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Central bank and asymmetric preferences: An application of sieve estimators to the U.S. and Brazil

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ABSTRACT

Whether central banks place the same weights on positive and negative deviations of inflation and of the output gap from their respective targets is an interesting question regarding monetary policy. The literature has sought to address this issue using a specific asymmetric function, the so-called Linex loss function. However, is the Linex an actually asymmetric specification? In an attempt to answer this question, we applied the sieve estimation method, a fully nonparametric approach, in which the result could be any proper loss function. This way, our results could corroborate the quadratic or Linex loss functions used in the literature or suggest an entirely new function. We applied the sieve estimation method to the United States and to Brazil, an emergent country which has consistently followed an inflation targeting regime. The economy was modeled with forward-looking agents and central bank commitment. Our results indicate that the FED was more concerned with inflation rates below the target, but no asymmetry was found in the inflation–output process in the Volcker–Greenspan period. As to Brazil, we found asymmetries in output gaps from 2004 onwards, when the Brazilian Central Bank was more concerned with positive output gaps; but we did not find any statistically significant asymmetries in inflation.

1. Introduction

The literature pays special attention to how central banks conduct the monetary policy. They act to control inflation and, owing to frictions in the economy, they also affect the real side in the short run. As monetary authorities have the power to affect the output temporarily, they likely include output and employment stability among their goals, in addition to price stabilization. Nonetheless, central banks do not always explicitly disclose their goals. Actually, their reaction to changes in economic variables – through the so-called reaction functions – is perceived more easily. In the seminal work by Taylor (1993), the monetary authority adjusts the nominal interest rate in response to deviations of inflation from its target and from the output gap.

This monetary authority's reaction function can be construed as the result of a model that treats the central bank as an usual economic agent, seeking to minimize a loss that depends on deviations of the inflation and the output as the consumer seeks to maximize her utility. Moreover, as consumer's decisions are limited by her budget constrain, the actions of the central bank are constrained the structure of economy, materialized usually in the investment-saving (IS) and aggregate supply (AS) curves. Therefore, observing the reaction function alone, to what extent the interest rate responds to inflation and output deviations, for example, does not allow distinguishing between how much of this effect comes from the monetary authority's preferences and how much is imposed by the structure of the economy. Several studies try to make a distinction between these effects by estimating the central bank's preferences and not only the reaction function. The traditional approach to this problem consists in modeling the economy (IS and AS curves) as linear equations, either backward-looking or forward-looking, and modeling the monetary authority as an agent that minimizes a loss that is a quadratic function of the difference between inflation and its target and of the output gap. A great advantage of this approach is its tractability, which can be solved analytically[2]. Another advantage of the quadratic loss function is that it can be seen as a second-order Taylor approximation to the expected utility function from a representative agent in a general equilibrium model with rational expectations and price frictions (Woodford, 2003, chapter 6), that is, it would represent the social preference over inflation and output.

However, the linear-quadratic approach has some drawbacks. It implies that the same weights are given in the loss function to positive and negative deviations from its target variables. For instance, the loss the monetary authority would have with inflation one percentage point

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[2] This approach consists in a dynamic programming problem with quadratic objective function and linear transition functions, which is solved by Ricatti equation. See, for instance, Ljungqvist and Sargent (2004, chapter 5).

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above its target would be the same as the loss resulting from inflation one percentage point below the target, which is not necessarily true: to increase its credibility, the central bank might show greater aversion to inflation levels that exceed its target, as a precautionary measure. On the other hand, when there is a risk of deflation, the monetary authority might have a greater aversion to inflation below its target and, mainly, to decreases in the price index (deflation). Second, this approach produces linear reaction functions with a constant marginal effect of the inflation over the interest rate, both for inflation rates close to or far away from their targets, and the same would occur with the output gap.

The first alternative to obtain reaction functions that are nonlinear is to assume nonlinearities in the structural functions of the economy. Theoretically, Nobay and Peel (2000) demonstrate that a discretionary policy under a nonlinear Phillips curve produces an inflationary bias if the output corresponds to the potential output. Schaling (2004), based on a theoretical model in which the Phillips curve is convex (positive deviations of the variables are more inflationary than negative deviations are disinflationary), shows that the larger the economic uncertainty, the more aggressive the monetary policy conduct should be. Using U.S. data to calibrate their model, Chiarella et al. (2003) model the economy as a dynamic system with several equations, including a Phillips curve with downwardly rigid wages and prices, and find that the equilibrium of such system is unstable. Dolado et al. (2005), based on a nonlinear Phillips curve (quadratic in terms of output gap), obtain a reaction function in which one of the terms is the interaction (multiplication) between inflation expectation and the output gap. Using monthly data, the authors found evidence of asymmetry in the monetary policy conduct for Germany, France, Spain, and for the Eurozone, but they could not reject the hypothesis of linearity for the U.S. case. Finally, Komlan (2013) found asymmetries in the preferences of the Canadian monetary authority, with a greater loss for inflation rates above its target, using a threshold model, in which the central bank has two different quadratic loss according to a threshold variable.

