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Estimating inflation persistence by quantile autoregression with quantile-specific unit roots[☆]

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ABSTRACT

In this paper we study inflation persistence, which is a key feature of inflation dynamics, related to how quickly a stationary inflation process reverts to its long-run equilibrium after a shock. Emerging economies with high inflation persistence need to adjust macroeconomic policies in a significant way to price shocks (e.g., at the cost of substantial output decrease), since these shocks can affect expectations and inflation for a much longer period. We propose a novel way to estimate inflation persistence by using a quantile autoregression (QAR) model, which allows for asymmetric dynamics and quantile-specific unit roots. An empirical exercise with Brazilian data from January 1995 to May 2017 illustrates the method. The results indicate that inflation is globally stationary, but exhibits non-stationary behavior in 28% of the observations. In addition, shocks occurring when inflation is higher seem to have greater dissipation time compared to shocks that occur when inflation is lower.

1. Introduction

One of the most important features of inflation dynamics is the degree of persistence (or inertia). It is related to how quickly a stationary inflation process reverts to its initial level, long-run equilibrium or inflation target after a shock. Inflation persistence is still a relevant concern in economics for several reasons. Historically, high inflation has been a major threat to economic growth in many developing countries (Mallick and Sousa, 2012). The latest World Economic Outlook (WEO) report published by the International Monetary Fund (IMF, 2017) projected double-digit inflation (or more) for 23 countries in 2017 (e.g., Angola 30.9%; Egypt 23.5%; Ukraine 12.8%; Turkey 10.9%).[1] On the other hand, inflation persistence directly affects the output costs of bringing inflation back to the target, often described in the literature as the sacrifice ratio. In other words, persistent inflation increases the costs of monetary policy to keep inflation under control, since rapid reductions of inflation are produced at the cost of substantial increase in unemployment and/or decrease of output (Mishkin, 2007). For instance, emerging economies which exhibit high inflation persistence may need to adjust macroeconomic policies in a substantial way to price shocks given that these might influence overall inflation (and

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[1] Although the report projects consumer price inflation in 2017 (annual percent change) of 1.7% for the advanced economies and 4.2% for the emerging market and developing economies, these figures are very heterogeneous among countries. For instance, inflation forecasts for Brazil and Chile in 2017 are 3.7% and 2.3%, respectively, whereas for Argentina the figure is 26.9% and for Venezuela 652.7%.

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inflation expectations) for a sustained period.

Several studies have shown that inflation persistence has been diminishing over the past decades in developed economies (e.g., Mishkin, 2007; Stock and Watson, 2007). The 1960s and 1970s were considered periods of high (and persistent) inflation in such countries, while more recent years have seen low levels of inflation and persistence. For instance, there has been a reduction of persistence in the U.S., especially after the 1990s, due to the great moderation period. There is also evidence of declining persistence in the G7 countries according to Cecchetti et al. (2007). Contrary to industrial countries, emerging economies have experienced high levels of inflation for a longer period. Some of these countries, such as Brazil, Argentina, Peru, Mexico, Israel and Turkey, have had periods of hyperinflation in the last 30 years. After the 1990s, the inflation levels started to decline in these countries, partly due to the important changes in the conduct of their macroeconomic policies.[2] However, it is not clear if the inflation decrease has been accompanied by a reduction of their inflationary persistence (Oliveira and Petrassi, 2014).

In Brazil, some studies indicate a diminishing persistence, whereas others suggest the opposite. For example, Machado and Portugal (2014) decompose inflationary inertia into three components[3] and conclude that intrinsic persistence declined between 1995 and 2011, while the other components remained relatively stable. On the contrary, Roache (2014) compares inflation targeting countries and concludes that inflationary persistence in Brazil increased until 2013, in particular, for periods with inflationary shocks. In turn, Oliveira and Petrassi (2014), based on a sample of 40 countries, suggest that inflation persistence is decreasing over time for the great majority of industrial economies. Many emerging economies, however, show increasing persistence and a few even have highly persistent inflationary processes. In Brazil, according to the authors, persistence remained relatively stable.

There are several methods available in the literature to estimate inflation persistence. The simplest approach consists of regressing the inflation rate on its own lagged values and then computing the sum of autoregressive coefficients. The higher the sum, the longer it takes for inflation to return back to its mean after a shock.[4] According to Roache (2014), a natural way to assess inflation persistence is to verify whether it is stationary (i.e., whether shocks permanently affect the level of inflation or instead fade over time). Methods that are more sophisticated include, for instance, the estimation of reduced-form Phillips curves, or even building structural macroeconomic models representing the inflationary dynamics based on latent factors and Kalman filtering (see Rudd and Whelan, 2007, or Pivetta and Reis, 2007).

