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The role of breakevens in trend inflation in Brazil

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Abstract

This paper obtains estimates of trend inflation and its stochastic volatility for Brazil, through models that incorporate information from breakeven inflation rates and their monthly volatility. Periods with high and low inflation expectations uncertainty are identified and compared to measures of forecast disagreement from survey expectations.

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1 Introduction

Developments in financial markets in the last 20 years have made available information of breakeven inflation rates (BEIR), defined as the difference between the returns of nominal and real bonds. This data can be used to assess the outlook for inflation, along with inflation expectations obtained from surveys of professional forecasters. Since financial prices incorporate new information in a timely way, there is a growing interest in how well BEIRs reflect inflation expectations or can forecast inflation over different horizons.

This paper incorporates information from BEIRs to estimate trend inflation and its stochastic volatility for Brazil. These variables provide information about the degree of anchoring of inflation expectations and its evolution over time (Garcia and Poon, 2018). It intends to contribute the literature on trend inflation in Brazil, a country with a history of high inflation.

The main models of Chan and Song (2018) are used to estimate the evolution of trend inflation and its stochastic volatility for Brazil. The latter variable can be understood as a proxy for inflation expectations uncertainty, along with inflation disagreement. According to Mertens (2016), when the volatility of trend shocks is low, the trend behaves like a constant and inflation expectations are well anchored. When the volatility of trend inflation is high, inflation expectations will likely become unanchored. The stochastic volatility of trend inflation therefore provides an estimate of the risks of changes in 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. It can be interpreted as the optimal conditional long-term forecast (Garcia and Poon, 2018). 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, as trend inflation can be viewed as the level 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 how inflation expectations are well anchored.

In the context of Brazil, there is a debate that inflation expectations from professional forecasters are over reliant on the views of the financial sector, which may behave opportunistically. By using financial market data from inflation-linked swaps, this limitation can be overcome, as traders "put their money where their mouth is". The second advantage of using financial market data to estimate trend inflation is that the adjustment of survey measures of inflation expectation to news tends to be more sluggish.

This rest of 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

This paper is related to the literatures on trend inflation and breakeven inflation rates.

The main references of the former are Ascari and Ropele (2009) and Ascari and Sbordone (2014). They show theoretically 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.

The main implications are that higher trend inflation tends to destabilize inflation expectations and that with a higher trend inflation, monetary policy should respond more to deviations of inflation from the target and less to output gaps.

Related to this paper, Garcia and Poon (2018) obtain trend inflation estimates for the euro area. They use data from the inflation-linked swap market in the model of Chan et al. (2018). In contrast, this paper uses BEIR data from the inflation-linked swap market in Brazil in the suite of models of Chan and Song (2018).

Regarding Brazilian studies, this paper is mainly related to Caldeira and Furlani (2013), Vicente and Guillen (2013) and Mariani and Laurini (2017).

The first paper uses BEIR data from 2005 to 2010 and finds that it is an unbiased estimator for future IPCA inflation for the 3-month horizon. For the 6- and 9-month horizons, the BEIR brings relevant information about future inflation. For the 12- and 15-month horizons, there is no statistically significant association, while for longer maturities it turns negative. Another result is that BEIRs forecast inflation more precisely than VAR models.

The second paper finds similar results. BEIRs are an unbiased estimator for short-term inflation (3- and 6-month horizons). BEIRs lack explanatory power for future inflation on the 12- and 18-month horizon, but are informative for 24- and 30-month ahead IPCA inflation, but with a counterintuitive negative relationship, which the authors associate to the inflation risk premium.

Mariani and Laurini (2017) jointly estimate the nominal and real yield curves in Brazil using a 4-factor model: two factor for the level - one for the real and other for the nominal yield curve-, and a common slope and curvature factors. They use data from 2006 to 2013, and find that inflation expectations from BEIRs forecast inflation better than the Focus survey for the horizon of 6- and 12-month ahead. Moreover, the implicit inflation is an unbiased estimator for inflation for up to 9-months, result close to the ones obtained in Caldeira and Furlani (2013) and Vicente and Guillen (2013).

Other works about BEIR in Brazil do not deal directly with its relationship with inflation, but rather try to decompose it. For instance, Vicente and Graminho (2015) measure inflation expectations from the FOCUS survey and obtain estimates of the inflation risk premium for 2006 and 2013. Nunes et al. (2017), through a VAR analysis, find a positive relationship between the 12-month inflation disagreement from the Focus survey and the inflation risk premium for the period 2006 and 2015, concluding that shocks to the former impacts the level of the term structure of inflation risk premium. Fernandes and Thiele (2015) fit a dynamic factor model for Brazilian BEIRs for the period 2004-2013 and assess the impact of shocks on the CDS, inflation rate, exchange rate and commodity prices.

