Beyond Frictions: A Behavioral Route to Asset Price Non-Neutrality and the Stabilizing Role of Monetary Policy

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Abstract

This paper develops a New Keynesian model in which stock market fluctuations affect consumption through behavioral rather than financial channels. Building on Gul and Pesendorfer (2004) dynamic temptation framework with convex self-control costs (Noor and Takeoka, 2010)), households face temptation to use all wealth for immediate consumption, resisting which entails cognitive disutility. This mechanism introduces a behavioral financial channel whereby asset prices influence intertemporal choices even in the absence of credit frictions. We derive analytical results linking wealth and consumption to an endogenous discount factor that can exhibit increasing or decreasing marginal impatience. Quantitatively, a 1% rise in stock prices raises consumption by about 0.06%, consistent with empirical estimates. The response strengthens with greater temptation and self-control convexity but weakens with shock persistence. A leaning-against-the-wind monetary policy rule reacting to stock prices can fully offset such sentiment shock.

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1 Introduction

Numerous studies have documented the existence of positive wealth effects on consumption resulting from an increase in financial wealth, both for the United States and other developed economies[1]. Nevertheless, the debate over the underlying mechanism that drives households to consume more remains unresolved. On the one hand, a *market failure* view has the existence of financial/credit frictions as the key driver. For instance, having pledged a collateral (e.g. an equity portfolio) to secure a loan from banks worried about default risk, borrowing constrained household may be able/willing to consume more during a stock market boom as it would allow them to get better credit conditions. On the other hand, a more *behavioral* stream of literature highlights the importance of psychological and cognitive factors in economic decision-making under uncertainty. Myopia or limited rationality may well influence individuals' responses to fluctuations in financial wealth: focusing on immediate gains (or losses), household may react more strongly to short-term market changes, sometimes disregarding long-term implications.

Our contribution belongs to the behavioral realm: we build a tractable dynamic general equilibrium model which, despite the absence of credit/financial frictions, i) delivers a positive (respectively, negative) response of consumption to a stock market boom (respectively, crash), and ii) by allowing for a meaningful role of monetary policy, has something to say on whether central banks should grant an explicit response to the stock market. For such purpose, we embed dynamic *temptation with convex self-control* preferences – as originally formalized by Gul and Pesendorfer (2001, 2004) and then extended to convexity by Noor and Takeoka (2010) – into an otherwise standard New Keynesian (henceforth, NK) model. Under such preferences, a household faces temptation to deviate from his long-run (consumption smoothing) best by liquidating his financial wealth to maximize current consumption, a myopic *hand-to-mouth* behavior. Temptation may be resisted, but doing so involves costly cognitive self-control in the form of disutility.

By affecting both current and future costs of self-control, household's wealth, con-

[1]Notable contributions are Carroll et al. (2011), Case et al. (2005), Chodorow-Reich et al. (2021), Kichian and Mihic (2018), Ludwig and Sløk (2004), and Paiella and Pistaferri (2017). Although there is variation across countries, periods considered and wealth measurements, the general findings can be summarized as follows: 1) a 1% increase in financial wealth leads to an increase in consumption within the 0.03 to 0.1% range; 2) wealth effects related to housing appear larger than those related to stocks. For an overview of the related literature, see Paiella (2009), and Cooper and Dynan (2016).

sisting of a portfolio of risk-free government bonds and risky equity (i.e. profit shares issued by firms through a frictionless capital market), can alter the optimal consumption-saving trade-off faced by a forward-looking decision-maker. As a consequence, the strong dichotomy between real and financial variables characterizing the standard NK framework under conventional preferences is no longer present: temptation with self-control preferences induce a *behavioral financial channel* whereby asset price fluctuations are no longer redundant for the business cycle. Intuitively, a stock market boom makes the tempting option to use all wealth for immediate gratification more attractive – equivalently, the costs of self-control more cumbersome - and therefore generates a wealth effect on consumption.

In this context, we study how output/consumption and inflation respond to a *near-rational* expectational error made by individuals when forming conditional expectations on the return on risky equity, along the lines of Hassan and Mertens (2017), as well as Miao et al. (2021)[2]. This is a purely financial exogenous disturbance to be interpreted as market sentiment (i.e. optimistic vs pessimistic stock price expectations with respect to the underlying fundamentals)[3].

Our main results are the followings. First, we provide analytical results on how variations in households' propensity to consume and wealth affect their endogenous discount factor. By allowing for either a positive or a negative response of the latter to a stock market upturn depending on its timing, our model can then feature decreasing or increasing marginal impatience, as in the literature where endogenous discounting has been introduced in reduced-form.

Second, we show that, under quantitatively motivated restrictions, the (unique) steady state equilibrium features a real interest rate which i) is always increasing in temptation, but ii) may respond either positively or negatively to convexity depending on households' average propensity ti consume.

Third, for a benchmark calibration, the model delivers a response of consumption to the financial shock which is in line with available empirical estimates: namely, following an exogenous 1% stock price boom, consumption increases by about

[2]Differently from ours, in both of these papers, information is dispersed across agents. The introduction of a near-rational error serves the purpose of making equilibrium stock prices not fully revealing of underlying shocks, and therefore helps generate excess stock price volatility.

[3]See Dupor (2005) and Smets and Wouters (2005) for a similar modeling of near-rational disturbances. Relatedly, Lansing (2024) argues that a sentiment shock to the equity price is key to replicate U.S. business cycle dynamics, and provides a brief (yet insightful) overview of the existing evidence on belief distortions in asset pricing.

0.06%. We show the response to be strictly increasing in the extent of temptation (i.e. household's myopia) and the degree of convexity in self-control costs (i.e. how uphill is the struggle to resist consumption urges), but strictly decreasing in the persistence of the shock. This last result is related to the fact that, under our preferences, the expectation of higher wealth in the future - which occurs if the current boom is perceived to be persistent - lowers the future costs of self-control and therefore creates an additional incentive to save more (hence consume less) today.

Finally, an appropriately designed *leaning against the wind* policy, taking the form of an explicit response to the stock price index in the monetary policy rule adopted by the central bank, can fully neutralize the financial shock. For the benchmark calibration, the required response is very close to the empirical estimates of extended Taylor rules provided by Aastveit et al. (2023), Castelnuovo and Nisticò (2010) and Rigobon and Sack (2003)[4].

Our work relates to two strands of literature: one assessing the non-neutral effects of asset price fluctuations through the lenses of DSGE models featuring alternative sources of credit frictions; the other – often referred to as *behavioral macroeconomics* – trying to overcome the shortcomings of the traditional Rational Expectations discounted utility framework by incorporating behavioral threads supported by experimental/empirical evidence.

For what concerns the former, the literature – which dates back to the seminal work of Bernanke et al. (1999) – emphasizes the borrower's balance sheet channel and the consequential financial accelerator as a way to amplify shocks to fundamentals and/or to make the macroeconomy respond to extrinsic uncertainty (e.g. bubbles, fads, sunspots, etc.). We refer the reader to Gertler and Kiyotaki (2011) and Gertler et al. (2016) for more recent developments, as well as to Gertler and Gilchrist (2018) for an overview of the related literature.

In regards to a behavioral approach, this is not the first paper to incorporate the Gul-Pesendorfer's *temptation with self-control* paradigm in a macroeconomic model[5]. Such preferences have been shown to deliver interesting implications for monetary

[4]See also Cieslak and Vissing-Jorgensen (2021) for indirect evidence – i.e. textual analysis of FOMC documents – on the Fed's concern for the stock market

[5]Obviously, a macro-model can go "behavioral" through alternative routes. Among others, notable examples are *cognitive discounting* (Gabaix, 2020), *dispersed information* (Angeletos and Lian, 2018), *level-k thinking* (Farhi and Werning, 2019), and *finite planning horizon* (Woodford, 2019).

policy (Airaudo, 2020, 2025), the design of social security (Kumru and Thanopoulos, 2011), optimal taxation (Krusell et al., 2010), asset pricing (DeJong and Ripoll, 2007), the welfare costs of business cycle fluctuations (Huang et al., 2015), as well as the explanation of the large share of wealthy hand-to-mouth households in the U.S. (Attanasio et al., 2024). Their desirability comes from strong microfoundations of preference reversals in intertemporal choices, supporting empirical/experimental evidence (Toussaert, 2018), as well as higher tractability in comparison to competing alternatives such as hyperbolic discounting (e.g. they are not subject to time-inconsistency and equilibrium indeterminacy issues)[6].

The rest of the paper is organized as follows. Section 2 lays out the model in all its components (households, firms and the government). Section 3 defines the equilibrium, describes the near-rationality of expectations, highlights the behavioral financial channel, and discusses the similarities with models that, in reduced form, feature endogenous discounting. Section 4 characterizes both analytically and numerically the steady state, in particular for what concerns the relationship between the real interest rate and temptation related parameters. Section 5 presents the reduced-form linearized system. Section 6 studies the economy's response to the non-fundamental stock price disturbance under a benchmark calibration, providing some sensitivity analysis with respect to temptation-related coefficients. It also assesses the stabilizing properties of a Taylor rule granting an explicit positive response to the stock market. Section 7 concludes.

2 Model

2.1 Households

Consider an economy populated by a continuum of homogeneous infinitely-lived households. The representative household's resources consist of gross returns from risk-free government bonds, shares (plus related dividends) of risky equity issued by a continuum of firms, and labor income (net of lump-sum taxes). They are used to finance consumption, new bond and equity holdings. Letting P_t denote the aggregate price index and $\pi_t \equiv \frac{P_t}{P_{t-1}}$ gross inflation, the household's real-valued

[6]See also extensions of the original Gul-Pesendorfer specification by Noor and Takeoka (2010, 2015), and the dual-self framework of Fudenberg and Levine (2006, 2011).

budget constraint is:

$$c_t + b_t + \int_0^1 q_t(i)a_t(i)di = R_{t-1}\frac{b_{t-1}}{\pi_t} + \int_0^1 \left[q_t(i) + d_t(i)\right] a_{t-1}(i)di + w_t h_t - \tau_t \quad (1)$$

where $b_t \equiv B_t/P_t$ and $a_t(i)$ are holdings of, respectively, government bonds and the i-*th* firm risky equity, with related per-share real price $q_t(i) \equiv Q_t(i)/P_t$ and real dividend $d_t(i) \equiv D_t(i)/P_t$; R_t is the gross nominal return on bonds; $w_t \equiv W_t/P_t$ is the real wage rate, and τ_t are real lump sum taxes. The household is also subject to non-negativity constraints on both bonds (he cannot borrow from the government) and equity (no short-selling): $b_t \geq 0$ and $a_t(i) \geq 0$ for every $i \in [0, 1]$.

The household has Gul and Pesendorfer (2001, 2004) temptation with self-control preferences (henceforth, GP preferences). The latter describe a household who, in every period, is tempted to use all his financial wealth for current consumption purposes – thus behaving like a hand-to-mouth consumer – but incurs a self-control cognitive cost (disutility) to resist such temptation. Following Gul and Pesendorfer (2004), the recursive representation of the household's intertemporal utility maximization problem is a Bellman equation:

$$U_t = \max_{c_t, h_t, b_t, \{a_t(i)\}_{i\in[0,1]}} \{u(c_t, h_t) - f(\Delta_t) + \beta \mathcal{E}_t U_{t+1}\} \quad (2)$$

where $\mathcal{E}_t$ is the household's subjective expectation operator satisfying standard probability laws[7]. The terms $u(c_t, h_t) + \beta\mathcal{E}_t U_{t+1}$ describe *commitment* utility - made of a Von-Neuman-Morgenstern (henceforth, VNM) temporary utility $u(\cdot)$ and the discounted expected continuation value $\mathcal{E}_t U_{t+1}$ - used by the household to evaluate his long-run best. Letting $\tilde{s}_t$ denote the optimal choice of a generic variable s if succumbing to temptation, the term $\Delta_t \equiv \max v(\tilde{c}_t, \tilde{h}_t) - v(c_t, h_t)$ represents the opportunity cost of temptation (or the cost of self-control). The latter corresponds to the lost utility - evaluated by an alternative VNM utility $v(\cdot)$ - incurred by the household as a result of exerting self-control by choosing the allocation c_t, h_t, b_t and $a_t(i)$) over the tempting alternative $\tilde{c}_t$, $\tilde{h}_t$, $\tilde{b}_t$ and $\tilde{a}_t(i)$ for every $i \in [0, 1]$.

