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Risk management, nonlinearity and aggressiveness in monetary policy: The case of the US Fed

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ABSTRACT

We contribute to the empirical literature on the risk-management approach to monetary policy by estimating regime switching models where the strength of the response of monetary policy to macroeconomic conditions depends on the level of risk associated with the inflation outlook and risk in financial markets. Using quarterly data for the Greenspan period we find that: (i) risk in the inflation outlook and in financial markets are a more powerful driver of monetary policy regime changes than variables typically suggested in the literature, such as the level of inflation and the output gap; (ii) estimation of regime switching models shows that the response of the US Fed to the inflation outlook is invariant across policy regimes; (iii) however, in periods of high economic risk monetary policy tends to respond more aggressively to the output gap and the degree of inertia tends to be lower than in normal circumstances; and (iv) the US Fed is estimated to have responded aggressively to the output gap in the late 1980s and beginning of the 1990s, and in the late 1990s and early 2000s. These results are consistent with Mishkin (2008)'s view that in periods of high economic risk monetary authorities should respond aggressively to changes in macroeconomic conditions while the degree of inertia should be lower than in normal circumstances.

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1. Introduction

Starting with Taylor (1993), a large body of literature has focused on the derivation and estimation of linear monetary policy reaction functions in the United States and abroad. More recently, economists started to focus on the possibility that monetary policy may react in a nonlinear manner to economic activity and inflation. This nonlinear behaviour may arise as a result of deviations from the conventional minimisation of quadratic loss functions subject to linear Phillips curves and aggregate demand schedules (Svensson, 1997; Ball, 1999; Clarida et al., 1999). Another factor that can lead to potential nonlinearity in monetary policy is an uncertain economic environment. Former Chairman Greenspan stated that “Uncertainty is not just an important feature of the monetary policy landscape; it is the defining characteristic of that landscape” (Greenspan, 2004).

Several sources of uncertainty affect the implementation of monetary policy in real time. First, policymakers are uncertain about the state of the economy because data used in monetary

policymaking are measured imperfectly (*data uncertainty*). There seems to be agreement in the literature that policymakers should be less aggressive with respect to poorly measured targets. Second, policymakers are uncertain regarding the impact of policy on the economy, and about the structure of the economy (*parameter uncertainty*). So far, the literature has been divided as to whether or not monetary policy in the presence of parameter uncertainty should be more or less aggressive than absent uncertainty. Whereas Brainard (1967) postulated that uncertainty about the quantitative impact of policy on the economy should lead to less aggressiveness in monetary policy, Estrella and Mishkin (1999), Peersman and Smets (1999) and Rudebusch (2001) found that parameter uncertainty has only negligible quantitative effects on the feedback parameters. Yet another strand of literature shows that uncertainty regarding the structure of the economy and/or the impact of policy should lead to a more responsive approach to monetary policy. Finally, policymakers are uncertain about the distribution of shocks hitting the economy (*shock uncertainty*). As it is well known, optimal policy in a linear-quadratic framework with shock uncertainty exhibits certainty equivalence. This literature has been criticised on the grounds that it implies that the costs of being wrong do not depend on whether the future

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value of inflation is over or underestimated. In the “robust control” approach to monetary policy, the authorities do care about the worst case scenario. In this case, an aggressive monetary policy may help to avoid very bad outcomes (Giannoni, 2002; Onatski and Stock, 2002).

Former US Fed Governors have also stressed the importance of an uncertain outlook for the conduct of monetary policy. Former Chairman Greenspan describes the “risk-management approach” to monetary policy” by stating that “Given our inevitably incomplete knowledge ... a central bank needs to consider not only the most likely future path for the economy but also the distribution of possible outcomes about that path” (Greenspan, 2004). This approach may also lead to a more aggressive response of monetary policy to macroeconomic conditions depending on the level of risk facing the economy. Former Governor Mishkin discusses the case of financial market disruptions, which pose significant risks to the macroeconomic outlook. He maintains that when financial markets are strained, “policy in this setting tends to respond aggressively when a large shock becomes evident; for this reason, the degree of inertia in such cases may be markedly lower than in more routine circumstances”. In that light, he maintains that “the Federal Reserve’s policy strategy is aimed at providing insurance to help avoid more severe macroeconomic outcomes”. Therefore, risk management appears critical for both academics and central bankers, because as emphasized by Greenspan (2004) “... the conduct of monetary policy in the United States has come to involve, at its core, crucial elements of risk management”.

