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The Taylor principle fights back, Part II

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ABSTRACT

The existing literature holds that the Taylor principle often leads to indeterminacy in New Keynesian models that allow for capital accumulation and limited asset market participation. This conclusion is special, however, to the case of continuous full employment. When the assumption of perfect wage flexibility is relaxed very slightly so that the labor market clears quickly but not instantaneously, determinacy is the norm. The threat of indeterminacy is limited to a tiny, irrelevant corner of the parameter space where the elasticity of labor supply is unusually high and real wage adjustment is unbelievably fast. Everywhere else, the Taylor principle guarantees a unique rational expectations equilibrium. The dramatic difference in results reflects the sensitivity of the monetary transmission mechanism to the speed of adjustment in the labor market.

1. Introduction

Some type of Taylor rule guides the conduct of monetary policy in most developed countries and an increasing number of less developed countries. The exact form of the rule depends on the nature of information lags, the structure of the economy, and policy makers' preferences. All Taylor rules, however, share a common feature: ceteris paribus, they instruct the central bank to increase the real interest rate when inflation exceeds its target level. The rationale for the Taylor principle is that monetary policy should contract aggregate demand to neutralize incipient inflationary pressures. This requires the central bank to react aggressively, increasing the nominal interest rate more than the inflation rate. Passive policy, by contrast, accommodates adverse shocks by allowing higher inflation to reduce the real interest rate and increase aggregate demand.

Taylor rules are simple and intuitively appealing, but they also carry some risk. Any rule that mechanically links policy adjustment to changes in endogenous variables may introduce indeterminacy into an economy that would otherwise have a unique equilibrium. This is thought to be an especially serious problem in models that allow for capital accumulation. Dupor (2000) proved in a continuous-time New Keynesian (NK) model with perfect substitution between government bonds and capital that the Taylor rule engenders indeterminacy. The causal explanation for indeterminacy is that higher interest rates *immediately* increase the capital rental and marginal costs. Since an increase in real marginal cost translates directly into higher inflation in NK models, arbitrary expectations of higher inflation prove to be self-fulfilling.

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In continuous time the absence of adjustment costs to changes in the capital stock forces the current capital rental to move in lockstep with the real interest rate. This "extra restriction" is inconsequential. Carlstrom and Fuerst (2005) and Kurozumi and Van Zandweghe (2008) have confirmed that Dupor's results in similar models cast in discrete time.[1] The central issue therefore is whether the results in all three papers are an artifact of the assumption that the elasticity of investment with respect to Tobin's q is infinite. At present the answer in the literature is a tentative no (Table 1). Although the contradictory results in Gali et al. (2004) and Carlstrom and Fuerst (2005)[2] do not justify the claim that "the presence of capital makes determinacy essentially impossible" (Carlstrom and Fuerst, 2005, p.10), it is clear that the Taylor principle is problematic in a large part of the potentially relevant parameter space.

The canonical NK model assumes full participation of agents in asset markets. In this model, a slight tweak of the Taylor rule may convert pessimism into optimism. GLV (short for Gali et al., 2004), Kurozumi and Van Zandweghe (2008), and Huang and Meng (2007) all show that the indeterminacy problem suddenly vanishes when the interest rate rule includes a *very* small positive coefficient on real output. This comforting result is sensitive, however, to the elasticity of labor supply (Huang et al., 2009). Moreover, the latest refinement to the NK model brings the indeterminacy problem back in full force. In models featuring limited asset market participation (LAMP), the determinacy region decreases steadily with the share of households that live check to check (GLV, 2004; Bilbiie, 2008) until, when the share enters the neighborhood of its estimated value,[3] the Taylor principle and standard aggregate demand logic get stood on their head: higher interest rates cause aggregate demand to *increase* and passive policy (allowing higher inflation to reduce the real interest rate) is necessary and sufficient for a unique equilibrium. Attaching a large positive coefficient to real output in the Taylor rule does not solve the problem or even alter the threshold level of non-savers at which active policy triggers indeterminacy. The upshot of all this is that theory still withholds its endorsement; doubts about the general validity of the Taylor principle are, if anything, greater than before.

