Temptation and Monetary-Fiscal Policy Coordination*

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Abstract

How should monetary and fiscal policy be coordinated to guarantee equilibrium determinacy when agents are subject to temptation and preference reversals in consumption/saving decisions? How effective can an expansionary fiscal policy be under such circumstances? Motivated by the empirical and experimental evidence documenting these behavioral threads, we seek answers to both questions through the lenses of a New Keynesian model where agents are characterized by Gul-Pesendorfer's temptation with self-control preferences. We find that temptation reduces the risk of explosive debt dynamics (a unique stationary equilibrium can occur even if both monetary and fiscal policy are active) but enlarges the policy space for which multiple equilibria occur (sunspot equilibria may occur under both the active monetary/passive fiscal and passive monetary/active fiscal regimes). Along a determinate equilibrium, temptation can generate a government spending multiplier for output larger than unity (hence, a positive consumption mutliplier) without requiring unrealistically high degrees of price stickiness.

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1 Introduction

A large body of experimental and field research documents that consumers are very much subject to preference reversal in intertemporal choices. More precisely, if asked today about choosing between

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a low reward at a future period t and a high reward at $t+1$, they would act patiently and opt for the latter. However, if put in front of the same choice problem between today and tomorrow, they would act impatiently and prefer the high reward today. Such time-inconsistent behavior cannot be explained by the standard discounted utility framework where, because of constant discounting between any two subsequent periods, future selves always choose according to the preferences of earlier selves (preferences are time consistent).[1]

In an important contribution to the literature, Gul and Pesendorfer (2001, 2004) show how it is possible to reconcile the experimental evidence on the bias for immediate consumption with a model of dynamic consumption choice which preserves time consistency in preferences. As they argue, one should think of households' welfare as depending not only on actual consumption choices but also on the set of choices available to the them. This way a larger set might be worse than a smaller one if the former includes tempting choices which are eventually harmful.[2] Gul and Pesendorfer (2004) axiomatize preferences where the consumer is tempted to consume immediately his entire endowment, but exert cognitive effort (self-control) to resist and therefore save. Under temptation/dynamic-self-control (henceforth, just temptation) preferences, optimal behavior involves a trade-off between immediate consumption (temptation utility) and intertemporal consumption smoothing (commitment utility). In Airaudo (2020), we introduce Gul-Pesendorfer's temptation preferences into an otherwise standard New Keynesian model. We show that, provided temptation utility is sufficiently more risk averse that its commitment counterpart, these preferences i) induce *discounting* into the linearized Euler equation and ii) lower the temporal elasticity of current consumption to the real interest rate. As a result, by weakening the standard intertemporal demand-side channel of monetary policy transmission, temptation preferences can greatly help to tame the so called *forward guidance puzzle.*[3]

[1] Frederick et al. (2002) provide an extensive review of the discounted utility framework, highlighting its key features and anomalies. They overview how both experimental and field studies have detected the presence of a bias for immediate satisfaction in individual decisions, and survey several alternative models of intertemporal choice, such as, among others, models including hyperbolic discounting, reference-based preferences, anticipated-utility, and temptation/self-control. Of the alternatives, hyperbolic/quasi-geometric discounting (HQGD) is probably the most common approach to introduce preference reversal in dynamic macroeconomic models. For instance, Angeletos et al. (2001) show how HQGD can capture key facts about household consumption and investments, such as the presence of large amounts of illiquid assets in financial portfolios, high credit card debt, and close commovement between consumption and disposable income. Unfortunately, HQGD does not yield uniquely defined optimal decision rules, making those models highly untractable.

[2] In a static context, a classic example is a meal at a resturant whose menu includes both tasty unhealthy dishes (e.g. a high sugar dessert) and healthier options (e.g. a fruit salad).

[3] See Del Negro et al. (2015) and McKay et al. (2016) for an overview of the related literature. Alternative behavioral solutions to the forward guidance puzzle involving some form of bounded rationality have been proposed,

The main objective of this paper is to use the framework developed in Airaudo (2020) to assess the implications of temptation for a) the design of monetary and fiscal policy rules yielding macroeconomic stability, and b) the transmission of government spending shocks. For what concerns the former, we revisit the classic monetary-fiscal coordination problem of inducing a unique Rational Expectations Equilibrium (REE), as highlighted in the seminal work of Leeper (1991). As well known, in the baseline infinitely-lived representative agent New Keynesian framework, under standard preferences, a stark dichotomy arises: equilibrium determinacy require either an *active monetary/passive fiscal* (AM/PF) regime - whereby the central bank aggressively responds to inflationary pressure while the fiscal authority makes sure public debt does not explode - or a *passive monetary/active fiscal* (PM/AF) regime - whereby inflation adjusts to put debt on an intertemporally sustainable path (the fiscal theory of the price level, FTPL, logic applies). With temptation, *Ricardian equivalence fails* and debt dynamics introduce wealth effects on real activity. The stark distinction between theses two regimes vanishes, and Leeper's dichotomy is broken. On the one hand, *temptation reduces the risk of explosive debt dynamics.* In particular, it becomes possible to induce a unique REE also under an *active monetary/active fiscal* (AM/AF) regime, provided monetary policy is not too aggressive (a bounded Taylor principle). On the other hand, *temptation can induce equilibrium multiplicity* also in the AM/PF and PM/AF *regimes.* For instance, given a passive fiscal policy, an active monetary policy does not guarantee uniqueness unless the monetary policy's response to inflation is sufficiently larger than unity (a reinforced Taylor principle).[4] All in all, when agents are subject to temptation, aggregate stability requires a closer coordination between monetary and fiscal policy.

Temptation also significantly affects the qualitative and quantitative impact of government spending on economic activity. First, it increases the magnitude of fiscal multiplier, bringing them more in line with empirical estimates. More specifically, it can generate a government spending multiplier for output larger than unity, or, equivalently, a positive spending multiplier for consumption. Under conventional monetary policies - i.e. away from the zero-lower-bound - this is basically impossible to attain for utility specification commonly used in New Keynesian models (e.g. King-Plosser-Rebelo or MaCurdy utility functions), but also under Greenwood-Hercovitz-Huffman-type (henceforth, GHH) preferences (featuring no income effects on labor supply) unless

among others, by García-Schmidt and Woodford (2015), Angeletos and Lian (2018) and Gabaix (2020).

[4] As for the baseline model without temptation, equilibrium indeterminacy continues to occur in the *passive monetary/passive fiscal* (PM/PF) regime.

one is willing to assume rather large degrees of nominal rigidities. In both cases, the increase in labor income following a positive government spending shock is not sufficient to counteract the negative wealth effect households suffer from an expected increase in future taxes. Temptation can create the additional boost as households, in the attempt to smooth intertemporally the costs of self-control, increase current consumption by responding less negatively to the expected future tax burden. Second, temptation amplifies the wealth effect from bond holdings in the FTPL PM/AF regime, thus strengthening the fiscalist view of inflation.

Our paper belongs to the growing literature introducing bounded-rationality and other behavioral threads into Dynamic Stochastic General Equilibrium (DSGE) models to resolve policy paradoxes occurring under rational expectations, as well as to account for some hard-to-explain features observed in the data. While there is indeed a widespread agreement on the concept of "rational expectations" in the profession, the term bounded rationality has been associated to several alternatives, such as *learning* (Evans and Honkapohja, 2001; Eusepi and Preston, 2018), *cognitive myopia* (Gabaix, 2014, 2020), *level-k thinking* (García-Schmidt and Woodford, 2019; Fahri and Werning, 2019), *higher-order beliefs* (Angeletos and Lian, 2016, 2018; Angeletos and Huo, 2020), and *finite planning horizon* (Woodford, 2019). Besides our previous work in Airaudo (2020), other works have explored the positive and normative implications of Gul-Pesendorfer preferences in dynamic macroeconomic models, for instance, for what concerns the design of social security (Kumru and Thanopoulos, 2011), optimal capital taxation (Krusell et al., 2010), asset pricing (DeJong and Ripoll, 2007; Airaudo, 2019), Friedman's rule (Hiraguchi, 2018), and the welfare cost of business cycle fluctuations (Huang et al., 2015). Convincing experimental evidence on the existence of Gul-Pesendorfer preferences is provided by Toussaerts (2018, 2019). Her lab and field experiments allow to distinguish between present-biased/time inconsistent agents (who value commitment as they expect to fall to temptation) and self-control types (who value commitment as it enables them to reduce/eliminate self-control costs), shows close coincidence between perceived and actual self-control (a sign of consumers' sophistication), and supports the common wisdom that self-control is a depletable resource. Houser et al. (2018) find similar results in a lab experiment with persistent temptations.

Several contributions have assessed the stabilizing properties of monetary/fiscal policy rules in models where Ricardian equivalence does not hold. Leeper's dichotomy also fails in models featuring an overlapping generation structure (Leith and von Thudden, 2008), transaction services from government bonds (Linnemann and Schabert, 2010; Canzoneri et al., 2011), limited asset market participation (Rossi, 2014), or debt-sensitive risk premia on government bonds (Schabert and van Wijnbergen, 2010; Bonan and Lukkezen, 2019).[5] Temptation preferences break Ricardian equivalence while keeping in place a simpler infinitely-lived representative agent framework, and without imposing *ad hoc* assumptions on preferences for wealth and/or financial market imperfections.

Empirical estimates of the government spending multiplier for output range, roughly, between 0.5 and 1.5, and have been shown to depend on the state of the economy as well as on how close monetary policy is to the zero lower bound. Ramey and Zubairy (2018) provide an extensive review of the literature and new results. A detailed analysis about the challenges faced by DSGE models in generating sizable government spending multipliers is found in Christiano et al. (2011) and Woodford (2011). These works show theoretically how the magnitude of the multiplier might depend on the severity and duration of a zero-lower-bound spell. Monacelli and Perotti (2008) and Bilbiie (2011) scrutinize instead the role played by a non-separable GHH-type utility (as introduced by Greenwood et al., 2008) and the related absence of wealth effects on labor supply. Our model is complementary to the last two as it also adopts a GHH utility specification, showing how adding temptation can "substitute" for high nominal rigidities.

The rest of the paper is organized as follows. Section 2 lays out the model. Section 3 defines the equilibrium and its steady state. Section 4 derives the log-linearized equilibrium relationships and highlights the key differences with respect to a baseline model without temptation. Section 5 derives analytical and numerical results for equilibrium determinacy. Section 6 discusses about the transmission mechanism of fiscal policy and the magnitude of government spending multipliers implied by temptation preferences. Section 7 concludes.

2 The Model

2.1 Households

The economy is populated by a continuum of identical infinitely-lived agents/households. In every period, the representative agent's resources are made of gross-returns from a nominal risk-free

[5] The strict determinacy requirement of falling in either the AM/PF or the PM/AF regime is not necessary in models allowing for stochastic regime switching across policy regimes, as in Bianchi and Ilut (2017), Bianchi and Melosi (2019), and Ascari et al. (2020). Failure of Ricardian equivalence may also occur once we depart from rational expectations, as shown by Eusepi and Preston (2012).

bond issued by the government, money balances carried from the previous period, labor income, and dividends from firm ownership. The household is also subject to lump-sum taxes collected by the fiscal government, and receives a monetary transfer from the central bank. Resources are used to finance consumption, as well as new bond and money holdings. His period budget constraint, in real terms, is:

$$c_t + \frac{b_t}{R_t} + m_t = \frac{b_{t-1}}{\pi_t} + \frac{m_{t-1}}{\pi_t} + w_t h_t + d_t - \tau_t + \tau_t^m \tag{1}$$

where $b_t \equiv \frac{B_t}{P_t}$, $m_t \equiv \frac{M_t}{P_t}$, $w_t \equiv \frac{W_t}{P_t}$, $d_t \equiv \frac{D_t}{P_t}$ and $\pi_t \equiv \frac{P_t}{P_{t-1}}$ denote, respectively, real bond holdings (purchased at unit price R_t^{-1}), real money balances, the real wage, real dividends, and gross inflation. The term τ_t stands for (real) lump-sum taxes, while τ_t^m is the (real) money transfer.[6]

The agent has temptation with self-control preferences (henceforth, just temptation preferences), as formalized by Gul and Pesendorfer (2001, 2004). These preferences imply that, in each period, he is tempted to liquidate all his wealth for current consumption purposes, and that in order to resist such temptation he has to incur a self-control cognitive cost (disutility). Following Gul and Pesendorfer (2004), the recursive representation for the his intertemporal utility maximization problem is:

$$\mathcal{W}_t = \max_{c_t,\, h_t,\, m_t,\, b_t} \left[u\left(c_t, h_t, m_t\right) + v\left(c_t, h_t, m_t\right) + \beta E_t \mathcal{W}_{t+1} \right] - \max_{\tilde{c}_t,\, \tilde{h}_t,\, \tilde{m}_t,\, \tilde{b}_t} v\left(\tilde{c}_t, \tilde{h}_t, \tilde{m}_t\right) \tag{2}$$

subject to (1), and non-negativity constraints on money and bond holdings, $b_t \geq 0$ and $m_t \geq 0$. The functions u and v are both Von Neuman-Morgenstern utility functions. On the one hand, the term u_t+ $\beta E_t \mathcal{W}_{t+1}$ represents standard *commitment* utility: it captures the household's evaluation of his long-run best. On the other hand, the term v_t captures *temptation* utility: this is how the household values his urges. The household is sophisticated in the sense that he is cognizant of his current and future costs of self-control.[7] The money-in-the-utility function assumption introduces liquidity

[6] The separation between lump-sum taxes and the monetary transfer removes the latter from the government budget constraint. While this assumption is irrelevant in a baseline New Keynesian model, it allows us to derive analytical results when preferences are subject to temptation and prices are fully flexible.

[7] Muraven et al. (2006) (see also references therein) and, more recently, Schilback (2019) provide experimental evidence on the existence of sophistication (foresight) in decision problems with persistent self-control. A naive household would instead neither recognize nor care about future self-control costs, as well as would not anticipate future preference reversals. This would lead to a game-theoretic set-up between current and future selves, as in models with hyperbolic discounting. Ahn et al. (2018) is a first attempt to develop a theory of naiveté about temptation and self-control.

services from non-interest-bearing money holdings, making them different from government bonds.[8]

Letting $\tilde{c}_t$, $\tilde{h}_t$, $\tilde{m}_t$ and $\tilde{b}_t$ denote, respectively, the optimal levels of consumption, labor, money and bond holdings chosen by the household in period t if he falls to temptation, the term $\max v\left(\tilde{c}_t, \tilde{h}_t, \tilde{m}_t\right) - v\left(c_t, h_t, m_t\right)$ corresponds to the opportunity cost of temptation: this is the utility loss the household suffers when he exerts self-control by choosing the triple $(c_t,\ h_t,\ m_t,\ b_t)$ over the most tempting option $(\tilde{c}_t,\ \tilde{h}_t,\ \tilde{m}_t,\ \tilde{b}_t)$. We will refer to this as the *cost of self-control.*[9] The utility $\mathcal{W}_t$ is therefore the maximum of commitment utility net of costs of self-control.