To capture the notion that self-control is an uphill battle - i.e. because of limited mental resources, it is harder for an individual to resist sudden urges when instant gratification is greater - we follow Noor and Takeoka (2010), as well as Fudenberg and Levine (2006, 2011), by assuming the function $f(\cdot)$ to be strictly increas-

[7]Section 3.1 below provides a more detailed discussion about expectations.

ing and convex in its argument Δ_t[8]. Convexity implies that the marginal costs of self-control are increasing, a feature consistent with the experimental evidence by Shiv and Fedorikhin (1999), Muraven et al. (1998), and Muraven and Baumeister (2000)[9].

Guided by the related literature, as well as by the desire to retain as much analytical tractability as possible, we assume the following functional forms. For what concerns the *commitment* utility $u(\cdot)$ and the *temptation* utility $v(\cdot)$, we adopt a Greenwood-Hercovitz-Huffman (henceforth, GHH) type specification (as in Greenwood et al. (1988)):

$$u(c_t, h_t) = \frac{x_t^{1-\sigma}}{1-\sigma}, \qquad v(c_t, h_t) = \xi \frac{x_t^{1-\sigma}}{1-\sigma} \tag{3}$$

$$x_t = c_t - \frac{h_t^{1+\chi}}{1+\chi} \tag{4}$$

where $\xi \geq 0$ captures the degree of temptation, with the baseline NK framework nested as a special case for $\xi = 0$. By eliminating wealth effects on labor supply, the GHH specification will allow us to solve for the temptation allocation in closed form, which will prove helpful in the derivation of some of the analytical results. In regards to self-control costs, we assume that

$$f(\Delta_t) = \frac{\Delta_t^{1+\zeta}}{1+\zeta}, \qquad \Delta_t = \frac{\xi}{1-\sigma}\left(\tilde{x}_t^{1-\sigma} - x_t^{1-\sigma}\right) \tag{5}$$

with $\zeta \geq 0$. For $\zeta = 0$ we retrieve the baseline linear costs set-up of Gul and Pesendorfer (2001, 2004), while $\zeta > 0$ makes overall costs convex.

The solution to the optimal consumption-saving problem of the representative household involves two stages. In the **first stage**, we solve a static optimization problem to identify the optimal choice under temptation:

[8] In reduced form, the GP preferences environment is isomorphic to the dual-selves set-up of Fudenberg and Levine (2006, 2011).

[9] As shown by Noor and Takeoka (2010) and Fudenberg and Levine (2006, 2011), convexity allows to explain some puzzling results and paradoxes of experiments on intertemporal decisions under risk. See also Ikeda and Ojima (2021) for an extensive review of the psychological literature on the fatiguing nature of self-control.

$$\max_{\tilde{c}_t,\tilde{h}_t,\tilde{b}_t,\{\tilde{a}_t(i)\}_{i\in[0,1]}} \frac{\xi}{1-\sigma}\left[\tilde{c}_t - \frac{\tilde{h}_t^{1+\chi}}{1+\chi}\right]^{1-\sigma} \tag{6}$$

$$\text{s.t. } \tilde{c}_t + \tilde{b}_t + \int_0^1 q_t(i)\tilde{a}_t(i)di = R_{t-1}\frac{b_{t-1}}{\pi_t} + \int_0^1 \left[q_t(i) + d_t(i)\right] a_{t-1}(i)di + w_t\tilde{h}_t - \tau_t \tag{7}$$

First-order conditions with respect to $\tilde{c}_t$, $\tilde{h}_t$, $\tilde{b}_t$ and $\{\tilde{a}_t(i)\}_{i\in[0,1]}$ and simple algebraic manipulation lead to the following expressions:

$$\tilde{b}_t = 0, \qquad \tilde{a}_t(i) = 0 \;\; \forall i \in [0,1] \tag{8}$$

$$\tilde{h}_t = w_t^{\frac{1}{\chi}} \tag{9}$$

$$\tilde{c}_t = R_{t-1}\frac{b_{t-1}}{\pi_t} + \int_0^1 [q_t(i) + d_t(i)]a_{t-1}(i)di + w_t^{\frac{1+\chi}{\chi}} - \tau_t \tag{10}$$

$$\tilde{x}_t = R_{t-1}\frac{b_{t-1}}{\pi_t} + \int_0^1 [q_t(i) + d_t(i)]a_{t-1}(i)di + \frac{\chi}{1+\chi}w_t^{\frac{1+\chi}{\chi}} - \tau_t \tag{11}$$

$$\tilde{\lambda}_{c,t} = \xi\tilde{x}_t^{-\sigma} \tag{12}$$

As stated in (8), there is no saving under temptation. The household chooses a positive labor supply (9) and consumes all resources according to (10). From the latter, we note that temptation consumption $\tilde{c}_t$ depends on the beginning of period asset holdings. Equations (11) and (12) define the GHH aggregator under temptation $\tilde{x}_t$ and the associated marginal utility of consumption $\tilde{\lambda}_{c,t}$ (to be used later in the analysis).

Let $\bar{a}_t \equiv \{a_t(i)\}_{i\in[0,1]}$, and denote by $\tilde{x}\left(b_{t-1}, \bar{a}_{t-1}\right)$ the expression for $\tilde{x}_t$ in (11) as function of initial bond and equity holdings. The **second stage** of the household's problem is given by the Bellman equation (2), which can be re-written as follows:

$$U_t = \max_{c_t,h_t,b_t,\bar{a}_t}\left\{u(c_t,h_t) - \frac{1}{1+\zeta}\left[\xi\frac{\left(\tilde{x}\left(b_{t-1},\bar{a}_{t-1}\right)\right)^{1-\sigma}}{1-\sigma} - \xi\frac{x_t^{1-\sigma}}{1-\sigma}\right]^{1+\zeta} + \beta\mathcal{E}_t U_{t+1}\right\} \tag{13}$$

subject to the budget constraint (1), and the non-negativity constraints $b_t \geq 0$ and $a_t(i) \geq 0$ for every $i \in [0,1]$.

With $\lambda_{c,t}$, $\lambda_{b,t}$ and $\{\lambda_{a,t}(i)\}_{i\in[0,1]}$ denoting the Lagrange multipliers associated with, respectively, the budget constraint (1) and the non-negativity constraints, the first order conditions are:

$$\lambda_{c,t} = x_t^{-\sigma}\left(1+\xi\Delta_t^{\zeta}\right) \tag{14}$$

$$\lambda_{c,t} w_t = x_t^{-\sigma}\left(1+\xi\Delta_t^{\zeta}\right) h_t^{\chi} \tag{15}$$

$$\lambda_{c,t} = \lambda_{b,t} + \beta\mathcal{E}_t \frac{\partial U_{t+1}}{\partial b_t} \tag{16}$$

$$\lambda_{c,t} q_t(i) = \lambda_{a,t}(i) + \beta\mathcal{E}_t \frac{\partial U_{t+1}}{\partial a_t(i)}, \qquad \forall i \in [0,1] \tag{17}$$

with complementary slackness conditions $\lambda_{b,t} b_t = 0$ and $\lambda_{a,t}(i) a_t(i) = 0$ for every $i \in [0,1]$. Merging (14) and (15) we obtain the labor supply equation:

$$h_t = w_t^{\frac{1}{\chi}}, \tag{18}$$

with labor responding exclusively to the real wage – since the GHH specification rules out a consumption-related wealth effect – with elasticity $1/\chi$.

Let $R_{t+1}^a \equiv \left[Q_{t+1}(i) + D_{t+1}(i)\right]/Q_t(i)$ denote the gross *nominal* return on risky equity issued by the i-th firm. At an interior optimum where $b_t > 0$ (hence $\lambda_{b,t} = 0$) and $a_t(i) > 0$ (hence $\lambda_{a,t}(i) = 0$) for every $i \in [0,1]$, the first order conditions (16) and (17), combined with the Envelope Theorem and the expression for $\tilde{x}_t$ in (11), deliver the following asset pricing conditions:

$$1 = R_t \mathcal{E}_t\left[\mathcal{F}_{t,t+1}\right] \tag{19}$$

$$1 = \mathcal{E}_t\left[\mathcal{F}_{t,t+1} R_{t+1}^a(i)\right] \qquad \forall i \in [0,1] \tag{20}$$

where

$$\mathcal{F}_{t,t+1} \equiv \beta \frac{\lambda_{c,t+1}}{\lambda_{c,t}} \frac{\Gamma_{t+1}}{\pi_{t+1}} \tag{21}$$

$$\Gamma_{t+1} \equiv 1 - \Delta_{t+1}^{\zeta} \frac{\tilde{\lambda}_{c,t+1}}{\lambda_{c,t+1}} \tag{22}$$

correspond, respectively, the household's stochastic discount factor (SDF) $\mathcal{F}_{t,t+1}$, and the temptation/self-control wedge Γ_{t+1}[10]. The latter - which differentiates the pricing conditions in (19)-(20) from the baseline model without GP preferences - depends negatively upon the ratio of next period's marginal utilities of consump-

[10] See Appendix B.1 for more details about the derivation of (19) and (20).

tion under temptation and commitment, $\tilde{\lambda}_{c,t+1}/\lambda_{c,t+1}$, and the opportunity cost of temptation, Δ_{t+1}.

2.2 Firms

The supply side of the model is standard. It consists of a flexible price perfectly competitive final good sector (retail), and a sticky-price intermediate goods sector (wholesale) populated by a continuum of monopolistically competitive firms indexed by $i \in [0,1]$. The representative retail firm bundles together (via a CES aggregator with intra-temporal elasticity of substitution $\epsilon > 1$) the continuum of intermediate products $\{y_t(i)\}_{i\in[0,1]}$ (each of which is purchased at price $P_t(i)$ from the i-th wholesaler) to produce final output y_t sold to consumers at final price $P_t = \left[\int_0^1 P_t(i)^{1-\epsilon} di\right]^{\frac{1}{1-\epsilon}}$ (the aggregate CPI). In the wholesale sector, the generic i-th firm produces a differentiated intermediate good out of an homogeneous labor input, $y_t(i) = h_t(i)$ (TFP is constant and, without loss of generality, normalized to unity), such that real marginal costs equal the real wage for all firms: $mc_t = w_t$. Prices are sticky á-la Calvo with $\theta \in (0,1)$ denoting the (time-invariant) probability that a firm cannot reset its price optimally between two subsequent periods. Each firm chooses its price to maximize the expected present discounted value of lifetime profits subject to a downward sloping demand $y_t(i) = [P_t(i)/P_t]^{-\epsilon} y_t$[11]. Finally, profits are distributed as dividends to households through a decentralized frictionless financial market: namely, the generic i-th firm issues $a_t(i)$ equity shares, at *real* market price $q_t(i)$ per unit, entitling the bearer to a share of its dividends $d_t(i) = [P_t(i)/P_t]^{1-\epsilon} y_t - mc_t [P_t(i)/P_t]^{-\epsilon} y_t$.

2.3 Government

The government/central bank sets fiscal and monetary policy. Assuming, without loss of generality, no public spending, the fiscal budget is given by:

$$b_t + \tau_t = R_{t-1} \frac{b_{t-1}}{\pi_t} \tag{23}$$

where, $b_t \geq 0$ are newly issued risk-free bonds yielding gross nominal return R_t. In each period, lump sum taxes τ_t are used to manage public debt according to the

[11] Profits are discounted by the representative household SDF which between period t and a generic future $t+k$ is $\mathcal{F}_{t,t+k} \equiv \beta^k \frac{\lambda_{c,t+k}}{\lambda_{c,t}\pi_{t,t+k}} \prod_{j=1}^{k} \Gamma_{t+j}$ with $\pi_{t,t+k} \equiv P_{t+k}/P_t$ and $\Gamma_{t+j} \equiv 1 - \Delta_{t+j}^{\zeta} \frac{\tilde{\lambda}_{c,t+j}}{\lambda_{c,t+j}}$ for $k \geq 0$.

following fiscal rule:

$$\frac{\tau_t}{\tau} = \left(\frac{R_{t-1}/\pi_t}{R/\pi}\right)^{\phi_r} \left(\frac{b_{t-1}}{b}\right)^{\phi_b} f_t \tag{24}$$

where ϕ_r and ϕ_b are both non-negative coefficients, f_t is a fiscal shock with unitary unconditional mean, while τ, R, π and b denote "target levels" (set equal to their corresponding steady state values; see Section 4). For reasons that will be clarified later, we allow the fiscal authority to respond to the outstanding debt level b_{t-1} and the related (gross) real interest rate R_{t-1}/π_t with different elasticities[12].

Monetary policy controls the short-term interest rates R_t according to a standard Taylor-type interest rate rule:

$$\frac{R_t}{R} = \left(\frac{\pi_t}{\pi}\right)^{\phi_\pi} \tag{25}$$

where $\phi_\pi > 1$. Later, we will consider the case of a central bank to responding explicitly to the stock market.

