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NEO-FISHERIAN POLICIES AND LIQUIDITY TRAPS

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NEO-FISHERIAN POLICIES AND LIQUIDITY TRAPS

Abstract

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JEL Classification: E3, E4, E5, E6

Keywords: confidence and fundamental liquidity traps, neo-Fisherian, monetary policy, forward guidance, Fiscal multipliers, optimal policy

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Florin O. Bilbiie[II]

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1 Introduction

The majority of policymakers in OECD countries today have to confront what once seemed only a theoretical possibility: a liquidity trap (LT). In its extreme incarnation, Japan is well into its third decade; the Eurozone also graduated its first, and the US visited after the 2008 financial crisis until late 2015. The stubborn persistence of the trap, in particular in Japan, can be taken as evidence that perhaps not everything has been learned about how to deal with it.

Yet much *has* been learned, in large part thanks to several seminal studies. For our purposes it is useful to distinguish among these the two dominant LT theories: the first, introduced by the path-breaking work of Benhabib, Schmitt-Grohé, and Uribe (2001a,b; 2002), ascertains that LTs are triggered by a "confidence" shock (or expectation, sunspots, or pessimism)—with no change in fundamentals. The second, due to the equally path-breaking work of Eggertsson and Woodford (2003), holds as the source of LTs changes in economic fundamentals—e.g. households' tastes, changes in spreads (Curdia and Woodford (2016)), or deleveraging (Eggertsson and Krugman (2012)). I refer to the former LT variety as "confidence-driven" or BSGU (by the initial of their main proponents); and the latter as "fundamental", or EW.[1]

This paper proposes a unified treatment of these two complementary theories in a simplified framework that captures their duality. This allows a transparent understanding of the conditions for their respective occurrence, and of the effects and optimal design of macro policies therein. A first analytical insight is that the very same condition governs the possibility of *both* confidence-driven traps *and* "neo-Fisherian" effects (short-run expansionary-inflationary interest rate increases, Schmitt-Grohé and Uribe (2014, 2017)).[2]

The common analytical condition is that shocks be persistent enough (have enough of a "news" component); and that a key composite parameter—the equilibrium aggregate-demand elasticity to future income news, which depends chiefly on the degree of price flexibility—be large enough. When the opposite holds fundamental traps prevail, in which interest rate increases are contractionary. This has an intuitive interpretation in terms of income versus substitution effects and how they shape the key "news elasticity", as well as an insightful graphical representation.

This duality of LT varieties is a general theme: standard monetary-fiscal policies (forward guidance, public spending, labor tax rates) have diametrically opposed effects depending on the trap variety—this has been noticed and discussed in the context of fiscal stimulus in important work by Mertens and Ravn (2014) based on a numerical analysis of the nonlinear NK model.[3] My simpler framework owes much to that insightful contribution, which it extends not only to

[1] Earlier pioneering work explored the consequences of the ZLB in formal New Keynesian models, e.g. Fuhrer and Madigan (1997), Wolman (1998), Orphanides and Wieland (1998), Krugman (1998), and Svensson (1999).

[2] A separate recent literature abstracts from LT analysis focusing on neo-Fisherian effects under a Taylor rule: Cochrane (2017), Garin, Lester, and Sims (2018), Uhlig (2018).

[3] Learnability and e-stability of the confidence-driven equilibrium are the subject of a separate literature, see Evans et al (2008), Benhabib et al (2014), and Christiano, Eichenbaum, and Johannsen (2018). Schmidt (2016) studies fiscal rules that eliminate confidence-driven traps.

different (monetary) policies but also to an analysis of optimal policies. Worryingly, none of the standard set of policies "works" (is expansionary) in both cases.

The sharp divide translates to optimal policies too: they are diametrically opposed according to the trap type. Existing analysis focused on fundamental traps, the chief insight being that optimal monetary policy implies "forward guidance" FG (keeping rates low beyond the end of the trap)—starting with Eggertsson and Woodford (2003), and extended by Jung, Teranishi and Watanabe (2005), Adam and Billi (2006), and Nakov (2008). Refinements focused on uncertainty, institutional arrangements, and "sustainable" policies—Nakata (2014), Nakata and Schmidt (2016), and Walsh (2016). Bilbiie (2016) models FG as a state, calculating its closed-form optimal duration (a proxy to fully-optimal Ramsey policy) and proposing a simple rule that approximates it: announcing an FG duration of "*half of the trap's duration times the disruption*".

In the realm of optimal *fiscal* policy, Woodford (2011) found that optimal public spending in a fundamental LT is positive, and increasing with the recession's duration and depth. The landmark analyses of Eggertsson (2010) and Christiano, Eichenbaum, and Rebelo (2011) had shown that fundamental-LT *spending multipliers* are large; in a deep LT-recession therefore, insofar as spending also yields some direct utility benefit, it is optimal to stimulate the economy—increasing private consumption when its marginal utility is high.[4]

In a confidence-driven trap, the *opposite* prescriptions apply. Optimal MP consists of increasing interest rates—exploiting the Neo-Fisherian effects emphasized by Schmitt-Grohé and Uribe— and cutting them back after the trap; unlike for FG in fundamental LTs, this implies no tradeoff and no time-inconsistency or credibility issue. Nevertheless, even if the central needs to keep rates high, committing to be very aggressive to inflation once the trap is over achieves the same outcome—this is the opposite of FG.[5] Optimal fiscal policy in confidence-driven traps is also the opposite: it consists of cutting spending or labor taxes. This novel analytical finding is naturally aligned with the positive insights pertaining to multipliers—themselves the opposite of fundamental traps, as shown by Mertens and Ravn (2014) and here in the linearized NK model (Braun et al (2016) focus on multipliers in similar equilibria of the nonlinear model).

In view of this paper's analysis, it is essential to disentangle empirically which LT variety occurs—since that determines what policy works. Two important recent contributions shed light on this question. Aruoba, Cuba-Borda and Schorfheide (2018) estimate a DSGE model and find support for the Japan LT having been confidence-driven, but not for the US; while Uribe (2018) finds evidence for both Japan and the US that neo-Fisherian effects prevail. My findings provide additional testable implications for this hypothesis and chiefly inform the choice of optimal policies.

[4] Nakata (2016) and Schmidt (2013) studied jointly-optimal monetary-fiscal policies showing that uncertainty creates more scope for stimulus, which it is optimal to frontload (a conclusion shared by Werning (2012)). The main normative conclusions extend to a medium-scale DSGE model reproducing the Great Recession, as shown by Bilbiie, Monacelli and Perotti (2018).

[5] In a similar vein, Coyle and Nakata (2018) show that another prescription is opposite: the risk of entering a confidence trap *lowers* the optimal inflation *target*.

2 Neo-Fisherian Effects Under a Peg

Throughout, I use the standard loglinearized NK model the detailed treatment of which can be found in Woodford (2003) or Gali (2008); this consists of a Phillips-Aggregate Supply PC-AS curve relating inflation π with consumption c_t:

$$\pi_t = \kappa c_t + \beta E_t \pi_{t+1}, \tag{1}$$

where the slope $\kappa = \psi\left(\varphi + \sigma^{-1}\right)$ is the product of an index of price stickiness ψ (going from 0 for fixed prices to infinity for flexible prices) and the sum of inverse labor elasticity φ and the income effect on labor supply—which with separable CRRA preferences corresponds to the coefficient of risk aversion σ^{-1}. The latter is also the inverse of the elasticity of intertemporal substitution in the other key equation, the IS-AD (Aggregate Demand) curve:

$$c_t = E_t c_{t+1} - \sigma\left(i_t - E_t \pi_{t+1} - \rho_t\right), \tag{2}$$

where i_t is the short-term nominal interest rate *in levels* (not deviations) and ρ_t an exogenous process for the natural rate with $\rho = \beta^{-1} - 1$ in steady state.

