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By Tommy Sveen and Lutz Weinke

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The Taylor Principle in a Medium-Scale Macroeconomic Model*

Tommy Sveen[a,†], Lutz Weinke[b,‡]

[a] Research Department, Norges Bank
[b] Institute of Economic Policy, Humboldt-Universität zu Berlin

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Abstract

The Taylor Principle is often used to explain macroeconomic stability (see, e.g., Clarida et al. 2000). The reason is that this simple principle guarantees determinacy, i.e., local uniqueness of rational expectations equilibrium, in many New Keynesian models. However, analyses of determinacy are generally conducted in the context of highly stylized models. In the present paper we use a medium-scale model which combines features that have been shown to explain fairly well postwar U.S. business cycles. Our main result demonstrates that the stability properties of forward-looking interest rate rules are very similar to the corresponding outcomes under current-looking rules. This is in stark contrast with many findings that have been obtained in the context of models whose empirical relevance is limited.

Keywords: Nominal Rigidities, Real Rigidities, Monetary Policy.

JEL Classification: E22, E31

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†E-mail: tommy.sveen@norges-bank.no

‡E-mail: lutz.weinke@wiwi.hu-berlin.de

1 Introduction

To the extent that prices are sticky a central bank can become a source of unnecessary macroeconomic fluctuations. How can this problem be avoided? The classical answer to that question is that monetary policy needs to respect the Taylor principle according to which the nominal interest rate is adjusted by more than one-for-one in response to changes in inflation.[1] The reason is that this is a sufficient condition for determinacy, i.e., local uniqueness of rational expectations equilibrium, in the context of many New-Keynesian (NK) models.

Sveen and Weinke (2005) show, however, that the Taylor principle can easily *fail* to guarantee determinacy if it is taken into account that firms do not only post prices but also make investment decisions.[2] Specifically, we demonstrate that there exists a non-standard indeterminacy region which obtains for policies that respect the Taylor principle (in addition to the usual region which corresponds to interest rate rules that are inconsistent with that principle). In a nutshell, the reason is as follows. Investment has counteracting effects on the determination of inflation. On the one hand, investment demand increases inflation, but on the other hand, the resulting additional capital tends to increase labor productivity thereby decreasing inflation by the time when it becomes productive. To the extent that the central bank follows the Taylor principle, the long real interest rate could therefore drop in the presence of an increase in real economic activity that is unrelated to the economy's fundamentals. Under those circumstances such a boom would be rationalized ex post. The potential failure of the Taylor principle in the presence of endogenous capital accumulation also motivates the work by Carlstrom and Fuerst

[1] See, e.g., Taylor (1999), Clarida et al. (2000) and Woodford (2001, 2003).

[2] For an early example of a model which demonstrates that the Taylor principle might fail in the presence of endogenous capital accumulation, see Dupor (2001). His conclusion that a passive interest rate rule is needed to guarantee determinacy is, however, specific to his continuous time framework, as observed by Carlstrom and Fuerst (2005). Some problematic aspects of the Taylor principle that are unrelated to the presence of capital accumulation are discussed in Edge and Rudd (2002), Røisland (2003), Galí et al. (2004), Carlstrom and Fuerst (2007), Natvik (2009), among others.

(2005). The main contribution of the latter paper is to show that responding to expected rather than current inflation generally creates indeterminacy.[3]

Other papers have followed up on the implications of endogenous capital accumulation for determinacy in the context of NK models. Examples include the recent work by Huang and Meng (2007), Sveen and Weinke (2007), Kurozumi and Van Zandweghe (2008) and Huang et al. (2009). We note, however, that those analyses of determinacy have been conducted in the context of highly stylized models which are limited in their ability to account for actual observed business-cycle fluctuations. The goal of the present paper is to analyze determinacy in the context of an empirically plausible model of the U.S. business cycle. Our motivation is twofold. First, capital accumulation is a key feature of medium-scale macroeconomic models which have been estimated and shown to account fairly well for postwar U.S. business-cycle fluctuations.[4] It is therefore natural to ask whether the indeterminacy issues that are linked to the presence of capital accumulation still exist once that feature is combined with other bells and whistles that increase the empirical relevance of NK models. Second, some of those bells and whistles have been considered in isolation in the above mentioned literature precisely because they are also relevant for the determinacy properties of NK models. Our model is similar to the frameworks proposed by Altig et al. (2005) and Schmitt-Grohé and Uribe (2007). Its main features are an external consumption habit, sticky prices and wages, price-indexation in wage-setting, and variable capital utilization as well as firm-specific capital accumulation that is subject to a convex investment adjustment cost.[5]

[3] Carlstrom and Fuerst (2005) also analyze current-looking interest rate rules and find that the Taylor Principle guarantees determinacy unless prices are extremely sticky. This result is, however, overturned in the presence of firm-specific capital accumulation, as shown in Sveen and Weinke (2005). Other related papers are Benhabib and Eusepi (2005) and Hornstein and Wolman (2005). The former discusses the possibility of global instability, whereas the latter is concerned with the consequences of non-zero inflation for determinacy in a Taylor-type pricing model.