Household's utilities take the following functional forms:

$$u_t = \frac{f_t^{1-\sigma}}{1-\sigma}, \qquad v_t = \xi \frac{f_t^{1-\eta}}{1-\eta}, \tag{3}$$

$$f_t \equiv \left[(1-\psi)^{\frac{1}{\zeta}} \left(x_t\right)^{\frac{\zeta-1}{\zeta}} + \psi^{\frac{1}{\zeta}} m_t^{\frac{\zeta-1}{\zeta}}\right]^{\frac{\zeta}{\zeta-1}} \tag{4}$$

$$x_t \equiv c_t - \frac{h_t^{1+\chi}}{1+\chi} \tag{5}$$

These specifications are a generalization of the temptation preferences studied in Airaudo (2020). Few remarks are necessary. First of all, we assume that σ and η are both positive, such that both commitment and temptation utilities feature strict concavity and risk aversion, as well as satisfy Inada conditions, with respect to their argument f. The strength of temptation in the model is captured by the parameter ξ. For $\xi = 0$, the model reduces to a New Keynesian without temptation preferences. Second, f is a CES aggregator of a consumption-labor composite x_t and real money holdings m_t with $\psi \in [0, 1)$ indexing the importance of money in utility, and $\zeta > 0$ being the intratemporal elasticity of substitution between the CES arguments. The term x_t is a Greenwood-Hercovitz-Huffman (henceforth, GHH) composite of consumption c_t and hours h_t (see Greenwood et al., 2008). As shown in the literature, this way of introducing consumption and labor disutility non-separably in households' preferences rules out distortionary income effects on labor supply. This will allow us to solve for the temptation allocation in closed-form, and therefore derive some

[8] Because of temptation preferences, money holdings will have real effects even if one assumes full-separability between consumption and money in the utility function. Hence, money demand will not be just a residual, and considering a cash-less economy - as it is often done in the New Keynesian literature - would not be without loss of generality.

[9] As in Gul and Pesendorfer (2001, 2004), the cost of self-control is *linear* in the opportunity cost of temptation. Noor and Takeota (2010) and Fudenberg and Levine (2006, 2011) consider the case of convex costs of self-control. Airaudo (2020) discusses about this possibility in a New Keynesian model.

analytical implications.[10] The utility from the temptation choice, $\tilde{v}_t \equiv v\left(\tilde{c}_t, \tilde{h}_t, \tilde{m}_t\right)$, takes the same functional form as in (3)-(5), with $\tilde{f}_t$, $\tilde{x}_t$, $\tilde{m}_t$, $\tilde{x}_t$, $\tilde{c}_t$, and $\tilde{h}_t$ as arguments.

To start with, we solve for the optimal choice when the representative household falls to temptation. This involves solving a simple static optimization problem: $\max \tilde{v}_t$ subject to (1), as well as $\tilde{b}_t, \tilde{m}_t \geq 0$. Taking first order conditions with respect to choice variables, after simple manipulation of terms, we obtain the following set of conditions:[11]

$$\begin{aligned} \tilde{b}_t &= 0, \qquad\qquad \tilde{h}_t = w_t^{\frac{1}{\chi}}, \qquad\qquad \tilde{\lambda}_t = \xi \tilde{f}_t^{-\eta} && (6) \\ \tilde{m}_t &= \frac{\psi}{1-\psi}\tilde{x}_t, && (7) \\ \tilde{c}_t &= \frac{b_{t-1}}{\pi_t} + \frac{m_{t-1}}{\pi_t} + w_t^{\frac{1+\chi}{\chi}} + d_t - \tau_t + \tau_t^m - \tilde{m}_t && (8) \end{aligned}$$

The temptation solution involves no bond holdings, a labor supply function responding to the real wage with elasticity χ^{-1} (no direct impact of the marginal utility of consumption, due to the GHH specification), a non-speculative demand for money ($\tilde{m}_t$ does not depend on the nominal interest rate), and consumption of all available resources (net of money demand). In the analysis to follow, we will also make use of the expressions for $\tilde{x}_t$ and $\tilde{f}_t$. Using the definitions from (4)-(5), simple algebra gives:

$$\begin{aligned} \tilde{x}_t &= (1-\psi)\left(\frac{b_{t-1}}{\pi_t} + \frac{m_{t-1}}{\pi_t} + \frac{\chi}{1+\chi} w_t^{\frac{1+\chi}{\chi}} + d_t - \tau_t + \tau_t^m\right) && (9) \\ \tilde{f}_t &= \frac{\tilde{x}_t}{1-\psi} && (10) \end{aligned}$$

Based on (9)-(10), we let $\tilde{f}\left(b_{t-1}, m_{t-1}\right)$ denote the temptation level for the CES aggregator $\tilde{f}_t$ as function of initial bond and money holdings.[12]

[10] GHH preferences find empirical support both at the *aggregate* macro (see Schmitt-Grohé and Uribe, 2012) and *individual* micro (see Cesarini et al., 2017) levels. These preferences are often used to generate government spending multipliers for output larger than unity. See Monacelli and Perotti (2008) and Christiano et al. (2011) for an extensive review, and Auclert and Ronglie (2017) for a criticism of such preferences. As shown in Airaudo (2020), under more standard consumption-labor separable utility functions, the qualitative implications of temptation in a New Keynesian framework are similar to what obtained under the GHH assumption.

[11] Let $\tilde{\lambda}_t$, $\tilde{\lambda}_{b,t}$, and $\tilde{\lambda}_{m,t}$ denote, respectively, the Lagrange multipliers for the household's budget constraint, and the non-negativity constraints on bond and money holdings. Inada conditions guarantee that $\tilde{f}_t > 0$, such $\tilde{\lambda}_t > 0$, which in turn implies that $\tilde{\lambda}_{b,t} (= \tilde{\lambda}_t$, from the first order conditions for bonds) is strictly positive as well. By the complementary slackness condition, $\tilde{\lambda}_{b,t}\tilde{b}_t = 0$, it follows that $\tilde{b}_t = 0$. At an interior solution where $\tilde{m}_t > 0$, we have that $\tilde{\lambda}_{m,t} = 0$, by complementary slackness again.

[12] To shorten the notation, we intentionally omit as specific arguments all other variables that are beyond households'

The dynamic programming problem in (2) can then be re-written as follows:

$$\mathcal{W}_t = \max_{c_t,\, h_t,\, b_t} u\left(c_t, h_t, m_t\right) + v\left(c_t, h_t, m_t\right) + \beta E_t \mathcal{W}_{t+1} - v\left(\tilde{f}\left(b_{t-1}, m_{t-1}\right)\right) \tag{11}$$

Focusing on an interior solution where m_t and b_t are both strictly positive, first order conditions with respect to c_t, h_t, m_t and b_t give, respectively:

$$\lambda_t = \left(f_t^{-\sigma} + \xi f_t^{-\eta}\right) f_t^{\frac{1}{\zeta}} \left(1-\psi\right)^{\frac{1}{\zeta}} \left(x_t\right)^{-\frac{1}{\zeta}}, \qquad h_t = w_t^{\frac{1}{\chi}}. \tag{12}$$

$$\lambda_t = \left(f_t^{-\sigma} + \xi f_t^{-\eta}\right) f_t^{\frac{1}{\zeta}} \psi^{\frac{1}{\zeta}} m_t^{-\frac{1}{\zeta}} + \beta E_t \frac{\partial \mathcal{W}_{t+1}}{\partial m_t}, \qquad \lambda_t = \beta R_t E_t \frac{\partial \mathcal{W}_{t+1}}{\partial b_t} \tag{13}$$

Similar to the case of temptation, labor supply depends only on the real wage, and therefore $h_t = \tilde{h}_t$: commitment and temptation labor supplies are identical. From the Envelope Theorem, making use of the expression for $\tilde{f}_t$ in (9)-(10), and $\partial \tilde{f}\left(b_{t-1}, m_{t-1}\right)/\partial b_{t-1} = \partial \tilde{f}\left(b_{t-1}, m_{t-1}\right)/\partial m_{t-1} = \pi_t^{-1}$, simple calculus and algebra give $\partial \mathcal{W}_t/\partial b_{t-1} = \partial \mathcal{W}_t/\partial m_{t-1} = \left(\lambda_t - \tilde{\lambda}_t\right)\pi_t^{-1}$. The latter, combined the first order conditions in (13), yields the generalized Euler equation and money demand:

$$\lambda_t = \beta R_t E_t \left[\frac{\lambda_{t+1}}{\pi_{t+1}} \Gamma_{t+1}\right], \qquad \text{for} \qquad \Gamma_{t+1} \equiv \left(1 - \frac{\tilde{\lambda}_{t+1}}{\lambda_{t+1}}\right), \tag{14}$$

$$m_t = \frac{\psi}{1-\psi} x_t \left(\frac{R_t}{R_t - 1}\right)^{\zeta}. \tag{15}$$

The term Γ_{t+1} in the Euler equation (14) constitutes the wedge between our set-up and the model without temptation, and acts like a distortion on household's optimal consumption smoothing. In particular, Γ_{t+1} depends negatively on the ratio between the marginal utility of the temptation to the commitment choice faced by the household in the next period. After combining the money demand function (15) with the CES aggregator (4), we obtain

$$f_t = \frac{x_t}{1-\psi} \left(\Delta_t\right)^{\zeta}, \qquad \text{for} \qquad \Delta_t \equiv \left[1 - \psi + \psi \left(\frac{R_t}{R_t - 1}\right)^{\zeta - 1}\right]^{\frac{1}{\zeta - 1}}. \tag{16}$$

The latter can be substituted into the expression for λ_t in (12), giving a compact expression for

control.

the marginal utility from commitment:

$$\lambda_t = \left(f_t^{-\sigma} + \xi f_t^{-\eta}\right)\Delta_t \tag{17}$$

Lemma 1 *Recall the definitions of x_t and $\tilde{x}_t$. Since $h_t = \tilde{h}_t$, we have that*

$$\tilde{x}_t = (1-\psi)\left(x_t + m_t + \frac{b_t}{R_t}\right), \tag{18}$$

where, for any parameterization of the model, $\tilde{x}_t \geq x_t (\Delta_t)^{\zeta}$. The latter implies that resisting to temptation involves a non-negative utility cost:

$$\max v\left(\tilde{c}_t, \tilde{h}_t, \tilde{m}_t\right) - v\left(c_t, h_t, m_t\right) = \frac{\xi}{1-\eta}\left(\tilde{f}_t^{1-\eta} - f_t^{1-\eta}\right) \geq 0.$$

Proof. See Appendix A.1.1. ■

Using the expressions for the marginal utilities λ_t and $\tilde{\lambda}_t$, and for the wedge Γ_{t+1}, the generalized Euler equation (14) can be written in expanded form:

$$\Delta_t f_t^{-\sigma} + \xi \Delta_t f_t^{-\eta} = \beta E_t \left\{\frac{R_t}{\pi_{t+1}}\left[f_{t+1}^{-\sigma}\Delta_{t+1} - \xi\left(\tilde{f}_{t+1}^{-\eta} - \Delta_{t+1} f_{t+1}^{-\eta}\right)\right]\right\} \tag{19}$$

Let's inspect it more closely. Its left-hand-side represents the marginal utility cost of saving today. Because of the non-separable utility, this is expressed with respect to the CES aggregator f (instead of just the consumption-labor composite x), and depends also on the nominal interest rate factor Δ_t. The second term identifies the higher marginal utility cost of saving today due to the temptation to consume all assets immediately, and is strictly increasing in ξ.[13]

The right-hand-side captures instead the marginal utility benefits of investing in the risk-free bond. The additional term $\xi\left(\tilde{f}_{t+1}^{-\eta} - \Delta_{t+1} f_{t+1}^{-\eta}\right)$ corresponds to the marginal impact of an increase in savings on the future costs of self-control. Due to concavity/risk aversion in temptation utility v - i.e. $\eta > 0$ - and the fact that $\tilde{x}_t \geq x_t (\Delta_t)^{\zeta}$ (Lemma 1), it is straightforward to verify that $\tilde{f}_{t+1}^{-\eta} - \Delta_{t+1} f_{t+1}^{-\eta} \leq 0$: that is, higher savings today reduce the expected future costs of resisting to temptation. Hence, temptation preferences increase also the future marginal benefits of savings. This seemingly counter-intuitive implication can be rationalized as follows: higher savings today

[13] As the labor choice just depends on the real wage, the composite f_t is strictly increasing in c_t.

allow the household to afford higher *commitment* consumption in the next period. By concavity, the marginal utility benefit of the latter is larger than the marginal utility benefit of using the extra savings for *temptation* consumption. This makes the liquidation of wealth less tempting, and hence lowers the cognitive costs of self-control.

This logic is consistent with the empirical evidence on poverty and self-control, whereby poorer individuals appear to face higher costs of self-control as their marginal utility benefit of falling for the tempting choice are higher. Studies by Shah et al. (2012) and Mani et al. (2013) show that poverty reduces cognitive capacity and therefore leads to behavior that further exacerbate the poverty status. Scarcity of resources affects how people allocate attention to different economic decisions. In particular, it makes relatively simple economic decisions more pressing and attention consuming, which in turn leads to myopic choices for more important tasks. In a nutshell, if given an extra dollar today, our sophisticated consumer faces two contrasting forces. On the one hand, he is *inclined to save more* as, by doing so, he would lower the *future* costs of self-control, since temptation is stronger at low consumption levels. On the other hand, he is *reluctant to save more*, because that would increase the *current* costs of self-control and also because the self-control benefits of saving have diminishing returns.[14]

2.2 Firms

The supply side of the economy is standard. Production is split into two sectors: retail and wholesale. The retail sector is perfectly competitive and produces a final consumption good y_t out of a continuum of intermediate goods via the following CRS technology: $y_t = \left[\int_0^1 y_t(i)^{(\epsilon-1)/\epsilon} di\right]^{\epsilon/(\epsilon-1)}$, where $\epsilon > 1$ is the elasticity of substitution between any two varieties of intermediate goods Prices in the retail sector are perfectly flexible. The optimal demand for the intermediate good $y_t(i)$ is given by $y_t(i) = \left(\frac{P_t(i)}{P_t}\right)^{-\epsilon} y_t$, while $P_t = \left[\int_0^1 P_t(i)^{1-\epsilon}\, di\right]^{1/(1-\epsilon)}$ is the price of the final consumption good (CPI).

The wholesale sector is made of a continuum of firms indexed by i, for $i \in [0,1]$. They act under monopolistic competition and are subject to nominal rigidities in price setting. The i-th firm hires labor from a competitive labor market to produce the i-th variety of a continuum of differentiated intermediate goods which are sold to retailers. Wholesale firms operate a simple linear technology:

[14] Although $\xi\left(\tilde{f}_{t+1}^{-\eta} - \Delta_{t+1} f_{t+1}^{-\eta}\right) < 0$ implies that savings reduce self-control costs, this occurs at a declining rate (the second derivative is positive).