3 Equilibrium

In equilibrium, households solve their intertemporal utility maximization problem, firms maximize profits, and all markets clear. Letting $D_t \equiv \int_0^1 D_t(i)di$ denote aggregate nominal dividends and $d_t \equiv D_t/P_t$ their real value, without loss of generality, we normalize to unity the share supply by each firm so that financial market clearing implies $a_t(i) = 1$ for every $i \in [0, 1]$. Market clearing in the goods market is trivial: $y_t = c_t$.

From the definition of firms' profits, it is straightforward to obtain the expression for aggregate dividends d_t:

$$d_t = y_t \left(1 - mc_t \Xi_t\right), \tag{26}$$

where $\Xi_t \equiv \int_0^1 \left[P_t(i)/P_t\right]^{-\epsilon} di$ denotes price dispersion. Recalling that $mc_t = w_t$, making use of the labor supply equation (18) and letting $h_t \equiv \int_0^1 h_t(i)di$ be aggregate hours such that $h_t = \int_0^1 y_t(i)di = y_t \Xi_t$, we have

$$mc_t = (y_t \Xi_t)^{\chi} \tag{27}$$

[12] See Linnemann (2006) for a similar specification.

After combining the expression for $\tilde{x}_t$ in (11) with the household's budget constraint (1), the definition of x_t in (4), and the labor supply equation (18), simple algebra yields $\tilde{x}_t = x_t + q_t + b_t$.

3.1 Households' Near-Rational Expectations

Following Hassan and Mertens (2017), we assume households are *near-rational* when forming conditional expectations on the return on risky equity: namely, the right hand side of the asset price equation (20) becomes

$$\mathcal{E}_t \left[\mathcal{F}_{t,t+1} R^a_{t+1}(i)\right] = \mathbb{E}_t \left[\mathcal{F}_{t,t+1} R^a_{t+1}(i)\right] e_t \tag{28}$$

where $\mathbb{E}_t$ denotes the rational expectation operator (conditional on all available information at time *t*) while e_t is a small expectational error (with unconditional mean $\mathbb{E}(e_t) = 1$), to be interpreted as market sentiment, e.g. optimism (respectively, pessimism) for e_t larger (respectively, smaller) than one.

We assume such a distortion does not apply to the pricing of a risk-less nominal bond with the household maintaining instead full rationality when forecasting his own SDF: that is

$$\mathcal{E}_t \left[\mathcal{F}_{t,t+1}\right] = \mathbb{E}_t \left[\mathcal{F}_{t,t+1}\right] \tag{29}$$

in the bond pricing equation (19). Implicitly, we let the household remain rational when forming expectations on future inflation as the latter interacts with his current and future temptation/self-control incentives (which he is fully cognizant of) to determine his SDF.[13]

Borrowing terminology from Hassan and Mertens (2017), an equilibrium with this expectational set-up will be referred to as a *Near-Rational Expectations Equilibrium* (henceforth, NREE).

3.2 The Behavioral Financial Channel

Plugging the expression for the SDF (21) and for the temptation wedge Γ_{t+1} (22) back into the risk-less bond pricing equation (19), substituting in the equations for $\lambda_{c,t}$ (14) and $\tilde{\lambda}_{c,t}$ (12), and accounting for the expectations formation in (29), after simple manipulation of terms, we arrive at the individual household's Generalized

[13] An equivalent set-up would have $\mathcal{E}_t \left[\mathcal{F}_{t,t+1}\right] = \mathbb{E}_t \left[\mathcal{F}_{t,t+1}\right] e_{b,t}$ with the additional expectational error $e_{b,t}$ orthogonal to e_t.

Euler equation (henceforth, GEE) capturing the marginal benefits of current and future consumption:

$$x_t^{-\sigma}\left(1+\xi\Delta_t^{\zeta}\right)=\beta\mathbb{E}_t\left\{\frac{R_t}{\pi_{t+1}}\left[x_{t+1}^{-\sigma}+\xi\Delta_{t+1}^{\zeta}\left(x_{t+1}^{-\sigma}-\tilde{x}_{t+1}^{-\sigma}\right)\right]\right\}, \tag{30}$$

where, to facilitate the economic interpretation, we recall that

$$\Delta_{t+j}=\frac{\xi\left(\tilde{x}_{t+j}^{1-\sigma}-x_{t+j}^{1-\sigma}\right)}{1-\sigma} \tag{31}$$

$$\tilde{x}_{t+j}=x_{t+j}+b_{t+j}+q_{t+j} \qquad \text{for} \qquad j=0,1. \tag{32}$$

GP preferences induce a *behavioral* financial wealth channel through the effects of current and expected stock market fluctuations on the temptation-related terms $\tilde{x}_t$ and $\tilde{x}_{t+1}$. By the asset price equation (20) and the expectation formation (28), the aggregate stock price index q_t obeys the following dynamic pricing condition:

$$q_t=\beta\mathbb{E}_t\left[\frac{\lambda_{c,t+1}}{\lambda_{c,t}}\Gamma_{t+1}(q_{t+1}+d_{t+1})\right]e_t \tag{33}$$

with marginal utility of consumption $\lambda_{c,t}$ and the temptation wedge Γ_{t+1} still given by, respectively, equations (14) and (22).

A close inspection of how the consumption-saving trade-off embedded in the GEE (30) depends on temptation and the specification of self-control costs is instructive. To start with, consider the case of $\xi=0$, yielding a familiar Euler equation (with the consumption-labor aggregator x_t instead of just consumption c_t because of GHH utility):

$$x_t^{-\sigma}=\beta\mathbb{E}_t\left(\frac{R_t}{\pi_{t+1}}x_{t+1}^{-\sigma}\right) \tag{34}$$

As well understood, in the standard NK model, the optimal consumption-saving trade-off is entirely driven by the *ex ante* real interest rate $\mathbb{E}_t\left(R_t/\pi_{t+1}\right)$. Stock market fluctuations have *neutral* effects on real activity.

Allowing for temptation (i.e. $\xi>0$) but keeping self-control costs linear (i.e. $\zeta=0$), we have instead

$$x_t^{-\sigma}\left(1+\xi\right)=\beta\mathbb{E}_t\left\{\frac{R_t}{\pi_{t+1}}\left[x_{t+1}^{-\sigma}+\xi\left(x_{t+1}^{-\sigma}-\tilde{x}_{t+1}^{-\sigma}\right)\right]\right\} \tag{35}$$

Comparing (35) with (34), temptation increases both the marginal benefits of consumption – since $x_t^{-\sigma}(1+\xi) > x_t^{-\sigma}$ on the left hand side of (35) – and saving (hence, future consumption) – since $\tilde{x}_{t+1} > x_{t+1}$ combined with concave preferences implies that $x_{t+1}^{-\sigma} - \tilde{x}_{t+1}^{-\sigma} > 0$ on its right hand side. For what concerns financial wealth, notice that, on the one hand, under a linear costs specification, the marginal benefits of current consumption do not depend on the most tempting option today, and are therefore insulated from contemporaneous fluctuations in stock prices. On the other hand, the expectation of an upcoming stock market boom increases $\tilde{x}_{t+1}$, which, by the concavity of utility, lowers the marginal gain from falling to temptation tomorrow $\tilde{x}_{t+1}^{-\sigma}$[14]. The ensuing contraction in the marginal costs of future self-control – i.e. $\tilde{x}_{t+1}^{-\sigma} - x_{t+1}^{-\sigma}$ declines – creates an additional incentive to save more, hence consume less today. In summary, under a linear costs specification, current consumption is unaffected by current financial wealth but responds *negatively* to expected financial wealth.

With convex costs (i.e. $\zeta > 0$), a contemporaneous stock market boom makes the *current* tempting option $\tilde{x}_t$ more alluring, and therefore, by increasing the *current* costs of self-control (i.e. higher Δ_t on the left hand side of (30)), exerts a *positive wealth effect* on current consumption. The negative wealth effect induced by the expectation of a future stock market boom described in the previous paragraph remains[15].

3.3 Endogenous Discounting

Alternatively, the temptation-driven wealth effects on consumption can be inspected by looking at the relationship between stock prices and the individual discount factor affecting households' intertemporal marginal rate of substitution. For this purpose, let m_t denote cash-in-hand (henceforth, CIH), the right hand side of the household's budget constraint (1), and define the ratio

$$\vartheta_{x,t} \equiv \frac{x_t}{\tilde{x}_t} = \frac{c_t - \frac{h_t^{1+\chi}}{1+\chi}}{m_t - \frac{h_t^{1+\chi}}{1+\chi}} \tag{36}$$

[14] Anticipating higher future wealth, the household foresees an increase in commitment consumption in the next period. It will be therefore less tempted to use all his wealth for consumption purposes. This logic is in line with the relationship between poverty and self-control documented in the data according to which poorer households face higher costs of self-control as their marginal benefit from falling to the tempting option are higher. See, for instance, Shah et al. (2012) and Mani et al. (2013) for some experimental evidence in support of this.

[15] The partial derivative of the right hand side of the GEE (30) with respect to q_{t+1} is in fact still negative.

where the equality comes from the definitions of x_t and $\tilde{x}_t$ in, respectively, equations (4) and (11). In the discussion to follow, we are going to "neglect" the labor-disutility adjustment entering (36), and, with some abuse of terminology, simply refer to the ratio $\vartheta_{x,t}$ as the average propensity to consume (henceforth, APC)[16]. Furthermore, to simplify the argument while retaining the core logic, let's focus on a perfect foresight equilibrium (henceforth, PFE) of the model – namely, let's rule out uncertainty by setting $e_t = 1$ at all times, and therefore drop the expectation operator $\mathbb{E}_t$ – and consider a log-utility specification, $\sigma = 1$[17]. With the real interest rate $r_{t+1} \equiv R_t/\pi_{t+1}$, along a PFE, the GEE (30) can be written as follows:

$$x_t^{-1} = r_{t+1}\beta_{t+1}x_{t+1}^{-1} \tag{37}$$

$$\beta_{t+1} \equiv \beta\left[\frac{1+\xi\Delta_{t+1}^{\zeta}}{1+\xi\Delta_t^{\zeta}}\left(1-\frac{\xi\Delta_{t+1}^{\zeta}}{1+\xi\Delta_{t+1}^{\zeta})}\vartheta_{x,t+1}\right)\right] \tag{38}$$

$$\Delta_{t+j} = -\xi \ln \vartheta_{x,t+j}, \qquad j = 0, 1 \tag{39}$$

where the expression for self-control costs in (39) follows from $\Delta_t = \xi(\ln\tilde{x}_t - \ln x_t)$ and the definition of $\vartheta_{x,t}$ in (36)[18]. The GEE in (37) equates the marginal rate of substitution between current and future consumption, $x_t^{-1}/\beta_{t+1}x_{t+1}^{-1}$ – with time varying discounting β_{t+1} instead of β – to the real interest rate r_{t+1}.

Lemma 1. *Consider a PFE of the model.*

- *When self-control costs are linear ($\zeta = 0$), the endogenous discount factor β_{t+1} is always lower than β. Furthermore, an increase (respectively, a decline) in anticipated APC $\vartheta_{x,t+1}$ makes households more (respectively, less) impatient*[19].

- *When self-control costs are convex ($\zeta > 0$), the endogenous discount factor β_{t+1} is lower than β if households expect self-control costs not to increase.*

[16] Technically, the APC corresponds to the ratio of consumption to CIH, c_t/m_t. Notice that, because of the GHH utility specification, hours worked h_t are exclusively driven by the real wage w_t, such that, at the partial equilibrium level, the labor-disutility adjustment in (36) is taken as given by the individual.

[17] A log-utility will be our benchmark specification for the rest of the analysis. See Assumption 1 in th next section

[18] Dividing both sides of the GEE (30) by $1 + \xi\Delta_t^{\zeta}$, using the definition of $\vartheta_{x,t}$ in (36), and eliminating the expectation operator, we obtain the perfect foresight GEE given by equations (37)-(39).

[19] This result appears in similar form in Kaplan and Violante (2022) who show that, under linear costs, the effective discount rate depends negatively on households' average propensity to consume, so that those consuming a higher fraction of their wealth (typically, poorer households) tend to act more impatiently. The authors therefore argue that GP preferences can be seen as a *behavioral* alternative to heterogeneous agents incomplete markets models to generate a marginal propensity to consume larger than what obtained for a standard representative agent model.