[4] See, e.g., Altig et al. (2005), Christiano et al. (2005) and Smets and Wouters (2007).

[5] Let us note that Schmitt-Grohé and Uribe (2007) also analyze indeterminacy under current-looking monetary policy in the context of their model. This is, however, not the main focus of their work and it is therefore natural that they did not choose to disentangle the respective roles of the model features for that particular issue. In our analysis this aspect is at center stage.

Two sets of results emerge. First, under a current-looking interest rate rule we find that the Taylor principle is not a sufficient condition for determinacy in the presence of an empirically plausible degree of price stickiness. This confirms our earlier results in Sveen and Weinke (2005, 2007). Second, we analyze the stability properties of interest rate rules prescribing that the nominal interest rate is set as a function of future expected inflation. Importantly, the results resemble, at least qualitatively, to the corresponding outcomes under a current-looking interest rate rule. This is in stark contrast with some of the findings in Carlstrom and Fuerst (2005), Huang and Meng (2007), Kurozumi and Van Zandweghe (2008) and Huang et al. (2009) who have found dramatic differences in the stability properties implied by current-looking and forward-looking interest rate rules. We explain why this result does not hold up in the context of an empirically relevant medium-scale model. Finally, and consistent with earlier findings, the present paper also shows that the indeterminacy problem can be solved if the nominal interest rate is set not only as a function of inflation but is also adjusted in response to changes in (current or future expected) output or past nominal interest rates.

The remainder of the paper is organized as follows. Section 2 outlines the model structure. In Section 3 we consider the resulting linearized equilibrium conditions. Our results are presented in Section 4 and Section 5 concludes.

2 The Model

We use a NK model with complete markets. Sunspot shocks are assumed to be the only source of aggregate uncertainty. There is a continuum of firms and a continuum of households. Each firm is the monopolistically competitive supplier of a differentiated good and we assume Calvo (1983) pricing. We also allow for the possibility of indexation in price-setting. Firms use labor and capital in their production. Capital accumulation takes place at the firm level with the additional capital resulting from an investment decision becoming productive with a one period delay. We also assume a convex investment adjustment cost as well as variable capital utilization. Period utility is assumed to be separable in its two arguments leisure and consumption with external habit persistence. Each household is the monopolistically competitive supplier of a differentiated type of labor and we assume sticky wages à la Erceg et al. (2000), i.e., each household gets to reoptimize its wage with a constant and exogenous probability. We also assume price indexation in wage-setting. Since the details of the model have been discussed in Altig et al. (2005) and Schmitt-Grohé and Uribe (2007) we turn directly to the resulting linearized equilibrium conditions.

3 Some Linearized Equilibrium Conditions

We restrict attention to a linear approximation around a zero inflation steady state. In what follows variables are expressed in terms of log deviations from their steady state values except for the nominal interest rate, r_t, wage inflation, ω_t, and price inflation, π_t, which denote the levels of the respective variables. The consumption Euler equation reads

$$c_t = \frac{h}{1+h}c_{t-1} + \frac{1}{1+h}E_t c_{t+1} + \frac{1-h}{1+h}\left(r_t - E_t\pi_{t+1} - \rho\right), \tag{1}$$

where c_t denotes aggregate consumption and E_t is the expectational operator conditional on information available through time t. Parameter $h \in [0,1]$ measures an external consumption habit. We have also used the notation $\rho \equiv -\log\beta$ to indicate the time discount rate. In the latter definition parameter β denotes the household's subjective discount factor. The law of motion of aggregate capital, k_t, is

$$k_{t+1} = (1-\delta)\,k_t + i_t, \tag{2}$$

where i_t is aggregate investment. The investment Euler equation is given by

$$i_t = \frac{1}{1+\beta} i_{t-1} + \frac{\beta}{1+\beta} E_t i_{t+1} + \frac{1}{\epsilon_\psi (1+\beta)} q_t, \tag{3}$$

where parameter ϵ_ψ measures the investment adjustment cost. Moreover, q_t denotes Tobin's Q whose Euler equation takes the following form

$$q_t = \beta (1-\delta) E_t q_{t+1} + [1-\beta(1-\delta)] E_t r_{t+1}^K - (r_t - E_t \pi_{t+1} - \rho), \tag{4}$$

with $r_t^K \equiv w_t - (k_t + b_t - n_t)$ denoting the average real shadow rental price of capital. In the latter definition we have used the notation w_t for the average real wage and n_t for aggregate labor. Finally, parameter δ is the depreciation rate of capital. Up to the first order, aggregate production, y_t, is pinned down by

