P_{i,t}^T di - \int_0^1 \log P_{i,t-1}^T di\right) = \bar{\pi},$$



**PROPOSITION 1:** *In a laissez-faire equilibrium with vanishing liquidity if  $R^{lf} \geq R^* \equiv (\bar{\pi}\beta)^{-1/2}$  then  $Y_h^N = Y_l^N = 1$ , otherwise  $Y_h^N = 1$  and  $Y_l^N = (R^{lf}/R^*)^2 < 1$ .*

Proposition 1 highlights the crucial role that the world interest rate plays in determining global output of nontradable goods. In fact, if  $R^{lf} \geq R^*$  every country in the world operates at potential. Otherwise the zero lower bound binds in low-state countries and world output is below potential. Moreover, if  $R^{lf} < R^*$ , drops in the world interest rate are associated with falls in global output.

Depending on fundamentals, the equilibrium interest rate  $R^{lf}$  might be greater or smaller than  $R^*$ .<sup>25</sup> We think of the case  $R^{lf} < R^*$  as capturing a world stuck in a global liquidity trap. In such a world, global aggregate demand is weak and countries hit by negative shocks experience liquidity traps with unemployment. Interestingly, this state of affair can persist for an arbitrarily long period of time. In this sense, the model captures in a simple way the salient features of a world undergoing a period of secular stagnation, in which interest rates are low and liquidity traps frequent.<sup>26</sup>

### III. Current Account Policies and the Paradox of Global Thrift

Since there is no disutility from working, unemployment in our model is inefficient. Hence, governments have an incentive to implement policies that limit the incidence of liquidity traps on employment and output. For instance, a large literature has emphasized how raising expected inflation can mitigate the inefficiencies due to the zero lower bound. However, a robust conclusion of this literature is that, in presence of inflation costs, circumventing the zero lower bound by raising inflation expectations is not an option when the central bank lacks commitment (Eggertsson and Woodford 2003).<sup>27</sup>

In this paper we take a different route and consider the role of policies that affect agents' saving and borrowing decisions, such as fiscal or financial policies, in stabilizing aggregate demand and employment. While these policies can take a variety of forms, their common trait is that they influence national savings and, in financially-open economies, the country's current account. Hence, we refer to them as *current account policies*.

We implement the notion of current account policies by endowing governments with the power to choose directly their country's net foreign asset position and the path of tradable consumption, as long as these do not violate the resource constraint (13) and the borrowing limit (3). Crucially, even in presence of current account policies the market for nontradable goods clears competitively, and hence the (AD) and (MP) equations enter the government problem as implementability constraints.<sup>28</sup> In

where we have used (7) and the fact that  $P_{i,t}^N/P_{i,t-1}^N = \{\bar{\pi}, \gamma\}$  in every country  $i$  and the assumption  $\gamma \rightarrow \bar{\pi}$ . In words, on average the prices of tradable and nontradable goods grow at the same rate.

<sup>25</sup> Precisely,  $R^{lf} < R^*$  if  $\bar{\pi} < \beta(Y_h^T/Y_l^T)^2$ , otherwise  $R^{lf} \geq R^*$ .

<sup>26</sup> Lawrence Summers, "The Age of Secular Stagnation," *Foreign Affairs*, February 15, 2016.

<sup>27</sup> We extend this insight to our model in online Appendix D.

<sup>28</sup> Notice that to derive that (AD) equation we have used the no-arbitrage condition between real and nominal bonds. Hence, we are effectively assuming that governments cannot influence households' decision on how to allocate their savings between the two bonds. This assumption captures a world with a high degree of capital mobility, in which it is difficult for governments to discriminate, for instance through capital controls, between domestic and

fact, as we will see, in our model a role for current account policies emerges precisely because the government internalizes the impact of agents' saving decisions on the nontradable goods market.

### A. The National Planning Problem

How does a government optimally intervene on the current account? We address this question by taking the perspective of a national planner that designs current account policies to maximize domestic households' welfare.<sup>29</sup> Importantly, the national planner does not internalize the impact of its decisions on the rest of the world. Hence, the planning allocation that we consider corresponds to the noncooperative optimal current account policy.

As it turns out, the planning allocation might differ depending on whether the planner operates under commitment or discretion. In the interest of brevity, for most of the paper we will restrict attention to planners who lack commitment. We make this choice because, as we will see, the planning allocation under discretion captures particularly well the spirit of the prudential policies studied by Farhi and Werning (2016) and Korinek and Simsek (2016). However, in Section IVA we show that our main results hold true even when national planners operate under commitment.

Formally, we focus on Markov-stationary policy rules that are functions of the payoff-relevant state variables  $(B_{i,t}, Y_{i,t}^T)$  only. Since the planner operates under discretion, it chooses its policy rules in any given period taking as given the policy rules associated with future planner's decisions. A Markov-perfect equilibrium is then characterized by a fixed point in these policy rules. Intuitively, at this fixed point the current planner does not have an incentive to deviate from future planners' policy rules, so that these rules are time consistent. In what follows, we define  $\mathcal{B}(B_{i,t}, Y_{i,t}^T)$  as the policy rule for bond holdings of future planners, while  $\{\mathcal{C}^T(B_{i,t}, Y_{i,t}^T), \mathcal{Y}_N(B_{i,t}, Y_{i,t}^T)\}$  are the functions that return the values of the corresponding variables associated with the planners' policy rules.

The problem of the national planner in a generic country  $i$  can be represented as

$$(19) \quad V(B_{i,t}, Y_{i,t}^T) = \max_{C_{i,t}^T, Y_{i,t}^N, B_{i,t+1}} \omega \log C_{i,t}^T + (1 - \omega) \log Y_{i,t}^N + \beta V(B_{i,t+1}, Y_{i,t+1}^T)$$

subject to

$$(20) \quad C_{i,t}^T = Y_{i,t}^T - B_{i,t+1} + RB_{i,t}$$

$$(21) \quad B_{i,t+1} \geq -\kappa_{i,t}$$

$$(22) \quad Y_{i,t}^N \leq 1,$$

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foreign assets. This feature of the model resonates with the fact that capital controls have essentially been absent in advanced economies since the early 1990s (Ilzetzki, Reinhart, and Rogoff 2017).

<sup>29</sup> Later on, in Section IIIB, we show that a government can implement the planning allocation as part of a competitive equilibrium using some simple fiscal or financial policy instruments.

$$(23) \quad Y_{i,t}^N \leq C_{i,t}^T R \bar{\pi} \frac{\mathcal{Y}^N(B_{i,t+1}, Y_{i,t+1}^T)}{C^T(B_{i,t+1}, Y_{i,t+1}^T)}.$$

The resource constraints are captured by (20) and (22). Equation (21) implies that the government is subject to the same borrowing constraint imposed by the markets on individual households.<sup>30</sup> Instead, constraint (23), which is obtained by combining the (AD) and (MP) equations, encapsulates the requirement that production of nontradable goods is constrained by private sector’s demand. The functions  $C^T(B_{i,t+1}, Y_{i,t+1}^T)$  and  $\mathcal{Y}^N(B_{i,t+1}, Y_{i,t+1}^T)$  determine respectively consumption of tradable goods and production of nontradable goods in period  $t + 1$  as a function of the country’s stock of net foreign assets ( $B_{i,t+1}$ ) and the endowment of tradables ( $Y_{i,t+1}^T$ ) at the beginning of next period. Since the current planner cannot make credible commitments about its future actions, these variables are not into its direct control. However, the current planner can still influence these quantities through its choice of net foreign assets. In what follows, we focus on equilibria in which these functions are differentiable. Moreover, we will restrict attention to equilibria in which  $C^T(B_{i,t+1}, Y_{i,t+1}^T)$  is nondecreasing in  $B_{i,t+1}$ , that is in which tradable consumption is nondecreasing in start-of-period wealth. We make this mild assumption to simplify some of the proofs.

