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Trend inflation in Brazil

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Abstract

This paper estimates trend inflation for Brazil, using a model of unobserved components and stochastic volatility. The model allows a flexible dynamics between trend inflation and survey inflation expectations. Estimated trend inflation has been on a downward trend since 2017, and has not been significantly affected by the surge in inflation following the Covid-19 outbreak.

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1 Introduction

Higher inflation following the Covid-19 pandemic raised questions about the likelihood of continued high inflation, in a context of negative supply shocks, similar to what happened in the 1970s. This scenario motivated renewed interest in the determinants of inflation, and whether the double digit figures observed in the last two years are transitory or permanent, or inflation will become entrenched (for instance Bolhuis *et al.*, 2022; Reis, 2022; Walsh, 2022).

This paper uses the model of Chan *et al.* (2018) to estimate the evolution of trend inflation for Brazil. It aims to contribute to the literature on trend inflation, which has received recent attention for both advanced and emerging economies, against the backdrop of higher inflation in the last years.

The history of high inflation of Brazil, along with the surge in inflation globally, following the outbreak of Covid-19, makes the country a natural candidate to estimate the evolution of trend inflation.

Trend inflation is defined as the level of inflation to which inflation will converge after short-run fluctuations and shocks dissipate. It intends to capture long-run inflation, the rate that would prevail in the absence of or resource slack, supply shocks and temporary disturbances to inflation (Cascaldi-Garcia *et al.*, 2022). Mathematically, $lim_{j\to\infty} E[\pi_{t+j} \mid \Omega_t] = \pi_t^*$, where π_t^* is the trend inflation and Ω_t is the information set available in period t. Changes in trend inflation have implications for its dynamics, making it more volatile and persistent (Ascari and Sbordone, 2014).

If trend inflation runs above the inflation target, this can be a signal of de-anchoring of inflation expectations. In this way, trend inflation is a metric to evaluate monetary policy stance, i.e., if the inflation target differs substantially from trend inflation, then monetary policy must be adjusted accordingly. It can also be used to inform the setting of monetary policy, providing a centering point for the evaluation of inflation forecasts. Therefore, trend inflation can be used to assess the anchorage of inflation expectations.

Estimates of trend inflation can also provide a metric to gauge the appropriate level of the inflation target. If the latter is set above trend inflation, actual inflation will be higher and more volatile, increasing inflation expectations and risk premia in financial markets. On the other hand, if the inflation target is set below trend inflation, this could spark a deflation bias in the economy, lowering inflation expectations. This risk is particularly true for countries prone to zero lower bound episodes.

This paper is organized as follows. In addition to this introduction, Section 2 discusses the related literature. Section 3 introduces the model. Section 4 describes the data. Section 5 presents the results. Section 6 concludes.

2 Literature Review

From a theoretical point of view, Ascari and Ropele (2009) and Ascari and Sbordone (2014) show that, in the New-Keynesian model linearized around a positive inflation, the resulting Phillips curve flattens, with inflation depending more on expected future marginal costs in contrast to current marginal costs, i.e., firms become more forward looking, and inflation depends less on output.

Furthermore, price dispersion increases with trend inflation, with a greater difference between the price set by the resetting firms and the average price level. A side effect of the increased price dispersion is a lower output (price dispersion acts like a negative productivity shock) and an increased persistence of macroeconomic variables and their volatilities, particularly in face of persistent supply shocks, as in the case of the Covid-19 pandemic.

From a policy perspective, their main implications is that higher trend inflation tends to destabilize inflation expectations and that with a higher trend inflation, monetary policy should response more to deviations of inflation from the target and less to output gaps (Ascari and Ropele, 2009).

Theoretically, Ascari and Ropele (2009), Coibon and Gorodnichenko (2011) and Kiley (2018) show that the determinacy of the New Keynesian model changes with positive levels of trend inflation. Moderate rates of trend inflation (between 4 and 8 percent per year) shrink the range of policy settings consistent with equilibrium determinacy of the New Keynesian model, with a larger response of inflation being required for determinacy. All in all, the literature shows that higher trend inflation results in a lower level of steady-state output, a flatter Phillips curve and a less effective monetary policy.

Mertens (2011) estimates trend inflation for the United States, based on information from survey expectations, realized inflation and the term structure of interest rates, assuming that these variables follow a common trend. The model allows a time-varying volatility of trend shocks. Whenever these shocks are large, inflation expectations became unanchored. Using data from 1960 to 2011, he found that trend uncertainty tends to follow trend inflation. The reason is that periods of high trend inflation are usually associated with unanchored inflation expectations, creating upside risks on the inflation trend. This result is consistent with the Friedman-Ball hypothesis on the level and variability of inflation (Friedman 1977; Ball, 1992).