Proof. See Appendix A.1. □

Under linear costs, individuals always act more impatiently in comparison to the case of standard preferences as temptation outweighs current consumption. Furthermore, the degree of impatience depends positively on their anticipated future APC. Intuitively, the anticipation of spending a larger fraction of their CIH in the next period reduces the expected discrepancy between optimal consumption and its maximum (temptation-driven) level. As future self-control costs appear less cumbersome relative to current costs, there is a stronger incentive to consume more today, making the household more impatient.

As stated in the Lemma, in the case of convexity, temptation does not necessarily make households more impatient at any date along the PFE path. A sufficient (but not necessary) condition is that households expect their self-control costs not to increase over time, which, by the expression in (39), requires a non-decreasing APC profile ($\vartheta_{x,t+1} \geq \vartheta_{x,t}$). Nevertheless, any PFE path that remains in a sufficiently small neighborhood of the steady state – such that $\vartheta_{x,t+1} \approx \vartheta_{x,t}$ – is characterized by higher discounting.[20].

With financial wealth affecting the temptation level of consumption and, as a result, the costs of self-control, the endogenous discount factor β_{t+1} responds then to the stock market. As Corollary 1 shows, whether a boom makes households more or less impatient depends on its timing.

Corollary 1. *The endogenous discount factor β_{t+1} is a strictly decreasing (respectively, increasing) function of the current (respectively, the anticipated future) stock price.*

Proof. See Appendix A.2. □

Following a contemporaneous stock market boom (i.e. a higher q_t), households become more impatient, and are therefore willing to consume more today: by increasing the maximum level of current consumption, a more valuable stock portfolio makes it harder to resist such temptation. The opposite occurs if wealth is instead anticipated to increase the next period (i.e. a higher q_{t+1}) since resisting to temptation will be harder then.

A GP framework with convex costs is therefore general enough to be thought as a possible micro-foundation for models which, building on the seminal work of

[20]Our main analysis will in fact focus on the dynamic responses of output and inflation to a sufficiently small financial shock displacing them from their steady state levels. See Sections 5 and in 6 below.

Uzawa (1968), have introduced a reduced-form relationship between individual discounting and wealth to explain puzzling consumption-saving decisions[21]. Our set-up allows in fact for both *decreasing* and *increasing* marginal impatience – respectively, a positive and a negative relationship between the discount factor and wealth – as considered in that literature[22].

4 Steady State and Calibration

For a generic variable n_t, let's denote by n its steady state value (if the variable is endogenous) or its unconditional mean (if exogenous), and by $\hat{n}_t \equiv \ln(n_t/n)$ its log-deviation from steady state. We focus on a non-stochastic steady state with $e = 1$, zero net inflation $\pi = 1$, and a debt-to-GDP ratio $b_y \equiv b/y$ consistent with empirical evidence (see below for more details). To simplify the analytical expressions, we assume a log-utility specification for both *commitment* and *temptation*.

Assumption 1. $\sigma = 1$ such that $u(x_t) = \ln x_t$, $v(x_t) = \xi u(x_t)$, and $\Delta_t = \xi \ln(\tilde{x}_t/x_t)$.[23]

Similarly to the baseline NK model, real marginal costs are $mc = w = 1/\mu$, where $\mu \equiv \epsilon/(\epsilon - 1)$ denotes the gross price mark-up. The labor supply equation (18) combined with market clearing for goods and technology yields then $y = c = h = (1/\mu)^{1/\chi}$. Substituting the latter into the definition of x_t in (4), straightforward algebra gives $x = \omega y$ for $\omega \equiv \frac{(1+\chi)\mu - 1}{(1+\chi)\mu} \in (0,1)$, while $\tilde{x} = x + b + q$ as stated in (32). The stock price equation (33) gives instead $q = [R/(R-1)]\, d$, where, because of no price dispersion in steady state ($\Xi = 1$), real dividends are simply $d = (1 - mc) = [(\mu - 1)/\mu]\, y$. Steady state output y together with the ratio b_y gives b.

Making use of the definition of $\vartheta_x \equiv (x/\tilde{x}) \in (0,1)$ in (36), at the steady state, the GEE (30) is

$$1 = R\beta \underbrace{\left[1 - \frac{\xi \Delta^{\zeta}}{(1 + \xi \Delta^{\zeta})} \vartheta_x\right]}_{\Gamma \in (0,1)} \qquad \Longrightarrow \qquad \frac{1}{R\beta} = \Gamma(R) \tag{40}$$

where, under Assumption 1, $\Delta = -\xi \ln \vartheta_x > 0$. With Γ depending on R through the

[21] Gul and Pesendorfer (2004) briefly discuss this point in their paper.

[22] See Das (2003), Schumacher (2009) and Strulik (2012) for examples of decreasing impatience, and Drugeon (1996) and Kam (2005) for the opposite case. Ikeda and Ojima (2021) show that, in an environment featuring i) both tempting and non-tempting goods and ii) limited self-control resources, impatience may be increasing or decreasing in wealth depending on whether the tempting good is a luxury or an inferior good.

[23] Our results are not qualitatively affected by this assumption.

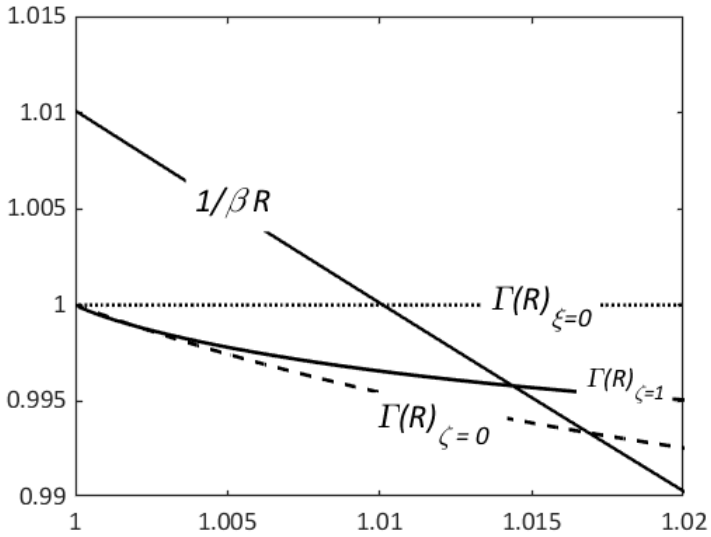


Figure 1: **Steady state interest rate**. $1/\beta R$ is the left hand side of equation (40), $\Gamma(R)$ its right hand side for $\xi = 0$ (dotted), $\xi = 0.2$ and $\zeta = 0$ (dashed), and $\xi = 0.2$ and $\zeta = 1$ (solid). The steady state R is given by the intersection of $1/\beta R$ and $\Gamma(R)$.

term q affecting ϑ_x via $\tilde{x}$, equation (40) implicitly defines the steady state interest rate R. Notice that $\Gamma(R) = 1$ if $\xi = 0$ (no temptation), which yields the usual outcome $R = 1/\beta$.

Proposition 1. *A steady state $R > 1$ always exists.*

Proof. See Appendix A.3 □

Unable to establish uniqueness analytically for a general case, we pursue a numerical characterization of the steady state for a benchmark parameterization of our model and display the result in Figure 1. For what concerns parameters that are common to the standard NK framework, we adopt a textbook calibration: a subjective discount factor $\beta = 0.99$, an inverse Frisch elasticity of labor supply $\chi = 1$, an intra-temporal elasticity of substitution across goods $\epsilon = 6$ (implying a gross price markup $\mu = 1.2$), and a Calvo probability $\theta = 0.75$. Since the model is quarterly, we set the debt-to-GDP ratio b/y equal to 4 (hence, a 100 percent annual debt-to-GDP ratio).

In regard to temptation, we refer to the empirical estimates by DeJong and Ripoll (2007), Huang et al. (2015), and Kovacs et al. (2021), and therefore consider the range $\xi \in [0, 0.3]$. With respect to convexity, we follow Fudenberg and Levine (2011), who show that a log-utility for foregone consumption (temptation) and a

quadratic specification for self-control costs (hence, $\zeta = 1$) fit well the evidence on consumption/savings decisions under risk[24].

Figure 1 plots the left and right hand sides of equation (40) - respectively, $1/\beta R$ and $\Gamma(R)$ - as functions of R, with the steady state corresponding to their intersection. The baseline NK model without temptation ($\xi = 0$) has $\Gamma(R) = 1$ (the flat dotted line) such that $R = 1/\beta \approx 1.01$. With temptation ($\xi = 0.2$) but linear self-control costs ($\zeta = 0$) $\Gamma(R)$ is instead the downward-sloping dashed line, yielding then a higher interest rate, $R \approx 1.0175$ (i.e. a 7% annualized net rate). With convexity (e.g. $\zeta = 1$), $\Gamma(R)$ rotates upwards (the solid line), and the real rate declines to $R \approx 1.0145$ (i.e. a 5.8% annualized net rate)[25].

Corollary 2. *Assume there exists a unique steady state interest rate R solving (40). Then*

1. *R is strictly increasing in temptation ξ;*
2. *there exists a threshold $\vartheta_x^* \in (0, 1)$ such that R is strictly increasing (respectively, decreasing) in convexity ζ for ϑ_x smaller (respectively, larger) than ϑ_x^*.*

Proof. See Appendix A.4. □

An economic rationale for these results can be built from the steady state GEE (40). Letting $\tilde{\beta} \equiv \beta\Gamma$ denote the endogenous discount factor β_{t+1}, as defined in (38), evaluated at the steady state, the GEE written as $1 = \tilde{\beta}R$ yields the standard negative relationship between patience $\tilde{\beta}$ and R. By making households "less patient" – a higher ξ lowers Γ, hence $\tilde{\beta}$ – temptation requires a higher interest rate to induce the equilibrium amount of savings. The effect of convexity depends instead on ϑ_x, a proxy for the APC. Households featuring a small APC – i.e. $\vartheta_x < \vartheta_x^*$ – face higher self-control costs because of a larger positive discrepancy between the maximum and the optimal level of consumption. Higher convexity – i.e., more costly self-control – generates then a stronger incentive to consume more today. As households become *de facto* "less patient" ($\tilde{\beta}$ drops), the interest rate must increase.

At this point, it should be obvious that an arbitrary parameterization of ξ and ζ may deliver an unrealistic value for the long-run interest rate. To avoid that, we

[24]The GP approach features a single agent with preferences over choice sets who attempts to restrict available alternatives. Although the Fudenberg and Levine (2006, 2011) dual-self set-up models the choice between menus as a conflict between two selves, in reduced form, the two environments are very similar

[25]A more extensive quantitative analysis confirms what found for the benchmark calibration: namely, for given temptation, the steady state is always unique irrespective of the convexity of self-control costs.

proceed as follows: for given ξ and ζ, we set β such that $R = 1.01$, corresponding to an annualized net real interest rate of 4%, as consistent with empirical evidence.

5 Linear Equilibrium Dynamics

We log-linearize the equilibrium conditions around the unique non-stochastic steady state. Starting with the central bank, the monetary policy specification in (25) yields a standard linear Taylor rule:

$$\hat{R}_t = \phi_\pi \hat{\pi}_t \tag{41}$$

Moving to the government, its fiscal budget (23) becomes

$$\tau_b \hat{\tau}_t + \hat{b}_t = R(\hat{R}_{t-1} + \hat{b}_{t-1} - \hat{\pi}_t) \tag{42}$$

where $\tau_b \equiv \tau/b = (R-1)$. From the fiscal rule (24) we obtain

$$\hat{\tau}_t = \phi_b \hat{b}_{t-1} + \phi_r(\hat{R}_{t-1} - \hat{\pi}_t) + \hat{f}_t, \tag{43}$$

Imposing the restrictions i) $\phi_r = \bar{R}/\bar{\tau}_b$, and ii) $\phi_b \in \left(\frac{R-1}{\tau_b}, \frac{1+R}{\tau_b}\right)$, the combination of equations (42) and (43) yields $\hat{b}_t = \rho_b \hat{b}_{t-1} + \hat{\varepsilon}_{b,t}$ with $\hat{\varepsilon}_{b,t} \equiv -\tau_b \hat{f}_t$ and $\rho_b \equiv R - \tau_b \phi_b$ strictly inside the unit circle, i.e. public debt follows a stationary AR(1) process, which is consistent with the post-WWII empirical evidence provided by Bohn (1998) and D'Erasmo et al. (2016) for the U.S. Absent fiscal shocks (i.e. $\hat{\varepsilon}_{b,t} = 0$), public debt would stay at its steady state level at all times (a balanced budget policy): $\hat{b}_t = 0$.

