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# Macroeconomic equilibrium and welfare under simple monetary and switching fiscal policy rules

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ABSTRACT

Using a standard forward-looking New Keynesian model, this paper investigates rational expectation equilibrium determinacy and macroeconomic performance of simple monetary policy rules under exogenous versus endogenous tax policies when there is tax uncertainty. Under the endogenous tax framework, we found: 1. responding to tax allows monetary policy to have control on the determinacy region, hence higher policy flexibility with respect to the fiscal policy conduct; 2. welfare improvement may come at the expense of cycling. The risk minimizing monetary policy behavior may become problematic since loss function values display huge variations depending on the probabilities given to future tax policy outcomes.



## 1. Introduction

It is well known theoretically that given monetary policy the determinacy properties of the rational expectation equilibrium crucially depend on the nature of fiscal policy. Sargent and Wallace (1981), Leeper (1991), and Sims (1994) connected monetary and fiscal policies, showing that one policy may impose restrictions on the other, and that the two policies should interact in a coherent way in order to deliver a unique equilibrium.

The New Keynesian literature assumed in most cases that the fiscal policy is Ricardian and therefore it is up to the monetary policy to determine the price level and inflation. More recently, Schmitt-Grohe and Uribe (2007) have analyzed the combinations of fiscal and monetary rules that lead to a unique equilibrium when allowing for the more realistic case of distortionary taxation.

In the context of a New Keynesian setup for monetary policy analysis, the Taylor principle (Taylor, 1993) was derived by assuming that the fiscal authority sets lump sum taxes that satisfy a balanced budget requirement. In this framework, Woodford (2003) showed that the necessary and sufficient condition for a locally unique rational expectations equilibrium is an interest rate rule which instructs the policy makers to adjust the nominal interest rate by more than one-for-one in response to inflation.

However, a number of studies as for example Benhabib et al. (2001), Carlstrom and Fuerst (2001), Gali et al. (2004), Sveen and Weinke (2005), Branch et al. (2008), and Zubairy (2011) among others, pointed out at the limitation of the Taylor principle in avoiding indeterminacy and fluctuations driven by self-fulfilling fluctuations when departing from standard modeling assumptions. According to these authors, the conditions for the determinacy of a unique equilibrium are model dependent and consequently the robustness of simple interest rate rules to model specification is a concern.

Despite the fact that the design of monetary policy depends upon the underlying fiscal policy features, few papers investigated what should be an adequate design. One of the few studies tackling this issue is Kumhof et al. (2010). The authors investigated whether interest rate rules that respond aggressively to inflation following the Taylor principle are feasible in countries that suffer from fiscal dominance. They found that, if interest rates are allowed to also respond to government debt, they can produce unique equilibria but such equilibria are associated with extremely volatile inflation. Moreover, they found that the welfare gain from responding to government debt is minimal compared to the gain from eliminating fiscal dominance.

The motivation for our work was the recent empirical studies by Romer and Romer (2010a, 2010b). The authors used the narrative record, such as presidential speeches and Congressional reports to identify the size, timing and principal motivation for all major U.S. postwar tax policy actions. The chronology of major U.S. tax events as surveyed by Romer and Romer (2010a, 2010b) unveiled a fluctuating fiscal policy

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with tax and government spending cuts and increases, actions operated under different motivations and which do not seem to be correlated. Romer and Romer (2010a, 2010b) separated legislated tax changes into endogenous and exogenous. The authors labeled as endogenous tax changes motivated by prospective economic conditions as, for example, changes in government spending, output and inflation, and as exogenous, the ones whose main purposes were to reduce an inherited budget deficit or to promote long-run growth.

Several questions arise in connection with the U.S. post-war legislated tax changes as documented by Romer and Romer (2010a, 2010b). For example, among the "endogenous" tax actions Romer and Romer (2010a, 2010b) document legislated changes having as motivation the control of inflationary/deflationary pressures (See for example: Revenue Act of 1945, Revenue Act of 1950, Excess Profits Tax Act of 1950, Revenue Act of 1951, Social Security Amendments of 1954, Federal Aid Highway Act of 1956, Public Law 89-800 (Suspension of Investment Tax Credit), Revenue and Expenditure Control Act of 1968, Tax Reform Act of 1969). In this context of a fiscal policy that aims to control inflation one question is whether the monetary authority commitment to fight inflation aggressively following a Taylor rule is still a sufficient condition for ensuring price stability. Is an active monetary policy like a Taylor rule still feasible and desirable? Does a unique bounded equilibrium still exist in this environment? How does this type of tax policy change the impact of policy shocks?

Also, Romer and Romer (2010a, 2010b) documents that most of the recent (after 1975) U.S. postwar tax actions were of the "exogenous" type with tax cuts and increases that do not follow in a particular order. Therefore, in this "exogenous" switching tax policy environment the question is whether an active monetary policy like a Taylor rule is still sufficient to insulate the economy against the tax shocks. In these circumstances would the monetary authority increase its ability to react aggressively to inflation by taking fiscal variables such as tax into account in formulating its policy?