In this paper, we tackle this topic from a different perspective. The objective here is to study the persistence of Brazilian inflation, and its main components, using quantile regression techniques. Quantile regression is a statistical method for estimating models of the conditional quantile function.[5] Nowadays, it is applied in many fields, since it allows for statistical inference about the entire conditional distribution. Based on a semiparametric approach, it provides a complete picture to analyze statistical relationships, by showing how covariates influence the location, scale and shape of the entire response distribution.

Since the seminal paper of Koenker and Basset (1978), a great amount of research has been dedicated to developing (and expanding) the quantile regression field and related semiparametric methods. Just to mention a few examples: (i) extension of the standard linear quantile regression setup to consider models with dependency and mixing conditions (Cai and Xiao, 2012; Galvão and Wang, 2015); (ii) quantile autoregression (Koenker and Xiao, 2004; Galvão, 2009); (iii) censored quantile regression (Wang and Wang, 2009; Galvão, Lamarche and Lima, 2013); (iv) quantile regression with interactive effects (Harding and Lamarche, 2014); (v) conditional quantiles for heavy-tailed distributions (Wang et al., 2012); and (vi) quantile regression with high dimensional data (Zheng et al., 2015).

In particular, in recent decades, many empirical applications have appeared in the literature using quantile regression and other semiparametric models, such as: Koenker and Zhao (1996); Engle and Manganelli (2004); Koenker and Xiao (2006); Lima et al. (2008); Xiao (2009); Gaglianone and Lima (2012, 2014), Xiao (2014); among many others. Regarding the use of quantile autoregression for analyzing inflation, Çiçek and Akar (2013) for Turkey and Wolters and Tillmann (2015) and Manzan and Zerom (2015) for the United States are recent examples. In terms of Brazilian inflation, Maia and Cribari-Neto (2006) analyze the dynamics of the IPCA and IGP-DI indexes from August 1994 to April 2004, finding that the inflationary dynamics is not uniform across different quantiles.

To characterize the dynamics of inflation, in this paper we use the quantile autoregression model (QAR), proposed by Koenker and Xiao (2002, 2004, 2006), in which the autoregressive coefficient may assume different values in distinct quantiles, allowing testing the asymmetry hypothesis for the inflation dynamics. Furthermore, the model allows investigating the existence of quantile-specific unit roots. In other words, the model enables us to identify locally non-stationary dynamics while remaining compatible with a global stationarity hypothesis of the investigated series. In addition, the model can be reformulated in a more conventional random coefficient notation, in order to reveal the periods of local non-stationarity. Another advantage of this technique is the estimation method, which does not require knowledge of the innovation process distribution, making this approach robust against poorly specified models.

In this paper, we study the monthly Brazilian consumer price index (IPCA) and its components from January 1995 to May 2017. To explore possible differences in disaggregated inflation dynamics, we investigate the two main components of the headline inflation (market prices and regulated prices) and disaggregate the market prices in two ways: (i) tradables and non-tradables; and (ii) services, food and beverages, and industrial goods. This way, our work differs from that of Maia and Cribari-Neto (2006) by using a larger data sample that includes almost 18 years under the inflation-targeting regime (which started in 1999 in Brazil) and taking into account the components of IPCA inflation.

The results suggest that inflation in Brazil is globally stationary, with the process even reaching non-stationarity, in the upper tail of the conditional distribution, for 28% of the considered sample (1995–2017). Overall, shocks have short-term effects, provided that inflation is stationary, but the time to dissipate shocks depends on the local behavior of the inflation dynamics. For example, shocks occurring when inflation is high have greater dissipation time compared to shocks that occur when inflation is lower.

The outline of the paper is as follows. In Section 2 we provide an overview of the methodology. Section 3 presents the empirical exercise and Section 4 concludes.

[2] For example, monetary aggregates targeting, often used prior to the 1990s, was highly inflationary.

[3] Inflation persistence can change for a number of reasons. For instance, from a new Keynesian Phillips curve, one can list various factors that may produce persistence: (i) dependence of inflation on its own past (intrinsic persistence, such as indexation by price-setters); (ii) inertial inflation expectations (e.g., due to agents' perceived reaction function of the policymaker to price or output shocks); and (iii) persistent fluctuations in the determinants of inflation (extrinsic persistence, like marginal costs or output gap).

[4] This approach assumes that the inflation rate process has no unit roots and the absolute value of the sum of autoregressive coefficients is lower than one.

[5] Indeed, quantile regression can be viewed as a generalization of median regression. As an alternative approach, expectiles form a generalized approach to the classic mean regression. See Schulze Waltrup et al. (2015) for a good discussion of expectiles and quantile regression.