The content of this paper can also be related to the literature on central bank's credibility and inflation forecasting.

Regarding the former, Val et al. (2017) use data from BEIRs to estimate the credibility of the Central Bank of Brazil from 2006 to 2017. They also find that BEIRs Granger-cause macroeconomic and financial variables such as the unemployment rate, the exchange rate, the EMBI risk premium and the IPCA inflation. Oliveira and Gaglianone (2020) use BEIRs data from 2005 to 2017 to construct indexes of long-term inflation expectations anchoring for Brazil.

Concerning the latter, Garcia et al. (2017) provide evidence using Brazilian data that models of the class used in this paper (UCSV) are comparable to univariate models, having the same forecasting ability as the random walk for short horizons and similar to the AR model for long horizons. There is a whole literature on the role of term structure information to forecast inflation (Ang et al. 2007).

3 Model

The main models of Chan and Song (2018) are given by the following equations. Inflation is decomposed as the sum of its trend π_t^* and a transitory deviation from the trend u_t^π:

$$\pi_t = \pi_t^* + u_t^\pi \qquad u_t^\pi \sim N(0, e^{h_t}) \tag{1}$$

It is assumed that trend inflation follows a random walk :

$$\pi_t^* = \pi_{t-1}^* + u_t^{\pi^*} \qquad u_t^{\pi^*} \sim N(0, e^{g_t}) \tag{2}$$

For the cyclical component u_t^π, it is assumed that $lim_{j\to\infty} E_t u_{t+j}^\pi = 0$. Equation 2 is the state equation for the trend inflation π_t^*.

In equations (1) and (2), h_t and g_t are respectively the log volatility of the transitory and trend components, and they follow random walk processes:

$$h_t = h_{t-1} + u_t^h \qquad u_t^h \sim N(0, \sigma_h^2) \tag{3}$$

$$g_t = g_{t-1} + u_t^g \qquad u_t^g \sim N(0, \sigma_g^2) \tag{4}$$

In the UCSV-RV of Chan and Song (2018), the log realized volatility of the the BEIRs, given by z_t, is related to the log volatility of the trend inflation, given by g_t.

$$log\, z_t = a_0 + a_1 g_t + u_t^z \qquad u_t^z \sim N(0, \sigma_z^2) \tag{5}$$

Finally, a second model, named UCSV-RV-BE, relates the average breakeven inflation in month t, given by x_t, to trend inflation:

$$x_t = b_0 + b_1 \pi_t^* + u_t^x \qquad u_t^x \sim N(0, \sigma_x^2) \tag{6}$$

Equation 6 relates BEIRs to trend inflation π_t^*, through the coefficients b_0 and b_1, respectively the intercept and the slope.

The model is estimated with Bayesian methods, using the Markov Chain Monte Carlo algorithm. The priors follow Chan and Song (2018). Results of UCSV-RV and UCSV-RV-BE are presented considering BEIRs of 1-, 2- and 3-years ahead.

4 Data

In order to estimate the models, daily data from nominal (Pre-DI swaps) and real (DI-IPCA swaps) yields were downloaded from the RB3 package for the period 2005-2023. Since this package was discontinued in 2024, for this year nominal yields come from Investing.com, and zero-coupon real yields from the Tesouro Direto database. Nominal and real yields for the period 2005-2024 were then linear interpolated to obtain constant maturity series[1]. In the next step, daily BEIRs were built using the formula $BEIR_t = \frac{(1+PreDi)_t}{(1+DIIPCA_t)}$, where $t = 1, 2, 3$ years. The final step was to construct the standard deviation (realized volatility) of the breakeven series for each month, variable z_t, and the monthly average of the breakevens, variable x_t. These variables are displayed in Figure 1.

There is evidence of an increasing holdings of financial institutions and other players in the inflation-linked market in Brazil. If these players are more prone to trading, this would reflect in an increasing liquidity and information content of BEIRs over time. Nonetheless, results are presented for 1-,2- and 3-year ahead, in order to limit concerns that they depend on specific maturities.