$$y_t = (1-\alpha) n_t + \alpha (k_t + b_t), \tag{5}$$

where parameter α denotes the capital share and b_t measures the extent to which capital is utilized. The wage inflation equation is obtained from averaging and aggregating optimal wage-setting decisions on the part of households. It takes the following form

$$\omega_t - \phi_w \pi_{t-1} = \beta (E_t \omega_{t+1} - \phi_w \pi_t) + \kappa_w (mrs_t - w_t), \tag{6}$$

where ω_t denotes wage inflation, and $mrs_t \equiv \frac{1}{1-h}(c_t - hc_{t-1}) + \phi n_t$ measures the average marginal rate of substitution of consumption for leisure. Finally, parameter ϕ_w indicates the degree of price indexation in wage-setting and we have also used the definition $\kappa_w \equiv \frac{(1-\beta\theta_w)(1-\theta_w)}{\theta_w} \frac{1}{1+\eta\varepsilon_N}$. In the latter expression parameter θ_w denotes the probability that a household is not allowed to reoptimize its nominal wage in any given period, while parameter ε_N measures the elasticity of substitution between different types of labor. The identity $w_t = w_{t-1} + \omega_t - \pi_t$ must also hold. The price inflation equation reads

$$\pi_t - \phi_\pi \pi_{t-1} = \beta \left(E_t \pi_{t+1} - \phi_\pi \pi_t \right) + \kappa_p \; mc_t, \tag{7}$$

where $mc_t \equiv w_t - (y_t - n_t)$ denotes the average real marginal cost and parameter ϕ_π measures the degree of indexation in price-setting. Finally, parameter κ_p is a function of the model's structural parameters which is computed numerically using the method developed in Woodford (2005).[6] Let us also note that cost-minimization implies

$$\epsilon_b b_t + k_t - (y_t - b_t) = w_t - (y_t - n_t), \tag{8}$$

where parameter ϵ_b measures the cost of varying the capital utilization rate. The aggregate goods market clearing condition is given by

$$y_t = c_y c_t + (1 - c_y) \, i_t, \tag{9}$$

where $c_y \equiv 1 - \frac{\delta\alpha}{\mu(\rho+\delta)}$ denotes the steady state consumption to output ratio. In the latter definition we have denoted the frictionless desired markup by $\mu \equiv \frac{\varepsilon}{\varepsilon - 1}$ with ε denoting the elasticity of substitution between different varieties of goods. To close the model we assume that monetary policy is conducted according to a simple rule which takes the following form

$$r_t = \tau_r r_{t-1} + (1 - \tau_r) \left(\rho + \tau_\pi E_t \pi_{t+j} + \tau_y E_t y_{t+k} \right), \tag{10}$$

where $j, k \in \{0, 1\}$. Parameter τ_r measures the degree of interest rate smoothing, whereas parameters τ_π and τ_y denote the long-run responsiveness of the nominal interest rate to changes in the associated endogenous variables.

[6] We have used the code developed by Altig et al. (2005), which can be found at http://faculty.wcas.northwestern.edu/~lchrist/research.htm

4 Results

Our goal is to explore what are desirable features of interest rate rules in the sense that they guarantee determinacy. To this end we use the theoretical framework developed so far. Our medium-scale model also allows us to understand why some results in the previous related literature are not robust.

4.1 Baseline Parameter Values

The period length is one quarter. Most of our baseline parameter values are justified in Altig. et al. (2005). We deviate from their work in the parameter values for price- and wage-setting.[7] Conventional values are assigned to the respective stickiness parameters and the corresponding degrees of indexation are roughly in line with the estimates obtained by Smets and Wouters (2007). Our baseline choices are summarized in table 1.

[Table 1 about here]

4.2 Current or Forward-Looking Policy: Does the Difference Matter?

Let us first consider a simple rule prescribing that the nominal interest rate is a linear function of current inflation only, i.e., we set $\tau_r = \tau_y = j = k = 0$ in (10). We ask what combinations of values for the inflation response coefficient, τ_π, and the price stickiness parameter, θ, result in a determinate equilibrium. The result is shown in the upper panel of figure 1.

[Figure 1 about here]

An inflation response coefficient strictly larger than one is necessary but not sufficient for determinacy. In fact, a large range of values of parameter τ_π that

[7] Schmitt-Grohé and Uribe (2007) follow a similar strategy.