To understand the key mechanisms for the link between neo-Fisherian effects and confidence-driven traps, start with permanent peg (this extreme case gives the sharpest results and intuition but is not necessary; recent analyses show how this extends to standard Taylor rules with interest-rate smoothing, see Cochrane (2017), Garin, Lester and Sims (2018), and Uhlig (2018)). Assume that the central bank sets i_t as an exogenous process i_t^* with persistence μ, $E_t i_{t+1}^* = \mu i_t^*$, and ignore natural-rate shocks ρ_t. The purely forward-looking model (1)-(2) is then evidently indeterminate; but we can choose *one* equilibrium, in particular the most "reasonable" one in which there is no extra persistence induced by indeterminacy. This is called the "minimum state variable MSV" solution by McCallum (1998) and Lubik and Schorfheide (2004), with $E_t \pi_{t+1} = \mu \pi_t$. Under this solution, (1) becomes:

$$\pi_t = \frac{\kappa}{1 - \beta\mu} c_t \tag{3}$$

Replacing in (2) we obtain:

$$c_t = \nu\left(\mu\right) E_t c_{t+1} - \sigma i_t^* \tag{4}$$

$$\text{where } \nu\left(\mu\right) \equiv 1 + \sigma \frac{\kappa}{1 - \beta\mu} \geq 1$$

is a key parameter capturing the elasticity to future "news" shocks on aggregate demand-income $E_t c_{t+1}$. With either $\mu = 0$ or $\beta = 0$ this is $\nu\left(\mu\right) = \nu = 1 + \kappa\sigma$: future income means future demand, future expected inflation, lower real rates, and intertemporal substitution towards today. When the shock is persistent and the PC is forward-looking $\beta > 0$, this is further amplified as the whole future path of income matters for current inflation through (3). Replacing the MSV conjecture $E_t c_{t+1} = \mu c_t$ in (4) we obtain Proposition 1.[6]

Proposition 1 ***Neo-Fisher Effect:*** *Under a peg interest rate increases are expansionary, inflationary, and reduce the real rate $r_t = i_t - E_t \pi_{t+1}$:*

$$\frac{\partial c_t}{\partial i_t^*} = -\frac{\sigma}{1-\mu\nu(\mu)}; \frac{\partial \pi_t}{\partial i_t^*} = -\frac{\nu(\mu)-1}{1-\mu\nu(\mu)}; \frac{\partial r_t}{\partial i_t^*} = \frac{1-\mu}{1-\mu\nu(\mu)}.$$

if and only if they are ***persistent enough*** *and there is enough* ***news-amplification****, namely:*

$$\mu\nu(\mu) > 1.$$

It is instructive to start with the two limit cases. The case of zero persistence $\mu = 0$ illustrates the standard intertemporal-substitution NK channel: an increase in interest rates makes agents want to save more and, with zero equilibrium savings, income must adjust downwards; as consumption falls, so does demand and there is deflation—even though expected inflation does not move, so that the ex-ante real rate increases, giving agents' the right incentives for the intertemporal allocation with an increasing consumption path. At the other extreme, with permanent change $\mu = 1$ we have the ("old") Fisher effect: inflation increases one-to-one, and consumption by $(1-\beta)/\kappa$ (insofar as prices are not fully flexible, κ finite).

Starting from the zero-persistence case and increasing persistence, the effects are amplified: the recession, deflation, and real rate increase get larger. Persistent shocks trigger income effects: anticipating high rates for a while, agents want to save even more, and income adjusts down to bring savings back in line; deflation ensues because income and demand go down, and they go down because deflation delivers the increase in real rate consistent with that intertemporal allocation. Finally, conditional upon there being a deflation, more price flexibility implies a deeper deflation and recession: the intuition is clear, since more price flexibility implies a larger supply feedback and a larger elasticity to news $\nu(\mu)$. Figure 1 plots the elasticity of consumption (left) and real rate (right) calculated in Proposition 1 (inflation is proportional to consumption), as a function of shock persistence, for two values of PC-AS slope $\kappa = 0.02$ (solid) and more flexible prices $\kappa = 0.2$ (dashed), with $\sigma = 1$ and $\beta = 0.99$. Starting from zero persistence, this illustrates the mechanism discussed before, with the recession getting deeper and the real rate increasing—more so with more flexible prices.

The key insight is that this recession-deflation-high real rates response is *not monotonic* over the domain of persistence (and price stickiness). As the shock becomes more persistent and/or

[6] With $\beta = 0$ we obtain a simple case $\pi_t = \kappa c_t$ giving $c_t = \nu E_t c_{t+1} - \sigma i_t^*$ and since $\nu \equiv 1 + \kappa\sigma \geq 1$ we *need to* solve the equation "backward" by MSV to obtain $c_t = -\frac{\sigma}{1-\nu\mu} i_t^*$. Attempting to solve "forward" yields the *FG puzzle* (Del Negro et al) as the equation explodes; in particular for a one-time interest rate cut at time $t+T$: $\partial c_t / \partial \left(-i_{t+T}^*\right) = \sigma \nu^T$ which is increasing with T. Evidently, this case of *indeterminacy* is the very rationale for an active (Leeper, 1991) rule $i_t = \phi \pi_t$, $\phi > 1$ under which the root becomes $\nu = \frac{1+\kappa\sigma}{1+\kappa\sigma\phi} < 1$ allowing one to solve the equation forward.

prices more flexible the recession becomes unboundedly large, violating equilibrium: the model features a discontinuity at $\mu\nu(\mu) = 1$, which is a bifurcation. To see this rewrite the IS-AD curve under the conjectured expectations:

$$c_t = \frac{\sigma\mu}{1-\mu}\pi_t - \frac{\sigma}{1-\mu}i_t^* \tag{5}$$

In the region $\mu\nu(\mu) < 1$, PC-AS (3) is steeper than IS-AD (5); as the persistence and/or price flexibility increase (or labor elasticity decreases) the two curves overlap (at the bifurcation point) and then cross, with IS-AD becoming steeper and crossing PC-AS from below. (I use such graphical representations when discussing LTs below, see Figures 2-4.)

In this "neo-Fisherian" region, interest-rate increases are expansionary, inflationary and decrease real rates, for with persistent enough shocks there are over-compensating income effects that dominate the substitution effects when prices are flexible enough. To be sure, the initial effect is still that agents want to save more at given inflation; but if the shock persistence μ is high enough and the compounding of news $\nu(\mu)$ is strong enough this leads to higher income, higher demand, and inflation: The substitution effect then follows, adjusting to bring savings back to zero as the real rate goes down, not up. This is an example of a fallacy of composition: one agent wants to save more, but in general equilibrium the whole economy saves less (consumes more). The neo-Fisherian region, illustrated in Figure 1 by the areas with positive consumption elasticity and negative real rate elasticity, is the mirror image of the previous: herein, more persistence and more price flexibility now make the effects *smaller* in absolute value—the limit cases of permanent shock or fully flexible prices delivering the "old" Fisher effect with unchanged real rates.

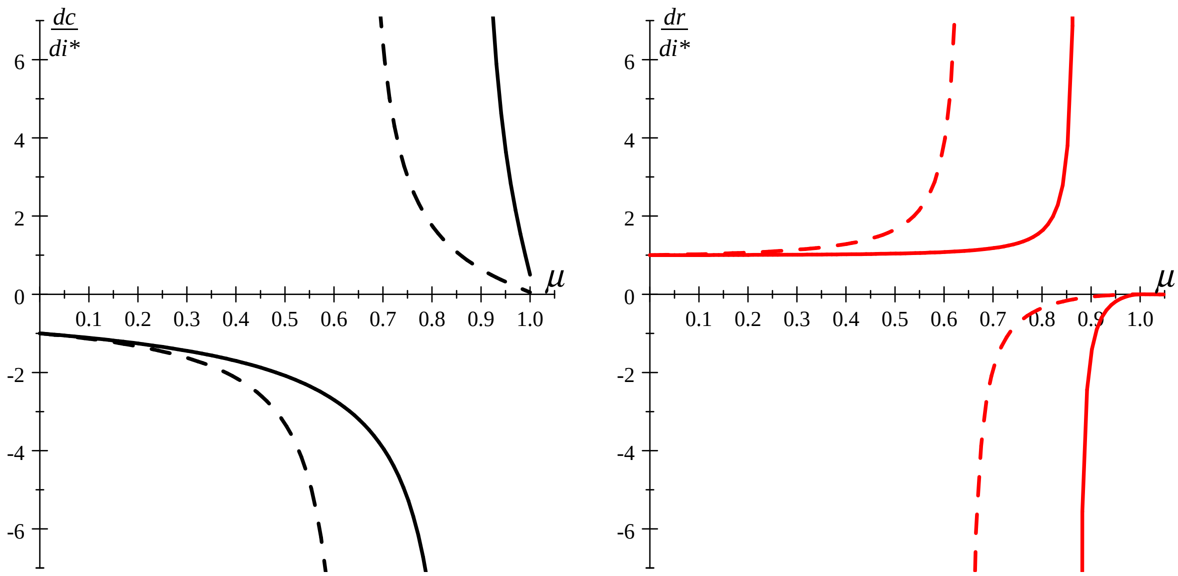

Fig. 1: Neo-Fisherian Effects

We will now see that the same intuition governs the possibility of confidence-driven traps, whereby neo-Fisherian effects *intrinsically* apply.