Garnier *et al.* (2018), with a model similar to Mertens (2011), estimated the level and uncertainty of trend inflation for 14 advanced economies, based on an unobserved-components model with stochastic volatility, in which different inflation measures (core and headline CPI and the GDP deflator) share the same common trend. The estimates share similarities across countries, with trend inflation in the 1970s reflecting higher inflation at the time, and anchored inflation expectations in the last two decades.

Higher global inflation following the Covid-19 outbreak has motivated new research on trend inflation, for instance, Österholm and Poon (2022) for Sweden, Cascaldi-Garcia *et al.* (2022) for the U.S., and Behera and Patra (2022) for India.

For advanced economies, Forbes *et al.* (2021) estimated an unobserved component stochastic volatility model (UCSV) where trend inflation follows a unit root, finding that inflation in the U.K. is well described by trend inflation and global variables (commodity prices, world export prices and the sterling exchange rate), and less by measures of slack and inflation expectations. Österholm and Poon (2022) estimated trend inflation for Sweden using the model of Chan *et al.* (2018) employing data from 1995 to 2021. In the context of the debate of whether the surge in inflation following the Covid outbreak is permanent or transitory, they found that trend inflation in Sweden has been fairly stable and lower than the inflation target. For the U.S., Cascaldi-Garcia *et al.* (2022) used an unobserved component model of trend inflation, with data from past inflation, trimmed inflation, and survey measures of inflation from 2000 to 2022, finding evidence of a rise in both the level and uncertainty of trend inflation following the recovery from the Covid-19 outbreak.

For emerging economies, Behera and Patra (2022) used a regime-switching approach and estimate a New-Keynesian Phillips Curve (NKPC) to capture trend inflation dynamics for India. In their model, trend inflation and the Phillips curve coefficients are computed as time-varying estimates. The main result is that trend inflation came down after 2014, ahead of the adoption of the inflation target regime in 2016, hovering around 4% before the Covid-19 outbreak. There is also evidence of flattening of the Phillips curve, i.e., lower response of inflation to economic activity.

Another recent study is Garcia and Poon (2022), who used the unobserved components model of Chen *et al.* (2018) to analyze inflation trends of 12 Asian economies, encompassing both advanced and emerging markets. They found that the lower trend inflation in the region responds for the decline in inflation in the last 20 years, although with substantial heterogeneity across countries.

Concerning Brazilian studies, Freitas and Sampaio (2021) reviewed the literature on inflation – particularly papers that estimate Phillips curves – over the last 10 years. Directly related to this paper is Caetano *et al.* (2023), who uses the model of Chan *et al.* (2013) with Brazilian data from 1999 to 2021 to study trend inflation and the persistence and volatility of the inflation gap, defined as the difference between realized inflation and trend inflation. They found that the persistence of the inflation gap reached peaks in 2002-2003 and around the recession of 2014-2016. Likewise, they documented that the volatility of the inflation gap increased between 2002-2003 and has been increasing after the 2014-2016 recession. Finally, they found that trend inflation is helpful in predicting inflation, beating measures of core inflation and the inflation targeting for horizons above one quarter.

3 Model

The model of Chan *et al.* (2018) is given by the following equations, where π_t is the inflation rate, which is an autoregressive process which moves around trend inflation (π_t^*), b_t is the autoregressive parameter which is also time-varying, z_t is the long-run inflation expectations, expressed as a function of trend inflation, where the coefficients $d_{i,t}$ are also time-varying.

$$\pi_t - \pi_t^* = b_t(\pi_{t-1} - \pi_{t-1}^*) + \nu_t \qquad \nu_t \sim N(0, e^{h_{\nu,t}}) \tag{1}$$

$$\pi_t^* = \pi_{t-1}^* + \eta_t \qquad \eta_t \sim N(0, e^{h_{\eta,t}}) \tag{2}$$

$$b_t = b_{t-1} + \epsilon_{b,t} \qquad \epsilon_{b,t} \sim TN_{(0,1)}(0, \sigma_b^2) \tag{3}$$

$$z_t = d_{0,t} + d_{1,t}\pi_t^* + \epsilon_{z,t} + \psi\epsilon_{z,t-1} \qquad \epsilon_{z,t} \sim N(0, \sigma_z^2) \tag{4}$$

$$d_{i,t} - \mu_{di} = \rho_{di}(d_{i,t-1} - \mu_{di}) + \epsilon_{d_i,t} \qquad \epsilon_{d_{i,t}} \sim N(0, \sigma_{d_i}^2), i = 0, 1 \tag{5}$$

$$h_{i,t} = h_{i,t-1} + \gamma_{i,t} \qquad \gamma_{h_i,t} \sim N(0, \sigma_{h_i}^2), i = \nu, \eta \tag{6}$$