meet the Taylor principle are inconsistent with determinacy. The intuition relies on the economic mechanism described in Sveen and Weinke (2005). The presence of capital accumulation implies that an increase in real activity that is unrelated to the economy's fundamentals might be rationalized ex post. The reason is that an increase in current investment has counteracting effects on marginal costs. First, the additional investment demand tends to increase the current marginal cost. Second, one period later when the resulting additional capital becomes productive the marginal cost tends to decrease. It is therefore possible that the long real interest rate decreases, if the central bank follows the Taylor principle. In this case, the investment boom can be rationalized ex post. Interestingly, the shape of the non-standard indeterminacy area shown in the upper panel of figure 1 is qualitatively similar to its counterpart in Sveen and Weinke (2005). Let us also notice that the non-standard indeterminacy area, i.e., the one that is associated with values of the inflation response coefficient that meet the Taylor principle, has an upper limit which is increasing in the price stickiness.[8] The reason behind this property of the non-standard indeterminacy area is also related to the fact that investment demand has counteracting effects on the determination of the marginal cost. Let us therefore go back to the thought experiment of an investment boom and consider a central bank that follows the Taylor Principle in a way that gives rise to the non-standard indeterminacy problem. What happens if the responsiveness of the nominal rate to changes in inflation, τ_{π}, is increased? This stabilizes current and future expected inflation. Due to the forward-lookingness in price-setting, however, the future stabilization is more effective than the current one because a reduction in future deflation increases, in itself, current inflation. For large enough values of τ_{π} the possibility of a drop in the long real interest rate is therefore ruled out. With those prepa-

[8] The respective economic reasons for the existence of the upper and the lower limit of the non-standard indeterminacy area are developed in Sveen and Weinke (2005). However, let us notice already here that the lower limit of the non-standard indeterminacy area is generally very close to the standard critical value of one. In other words, the size of the determinacy area that separates the standard and non-standard indeterminacy areas is quantitatively unimportant. We will come back to this later in the text.

rations in mind we can understand the role of price-stickiness for the upper limit of the nonstandard indeterminacy area. Other things being equal, a higher degree of forward-lookingness in price-setting (i.e., a larger value of the price stickiness parameter θ) makes the impact of the future drop in the marginal cost on current inflation larger. The negative impact of the expected future drop in the marginal cost on the relevant long real interest rate does therefore also become larger. This in turn requires a stronger responsiveness of the nominal interest rate to changes in inflation (as measured by coefficient τ_π) in order to guarantee determinacy. Finally, let us also observe that the extent to which an investment boom implies a drop in future expected marginal costs depends crucially on the smoothness of aggregate demand.

Much of the related existing literature has focused on forward-looking specifications of monetary policy. In order to relate to this strand of the literature we now analyze an interest rate rule according to which the nominal interest rate is a linear function of one period ahead expected inflation, i.e., we set $\tau_r = \tau_y = 0$, combined with $j = 1$, in (10). Once again, we ask what combinations of values for the inflation response coefficient, τ_π, and the price stickiness parameter, θ, imply a determinate equilibrium. The result is shown in the lower panel of figure 1. Also in this case we find that an inflation response coefficient strictly larger than one is necessary but not sufficient for determinacy. More importantly, the non-standard indeterminacy region is larger but qualitatively similar to its counterpart under a current-looking interest rate rule. This is in stark contrast with the findings in Carlstrom and Fuerst (2005), Huang and Meng (2007), Kurozumi and Van Zandweghe (2008), and Huang et al. (2009). Those authors have found dramatic differences between the shapes of the non-standard indeterminacy areas implied by current-looking and forward-looking interest rate rules. More precisely, they argue that the Taylor principle fails for almost all combinations of values for the inflation response coefficient, τ_π, and the price stickiness parameter, θ, whereas we show that the size of the non-standard indeterminacy area is not much larger than its counterpart under a current-looking interest rate rule. The difference in results is a consequence of the empirically plausible degree of smoothness in aggregate demand that is embedded in our model. Figure 1 clearly illustrates this point.

Related to this, we also observe that the statements in Huang and Meng (2007), Kurozumi and Van Zandweghe (2008), and Huang et al. (2009) on the role of price stickiness for the shape of the non-standard indeterminacy area are somewhat misleading. They find that the size of the non-standard indeterminacy area *decreases* with price stickiness. However, figure 1 shows that both for the current-looking and for the forward-looking monetary policy rule the size of this area *increases* with price stickiness.[9] The reason for this difference in results is simple. Regardless of whether monetary policy is current-looking or forward-looking, there exists a tiny determinacy region that is associated with values of τ_π that are just a little bit larger than one.[10] The above mentioned authors analyze forward-looking interest rate rules and find that the size of this tiny area does indeed become larger (and correspondingly the non-standard indeterminacy area becomes smaller) with price stickiness. They find that this is the only effect of price stickiness on the size of the non-standard indeterminacy area. The reason is that their models do not imply the existence of any upper limit of the non-standard indeterminacy area. This property of their models is in turn a consequence of an unrealistically small degree of smoothness in aggregate demand. In the context of an empirically plausible medium-scale model, however, this upper limit exists and lies in the empirically plausible area of the parameter space. Most importantly, the increase of the upper limit is the quantitatively dominant effect of price stickiness on the size of the non-standard indeterminacy area. The practical relevance of the findings in the related existing literature on the role of price stickiness for the shape of the non-standard indeterminacy is therefore very limited. Next, we will use our model to further

[9] Let us also note that the result in Sveen and Weinke (2007), according to which the size of the non-standard indeterminacy area is increasing in wage stickiness, holds up in the context of the medium-scale model which is used in the present paper. This result is available upon request.