This paper takes into consideration in modeling the motivations for tax policy actions as grouped by Romer and Romer (2010a, 2010b) and investigates how the monetary policy should change to accommodate these types of fiscal behavior.

Several previous studies documented also the stochastic behavior of taxes. For example Chung et al. (2007) documented that a growing body of evidence found that tax policy reaction functions vary substantially over different periods in the United States. Consequently, they model the tax policy as a rule that adjusts lump sum taxes in response to the real value of total government liabilities, allowing the response of taxes to liabilities to take values that depend on the realization of fiscal regime. Davig and Leeper (2006) specified a regime-switching tax rule which responds to current government purchases, output gap, and debt held by public. They estimated their model and found that this type of stochastic behavior is important in U.S. data. Also, Dotsey (1990), Krusell et al. (1996), Klein and Rios-Rull (2003), and Davig (2004) among others found supporting evidence for the stochastic behavior of taxes and analyzed the effects of this behavior in stochastic growth models.

This paper contributes to the literature in several ways. First, it investigates what should be an appropriate reaction from the monetary policy part given the fiscal policy features documented by Romer and Romer (2010a, 2010b). More precisely, within the framework of the New Keynesian model, we show how a continuous swing between endogenous and exogenous tax policies as labeled by Romer and Romer (2010a, 2010b), high and low taxation periods, affect the performance of simple, implementable interest rate rules, and assess whether the Taylor principle is a sufficient condition for the determinacy. The simplicity and implementability conditions should be understood as in Schmitt-Grohe and Uribe (2007) and Kumhof et al. (2010). These authors define simplicity as the requirement which restricts attention to rules where the interest rate is set as a function of a small number of easily observed macroeconomic indicators, and implementability as the condition which requires policies to deliver uniqueness of the rational expectation equilibrium.

Second, we incorporated in the standard New Keynesian model tax rules which capture Romer and Romer (2010a, 2010b) empirical findings. We modeled the tax rules following Davig and Leeper (2006) approach, i.e. in the endogenous tax policy case we considered a tax rule which maps endogenous variables (inflation and output) into tax policy choices while in the exogenous case the feedback from these endogenous variables is missing. More precisely, we specified the tax rule either as an autoregressive process of order 1 (AR1) with switching autoregressive coefficient (for exogenous tax policy case) or as a rule in which tax responds in a linearly fashion to contemporaneous inflation and output variables (for the endogenous tax policy case). In the second case regime switching is introduced through fiscal disturbances.

Third, on the monetary policy side, we study interest rate feedback rules that respond not only to inflation and output variables as modeled usually in the literature, but also to the tax variable. The response to the tax variable is in the spirit of Kumhof et al. (2010) work. Kumhof et al. (2010) allowed the nominal interest rate to respond to measures of government debt and government spending in addition to measures of inflation and output. The authors motivated the respective interest rule specifications based on the observation that, under fiscal dominance, the monetary authority must be clearly aware that it is the only entity capable of ensuring not only price stability but also fiscal solvency. Therefore, it should be natural to suppose that it will take fiscal variables into account in formulating its policy.

We analyze two types of interest rate rules: contemporaneous rules, where the interest rate responds to current values of the macroeconomic variables, and forward-looking rules where the interest rate responds to expected values of the macroeconomic variables. For each of these two types of rules, we consider two cases: in the first case we allow the interest rate to respond only to the inflation and output variables, while in the second case we allow the interest rate to respond also to tax in addition to the inflation and output variables.

Following Schmitt-Grohe and Uribe (2007) and Kumhof et al. (2010), this paper also contributes to the literature by analyzing not only the feasibility but also the desirability of the respective interest rate rules given the documented tax policy features. More precisely, by computing welfare implications, we rank these rules or equilibria. Welfare is calculated using two alternative criteria: the non-approximated household utility function and a loss function calculated as the sum of the inflation and output gap variances. The second welfare criterion allows us to assess welfare in terms of inflation and output gap observables and consequently to quantify the risks of adopting the policies under investigation.

The main findings of the paper can be summarized as follows. The first finding is that the type of tax policy: endogenous versus exogenous, can alter the rational expectation equilibrium in a manner that is quantitatively and qualitatively significant. The form of the Taylor principle needs to be adjusted depending on the tax policy in place. When tax policy is endogenous, a larger response to inflation is needed from the monetary policy part in order to obtain determinacy. The interesting part is that the size of the monetary policy response to inflation depends on the size of the tax policy response to output gap and steady state tax value. The monetary policy response to output gap needs either to be decreased proportionally with the size of the tax policy response to inflation if interest rate is responsive to contemporaneous values of variables, or be kept the same as in the exogenous tax case if interest rate is responsive to the expected values of variables.

The second interesting result is that if the monetary authority takes into consideration the type of the tax policy followed, she will get more flexibility in her policy conduct and decrease the welfare losses on the private agents' part. Under the endogenous tax policy framework, an interest rate rule responsive to tax will allow the monetary authority to get control over the determinacy region. She can either expand or contract the determinacy region depending on the size of the interest