Equation 1 associates current inflation π_t and trend inflation π_t^* to past inflation and past trend inflation, expressed in inflation gap form $(\pi_{t-1} - \pi_{t-1}^*)$. The parameter b_t is time-varying (equation 3), measuring the degree of persistence in the inflation gap. It is assumed that the variance of this parameter follows a truncated Normal, to ensure that $b_t <\mid 1 \mid$, so that the inflation gap is stationary at each point of time. Equation 2 is the state equation for the trend inflation π_t^*. Equation 4 relates long-term survey expectations (variable z_t) to trend inflation π_t^*, through the coefficients $d_{0,t}$ and $d_{1,t}$, respectively the intercept and the slope. The latter parameter capture the effect of trend inflation in long-term inflation expectations. Equation 4 also includes an MA(1) term to capture changes in survey expectations that may not be fully captured by the parameters $d_{0,t}$ and $d_{1,t}$. Equation 5 is the state equation for the time-varying parameters $d_{i,t}$. It allows one to assess how the relationship between inflation expectations and trend inflation changed over time. The volatility of the inflation gap and trend inflation follow random walk processes, represented by equation 6.

The model is estimated with Bayesian methods, using the Markov Chain Monte Carlo algorithm. The priors follow Chan et al. (2018). Results are qualitative the same with slightly different priors for the parameters $d_{i,t}$, that link inflation expectations to trend inflation.

4 Data

To estimate the model, I use data of core inflation (code 4466) and inflation expectations from the SGS of the Central Bank of Brazil. I focus on core inflation, because headline inflation tend to be more volatile and subject to on-offs measures, such as tax breaks. Core inflation is more appropriate to assess the underlying inflationary pressures of the economy. To obtain a series of long-term inflation expectations, I transform annual data into a 3-year constant maturity series. Monthly inflation figures were compounded in a given quarter and annualized to obtain the series used in the estimation. Inflation expectations figures come from the arithmetic average of the daily series in a given quarter. The sample period runs from 2002Q1 to 2022Q4, encompassing 84 observations.

5 Results

The left panel in Figure 1 plots the trend inflation measure (π_t^*), along with core inflation π_t and long-term inflation expectations (z_t). The right panel depicts trend inflation together with long-term inflation expectations. Trend inflation tracked quite closely the dynamics of long-term inflation expectations over the last 21 years. Up to 2017Q2, trend inflation has remained mostly below long-term inflation expectations, according to median estimates. Since 2017Q3, trend inflation began to run above long-term inflation expectations. Put differently, long-term inflation expectations acted as a ceiling for trend inflation before 2017Q2. Afterwards, trend inflation began to fall, alongside with the fall in long-term inflation expectations. Despite the rise in core inflation during the pandemic, trend inflation continued its downward trend that began in 2017Q3, following the decline in long-term inflation expectations. At the end of the sample period, trend inflation was hovering around 3.6 % per year, according to median estimates.

Figure 1 - Estimated trend inflation (π^*)

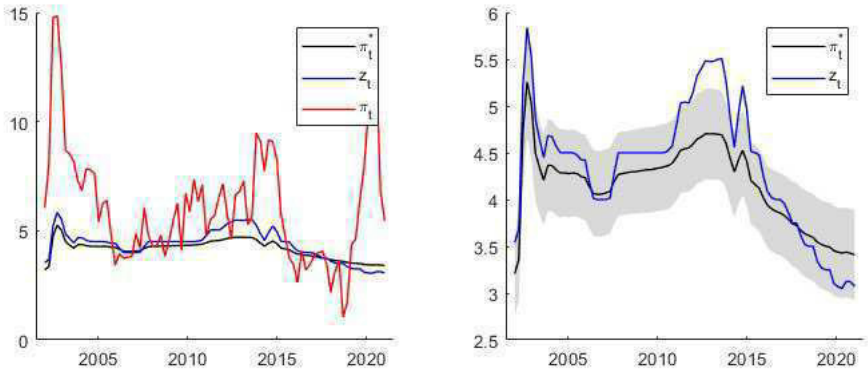


Figure 2 shows the intercept and slope of equation 4, which relates long-term inflation expectations to trend inflation. Both parameters show a downward trend from 2016 onwards. Figure 3 depicts the estimated stochastic volatility of the inflation gap and trend inflation, respectively. The former shows a higher volatility in the beginning of the sample period, during the consolidation of the inflation targeting regime. After stabilizing from 2005 onwards, it began to rise again during the 2014-2016 Brazilian recession, and more sharply during the pandemic years, since 2020. In contrast, the volatility of trend inflation was very high during the stabilization years of the inflation target regime, but it declined substantially from 2005 onwards, and remained low since, remaining intact during the pandemic years.