Notice that, since each country is infinitesimally small, the domestic planner takes the world interest rate  $R$  as given. Hence, domestic planners do not take into account the spillovers from their policy decisions toward the rest of the world.

The first-order conditions of the planning problem can be written as

$$(24) \quad \bar{\lambda}_{i,t} = \frac{\omega}{C_{i,t}^T} + \bar{v}_{i,t} \frac{Y_{i,t}^N}{C_{i,t}^T},$$

$$(25) \quad \frac{1 - \omega}{Y_{i,t}^N} = \bar{v}_{i,t} + \bar{v}_{i,t},$$

$$(26) \quad \bar{\lambda}_{i,t} = \beta R \bar{\lambda}_{i,t+1} + \bar{\mu}_{i,t} + \bar{v}_{i,t} Y_{i,t}^N \left[ \frac{\mathcal{Y}_B^N(B_{i,t+1}, Y_{i,t+1}^T)}{\mathcal{Y}^N(B_{i,t+1}, Y_{i,t+1}^T)} - \frac{C_B^T(B_{i,t+1}, Y_{i,t+1}^T)}{C^T(B_{i,t+1}, Y_{i,t+1}^T)} \right],$$

$$(27) \quad B_{i,t+1} \geq -\kappa_{i,t} \quad \text{with equality if } \bar{\mu}_{i,t} > 0,$$

$$(28) \quad Y_{i,t}^N \leq 1 \quad \text{with equality if } \bar{v}_{i,t} > 0,$$

$$(29) \quad Y_{i,t}^N \leq C_{i,t}^T R \bar{\pi} \frac{\mathcal{Y}^N(B_{i,t+1}, Y_{i,t+1}^T)}{C^T(B_{i,t+1}, Y_{i,t+1}^T)} \quad \text{with equality if } \bar{v}_{i,t} > 0,$$

where  $\bar{\lambda}_{i,t}, \bar{\mu}_{i,t}, \bar{v}_{i,t}, \bar{v}_{i,t}$  denote respectively the nonnegative Lagrange multipliers on constraints (20), (21), (22), and (23), while  $\mathcal{Y}_B^N(B_{i,t+1}, Y_{i,t+1}^T)$  and  $C_B^T(B_{i,t+1}, Y_{i,t+1}^T)$  are the partial derivatives of  $\mathcal{Y}^N(B_{i,t+1}, Y_{i,t+1}^T)$  and  $C^T(B_{i,t+1}, Y_{i,t+1}^T)$  with respect to  $B_{i,t+1}$ .

<sup>30</sup>To write this constraint we have used the equilibrium condition  $B_{i,t+1}^n = 0$ . It is straightforward to show that allowing the government to set  $B_{i,t+1}^n$  optimally would not change any of the results.

It is useful to combine (24) and (26) to obtain

$$(30) \quad \frac{1}{C_{i,t}^T}(\omega + \bar{v}_{i,t} Y_{i,t}^N) = \frac{\beta R}{C_{i,t+1}^T}(\omega + \bar{v}_{i,t+1} Y_{i,t+1}^N) + \bar{\mu}_{i,t} \\ + \bar{v}_{i,t} Y_{i,t}^N \left[ \frac{\mathcal{Y}_B^N(B_{i,t+1}, Y_{i,t+1}^T)}{\mathcal{Y}^N(B_{i,t+1}, Y_{i,t+1}^T)} - \frac{C_B^T(B_{i,t+1}, Y_{i,t+1}^T)}{C^T(B_{i,t+1}, Y_{i,t+1}^T)} \right].$$

This is the planner's Euler equation. Comparing this expression with the households' Euler equation (4), it is easy to see that the marginal benefit from a rise in  $C_{i,t}^T$  perceived by the planner differs from households' whenever  $\bar{v}_{i,t} > 0$  in any period  $t$ , that is when the zero lower bound constraint binds. This happens because, contrary to atomistic households, the planner internalizes the impact that financial decisions have on output when monetary policy is constrained by the zero lower bound.

We are now ready to define an equilibrium with current account policies.

**DEFINITION 2:** *An equilibrium with current account policies is a path of real allocations  $\{C_{i,t}^T, Y_{i,t}^N, B_{i,t+1}, \bar{\mu}_{i,t}, \bar{v}_{i,t}, \bar{v}_{i,t}\}_{i,t}$  and world interest rate  $\{R_t\}_t$ , satisfying (14), (20), (25), (27), (28), (29), and (30) given a path of endowments  $\{Y_{i,t}^T\}_{i,t}$ , a path for the borrowing limits  $\{\kappa_{i,t}\}_{i,t}$ , and initial conditions  $\{R_{-1} B_{i,0}\}_i$ . Moreover, the functions  $C^T(B_{i,t+1}, Y_{i,t+1}^T)$  and  $\mathcal{Y}^N(B_{i,t+1}, Y_{i,t+1}^T)$  have to be consistent with the national planners' decision rules.*

### B. Current Account Policies in a Small Open Economy

Under the simplifying assumptions stated in Section IF, it is possible to solve analytically for the equilibrium with current account policies. We start by taking the perspective of a single small open economy, and characterize the solution to the national planning problem as a function of the world interest rate.

**PROPOSITION 2:** *Suppose that  $1/\bar{\pi} < R < 1/\beta$ . Define  $\bar{R}^* \equiv (\omega/(\bar{\pi}\beta))^{1/2}$ . A stationary solution to the national planning problem satisfies  $B_l = 0$  and  $B_h = \max\{\mathcal{B}_h^p(R), 0\}$ , where the function  $\mathcal{B}_h^p(R)$  is defined by*

$$(31) \quad \mathcal{B}_h^p(R) = \begin{cases} \frac{\beta}{\omega + \beta} \left( Y_h^T - \frac{\omega Y_l^T}{\beta R} \right) & \text{if } R < \bar{R}^* \\ \frac{Y_h^T - R\bar{\pi}Y_l^T}{1 + R^2\bar{\pi}} & \text{if } \bar{R}^* \leq R < R^* \\ \frac{\beta}{1 + \beta} \left( Y_h^T - \frac{Y_l^T}{\beta R} \right) & \text{if } R^* \leq R. \end{cases}$$

Moreover,  $\bar{\mu}_h > 0$  if  $\mathcal{B}_h^p(R) < 0$ , otherwise  $\bar{\mu}_h = 0$ . Finally,  $Y_h^N = 1$  and  $Y_l^N = \min\{1, R\bar{\pi}(Y_l^T + RB_h)/(Y_h^T - B_h)\}$ .

**COROLLARY 1:** *Consider a small open economy facing the world interest rate  $R^{lf}$ . If  $R^{lf} < R^*$  the national planner allocation features higher  $Y_l^N$ ,  $B_h$  and welfare compared to laissez-faire, otherwise the two allocations coincide.*

Corollary 1, which considers a scenario in which the world interest rate is at its equilibrium value under laissez-faire, provides two results. First, if  $R^{lf} \geq R^*$ , so that the zero lower bound never binds, the planner chooses the same path for tradable consumption and bonds that households would choose under laissez-faire. This result highlights the fact that in our simple model there are no incentives for the domestic government to intervene on the current account if monetary policy is not constrained by the zero lower bound.