$y_t(i) = zh_t(i)$, where z denotes (constant) aggregate TFP.

We introduce nominal rigidities following Calvo's staggered price setting: each firm in the wholesale sector optimally revises its price with probability $1-\theta$ in any given period t. Real marginal costs are equal across firms and given by $mc_t = w_t/z$. The i-th firm chooses the optimal price $P_t^*(i)$ to maximize $E_t \sum_{k=0}^{\infty} \theta^k \mathcal{F}_{t,t+k} y_{t+k}(i) \left(P_t^*(i) - P_{t+k} mc_{t+k}\right)$, subject to the demand constraint $y_{t+k}(i) = \left(\frac{P_t^*(i)}{P_{t+k}}\right)^{-\epsilon} y_{t+k}$. The term $\mathcal{F}_{t,t+k}$ denotes the household's stochastic discount factor (SDF) between period t and a generic $t+k$, for $k \geq 0$. Since for a risk-less nominal pay-off, the SDF between period t and $t+1$ is defined as $R_t E_t \mathcal{F}_{t+1} = 1$, by the household's Euler equation (14), we have that

$$\mathcal{F}_{t,t+k} = \beta^k \frac{P_t}{P_{t+k}} \frac{\lambda_{t+k}}{\lambda_t} \prod_{j=1}^{k} \Gamma_{t+j}, \qquad \text{for} \qquad \Gamma_{t+j} \equiv \left(1 - \frac{\tilde{\lambda}_{t+j}}{\lambda_{t+j}}\right), \ j = 1, ..., k \tag{20}$$

It is straightforward to solve for the optimal price P_t^* (where the index i has been dropped since all price-setting firms face same economic conditions and therefore choose the same price) relative to the CPI index P_t:

$$\frac{P_t^*}{P_t} = \mu \frac{E_t \sum_{k=0}^{\infty} \theta^k Q_{t,t+k} y_{t+k} mc_{t+k} \pi_{t,t+k}^{\epsilon}}{E_t \sum_{k=0}^{\infty} \theta^k Q_{t,t+k} y_{t+k} \pi_{t,t+k}^{\epsilon-1}} \tag{21}$$

where $\mu_t \equiv \frac{\epsilon}{\epsilon-1}$ is the gross price mark-up, and $Q_{t,t+k} \equiv \mathcal{F}_{t,t+k} \pi_{t,t+k}$, with $\pi_{t,t+k} \equiv \frac{P_{t+k}}{P_t}$.

Dividends are distributed to household in a lump-sum fashion. For the i-th firm, real dividends $d_t(i) \equiv \frac{D_t(i)}{P_t}$ are given by the following expression:

$$\begin{aligned} d_t(i) &= \frac{P_t(i)}{P_t} y_t(i) - \frac{W_t}{P_t} h_t(i) \\ &= \left[\frac{P_t(i)}{P_t}\right]^{1-\epsilon} y_t - mc_t \left[\frac{P_t(i)}{P_t}\right]^{-\epsilon} y_t \end{aligned} \tag{22}$$

2.3 The Government

The government is made of a fiscal authority (the Treasury, superscript T) and a monetary authority (the central bank, superscript CB). The Treasury levies lump-sum taxes on household and issues risk-free nominal bonds to finance real government spending g_t, as well as to repay previously issued bonds. Its temporary budget, in real terms, is:

$$\tau_t + \frac{b_t^T}{R_t} = \frac{b_{t-1}^T}{\pi_t} + g_t \tag{23}$$

Government spending is assumed to be stochastic, with unconditional mean $\bar{g} > 0$. We assume that $\hat{g}_t = \ln(g_t/\bar{g})$ follows a stationary AR(1) process: $\hat{g}_t = \rho_g \hat{g}_{t-1} + \varepsilon_{g,t}$, for $\rho_g \in (0,1)$ and $\varepsilon_{g,t}$ ~iid $N\left(0, \sigma_g^2\right)$. Fiscal policy takes the form of a feedback rule, whereby taxes τ_t respond to public debt deviations from target:

$$\tau_t = \tau^* \left(\frac{b_{t-1}^T}{b^*}\right)^{\phi_b}, \qquad \phi_b \geq 0, \tag{24}$$

with τ^* and b^* denoting, respectively, target levels for taxes and real debt set by the government.

The central bank sets the short term nominal interest rate R_t following a standard Taylor-type rule:[15]

$$R_t = R^* \left(\frac{\pi_t}{\pi^*}\right)^{\phi_\pi}, \qquad \phi_\pi \geq 0, \tag{25}$$

where R^* and π^* are the target levels for the nominal interest rate and gross inflation. The proceeds from money creation are rebated to households in a lump-sum fashion:

$$m_t^{CB} - \frac{m_{t-1}^{CB}}{\pi_t} = \tau_t^m \tag{26}$$

3 Equilibrium

In equilibrium, all economic agents take optimal decisions (taking as given aggregate quantities and prices) and all markets clear. Output equals consumption plus government spending, $y_t = c_t + g_t$, while all bonds issued by the Treasury and all money printed by the central bank are held by the representative household: $b_t^T = b_t$ and $m_t^{CB} = m_t$. Aggregate dividends d_t are defined as

$$d_t = \int_0^1 d_t(i)\, di = y_t \left(1 - mc_t \Xi_t\right) \tag{27}$$

with $\Xi_t \equiv \int_0^1 \left[\frac{P_t(i)}{P_t}\right]^{-\epsilon} di$ denoting price dispersion across firms. As in the baseline New Keynesian model, market clearing in the labor market requires $h_t = \int_0^1 h_t(i)\, di = \frac{y_t}{z}\Xi_t$. In turn, since $w_t = h_t^\chi$,

[15] For simplicity, we omit other arguments (e.g. output) in the monetary policy rule.

real marginal costs are $mc_t = \left(\frac{y_t}{z}\Xi_t\right)^{\chi}$. Given the Calvo-style price rigidity, the CPI price index P_t evolves as follows:

$$P_t = (1-\theta)\, P_t^* + \theta P_{t-1} \tag{28}$$

3.1 Steady State Equilibrium

First, we characterize the steady state equilibrium, letting a "bar" on top of a variable denote its steady state value. For this purpose, we set all exogenous variables equal to their unconditional means. Without loss of generality, we assume that $z = 1$. Furthermore, we assume policy targets coincide with steady state values: namely, $\pi^* = \bar{\pi}$ (with $\pi^* = 1$, such that steady state inflation is zero), and $b^* = \bar{b}$. The policy rules (24) and (25) therefore imply that $\bar{\tau} = \tau^*$ and $\bar{R} = R^*$. Consistency with the government budget constraint (23) requires that $\bar{\tau} = \bar{b}\left(\frac{\bar{R}-1}{\bar{R}}\right) + \bar{g}$. From the latter, for given $\bar{g}_b \equiv \frac{\bar{g}}{\bar{b}}$, we have $\bar{\tau}_b \equiv \frac{\bar{\tau}}{\bar{b}} = \frac{\bar{R}-1}{\bar{R}} + \bar{g}_b$. The following assumption - which is easily verified for any realistic parameterization of the model - guarantees that $\bar{\tau}_b \in (0,1)$.

Assumption 1: $\bar{g}_b < \bar{R}^{-1}$.

From the law of motion of P_t in (28), zero steady state inflation implies that the steady state relative price $\frac{\bar{P}^*}{\bar{P}}$ equals unity. This, together with the price setting rule (21) - where $\bar{Q}_{t,t+k} = \beta^k \prod_{j=1}^{k} \bar{\Gamma}$ with $\bar{\Gamma} = 1 - \frac{\bar{\bar{\lambda}}}{\bar{\lambda}}$ - implies that real marginal costs are equal to the inverse gross price mark-up: $\overline{mc} = \overline{w} = \mu^{-1}$, where $\mu \equiv \frac{\epsilon}{\epsilon-1}$. The latter, together with the labor supply equation $\bar{h} = \bar{w}^{\frac{1}{\chi}}$, gives $\bar{y} = \left(\frac{1}{\mu}\right)^{\frac{1}{\chi}}$, while the absence of price dispersion in steady state ($\bar{\Xi} = 1$) yields $\bar{d} = \frac{\mu-1}{\mu}\bar{y}$. Assuming that steady state government spending is a fraction $\bar{g}_y$ of aggregate output, $\bar{g} = \bar{g}_y\bar{y}$, steady state consumption is $\bar{c} = (1-\bar{g}_y)\left(\frac{1}{\mu}\right)^{\frac{1}{\chi}}$. Using the definitions in (5), simple algebra gives

$$\begin{aligned}
\bar{x} &= \omega\bar{y}, && (29)\\
\omega &\equiv \frac{(1-\bar{g}_y)(1+\chi)\,\mu - 1}{(1+\chi)\,\mu}, && (30)
\end{aligned}$$

while, from Lemma 1, we obtain

$$\bar{\bar{x}} = \bar{x}\left[1 - \psi + \psi\left(\frac{\bar{R}}{\bar{R}-1}\right)^{\zeta}\right] + (1-\psi)\,\frac{\bar{b}}{\bar{R}}. \tag{31}$$

Assumption 2 - which holds for any realistic parameterization of $\bar{g}_y$, χ and μ - guarantees that $\bar{x}$ is always positive, so that GHH preferences are well-defined.

Assumption 2: $\omega > 0$.

To conclude, consider the Euler equation (14), whose steady state version is $1/\beta\bar{R} = \bar{\Gamma}$, where $\bar{\Gamma} \in (0,1)$. Using the definition of $\bar{\Gamma}$, together with steady state expressions for marginal utilities $\bar{\lambda}$ and $\bar{\bar{\lambda}}$, the steady state real interest rate $\bar{R}$ is defined implicitly by the following equation:

$$\frac{1}{\beta\bar{R}} = 1 - \xi \frac{\left(\frac{\bar{\bar{x}}(\bar{R})}{1-\psi}\right)^{-\eta}}{\bar{\Delta}\left(\bar{R}\right)\left[\left(\frac{\bar{x}}{1-\psi}\left(\bar{\Delta}\left(\bar{R}\right)\right)^{\zeta}\right)^{-\sigma} + \xi\left(\frac{\bar{x}}{1-\psi}\left(\bar{\Delta}\left(\bar{R}\right)\right)^{\zeta}\right)^{-\eta}\right]}, \tag{32}$$

where $\bar{\Delta}\left(\bar{R}\right)$ and $\bar{\bar{x}}\left(\bar{R}\right)$ denote $\bar{\Delta}$ and $\bar{\bar{x}}$ as functions of $\bar{R}$, as defined in (16) and (31). Notice that, absent temptation, $\xi = 0$, equation (32) reduces to the standard $\bar{R} = \beta^{-1}$, i.e. the steady state real interest rate is just the inverse of the subjective discount factor. For $\xi > 0$, the expression is highly non-linear and does not lead to a closed form solution for $\bar{R}$. Nevertheless, for any parameterization of the model, a steady state equilibrium $\bar{R} > \beta^{-1}$ always exists. To see that let $\Gamma\left(\bar{R}\right)$ denote the right hand side of equation (32), and notice that $\bar{\Gamma} \in (0,1)$ for any $\bar{R} > 1$, with $\bar{\Gamma}^{\min} \equiv \lim_{\bar{R}\to+\infty} \Gamma\left(\bar{R}\right) > 0$. Its left hand side is instead strictly decreasing in $\bar{R}$, with $\lim_{\bar{R}\to+\infty}\left(\beta\bar{R}\right)^{-1} = 0$ and $\left(\beta\bar{R}\right)^{-1} \geq 1$ for any $\bar{R} \leq \beta^{-1}$. Hence, there can never be a steady state equilibrium for $\bar{R} \leq \beta^{-1}$, while there must exists at least one value for $\bar{R} > \beta^{-1}$ solving (32). The following proposition shows that, for a specific parameterization of the model, it is possible to prove analytically that the steady state is unique.[16]

Proposition 1 *Assume that $\sigma = \eta = 1$ and consider the limiting case of $\zeta \to 1$, such that commitment and temptation utilities display unitary risk aversion and are both fully separable between x and m. Then, as long as $1 + \xi < 2\beta$, there exists a unique steady state real interest rate $\bar{R} \in \left(\frac{1}{\beta}, \frac{1+\xi}{\beta}\right)$, and is strictly increasing in ξ.*

Proof. See Appendix A.1.2. ■

[16] Given a steady state value for the interest rate, we can solve for all remaining variables. In particular, given values for $\bar{\bar{x}}$ from (31) and $\bar{\Delta}$ from (16), it is straightforward to compute the steady state values for $\bar{\bar{f}}$, $\bar{f}$, $\bar{\bar{\lambda}}$, $\bar{\lambda}$, $\bar{\bar{m}}$, $\bar{m}$, and $\bar{\Gamma}$. Through extensive numerical analysis, we have found that a) a unique $\bar{R}$ exists also for the case of $\eta > \sigma$ (higher risk aversion in temptation) and of $\zeta \neq 1$; b) $\bar{R}$ is a strictly decreasing function of η and ζ.

4 Log-Linearized Equilibrium

We proceed by log-linearizing the equilibrium conditions around the steady state, letting $\hat{n} \equiv \ln(n_t/\bar{n})$ for a generic variable n_t. Starting with the monetary policy rule, we have:

$$\hat{R}_t = \phi_\pi \hat{\pi}_t \tag{33}$$

The government budget constraint (23), combined with the linearized version for the fiscal rule (24), yields

$$\hat{b}_t - \hat{R}_t = \varphi_b \hat{b}_{t-1} - \bar{R}\hat{\pi}_t + g_b \bar{R}\hat{g}_t, \qquad \text{for} \qquad \varphi_b \equiv \bar{R}\left(1 - \tau_b \phi_b\right) \tag{34}$$

From the labor supply equation in (12) and aggregate technology, $\hat{y}_t = \hat{h}_t$, we obtain $\widehat{mc}_t = \chi \hat{y}_t$. Log-linearization of the pricing equation (21) gives the New Keynesian Phillips curve:

$$\hat{\pi}_t = \beta_\pi E_t \hat{\pi}_{t+1} + \kappa \chi \hat{y}_t \tag{35}$$

$$\beta_\pi \equiv \beta \bar{\Gamma}, \qquad \kappa \equiv \frac{(1-\theta)(1-\theta\beta_\pi)}{\theta} \tag{36}$$

With respect to the baseline model without temptation, since $\bar{\Gamma} \in (0,1)$ (hence, $\beta_\pi < \beta$), the Phillips curve is steeper - i.e., current inflation responds more to current marginal costs - and less forward-looking.