Figure 2 - Estimates of the parameters relating long-term inflation expectations and trend inflation

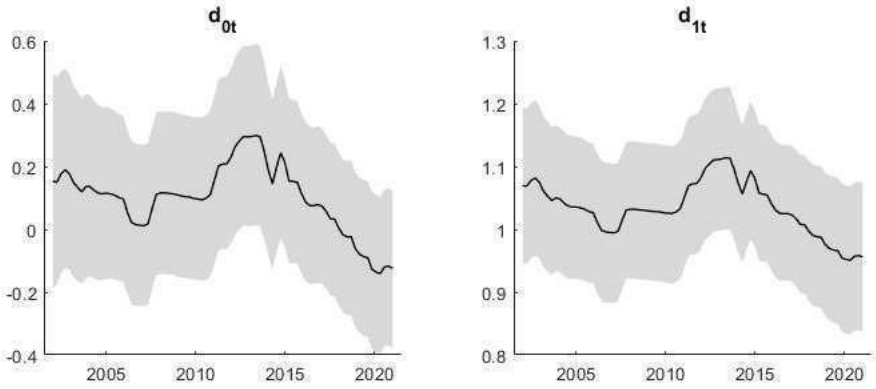
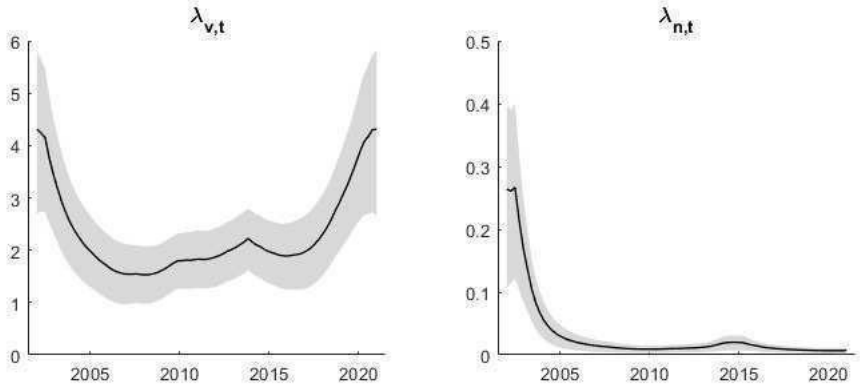
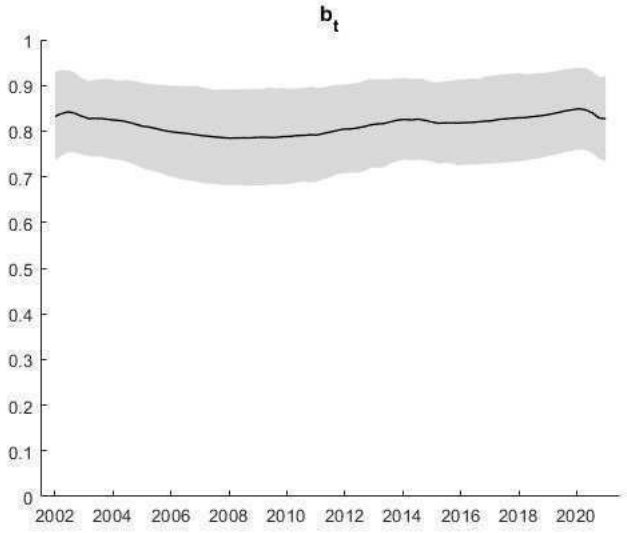


Figure 3 - Estimated stochastic volatility of the inflation gap and of trend inflation



Finally, Figure 4 shows the estimated persistence of the inflation gap (b_t). It remained quite stable over the sample period, ranging between 0.8 and 0.9.

Figure 4 - Estimated persistence of inflation gap



6 Conclusion

In this paper I used the model of Chan *et al.* (2018) to obtain measures of trend inflation in Brazil. The motivation was the inflationary history of the country and the surge in inflation globally following the Covid-19 pandemic. The model allows an interplay between long-term inflation expectations and trend inflation. Recent papers by Behera and Patra (2022), Cascaldi-Garcia *et al.* (2022), Forbes *et al.* (2021), Garcia and Poon (2022), and Österholm and Poon (2022) used models of a similar vein to analyze trend inflation in India, U.S., U.K., Asian countries and Sweden, respectively.

The results show that long-term inflation expectations acted as a barrier for trend inflation in Brazil up to 2017Q2. Afterwards, long-term inflation expectations started to run below trend inflation, following the fall in long-run inflation targets. This finding reinforces the importance of long-term inflation expectations for inflation dynamics in Brazil. The downward trend of trend inflation since 2017 shows that the backbone of inflation dynamics was broken. Despite the rise in core inflation during the pandemic years, trend inflation has remained intact, hovering around 3.6 per year in the end of the sample.

This paper also contributes to evaluate the appropriate inflation target in Brazil. According to Behera and Patra (2022), the optimal approach is to set the inflation target aligned with or slightly below trend inflation.

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