[10] In each case, the size of this region is, however, so small that it is not even possible to see it with the eye in figure 1.

elaborate on the economic mechanisms behind our results.

4.3 Inspecting the Mechanism

We now use our medium-scale model and disentangle the respective roles of its main features. Starting from the baseline case we introduce one change at a time. Specifically, we hold the price stickiness parameter, θ, fixed at its baseline value, 0.75, and analyze how variations in the remaining parameters of interest change the results presented in figure 1. Those parameters measure investment adjustment cost, consumption habit, variable capital utilization, and indexation in price- and wage-setting. We analyze both current- and forward-looking interest rate rules. The results are shown in figure 2.

[Figure 2 about here]

The two panels in the first row of figure 2 show how the results obtained so far depend on the value of the investment adjustment cost parameter, ϵ_ψ. Around the baseline value, 2.79, a clear pattern emerges. Regardless of whether monetary policy is current-looking or forward-looking the size of the non-standard indeterminacy area becomes larger if parameter ϵ_ψ decreases. This is consistent with the intuition that we had already developed. If parameter ϵ_ψ decreases then a current investment boom has smaller effects on future investment demand. But it is precisely future demand which may offset the negative effects of current investment on the future marginal cost. Consequently, the non-standard indeterminacy area becomes larger. It is also interesting to note that this effect is much stronger in the case of forward-looking monetary policy. So strong, in fact, that the upper limit of the area does not even exist for small enough values of parameter ϵ_ψ. What is the reason why the effect of reducing the value of parameter ϵ_ψ on the size of the non-standard indeterminacy area is so different depending on whether monetary policy is current- or forward-looking? Only to the extent that the central bank reacts to current inflation an increase in current investment demand has a direct impact on the determination of the long real interest rate. The persistence of investment in the aftermath of a boom is therefore less relevant for the size of the non-standard indeterminacy area. Figure 2 also shows that, in the case of a current-looking interest rate rule, the upper bound of the non-standard indeterminacy area becomes smaller for minuscule values of parameter ϵ_ψ. The reason is that for those values the coefficient premultiplying the marginal cost in the inflation equation, κ, changes in a way that reflects a reduction in the endogenous price stickiness in the model. For larger values of parameter ϵ_ψ this effect is negligible in a way that is analogous to the corresponding result in Sveen and Weinke (2004) for the case of a capital adjustment cost.

Let us now consider the role played by the consumption habit parameter, h. The results are shown in the second row of figure 2. In the case of a current-looking monetary policy, results are almost unchanged for variations in this parameter around its baseline value 0.69. The reason is once again that the persistence of demand matters very little for the determination of the relevant long real interest rate, if the central bank reacts to current inflation. In the case of a forward-looking monetary policy, however, the determination of the relevant long real rate depends crucially on the extent to which the negative effect on the marginal cost (resulting from an increase in labor productivity in the aftermath of an investment boom) is counteracted by future consumption demand. However, the Euler equation (1) makes clear that an increase in parameter h does not only increase the relative importance of past consumption for the current consumption decision, it also reduces the importance of the long real interest rate for that decision. In the second row of figure 2 this is reflected by the fact that for most values that are larger than the baseline value the upper bound of the non-standard indeterminacy area is increasing in the value of parameter h.

The economic mechanisms inspected so far substantiate our earlier claim that it is the empirically plausible degree of smoothness in aggregate demand which is behind our main result: the determinacy properties of current- and forward-looking monetary policy rules are much more similar than it appears to be the case based on the analyses conducted in Carlstrom and Fuerst (2005), Huang and Meng (2007), Kurozumi and Van Zandweghe (2008) and Huang et al. (2009). Let us also mention here that Huang et al. (2009) do consider a convex capital adjustment cost as well as a consumption habit, but they analyze each feature in isolation. The results shown in the first two rows of our figure 2 make clear, however, that the introduction of one single source of smoothness in aggregate demand is not sufficient to change the indeterminacy properties of the model in a quantitatively important way.

Next, we analyze the way in which variable capital utilization, as measured by parameter ε_b, affects our results. A clear pattern emerges. The less costly it is for firms to vary the degree of capital utilization, the smaller the non-standard indeterminacy area becomes. This is for the following reason. Other things being equal, a decrease in the cost of capital utilization makes the marginal cost less volatile. In the thought experiment of an investment boom the stabilization of future deflation leads, in itself, to an increase in current inflation. But this must reduce the size of the non-standard indeterminacy area. (This argument is similar to the one that we have used to explain the role of price stickiness for the upper limit of the non-standard indeterminacy area.)