Noting that, by the definition $\tilde{\beta} \equiv \beta\Gamma$, $q/(q+d) = \tilde{\beta}$ and $d/(q+d) = 1 - \tilde{\beta}$, the log-linearizaiton of the stock price equation (33) combined with the risk-less bond pricing conditions (19) and (21) yields

$$\hat{q}_t = \tilde{\beta}\mathbb{E}_t \hat{q}_{t+1} + (1-\tilde{\beta})\mathbb{E}_t \hat{d}_{t+1} - (\hat{R}_t - \mathbb{E}_t \hat{\pi}_{t+1}) + \hat{e}_t. \tag{44}$$

Combining the latter with (the linearized versions of) equations (26) for dividends and (27) for marginal costs results in the following expression:

$$\hat{q}_t = \tilde{\beta}\mathbb{E}_t \hat{q}_{t+1} + \lambda_y \mathbb{E}_t \hat{y}_{t+1} - (\hat{R}_t - \mathbb{E}_t \hat{\pi}_{t+1}) + \hat{e}_t, \tag{45}$$

where $\lambda_y \equiv (1-\tilde{\beta})\left[1 - \frac{\chi}{\mu - 1}\right]$. We assume the expectational shock $\hat{e}_t$ follows a stationary AR(1) process:

$$\hat{e}_t = \rho_e \hat{e}_{t-1} + \hat{\varepsilon}_{e,t}, \qquad \text{for} \qquad |\rho_e| < 1, \;\; \hat{\varepsilon}_{e,t} \sim \text{IID}\left(0, \sigma_\varepsilon^2\right). \tag{46}$$

The firms' optimal pricing condition yields the New Keynesian Phillips curve:

$$\hat{\pi}_t = \tilde{\beta}\mathbb{E}_t\hat{\pi}_{t+1} + \kappa_y \hat{y}_t \tag{47}$$

where $\kappa_y \equiv \kappa\chi$ with $\kappa \equiv (1-\tilde{\beta}\theta)(1-\theta)/\theta$. With respect to a temptation-free environment, current inflation appears less sensitive to its next period expectation as $\tilde{\beta} < \beta$.[26]

The demand-side is instead summarized by a IS curve[27]:

$$\hat{y}_t = \alpha\mathbb{E}_t\hat{y}_{t+1} - \delta(\hat{R}_t - \mathbb{E}_t\hat{\pi}_{t+1}) + \gamma\hat{q}_t - \gamma^e\mathbb{E}_t\hat{q}_{t+1} \tag{48}$$

Lemma 2. *All coefficients entering the IS curve are positive. Moreover, the output elasticity to the real interest rate, δ, and to the current stock price, γ, are, respectively, strictly decreasing and strictly increasing in ξ.*

Proof. See Appendix A.5. □

The IS equation differs from the baseline NK model along three dimensions. First, current output responds to its next period expectation with an elasticity α which is not necessarily unity.[28]. Second, following the discussion in Section 3.2, the IS curve displays a *financial wealth channel*: output responds positively (respectively, negatively) to the current (respectively, the expected future) stock market. Hence, despite the absence of financial frictions, the dichotomy between real and financial variables present in the baseline NK model is broken. Third, stronger temptation makes real activity less responsive to the real interest rate (it lowers the interest rate elasticity δ), thus weakening the demand channel of monetary policy stabilization.

[26] However, since a) in our environment $\tilde{\beta} = 1/R$ and b) we calibrate the economy to give $R \approx 1.01$, the elasticity of current inflation to its next period expectation in the Phillips curve (47) is identical to the baseline NK model where $\beta = 1/R$.

[27] See Appendix B.2 for a detailed derivation.

[28] Depending on the parameterization of the model we could have discounting ($\alpha \in (0,1)$) or compounding ($\alpha > 1$). However, we have found that $\alpha \approx 1$ for any realistic parameterization of the model. Hence, at least in this respect, the IS equation behaves similarly to the baseline model

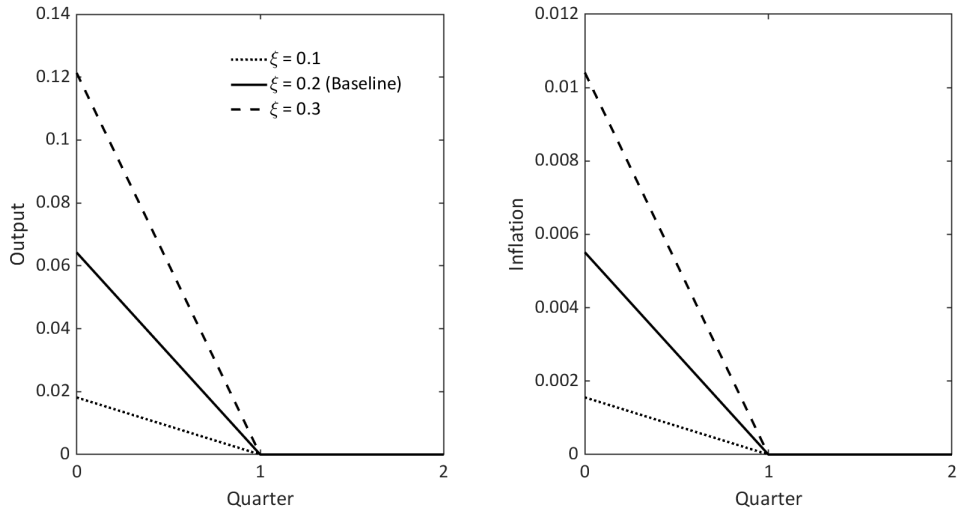


Figure 2: **Impulse Responses to Stock Price Shock: Temptation**. Shock is $e_0 = 1$ (one percent). Key parameters: $\zeta = 1$ (quadratic costs), $\rho_e = 0$ (IID shock).

6 Non-Neutral Stock Price Fluctuations and Stabilization

Armed with this behavioral NK model, we study the responses of output (hence, consumption) and inflation to a positive stock market expectational error occurring at $t = 0$ ($\hat{e}_0 > 0$) along the Minimum State Variable representation of the unique NREE (henceforth, MSV-NREE). We will assess how the outcome relies on the parameterization of GP preferences (specifically, temptation ξ and convexity ζ) and the shock persistence ρ_e. Following Hassan and Mertens (2017), as well as Miao et al. (2021), our benchmark experiment has $\rho_e = 0$, making the *near-rational* financial shock IID. Proposition 2 states our main analytical result.

Proposition 2. *For $\rho_e = 0$, the unique MSV-NREE has $\hat{y}_t = m_y \hat{e}_t$ and $\hat{\pi}_t = m_\pi \hat{e}_t$ with coefficients*

$$m_y \equiv \frac{\gamma}{1 + \kappa_y \phi_\pi (\delta + \gamma)}, \qquad m_\pi \equiv \kappa_y m_y \tag{49}$$

satisfying the following properties: i) given $\xi > 0$, m_y and m_π are strictly positive if and only if $\zeta > 0$; ii) $m_y = m_\pi = 0$ if ξ and/or ζ are zero; and iii) both m_y and m_π are strictly increasing in ξ.

Proof. See Appendix A.6 □

The positive response of real activity to the stock price disturbance is entirely due to the positive wealth effect driven by the convexity of current cost of self-control,

i.e. the term $\gamma\hat{q}_t$ in the IS curve. As discussed in Section 3.2, an increase in current financial wealth makes resisting to temptation very costly, and therefore induces the household to over-consume. Since the shock is IID, the counter-acting negative wealth effect related to the expected future costs of self-control is muted, i.e. the term $-\gamma^e\mathbb{E}_t\hat{q}_{t+1}$ in the IS curve is zero. Strengthening temptation (higher ξ) amplifies the real effects through two distinct channels. On the one hand, the stock price elasticity γ increases: it is more costly to exert self-control. On the other hand, the interest rate elasticity δ declines: as the household becomes more focused on instantaneous gratification (effectively, he becomes more myopic), current consumption responds less to the nominal interest rate hike engineered by the central bank to fight inflation.

Figure 2 provides a visual representation of Proposition 2. Under the baseline parameterization - i.e. $\xi = 0.2$ and $\zeta = 1$ (quadratic self-control costs) - following a non-fundamental 1% stock market increase, output (and consumption) increases by 0.06%, a result which appears consistent with the empirical evidence on the stock market wealth effects on consumption discussed in the Introduction. The response is strictly increasing in the extent of temptation ξ, with the baseline New Keynesian framework ($\xi = 0$) corresponding to the horizontal line at the origin given the neutrality of stock price fluctuations. By the Phillips curve, the financial shock is also inflationary.

A closer look at Proposition 2 also tells us that temptation *per se* is not sufficient for the financial shock to affect real activity and inflation: self-control costs must exhibit some convexity. This is also shown in Figure 3. Under the original GP specification of linear costs with $\zeta = 0$, following the shock, real activity (hence, also inflation) remains at its steady state value (the dotted line at zero), while steeper self-control (e.g. $\zeta = 2$) amplifies the responses.

Although somewhat desirable - as it implies unpredictable expectational errors - assuming the non-fundamental shock to be IID is not without loss of generality. As displayed in Figure 4, introducing persistence initially amplifies the output response - i.e. going from $\rho_e = 0$ (solid line) to $\rho_e = 0.5$ (dashed line) - but eventually leads to a more contained reaction (dotted line). This non-monotonicity is explained by the financial wealth related terms $\gamma_q\hat{q}_t$ and $-\gamma_q^e\mathbb{E}_t\hat{q}_{t+1}$ entering the IS curve (48). Other things equal, persistence makes household expect the stock price to deviate from its fundamental value also in the future. By strengthening the negative wealth effect $-\gamma_q^e\mathbb{E}_t\hat{q}_{t+1}$, persistence thus counteracts $\gamma_q\hat{q}_t$ which instead

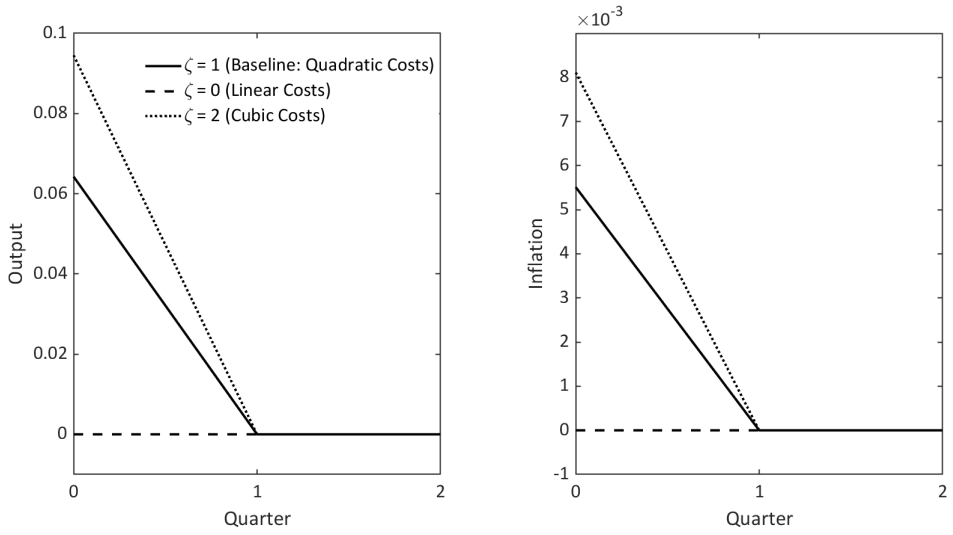


Figure 3: **Impulse Responses to Stock Price Shock: Convexity of Self-Control Costs**. Shock is $e_0 = 1$ (one percent). Key parameters: $\xi = 0.2$, $\rho_e = 0$ (IID shock), and $\phi_q = 0$ (no monetary policy response)

.

captures the contemporaneous positive impact of a stock market boom on real activity through the costs of self-control. This result is also illustrated in Figure 5 which plots the on-impact responses $\hat{y}_0$ and $\hat{\pi}_0$ as functions of ρ_e for $\xi \in [0, 0.3]$.

A natural question is whether having the central bank granting an explicit response to the stock price index - a *leaning against the wind* policy - can tame the real effects of the financial shock[29] As Proposition 3 shows, the answer is yes.

Proposition 3. *Suppose the central bank adopt the following Taylor rule:*

$$\hat{R}_t = \phi_\pi \hat{\pi} + \phi_q \hat{q}_t \tag{50}$$

for $\phi_q > 0$, i.e. it explicitly responds to the stock market. There exits a unique value $\phi_q^* > 0$ such that the financial shock is fully neutralized if and only if $\phi_q = \phi_q^*$. Moreover, $\phi_q^* > 0$ is strictly increasing in temptation ξ

Proof. See Appendix A.7 □

[29]To gather alternative views on the debate between *clean* (i.e. price stability and financial stability are highly complementary goals, hence monetary policy should not explicitly respond to asset prices) versus *lean* (i.e. asset price misalignments generate substantial risk to the stability of the financial system and the broader macroeconomy, calling for a preemptive response by central banks) see, respectively, Bernanke and Gertler (1999, 2001), and Borio and Lowe (2002) and Cecchetti et al. (2003).