3 Fundamental and Confidence-Driven Liquidity Traps: A Simple Unified Framework

In this Section I relax the permanent-peg assumption and analyze the two LT varieties under an active policy rule. Throughout, I assume that uncertainty (be it fundamental or not) evolves according to a Markov chain. Since the model is linear and forward-looking, endogenous variables inherit the persistence of these exogenous forces. In particular, there are two states: the first, "intended" steady state $(i,\pi,c)^I = (\rho,0,0)$ is absorbing (once in it, the economy stays there).

Liquidity traps occur when the second state materializes and the model's endogenous forces make the lower bound bind. This state is transitory with persistence probability z_j, and transition probability $1-z_j$, where j is an index for the shock source: no index when fundamental (z), and s for sunspot-confidence (z_s). The duration of the transitory state is a random variable T with expected value $E(T) = (1-z_j)^{-1}$. Given this Markov chain structure and the Taylor rule:

$$i_t = \max\left(0, \rho_t + i_t^* + \phi\pi_t\right), \tag{6}$$

with $\phi > 1$, we conjecture and verify that the LT equilibrium is time-invariant, regardless of the source of uncertainty; denote by (c_L, π_L) consumption and inflation in this equilibrium, prevailing for any time t between 0 and T (after date T it is straightforward to show that the system formed by (1), (2) and (6) has a unique equilibrium $(i_t,\pi_t,c_t)^I = (i,\pi,c)^I = (\rho,0,0)$). Equation (1) implies $\pi_L = \frac{\kappa}{1-\beta z_j}c_L$ and, with a binding lower bound $i_L = 0$, (2) implies:

$$c_L = \frac{\sigma}{1-z_j\nu(z_j)}\rho_j;\ \ \pi_L = \frac{\nu(z_j)-1}{1-z_j\nu(z_j)}\rho_j \tag{7}$$

$$\text{with } \nu(z_j) \equiv 1+\sigma\frac{\kappa}{1-\beta z_j}.$$

A **fundamental (EW) LT equilibrium** occurs when a fundamental shock makes agents want to save more: in the transitory state of the Markov chain the natural rate takes the value $\rho_j = \rho_L < 0$ between 0 and T. As clear from (7), this is an equilibrium with a recession and deflation ($c_L < 0;\ \pi_L < 0$) if and only if:

$$z_j\nu(z_j) < 1. \tag{8}$$

This is the opposite of Proposition 1: the compounding of future shocks $\nu(.)$ should *not* be too strong, and the persistence of shocks (their "news" component) should be *low enough.* ZLB binds if $\rho_L + \phi\pi_L < 0$, that is $1+\phi\frac{\nu(z)-1}{1-z\nu(z)} > 0$, which always holds as long as (8) holds.[7]

[7] The exact threshold defined in (8) is $z < \left(1+\sigma\kappa+\beta-\sqrt{(1+\sigma\kappa+\beta)^2-4\beta}\right)/2\beta$ with the most intuitive

A **confidence-driven (BSGU) LT equilibrium** can instead occur *without* any fundamental shock: $\rho_j = \rho > 0$. Agents recognize a second "unintended" steady state where the ZLB binds $(i, \pi, c)^U = (0, -\rho, -\rho(1-\beta)/\kappa)$ and randomize between $(i, \pi, c)^I$ and $(i, \pi, c)^U$: they believe that the latter occurs today and will persist tomorrow with probability z_s. A self-fulfilling LT occurs if *the same condition* as for Neo-Fisherian effects under a peg (Proposition 1) holds:

$$z_s \nu(z_s) > 1,$$

since (with $\rho > 0$) a deflationary-recession can only occur when the denominator in (7) is negative. This is an equilibrium: the ZLB binds when $\rho + \phi\pi_L \leq 0$, i.e. $\phi > 1 - \nu(z_s)\frac{1-z_s}{\nu(z_s)-1}$, which always holds with $\phi > 1$.[8]

Notice that this is the *exact complement* to the condition for fundamental traps (8): the two cannot occur at the same time. Figure 2 illustrates each case by plotting with black solid line the PC-AS $c_L = \frac{1-\beta z_j}{\kappa}\pi_L$ and with dashed (red) broken line the IS-AD, having replaced the Taylor rule: $c_j = -\frac{\sigma}{1-z_j}\max\left(0, \rho_j + i_j^* + \phi\pi_L\right) + \frac{\sigma z_j}{1-z_j}\pi_L + \frac{\sigma}{1-z_j}\rho_j$, using the parameterization $\kappa = 0.02$, $\phi = 1.5$ and for the EW trap $\rho_j = \rho_L = -0.005$ (2 percent per annum) and $z = 0.8$, while for the BSGU trap $\rho_j = \rho = 0.01$ and $z_s = 0.95$; in both cases $i^* = 0$. (The dotted line represents the case of $i^* > 0$ covered in the next subsection.)

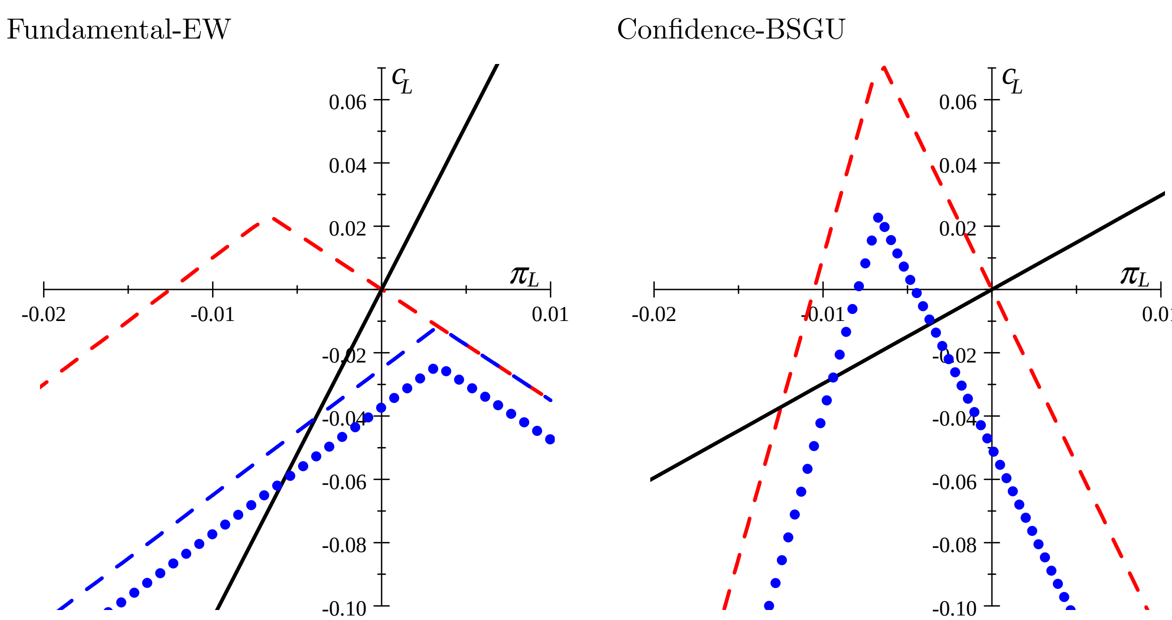

Fig. 2: Fundamental vs Confidence-Driven Traps and Neo-Fisherian effects

The EW LT occurs as agents decide to save more and consume less today; this shifts their

interpretation in the limit $\beta \to 0$ (obtained with l'Hopital's rule): $z < \nu^{-1} = (1+\sigma\kappa)^{-1}$.The threshold for ZLB depends only on persistence not on scale ρ_L because the Taylor rule tracks the natural rate; if it did not, the threshold would also depend on the relative size of ρ_L/ρ.