Second, if the zero lower bound binds when the economy is in the low state ( $R^{lf} < R^*$ ), the government intervenes to increase the current account surplus while the economy is in the high state. To understand the logic behind this result, consider a case in which the economy operates below potential in the low state, so that<sup>31</sup>

$$(32) \quad Y_l^N = R^{lf} \bar{\pi} C_l^T / C_h^T < 1.$$

Now imagine that the government implements a policy that leads to an increase in  $B_h$ , and thus in the country's current account surplus while the economy is booming. Households now enter the low state with higher wealth and, since they are borrowing constrained, this leads to a rise in  $C_l^T$ . But the rise in  $C_l^T$  also boosts demand for nontradables in the low state.<sup>32</sup> In turn, since the central bank is constrained by the zero lower bound, higher demand for nontradables leads to higher output and employment. Hence, holding constant the world interest rate, current account interventions lead to higher output of nontradable goods in the low state.

Moreover, again holding constant the world interest rate, current account policies have a positive impact on welfare. As in Farhi and Werning (2016) and Korinek and Simsek (2016), this result is due to the presence of an aggregate demand externality. Atomistic households, indeed, take aggregate demand and employment as given, and do not internalize the impact of tradable consumption decisions on aggregate demand and production of nontradable goods. Interestingly, the current account interventions implemented by the government to correct these externalities have a prudential flavor. In fact, the government intervenes to increase national savings and the current account surplus in the high state, when the economy is booming, to mitigate the drop in employment associated with future liquidity traps occurring when the economy transitions toward the low state.

Before moving on, it is useful to spend some words on the instruments that a government needs to decentralize the planning allocation. One possibility is to allow

<sup>31</sup> To derive this expression we have used the fact that Proposition 2 implies  $Y_h^N = 1$ .

<sup>32</sup> In a stationary equilibrium there is also a second effect. Indeed, the rise in  $B_h$  lowers  $C_h^T$ , i.e., tradable consumption in the high state. This effect also contributes to the rise in demand for nontradables when the economy is in the low state. See Section IVA for further discussion on this point.

the government to impose a borrowing limit tighter than the market one. Under this financial policy, (3) is replaced by

$$B_{i,t+1} + \frac{B_{i,t+1}^n}{P_{i,t}^T} \geq -\min\{0, \kappa_{i,t}^g\},$$

where  $\kappa_{i,t}^g$  is the borrowing limit set by the government. The government can implement the planning allocation characterized in Proposition 2 as part of a competitive equilibrium by setting  $\kappa_h^g = -\max\{B_h^n(R), 0\} \leq 0$  and  $\kappa_l^g = 0$ . Intuitively, to decentralize the planning allocation with financial policy the government should tighten households' access to credit when the economy is in the high state.

Alternatively, the planning allocation could be decentralized using fiscal policy. Consider a case in which the government can levy lump-sum taxes on households  $T_{i,t}$ , to be paid with tradable goods, and use the proceeds to purchase foreign bonds. The government budget constraint is  $B_{i,t+1}^g = T_{i,t} + R_{t-1}B_{i,t}^g$ , where  $B_{i,t}^g$  denotes the stock of foreign bonds held by the government at the start of period  $t$ .<sup>33</sup> Under these assumptions, equation (13) is replaced by

$$C_{i,t}^T = Y_{i,t}^T + R_{t-1}(B_{i,t} + B_{i,t}^g) - (B_{i,t+1} + B_{i,t+1}^g).$$

The planning allocation characterized in Proposition 2 can be implemented as part of a competitive equilibrium with fiscal policy by setting  $B_h^g = \max\{B_h^n(R), 0\}$  and  $B_l^g = 0$ . In words, the government accumulates foreign assets while the economy is booming, and rebates them to households when the economy is in a liquidity trap. This simple form of fiscal policy is effective because the presence of the borrowing limit prevents households from undoing asset accumulation by the government through increases in private borrowing.

Taking stock, the government can use simple forms of financial and fiscal policy to implement the planning allocation. In particular, in our model a government can attain an increase in the country's current account surplus either by tightening financial regulation or through a rise in the fiscal surplus. Hence, prudential financial and fiscal policies are the natural counterpart of the current account policy outlined in Proposition 2.

In this section, we have essentially extended the insights from the literature on aggregate demand externalities and prudential policy interventions to our setting (Farhi and Werning 2016, Korinek and Simsek 2016). In particular, we have shown that governments have an incentive to implement prudential current account policies to complement monetary policy, when the monetary authority is constrained by the zero lower bound. As in Farhi and Werning (2016), when implemented by a single small open economy current account policies lead to higher average output and welfare. While this point is well understood, little is known about what happens when current account policies are implemented by a significantly large group of countries. We tackle this issue next.

<sup>33</sup>To prevent governments from circumventing the private borrowing limit, we also assume that governments cannot sell bonds to foreign agents, i.e.,  $B_{i,t+1}^g \geq 0$ .



### C. Global Equilibrium with Current Account Policies

We now characterize the global equilibrium when all the countries implement the current account policy described in Proposition 2. We show that, once general equilibrium effects are taken into account, government interventions on the international credit markets can backfire by exacerbating the global liquidity trap and give rise to a paradox of global thrift.

Given our focus on a zero liquidity economy, in a global equilibrium all the countries must hold zero bonds. It follows that, just as in the *laissez-faire* equilibrium, the allocation of tradable consumption corresponds to the autarky one ( $C_1^T = Y_1^T$  and  $C_h^T = Y_h^T$ ). Hence, when current account policies are implemented on a global scale governments' efforts to alter the path of tradable consumption are ineffective.

This does not, however, mean that current account policies do not have any impact. Indeed, the following proposition provides a striking result: current account interventions exacerbate the global liquidity trap, and have a negative effect on global output and welfare.

**PROPOSITION 3:** *Suppose that  $R^{lf} < R^*$  and  $\omega R^{lf} \bar{\pi} > 1$ . Then in a vanishing-liquidity equilibrium with current account policies  $R = R^p \equiv \omega R^{lf}$ . Moreover, for every country output and welfare are lower in the equilibrium with current account policies compared to the *laissez-faire* one.*

Perhaps the best way to gain intuition about this result is through a diagram. Panel A of Figure 2 displays the demand for bonds by countries in the high state ( $B_h$ ) and supply of bonds by countries in the low state ( $-B_l$ ), as a function of the world interest rate ( $R$ ). The dashed line  $B_h^p$  corresponds to the demand for bonds when governments intervene on the international credit markets, while the solid line  $B_h^{lf}$  displays the demand for bonds under *laissez-faire*. Notice that for  $R^p < R < R^*$  the demand for bonds under current account policy is higher than under *laissez-faire*. Indeed, this is the range of  $R$  for which governments in high-state countries intervene to increase the current account surplus.<sup>34</sup> The supply of bonds, instead, does not depend on whether governments intervene. In fact, in both cases countries in the low state end up being borrowing constrained, and the supply of bonds is  $-B_l = 0$ .

The equilibrium world interest rate is found at the intersection of the  $B_h$  and  $-B_l$  schedules, corresponding to a kink in the  $B_h$  schedule.<sup>35</sup> The diagram shows that  $R^p < R^{lf}$ , meaning that the equilibrium with current account interventions features a lower world interest rate compared to the *laissez-faire* one. To understand

<sup>34</sup>The non-monotonicity of  $B_h^p$  arises for the following reason. According to Proposition 2, when  $\bar{R} \leq R < R^*$  the national planners choose a value of  $B_h$  such that  $Y_1^N$  is exactly equal to 1. In words, governments intervene to increase the current account during booms so that the economy operates at full employment during busts. But a lower world interest rate implies that a country needs to save more while in the high state to keep the economy at full employment in the low state. Hence, for  $\bar{R} \leq R < R^*$  the demand for bonds by countries in the high state is decreasing in  $R$ . Once  $R$  gets too low, precisely for  $R < \bar{R}$ , it becomes too costly for the government to increase  $B_h$  so as to always keep the economy at full employment. In this case, the standard logic applies and demand for bonds becomes increasing in the world interest rate.