Moving to the demand side of the model, from the Euler equation (14), we have:

$$\hat{\lambda}_t = E_t \hat{\lambda}_{t+1} + \hat{R}_t - E_t \hat{\pi}_{t+1} + E_t \hat{\Gamma}_{t+1} \tag{37}$$

From its definition in (20), as well as the expressions for $\tilde{\lambda}_t$ and λ_t, the last term in (37) is

$$E_t \hat{\Gamma}_{t+1} = -\varkappa E_t \left(\widehat{\tilde{\lambda}}_{t+1} - \hat{\lambda}_{t+1} \right), \qquad \text{for} \qquad \varkappa \equiv \frac{\xi \overline{\tilde{f}}^{-\eta}}{\bar{\Delta}\bar{f}^{-\sigma} + \xi\left(\bar{\Delta}\bar{f}^{-\eta} - \overline{\tilde{f}}^{-\eta}\right)} > 0, \tag{38}$$

where the sign of the composite parameter $\varkappa$ is a direct consequence of Lemma 1. Log-linearization of the first order condition for consumption in (12) gives

$$\hat{\lambda}_t = \left(\frac{1}{\zeta} - \varphi_f\right)\hat{f}_t - \frac{1}{\zeta}\hat{x}_t, \qquad \text{for} \qquad \varphi_f \equiv \frac{\sigma \bar{f}^{-\sigma} + \xi\eta\bar{f}^{-\eta}}{\bar{f}^{-\sigma} + \xi\bar{f}^{-\eta}} \tag{39}$$

where, from the CES in (4),

$$\hat{f}_t = (1-\psi_m)\,\hat{x}_t + \psi_m \hat{m}_t, \qquad \text{for} \qquad \psi_m \equiv \psi^{\frac{1}{\zeta}} \left(\frac{\bar{m}}{\bar{\bar{f}}}\right)^{\frac{\zeta-1}{\zeta}}. \tag{40}$$

Combining the latter with the log-linearized version of money demand in (15),

$$\hat{m}_t = \hat{x}_t - \zeta_R \hat{R}_t, \qquad \text{for} \qquad \zeta_R \equiv \zeta / \left(\bar{R}-1\right), \tag{41}$$

we can rewrite $\hat{\lambda}_t$ as follows

$$\hat{\lambda}_t = -\varphi_x \hat{x}_t - \varphi_R \hat{R}_t \qquad \text{for} \qquad \varphi_x \equiv \varphi_f, \qquad \varphi_R \equiv \psi_m \left(\frac{1}{\zeta} - \varphi_x\right) \zeta_R \tag{42}$$

Moving on, consider the expression for $\tilde{\lambda}_t = \xi \tilde{f}_t^{-\eta}$. As $\tilde{f}_t = (1-\psi)^{-1} \tilde{x}_t$, its log-linearization gives $\widehat{\tilde{\lambda}}_t = -\eta \widehat{\tilde{x}}_t$, where $\widehat{\tilde{x}}_t$ is obtained from (18)

$$\widehat{\tilde{x}}_t = \vartheta_x \hat{x}_t + \vartheta_m \hat{m}_t + \vartheta_b \left(\hat{b}_t - \hat{R}_t\right), \tag{43}$$

$$\vartheta_n \equiv \frac{(1-\psi)\,\bar{n}}{\bar{\tilde{x}}} \in (0,1)\,, \quad \bar{n} = \bar{x}, \bar{m}, \frac{\bar{b}}{\bar{R}}, \quad \text{with} \quad \sum \vartheta_n = 1 \tag{44}$$

In order to rule out implausible parameterizations - and therefore reduce the number of cases to consider - we impose an additional assumption.[17]

Assumption 3: $\vartheta_m > \vartheta_b$.

Finally, from the definitions of x_t in (5), and market clearing conditions, we obtain:

$$\hat{x}_t = \frac{\mu-1}{\mu\omega} \hat{y}_t - \frac{g_y}{\omega} \hat{g}_t \tag{45}$$

After combining all these equation, we reach the following expression for the aggregate generalized Euler equation (IS curve):

$$\begin{aligned} \hat{y}_t \;=\; & \alpha E_t \hat{y}_{t+1} - \delta_r \left(\hat{R}_t - E_t \hat{\pi}_{t+1}\right) - \delta_R \hat{R}_t \\ & + \gamma_R E_t \hat{R}_{t+1} - \gamma_b E_t \hat{b}_{t+1} + \frac{\left(1-\alpha\rho_g\right) g_y \mu}{\mu-1} \hat{g}_t, \end{aligned} \tag{46}$$

[17] The assumption easily holds for any pameterization of the model matching the gross real interest rate and money velocity observed in the data.

where the composite coefficients in front of endogenous variables are

$$\alpha \equiv 1+\varkappa\left[1-\frac{\eta}{\varphi_x}\left(\vartheta_x+\vartheta_m\right)\right], \tag{47}$$

$$\delta_r \equiv \frac{\mu\omega}{\varphi_x\left(\mu-1\right)}, \qquad \delta_R \equiv \delta_r\varphi_R \tag{48}$$

$$\gamma_R \equiv \delta_r\left[\varphi_R\left(1+\varkappa\right)+\varkappa\eta\left(\vartheta_b+\vartheta_m\zeta_R\right)\right], \qquad \gamma_b \equiv \delta_r\varkappa\eta\vartheta_b. \tag{49}$$

Consider a model without temptation, $\xi = 0$. Using previous expressions, this gives $\varkappa = 0$, which, in turn, yields $\alpha = 1$, $\gamma_R = \delta_R$ and $\gamma_b = 0$. In this case, current output $\hat{y}_t$ responds one-to-one to its future expectation $E_t\hat{y}_{t+1}$ (using a standard terminology in the literature, there is "no discounting" in the Euler equation) and responds negatively to the ex-ante real interest rate $\hat{R}_t - E_t\hat{\pi}_{t+1}$ (with elasticity δ_r), as in the baseline NK model. As money enters non-separably in the utility function, current output also responds to expected changes in the nominal interest rate, $E_t\hat{R}_{t+1} - \hat{R}_t$, with elasticity $\gamma_R = \delta_r\varphi_R$. From the definition of φ_R in (42), since, without temptation, $\varphi_x = \sigma$, such elasticity γ_R is positive (negative) when ζ - the *intratemporal* elasticity of substitution between money m_t and labor-adjusted consumption x_t in the CES aggregator - is smaller (larger) than σ^{-1} - the *intertemporal* elasticity of substitution for the money-consumption aggregate. Clearly, output does not respond to expected nominal interest rate changes when $\zeta = \sigma^{-1}$, which is the case if utility is fully separable (e.g. $\zeta = \sigma = 1$). Finally, since $\gamma_b = 0$, public debt dynamics do not distort consumption choices, and hence do not affect equilibrium output.

With temptation, the New Keynesian equilibrium system is altered in several dimensions. **First**, it is easy to show that, provided temptation utility displays higher risk aversion with respect to commitment, $\eta > \sigma$, the elasticity of output to the expected *real* interest rate, δ_r, is strictly decreasing in ξ, that is, the standard aggregate demand channel of monetary policy transmission weakens. **Second**, temptation affects both the sign and the magnitude of the responsiveness of current output to changes in future expected (with elasticity γ_R) or current (with elasticity δ_R) *nominal* interest rates. Notice that, even if utility was fully separable ($\zeta = \sigma = 1$), there would still be direct distortionary effects of nominal interest rate fluctuations in the Euler equation. **Third**, public debt dynamics become non-neutral for real activity, as they induce *negative* wealth effects on current output (with elasticity γ_b). As shown in the next Section, this particular aspect breaks the standard monetary policy - fiscal policy dichotomy which runs in the baseline New Keynesian model, and therefore influences policy coordination. **Fourth**, the ex-ante expected future output is discounted by the composite coefficient α. Proposition 2 establishes some of its key properties.

Proposition 2 *Assume households' preferences feature temptation, $\xi > 0$, and consider the coefficient α in the generalized Euler equation (46).*

1. *For $\vartheta_b \to 0$, the following properties hold: i) $\alpha \lesseqqgtr 1$ for $\eta \gtreqqless \sigma$; ii) if $\eta > \sigma$, then α is strictly decreasing in ξ and η;*

2. *For $\vartheta_b \in (0,1)$, there exists a threshold $\eta^* > \sigma/(1-\vartheta_b)$ such that $\alpha \lesseqqgtr 1$ for $\eta \gtreqqless \eta^*$. The threshold η^* is strictly increasing in ξ and ϑ_b.*

Proof. See Appendix A.1.3. ■

In the limiting case of $\vartheta_b \to 0$ (no debt in the economy), discounting in the Euler equation ($\alpha < 1$) requires temptation utility v to display more risk aversion than commitment utility u, i.e. $\eta > \sigma$. When that is the case, future output gets discounted more heavily as temptation utility become more important (higher ξ) and/or more risk averse (higher η). With positive bonds supply, the conditions for discounting are stricter. When utilities display equal risk aversion, stronger temptation raises the elasticity of current output to its future level above unity, or, equivalently, we have *negative* discounting ($\alpha > 1$) in the Euler equation. In this case, we actually need temptation to be *sufficiently more risk averse* than commitment ($\eta > \eta^* > \sigma$) for α to drop below unity. It follows that a necessary (but not sufficient) conditions for discounting in the Euler equation is that temptation utility v features higher risk aversion than commitment utility u.[18]

5 Policy Coordination and Equilibrium Multiplicity

We revisit the classic question of how monetary and fiscal policy rules should be coordinated to induce a (locally) determinate Rational Expectations Equilibrium (REE).

Plugging the interest rate rule (33) into (34), public debt evolves as follows:

$$\hat{b}_t = \varphi_b \hat{b}_{t-1} + \varphi_\pi \hat{\pi}_t + g_b \bar{R} \hat{g}_t, \qquad \text{for} \qquad \varphi_\pi \equiv \phi_\pi - \bar{R} \tag{50}$$

Before showing numerical results for the general model, we consider the case of a flexible price economy for which clear-cut analytical results are attainable. Setting the Calvo probability θ

[18] Airaudo (2020) discusses in full details the underlying economic intuition linking discounting to risk aversion in temptation, as well as the theory and experimental evidence in its support.

equal to zero, the Phillips curve (35) gives $\hat{y}_t = 0$ in every period, and hence $E_t \hat{y}_{t+1} = 0$ as well. These, together with the monetary policy rule (33) and the generalized Euler equation (46), yield a difference equation for inflation:

$$E_t \hat{\pi}_{t+1} = \frac{(\delta_r + \delta_R)\, \phi_\pi}{\delta_r + \gamma_R \phi_\pi - \gamma_b \varphi_\pi} \hat{\pi}_t + \frac{\gamma_b \varphi_b}{\delta_r + \gamma_R \phi_\pi - \gamma_b \varphi_\pi} \hat{b}_t, \tag{51}$$

where $\hat{b}_t$ evolves according to (50), where, without loss of generality for the purpose of the determinacy analysis, we can set $\hat{g}_t = 0$.

To better appreciate the contribution, it is worth looking back at the baseline case without temptation preferences, $\xi = 0$. To rule out distortionary wealth effects induced by non-separability between the consumption-labor composite x_t and money m_t in utility, suppose $\sigma = 1$ and $\zeta \to 1$ (utility is log-separable between x and m). As one can see from (42), by making $\varphi_x = 1$, this assumption guarantees that the marginal utility $\hat{\lambda}_t$ does not depend directly on the nominal interest rate, making the model isomorphic to Leeper (1991).[19] As Proposition 3 shows, Leeper's stark dichotomy applies: determinacy of REE require either an *active monetary/passive fiscal* (AM/PF) regime or a *passive monetary/active fiscal* (PM/AF) regime. In the AM/PF, the central bank strongly responds to inflationary pressure in setting the short-term nominal interest rate - i.e., $\phi_\pi > 1$ in (33) - while the fiscal authority sets taxes such that real government debt does not explode, for any path of inflation - i.e. ϕ_b is such that $\varphi_b \in (0, 1)$ in (34). The PM/AF sees instead the central bank responding weakly to inflation - i.e. $\phi_\pi \in [0, 1)$ - and the fiscal authority setting taxes without being concerned about intertemporal solvency under all circumstances - i.e. it allows $\varphi_b > 1$.[20]

Proposition 3 *Consider a flexible price economy ($\theta = 0$) without temptation preferences ($\xi = 0$), and a utility function separable between the consumption-labor composite and money ($\sigma = 1$ and $\zeta \to 1$). Moreover, assume that $\phi_b < \frac{1+\bar{R}}{\bar{R}\tau_b}$.*[21] *The following results apply.*

[19] A non-separable utility function can lead to a failure of the Taylor principle by iteself if consumption and money are Edgeworth substitute in utility, i.e. $\frac{\partial^2 u_t}{\partial x_t \partial m_t} < 0$ (see Benhabib et al., 2001). Under the CRRA-CES specification adopted in this paper, this occurs when $\sigma > \zeta^{-1}$.

[20] The same conditions apply to the case of price rigidities. This is because, in the baseline New Keynesian model without temptation the aggregate demand/aggregate supply block (the Euler equation and the Phillips curve) does not depend on the dynamics of debt.

[21] This assumption is easily satisfied as, for any realistic calibration, the threshold $\frac{1+\bar{R}}{\bar{R}\tau_b}$ is rather large. For instance, for the post-WWII period in the U.S., the average government spending to GDP ratio, g_y, is about 0.18, while the average debt to GDP ratio, b_y, is about 0.4 annual, or, equivalently, 1.6 quarterly. This implies that $g_b = \frac{0.18}{1.6} = 0.11$.

i. *The REE is locally* ***determinate*** *in either one of the following cases: a)* $0 \leq \phi_\pi < 1$ *and* $0 \leq \phi_b < \frac{\bar{R}-1}{\bar{R}\tau_b}$ ***(PM/AF regime)****; b)* $\phi_\pi > 1$ *and* $\phi_b > \frac{\bar{R}-1}{\bar{R}\tau_b}$ ***(AM/PF regime)****.*

ii. *The REE is locally* ***indeterminate*** *when* $0 \leq \phi_\pi < 1$ *and* $\phi_b > \frac{\bar{R}-1}{\bar{R}\tau_b}$ ***(PM/PF regime)****.*

iii. *There is no stationary REE (i.e., the equilibrium is* ***explosive****) when* $\phi_\pi > 1$ *and* $0 \leq \phi_b < \frac{\bar{R}-1}{\bar{R}\tau_b}$ ***(AM/AF regime)****.*

Proof. See Appendix A.1.4. ■

The economic intuition for these results is well-known. Consider the AM/PF regime. From (51), we simply have $E_t\hat{\pi}_{t+1} = \phi_\pi \hat{\pi}_t$: by setting $\phi_\pi > 1$, the central bank guarantees that inflation will stay at target ($\hat{\pi}_t = 0$) as i) any positive deviation will make the central bank *blow the economy away* (leading to hyperinflation), which would then falsify the existence of a bounded equilibrium; and ii) any negative deviation will lead to hyperdeflation and eventually to negative prices.[22] With inflation always stabilized by monetary policy, the fiscal authority ensures that real debt does not explode: by setting $\phi_b > \frac{\bar{R}-1}{\bar{R}\tau_b}$, it guarantees that $\varphi_b \in (0,1)$. In the PM/AF regime instead, inflation determination follows a fiscal theory of the price level (FTPL) logic. Given any initial belief-driven deviation from target, inflation will always revert back to steady state, as $0 \leq \phi_\pi < 1$. This indeterminacy is solved by fiscal policy. Given initial debt $\hat{b}_{t-1}$, the lack of sufficient fiscal feedback requires that $\hat{\pi}_t = -\frac{\varphi_b}{\varphi_\pi}\hat{b}_{t-1}$ to rule out diverging debt dynamics.