To estimate the models, the measure of inflation used was the annualized monthly core IPCA inflation figures (series 4466 in the SGS database of the Central Bank of Brazil). It was preferred to work with core inflation, because headline inflation tends to be more volatile and subject to on-offs measures. Core inflation is more appropriate to assess the underlying inflationary pressures of the economy. For the sake of comparison, Chan and Song (2018) use the annualized monthly CPI inflation in their results. The other series in the database, used to compare the results, are the disagreement of inflation expectations, measured as the standard-deviation of the inflation expectations and the IPCA inflation expectations. The sample period runs from February 2005 to December 2024, encompassing 239 observations.

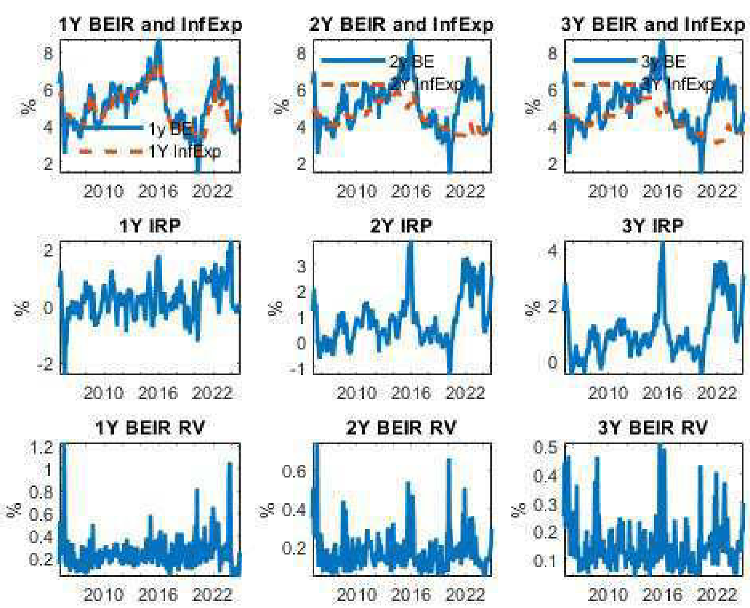
[1] Spreadsheets with the data are available upon request.

5 Results

The first line in Figure 1 plots the 1-,2- and 3-year ahead BEIRs along with the corresponding measures of inflation expectations. Overall, there is an increase in the first part of the sample period, reaching a peak in 2016, in the middle of the 2014-2016 recession. Afterwards the measures recede, following the decline in inflation and lower inflation targets, reaching a trough during the pandemic outbreak in 2020. Afterwards, BEIRs rose again during the period 2021-2023, following the increase in inflation. In the end of 2024 they were rising again.

The panels in the second row of Figure 1 show the inflation risk premium (IRP), computed as the difference between the BEIRs and inflation expectations from the SGS database. Vicente and Graminho (2015) find a negligible role for the convexity and liquidity premiums in Brazilian BEIRs. The averages of the 1-,2- and 3-year measures are 0.20, 0.81 and 1.06 p.a., The panels in the bottom of Figure 1 show the realized volatility (RV) of the BEIRs, which corresponds to variable z_t in equation 5.

Figure 1 - Data



The upper panel of Figure 2 compares the stochastic volatility of the UCSV-RV model and the IPCA inflation disagreement obtained from the SGS database for 1-,2- and 3-years ahead. The coefficients of correlation are mild: 0.49, 0.45 and 0.42, respectively. Stochastic volatility of trend inflation was high during the beginning of the sample, during the 2014-2016 recession and during the COVID-19 outbreak. Likewise, the bottom panel of Figure 2 depicts the stochastic volatility obtained from the UCSV-RV-BE model and the IPCA inflation disagreement. Again, the correlation between both series is modest: 0.48, 0.51 and 0.48 for the 1-,2- and 3-year ahead, respectively. Noticeable, long-term inflation disagreement was high during 2012-2013, a movement that was not accompanied by higher stochastic volatility measures of trend inflation.