<sup>35</sup>All the other intersections between the  $B_h$  and  $B_l$  curves correspond to cases in which all the countries are borrowing constrained. As explained above, these equilibria are not robust to the introduction of small amounts of liquidity, and we thus disregard them.

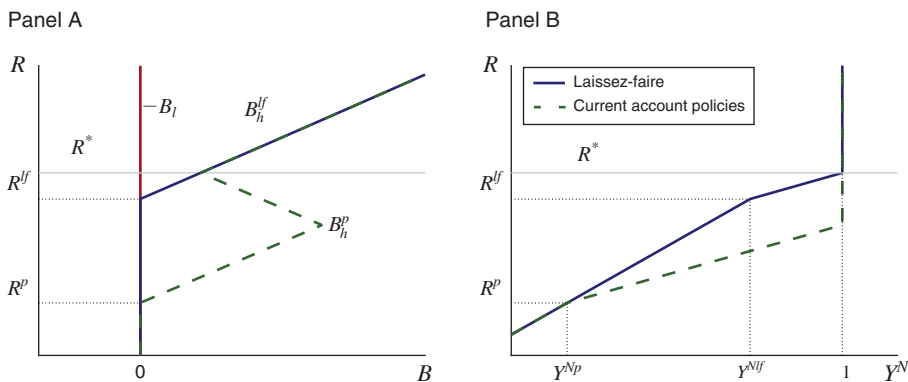


FIGURE 2. IMPACT OF CURRENT ACCOUNT POLICIES DURING A GLOBAL LIQUIDITY TRAP

this result, consider a world with no current account interventions. Now imagine that governments in countries in the high state start intervening to increase their current account surpluses. This generates an increase in the global demand for bonds. But world bonds supply is fixed because countries in the low state are borrowing constrained. To restore equilibrium the world interest rate has to fall, so as to bring back the demand for bonds to its equilibrium value of zero.

Panel B of Figure 2 shows how world output of nontradable goods ( $Y^N$ ) adjusts following the implementation of current account policies. The solid line plots global output as a function of the world interest rate under laissez-faire, while the dashed line displays world output when current account policies are implemented. Holding constant  $R$ , the implementation of current account policies increases global output by shifting tradable consumption and aggregate demand from the high to the low state (see Corollary 1). In equilibrium, however, current account policies cannot alter the path of tradable consumption and their only effect is to produce a drop in the world interest rate. In turn, a lower world rate depresses demand for nontradable consumption across the whole world. Due to the zero lower bound constraint, central banks in low-state countries cannot respond to the drop in aggregate demand by reducing the policy rate. Through this channel, current account interventions in booming high-state countries exacerbate the recession in low-state countries stuck in a liquidity trap.<sup>36</sup> As a result of these negative international aggregate demand externalities, the implementation of current account policies produces a drop in global output and welfare.<sup>37</sup>

This is the essence of the *paradox of global thrift*, as well as the key insight of the paper. Due to their general equilibrium impact on the world interest rate and global aggregate demand, prudential current account policies aiming at mitigating

<sup>36</sup> As in the case of laissez-faire, we focus on equilibria in which liquidity traps are temporary, and so high-state economies operate at full employment. This is guaranteed by condition  $\omega R^{lf} \bar{\pi} > 1$ . See online Appendix F for a discussion on why we need this condition to hold in equilibrium.

<sup>37</sup> To see why welfare is lower with current account policy compared to laissez-faire, consider that both policy regimes are characterized by the same equilibrium path of tradable consumption. It follows that the impact of current account interventions on welfare is fully captured by the drop in output and consumption of nontradable goods.

the output and welfare losses associated with liquidity traps might end up exacerbating them.

#### D. Multiple Equilibria with Current Account Policies

We now consider the impact of current account interventions when fundamentals are such that  $R^{lf} \geq R^*$ . This corresponds to a case in which, under laissez-faire, the world interest rate is sufficiently high so that the zero lower bound never binds.

**PROPOSITION 4:** *Suppose that  $R^{lf} \geq R^*$ . Then there exists a vanishing-liquidity equilibrium with current account policies with  $R = R^{lf}$ . This equilibrium is isomorphic to the laissez-faire one. However, if  $\omega R^{lf} < R^*$  and  $\omega R^{lf} \bar{\pi} > 1$ , there exists at least another equilibrium with current account policies associated with a world interest rate  $R = R^p \equiv \omega R^{lf}$ . This equilibrium features lower output and welfare than the laissez-faire one.*

One might be tempted to conclude that if  $R^{lf} \geq R^*$  then governments will not intervene on the international credit markets, and the equilibrium with current account policies will coincide with the laissez-faire one. Indeed, Proposition 4 states that this is a possibility. However, Proposition 4 also states that there might be other equilibria, characterized by current account interventions and associated with global liquidity traps. Hence, the fact that fundamentals are sufficiently good to rule out a global liquidity trap under laissez-faire does not exclude the possibility of a global liquidity trap when governments intervene on the current account. This result is illustrated by Figure 3, which shows that multiple intersections between the  $B_h^p$  and  $-B_l$  curves are possible.

To gain intuition about this result, consider that governments' actions depend on their expectations about the future path of the world interest rate. This happens because the zero lower bound binds only if the world interest rate is sufficiently low. For instance, consider a case in which governments expect that the world interest rate will never fall below  $R^*$ . In this case, governments expect that the zero lower bound will never bind and hence do not intervene. Since we are focusing on the case  $R^{lf} \geq R^*$ , in absence of policy interventions the zero lower bound will indeed never bind, confirming the initial expectations. But now think of a case in which governments anticipate that the world interest rate will always be below  $R^*$ , so that the zero lower bound is expected to bind in low-state countries. Then governments in high-state countries will start intervening on the current account in an attempt to reduce future unemployment. These interventions will increase the global supply of savings above its value under laissez-faire, putting downward pressure on the world interest rate. If  $\omega R^{lf} < R^*$  holds, the resulting drop in the interest rate is sufficiently large so that  $R < R^*$ , validating governments' initial expectations. Thus, expectations of a future global liquidity trap might generate a global liquidity trap in the present.

We have seen that in our baseline model current account interventions, while being desirable from the point of view of a single country, lead to perverse outcomes once their general equilibrium effects are taken into account. First, current account policies implemented during a global liquidity trap lead to a drop in global output

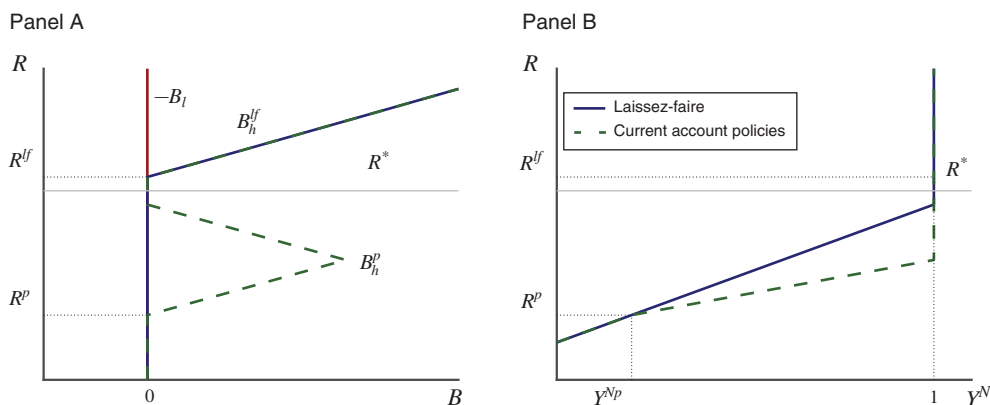


FIGURE 3. MULTIPLE EQUILIBRIA UNDER CURRENT ACCOUNT POLICIES

and welfare. Second, current account policies open the door to global liquidity traps purely driven by pessimistic expectations. Since all these general equilibrium effects are mediated by the world interest rate, which national governments take as given, the perverse effects associated with current account policies are not internalized by governments.<sup>38</sup> Our results thus suggest that international cooperation is needed during a global liquidity trap, in order to limit the negative international aggregate demand externalities arising from unilateral current account interventions. Otherwise, self-oriented interventions on the current account might backfire by triggering a paradox of global thrift.

