



# Taylor rules in the open economy<sup>☆</sup>

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## ABSTRACT

Taylor rules, which link short-term interest rates to fluctuations in inflation and output, have been shown to be a good guide (both positively and normatively) to the conduct of monetary policy. As a result they have been used extensively to model policy in the context of both closed and open economy models. Their determinacy properties have also been analysed in the context of closed and, to a more limited degree, in small open economy models. In this paper, we extend the analysis of the determinacy properties of Taylor rules to the case of a benchmark two-country model. When the rules are specified in terms of output-price inflation we confirm and extend the conventional results from the closed economy literature—satisfying the Taylor principle is the key to ensuring determinacy, although the presence of backward-looking price-setting can affect the determinacy properties of the two-country model. However, the conventional results do not hold when we replace output-price inflation with consumer price inflation in the specification of the rule. In this case, Taylor rules which satisfy the Taylor principle will be indeterminate, unless there is an unusually large home bias in consumption. Similar indeterminacy problems arise when one country targets CPI inflation and the other output-price inflation. In this case we show that, even if determinacy is achieved, large spillovers may occur between countries.

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## 1. Introduction

Monetary policy rules based on inflation targets are widely used in the literature, in the context of both closed and open economy models. The best known example is the Taylor rule (see Taylor, 1993), which takes the following form:

$$R_t = \bar{r} + \pi_t + m_p(\pi_t - \pi^T) + m_y(y_t - \bar{y}_t) \quad (1)$$

where  $R_t$  represents the short-term nominal interest rate. The rule requires the central bank to raise this interest rate such that real interest rates rise above their steady-state value ( $\bar{r}$ ) in response to inflation ( $\pi_t$ ) lying above target ( $\pi^T$ ) and positive values of the output gap, ( $y_t - \bar{y}_t$ ). Taylor (1993) argued that for such a rule to approximate optimal monetary policy it should satisfy what has become known as the *Taylor Principle*, which states that the response of nominal interest rates to excess inflation should be more than one for one, such that real rates rise whenever inflation lies above its target, *cet. par.* That the rule should satisfy this principle has been confirmed more formally in the context of simple general equilibrium

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models which include nominal price rigidities (see for example, Clarida et al., 1999; Woodford, 2001a, 2003). Following Leeper (1991), we will use the term ‘active’ to describe a monetary policy rule that obeys the Taylor principle, and ‘passive’ for one that does not.

In extending this analysis to the open economy, a key issue is whether consumer price inflation might be a better target than output-price inflation. As discussed in Svensson (2000) and later in this paper, the direct role of the exchange rate in influencing consumer prices will mean that consumer and output prices will react differently to policy. However, empirical work which seeks to estimate Taylor rules as a means of describing and evaluating past policy has not considered this to be an important issue.<sup>1</sup> Critically, in practice all central banks implementing inflation targeting have chosen a consumer price-based measure of inflation.

At the same time a related theoretical literature has attempted to characterise optimal monetary policy in the context of small country open economy models.<sup>2</sup> In deriving optimal monetary policy rules for a benchmark small open economy model, Clarida et al. (2001) argue that the policy maker’s problem is isomorphic to that in the closed economy case, and that optimal monetary policy should, therefore, follow a simple Taylor rule, with excess inflation defined in terms of output-price inflation. Subsequent work has suggested that relaxing some of the assumptions underpinning this benchmark model, say, for example, by allowing for stickiness or incomplete exchange-rate pass-through in the setting of import prices, non-traded goods or shocks to international risk sharing, may result in open economy variables, such as the exchange rate, entering into the optimal monetary rule (see, for example, Corsetti and Pesenti, 2005; Monacelli, 2003; Kara and Nelson, 2003; Leith and Wren-Lewis, 2007; Kirsanova et al., 2006). However, this optimal monetary policy literature does not, typically, suggest that adopting one definition of inflation over the other will lead to indeterminacy provided any rule satisfies the Taylor principle.