If we increase the degree of indexation (either in price-setting, as parametrized by ϕ_π, or in wage-setting, as measured by ϕ_w) the size of the indeterminacy region decreases. This is true not only for current-looking interest rate rules but also for forward-looking ones, as the forth and fifth rows of figure 2 clearly show.[11] Intuitively, an increase in current real economic activity has a stronger impact on the determination of (future) real interest rates if pricing decisions are affected by past pricing decisions, or past wages.

[11] The last result might be expected given a finding in Huang and Meng (2007) according to which a pre-determined price level implies a non-standard indeterminacy area that is smaller than the one that obtains if the price level is a jump variable.

4.4 Remedies

Next, we ask to what extent the indeterminacy problem can be mitigated, if the nominal interest rate is adjusted not only in response to inflation but also as a function of past interest rates or current output, i.e., we now allow parameters τ_r and τ_y to be different from zero in (10). Those results are shown in the first two rows of figure 3, where we introduce one change at a time with respect to the specification underlying the results shown in figure 1. The last set of results shows that monetary policy can render rational expectations equilibrium determinate if an interest rate rule is in place which combines the Taylor principle with interest rate smoothing and/or some responsiveness of the nominal interest rate to a measure of real economic activity. Also here, the intuition developed in Sveen and Weinke (2005) is useful to understand this result. First, interest rate smoothing implies that an increase in current real economic activity keeps being relevant for the determination of future (real) interest rates. This counteracts any tendency of the long real interest rate to drop. Second, adjusting the nominal interest rate in response to output also reduces the size of the non-standard indeterminacy area because this way the central bank reacts directly to any change in real economic activity. Taken together, this substantiates our earlier claim that, at least in a qualitative sense, we confirm the results in Sveen and Weinke (2005) in the context of the medium-scale model which is used in the present paper.[12]

Finally, let us comment on another result in Huang and Meng (2009). They analyze monetary policy rules prescribing that the nominal interest rate is adjusted not only in response to expected inflation but also as a function of expected output. They argue that those rules have stability properties that are crucially different from the ones implied by rules prescribing to adjust the nominal interest rate in response to current output. In order to relate to their analysis we also consider

[12] The result in Sveen and Weinke (2007) according to which an increase in the share of the responsiveness to wage-inflation (for a given value of the central bank's response to overall inflation) reduces the size of the non-standard indeterminacy area is also robust in the context of our medium-scale model. Those results are available upon request.

a forward-looking output response in the rule, i.e., the cases $k = 0$ and $k = 1$. We find that their conclusion cannot be regarded as a general result. Indeed, the determinacy properties implied by those rules are almost identical in the context of our medium-scale model, as documented in the third row of figure 3.

[Figure 3 about here]

The intuition behind this result relies again on the simple fact that the timing of monetary policy matters very little for the implied stability properties if aggregate demand is reasonably smooth.

5 Conclusion

This paper is motivated by the fact that analyses of determinacy, i.e., local uniqueness of rational expectations equilibrium, are generally conducted in the context of highly stylized models. In the present paper we use a medium-scale model which combines features that have been shown to explain fairly well postwar U.S. business cycles. Two results emerge. First, the empirically plausible design of monetary policy in the US since the early eighties[13] can explain the observed stabilization of macroeconomic outcomes, whereas the Taylor principle in itself cannot. This strengthens the practical relevance of some of our earlier results in Sveen and Weinke (2005). Second, the stability properties of forward-looking interest rate rules are very similar to the corresponding outcomes under current-looking rules. The last result is in stark contrast with many findings that have been obtained in the related existing literature. We use our framework to explain why those results are not robust.

[13] See, e.g., Woodford (2003, Ch. 1) for an overview of empirical studies on interest rate rules.

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Table 1: Baseline Parameter Values

Parameter	Value	Justification
β	$1.03^{-1/4}$	Steady state annual real interest rate of 3%.
η	1	Labor supply elasticity of 1.
h	0.69	Habit formation.
ϵ_N	21	Mark-up in wage setting of about 5%.
θ_w	0.75	Nominal wage stickiness of about 4 quarters.
ϕ_w	0.5	Partial indexation to past inflation in wage setting.
ϕ_π	0	No price indexation.
ϵ	6	20% mark-up.
α	0.36	Capital share.
δ	0.025	Annual depreciation of about 10%.
ϵ_ψ	2.79	Elasticity of the marginal capital adjustment cost.
ϵ_B	1.46	Elasticity of the marginal cost of capacity utilization.
θ_p	0.75	Price stickiness of about 4 quarters.