#### IV. When Is a Paradox of Global Thrift Likely to Occur?

So far we have drawn insights based on an admittedly stylized model. While the simplicity of our baseline model is useful to derive intuition, it is interesting to know whether and how our results would apply to richer settings. In this section we extend the model in several directions, and discuss the conditions under which a paradox of global thrift is more likely to occur.

##### A. Current Account Policies under Commitment

As our baseline case, we considered national planners that operate under discretion. In this section we endow planners with the ability to commit.<sup>39</sup> Our key finding is that the logic of the paradox of global thrift applies even in this case.

<sup>38</sup>One might wonder what would happen in a framework in which countries are large enough, so that governments take into account the impact of their policy decisions on the world interest rate. Though a formal analysis of this case is beyond the scope of this paper, we conjecture that our key results would survive in this alternative setting. In our model, in fact, prudential current account policies backfire because governments in booming countries do not internalize the impact of their current account interventions on welfare in countries experiencing a recession. Hence, the logic behind our results should survive, as long as one considers self-oriented national governments that ignore the impact of their policy decisions on welfare in the rest of the world.

<sup>39</sup>To be clear, we consider what happens when current account policies are designed under commitment, holding constant the monetary policy rule. We make this choice because there is a large literature describing how the ability to commit affects optimal monetary policy around liquidity trap episodes.

In the interest of space, in this section we sketch the solution to the planning problem under commitment. We provide a formal description in online Appendix G. Under commitment, the planner’s Euler equation (30) is replaced by

$$\frac{1}{C_{i,t}^T} \left( \omega + \bar{v}_{i,t} Y_{i,t}^N - \bar{v}_{i,t-1} \frac{Y_{i,t-1}^N}{\beta} \right) = \frac{\beta R}{C_{i,t+1}^T} \left( \omega + \bar{v}_{i,t+1} Y_{i,t+1}^N - \bar{v}_{i,t} \frac{Y_{i,t}^N}{\beta} \right) + \bar{\mu}_{i,t}.$$

Here the policy intervention has a flavor of forward guidance, captured by the terms  $\bar{v}_{i,t-1} Y_{i,t-1}^N / (\beta C_{i,t}^T)$  and  $\bar{v}_{i,t} Y_{i,t+1}^N / (\beta C_{i,t+1}^T)$ . Through these terms, the planner internalizes the fact that lowering tradable consumption in the future sustains aggregate demand in the present.

To see this point more clearly, consider a case in which the zero lower bound does not bind in the present and is never expected to bind in the future ( $\bar{v}_{i,t} = 0$  for  $t \geq 0$ ), but it was binding in period  $t - 1$  ( $\bar{v}_{i,t-1} > 0$ ). The planner Euler equation now reduces to

$$\frac{1}{C_{i,t}^T} \left( \omega - \bar{v}_{i,t-1} \frac{Y_{i,t-1}^N}{\beta} \right) = \frac{\beta R \omega}{C_{i,t+1}^T}.$$

Comparing this expression with (30), one can see that the term  $\bar{v}_{i,t-1} Y_{i,t-1}^N / (C_{i,t}^T \beta)$  creates a wedge between the solutions to the planning problem under discretion and commitment.

Intuitively, when the zero lower bound constraint binds, the planner has an incentive to promise future current account interventions that will lower future tradable consumption. If households believe this promise, the prospect of low future tradable consumption induces them to front-load consumption of nontradable goods. This form of forward guidance sustains aggregate demand and output during the liquidity trap. This promise, however, is not credible if the government operates under discretion. That is why the term  $\bar{v}_{i,t-1} Y_{i,t-1}^N / (C_{i,t}^T \beta)$ , which encapsulates the impact of past promises on current government policy, is absent from the discretionary planner Euler equation (30).

In terms of our two-period stationary equilibria, this result implies that a planner who operates under commitment has an even stronger incentive to suppress households’ tradable consumption during booms. In fact, a lower  $C_h^T$  not only increases output during future liquidity traps, through the precautionary channel described in Section IIIB. In addition, under commitment planners reduce tradable consumption during booms to fulfill the promises made during past liquidity traps, because of the forward guidance channel explained above.

Hence, when the zero lower bound binds in the low state, current account interventions under commitment foster national savings during booms even more than under discretion. But, in a zero liquidity economy, current account policies cannot alter the equilibrium path of tradable consumption. It follows that current account policies produce an even larger drop in the equilibrium world interest rate and global output compared to the case of discretion. The conclusion is that governments’ ability to commit when designing current account policies does not free them from the logic of the paradox of global thrift.

### B. Positive Liquidity

Our baseline model features zero liquidity. While useful for illustrative purposes, this assumption is admittedly unrealistic. It is then natural to investigate the impact of prudential policies in a world with positive liquidity supply, in which current account policies can affect equilibrium savings. To anticipate, our main results are that with positive liquidity current account policies have an ambiguous impact on world output, and that a paradox of global thrift is likely to arise when the elasticity of liquidity supply with respect to the world interest rate is low. In this case, in fact, prudential policies trigger a large drop in the world interest rate, while failing to increase significantly savings by booming countries.

There are many ways to introduce positive liquidity. The simplest option is to open up our model economies to trade in financial assets with agents from the rest of the world. We thus replace the world bond market clearing condition (14) with

$$\int_0^1 B_{i,t+1} di = B_{t+1}^{row},$$

where  $B_{t+1}^{row}$  denotes the bonds supply by the rest of the world. We also assume that

$$B_{t+1}^{row} = \frac{\bar{B}}{2} \left( \frac{\bar{R}}{R_t} \right)^\phi,$$

with  $\bar{B} > 0$ ,  $\bar{R} > 0$ , and  $\phi > 1$ . In words, the supply of bonds by agents from the rest of the world is decreasing in the world interest rate.

As in the case of zero liquidity, we consider stationary equilibria satisfying the assumptions stated in Section IF. Moreover, we are interested in studying equilibria in which liquidity is scarce enough so that the borrowing constraint binds in low-state countries. This is the case if

$$\bar{B}\bar{R}^\phi < \frac{(Y_h^T - Y_l^T)\beta^{1-\phi}}{1 + \beta},$$

which we assume from now on.

We are now ready to solve for the equilibrium on the international credit markets. Since the borrowing constraint binds in low-state countries  $B_l = 0$ . Hence, in equilibrium the world interest rate adjusts so that  $B_h/2 = B^{row}$ . Moreover, both under laissez-faire and with current account policies, the demand for bonds by countries in the high-state  $B_h$  is identical to the one derived in the zero liquidity economy. We can thus employ the same graphical apparatus developed in Section IIIC. In fact, as shown in Figure 4, the only difference is the presence of the downward-sloped  $B^{row}$  curve.