In this paper, we contribute to the empirical literature on monetary policy under uncertainty by estimating regime switching models where the strength of the response of monetary policy to macroeconomic conditions depends on the level of risk facing the economy. This monetary policy rule follows Mishkin’s idea that the strength of the monetary policy response to economic conditions should depend on the variances of shocks hitting the economy.² In doing so, we do not attempt to distinguish among the various theories mentioned before. Instead, we want to document empirically whether or not monetary policy implemented by the US Fed has depended on the level of risk facing the economy. Our measures of risk are based on the previously mentioned statements by former Fed officials. First, following Greenspan’s emphasis on the distribution of outcomes around central paths, we use a measure of dispersion associated with the outlook of inflation derived from individual responses to the survey of professional forecasters (SPF). Second, because former Governor Mishkin focused on the importance of stress in financial markets in formulating an appropriate monetary policy response, we use a measure of risk in financial markets derived from stock options. Moreover, we use real time data from the Greenbook to estimate the regime switching models because there is wide recognition that using *ex-post* data has a series of drawbacks. To our knowledge, this is the first time that real time data are used in the estimation of nonlinear Taylor rules for the United States. The focus is on the Greenspan period because of his emphasis on the risk-management approach to monetary policy making in the United States.

Our starting point is the estimation of linear monetary policy feedback rules that have been widely estimated in the literature. These feedback rules have been tested for neglected nonlinearity arising from the level of inflation, the output gap and the stance of monetary policy, as suggested by the empirical literature on nonlinear Taylor rules surveyed later on in this paper. They have also been tested for nonlinearities arising from the level or risk facing the economy, as suggested by the risk-management

approach and the other theories mentioned before. When linearity is rejected, nonlinear Taylor rules have been estimated using nonlinear least squares techniques. The main findings of the paper are as follows: (i) risk in the inflation outlook and in financial markets are a more powerful driver of monetary policy regime changes than the variables typically suggested in the literature; (ii) estimation of regime switching models shows that the response of the US Fed to the inflation outlook is invariant across policy regimes; (iii) however, in periods of high economic risk monetary policy tends to respond more aggressively to the output gap and the degree of inertia tends to be lower than in normal circumstances; and (iv) the US Fed is estimated to have responded aggressively to the output gap in the late 1980s and begging of the 1990s, and in the second half of the 1990s and early 2000s. These findings are by and large consistent with the views of former Governor Mishkin who suggested that in periods of high economic risk monetary authorities become more aggressive while the degree of inertia is markedly lower than in normal circumstances.

The remainder of the paper is organised as follows. Section 2 reviews the literature on linear and nonlinear Taylor rules while Section 3 describes the data used in the empirical analysis. Section 4 reports the results of the estimation of linear Taylor rules that have been widely used in the empirical literature. In Section 5, we tested for neglected nonlinearity in these linear rules using a large set of potential transition variables. We then estimated nonlinear monetary policy reaction functions where the strength of the response of monetary policy to macroeconomic conditions depends on the level of risk facing the economy. Section 6 concludes.

2. Nonlinear monetary policy reaction functions: literature review

Nonlinear monetary policy reaction functions may arise as a result of deviations from the conventional minimisation of quadratic loss functions subject to linear Phillips curves and aggregate demand schedules (Svensson, 1997; Ball, 1999; Clarida et al., 1999). The loss function of the central bank may not be quadratic because of asymmetries in the response of monetary policy to inflation in different points of the business cycle and/or the size of deviations of actual inflation from explicit or implicit targets (Bec et al., 2002; Martin and Milas, 2004; Rabanal, 2004; Dolado et al., 2005; Kim et al., 2005; Taylor and Davradakis, 2006; Cukierman and Muscatelli, 2008). It is also possible that the Phillips curve reflects more complex price-setting mechanisms than those subsumed in a linear specification (Schaling, 2004; Dolado et al., 2004, 2005).

Several nonlinear monetary policy reaction functions have been estimated for the United States and other developed countries and their performance has been found to be superior to their linear counterparts. For example, Martin and Milas (2004) and Taylor and Davradakis (2006) find that the Bank of England follows a nonlinear monetary policy rule, responding more strongly to changes in inflation when inflation is significantly above target. Bec et al. (2002) and Rabanal (2004) test the presence of asymmetries in US monetary policy and find that the US Fed was more concerned with inflationary pressures during economic booms, whereas contractions were essentially devoted to demand management. Dolado et al. (2005) tested the hypothesis that various central banks tighten monetary policy more aggressively when both inflation and output overshoot their targets. They provide empirical evidence supporting this hypothesis for central banks in Europe, but not for the United States. Petersen (2007) examines the behaviour of the US Federal Reserve in setting policy rates according to the level of inflation and/or the output gap. This author shows that US Fed followed a nonlinear Taylor rule over the period 1985–2005; once inflation approaches a certain threshold the Fed begins to respond more forcefully. Kim et al. (2005) and Cukierman and

² Another strand of literature has estimated monetary policy rules that include a measure of macroeconomic risk along with the more traditional drivers of monetary policy, such as inflation and the output gap. See Dolado et al. (2004), Beakaert et al. (2013), Alcidi et al. (2011), Baxa et al. (2013), and Andrade et al. (2011).

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