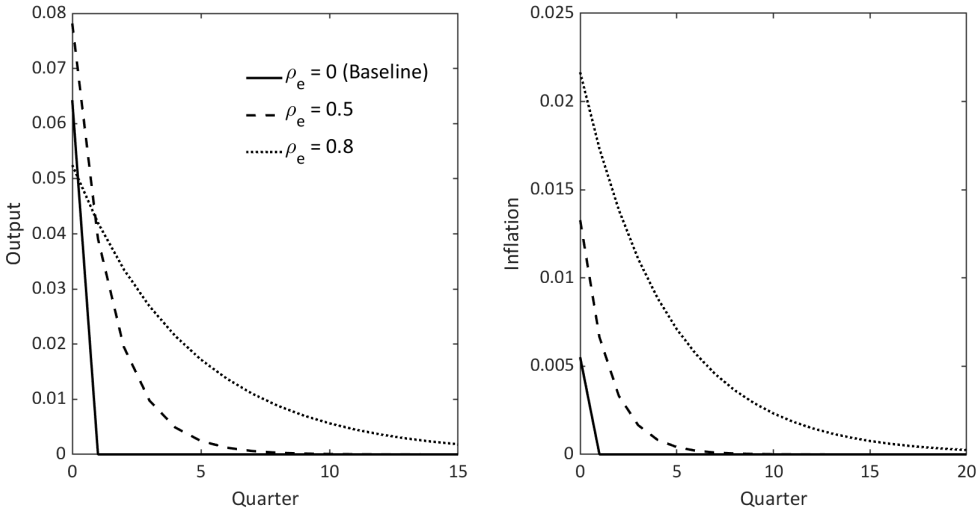


Figure 4: **Impulse Responses to Stock Price Shock: Shock Persistence**. Shock is $e_0 = 1$ (one percent). Key parameters: $\xi = 0.2$, $\zeta = 1$, and $\phi_q = 0$ (no monetary policy response)

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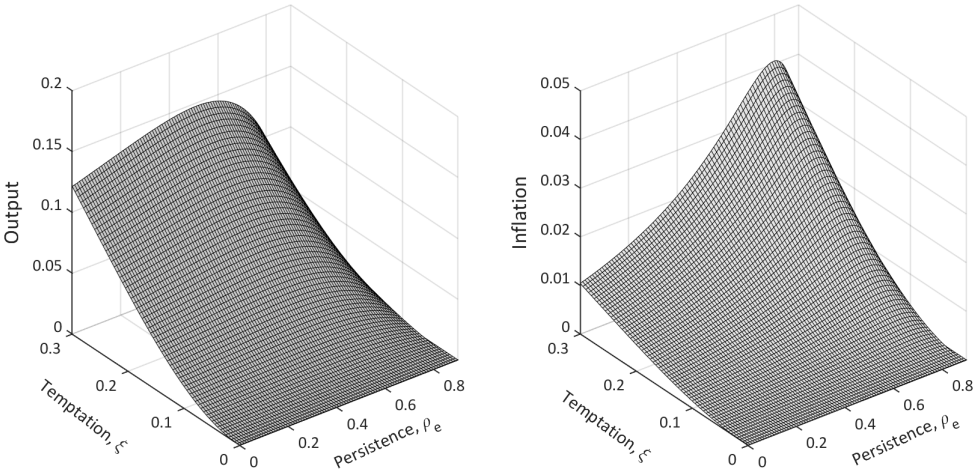


Figure 5: **On-Impact Responses to Stock Price Shock: Temptation and Persistence**. Shock is $e_0 = 1$ (one percent). Key parameters: $\zeta = 1$, and $\phi_q = 0$ (no monetary policy response)

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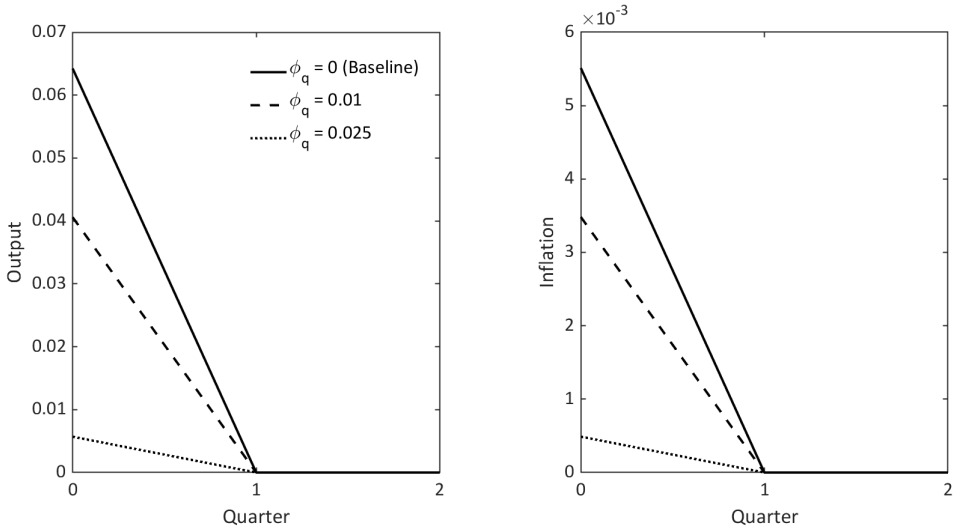


Figure 6: **Impulse Responses to Stock Price Shock: Stabilization**. Shock is $e_0 = 1$ (one percent). Key parameters: $\xi = 0.2$, $\zeta = 1$, and $\rho_e = 0$

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As displayed in Figure 6, a rather small value for ϕ_q suffices to counteract the non-fundamental stock market driven fluctuations. For instance, setting $\phi_q = 0.025$ - a value consistent with the empirical estimates by Aastveit et al. (2023) and Castelnuovo and Nisticò (2010) - the output response is reduced by more than 90 percent.

To conclude the analysis, Figure 7 shows the initial responses of output and inflation for all combinations of temptation ξ and the policy coefficient ϕ_q. For clarity, we only plot positive values (the shaded areas). At one extreme, we have the case of a central bank ignoring stock prices, $\phi_q = 0$: as we move along the temptation axis, the initial responses of output and inflation get larger, a result which is reminiscent of the baseline experiment in Figure 2. At the other extreme, we have the temptation-free baseline NK model, corresponding to the policy coefficient axis: responding to the stock market is clearly undesirable as it is both recessionary and deflationary. Looking at intermediate cases, we can infer that, with appropriate judgment, the central bank's concern for the stock market should be increasing in the extent of temptation.

7 Conclusions

We have presented a *behavioral* New Keynesian model consistent with the view that myopia/limited rationality may by itself - namely, without the introduction of fi-

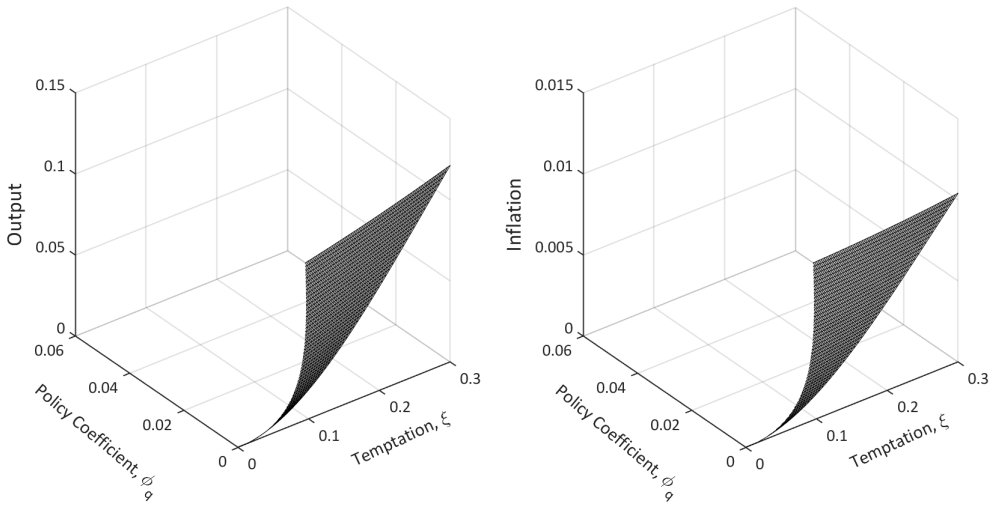


Figure 7: **On-Impact Responses to Stock Price Shock: Temptation and Persistence**. Shock is $e_0 = 1$ (one percent). Key parameters: $\zeta = 1$, and $\phi_q = 0$ (no monetary policy response)

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nancial/credit frictions - influence individuals' consumption choices in response to fluctuations in financial markets. Building on Airaudo (2020), our framework adopts the *temptation with dynamic self-control preferences* paradigm developed by Gul and Pesendorfer (2001, 2004) augmented with the *convex self-control* assumption by Noor and Takeoka (2010) to characterize the intertemporal consumption-saving decision problem of households who, in every period, are tempted to use all their financial wealth for current consumption purposes – thus behaving like *hand-to-mouth* consumers – but incur uphill self-control cognitive costs (disutility) to resist such temptation. Except for this, the model preserves all key ingredients of the baseline New Keynesian set-up, the skeleton of larger scale DSGE models used for monetary policy analysis: namely, a perfectly competitive labor market (where labor demand and supply are perfectly matched at all times), a frictionless financial market (where household can buy/sell risky equity shares of profit-maximizing firms), nominal price rigidities (to give monetary policy a meaningful role), and a government/central bank setting taxes (to stabilize public debt) and interest rates (to affect consumption/saving decisions). In such context, we have assessed the transmission of a purely financial shock taking the form of a small *near-rational* expectational error made by households when forming conditional expectations on the return on risky equity (e.g. market sentiment).

While stock price fluctuations have neutral effects on both real variables (con-

sumption, output, hours worked, etc.) and inflation in the baseline New Keynesian model, Gul-Pesendorfer's preferences generate a *behavioral wealth channel* with *current* and *expected* stock prices exerting, respectively, a *positive* and *negative* influence on real activity. The overall effect depends on two key parameters of the model: the extent of convexity in self-control costs (which boosts the positive effect) and the persistence in the *near-rational* financial shock (which instead amplifies the negative one). Under the benchmark calibration, the model generates a positive response of consumption to a stock market boom with magnitude in line with the empirical literature on financial wealth effects. To conclude, we have shown that, by granting an explicit response to the stock market in its Taylor rule (a lean-against-the-wind policy), the central bank can fully neutralize the temptation-driven real effects of a financial shock.

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Appendix A Proofs

A.1 Proof of Lemma 1

When self-control costs are linear ($\zeta = 0$), the endogenous discount factor (38) simplifies to

$$\beta_{t+1} = \beta\left(1 - \frac{\xi}{1+\xi}\vartheta_{x,t+1}\right) \tag{51}$$

Since $\tilde{x}_t > x_t$ in every period, the ratio $\vartheta_{x,t} \equiv x_t/\tilde{x}_t$ is always smaller than unity: hence, $\beta_{t+1} < \beta$ always. By simple differentiation, β_{t+1} is strictly decreasing in $\vartheta_{x,t+1}$.

Consider now the case of convex costs ($\zeta > 0$). Clearly, for $\beta_{t+1} < \beta$ we need the bracketed factor multiplying β on the right hand side of (38) to be less than one. Letting $G_t \equiv \xi\Delta_t^\zeta$, simple algebra shows that this requires

$$1 - \vartheta_{x,t+1} < \frac{G_t}{G_{t+1}}. \tag{52}$$

A sufficient condition for the inequality to hold is then $G_{t+1} \leq G_t$, which, in turn, requires $\Delta_{t+1} \leq \Delta_t$.