[8] Nakata and Schmidt (2016) and Armenter (2018) show that confidence-driven traps also occur under optimal *discretionary* policy.

"savings curve" through an (intertemporal) substitution effect. But in equilibrium savings are zero, so income needs to fall. In equilibrium with sticky prices there is deflation, which at the zero bound implies a real-rate increase consistent with zero savings at lower income. The ensuing recession and deflation are larger, the longer-lived is the disruption, the higher the elasticity of intertemporal substitution, and the more flexible are prices. All these features magnify the amplification that leads to the deflationary-recession spiral, up to a threshold—much like interest rate increases are contractionary when the condition of Proposition 1 fails.

The opposite mechanism applies for the BSGU trap. If agents are pessimistic enough, they expect low future income. They still demand more savings, but *now* due to an income effect. With zero savings in equilibrium, the substitution effect compensates as there is deflation and a higher real rate, and consumption falls simply because agents are pessimistic "enough". For this to materialize, prices have to be flexible enough to provide the equilibrium deflation making the sunspot self-fulfilling (in the flex-price limit with horizontal PC-AS the tiniest sunspot shock is self-fulfilling: prices adjust instantly to make it so). But unlike in the previous EW trap, price flexibility now makes the recession smaller.

The equilibrium recession and deflation implied by the *radically different* theories may nevertheless be *indistinguishable*: for the calibration in Figure 2, they both deliver a 4-percent recession (with slightly different deflation). Disentangling between the two theories thus requires additional exercises; the next section suggests such testable implications. The confidence-trap hypothesis is appealing for explaining long-lasting LTs with deflation—with Japan a most illustrative example. To reproduce an LT duration of 25 years, the simple model needs to deliver an equilibrium with $z = 0.99$. Recalling (8), the upper threshold for fundamental LTs is very stringent $\kappa < .0002$: the model needs very sticky, almost fixed prices; yet in Japan inflation consistently undershot the 2 percent target throughout the two and a half decades, sometimes falling below minus 2 percent. In light of the Japanese experience, a confidence trap (which instead *requires* $\kappa > .0002$) seems rather plausible.

4 Neo-Fisherian Effects of Macro Policies

The key intuition for the occurrence of both neo-Fisherian effects and traps is that the IS-AD curve is not only upward sloping, but more so than the PC-AS curve. It follows naturally that the effects of policies shifting the two curves are also diametrically different—and so are optimal policies.

4.1 *The* Neo-Fisher Effect: Expansionary Interest-Rate Increases?

The neo-Fisher effect in a LT is formalized by considering a discretionary change in the nominal rate (i_t^* in (6)) following a Markov chain with $i^* > 0$ and persistence z_j in the LT, and $i^* = 0$ in steady state. The LT solution is now:

$$c_L = \frac{\sigma}{1 - z_j \nu(z_j)} \left(\rho_j - i^*\right); \; \pi_L = \frac{\nu(z_j) - 1}{1 - z_j \nu(z_j)} \left(\rho_j - i^*\right). \tag{9}$$

Clearly, in a fundamental trap there are no neo-Fisherian effects: an increase in i^* deepens the recession when $z\nu(z) < 1$: agents save more, exacerbating the excess-saving deflationary spiral characteristic of fundamental LTs. This is illustrated by the left panel of Figure 2: the IS-AD shifts downwards to the dotted curve.

In a confidence-driven trap with $z_s \nu(z_s) > 1$ neo-Fisherian effects are consubstantial. In the right panel of Figure 2, the IS-AD still shifts down to the dotted broken line—but moving along a flatter PC-AS, it implies an expansion and inflation. Agents do initially want to save more and consume less, but they are already in an equilibrium with low income. Furthermore, saving cannot increase (it is zero in equilibrium), so the income effect needs to be moving in the other direction. This cannot be an equilibrium as it is inconsistent with further deflation, higher rates, and lower income. The equilibrium instead features inflation, lower real rate, and higher income to re-equilibrate the asset market (making agents not want to save despite the initial increase in rates).

4.2 Forward Guidance

To model FG, I follow the analytical approach in Bilbiie (2016) assuming that after the (random) T at which the trap ends, the central bank commits to keep the interest rate at 0 with probability q; denote this third state F. The probability to transition from L to L is still z_j, and from L to F it is $(1 - z_j) q$. The persistence of state F is q, and the probability to move back to steady state from F is $1 - q$ (with expected FG duration $(1 - q)^{-1}$). Under this stochastic structure, expectations are determined by $E_t x_{t+1} = z_j x_L + (1 - z_j) q x_F$ for both consumption and inflation $x = c, \pi$. Evaluating (2) and (1) during F and solving for the equilibrium therein delivers:

$$c_F = \frac{\sigma}{1 - q\nu(q)} \rho; \; \pi_F = \frac{\kappa}{1 - \beta q} c_F \tag{10}$$

where $\nu(q) = 1 + \frac{\sigma\kappa}{1-\beta q}$. Announcing zero rates after the trap creates a future expansion and inflation, regardless of the LT variety—but what does it imply *during* the trap? Using the FG equilibrium (10) and expectations formation, the solution is:

$$c_L = \frac{(1 - z_j) q\nu(q, z_j)}{1 - z_j \nu(z_j)} c_F + \frac{\sigma \rho_j}{1 - z_j \nu(z_j)}, \tag{11}$$

where $\nu(q, z_j) = 1 + \frac{\sigma\kappa}{(1-\beta z_j)(1-\beta q)} \geq 1$.

In the EW trap ($z\nu(z) < 1$ and $\rho_j = \rho_L < 0$) the future expansionary effect of FG mitigates the LT recession. Agents anticipate low real rates and high income and increase their consumption today, shifting their savings demand up (as in the left panel of Figure 3 to the dotted broken AD line) which also leads to inflation today.

In a confidence-driven trap, FG backfires: it still creates an expansion in the future, which shifts the IS-AD curve up (agents want to consume more today at given inflation). But because of the over-compensating income effects that make the neo-Fisherian equilibrium possible to start with, it implies a *deepening of the recession* during the trap.[9] In equilibrium, there is deflation and higher real rates—making zero savings optimal even though agents receive good news and would otherwise like to cut savings. The right panel of Figure 3 illustrates this: the AD broken line shifts up (dotted) but the equilibrium is at the intersection with the (flatter) PC line, further south-west (more deflation, larger recession).