With temptation, the dichotomy vanishes, and the monetary-fiscal policy mix leading to equilibrium determinacy is more complex. Proposition 4 presents analytical results for the flexible price economy case.

Proposition 4 *Consider a flexible price economy with* $\sigma = 1$ *and* $\zeta \to 1$*, where the representative household is subject to temptation,* $\xi > 0$*, with risk aversion* $\eta = 1$*. Moreover, assume that* $\phi_b < 1$*.*[23] *There, there exists thresholds* ξ_h *and* ξ_l *for temptation,* ϕ_b^* *and* ϕ_b^{**} *for the fiscal rule (both smaller than* $\frac{\bar{R}-1}{\bar{R}\tau_b}$*), and* $\bar{\phi}_\pi$ *for the Taylor rule, such that the REE is locally determinate under the following conditions.*

Hence, for $\bar{R} = 1.01$ (or, $\beta = 0.99$), we have $\tau_b \approx 0.12$, and then $\frac{1+\bar{R}}{\bar{R}\tau_b} \approx 16.2$, while empirical estimates of ϕ_b are below unity.

[22] Once again, we are ignoring the possibility of deflationary paths converging to a low steady state equilibrium, as highlighed by Benhabib et al. (2002). Cochrane (2011) argues that hyperinflationary paths should not be rule out *a priori* as they do not violate any transversality conditions.

[23] This assumption allows us to focus on empirically relevant cases.

1. *When $\xi \in (0, \xi_l)$ **(weak temptation)**: a) for $\phi_b \in [0, \phi_b^*)$ and $0 < \phi_\pi < \bar{\phi}_\pi$, where $\bar{\phi}_\pi > 1$ is strictly increasing in ϕ_b, with $\lim_{\phi_b \to \phi_b^*} \bar{\phi}_\pi = +\infty$; b) for $\phi_b \in (\phi_b^*, \phi_b^{**})$ and any $\phi_\pi \geq 0$; and c) for $\phi_b > \phi_b^{**}$ and $\phi_\pi > \bar{\phi}_\pi > 0$, where $\bar{\phi}_\pi$ is strictly increasing in ϕ_b and $\bar{\phi}_\pi > 1$ for $\phi_b > \frac{\bar{R}-1}{\bar{R}\tau_b}$.*

2. *When $\xi \in (\xi_l, \xi_h)$ **(intermediate temptation)**: a) for $\phi_b \in [0, \phi_b^{**}]$ and any $\phi_\pi \geq 0$; and b) for $\phi_b > \phi_b^{**}$, and $\phi_\pi > \bar{\phi}_\pi > 0$, where $\bar{\phi}_\pi$ has the same properties in 1.c.*

3. *When $\xi > \xi_h$ **(high temptation)**: for $\phi_b \in [0, \phi_b^*)$ and $\phi_\pi > \max\{0, \bar{\phi}_\pi\}$, where $\bar{\phi}_\pi$ is strictly increasing in ϕ_b with $\lim_{\phi_b \to \phi_b^*} \bar{\phi}_\pi = +\infty$.*

Proof. See Appendix A.1.5. ■

Although the determinacy conditions stated in Proposition 4 appear less clear-cut than those characterizing the baseline model without temptation, by close inspection, two key results emerge (see also Figure 1 for a visual representation).

1. It is possible to have a determinate equilibrium also under an *active monetary/active fiscal* (AM/AF) regime: i.e. for $\phi_\pi > 1$ and $\phi_b < \frac{\bar{R}-1}{\bar{R}\tau_b}$ (for which, as stated in Proposition 3, no stationary equilibrium exists in a model without temptation). In this regime, monetary policy is subject to an upper bound $\bar{\phi}_\pi$ (this is particularly the case when temptation is weak, statement 1.) which becomes less binding as the degree of temptation ξ increases (indeed there is no such upper bound for the case of intermediate temptation, statement 2.), and fiscal policy responds more aggressively to debt, higher ϕ_b.

2. Under a *passive fiscal* policy, $\phi_b > \frac{\bar{R}-1}{\bar{R}\tau_b}$, an *active monetary* policy does not guarantee uniqueness: the monetary policy's response to inflation has to be sufficiently larger than unity, $\phi_\pi > \bar{\phi}_\pi > 1$ (re-inforced Taylor Principle), with $\bar{\phi}_\pi$ increasing both in ξ and ϕ_b.

The rationale behind these results is as follows. Suppose the economy is in the AM/AF regime. With debt $\hat{b}_t$ growing at rate $\varphi_b > 1$, for a unique stable REE to exists inflation $\hat{\pi}_t$ needs to guarantee intertemporal fiscal solvency, as dictated by the FTPL logic. Hence, it has to be the case that, despite monetary policy being active, the inflation dynamics are not diverging from target, otherwise $\hat{\pi}_t$ will be pinned down by the Euler equation. To see whether this is the case, suppose that agents expect current inflation $\hat{\pi}_t$ to positively deviate from target, say by 1%. With $\sigma = \eta = 1$ and $\zeta \to 1$, full price flexibility combined with $\hat{g}_t = 0$ gives $\hat{\lambda}_t = -\hat{x}_t = 0$ (from equations (42) and

(45)), as well as $E_t\hat{\Gamma}_{t+1} = \varkappa E_t\widehat{\hat{x}}_{t+1}$ (from setting $\hat{\lambda}_{t+1} = 0$ and $\widehat{\hat{\lambda}}_{t+1} = -\widehat{\hat{x}}_{t+1}$ in equation (38)). From the Euler equation (14), we obtain a modified Fisher equation:

$$\hat{R}_t = E_t\hat{\pi}_{t+1} - \varkappa E_t\widehat{\hat{x}}_{t+1} \tag{52}$$

As previously discussed, absent temptation, the composite coefficient $\varkappa$ would be null and the Fisher equation (52) would yield unstable inflation dynamics: namely, $E_t\hat{\pi}_{t+1} = \phi_\pi\hat{\pi}_t > \hat{\pi}_t$ - making $\hat{\pi}_t = 0$ the only stationary equilibrium. As debt would grow without limit, there would not exists a stationary equilibrium in this case, making the active monetary/active fiscal combination not desirable.

With temptation, the Fisher equation is distorted by the (expected) future tempting option, $E_t\widehat{\hat{x}}_{t+1}$. As the latter depends positively on expected real money balances, $E_t\hat{m}_{t+1}$, and the expected market value of bonds, $E_t\left(\hat{b}_{t+1} - \hat{R}_{t+1}\right)$ (see equation (43)), the right hand side of (52) is strictly increasing in expected inflation $E_t\hat{\pi}_{t+1}$, with an elasticity larger than unity.[24] It follows that, with $\hat{R}_t$ increasing by more than 1% (as monetary policy is active), expected inflation will have to increase to satisfy (52), but *not by more than* 1%, unless the response coefficient ϕ_π is large enough. Hence, with the inflation dynamics reverting back to target - that is, $0 < E_t\hat{\pi}_{t+1} < \hat{\pi}_t$ - current inflation $\hat{\pi}_t$ is still determined by the FTPL, and debt is not explosive.

In the AM/PF regime the logic is reversed, and an active monetary policy is instead not sufficient for determinacy. With fiscal policy guaranteeing debt stability under all circumstances, determinacy requires inflation to diverge from target in expectations. However, as just argued, setting ϕ_π above unity might not suffice. The central bank will have to adhere to a re-inforced Taylor principle in order to make the inflationary dynamics implied by the Fisher equation (52) explosive.

Figure 1 provides a visual representation of the results stated in Propositions 3 and 4 for a baseline parameterization of the model. As stated in both propositions, we set $\sigma = 1$ and $\zeta \to 1$, such that commitment utility u_t is log-separable between x_t and m_t, a money-in-the-utility function specification commonly used in the literature.[25] . The risk aversion in temptation is assumed to be unitary as well: $\eta = 1$.[26] The labor disutility parameter χ is set equal to 1 (hence,

[24] Under the Taylor rule, $\partial\hat{m}_{t+1}/\partial\hat{\pi}_{t+1} = -\zeta_R\phi_\pi$, while, from the government budget, $\partial\left(\hat{b}_{t+1} - \hat{R}_{t+1}\right)/\partial\hat{\pi}_{t+1} = -\bar{R}$.

[25] This specification is also supported by Holman (1998) who cannot reject the null hypothesis of a log Cobb-Douglas specification on U.S. data.

[26] Macroeconomic models making use of Gul-Pesendorfer preferences have often assumed equal risk aversion in

a unitary elasticity of labor supply to the real wage), which is somewhat intermediate between the macro-based and micro-based empirical evidence on labor supply. Empirical estimates for the intratemporal elasticity of substitution across intermediate goods, ϵ, typically range between 5 and 11. We choose the intermediate value 8, giving a steady state net price mark-up of about 14 percent. For what concerns fiscal variables, we refer to post-1950 U.S. data. This gives a steady state government spending share of GDP, $g_y \equiv \bar{g}/\bar{y}$, equal to 18 percent, and a net debt-to-GDP ratio equal to 40 percent at annual frequency, which translates to $b_y \equiv \bar{b}/\bar{y} = 1.6$ in our quarterly model.[27] We pick ψ to match an annualized money velocity equal to 1.8, as observed in long-run U.S. data. We choose the subjective discount factor β such that the steady state net real interest rate equal 1% quarterly (hence, 4% annualized). In the figure, we let ξ range between 0 and 0.3. The GMM estimation of an aggregate generalized Euler equation by Huang et al. (2015) has temptation ξ ranging between 0 to 0.2. For each alternative parameterization of ξ, we re-calibrate β to keep the annualized real interest rate at 4%. This implies that *de facto* the reduced form coefficient β_π and κ in the Phillips curve (35) take the same values as in a baseline New Keynesian model without temptation.[28]The Calvo probability θ is set equal to 0.75, implying an expected price duration of 4 quarter.[29]

The REE is locally determinate in the white areas, locally indeterminate in the light grey areas, and explosive (no stationary equilibrium exists) in the dark grey areas. Panel a) corresponds to the baseline model without temptation. As discussed, Leeper's dichotomy applies: the REE is locally determinate for either an AM/PF or a PM/AF regime. Under the baseline parameterization, the switch occurs at $\phi_b = \frac{\bar{R}-1}{\bar{R}\tau_b} \approx 0.08$.

Temptation breaks the AM/PF versus PM/AF dichotomy. When temptation is weak ($\xi = 0.05$, panel b.), the area yielding an explosive equilibrium shrinks, opening the possibility of equilibrium determinacy under an active monetary policy even though fiscal policy is active as well. However, this may require monetary policy to be not too aggressive in fighting inflation, i.e. $\phi_\pi < \bar{\phi}_\pi$. This

commitment and temptation (see Huang et al., 2015, and Krusell et al., 2010, for instance). Motivated by some indirect experimental evidence, Airaudo (2020) assumes agents feature higher risk aversion in temptation. Gul and Pesendorfer (2004) and Airaudo (2019) study the asset pricing implications of "risk loving" behavior under temptation.

[27]This accounts for the fact that part of U.S. Treasury debt is held by other government institutions, such as the Social Security Administration and the Federal Reserve.

[28]In other words, in the reduced form equilibrium, firms discount future profits at the (steady state) market real interest rate $\bar{R} = 1.01$.

[29]We find close to zero sensitivity to θ, as long as we do not impose complete stickiness ($\theta = 1$). Hence, our results are robust to lowering θ (say, to $\theta \approx 2/3$, as in Bils and Klenow, 2004), or raising θ (say, to $\theta = 0.85$, as in Christiano et al., 2011).

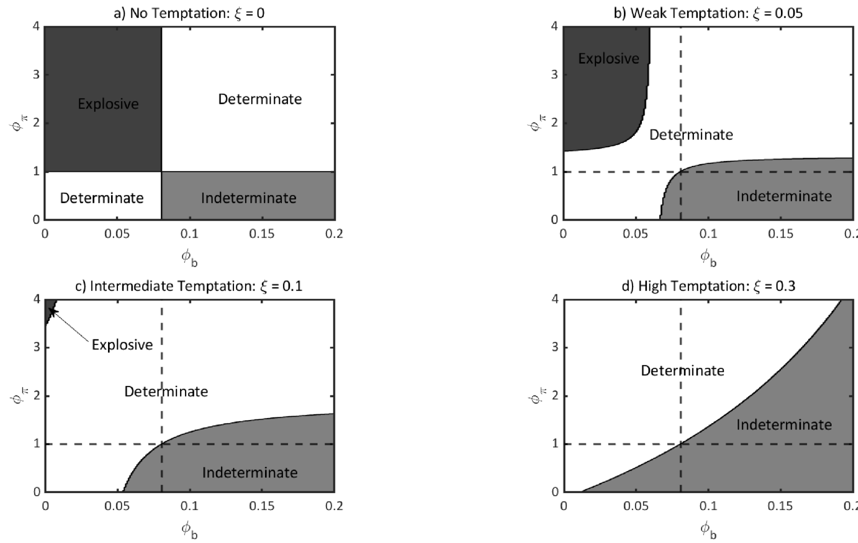

Figure 1: Equilibrium Determinacy. Visual representation of Propositions 3 and 4. The REE is determinate (white area), indeterminate (light grey area), or explosive (dark grey area). Dashed lines highlight four separate quadrants for the case without temptation (as displays in panel a.).

constraint appears to be tight for very small values of ϕ_b - e.g. for $\phi_b = 0$, we need $\phi_\pi < 1.4$ - but much less so for higher values (ϕ_π gets extremely large as ϕ_b approaches $\phi_b^* \approx 0.06$). For ϕ_b larger than that, monetary policy has to be sufficiently aggressive against inflation, i.e. $\phi_\pi > \bar{\phi}_\pi$, with the latter surpassing unity as we move into the passive fiscal policy regime. Stronger temptation significantly reduces the possibility of explosive equilibria (non-existence). Panel c) shows that for $\phi_b \in (0.01, 0.05)$, local determinacy occurs irrespective of the responsiveness to inflation. In particular, local determinacy also occurs for an AM/AF regime. As temptation gets larger ($\xi = 0.3$, panel d.), the lower bound on ϕ_π grows exponentially in ϕ_b. In this case, when fiscal policy is passive, determinacy requires a re-inforced Taylor principle, as long as $\phi_b < \phi_b^* \approx 0.4$.