A.2 Proof of Corollary 1

Consider the expression for β_{t+1} in (38) where $\xi\Delta_{t+1}^\zeta = \xi\left(-\xi\ln\vartheta_{x,t+1}\right)^\zeta$. Let $G_{t+j} \equiv \xi\left(-\xi\ln\vartheta_{x,t+j}\right)^\zeta$ for $j = 0, 1$ such that

$$\beta_{t+1} \equiv \beta \left[\frac{1+G_{t+1}}{1+G_t} \left(1 - \frac{G_{t+1}}{1+G_{t+1}} \vartheta_{x,t+1} \right) \right]. \tag{53}$$

Recall that q_t (respectively, q_{t+1}) affect β_{t+1} via the APC $\vartheta_{x,t}$ (respectively, $\vartheta_{x,t+1}$). The partial derivative of β_{t+1} with respect to q_{t+j} for $j = 0, 1$ is then

$$\frac{\partial \beta_{t+1}}{\partial q_{t+j}} = \frac{\partial \beta_{t+1}}{\partial \vartheta_{x,t+j}} \frac{\partial \vartheta_{x,t+j}}{\partial q_{t+j}} \qquad \text{for} \qquad j = 0, 1, \tag{54}$$

where $\partial \vartheta_{x,t+j}/\partial q_{t+j} < 0$ since $\vartheta_{x,t+j} = x_{t+j}/\tilde{x}_{t+j}$ and $\tilde{x}_{t+j} = x_{t+j} + b_{t+j} + q_{t+j}$. For what concerns the current stock price (i.e. $j = 0$ in (54)), simple calculus gives $\frac{\partial \beta_{t+1}}{\partial \vartheta_{x,t}} = \frac{\partial \beta_{t+1}}{\partial G_t} \frac{\partial G_t}{\partial \vartheta_{x,t}} > 0$ (since both partial derivatives are negative), which combined with $\partial \vartheta_x / \partial q_t < 0$ implies that $\partial \beta_{t+1}/\partial q_t < 0$. Moving to the future stock price (i.e. $j = 1$ in (54)), we have instead

$$\frac{\partial \beta_{t+1}}{\partial \vartheta_{x,t+j}} = \frac{\beta}{1+G_t} \left[(1 - \vartheta_{x,t+1}) \frac{\partial G_{t+1}}{\partial \vartheta_{x,t+1}} - G_{t+1} \vartheta_{x,t+1} \right] < 0 \tag{55}$$

since $\vartheta_{x,t+j} \in (0,1)$ and, from the expression for G_{t+j} given at the beginning of this proof, $\partial G_{t+1}/\partial \vartheta_{x,t+j} < 0$.

A.3 Proof of Proposition 1

The steady state interest rate R is the implicit solution to the equality $(\beta R)^{-1} = \Gamma(R)$ stated in (40). Simple calculus shows that its left-hand-side is strictly decreasing and convex in R, with $\lim_{R \to 1^+} (\beta R)^{-1} = 1/\beta > 1$ and $\lim_{R \to +\infty} (\beta R)^{-1} = 0$.

Its right hand side $\Gamma(R)$ depends on R via the stock price $q = [R/(R-1)]\, d$ entering $\tilde{x}$, which, in turn, affects $\vartheta_x \equiv x/(x+b+q)$ and then $\Delta = -\xi \ln \vartheta_x$. Since $\lim_{R \to 1^+} q = +\infty$, we have $\lim_{R \to 1^+} \vartheta_x = 0$ and hence $\lim_{R \to 1^+} \Delta = +\infty$, from which it follows that $\lim_{R \to 1^+} \Gamma(R) = 1$. From $\lim_{R \to \infty} q = 0$ we have instead $\lim_{R \to +\infty} \Gamma(R) \in (0,1)$.

Letting $F(R) \equiv (\beta R)^{-1} - \Gamma(R)$, these properties give $\lim_{R \to 1^+} F(R) > 0$ and $\lim_{R \to \infty} F(R) < 0$. By the Intermediate Value Theorem, we can easily conclude that at least one solution $R > 1$ to $F(R) = 0$ always exists.

A.4 Proof of Corollary 2

Consider again the equality $(\beta R)^{-1} = \Gamma(R, \xi, \zeta)$, which now accounts for the fact that its right hand side depends also on temptation ξ and convexity ζ. Let then $F(R, \xi, \zeta) \equiv (\beta R)^{-1} - \Gamma(R, \xi, \zeta)$. From the proof of Proposition 1 we know already that, for given ξ and ζ, there exists at least one value for $R \geq 1$ solving $F(R, \xi, \zeta) = 0$. To guarantee uniqueness, assume $\Gamma_R > -1/(\beta R^2)$ for $R \geq 1$ (*) such that $F(R, \xi, \zeta)$ is strictly decreasing in R[30].

By the Implicit Function Theorem, we have that

$$\frac{\partial R}{\partial \xi} = -\frac{F_\xi}{F_R} = \frac{\Gamma_\xi}{-\frac{1}{\beta R^2} - \Gamma_R} \qquad \text{and} \qquad \frac{\partial R}{\partial \zeta} = -\frac{F_\zeta}{F_R} = \frac{\Gamma_\zeta}{-\frac{1}{\beta R^2} - \Gamma_R}. \tag{56}$$

From these partial derivatives and assumption (*), it immediately follows that $\text{sign}\left(\frac{\partial R}{\partial \xi}\right) = -\text{sign}\left(\Gamma_\xi\right)$ and $\text{sign}\left(\frac{\partial R}{\partial \zeta}\right) = -\text{sign}\left(\Gamma_\zeta\right)$.

Recalling the expression for Γ from (40) and writing $\xi\Delta^\zeta = \xi^{1+\zeta}\ln\vartheta_x^{-1}$, simple calculus yields

$$\Gamma_\xi = -\vartheta_x \frac{(1+\zeta)\xi^\zeta \ln\vartheta_x^{-1}}{(1+\xi\Delta^\zeta)^2} < 0 \tag{57}$$

$$\Gamma_\zeta = -\vartheta_x \frac{\xi\Delta^\zeta \ln\Delta}{(1+\xi\Delta^\zeta)^2} \gtreqless 0 \qquad \text{iff} \qquad \Delta \lesseqgtr 1. \tag{58}$$

From (57), we can conclude that $\partial R/\partial \xi$ is always positive: the steady state interest rate is always increasing in temptation. Since $\Delta = -\xi \ln\vartheta_x$, simple algebra shows that the inequality $\Delta \lesseqgtr 1$ in (58) is equivalent to $\vartheta_x \gtreqless \vartheta_x^*$ for $\vartheta_x^* \equiv [1/\exp(1)]^{1/\xi} \in (0, 1)$. This together with (58) and previous discussion allows us to conclude that

$$\frac{\partial R}{\partial \zeta} \gtreqless 0 \qquad \text{iff} \qquad \vartheta_x \lesseqgtr \vartheta_x^* \tag{59}$$

[30] To shorten the notation we let f_x denote the partial derivative of a generic function f with respect to its argument x. Simple but tedious calculus shows that $\lim_{R\to 1^+} \Gamma_R = -\omega \in (0, 1)$. Hence, given that $\beta \in (01)$, assumption (*) is likely to hold for R sufficiently close to unity.

A.5 Proof of Lemma 2

The proof makes repeated use of the composite coefficient $\varkappa$, φ_x, φ_q, ψ_x and ψ_q. Letting

$$K \equiv \frac{\zeta}{-\ln\vartheta_x} > 0 \qquad M \equiv \frac{\xi\Delta^\zeta}{1+\xi\Delta^\zeta} \in (0,1) \tag{60}$$

simple algebra allows to re-write them as follows

$$\varkappa = \frac{\vartheta_x\xi\Delta^\zeta}{1+(1-\vartheta_x)\xi\Delta^\zeta} \qquad \varphi_x = 1+(1-\vartheta_x)KM \qquad \varphi_q = \vartheta_q KM \tag{61}$$

$$\psi_x = (1-\vartheta_x)(1-K+KM) \qquad \psi_q = \vartheta_q(K-1-KM) \tag{62}$$

Notice that, since $\Delta = -\xi\ln\vartheta_x$, the term $\xi\Delta^\zeta$ entering some of the above expressions is equivalent to $\xi^{1+\zeta}\left[-\ln(\vartheta_x)\right]^\zeta$. Simple calculus then gives $\partial F/\partial\xi > 0$, a property we will use below.

Interest rate elasticity, δ. Given the definition $\delta \equiv (x_y\varphi_x)^{-1}$ and the expression for φ_x, we have that i) $\delta \in (0, x_y^{-1})$, and ii) $\partial\delta/\partial\xi < 0$ (since $\partial M/\partial\xi > 0$).

Current stock price elasticity, γ. Combining the definitions of γ and δ in (95), we have that $\gamma = x_y^{-1}(\varphi_q/\varphi_x)$. Since φ_q and φ_x are both positive, so is γ. Making use of the expressions in (61) above, simple calculus gives

$$\frac{\partial\gamma}{\partial\xi} = x_y^{-1}\frac{\vartheta_q}{\left[1+KM\left(1-\vartheta_x\right)\right]^2}K\frac{\partial M}{\partial\xi} > 0 \tag{63}$$

(Negative) expected stock price elasticity, γ^e. From its definition in (95), since $\delta > 0$, we have that $\text{sign}(\gamma^e) = \text{sign}(\varphi_q - \varkappa\psi_q)$. Using the expressions for $\varkappa$, ψ_q and ψ_q in (61)-(62), simple algebra and rearrangement of terms gives

$$\varphi_q - \varkappa\psi_q = \frac{\vartheta_q}{1+(1-\vartheta_x)\xi\Delta^\zeta}\left[K+(1-K)\vartheta_x\xi\Delta^\zeta\right] \tag{64}$$

It follows that a sufficient condition for γ^e to be positive is that $K \leq 1$. From the definition of K in (60), in the baseline case of $\zeta = 1$ (quadratic costs), this is equivalent to $\vartheta_x \leq 1/\exp(1) \approx 0.37$. This weak inequality holds for any realistic calibration of the model. To see why, rewrite ϑ_x as follows:

$$\vartheta_x \equiv \frac{x}{x+b+q} = \frac{\omega}{\omega+b_y+q_y} \tag{65}$$

where the second equality comes from dividing both the numerator and denominator by output y, recalling that $x = \omega y$, and introducing steady state ratios $b_y \equiv b/y$ and $q_y \equiv q/y$. Then, notice that ϑ_x is strictly increasing in ω with $\omega \in (0,1)$: hence, ϑ_x is bounded above by $\bar{\vartheta}_x \equiv (1 + b_y + q_y)^{-1}$. To guarantee that $K \leq 1$ we just need to show that $\bar{\vartheta}_x \leq 0.37$. To do so, consider first the stock-price-to-output ratio q_y entering $\bar{\vartheta}_x$. From the steady state expressions given in Section 4, we have that $q_y = [R/(R-1)]\,[(\mu-1)/\mu]$. It is straightforward to check that the latter is strictly larger than unity for $\mu > R$, a condition that holds for any realistic calibration of steady state mark-ups (e.g. $\mu \geq 1.1$) and the gross real interest rate (e.g. $R \leq 1.01$ at quarterly frequency). With $q_y > 1$, it is enough for $b_y > 1$ at quarterly frequency (hence, $b_y > 0.25$ annually) – a very mild restriction considering that the majority of industrialized economies has $b_y > 1$ annually – for $\bar{\vartheta}_x < 1/3$ and therefore lower than the required threshold. It then follows that $K \leq 1$ and therefore that γ^e is strictly positive.

Expected output elasticity, α. Plugging the expressions for $\varkappa$, φ_x and ψ_x into the definition of α given in (95), simple algebra gives

$$\alpha = 1 + \frac{\vartheta_x \xi \Delta^\zeta}{1 + (1-\vartheta_x)\xi\Delta^\zeta} \frac{(1-\vartheta_x)(1-K+KM}{1+(1-\vartheta_x)KM} \tag{66}$$

Clearly, if $K \leq 1$ (a condition that easily holds for any realistic calibration of the mode, as just discussed for γ^e) then $\alpha > 1$.