As drawn in Figure 4, the laissez-faire equilibrium corresponds to a global liquidity trap. Current account policies, just as in the case of zero liquidity, end up lowering the world interest rate because they increase the global saving supply. Different from the case of zero liquidity, however, here current account policies have



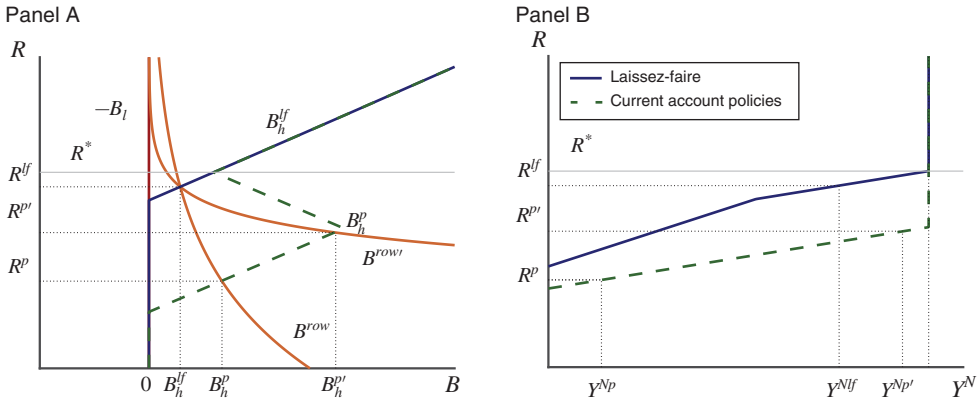


FIGURE 4. IMPACT OF CURRENT ACCOUNT POLICIES WITH POSITIVE LIQUIDITY

an impact on equilibrium savings and consumption of tradables. In fact, tradable consumption is now given by

$$C_h^T = Y_h^T - \bar{B} \left( \frac{\bar{R}}{R} \right)^\phi,$$

$$C_l^T = Y_l^T + \bar{B} R^{1-\phi} \bar{R}^\phi.$$

Hence, recalling that  $\phi > 1$ , a drop in the world interest rate induces a reallocation of tradable consumption from the high to the low state. This is possible because, as the world interest rate falls, rest-of-the-world agents expand their bond supply and allow high state countries to increase their equilibrium savings.

Tracing the output response to the implementation of current account policies is more difficult. Recall that output in the low state is given by  $Y_l^N = \bar{\pi} R C_l^T / C_h^T$ . The fall in the interest rate triggered by current account policies has thus two contrasting effects on output. On the one hand, a lower world rate has a direct negative impact on production of nontradables. On the other hand, the resulting reallocation of tradable consumption from the high to the low state increases aggregate demand and output. In general, it is difficult to obtain analytic results about which effect will prevail.

Luckily, it is possible to work out an insightful special case analytically. Let us assume that the endowment is received only by countries in the high state ( $Y_l^T = 0$ ). We then have the following results.

**PROPOSITION 5:** *Suppose that  $Y_l^T = 0$ ,  $((\omega/\beta + 1)\bar{B}/Y_h^T)^{1/\phi} \bar{R}\bar{\pi} > 1$ , and that under laissez-faire the world is stuck in global liquidity trap. Then if  $\phi < \phi^*$ , for every country output and welfare are lower in the equilibrium with current account policies compared to the laissez-faire one. The value of  $\phi^*$  is such that  $\omega^{\phi^*/2} = (\omega + \beta)/(1 + \beta)$ .*

Proposition 5 states that the impact that current account policies have on output and welfare crucially depends on the elasticity of liquidity supply to the world

interest rate, which is increasing in the parameter  $\phi$ . To understand this result consider that, as shown in Figure 4, a lower  $\phi$  is associated with a larger drop in the world rate following the implementation of current account policies. At the same time, for a given drop in the world rate, the lower  $\phi$  the less current account policies expand equilibrium savings by booming countries. It then follows naturally that if the liquidity supply is sufficiently inelastic, precisely if  $\phi < \phi^*$ , then current account policies induce a drop in output and welfare.<sup>40</sup>

To demonstrate that this result does not restrict itself to the case  $Y_l^T = 0$ , we turn to a numerical example. Figure 5 displays the equilibrium world interest rate, world output, and welfare under laissez-faire (solid lines) and current account policies (dashed lines), as a function of  $\phi$ .<sup>41</sup> The main message is that, in line with the illustrative case  $Y_l^T = 0$ , lower values of  $\phi$  make it more likely that current account policies generate a drop in output and welfare.

To conclude this section, we want to clarify that introducing an ad hoc supply of bonds from the rest of the world is akin to bring noise traders into the model. For this reason, the welfare results presented in this section need to be taken with a grain of salt. However, the logic of our results does not rest on this particular formulation of liquidity supply. For instance, we have worked out a version of the model in which liquidity is provided by investment in physical capital (the results are available upon request). While the analysis is more involved, the key results are unchanged. That is, also in the economy with physical capital, current account policies are more likely to lower output and welfare if the elasticity of liquidity supply with respect to the world interest rate is low. The only wrinkle is that in the model with capital this elasticity is determined by the technological factors shaping the production function.

### C. Extended Model and Numerical Analysis

In this section, we consider an extended version of the model and perform a simple calibration exercise. To be clear, the objective of this exercise is not to provide a careful quantitative evaluation of the framework, or to replicate any particular historical event. Rather, our aim is to show that our key results do not depend on the simplifying assumptions characterizing the baseline model. In the interest of space, we present a detailed description of the model and the results in online Appendix H. Here we just sketch the main insights delivered by this exercise.

For our numerical exercise, we enrich the baseline model along three dimensions. First, we consider more general households' preferences, that take into account households' disutility from working. Second, we relax the no-borrowing

<sup>40</sup>Notice the parallel with the results in Section III. There we showed that current account policies have a positive impact on output and welfare if implemented by a single small open economy. This corresponds to the case of an infinitely elastic supply of liquidity ( $\phi \rightarrow +\infty$ ). The global equilibrium of the zero liquidity economy, instead, can be thought as a case in which the supply of liquidity is infinitely inelastic ( $\phi = 0$ ).

<sup>41</sup>To construct the figure we set  $Y_h^T = 1$ ,  $Y_l^T = 0.8$ ,  $\beta = 0.8$ ,  $\omega = 0.9$ ,  $\bar{\pi} = 1.14$ , and  $\bar{B} = 0.01$ . For every value of  $\phi$  considered we adjust  $\bar{R}$  to keep the equilibrium under laissez-faire constant. Of course, this parametrization is purely illustrative and not meant to be realistic. In particular, we have set the share of tradable goods in consumption  $\omega$  to an unrealistically high value. Setting  $\omega$  to a realistic value, in fact, would lead to an extremely large impact of current account policies on the world interest rate. This is due to the fact that our simple model lacks many factors, such as the disutility that households derive from working or uncertainty about the occurrence of a liquidity trap in the future, that affect governments' incentives to intervene on the current account. In Section IVC we show, using a richer framework, that our results do not depend on setting  $\omega$  to an unrealistically high value.