Next, we consider a fully-fledged sticky price model subject to intermediate temptation ($\xi = 0.1$), and pursue some sensitivity analysis with respect to some key structural parameters. The results are displayed in Figure 2. Panel a) shows that the introduction of price stickiness does not alter the main message: the policy combinations for which the equilibrium displays determinacy, indeterminacy, or explosiveness are identical to those displayed in panel c) of Figure 1.[30] As the remaining panels show (all of them feature $\xi = 0.1$ and $\theta = 0.75$), while, qualitatively, the results

[30] This irrelevance of price stickiness for determinacy/indeterminacy also applies to the baseline model without temptation.

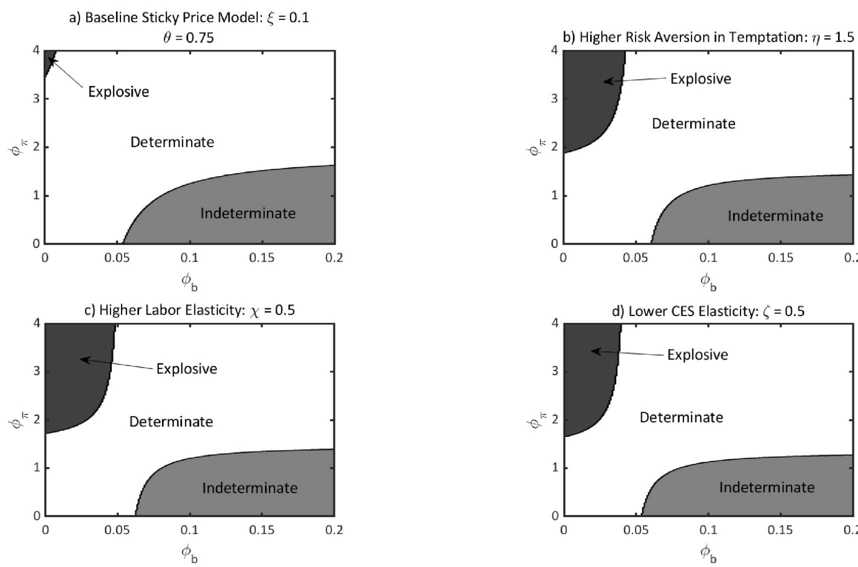

Figure 2: Equilibrium Determinacy under Sticky Prices: Sensitivity Analysis. The REE is determinate (white area), indeterminate (light grey area), or explosive (dark grey area).

are robust, the equilibrium determinacy region shrinks as we allow for higher risk aversion in temptation (panel b.), higher labor supply elasticity (panel c.), and lower elasticity between x and m in the CES aggregator (panel d.).

6 Fiscal Policy Transmission

In this section we study how temptation affects the transmission of fiscal policy shocks both in the AM/PF and PM/AF policy regimes. For what concerns the former, we are interested in whether the model can generate a government spending multiplier for output larger than unity (hence, a positive spending multiplier for consumption), without requiring implausibly large degrees of price rigidity. Then, we highlight how temptation amplifies the fiscal theory of the price level logic driving inflation in the PM/AF regime.

6.1 Spending Multipliers in the AM-PF Regime

In a determinate equilibrium, output and inflation are linear functions of past debt and government spending:

$$\hat{y}_t = \Upsilon_{y,b}\hat{b}_{t-1} + \Upsilon_{y,g}\hat{g}_t \tag{53}$$

$$\hat{\pi}_t = \Upsilon_{\pi,b}\hat{b}_{t-1} + \Upsilon_{\pi,g}\hat{g}_t, \tag{54}$$

where the linear coefficients $\Upsilon_{i,j}$, for $i = y, \pi$ and $j = b, g$, depend on both structural and policy parameters.[31] Following the related literature, the government spending multiplier is defined as the percentage increase in output following a 1% of output increase in government spending. In terms of our notation, around the steady state, the multiplier is:

$$\frac{\partial y_t}{\partial g_t} = \frac{\bar{y}}{\bar{g}}\frac{\partial \hat{y}_t}{\partial \hat{g}_t} = \frac{\Upsilon_{y,g}}{g_y} \tag{55}$$

Accordingly, the multiplier for private consumption is instead:

$$\frac{\partial c_t}{\partial g_t} = \frac{\bar{c}}{\bar{g}}\frac{\partial \hat{c}_t}{\partial \hat{g}_t} = \frac{\bar{c}}{\bar{g}}\left(\frac{\bar{y}}{\bar{c}}\frac{\partial \hat{y}_t}{\partial \hat{g}_t} - \frac{\bar{g}}{\bar{c}}\right) = \frac{\Upsilon_{y,g}}{g_y} - 1 \tag{56}$$

It follows that for the government spending multiplier of output to be larger than unity we need consumption to increase in response to a government spending shock.

Figure 3 plots both multipliers as functions of temptation coefficient ξ, for three alternative degrees of price stickiness. We have fixed the monetary policy coefficient ϕ_π and the fiscal feedback coefficient ϕ_b equal to, respectively, 2 and 0.1, so that, as we vary ξ, we remain well inside the determinate AM/PF region. Consider first the baseline New Keynesian model with $\xi = 0$. As well known, under a GHH utility, it is possible to have private consumption respond positively to government spending, provided prices are sufficiently sticky. In the context of our model, this would require a Calvo probability θ of at least 0.87. The introduction of temptation greatly helps to generate a positive multiplier for consumption. We find that consumption responds positively to public spending for ξ larger than, about, 0.09 (in the baseline model with $\theta = 0.75$), 0.07 (for $\theta = 0.8$), and 0.02 (for $\theta = 0.85$, the degree of rigidity used in Christiano et al., 2011).

To build an intuition for this result, it is worth reviewing the role of GHH preferences and price rigidity in the baseline model without temptation. As extensively discussed in the related literature, it is hard to make consumption respond positively to government spending under standard utility

[31] In the baseline NK model without temptation, in the AM/PF regime, $\Upsilon_{\pi,b} = \Upsilon_{y,b} = 0$, as debt dynamics do not feed back into the Euler equation and the Phillips curve.

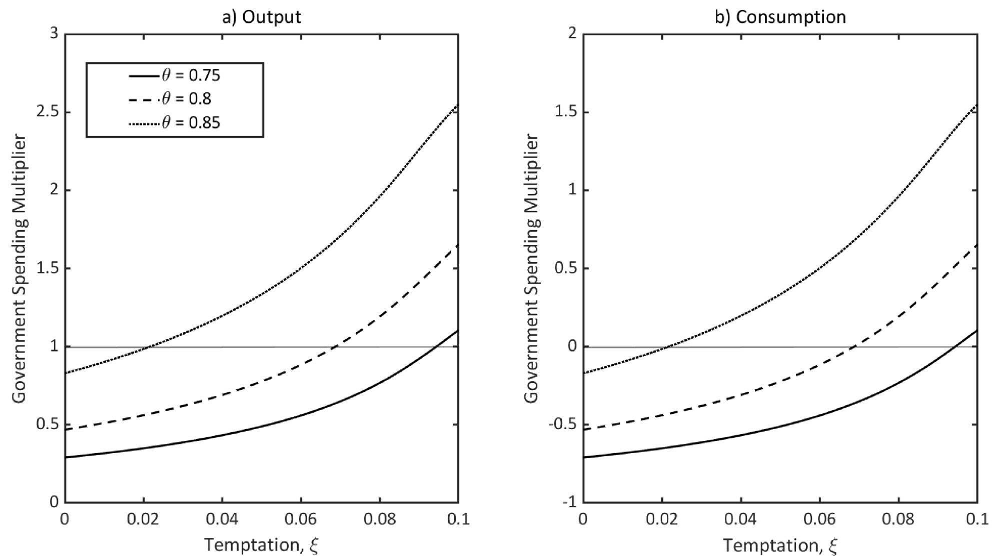

Figure 3: Government Spending Multipliers for Output and Consumption.

specifications.[32] Following an expansionary fiscal policy, households suffer a negative wealth effect driven by an expected increase in the present discounted value of future taxes. With standard preferences (e.g. King-Plosser-Rebelo, or MaCurdy utility functions), this drives down consumption, which in turn makes the labor supply curve shift outward: households are willing to work more as the marginal utility of consumption becomes larger. Under *flexible prices*, labor demand by firms stays still: the government spending generated increase in demand is entirely accommodated by price increases. As a result, along a flexible price equilibrium, wages drop, while hours (hence output) increase. On the contrary, with *sticky prices*, labor demand shifts rightward. While this will surely hamper the increase in hours worked, an increase in wages requires an unrealistically large degree of price rigidity in order to induce a sufficiently large shift in labor demand.

GHH preferences facilitate the process by insulating labor supply from the aforementioned negative wealth effect So, when a government spending increase occurs, labor supply stays still, while labor demand shifts outward. This necessarily creates an increase in both wages and hours (hence, larger labor income), which, if sufficiently large, can counteract the expected increase in taxation, and therefore make private consumption increase.

Nevertheless, as Figure 3 shows, high price rigidity and GHH utility combined may not suffice.

[32] By standard we mean utility functions where consumption and labor (or leisure) enter separably, or more general King-Plosser-Rebelo specifications. See Auclert and Ronglie (2017) for detailed comparrison between GHH and standard consumption-labor separable utility specifications for what concerns the magnitude of multipliers.

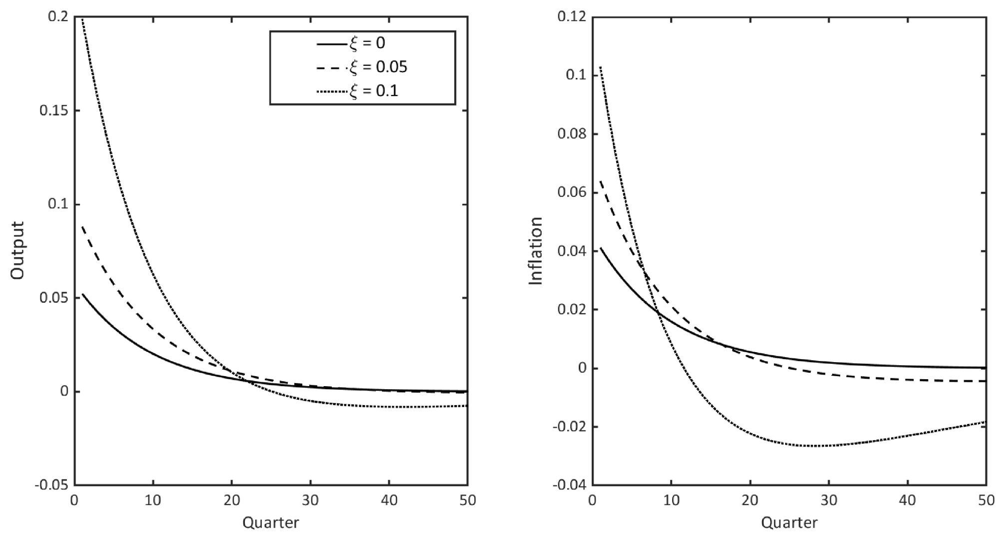

Figure 4: Government Spending Shock in the AM/PF Regime. Impulse responses of output (left panel) and inflation (right panel) to 1% increase in goverment spending with respect to steady state, for three alternative parameterizations of temptation.

Temptation creates the additional boost since households, besides consumption, also seek to smooth intertemporally the costs of self-control. Two complementary channels are at work. On the hand, with the GHH utility-driven increase in labor income allowing higher *temptation consumption*, in the attempt to keep *current* costs of self control contained, households increase their level of *commitment consumption* by responding less to the anticipated future fiscal burden. On the other hand, as the latter implies fewer resources to spend in the next period, households foresee a decline in the future costs of self-control. As the marginal benefits from saving diminish, the incentives to consume more today get further amplified.

Figure 4 plots the inflation and output responses to a 1% increase in government spending for three alternative degrees of temptation, keeping all other parameters at baseline values. Overall, we find that an increase in ξ amplifies the economy's on-impact response to a fiscal expansion. For what concerns output, the amplifying effect is due to the positive impact of temptation on consumption, as just discussed. The on-impact response of inflation to $\hat{g}_t$ is also increasing in ξ as a larger increase in output drives up marginal costs, and hence inflation via the Phillips curve.

6.2 Fiscalist Inflation in the PM-AF Regime

Even without temptation, in the PM/AF regime, inflation is a fiscal phenomenon: its equilibrium law of motion is given by equation (54), where both $\Upsilon_{\pi,b}$ and $\Upsilon_{\pi,g}$ are positive for any realistic parameterization of the model.[33] Suppose the economy starts off with debt above its steady state level, $\hat{b}_{t-1} > 0$. Because of an active fiscal policy, higher debt is unmatched by an offsetting increase in the present discounted value of future taxes. As bonds are perceived as net wealth, households experience a positive wealth effect. Private consumption increases, and so does inflation. A positive shock to government spending is also inflationary, as it leads to debt accumulation which is not compensated by an increase in taxes.

Temptation strengthens this fiscal channel. Setting $\phi_\pi = 0.8$ and $\gamma = 0.025$, Figure 5 plots both $\Upsilon_{\pi,b}$ and $\Upsilon_{\pi,g}$ as functions of ξ, for different degrees of price rigidity. Both coefficients are monotonically increasing in the degree of temptation, with the effect being stronger when prices are more rigid. Notice that for the case of complete price flexibility ($\theta = 0$), raising temptation from 0 to 0.1 doubles $\Upsilon_{\pi,b}$ and increases $\Upsilon_{\pi,g}$ by about 60%. With temptation, a larger $\hat{b}_{t-1}$ makes the household more tempted to liquidate his wealth for the purpose of immediate consumption. To smooth the increasing cost of self-control, the household saves and consume more today. This wealth effect, combined with the one coming from the FTPL channel, puts further upward pressure on prices. The amplification of temptation in the PM/AF regime is also evident in the responses of output and inflation to a 1% government spending shock, as displayed in Figure 6.

7 Conclusions

In an important contribution to economic theory, Gul and Pesendorfer (2001, 2004) axiomatize temptation with (dynamic) self-control preferences to account for the well-documented existence of preference reversals in individual consumption choices. In Airaudo (2020), we show these behavioral preferences can be easily incorporated into a baseline New Keynesian DSGE model to yield discounting in the (linearized) Euler equation, and therefore solve the forward guidance puzzle of monetary policy. Although that work points out how, by breaking Ricardian equivalence, temptation preferences induce wealth effects of bond holdings on real activity, it does not fully characterize

[33] Although it is possible to find analytical expressions for both Υ_b and Υ_g, the expressions are rather convoluted. We therefore restrict to a numerical analysis. Bhattarai et al. (2014) provide a full analytical characterization of these coefficients.