In this paper we show, in the context of a two-country model, that if both countries implement Taylor rules which satisfy the Taylor principle, defining excess inflation in terms of consumer prices and assuming an empirically plausible degree of openness will result in indeterminacy, such that there will not be a unique perfect foresight equilibrium path. This indeterminacy does not arise if each economy targets output-price inflation and satisfies the Taylor principle. We also show that ‘mixed regimes’, where one country targets consumer price inflation and the other output-price inflation, suffer similar problems of indeterminacy as when both target consumer price inflation. Even when parameters allow a determinate solution, significant spillovers between economies can occur, implying that one country has a clear interest in the monetary policy pursued by the other.

The current paper is related to recent work by De Fiore and Liu (2005), Linnemann and Schabert (2006) and Zanna (2003), who also consider the determinacy of interest rate rules, but in the context of small forward-looking open economy models. They also find that for sufficiently open (but, small) economies, adopting CPI inflation targeting may lead to indeterminacy. Our model differs from this work by considering determinacy in a two-country model.<sup>3</sup> The fact that the difference between CPI and output-price inflation involves both the exchange rate and foreign prices, means any results obtained under the small open economy assumption need not hold after relaxing this assumption. Indeed, our analysis shows that the definition of ‘sufficiently open’ depends upon the policy responses to inflation and the definition of excess inflation in both economies, and furthermore that unilaterally adopting a CPI inflation target in the rule is likely to raise the critical value of ‘openness’ needed to avert indeterminacy, relative to the case where both economies adopt a CPI-based rule. For plausible descriptions of policy most economies would be subject to indeterminacy should they adopt a Taylor rule specified in terms of CPI inflation. We also demonstrate that these results are robust to different assumptions about the degree of forward and backward-looking behaviour in price-setting, while non-standard combinations of policy parameters can ensure determinacy when there is a large degree of backward-looking price-setting in one or other economy.

In the main model analysed, we do not assume that consumers are infinitely lived. We do this for two reasons. Firstly, this removes the unit root property from the equilibrium dynamics which is well known in international macroeconomics (see for example, Schmitt-Grohe and Uribe, 2003), and which would otherwise preclude the local analysis of stability we undertake.<sup>4</sup> Secondly, the presence of finitely lived consumers potentially modifies the stability analysis in a non-trivial way, allowing for additional interactions between the two economies’ monetary policies. We assess the extent to which

<sup>1</sup> For example, the original Taylor rule (Taylor, 1993) is specified in terms of output prices in the form of the GDP deflator. This measure is also adopted in the empirical work of, for example, McCallum (2000) and Orphanides (2004). However, it is as least as common for the rule to be specified in terms of CPI inflation—see for example, Clarida et al. (1998), Gerlach and Schnabel (2000) and Altavilla (2003). A rare example of where the two measures are compared is, Clarida et al. (2000), who show that replacing an output-price definition of excess inflation with CPI inflation does not significantly alter the estimated coefficients of a Taylor-type rule describing US monetary policy.

<sup>2</sup> Benigno and Benigno (2006) and Clarida et al. (2002) consider the desirability of co-ordinating monetary policies in the context of a two-country model. However, the fundamental stabilising properties of interest rate rules under alternative definitions of excess inflation are not considered in these papers.

<sup>3</sup> Benigno and Benigno (2008) explore determinacy of interest rate rules in a two-country context, but they only consider rules cast in terms of output rather than cpi inflation. Nevertheless, adding terms in the level of the exchange rate to the rules, as in Benigno and Benigno (2008) and Benigno et al. (2007) maybe an alternative means of ensuring determinacy.

<sup>4</sup> Linnemann and Schabert (2006) employ the devices of perfect capital markets and a trade friction to render the model stationary, Zanna (2003) uses portfolio adjustment costs and De Fiore and Liu (2005) assume perfect risk sharing to close-off the current account.

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