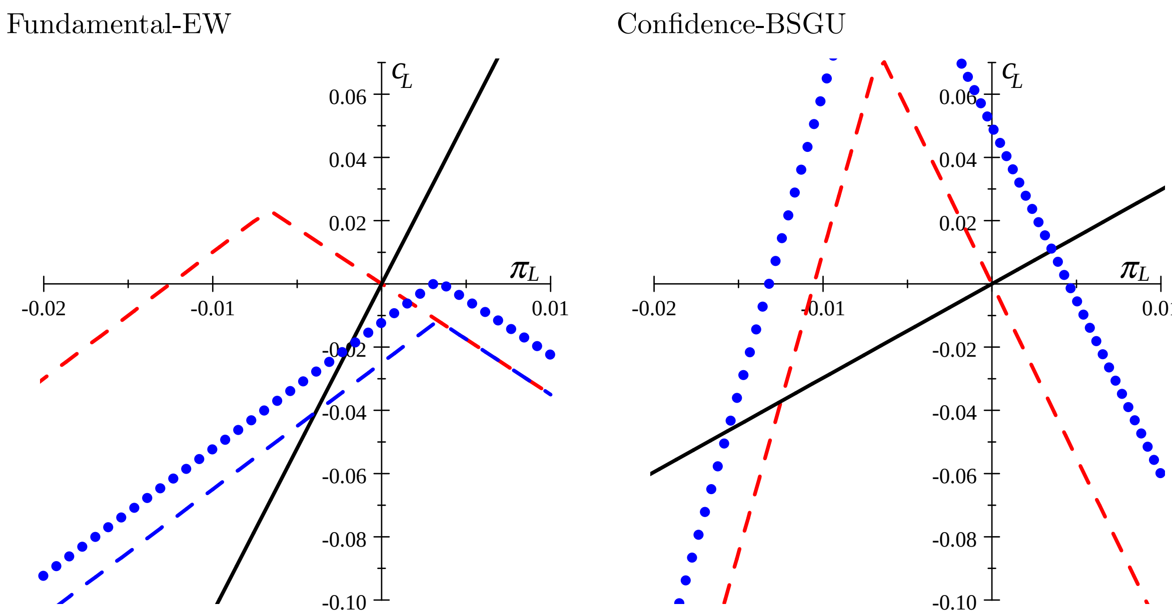

Fig. 3: Forward Guidance

4.3 Fiscal Multipliers: Public Spending and Labor Taxes

To model the effects of government spending and labor taxes, I extend the model following Eggertsson (2010), Christiano, Eichenbaum, and Rebelo (2011), Woodford (2011), and Mertens and Ravn (2014). The government has two instruments, the variations of which it covers every period using lump-sum transfers. First, it buys goods with the steady-state share in GDP G_Y and g_t the

[9] The expression is:

$$\frac{dc_L}{dq} = \frac{1-z_j}{1-z_j\nu(z_j)}\left[q\nu(q,z_j)\frac{dc_F}{dq} + [\nu(q,z_j) + q\nu_q(q,z_j)]\,c_F\right] < 0$$

in BSGU traps. I abstract from policies with $q\nu(q) > 1$ which generate a recession in the future to create an expansion today. As we will see n the next section, another policy option dominates and implies no tradeoff: increase rates today.

deviations of public as a share of private spending $g_t = \frac{G_Y}{1-G_Y}\frac{G_t-G}{G}$. Second, it changes marginal labor-tax rates τ_t^h, with $\tau_t = \frac{\tau_t^h-\tau^h}{1-\tau^h}$. The only modification is to the Phillips curve:

$$\pi_t = \beta E_t \pi_{t+1} + \kappa c_t + \kappa\zeta\left(g_t + \varphi^{-1}\tau_t\right). \tag{12}$$

where $\zeta = \frac{\sigma}{\varphi^{-1}+\sigma} \leq 1$, with $\sigma \equiv -\frac{U_C}{U_{CC}Y} = -\frac{U_C}{U_{CC}C}\left(1-G_Y\right)$.

Assuming that the two fiscal instruments have the same stochastic structure as whatever triggers the LT, with values (g_L, τ_L) during the LT and the conditional probability z_j that they prevail next period, the equilibrium is:

$$\begin{aligned} c_L &= \frac{\sigma}{1-z_j\nu\left(z_j\right)}\rho_j + M_c\left(g_L + \varphi^{-1}\tau_L\right), \\ \pi_L &= \frac{\nu\left(z_j\right)-1}{1-z_j\nu\left(z_j\right)}\rho_j + \frac{1-z_j}{\sigma z_j}M_c\left(g_L + \varphi^{-1}\tau_L\right), \end{aligned} \tag{13}$$

where:

$$M_c \equiv \zeta z_j \frac{\nu\left(z_j\right)-1}{1-z_j\nu\left(z_j\right)}$$

denotes "the multiplier" of public spending on private consumption, with $\varphi^{-1}M_c$ the multiplier of labor tax rates.

The multipliers are both positive in the fundamental trap, but *both negative* in the confidence-driven trap. The former is by now well-understood: a persistent increase in public spending creates future demand and expected inflation. With fixed nominal rates, this implies lower real rates and—intertemporal substitution—higher demand and actual inflation today. The negative income effect of lump-sum taxation makes agents work more to produce this extra demand. This is represented in the left panel of Figure 4, with PC-AS shifting right to the dotted line: public spending is inflationary at given demand, and equilibrium is reached at the intersection with the broken dashed (blue) lower AD line, with an expansion and inflation relative to the initial LT. Something similar occurs for increases in labor tax rates, which are also inflationary, insofar as labor supply is at least to some extent elastic $\varphi^{-1} > 0$.

The opposite holds in the confidence-driven trap, as shown numerically and discussed by Mertens and Ravn's landmark paper in a nonlinear NK model. Take an increase in spending with $\tau_L = 0$: the negative income effect applies to desired saving, which goes down—in line with what triggers the confidence-driven LT in the first place. But with zero equilibrium savings, another (substitution-effect) force needs to pull desired savings up: the real interest rate increases further, which at the zero bound happens with more *deflation* and *lower* income.

In a confidence-driven LT, this contractionary force intrinsically dominates the expansionary one—extra demand leading to inflation, with the negative income effect making it optimal to work more to produce it—whereas in the fundamental trap, the latter dominates. Intuitively, the former dominates the latter (making both confidence-driven LT possible and the multiplier negative) if prices are flexible enough, shocks are persistent enough, or labor is inelastic enough. This is illustrated in the right panel of Figure 4: the increase in public spending is still inflationary at given demand—it shifts PC-AS right, to the dotted line. But due to the over-compensating income effects inherent in a confidence-driven LT, the IS-AD curve is more upward-sloping than the PC-AS and the equilibrium moves at the intersection with the dashed line, with a deeper recession and deflation. By a very similar mechanism, an increase in labor tax rates, although inflationary at *given* demand, is also contractionary and deflationary (insofar as labor is at least to some extent elastic).

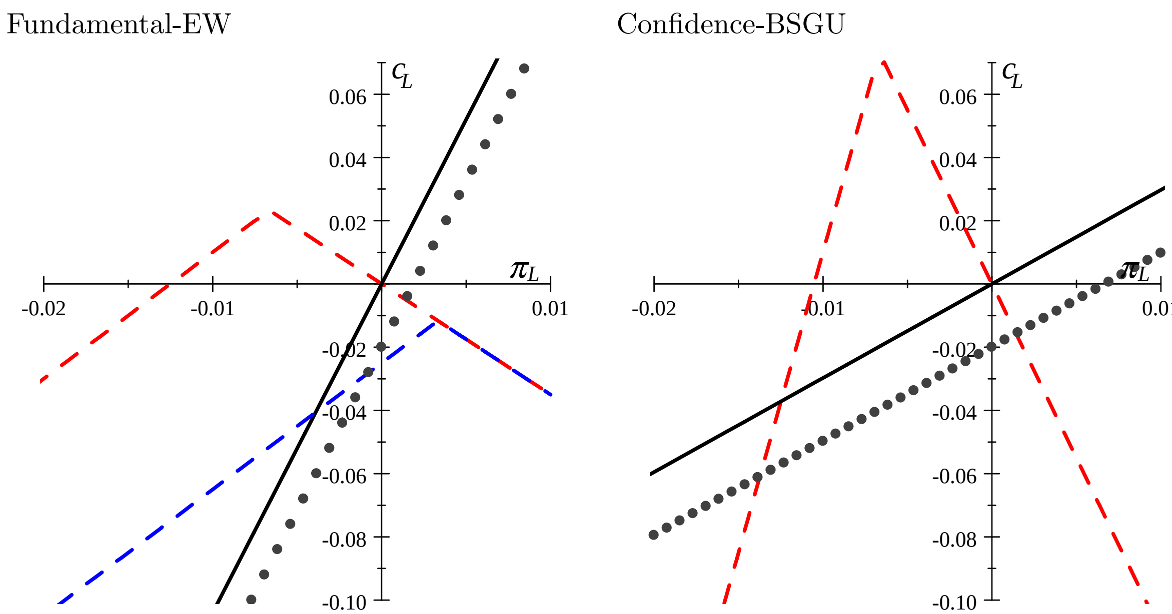

Fig. 4: Government Spending

5 Optimal Neo-Fisherian Macro Policies

The normative prescriptions are very much aligned with these positive insights. The welfare function can be written as a second-order approximation to household utility, which includes the direct utility derived from public spending (see e.g. Woodford (2011)):

$$\frac{1}{2}E_0\sum_{t=0}^{\infty}\beta^t\left[\pi_t^2+\omega_c\left(c_t+\zeta g_t\right)^2+\omega_g g_t^2\right],$$

where the weights are:

$$\omega_c=\frac{\kappa}{\varepsilon};\omega_g=\omega_c\left(1-\zeta\right)\left(\zeta+\frac{\sigma}{\sigma_G}\right),$$

with $\sigma_G\equiv-\frac{U_G}{U_{GG}Y}$ and ε the elasticity of substitution between intermediate goods; the "natural-rate", flexible-price level of consumption $c_t^*=-\zeta\left(g_t+\varphi^{-1}\tau_t\right)$ is now inefficient when the tax rate varies.