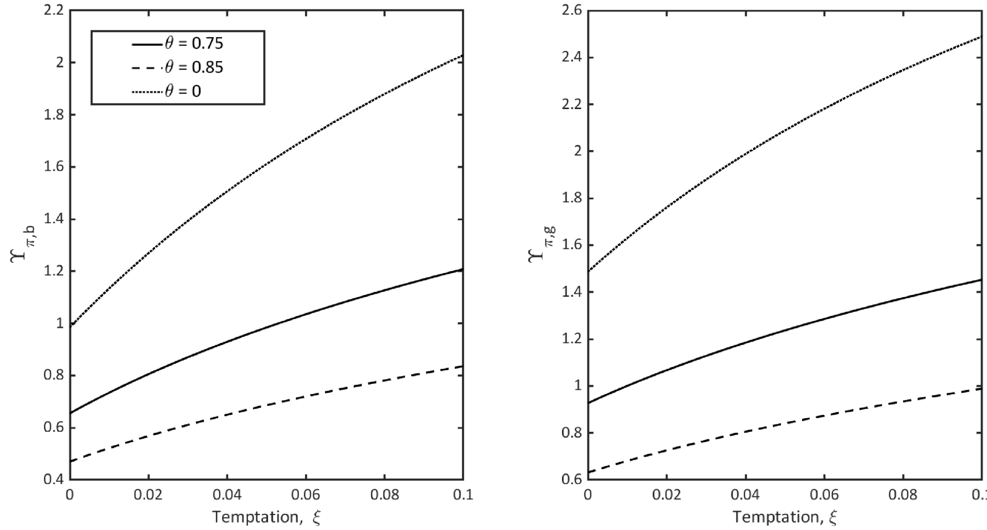

Figure 5: Fiscalist Inflation and Temptation. Passive Monetary/Active Fiscal Regime: under determinacy, $\hat{\pi}_t = \Upsilon_b \hat{b}_{t-1} + \Upsilon_g \hat{g}_t$. Figure plots Υ_b and Υ_g as functions of ξ, for different degrees of price stickiness.

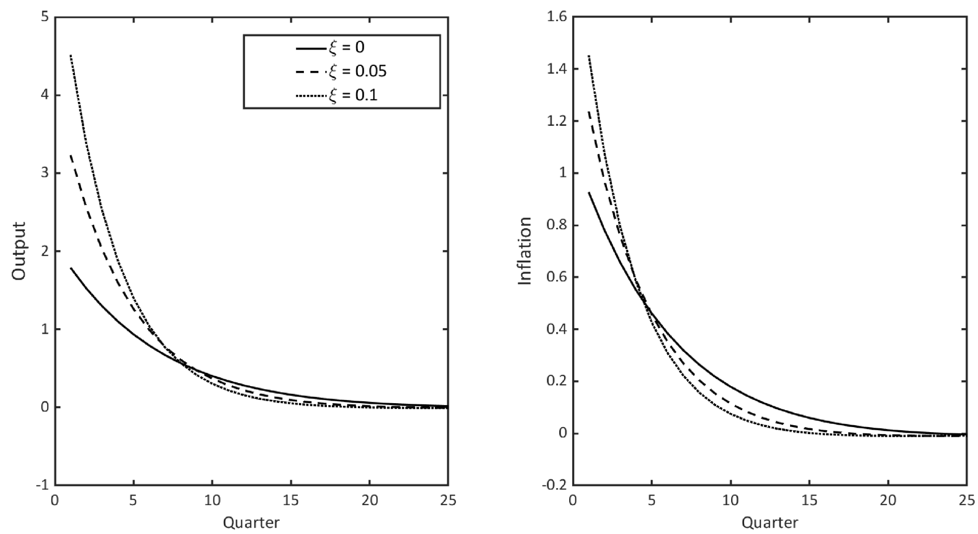

Figure 6: Government Spending Shock in the PM/AF Regime. Impulse responses of output (left panel) and inflation (right panel) to 1% increase in goverment spending with respect to steady state, for three alternative parameterizations of temptation.

the stabilizing properties of monetary-fiscal policy rules (hence, their coordination), as well as the transmission of government spending shocks.

We pursue both tasks in this paper. For what concerns the former, we show that temptation preferences break Leeper (1991) monetary-fiscal dichotomy according to which a (locally) unique rational expectations equilibrium requires either an active monetary/passive fiscal or passive monetary/active fiscal policy mix. In particular, we show temptation preferences i) reduce size of the policy space giving explosive debt dynamics (a unique REE may occur also when both monetary and fiscal policy are active), but ii) increase the scope for equilibrium multiplicity (indeterminacy becomes possible also in Leeper's dichotomous AM/PF and PM/AF regimes). With respect to impact of fiscal shocks, we find that temptation preferences can help generating a government spending multiplier for output larger than unity (hence, a positive spending multiplier for consumption), without requiring implausibly large degrees of price rigidity. Moreover, they amply the effects of fiscal variables on inflation for policy configurations where the fiscal theory of the price level prevails.

These results are interesting from both a normative and positive perspective. On the normative side, they show the existence of temptation in decision making requires closer coordination between monetary and fiscal policy for aggregate stability: how responsive the central bank should be toward inflation depends on how aggressive the fiscal authority is in stabilizing debt. This is not the case under no-temptation preferences whereby the extent to which monetary policy is either passive or active does not matter as long as it is appropriately coordinated with fiscal policy.

On the positive side, they might have stark implications for the identification of policy regimes in the data. While there appears to be a consensus on the fact that monetary policy shifted from passive to active across the late 70s/early 80s years (the pre-post Volcker structural break), the evidence for fiscal policy is less conclusive. If one dislikes the sunspot-based explanation of economic fluctuations, common practice in the estimation of New Keynesian DSGE models is to assume a synchronized switch of fiscal policy from active to passive across the same time threshold. With temptation, this is no longer necessary: a unique stationary REE still exists even if the fiscal authority fails to stabilize debt throughout the entire sample (it is permanently active), and monetary policy switches from (moderately) active to passive (or viceversa). Unless monetary policy is excessively aggressive, unstable aggregate dynamics cannot occur. As a result, one does not need to assume private agents expect a switch to either the AM/PF or the PM/AF regime to guarantee a globally stationary solution, as done in Bianchi and Ilut (2017) and Bianchi and Melosi (2019). Obviously this requires a joint estimation of the extent and curvature of temptation preferences (ξ and η, in our notation) and policy parameters. We are currently pursuing this in an ongoing research project.

A Appendix

A.1 Proofs

A.1.1 Proof of Lemma 1

The proof involves three parts.

PART I. From the fact that $h_t = \tilde{h}_t$, it immediately follows that:

$$\begin{aligned} \tilde{x}_t &= x_t + \tilde{c}_t - c_t \\ &= x_t + m_t + \frac{b_t}{R_t} - \tilde{m}_t \end{aligned}$$

where the second equality follows from equation (8) for the optimal level of consumption under temptation, and the budget constraint (1). Using the money demand condition for temptation (7), after simple rearrangement of terms, we find $\tilde{x}_t = (1-\psi)\left(x_t + m_t + \frac{b_t}{R_t}\right)$.

PART II. We are going to prove $\tilde{x}_t \geq x_t\,(\Delta_t)^{\zeta}$ for any parameterization of the model. Substituting the expression for money demand (15) into (18), the inequality is equivalent to

$$x_t\left[1-\psi+\psi\left(\frac{R_t}{R_t-1}\right)^{\zeta}\right]+(1-\psi)\,\frac{b_t}{R_t}\geq x_t\,(\Delta_t)^{\zeta}. \tag{A.1}$$

Recalling the definition of Δ_t in (16), since $\frac{b_t}{R_t} \geq 0$, for (A.1) to hold, it is sufficient to show that $\left[1-\psi+\psi\left(\frac{R_t}{R_t-1}\right)^{\zeta}\right] \geq \left[1-\psi+\psi\left(\frac{R_t}{R_t-1}\right)^{\zeta-1}\right]^{\frac{\zeta}{\zeta-1}}$ (*), for any $\psi \in [0,1)$ and $\zeta > 0$, with $\frac{R_t}{R_t-1} > 1$. Letting $LHS\,(\psi)$ and $RHS\,(\psi)$ denote, respectively, the left and right hand side of the inequality (*), simple calculus and algebra show the following properties: i) $LHS\,(\psi)$ is linearly increasing in ψ, with $LHS\,(0) = 1$ and $\lim_{\psi\to 1} LHS\,(\psi) = \left(\frac{R_t}{R_t-1}\right)^{\zeta} > 1$; ii) $RHS\,(\psi)$ is strictly increasing in ψ, with $RHS\,(0) = 1$ and $\lim_{\psi\to 1} RHS\,(\psi) = \left(\frac{R_t}{R_t-1}\right)^{\zeta} > 1$; iii) $RHS'\,(0) < LHS'\,(0)$, $\lim_{\psi\to 1} RHS'\,(\psi) > \lim_{\psi\to 1} LHS'\,(\psi)$, and $RHS''\,(\psi) > 0$. From i)-iii) it follows that $LHS\,(\psi) \geq RHS\,(\psi)$

for any $\psi \in [0,1)$. Hence, $\tilde{x}_t \geq x_t (\Delta_t)^{\zeta}$ for any parameterization of the model.

PART III. The utility cost of resisting temptation is defined as $\max v\left(\tilde{c}_t, \tilde{h}_t, \tilde{m}_t\right) - v(c_t, h_t, m_t)$. By the specification of utilities in (3)-(5), at the optimum, we have $\max v\left(\tilde{c}_t, \tilde{h}_t, \tilde{m}_t\right) - v(c_t, h_t, m_t) = \frac{\xi}{1-\eta}\left(\tilde{f}_t^{1-\eta} - f_t^{1-\eta}\right)$. Using expressions (10) and (16), such cost is equivalent to

$$\frac{\xi}{1-\eta}\left[\left(\frac{\tilde{x}_t}{1-\psi}\right)^{1-\eta} - \left(\frac{x_t}{1-\psi}(\Delta_t)^{\zeta}\right)^{1-\eta}\right]$$

Since $\tilde{x}_t \geq x_t (\Delta_t)^{\zeta}$, the expression within square brackets is always non-negative, such that $\max v\left(\tilde{c}_t, \tilde{h}_t, \tilde{m}_t\right) - v(c_t, h_t, m_t) \geq 0$ for any parameterization of the model.

A.1.2 Proof of Proposition 1

Let $\Gamma\left(\bar{R}\right)$ denote the right hand side of equation (32). First of all, by De L'Hopital's rule, it is straightforward to show that $\lim_{\zeta \to 1} \bar{\Delta} = \bar{R}^{\psi}$. Under the assumption of $\sigma = \eta = 1$, simple algebra implies that

$$\Gamma\left(\bar{R}\right) = 1 - \frac{\xi}{1+\xi}\frac{\bar{x}}{\bar{x}\left[1-\psi+\psi\left(\frac{\bar{R}}{\bar{R}-1}\right)\right] + (1-\psi)\frac{\bar{b}}{\bar{R}}}$$

Given the zero lower bound on interest rates, we restrict to the case of $\bar{R} > 1$. Simple calculus and algebra shows that $\Gamma\left(\bar{R}\right)$ satisfies the following properties: i) $\Gamma\left(\bar{R}\right) \in \left(\frac{1}{1+\xi}, 1\right)$, with $\lim_{\bar{R} \to 1^+} \Gamma\left(\bar{R}\right) = 1$ and $\lim_{\bar{R} \to +\infty} \Gamma\left(\bar{R}\right) = \frac{1}{1+\xi} \in (0,1)$; ii) $\Gamma'\left(\bar{R}\right) < 0$; iii) $\Gamma''\left(\bar{R}\right) > 0$ for $\bar{R} < 2$. Consider now the left hand side of (32). It converges to β^{-1} as $\bar{R}$ approaches unity, it is strictly decreasing in $\bar{R}$, taking a value of unity for $\bar{R} = \beta^{-1}$ and becoming smaller than $\frac{1}{1+\xi}$ for $\bar{R}$ larger than $\frac{1+\xi}{\beta}$. It immediately follows that $\left(\beta\bar{R}\right)^{-1} > \Gamma\left(\bar{R}\right)$ for any $\bar{R} \in \left(1, \beta^{-1}\right]$, and that $\left(\beta\bar{R}\right)^{-1} < \Gamma\left(\bar{R}\right)$ for any $\bar{R} \geq \frac{1+\xi}{\beta}$. This allows us to conclude that there cannot be a steady state equilibrium outside the interval $\left(\frac{1}{\beta}, \frac{1+\xi}{\beta}\right)$, while there must exists at least one inside. From property iii) stated above, $\Gamma\left(\bar{R}\right)$ is always convex for $\bar{R} < 2$. Hence, provided $\frac{1+\xi}{\beta} < 2$ (that is, $1+\xi < 2\beta$), there exists a unique value for $\bar{R} \in \left(\frac{1}{\beta}, \frac{1+\xi}{\beta}\right)$ that solves (32), i.e. a unique steady state equilibrium. Moreover, since at the steady state solution $\Gamma\left(\bar{R}\right)$ intersects $\left(\beta\bar{R}\right)^{-1}$ from below - i.e., at the steady state, $\Gamma\left(\bar{R}\right)$ is flatter than $\left(\beta\bar{R}\right)^{-1}$ - using the Implicit Function Theorem, it is straightforward to show that $\bar{R}$ is strictly increasing in ξ.

A.1.3 Proof of Proposition 2

Consider the limiting case of no (steady state) positive supply of public bonds: $\bar{b} \to 0$ such that $\vartheta_b \to 0$. As this implies $\vartheta_x + \vartheta_m \to 1$, and since $\varkappa > 0$, from its definition in (47), we have that $\alpha \lesseqqgtr 1$ for $\eta \gtreqqless \varphi_x$, which, by the definition of φ_x in (42) and simple algebra, is equivalent to $\eta \gtreqqless \sigma$. Simple calculus shows that if $\eta > \sigma$ then α is strictly decreasing in ξ and η.

Suppose now that public bonds are in positive supply, such that $\vartheta_b \in (0,1)$. In this case, using the definition of φ_x again, simple algebra shows that $\alpha \lesseqqgtr 1$ for

$$(1-\vartheta_b) - \frac{\sigma}{\eta} \gtreqqless \xi \vartheta_b \overline{f}^{\sigma-\eta} \tag{A.2}$$

Let $LHS(\eta)$ and $RHS(\eta)$ denote, respectively, the left and right hand sides of (A.2). It is straightforward to notice that for $\eta \leq \eta^L \equiv \sigma/(1-\vartheta_b)$ we have $LHS(\eta) \leq 0$ while $RHS(\eta) > 0$. Hence, in this case, α is always larger than unity. Consider then $\eta > \eta^L$. Simple calculus shows the following properties: i) $LHS(\eta)$ is strictly increasing and concave in η, with $\lim_{\eta \to \eta^L} LHS(\eta) = 0$ and $\lim_{\eta \to \infty} LHS(\eta) = (1-\vartheta_b)$; ii) $RHS(\eta)$ is strictly decreasing in η with $\lim_{\eta \to \eta^L} RHS(\eta) > 0$ and $\lim_{\eta \to \infty} RHS(\eta) = 0$. Hence, there exists a unique threshold $\eta^* > \eta^L$ such that $LHS(\eta) \gtreqqless RHS(\eta)$ for $\eta \gtreqqless \eta^*$. This allows us to conclude that $\alpha \lesseqqgtr 1$ for $\eta \gtreqqless \eta^*$. By the Implicit Function Theorem, we have that η^* is strictly increasing in ξ and ϑ_b.

