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The Taylor principle in a medium-scale macroeconomic model

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ABSTRACT

We consider a medium-scale New-Keynesian model which combines features that have been shown to explain fairly well postwar U.S. business cycles. Our main result demonstrates that the determinacy properties of forward-looking interest rate rules resemble, at least qualitatively, the corresponding outcomes under current-looking rules. We explain how and why the empirically relevant features of our model generate this novel result.

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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.

Carlstrom and Fuerst (2005) and Sveen and Weinke (2005) show, however, that the Taylor principle can fail to guarantee determinacy in the context of NK models with endogenous capital accumulation.² The former paper is mostly concerned with an indeterminacy problem that can exist if the nominal interest rate is set as a function of future expected inflation.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 (2007a), Kurozumi and Van Zandweghe (2008), Huang et al. (2009) and Duffy and Xiao (2011). We note, however, that those analyses of determinacy

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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). He considers, however, a continuous time framework.

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 steady state inflation for determinacy in a Taylor-type pricing model.

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 as follows. 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 how the indeterminacy issues that are linked to the presence of capital accumulation are affected by the investment adjustment cost assumption, which is typically employed in medium-scale macroeconomic models. A related question is how the indeterminacy properties of the model are affected when this type of endogenous capital accumulation is combined with other bells and whistles that increase the empirical relevance of NK models. Most importantly, 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. (2011) and Schmitt-Grohé and Uribe (2007).⁵ Its main features are an external consumption habit, sticky prices and wages, price indexation in price- and wage-setting, variable capital utilization as well as firm-specific capital accumulation that is subject to a convex investment adjustment cost.

The main result in the present paper shows that the determinacy properties of forward-looking interest rate rules resemble, at least qualitatively, the corresponding outcomes under a current-looking interest rate rule, in the context of an empirically relevant medium-scale macroeconomic model. This is interesting because Carlstrom and Fuerst (2005), Huang and Meng (2007), Kurozumi and Van Zandweghe (2008), Huang et al. (2009), and Duffy and Xiao (2011) have shown that forward-looking policy rules imply indeterminacy for almost all realistic parameter values in the context of the models under consideration. In order to disentangle the economic mechanisms at work our analysis proceeds as follows. We start by assessing the investment block's role for our main result. Specifically, we keep the assumption of firm-specific capital accumulation that is subject to a convex investment adjustment cost and shut down the remaining features listed above, except for the price and wage stickiness. For the case of current-looking interest rate rules this analysis is closely related to our earlier work in Sveen and Weinke (2005, 2007a), where we restrict attention to current-looking interest rate rules.⁶ In the present paper we also consider forward-looking policy rules. This part of our analysis confirms earlier results in the literature. More concretely, Huang et al. (2009) and Duffy and Xiao (2011) have found large differences in the stability properties implied by current- and forward-looking interest rate rules in the context of models featuring a convex capital adjustment cost. In the other papers mentioned above similar results had been obtained under the assumption of flexible capital accumulation. A property of NK models which has been extensively studied in the past and is well understood by now, is, however, that flexible capital accumulation gives rise to an unrealistic monetary transmission mechanism.⁷ It is therefore interesting to start our analysis by observing that the large differences in the stability properties implied by current- and forward-looking interest rate rules can also be found in the presence of empirically relevant restrictions on capital adjustment.

But what does then explain our main result? In a nutshell, the intuition is as follows. Sveen and Weinke (2005) observe that investment has counteracting effects on the determination of the marginal cost and therefore inflation. First, investment demand increases inflation. Second, 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 relevant for investment could therefore drop in the presence of an increase in real economic activity that is unrelated to the economy's fundamentals. Consistent with this intuition, forward-looking monetary policy tends to increase the range of parameter values for which indeterminacy obtains. The quantitative relevance of the distinction between current- and forward-looking monetary policy for the implied determinacy properties is, however, much less pronounced in the context of our medium-scale model. In fact, the interaction of the above-mentioned features tends to reduce the relative importance of the second effect in the determination of the marginal cost. Later in the text we will provide a detailed inspection of the mechanisms at work.

Finally, and consistent with earlier findings, the present paper also demonstrates 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 output, or past nominal interest rates. Interestingly, we show, however, that the distinction between rules that are current- or forward-looking with respect to output matters very little for the implied indeterminacy properties. Once again, this is explained by the presence of the empirically relevant features, as we are going to see. Taken together, we therefore show that those features of our business cycle model lead to some important changes in the implied indeterminacy properties compared with the state of the literature in this field. A comprehensive overview of that literature can be found in Duffy and Xiao (2011).⁸

The remainder of this 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.

⁴ See, e.g., Altig et al. (2011), Christiano et al. (2005), and Smets and Wouters (2007).

⁵ 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.

⁶ A difference with respect to our work in Sveen and Weinke (2005, 2007a) lies in the fact that we had considered before a convex capital adjustment cost à la Woodford (2003, Chapter 5, 2005).

⁷ See, e.g., Sveen and Weinke (2007b), among many others.

⁸ Another aspect of the paper by Duffy and Xiao (2011) is the analysis of learnability in the context of a New Keynesian model featuring endogenous capital accumulation. This issue has also been studied by Kurozumi and Van Zandweghe (2008). Both papers extend the early work on learnability in models without endogenous capital accumulation by Bullard and Mitra (2002).

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