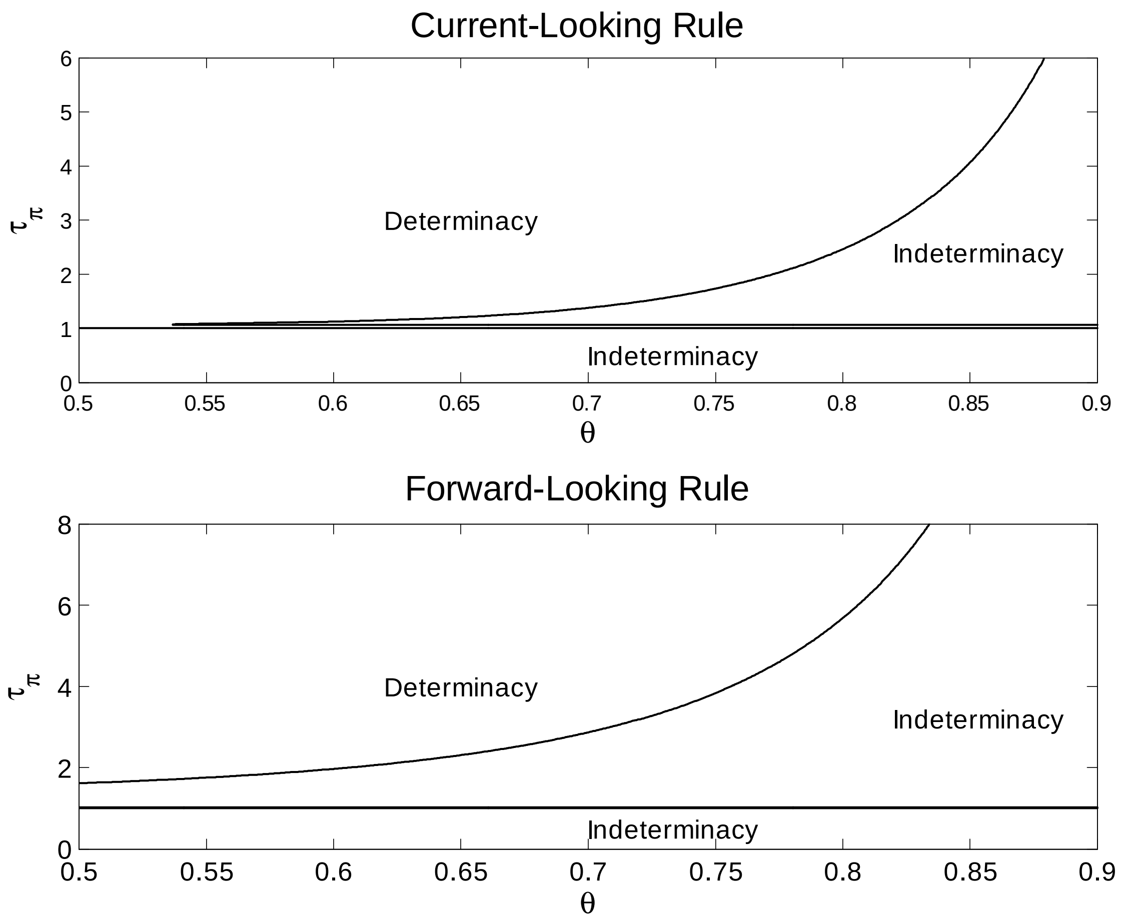

Figure 1: Current-Looking vs. Forward-Looking Monetary Policy.