The second alternative to obtain nonlinear reaction functions is by modeling the monetary authority's loss function as a possibly asymmetric function, unlike the usual quadratic function described in the literature. In this vein, Orphanides and Wieland (2000) developed a model with nonlinearities both in the structure of the economy and in the monetary authority's preferences. They consider that the monetary authority's loss function contains an interval on which it is linear, representing the target zone for inflation. In addition, they also allow the Phillips curve to have a linear segment. As a result, they show that there is some incentive for the monetary authority to shift away from a linear policy. Cukierman and Muscatelli (2002) develop a model in which the specification of the loss function is generic and, from a first-order condition of the monetary policy, they carry out a comparative static exercise. Kim et al. (2005) estimated the central bank's loss function non-parametrically using the method proposed by Hamilton Hamilton (2001)[3] and found asymmetry in the function for the pre-Volcker period, but linearity for the whole sample and for the Volcker–Greenspan period.

In the same line, Surico (2007), based on Robert Nobay and Peel (2003), estimated the asymmetry of the U.S. central bank's loss function, both for inflation and for the output gap, using a parametric function which allows nonlinearities and has the quadratic form as a special case[4]. By modeling the behavior of the monetary authority as discretionary, the author found evidence of asymmetry in the loss associated with the output gap for the pre-Volcker period, in which the central bank was far more concerned with negative than with positive output deviations. The author, however, did not reject the hypothesis of symmetry of the loss function for inflation. The method proposed by Surico (2007) was applied to Brazil by Aragón and Portugal (2010), who found asymmetry in the Brazilian central bank's loss associated with inflation for the 2000–2007 period, with inflation rate below the target, causing a welfare loss higher than the above-target inflation. For the 2004–2007 subperiod, or for the output gap in the whole sample or in this subperiod, they did not find evidence of asymmetry. Naraidoo and Raputsoane (2011) also used the linex specification, combining it with target zones for inflation, and applied the model to South Africa. They found that there exist target zones for both inflation and output and that outside these zones the preferences are symmetric for inflation and asymmetric for the output gap.

The literature on the preferences regarding the monetary authority's reaction function shows that the hypotheses of the model have been relaxed, including the hypothesis that posits that the preferences are symmetric. The linex specification used by Robert Nobay and Peel (2003), Surico (2007) and Aragón and Portugal (2010) generalizes the loss function, but it is still a parametric assumption about the central bank's behavior. The natural path for the improvement of this literature is to further reduce restrictions to the functional form of the monetary authority's preferences, with a nonparametric estimation. Its advantage is do not impose any functional form on the loss function; this way, the estimated function could corroborate another one currently used in the literature or suggest another functional form for the loss function. Thus, the aim of this paper is to estimate the central bank's loss function using a nonparametric estimation method. For that purpose, an optimization model with monetary authority's commitment is developed and, based on the resulting restrictions on the conditional moments of the variables, a sieve estimator is used to estimate the function that represents the central bank' s preferences. The method is applied to a developed country, the U.S., and to an emerging country, Brazil. Comparing a developed with an emerging country is important because the preferences of their monetary authorities could be rather different. Moreover, between the emerging countries, Brazil was chosen because it is the largest emerging economy that uses explicitly and consistently a system of inflation targeting. This way, it will be possible to determine whether the preferences of these two authorities are asymmetric in relation to inflation and (or) to the output gap and which the loss functions are.

However, the great liberty in the nonparametric estimation does not come at no costs. When we carry out a parametric estimation, for example a quadratic central bank loss function, $L = a\pi^2 + bx^2$, we look for two numbers in the real line, a and b, such that they minimize some criteria function which depends on these parameters and on the data observed. On the other hand, in a nonparametric estimation we look for a function, not a parameter, which lies in a functional space. It is important to realize that this search is lot harder, since there are “a lot more”[5] functions than there are pair of number in $\mathbb{R}^2$. For example, this functional space contains all quadratic functions $L = a\pi^2 + bx^2$ for all possible choices of a and b. Also, it also contains all possible linex functions, and so on. In order to address such issues, we use the sieve method proposed by Grenander (1981), which consists in minimizing the criterion function in a sequence of simpler spaces, generally of finite dimension, whose dimension increases with sample size. In other words, with this method we return, in a certain way, to a finite dimensional space, a bigger and more complex space, but still finite.

Besides this introduction, this paper is organized as follows. In the second section the economy's structure is descripted. The method used for estimation is presented in the third section. In the fourth section are presented the results, for both the U.S. and for Brazil. A brief conclusion follows.

[3] Hamilton (2001) estimated a model of the form $y = \mu(x) + \epsilon$, where $\mu(\bullet)$ is an unknown function, considering μ, a random variable itself.

[4] This function, known as the linex specification, is given by $L(\pi_t, x_t) = \alpha^{-2}[e^{\alpha(\pi_t - \pi^*)} - \alpha(\pi_t - \pi^*) - 1] + \lambda\gamma^{-2}(e^{\gamma x_t} - \gamma x_t - 1)$, in which parameters α and γ capture the asymmetry of the function. With $\alpha = \gamma = 0$, this specification collapses in the quadratic loss function. In the original model, the function also depends on an quadratic parameter of smoothing of interest rate.

[5] Precisely, the carnality of the functional space considered here is greater than the cardinality of R^n, for all n, even $n = \infty$.