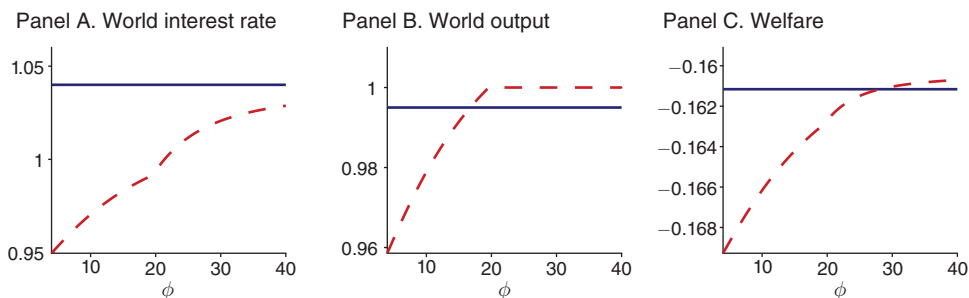


FIGURE 5. IMPACT OF CURRENT ACCOUNT POLICIES WITH POSITIVE LIQUIDITY

Note: Laissez-faire (solid lines); current account policies (dashed lines)

assumption, and allow countries to take positive amounts of debt. Third, we introduce uncertainty, in the form of idiosyncratic tradable endowment and financial shocks. Financial shocks are modeled as stochastic variations in the households' borrowing limit. The model does not admit an analytic solution, so we explore its properties using numerical simulations.

A key aspect of the model is that liquidity traps tend to occur in countries that have accumulated a large stock of debt. This happens because highly indebted households end up being borrowing constrained after a tightening in their country's borrowing limit. Once their borrowing constraint binds, households cut spending on consumption, giving rise to a liquidity trap and a recession. In this respect, the model shares many similarities with theories in which liquidity traps are triggered by episodes of deleveraging (Eggertsson and Krugman 2012, Guerrieri and Lorenzoni 2017).

When given the option to intervene on the current account, governments implement policies that limit debt accumulation in order to mitigate the impact of future liquidity traps on output. Interestingly, interventions by governments tend to happen mostly in countries that are experiencing abundant access to credit, and have already accumulated a sizable stock of external debt. These are the countries, in fact, that are mostly exposed to the risk of a recession in the event of a negative financial shock.

As in the baseline model, current account interventions lead to an increase in the global supply of savings and an associated drop in the world interest rate. If the fall in the interest rate is large enough a paradox of global thrift will ensue. That is, world output might be lower in the equilibrium with current account policies compared to laissez-faire. As an example, Figure 6 shows the dynamics triggered by a permanent shift from laissez-faire to current account policies under our baseline calibration. During the transition to the final steady state the world interest rate drops by 150 basis points and global output falls by more than 1 percent. To clarify, because our model is highly stylized we interpret these quantitative results as being only suggestive. Still, the model points toward the possibility of significant output losses associated with the paradox of global thrift.

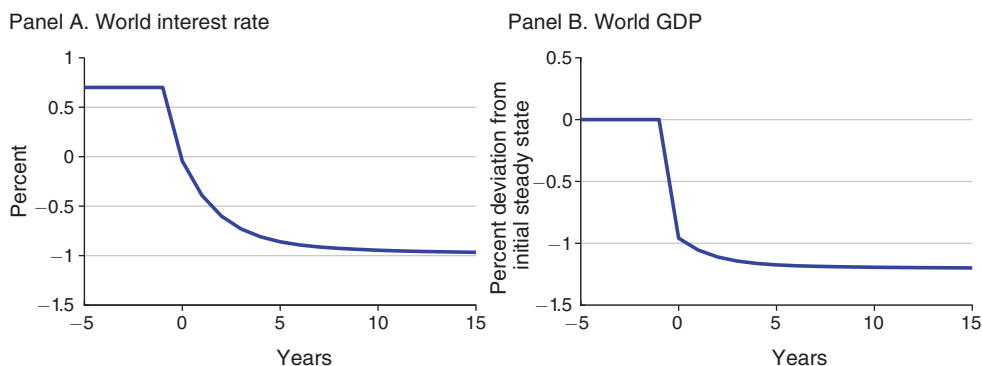


FIGURE 6. TRANSITION TOWARD STEADY STATE WITH CURRENT ACCOUNT POLICIES

Note: The procedure used to construct this figure is explained in online Appendix H.

#### D. Prudential Policies during Global Booms

We have seen that when global aggregate demand is scarce, so that monetary policy is constrained by the zero lower bound, prudential financial and fiscal policies by booming countries entail contractionary spillovers on countries undergoing a recession. But what if prudential policies are implemented during a global boom? We now show that during a global boom, when monetary policy is not constrained by the zero lower bound, the contractionary spillovers from prudential policies are muted. In fact, one can think of plausible scenarios under which prudential policies implemented during a global boom generate expansionary spillovers during future recessions.

We make this point through a simple example, inspired by the literature on debt deleveraging and liquidity traps (Eggertsson and Krugman 2012, Guerrieri and Lorenzoni 2017, Benigno and Romei 2014, Fornaro 2018). We study a global deleveraging shock that tightens agents' borrowing limit. Tighter access to credit forces debtors to cut consumption in order to pay down their debts. If the deleveraging shock is sufficiently large, the associated fall in aggregate demand generates a recession. Following Farhi and Werning (2016) and Korinek and Simsek (2016), we consider policy interventions that reduce borrowing during the boom preceding the deleveraging episode.

*Setup.*—Consider the baseline model of Section II, but with two key modifications with respect to the simplifying assumptions stated in Section IF. First, the borrowing limit now changes over time. In particular, in period  $t = 0$  the borrowing limit is sufficiently large so that no household ends up being borrowing constrained. Instead, in periods  $t \geq 1$  every agent faces a zero borrowing limit. This permanent tightening in the borrowing limit is anticipated by agents at date 0. Moreover, every household receives  $Y^T$  units of the tradable good in each period.

Second, we introduce heterogeneity in initial asset positions. In particular, one-half of the world population starts period 0 with some preexisting debt  $D_0$ . The other

half of the world population starts period 0 with positive assets  $D_0$ . We abstract, for simplicity, from within-country heterogeneity. We thus assume that one-half of the countries is inhabited by debtors, while the other half is inhabited by creditors. Throughout, we will denote variables pertaining to debtor countries with subscripts  $d$ , while creditor countries will be identified with the subscripts  $c$ .

*Final Steady State.*—We characterize the equilibrium backward. From period 2 on the world enters a steady state in which every household holds zero assets and consumes  $Y^T$  units of the tradable good. Moreover, the world interest rate is constant and equal to  $1/\beta$ . It is then easy to check that if  $\bar{\pi}/\beta > 1$ , which we assume to hold from now on, in steady state the zero lower bound does not bind and every country operates at full employment.

*Deleveraging and Recession in Period 1.*—Next consider period  $t = 1$ . Denote by  $D_1$  the debt held by households in debtor countries at the start of the period (i.e.,  $B_{d,1} = -D_1 < 0$ ). In period 1 the borrowing limit binds for debtors, and so

$$C_{d,1}^T = Y^T - R_0 D_1.$$

Moreover, in equilibrium creditors start period 1 with assets  $B_{c,1} = D_1$  and end the period with zero assets. Hence, tradable consumption in creditor countries is

$$C_{c,1}^T = Y^T + R_0 D_1.$$

To clear the global asset market, the world interest rate needs to adjust until desired savings by creditors are equal to 0. This happens if

$$(33) \quad R_1 = \frac{C_{c,2}^T}{\beta C_{c,1}^T} = \frac{Y^T}{\beta(Y^T + R_0 D_1)}.$$

Notice that the world interest rate is decreasing in borrowers' start-of-period debt  $D_1$ . The reason is that the deleveraging shock forces debtors to cut their consumption of tradable goods by an amount equal to  $R_0 D_1$ . In equilibrium, the world interest rate must fall so that creditors are induced to increase tradable consumption by exactly the same amount.