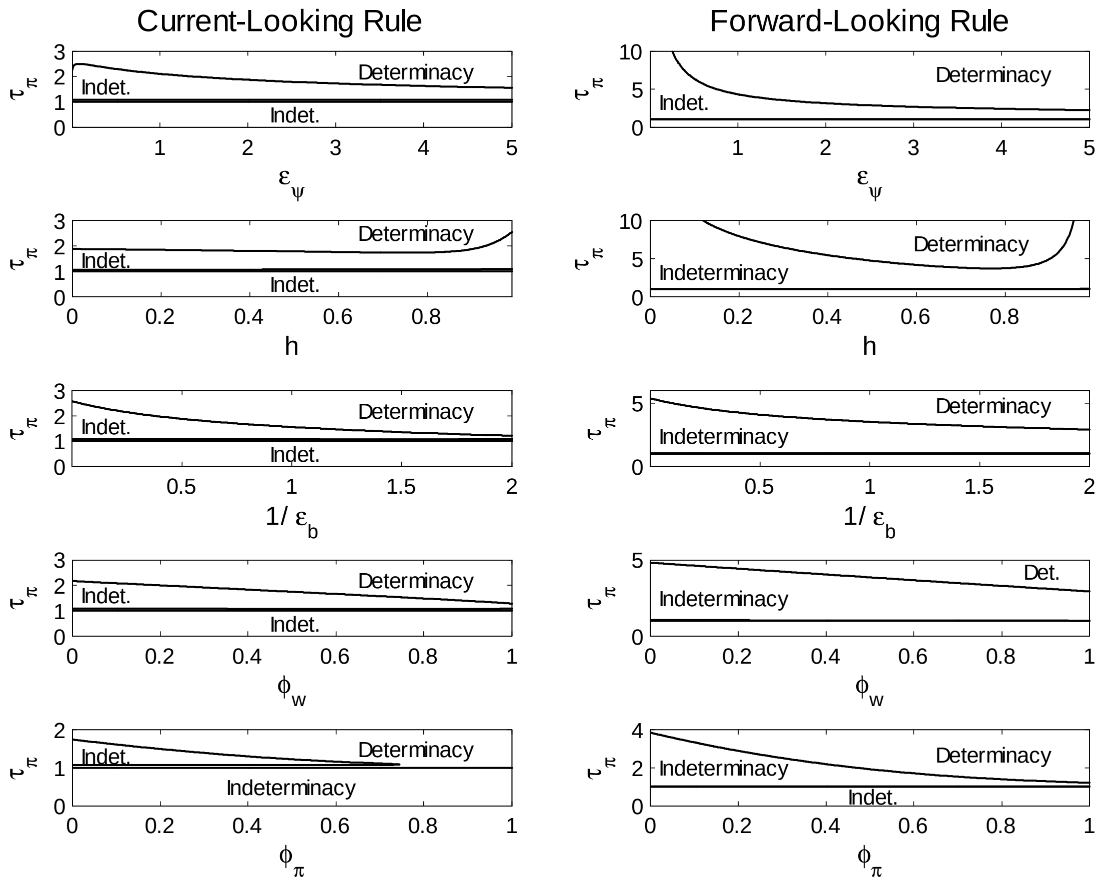

Figure 2: Inspecting the Mechanism

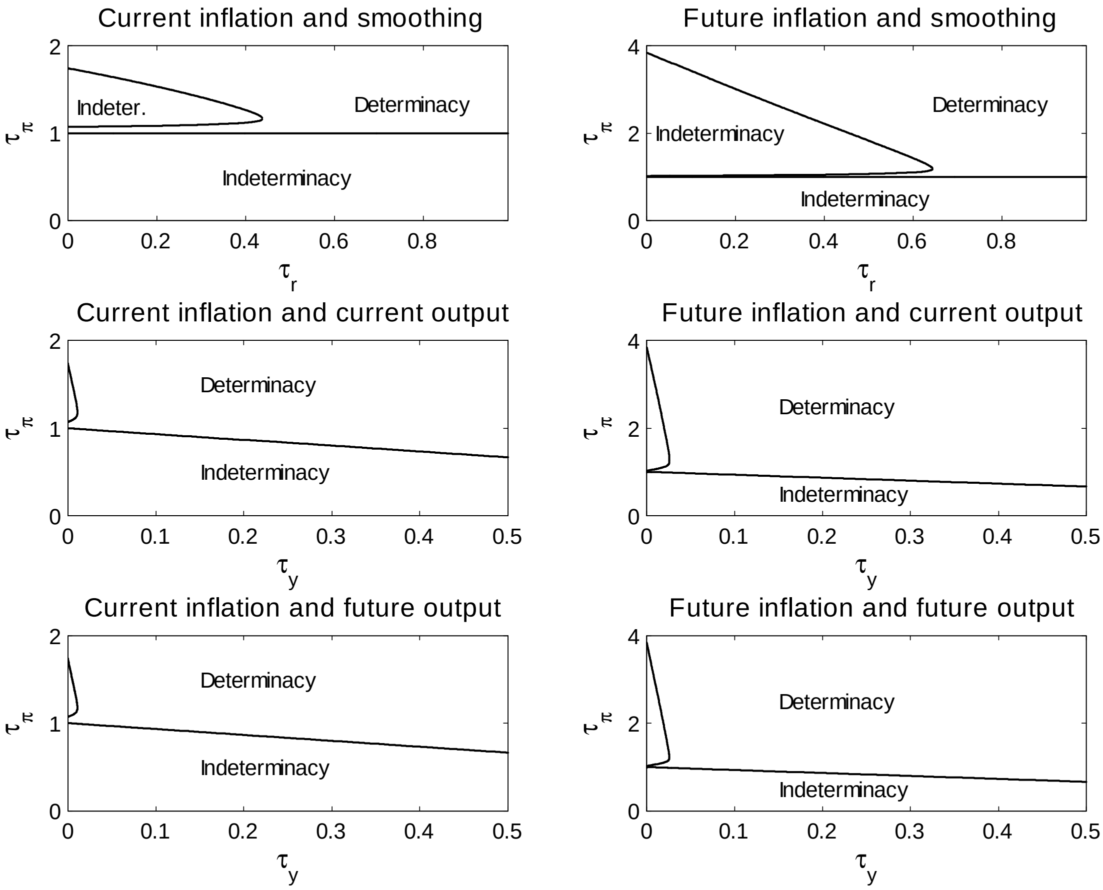

Figure 3: Remedies