A.1.4 Proof of Proposition 3

Assume $\xi = 0$. As $\varkappa = 0$, we have $\gamma_b = 0$ such that public debt does not enter the equation for inflation (51). Moreover, for $\sigma = 1$ and $\zeta \to 1$, we have $\varphi_R = 0$, such that $\delta_R = 0$ as well. The equilibrium dynamics around the non-stochastic steady state are therefore described by the following reduced form system:[34]

$$\begin{bmatrix} E_t \hat{\pi}_{t+1} \\ \hat{b}_t \end{bmatrix} = \underbrace{\begin{bmatrix} \phi_\pi & 0 \\ \phi_\pi - \bar{R} & \bar{R}(1-\tau_b\phi_b) \end{bmatrix}}_{\Omega} \begin{bmatrix} \hat{\pi}_t \\ \hat{b}_{t-1} \end{bmatrix}$$

From Blanchard and Kahn (1980), with one predetermined ($\hat{b}_{t-1}$) and one non-predetermined ($\hat{\pi}_t$) variable, equilibrium determinacy requires the Jacobian matrix Ω to have one eigenvalue inside

[34] Although without temptation $\bar{R} = \beta^{-1}$, we write conditions in terms of $\bar{R}$ to facilitate the comparrison with the case of $\xi > 0$ coming later, where the above equality does not hold.

and the other one outside the unit circle.

Since Ω is block-triangular, its eigenvalues are ϕ_π and $\bar{R}\left(1-\tau_b\phi_b\right)$. Suppose monetary policy is passive: $\phi_\pi \in [0,1)$. Determinacy requires then $\left|\bar{R}\left(1-\tau_b\phi_b\right)\right| > 1$. As we restrict to the case of $\phi_b < \frac{1+\bar{R}}{\bar{R}\tau_b}$, such inequality holds only for $0 \leq \phi_b < \frac{\bar{R}-1}{\bar{R}\tau_b}$ (which gives an eigenvalue larger than unity). Suppose instead that monetary policy is active: $\phi_\pi > 1$. In this case we need $\left|\bar{R}\left(1-\tau_b\phi_b\right)\right| < 1$, that is, $\frac{\bar{R}-1}{\bar{R}\tau_b} < \phi_b < \frac{1+\bar{R}}{\bar{R}\tau_b}$. This proves statement i.

Outside these policy intervals, the equilibrium is either indeterminate or explosive. On the one hand, if $\phi_b > \frac{\bar{R}-1}{\bar{R}\tau_b}$ and monetary policy is passive, $\phi_\pi \in [0,1)$, both eigenvalues are inside the unit circle. In this case both debt and inflation revert to their steady state levels, for any initial condition. Since inflation is not predetermined, the equilibrium is locally indeterminate (statement ii.). On the other hand, if $0 \leq \phi_b < \frac{\bar{R}-1}{\bar{R}\tau_b}$ and monetary policy was active, $\phi_\pi > 1$, both eigenvalues are larger than unity. With the dynamics of debt being explosive, there is no stationary equilibrium around the steady state (statement iii.).

A.1.5 Proof of Proposition 4

Plugging the law of motion of debt (50) with $\hat{g}_t = 0$ into the flexible price Euler equation (51), after rearranging terms, the equilibrium dynamics around the non-stochastic steady state are described by the following reduced form system:

$$\begin{bmatrix} E_t\hat{\pi}_{t+1} \\ \hat{b}_t \end{bmatrix} = \underbrace{\begin{bmatrix} \tilde{\phi}_\pi + \tilde{\phi}_b\varphi_\pi & \tilde{\phi}_b\varphi_b \\ \varphi_\pi & \varphi_b \end{bmatrix}}_{\Omega} \begin{bmatrix} \hat{\pi}_t \\ \hat{b}_{t-1} \end{bmatrix}$$

where

$$\tilde{\phi}_\pi \equiv \frac{\left(\delta_r+\delta_R\right)\phi_\pi}{\delta_r+\gamma_R\phi_\pi-\gamma_b\varphi_\pi}, \qquad \tilde{\phi}_b \equiv \frac{\gamma_b\varphi_b}{\delta_r+\gamma_R\phi_\pi-\gamma_b\varphi_\pi}$$

Let $\mathcal{P}(e) = e^2 - \operatorname{tr}(\Omega)\, e + \det(\Omega) = 0$ denote the characteristic polynomial of Ω, where $\operatorname{tr}(\Omega) = \tilde{\phi}_\pi + \tilde{\phi}_b\varphi_\pi + \varphi_b$ and $\det(\Omega) = \tilde{\phi}_\pi\varphi_b$. Local equilibrium determinacy requires $\mathcal{P}(e) = 0$ to have one root inside and the other outside the unit circle. Necessary and sufficient conditions are that either one of the following cases holds: 1) $\mathcal{P}(1) > 0$ and $\mathcal{P}(-1) < 0$; or 2) $\mathcal{P}(1) < 0$ and $\mathcal{P}(-1) > 0$.

Simple algebra gives that

$$\mathcal{P}(-1) = \frac{1+\varkappa\vartheta_b\bar{R}+\bar{R}\left(1-\bar{\tau}_b\phi_b\right)+\left[1+\varkappa\vartheta_m\zeta_R+\bar{R}\left(1+\varkappa\vartheta_b+\varkappa\vartheta_m\zeta_R\right)\left(1-\bar{\tau}_b\phi_b\right)\right]\phi_\pi}{1+\eta\varkappa\vartheta_b\bar{R}+\eta\varkappa\vartheta_m\zeta_R\phi_\pi} \tag{A.3}$$

By the definitions of all composite parameters, Assumption 1 (guaranteeing $\bar{\tau}_b \in (0,1)$), and the restriction $\phi_b \in [0,1)$, it immediately follows that $\mathcal{P}(-1) > 0$. Hence, we can immediately rule out case 1).

By case 2), it follows that the REE is locally determinate if and only if $\mathcal{P}(1) < 0$. To simplify the analysis, we define the following thresholds for the fiscal policy parameter ϕ_b:

$$\phi_b^* \equiv \frac{\bar{R} - 1 - \varkappa\vartheta_m - \bar{R}\varkappa\vartheta_b}{\bar{R}\tau_b\left(1 - \varkappa\vartheta_b - \varkappa\vartheta_m\zeta_R\right)}, \qquad \phi_b^{**} \equiv \frac{\bar{R} - 1 - \varkappa\vartheta_b\bar{R}}{\bar{R}\tau_b} \tag{A.4}$$

It is straightforward to verify that both ϕ_b^* and ϕ_b^{**} are strictly smaller than $\frac{\bar{R}-1}{\bar{R}\tau_b}$, the relevant threshold for the case without temptation identified in Proposition 3. Lemma 2 defines key properties for ϕ_b^* and ϕ_b^{**} which are auxiliary to the rest of the proof.

Lemma 2 *Let* $\bar{x}^r \equiv \bar{x}/\bar{\bar{x}}$. *For* $i = l, h$, *define* $\xi_i \equiv \frac{\varkappa_i}{(1+\varkappa_i)\bar{x}^r - \varkappa_i}$, *where* $\varkappa_l \equiv \frac{\bar{R}-1}{\bar{R}\vartheta_b + \vartheta_m}$ *and* $\varkappa_h \equiv \frac{\bar{R}-1}{(\bar{R}-1)\vartheta_b + \vartheta_m} > \varkappa_l > 0$, *such that* $\xi_h > \xi_l > 0$. *The following properties apply: i)* $\phi_b^{**} > \phi_b^* > 0$ *for* $\xi \in (0, \xi_l)$; *ii)* $\phi_b^{**} > 0 > \phi_b^*$ *for* $\xi \in (\xi_l, \xi_h)$; *iii)* $\phi_b^* > \phi_b^{**}$ *for* $\xi > \xi_h$.

Proof. Consider the composite parameter $\varkappa$ defined in (38). Under the assumption $\sigma = \eta = 1$, it simplifies to $\varkappa = \frac{\xi\bar{x}^r}{(1+\xi) - \xi\bar{x}^r}$, where $\bar{x}^r \equiv \bar{x}/\bar{\bar{x}}$. Let NUM and DEM denote, respectively, the numerator and denominator of ϕ_b^* defined in (A.4). One can verify that $DEN \gtreqless 0$ for $\xi \lesseqgtr \xi_h \equiv \frac{\varkappa_h}{(1+\varkappa_h)\bar{x}^r - \varkappa_h}$ where $\varkappa_h \equiv \frac{\bar{R}-1}{(\bar{R}-1)\vartheta_b + \vartheta_m}$. Moving to the numerator, we have instead that $NUM \gtreqless 0$ for $\xi \lesseqgtr \xi_l \equiv \frac{\varkappa_l}{(1+\varkappa_l)\bar{x}^r - \varkappa_l}$ where $\varkappa_l \equiv \frac{\bar{R}-1}{\bar{R}\vartheta_b + \vartheta_m} < \varkappa_h$, such that $0 < \xi_l < \xi_h$. It follows that $\phi_b^* > 0$ for $\xi \in (0, \xi_l)$ and $\xi > \xi_h$, while $\phi_b^* < 0$ for $\xi \in (\xi_l, \xi_h)$. Moving to ϕ_b^{**}, following a similar logic, there exists another threshold ξ_u such that that $\phi_b^{**} \gtreqless 0$ for $\xi \lesseqgtr \xi_u \equiv \frac{\varkappa_u}{(1+\varkappa_u)\bar{x}^r - \varkappa_u}$, where (under Assumption 3) $\varkappa_u \equiv \frac{\bar{R}-1}{\bar{R}\vartheta_b} > \varkappa_h > \varkappa_l$ and then $\xi_u > \xi_h$. Putting these results together, additional algebra yields statements i)-iii) in the Lemma. Q.E.D. ■

It is convenient to write $\mathcal{P}(1)$ as follows:

$$\mathcal{P}(1) = \frac{A - A_\pi\phi_\pi}{D}$$

where $D \equiv 1 + \eta\varkappa\vartheta_b\bar{R} + \eta\varkappa\vartheta_m\zeta_R\phi_\pi > 0$, and

$$A \equiv \bar{R}\tau_b\left(\phi_b - \phi_b^{**}\right), \qquad A_\pi \equiv \bar{R}\tau_b\left(1 - \varkappa\vartheta_b - \varkappa\vartheta_m\zeta_R\right)\left(\phi_b - \phi_b^*\right)$$

The rest of the proof makes use of the results stated in Lemma 2 and its proof. We have to consider different ranges of temptation.

Case I: Low Temptation. Suppose $\xi \in (0, \xi_l)$, such that $\phi_b^{**} > \phi_b^* > 0$, as well as $(1 - \varkappa\vartheta_b - \varkappa\vartheta_m\zeta_R) > 0$. We have to consider different cases.

- If the fiscal response is $0 \leq \phi_b < \phi_b^*$, we have that both A and A_π are negative. In this case, $\mathcal{P}(1) < 0$ (hence, the REE is locally determinate) if and only if $\phi_\pi < \bar{\phi}_\pi \equiv \frac{A}{A_\pi}$. Simple calculus shows that $\bar{\phi}_\pi > 1$, is strictly increasing ϕ_b, with $\lim_{\phi_b \to \phi_b^*} \bar{\phi}_\pi > +\infty$.

- If the fiscal response is $\phi_b^* < \phi_b < \phi_b^{**}$, we have that $A < 0$ and $A_\pi > 0$. In this case, $\mathcal{P}(1) < 0$ for any $\phi_\pi \geq 0$.

- If the fiscal response is $\phi_b > \phi_b^{**}$, we have that both A and A_π are positive. In this case, $\mathcal{P}(1) < 0$ if and only if $\phi_\pi > \bar{\phi}_\pi \equiv \frac{A}{A_\pi} > 0$. Simple calculus shows that $\bar{\phi}_\pi$ is strictly increasing in ϕ_b, and becomes larger than unity for $\phi_b > \frac{\bar{R}-1}{\bar{R}\tau_b}$.

Case II: Intermediate Temptation. Suppose $\xi \in (\xi_l, \xi_h)$, such that $\phi_b^{**} > 0 > \phi_b^*$, while $(1 - \varkappa\vartheta_b - \varkappa\vartheta_m\zeta_R)$ is still positive. Notice that in this case A_π is always positive for any $\phi_b \geq 0$. We have to consider different cases again.

- If the fiscal response is $0 \leq \phi_b < \phi_b^{**}$, then $A < 0$. In this case, $\mathcal{P}(1) < 0$ for any $\phi_\pi \geq 0$.

- If the fiscal response is $\phi_b > \phi_b^{**}$, as both A and A_π are positive, $\mathcal{P}(1) < 0$ if and only if $\phi_\pi > \bar{\phi}_\pi \equiv \frac{A}{A_\pi} > 0$. Simple calculus shows that $\bar{\phi}_\pi$ is strictly increasing in ϕ_b, and becomes larger than unity for $\phi_b > \frac{\bar{R}-1}{\bar{R}\tau_b}$.

Case III: High Temptation. Suppose $\xi > \xi_h$, such that $(1 - \varkappa\vartheta_b - \varkappa\vartheta_m\zeta_R) < 0$ and $\phi_b^* > \phi_b^{**}$, where the latter is not necessarily positive. We have to consider different cases.

- If the fiscal response is $0 \leq \phi_b < \phi_b^*$, we have that $A_\pi > 0$, such that, in this case, $\mathcal{P}(1) < 0$ if and only if $\phi_\pi > \bar{\phi}_\pi \equiv \frac{A}{A_\pi}$. Looking back at the expression for A, we can see that $\bar{\phi}_\pi \gtreqless 0$ for $\phi_b \gtreqless \phi_b^{**}$. As ϕ_b^{**} could be negative, while we are restricting to positive responses to inflation, we conclude that $\mathcal{P}(1) < 0$ if and only if $\phi_\pi > \max\left\{0, \bar{\phi}_\pi\right\}$. Simple calculus shows that $\bar{\phi}_\pi$ is strictly increasing in ϕ_b with $\lim_{\phi_b \to \phi_b^*} \bar{\phi}_\pi = +\infty$.

- If the fiscal response is $\phi_b > \phi_b^*$, we have that $A_\pi < 0$ while $A > 0$. As this makes $\mathcal{P}(1) > 0$ for any $\phi_\pi \geq 0$, the equilibrium would be locally indeterminate.

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