During the LT (given the Markov-chain structure) the objective becomes:

$$\min \frac{1}{1-\beta z_j}\left[\pi_L^2+\omega_c\left(c_L+\zeta g_L\right)^2+\omega_g g_L^2\right]. \tag{14}$$

Optimal (fiscal and monetary) policy in a *fundamental* LT has been extensively studied. Here, I study optimal policy in the confidence-driven trap, i.e. optimal Neo-Fisherian policy.[10]

5.1 Optimal Neo-Fisherian Monetary Policy

Start with monetary policy and abstract momentarily from fiscal ($g_L = \tau_L = 0$). Maximizing welfare in a confidence trap amounts to solving:

$$\begin{aligned}&\min_{i^*} \frac{1}{1-\beta z_s}\left[\pi_L^2+\omega_c c_L^2\right]\\ &\text{s.t. } (9).\end{aligned}$$

The solution to this problem is straightforward:

$$i^* = \begin{cases} \rho, \text{ for } 0 \leq t < T \\ 0, \text{ for } t \geq T \end{cases}$$

it consists of increasing nominal rates by $i^* = \rho$ for the whole duration of the trap and reverting to steady state (cutting nominal rates) once the trap is over.

Differently from optimal monetary policy in a fundamental trap, policy can thus perfectly close the gap and stabilize inflation. Whereas for FG in a fundamental LT there is a crucial intertemporal trade-off—between mitigating the trap recession, and creating a suboptimal post-trap expansion. Importantly, the neo-Fisherian policy is thus credible, as it is time consistent: when the trap ends, the central bank has no incentive to deviate from its announced policy.

This also emphasizes an important difference with neo-Fisherian proposals such as Schmitt-Grohé and Uribe's (2017) to implement a *permanent* increase in nominal rates. My analysis implies that this is optimal only if the trap itself is permanent (as it *is* in the different framework of Schmitt-Grohé and Uribe); when it is not permanent, the policy is suboptimal because it creates an inefficient future recession (once the wave of pessimism is over), which by the neo-Fisherian logic also implies an inefficiently large expansion today.

Nevertheless, something very close to the optimal policy can be obtained even when the increase in rates is permanent—if there is a concomitant commitment to fighting inflation after the trap is over. I provide the formalization in the Appendix using the same three-state apparatus used for

[10] Optimality is understood, as in Woodford, in the restricted sense: given the policy rule (6) (that is a good approximation to optimal policy outside the trap). I refer to the literature reviewed in the Introduction for more general notions of optimal policies, including considering confidence-driven traps (Nakata and Schmidt (2016), Armenter (2018))

FG above: a third state F in the Markov chain where the ZLB no longer binds but interest rates are maintained to a higher level. Assuming that $i^* = \rho$ is maintained permanently the equilibrium is, after and during the trap, respectively:

$$\begin{aligned} c_F &= -\frac{1-\beta}{\kappa(\phi-1)}\rho < 0; \quad (15) \\ c_L &= -\frac{\nu(z_s)-\beta}{\kappa(\phi-1)} \frac{1-z_s}{1-z_s\nu(z_s)}\rho > 0. \end{aligned}$$

Committing to a high enough Taylor coefficient ϕ mitigates the future recession and the current expansion, both of which are inefficient: when ϕ tends to infinity we recover the optimal policy.[11] Notice that this is the *opposite of FG*, which consists of committing to being *more accommodative* after the trap than otherwise required by optimality.

5.2 Optimal Neo-Fisherian Fiscal Policy

Suppose that monetary policy cannot stabilize the economy perfectly, perhaps because the central bank is unwilling to consider neo-Fisherian policies. Can fiscal policy help? What is the optimal level of government spending and/or labor tax rates in a LT when monetary policy follows (6) (which provides optimal stabilization in normal times but is constrained by the zero bound)? The answer is found by choosing g_L and τ_L respectively to solve (14), subject to the equilibrium conditions (13). Optimal spending is:

$$g_L^{opt} = -\frac{\Lambda(M_c+\zeta)^2}{\Lambda(M_c+\zeta)^2+\omega_g} \frac{\sigma}{(1-z_j)\zeta}\rho_j, \quad (16)$$

with $\Lambda \equiv \left(\frac{\kappa}{1-\beta z_j}\right)^2 + \omega_c$. In the fundamental trap with $\rho_j = \rho_L < 0$, this reproduces Woodford's (2011) equation 48: optimal spending is positive, proportional to the size of the LT-recession, and an increasing function of the duration of the recession.

The opposite holds in a confidence-driven trap with $\rho_j = \rho > 0$: optimal spending is *negative*. Because spending is contractionary, mitigating the LT-recession requires a spending-based fiscal *consolidation*. The level of spending that closes the gap completely (generating $c_L = c_t^* = -\zeta g_t$) is given by, from (13):

$$g_L^0 = -\frac{\sigma}{(1-z_j)\zeta}\rho_j.$$

It is clear by direct inspection of (16) that, insofar as spending yields a direct utility benefit and its volatility is costly ($\omega_g > 0$), it is not optimal to completely close the gap using fiscal policy. In the fundamental EW-trap this requires a smaller increase in spending, whereas in the neo-Fisherian

[11] The Appendix considers for completion an interest rate increase of arbitrary duration and potentially different size, allowing for the possibility to choose a second-best size of the rate increase i^* so as to balance these two effects.

case this requires a smaller spending cut.

Since the effects of labor taxes have opposite effects across the two LT varieties, it should come as no surprise that this translates to opposite prescriptions for optimal policy too. Indeed, the optimal level of labor tax rates is easily found to be:

$$\begin{aligned}\tau_L^{opt} &= -\Omega_j \frac{M_c+\zeta}{M_c} \frac{1}{(1-z_j)(1-\zeta)} \rho_j \, , \\ \text{with } \Omega_j &\equiv \frac{\frac{M_c+\zeta}{M_c}\left(\frac{\kappa}{1-\beta z_j}\right)^2 + \omega_c}{\left(\frac{M_c+\zeta}{M_c}\frac{\kappa}{1-\beta z_j}\right)^2 + \omega_c} > 0\end{aligned}$$

Since $\Omega > 0$ regardless of trap type, optimal policy in the fundamental trap consists of an (expansionary, therein) increase in tax rates (a tax-based fiscal consolidation); whereas in a confidence-driven trap, it requires cutting labor-tax rates—the more so, the more inelastic is labor (a tax-based fiscal expansion).[12]

6 Conclusion

A simple analytical framework allows the unified treatment of the two main theories for liquidity traps—driven by fundamental or confidence shocks—and analyzing the effects and optimal design of monetary and fiscal policies therein. An intuitive closed-form condition dictates what trap type the economy is in and also, intrinsically, whether or not policies are "neo-Fisherian".[13]

The two questions are intimately related: What policy "works"—in the sense of being expansionary and alleviating the LT welfare costs—is inherently determined by what triggered the LT. Table 1 summarizes the diametrically-opposed effects of policies: in a fundamental trap, increasing nominal rates is contractionary and deflationary, as is cutting labor taxes, whereas forward guidance and government spending are expansionary and inflationary. In confidence-driven traps increasing nominal rates is expansionary, as are tax cuts—but forward guidance and spending stimulus are contractionary.

[12] The optimal level is *always* lower that the gap-closing level (from (13)) $\tau_L^0 = -\frac{M_c+\zeta}{M_c}\frac{1}{(1-z_j)(1-\zeta)}\rho_j$, as tax-rate movements generate inefficient, cost-push inflation variations.