A.6 Proof of Proposition 2

Let's conjecture the MSV solution $\hat{y}_t = m_y \hat{e}_t$, $\hat{\pi}_t = m_\pi \hat{e}_t$ and $\hat{q}_t = m_q \hat{e}_t$. Since $\rho_e = 0$, along the unique MSV-NREE equilibrium, all variables are expected to return to their steady state value after one period, i.e. $\mathbb{E}_t \hat{n}_{t+1} = 0$ for $n = y, \pi, q$. The linearized system made of the IS curve (48), the Phillips curve (47), the stock price equation (45) and the Taylor rule (41) simplifies to the following

$$\hat{y}_t = -\delta\phi_\pi \hat{\pi}_t + \gamma \hat{q}_t \tag{67}$$

$$\hat{\pi}_t = \kappa_y \hat{y}_t \tag{68}$$

$$\hat{q}_t = -\phi_\pi \hat{\pi}_t + \hat{e}_t \tag{69}$$

Using the conjectured solution and applying the method of undetermined coefficients, simple algebra yields

$$m_y = \frac{\gamma}{1 + \kappa_y \phi_\pi (\delta + \gamma)}, \qquad m_\pi = \kappa_y m_y, \qquad m_q = 1 - \phi_\pi m_\pi. \tag{70}$$

Next, we study how the coefficient m_y depends on temptation ξ. Some intermediate steps facilitate the analysis. To start with, making use of the definitions of composite coefficients δ and γ given in (95) of Appendix B.2, we re-write m_y as follows:

$$m_y = \frac{x_y^{-1}\varphi}{1+\kappa_y\phi_\pi x_y^{-1}\eta} \tag{71}$$

where, for analytical convenience, we have defined $\varphi \equiv \varphi_q/\varphi_x$ and $\eta \equiv (1+\varphi_q)/\varphi_x$. By the expressions for φ_x and φ_q given by, respectively, equations (90) and (91) in Appendix B.2, it should be clear that both φ and η depend on ξ.[31] Simple calculus and algebra yields that

$$\text{sign}\left(\frac{\partial m_y}{\partial \xi}\right) = \text{sign}\left[x_y^{-1}\frac{\partial \varphi}{\partial \xi} + x_y^{-2}\kappa_y\phi_\pi\left(\frac{\partial \varphi}{\partial \xi}\eta - \varphi\frac{\partial \eta}{\partial \xi}\right)\right] \tag{72}$$

To figure out the partial derivatives $\partial\varphi/\partial\xi$ and $\partial\eta/\partial\xi$, we refer again to the expressions for φ_x and φ_q, and, letting $Z \equiv \frac{\zeta}{-\ln(\vartheta_x)}\frac{\xi\Delta^\zeta}{1+\xi\Delta^\zeta}$ (which is strictly positive since $\Delta > 0$ and $\vartheta_x \in (0,1)$), we conveniently re-write φ and η as follows:

$$\varphi = \frac{Z\vartheta_q}{1+Z(1-\vartheta_x)}, \qquad \eta = \frac{1+Z\vartheta_q}{1+Z(1-\vartheta_x)} \tag{73}$$

Differentiating both of them with respect to ξ, we obtain:

$$\frac{\partial \varphi}{\partial \xi} = \frac{\vartheta_q}{[1+Z(1-\vartheta_x)]^2}\frac{\partial Z}{\partial \xi} \tag{74}$$

$$\frac{\partial \eta}{\partial \xi} = -\frac{\vartheta_b}{[1+Z(1-\vartheta_x)]^2}\frac{\partial Z}{\partial \xi} \tag{75}$$

$$\frac{\partial \varphi}{\partial \xi}\eta - \frac{\partial \eta}{\partial \xi}\varphi = \frac{\vartheta_q}{[1+Z(1-\vartheta_x)]^2}\frac{\partial Z}{\partial \xi} \tag{76}$$

where (75) makes use of the equality $\vartheta_x+\vartheta_b+\vartheta_q = 1$ (see Appendix B.2), while (76) combines (74)-(75) with the expressions for φ and η in (73). Substituting (74)-(76) back into (77), it easily follows that

$$\text{sign}\left(\frac{\partial m_y}{\partial \xi}\right) = \text{sign}\left(\frac{\partial \varphi}{\partial \xi}\right) = \text{sign}\left(\frac{\partial Z}{\partial \xi}\right) \tag{77}$$

Finally, since $\xi\Delta^\zeta = \xi^{1+\zeta}[-\ln(\vartheta_x)]^\zeta$ in the definition of Z, simple calculus gives that $\partial Z/\partial\xi > 0$. We can therefore conclude that $\partial m_y/\partial\xi > 0$: strengthening temptation amplifies the response of output (and therefore also inflation) to the non-fundamental financial shock.

[31] The remaining parameters and composite coefficients entering (71) do not.

A.7 Proof of Proposition 3

Assume the central bank sets the interest rate according to the following Taylor rule: $\hat{R}_t = \phi_\pi \hat{\pi}_t + \phi_q \hat{q}_t$. Following the same steps in the proof of Proposition 2, given the *iid* shock, the MSV-NREE solution has a similar structure (namely $\hat{y}_t = m_y \hat{e}_t$ and $\hat{\pi}_t = \kappa_y m_y \hat{e}_t$) where now

$$m_y = \frac{\gamma - \delta\phi_q}{1 + \kappa_y \phi_\pi (\delta + \gamma)} \tag{78}$$

Using the definitions of γ and δ given in (95), its numerator is equivalent to $\delta(\varphi_q - \phi_q)$ with φ_q given by (91). It follows that $m_y = 0$ if and only if $\phi_q = \phi_q^* \equiv \varphi_q$. Letting $Z \equiv \frac{\zeta}{-\ln(\vartheta_x)} \frac{\xi\Delta^\zeta}{1+\xi\Delta^\zeta}$ such that $\phi_q^* = \vartheta_q Z$, simple differentiation gives

$$\frac{\partial \phi_q^*}{\partial \xi} = \vartheta_q \frac{\partial Z}{\partial \xi} > 0, \tag{79}$$

since, as shown in the proof of Proposition 2, $\partial Z / \partial \xi > 0$.

Appendix B Additional Derivations

B.1 Intertemporal Consumption-Saving Decision

At the interior solution, equation (16) reads

$$\lambda_{c,t} = \beta \mathcal{E}_t \frac{\partial U_{t+1}}{\partial b_t} \tag{80}$$

By the Envelope Theorem

$$\begin{aligned} \frac{\partial U_t}{\partial b_{t-1}} &= \lambda_{c,t} \frac{R_{t-1}}{\pi_t} - \left[\frac{\xi}{1-\sigma} \left(\tilde{x}^{1-\sigma} - x_t^{1-\sigma} \right) \right]^\zeta \xi \tilde{x}_t^{-\sigma} \frac{R_{t-1}}{\pi_t} \\ &= \frac{R_{t-1}}{\pi_t} \left(\lambda_{c,t} - \Delta_t^\zeta \tilde{\lambda}_{c,t} \right) \end{aligned} \tag{81}$$

where the first equality follows from simple calculus and the fact that $\partial \tilde{x} / \partial b_{t-1} = R_{t-1}/\pi_t$ from the expression for $\tilde{x}_t$ in (11), while the second makes use of the expressions for Δ_t and $\tilde{\lambda}_{c,t}$ in, respectively, (5) and (12).

Shifting (81) one period forward and plugging the result back into (80), after a simple rearrangement of terms, we obtain

$$\begin{aligned}\lambda_{c,t} &= \beta \mathcal{E}_t \left[\frac{R_t}{\pi_{t+1}} \left(\lambda_{c,t+1} - \Delta_{t+1}^{\zeta} \tilde{\lambda}_{c,t+1} \right) \right] \\ &= \beta \mathcal{E}_t \left[\frac{R_t}{\pi_{t+1}} \lambda_{c,t+1} \Gamma_{t+1} \right] \end{aligned} \tag{82}$$

where $\Gamma_{t+1} \equiv 1 - \Delta_{t+1}^{\zeta} \frac{\tilde{\lambda}_{c,t+1}}{\lambda_{c,t+1}}$. Dividing both sides by $\lambda_{c,t}$ and letting $\mathcal{F}_{t,t+1} \equiv \beta \left(\lambda_{c,t+1} / \lambda_{c,t} \right) \left(\Gamma_{t+1} / \pi_{t+1} \right)$ denote the household's stochastic discount factor, we obtain the risk-less bond pricing equation (19). The pricing equation for risky equity (20) is reached following similar steps starting from equation (17).

B.2 IS Curve Derivation

This section provides a detailed derivation of the aggregate IS curve equation (48). Log-linearizing the risky equity pricing conditions (19) and (21) we obtain

$$\hat{\lambda}_{ct} = \hat{R}_t - \mathbb{E}_t \hat{\pi}_{t+1} + \mathbb{E}_t \hat{\lambda}_{ct+1} + \mathbb{E}_t \hat{\Gamma}_{t+1} \tag{83}$$

where, from the definition of Γ_{t+1} in (22),

$$\hat{\Gamma}_{t+1} = -\varkappa (\zeta \hat{\Delta}_{t+1} + \hat{\tilde{\lambda}}_{c,t+1} - \hat{\lambda}_{c,t+1}) \tag{84}$$

$$\varkappa \equiv \frac{\vartheta_x \xi \Delta^{\zeta}}{1 + (1 - \vartheta_x) \xi \Delta^{\zeta}} > 0. \tag{85}$$

Accounting for the fact that fiscal policy keeps government debt at its steady state level at all times – i.e. $\hat{b}_t = 0$ for every $t \geq 0$ – the expressions for Δ_t in (5), $\tilde{\lambda}_{c,t}$ in (12), $\lambda_{c,t}$ in (14) and $\tilde{x}_t$ in (32) give the linear terms entering (84):

$$\hat{\lambda}_{c,t} = -\varphi_x \hat{x}_t + \varphi_q \hat{q}_t \tag{86}$$

$$\hat{\tilde{\lambda}}_{c,t} = -(\vartheta_x \hat{x}_t + \vartheta_q \hat{q}_t) \tag{87}$$

$$\hat{\Delta}_t = \frac{1}{-\ln \vartheta_x} \left[(\vartheta_x - 1) \hat{x}_t + \vartheta_q \hat{q}_t \right] \tag{88}$$

with composite coefficients

$$\vartheta_q \equiv \frac{q}{\tilde{x}} \in (0,1) \tag{89}$$

$$\varphi_x \equiv 1 + (1-\vartheta_x)\left(\frac{\zeta}{-\ln\vartheta_x}\right)\left(\frac{\xi\Delta^\zeta}{1+\xi\Delta^\zeta}\right) \tag{90}$$

$$\varphi_q \equiv \vartheta_q\left(\frac{\zeta}{-\ln\vartheta_x}\right)\left(\frac{\xi\Delta^\zeta}{1+\xi\Delta^\zeta}\right) \tag{91}$$

Before proceeding we make two remarks: i) since $\vartheta_x, \vartheta_q \in (0,1)$ we have that $\varphi_x \geq 1$ and $\varphi_q \geq 0$; and ii) if we let $\vartheta_b \equiv b/\tilde{x}$, the equilibrium equality $\tilde{x} = x + b + q$ implies that $\vartheta_x + \vartheta_b + \vartheta_q = 1$[32]. Plugging (86)-(88) in (84), and re-arranging terms, the temptation wedge $\hat{\Gamma}_{t+1}$ becomes

$$\hat{\Gamma}_{t+1} = -\varkappa(\psi_x \hat{x}_{t+1} + \psi_q \hat{q}_{t+1}) \tag{92}$$

$$\psi_x \equiv \frac{\zeta}{-\ln\vartheta_x}(\vartheta_x - 1) - \vartheta_x + \varphi_x, \qquad \psi_q \equiv \frac{\zeta}{-\ln\vartheta_x}\vartheta_q - \vartheta_q - \varphi_q \tag{93}$$

Substituting the expressions for $\hat{\lambda}_{c,t}$ (86) and $\hat{\Gamma}_{t+1}$ (92) back into (83), and rearranging terms, we get:

$$\hat{x}_t = \varphi_x^{-1}\left[(\varphi_x + \varkappa\psi_x)\,\mathbb{E}_t\hat{x}_{t+1} - \left(\hat{R}_t - \mathbb{E}_t\hat{\pi}_{t+1}\right) + \varphi_q\hat{q}_t - (\varphi_q - \varkappa\psi_q)\,\mathbb{E}_t\hat{q}_{t+1}\right] \tag{94}$$

The log-linearization of x_t in (4) combined with market clearing/technology $\hat{y}_t = \hat{c}_t = \hat{h}_t$ yields $\hat{x}_t = x_y\hat{y}_t$ for $x_y \equiv (\mu - 1)/\omega\mu$. Plugging the latter into (94), simple algebra gives the final expression for the IS curve (48) in the main text:

$$\hat{y}_t = \alpha\mathbb{E}_t\hat{y}_{t+1} - \delta(\hat{R}_t - \mathbb{E}_t\hat{\pi}_{t+1}) + \gamma\hat{q}_t - \gamma^e\mathbb{E}_t\hat{q}_{t+1}$$

where

$$\alpha \equiv \frac{\varphi_x + \varkappa\psi_x}{\varphi_x}, \qquad \delta \equiv \frac{1}{\varphi_x x_y}, \qquad \gamma \equiv \delta\varphi_q, \qquad \gamma^e \equiv \delta(\varphi_q - \varkappa\psi_q) \tag{95}$$

[32]Clearly, we have that $\varphi_x = 1$ and $\varphi_q = 0$ only in the limiting cases of $\xi = 0$ (no temptation) and/or $\zeta = 0$ (linear costs).