Let us now turn to output. It is easy to check that, given our assumption  $\bar{\pi}/\beta > 1$ , creditor countries operate at full employment in period 1 ( $Y_{c,1}^N = 1$ ). If  $D_1$  is sufficiently high, however, debtor countries experience a liquidity trap and a recession.<sup>42</sup> In this case, every debtor country operates below capacity and nontradable output is equal to

$$(34) \quad Y_{d,1}^N = \bar{\pi} R_1 \frac{Y^T - R_0 D_1}{Y^T} = \frac{\bar{\pi}}{\beta} \frac{Y^T - R_0 D_1}{Y^T + R_0 D_1} < 1,$$

<sup>42</sup>This is the case if

$$R_0 D_1 > \frac{\bar{\pi} - \beta}{\bar{\pi} + \beta} Y^T.$$

where the second equality uses equation (33). Intuitively, the deleveraging shock forces debtors to cut on spending to repay their preexisting debts. If  $D_1$  is sufficiently large, the associated fall in aggregate demand pushes debtor countries in a liquidity trap and a recession.<sup>43</sup> We will focus on this scenario from now on.

*Global Boom in Period 0.*—In period 0 borrowing is unconstrained and so

$$C_{j,1}^T = \beta R_0 C_{j,0}^T,$$

for  $j = d, c$ . It is then easy to verify that the period 0 allocation is such that  $C_{j,0}^T = C_{j,1}^T$  for  $j = d, c$  and  $R_0 = 1/\beta$ . Moreover,  $D_1 = \beta R_{-1} D_0 / (1 + \beta)$ . Finally, we assume that the fundamentals of the economy are such that  $Y_{d,0}^N = Y_{c,0}^N = 1$ , so that period 0 corresponds to a boom.<sup>44</sup>

*International Spillovers from Prudential Policies.*—Now imagine that governments in debtor countries intervene to reduce their citizens' borrowing in period 0. In particular, we are interested in tracing the impact of a marginal reduction in  $D_1$  on output. Clearly, period 1 output in creditor countries will not be affected, since there monetary policy is not constrained by the zero lower bound. Instead, the impact on period 1 output in debtor countries can be recovered by differentiating equation (34) to obtain

$$(35) \quad \frac{\partial Y_{d,1}^N}{\partial D_1} = -\frac{Y_{d,1}^N R_0}{C_{d,1}^T} + \frac{Y_{d,1}^N}{R_1} \frac{\partial R_1}{\partial D_1}.$$

The first term on the right-hand side of this expression captures the direct impact of the change in debt on output. Intuitively, if households in debtor countries reduce their period 0 borrowing, their consumption of tradable goods during deleveraging in period 1 rises. Higher consumption of tradables boosts demand for nontradables. Since during deleveraging the zero lower bound binds in debtor countries, the rise in demand produces an increase in output of nontradable goods. This effect is internalized by governments in debtor countries, which therefore have an incentive to reduce the debt held by their citizens in period 0, to boost output during the liquidity trap occurring in period 1.

The second term on the right-hand side of expression (35), instead, captures an international spillover due to the impact of the reduction in debt on the world interest rate. In general equilibrium, in fact, a drop in borrowers' debt has to be matched by an equivalent fall in the assets held by creditors. Hence, if governments in debtor

<sup>43</sup>In this example, creditor countries do not experience a recession during deleveraging. This result hinges on the fact that we are abstracting from within-country heterogeneity. Indeed, as long as a sufficiently high fraction of the country's population is made of debtors, deleveraging can generate a recession even in a country which is a net creditor toward the rest of the world.

<sup>44</sup>More formally, we assume that

$$(1 + \beta) \frac{\bar{\pi} - \beta}{\bar{\pi} + \beta} Y^T < R_{-1} D_0 \leq \frac{\bar{\pi}(1 + \beta)}{\beta} \frac{\bar{\pi} - \beta}{\bar{\pi} + \beta} Y^T.$$

In words, initial debt is high enough to generate a recession in debtor countries during deleveraging in period 1, but sufficiently low so that debtor countries operate at full employment in period 0.

countries intervene to reduce their citizens' borrowing in period 0, households in creditor countries will enter period 1 with a smaller stock of assets. To compute the effect on  $R_1$ , we can differentiate equation (33) to obtain

$$\frac{\partial R_1}{\partial D_1} = -R_0 \frac{R_1}{C_{s,1}^T} < 0.$$

Intuitively, as creditors enter period 1 with a smaller stock of wealth, the global saving supply in period 1 falls and the world interest rate rises. In turn, the rise in the world interest rate increases global aggregate demand and output in debtor countries. This effect is ignored by national governments, which take the world interest rate as given, and represents an expansionary international spillover.

What about the output response during the boom in period 0? As governments in debtor countries induce their citizens to borrow less, global demand for borrowing in period 0 falls. The result is a drop in the world interest rate  $R_0$ . The fall in  $R_0$ , however, has no impact on period 0 output. This happens because in period 0 monetary policy is not constrained by the zero lower bound. Thus, central banks react to the drop in  $R_0$  by cutting their policy rates so as to maintain full employment. Hence, there are no contractionary spillovers on output from prudential policies implemented during the boom in period 0.<sup>45</sup>

Notice the contrast with our baseline scenario. There, prudential policies generate contractionary spillovers because monetary policy, at least in part of the world, is constrained by the zero lower bound. In fact, as we have seen, during periods of weak global demand the contractionary spillovers from prudential policies can be strong enough to trigger a paradox of global thrift. But contractionary spillovers are muted during global booms, when the zero lower bound does not constrain monetary policy. In fact, the example of this section suggests that during periods of strong global demand prudential policies can generate expansionary spillovers. Taking stock, our analysis suggests that global coordination in the design of prudential fiscal and financial policies is needed both during periods of weak global demand and during global booms. During global downturns, international cooperation should focus on loosening prudential policies, in order to mitigate their contractionary spillovers. During global booms, instead, international cooperation should aim at tightening prudential policies, so as to exploit their expansionary spillovers.<sup>46</sup>

## V. Conclusion

In this paper we have shown that during a global liquidity trap governments have an incentive to complement monetary policy with prudential financial and fiscal policies. These policy interventions increase national savings and improve the current account in good times, in order to sustain aggregate demand and employment

<sup>45</sup>Of course, this argument applies to a marginal reduction in  $D_1$ . There could be cases in which prudential policies depress  $R_0$  so much so as to generate a recession in period 0.

<sup>46</sup>The need to coordinate prudential policies does not rest on the existence of asymmetries across countries. Indeed, in a previous version of the paper we have studied a deleveraging scenario in which countries are symmetric, and each country is inhabited by debtors and creditors. The same type of expansionary spillovers described in this section applies to that setting. That is, even when countries are symmetric, prudential policies implemented during a global boom generate expansionary spillovers during the subsequent bust. The analysis is available upon request.



in the event of a future liquidity trap. The key insight of the paper is that, however, prudential policies might backfire if implemented on a global scale. The reason is that prudential policies increase the global supply of savings and depress global demand. In turn, the drop in global demand exacerbates the output and welfare losses due to the zero lower bound constraint on monetary policy. This effect, which we refer to as the *paradox of global thrift*, might be so strong so that both global output and welfare end up being reduced by the implementation of well-intended prudential policies.

These results suggest that, during global liquidity traps, international cooperation is needed in order to exploit the stabilization properties of prudential policies. Thus, a natural next step in this research program is to evaluate the macroeconomic impact of different forms of international cooperation. Ideally, one would want to derive the optimal cooperative policy. While this task is feasible in the stylized model of Section I, matters become much more complicated once the framework is extended along the dimensions described in Section IV. For this reason, we have left the characterization of the optimal cooperative policy to future research. Alternatively, one could study simpler forms of international cooperation. For instance, in his 1941 plan Keynes proposed to discourage the emergence of excessively large current account surpluses by imposing simple taxes on capital outflows. We believe that our framework represents a useful starting point for future research aiming at evaluating this and other forms of international cooperation during global liquidity traps.

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