[13] Neo-Fisherian effects can be ruled out with e.g. deviations from rational expectations (Garcia-Schmidt and Woodford, 2018; Gabaix, 2018) or fiscal-theory with long-term debt (Cochrane, 2017). Bilbiie (2018) shows that heterogeneity can also undo neo-Fisherian effects but only if income inequality is *procyclical*; if *countercyclical*, neo-Fisherian effects are both more likely and stronger—through a "new Keynesian cross", AD-amplifying feedback-loop (see also i.a. Kaplan, Moll, and Violante (2018); McKay, Nakamura, and Steinsson (2015) for quantitative "HANK" models, and Bilbiie (2008, 2017) for analytical versions of this amplification).

Table 1: Effect on consumption and inflation

	EW	BSGU
Interest rate increase $i^* \uparrow$	$-$	$+$
Forward guidance (future $i \downarrow$)	$+$	$-$
Public spending increase $G \uparrow$	$+$	$-$
Labor tax rate cut $\tau \downarrow$	$-$	$+$

To give policy advice, it is of paramount importance to understand what LT-variety an economy is experiencing. The simple theory suggests an immediate test: when an LT is long-lasting and coupled with inflation variations, it is likely of the confidence variety—for the occurrence of fundamental LTs requires short duration and sticky enough prices. Two important recent empirical contributions reviewed in the Introduction (Aruoba, Cuba-Borda and Schorfheide (2018) and Uribe (2018)) find different pieces of supporting evidence for the neo-Fisherian view. My findings suggest that the complementary testable predictions in Table 1 can inform the same important question.

For an economy experiencing a confidence-driven trap optimal policy design requires a change of perspective. In the monetary realm, it requires increasing rates to exploit the neo-Fisher effect inherent therein, but cutting rates back to their normal-times level thereafter. The good news is that, unlike the optimal policy prescription in fundamental LTs (forward guidance) this policy is time-consistent and thus credible; it allows perfectly closing the gap and generates no intertemporal trade-off. Nevertheless, even if the central bank was for some reason unable to commit to cutting rates back, the welfare cost of keeping them high can be counterbalanced by a commitment to price stability once the trap is over. In the fiscal realm, it has implications for the stimulus *composition*—the fiscal authority should concentrate on cutting labor taxes instead of increasing spending, the alternative expansionary (cutting spending) being presumably harder to justify and communicate in a recession.

Central banks and governments dealing with liquidity traps have tried much, in particular in Japan. Yet if (and *only if*) the liquidity-trap is confidence-driven a solution is readily available: increase rates—as suggested over the past years by i.a. Schmitt-Grohé and Uribe, or Cochrane. This can be announced as permanent if coupled with a commitment to price stability once the trap is over—much the opposite of forward guidance. Complementary measures consist of cutting labor taxes and, perhaps especially, *refraining* from forward guidance and spending stimulus.

Before adopting such unconventional measures, research on the type of empirical question emphasized above is paramount, in order to ensure that the economy is indeed in such a Neo-Fisherian trap. Future research that informs policy also needs to concentrate on finding policies that are *robust:* expansionary in both traps. That in the realm of policies usually considered the two traps generate contradicting prescriptions suggest that this is a very hard problem—but an all the more important one at that.

References

[1] Adam, K. and Billi, R., 2006, "Optimal Monetary Policy under Commitment with a Zero Bound on Nominal Interest Rates", Journal of Money, Credit, and Banking, 2006, 38 (7), 1877-1905

[2] Armenter, R., 2018, "The Perils of Nominal Targets," Review of Economic Studies, forthcoming

[3] Aruoba, B., P. Cuba-Borda, and F. Schorfheide, 2018, "Macroeconomic Dynamics Near the ZLB: A Tale of Two Countries," The Review of Economic Studies, 85:1, 87–118.

[4] Benhabib, J. and R. Farmer, R. 2000, "Indeterminacy and Sunspots in Macroeconomics", in John Taylor and Michael Woodford (eds.): Handbook of Macroeconomics, North Holland.

[5] Benhabib, J., Schmitt-Grohé, S., and Uribe, M., 2001a, "The Perils of Taylor Rules," Journal of Economic Theory

[6] Benhabib, J., Schmitt-Grohé, S., and Uribe, M., 2001b, "Monetary Policy and Multiple Equilibria", American Economic Review, 91, 167–186.

[7] Benhabib, J., Schmitt-Grohé, S., and Uribe, M., 2002, "Avoiding Liquidity Traps", Journal of Political Economy

[8] Benhabib, J., Evans, G. W. and Honkapohja, S. 2014, "Liquidity Traps and Expectation Dynamics: Fiscal Stimulus or Fiscal Austerity?" Journal of Economic Dynamics and Control, 45, 220-238

[9] Bilbiie F. 2008. "Limited Asset Market Participation, Monetary Policy, and (Inverted) Aggregate Demand Logic". Journal of Economic Theory 140, 162-196.

[10] Bilbiie F. 2011. "Non-Separable Preferences, Frisch Labor Supply and the Consumption Multiplier of Government Spending: One Solution to a Fiscal Policy Puzzle," Journal of Money, Credit and Banking, 43(1), 221-251

[11] Bilbiie, F. 2016, "Optimal Forward Guidance", CEPR DP

[12] Bilbiie, 2017, "The New Keynesian Cross," CEPR DP

[13] Bilbiie F., Monacelli T. and R. Perotti 2018, "Is Government Spending at the Zero Lower Bound Desirable?", Forthcoming, American Economic Journal: Macroeconomics

[14] Bilbiie, 2018, "Heterogeneity and Determinacy: Amplification without Puzzles," CEPR DP

[15] Braun, A., L. Körber, and Y. Waki, 2016 "Some Unpleasant Properties of Loglinearized Solutions When the Nominal Rate is Zero," Journal of Monetary Economics, 84, 216–232

[16] Carlstrom, C., T. Fuerst, and M. Paustian, 2015. "Inflation and output in New Keynesian models with a transient interest rate peg," Journal of Monetary Economics, 76(C), 230-243

[17] Christiano L., M. Eichenbaum and S. Rebelo, 2011. "When Is the Government Spending Multiplier Large?," Journal of Political Economy, 119(1), pages 78 - 121.

[18] Christiano L., M. Eichenbaum, and B. Johannsen, 2018, "Does the New Keynesian Model Have a Uniqueness Problem," Mimeo

[19] Cochrane, J. 2011 "Determinacy and Identification with Taylor Rules,"Journal of Political Economy, 119 (3), pp. 565-615

[20] Cochrane, J. 2016, "The New-Keynesian Liquidity Trap", Forthcoming, Journal of Monetary Economics

[21] Cochrane, J., 2017 "Michelson-Morley, Fisher and Occam: The Radical Implications of Stable Inflation at the Zero Bound," NBER Macroeconomics Annual.

[22] Coyle, P. and T. Nakata, 2018, "Optimal Inflation Target with Expectations-Driven Liquidity Traps," mimeo

[23] Curdia, V. and M. Woodford 2016, “Credit Frictions and Optimal Monetary Policy,” Journal of Monetary Economics, forthcoming

[24] Del Negro, M., M. Giannoni, and C. Patterson 2012: “The Forward Guidance Puzzle,” mimeo

[25] Eggertsson G. and M. Woodford 2003, "The Zero Bound on Interest Rates and Optimal Monetary Policy", Brookings Papers on Economic Activity, No. 1.

[26] Eggertsson, G. 2010, "What Fiscal Policy Is Effective at Zero Interest Rates?", in: D. Acemoglu and M. Woodford, eds: NBER Macroeconomics Annual University of Chicago Press

[27] Eggertsson G. and P. Krugman 2012, "Debt, Deleveraging, and the Liquidity Trap: A Fisher-Minsky-Koo Approach," Quarterly Journal of Economics, 127(3): 1469-1513.

[28] Evans, G. W., E. Guse, and S. Honkapohja, 2008, “Liquidity Traps, Learning and Stagnation”, European Economic Review, 52, 1438–1463.

[29] Fuhrer, J. C., and B. F. Madigan. 1997. "Monetary Policy when Interest Rates Are Bounded at Zero." Review of Economics and Statistics 79(4): 573-85.