In the companion paper *The Taylor Principle Fights Back, Part I*, I proved that the Taylor principle is valid in LAMP models without investment as long as the real wage is not exceptionally flexible. This paper completes the defense of the Taylor principle by demonstrating that the results in models with capital accumulation are also highly sensitive to small departures from the assumption of perfect wage flexibility. Aiming for exact comparisons, I investigate the outcome for alternative degrees of wage flexibility with and without LAMP. In the base case of the flex-wage full-participation model, the equilibrium is indeterminate when the q-elasticity of investment exceeds .97, a value close to the median estimate in empirical studies. The determinacy region shrinks further if some households do not save and disappears altogether when the share of non-savers exceeds the same threshold level as in Bilbiie (2008). Thus the Taylor principle struggles in pure flex-wage models. The validity of the principle may be a judgment call in the canonical NK model, but indeterminacy dominates the landscape in models that allow for LAMP.

Temporary wage rigidity changes everything. In the rigid-wage full-participation model, the borderline value of the q-elasticity of investment jumps to 3–20 in runs where the labor market clears in 3–6 months. The results in GLV suggest that indeterminacy is a greater threat in LAMP models. But this is true only for the polar case of perfect wage flexibility. With high but imperfect wage flexibility, the determinacy region *expands very rapidly* as the share of non-saving households increases. For example, when the labor market clears in six months and 40% of households do not save, the borderline value of the q-elasticity (base case) is 39.4 vs. .35 in the pure flex-wage model. The dramatic difference reflects the sensitivity of the monetary transmission mechanism to the speed of adjustment in the labor market. Under perfect wage flexibility, higher interest rates reduce investment more the larger the share of non-saving households. The opposite relationship holds when the wage is temporarily rigid. Since sunspot equilibria stem from large near-term reductions in the capital stock that increase marginal costs, temporary wage rigidity changes LAMP from a powerful force for indeterminacy into an equally powerful force for uniqueness.

This is not the only paper to analyze how temporary wage rigidity affects the viability of the Taylor principle. Two other papers, Huang et al. (2009) and Colciago (2011), carry out similar analyses in models with sticky nominal wages and capital accumulation. Colciago sets the q-elasticity at unity in a model that allows for limited asset market participation.[4] Huang et al. assume full participation in asset markets but fix the q-elasticity at three. In contrast to the strong, positive results I obtain, the results in these models are discouraging: Colciago (2011) cautions that forward-looking rules "should be implemented with care" as the determinacy region is "severely restricted with respect to the case of a contemporaneous rule," while Huang et al. find that the determinacy region is completely empty. A lot rides therefore on the distinction between real and nominal wage rigidities; in one case the (forward-looking) Taylor principle is highly robust; in the other case it is exceedingly fragile.

The rest of the paper is organized in five sections. In Section 2 I develop flex- and rigid-wage variants of a model with LAMP. Sections 3–5 quantify how the region of indeterminacy depends on the speed of real wage adjustment and

[1] In a continuous-time model that treats inflation as a jump variable, $i=\rho+\alpha\pi$ is a forward-looking interest rate rule. Confusion on this point has led to confusion about the extent to which the results differ in continuous vs. discrete-time models. Under the correct interpretation of Dupor's interest rate rule, there is no contradiction between his results and those in Carlstrom and Fuerst (2005). Both conclude that indeterminacy is the norm for a forward-looking rule.

[2] Contradictory is probably not the right word. Presumably differences in calibration values and the form of the utility function explain the opposing results.

[3] Macroeconomic estimates and microeconomic studies put the share of non-saving households at 30–60% in the United States and the Euro zone. See Campbell and Mankiw (1989), Mankiw (2000), Wolff and Caner (2002), Johnson et al. (2004), Muscatelli et al. (2004), Di Bartolomeo and Rossi (2007), Forni et al. (2009), and Di Bartolomeo et al. (2010).

[4] Colciago does not state the value of the q-elasticity used to calibrate the model. But since the calibration is based on the parameter values in GLV, the q-elasticity probably equals unity.