[30] Gabaix, X, 2016, "A Behavioural New Keynesian Model" Mimeo

[31] Galí, J. 2008, "Monetary Policy, Inflation, and the Business Cycle: An Introduction to the New Keynesian Framework and Its Applications", Princeton University Press

[32] Garcia-Schmidt, M. and M. Woodford, 2014. “Are Low Interest Rates Deflationary? A Paradox of Perfect Foresight Analysis,” Forthcoming, American Economic Review

[33] Gürkaynak, R., B. Sack, and E. Swanson, 2005, “The Sensitivity of Long-Term Interest Rates to Economic News: Evidence and Implications for Macroeconomic Models,” American Economic Review 95(1), 425-36

[34] Kaplan, G., B. Moll, and G. Violante, 2018, "Monetary Policy According to HANK," American Economic Review

[35] Kiley, M. T., 2016, "Policy Paradoxes in the New Keynesian Model," Review of Economic Dynamics, 21, pp. 1-15

[36] Krugman, P., 1998, "It's Baaack: Japan's Slump and the Return of the Liquidity Trap", Brookings Papers on Economic Activity

[37] Leeper, E., 1991, "Equilibria Under "Active" and "Passive" Monetary and Fiscal Policies", Journal of Monetary Economics

[38] Lubik, T. A., and F. Schorfheide. 2004. "Testing for Indeterminacy: An Application to U.S. Monetary Policy." American Economic Review, 94 (1): 190-217

[39] McCallum, B. T. 1998 "Solutions To Linear Rational Expectations Models: A Compact Exposition," Economics Letters, 61(2), 143-147.

[40] McKay, A., E. Nakamura, and J. Steinsson 2015: “The Power of Forward Guidance Revisited,” American Economic Review

[41] Mertens K. and M. Ravn 2013. "Fiscal Policy in an Expectations Driven Liquidity Trap," Review of Economic Studies

[42] Nakata, T., 2016 "Optimal Fiscal and Monetary Policy with Occasionally Binding Zero Bound Constraints" Journal of Economic Dynamics and Control, 73: 220-240

[43] Nakata, T., 2017 "Optimal government spending at the zero lower bound: A non-Ricardian analysis," Review of Economic Dynamics, 23: 150-169

[44] Nakata, T., 2018 "Reputation and Liquidity Traps,” Review of Economic Dynamics, 28: 252-268

[45] Nakata, T. and S. Schmidt, 2016 "Conservatism and Liquidity Traps" Journal of Monetary Economics

[46] Nakov, A., 2008, " Optimal and Simple Monetary Policy Rules with Zero Floor on the Nominal Interest Rate," International Journal of Central Banking

[47] Orphanides, A., and V. Wieland. 1998. "Price Stability and Monetary Policy Effectiveness when Nominal Interest Rates Are Bounded at Zero."

[48] Schmidt, S. 2013 "Optimal Monetary and Fiscal Policy with a Zero Bound on Nominal Interest Rates," Journal of Money, Credit and Banking, 45(7), 1335-1350

[49] Schmidt, S. 2016 "Lack of confidence, the zero lower bound, and the virtue of fiscal rules," Journal of Economic Dynamics and Control, 70, 36-53

[50] Schmitt-Grohé, S. and Uribe, M., 2014, "Liquidity Traps: An Interest-Rate-Based Exit Strategy," The Manchester School.

[51] Schmitt-Grohé, S. and Uribe, M., 2017, "Liquidity Traps And Jobless Recoveries," American Economic Journal: Macroeconomics 9, 165-204

[52] Sargent, T. and N. Wallace, 1975, "Rational" Expectations, the Optimal Monetary Instrument, and the Optimal Money Supply Rule," Journal of Political Economy, 83(2), 241-254

[53] Garin, J., R. Lester, and E. Sims 2018, "Raise Rates to Raise Inflation? Neo-Fisherianism in the New Keynesian Model" Journal of Money, Credit and Banking 50(1), 243-259

[54] Svensson, L. O., 1999, "How Should Monetary Policy Be Conducted in an Era of Price Stability?" in New Challenges for Monetary Policy, Jackson Hole, Wyoming

[55] Uhlig, H., 2018, "Money and Banking: Some DSGE Challenges" Nobel Symposium presentation

[56] Uribe, M., 2018, "The Neo-Fisher Effect: Econometric Evidence from Empirical and Optimizing Models," Mimeo

[57] Walsh, C., 2016, "Sustainable Forward Guidance at the ELB", Mimeo UCSC

[58] Werning, I., 2012 "Managing a liquidity trap: monetary and fiscal policy" mimeo

[59] Wolman, A. 1998. "Staggered Price Setting and the Zero Bound on Nominal Interest Rates." Federal Reserve Bank of Richmond Economic Quarterly.

[60] Woodford, M., 2003, Interest and prices: foundations of a theory of monetary policy, Princeton University Press

[61] Woodford, M. 2011. "Simple Analytics of the Government Expenditure Multiplier," American Economic Journal: Macroeconomics, 3(1), p 1-35.

[62] Woodford, M. 2012, "Methods of Policy Accommodation at the Interest-Rate Lower Bound," Proceedings, Economic Policy Symposium, Jackson Hole

A Neo-Fisherian Policy: The Timing of Rate Increases

We model a situation whereby the neo-Fisherian policy of interest-rate increase is maintained beyond the end of the trap. Similarly to the FG apparatus, there is a third state in the Markov chain where the ZLB no longer binds but interest rates are maintained to a higher level (possibly different than the one chosen during the trap) $i_t = \rho + i_F^* + \phi\pi_t$: i_t^* takes value $i_F^* > 0$ which persists with probability f next period (after which it eventually reverts to the absorbing intended steady state). Calling this "post-trap but with high rates" state F, (1) implies $\pi_F = \frac{\kappa}{1-\beta f} c_F$ which replaced in (2) together with (6) delivers consumption at F:

$$c_F = -\frac{\sigma}{1 - f + \sigma(\phi - f)\frac{\kappa}{1-\beta f}} i_F^*$$

Similarly to the FG solution, we have for expectations during the trap: $E_t x_{t+1} = z_s x_L + (1 - z_s) f x_F$. Using this in (1):

$$\pi_L = \frac{\kappa}{1 - \beta z_s} c_L + f \frac{\beta(1 - z_s)}{1 - \beta z_s} \pi_F$$

which replaced in (2) delivers:

$$c_L = (1 - z_s) f \frac{\nu(z_s, f)}{1 - z_s \nu(z_s)} c_F + \frac{\sigma}{1 - z_s \nu(z_s)} (\rho - i_L^*)$$

with $\nu(z_s, f) \equiv 1 + \frac{\sigma\kappa}{1-\beta z_s} \frac{1}{1-\beta f}$. This nests the optimal policy in text with $i_L^* = \rho$ and $i_F^* = 0$ which delivers $(c_L, c_F) = 0$. While when the increase is permanent (for instance because the central bank does not know z_s), replacing $f = 1$ we obtain (15) in text.

Another possibility is to assume that the policy is a fortiori second-best—the central bank chooses a constant path for the permanent increase $i_L^* = i_F^* = i^*$; it then sets rates so as to balance the welfare cost of the future recession with the benefit of the current expansion. Maximizing welfare under the Markov chain and assuming for simplicity equal weighting of present and future (see Bilbiie, 2016 for the full solution to such problems), the first-order condition is:

$$-c_L \frac{dc_L}{di^*} = c_F \frac{dc_F}{di^*},$$

which replacing the equilibrium values delivers the optimal relative size of the permanent rate increase:

$$\frac{i_{opt}^*}{\rho} = \frac{\left(1 + \frac{(\nu(z_s)-\beta)(1-z_s)}{\sigma\kappa(\phi-1)}\right)\left(\frac{\sigma}{1-z_s\nu(z_s)}\right)^2}{\left[\left(1 + \frac{(\nu(z_s)-\beta)(1-z_s)}{\sigma\kappa(\phi-1)}\right)\frac{\sigma}{1-z_s\nu(z_s)}\right]^2 + \left(\frac{1-\beta}{\kappa(\phi-1)}\right)^2}.$$

Intuitively, this is positive and smaller than 1 (value to which it tends as ϕ goes to infinity).