Figure 2 - Stochastic Volatility and Inflation Disagreement

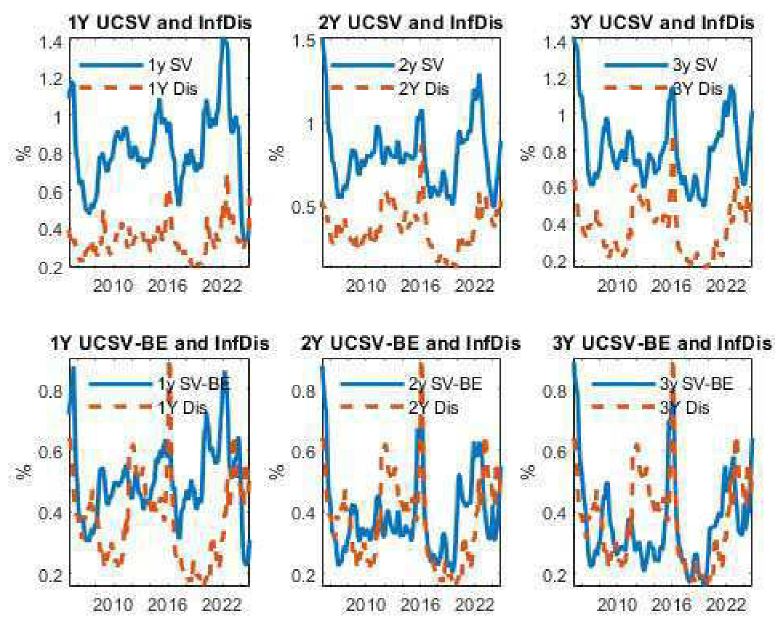
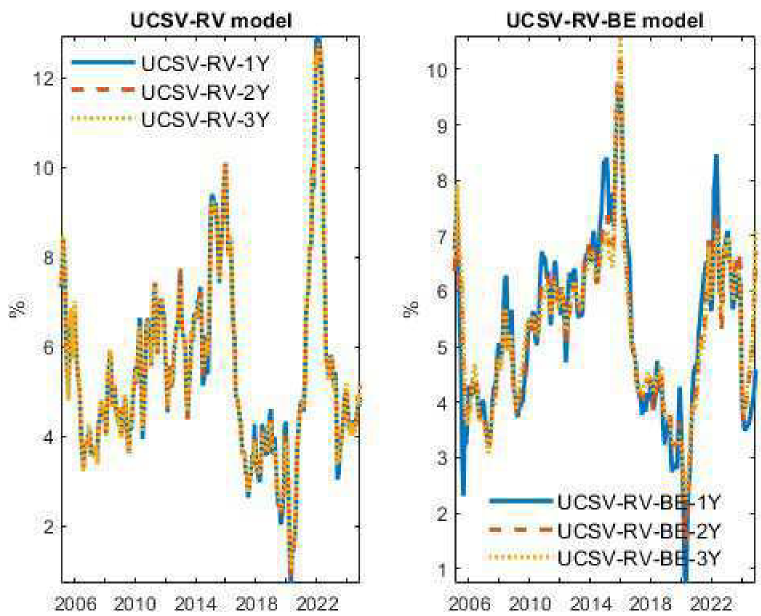


Figure 3 presents the measures of trend inflation from the UCSV-RV (left panel) and the UCSV-RV-BE (right panel). After an initial decline in trend inflation in the beginning of the sample, there is an overall upward movement, that reaches a peak in 2015-2016, during the recession. Afterwards, trend inflation falls significantly, increasing again during the COVID-19 pandemic outbreak. In the last years of the sample period, trend inflation falls again, a movement that is more pronounced in the series obtained from the UCSV model. Trend inflation from the UCSV-RV-BE shows an uptick at the end of the sample period in the last quarter of 2024, following the increase in BEIRs. The correlation between measures of both models is high: 0.78, 0.76 and 0.74 for the 1-, 2- and 3-years ahead, respectively.

Figure 3 - Trend Inflation Estimates



Finally, Table 1 presents the results of the Bayesian estimation of the measurement equations (5) and (6) and their variances, along with the variances of the state equations (3) and (4). For equation (5), that relates the realized volatility of the breakevens ($log\ z_t$) with the stochastic volatility of trend inflation (g_t) , there is evidence of some bias in the relationship. Across all specifications, a_0 is negative. On the other hand, the slope a_1 estimates are closer to 0.5, showing a not so strong relationship between the realized volatility of breakevens and stochastic volatility of trend inflation, a proxy for inflation expectations uncertainty. For equation (6), that relates BEIRs (x_t) with trend inflation (π_t^*), there is evidence of some positive bias, with $b_0 > 0$. The estimates of b_1 are closer to 1, indicating a stronger association between the level of BEIRs with trend inflation.

Table 1 - Posterior estimates of selected parameters

Model	Parameter	a_0	a_1	b_0	b_1	σ_h^2	σ_g^2	σ_z^2	σ_x^2
UCSV-RV 1Y	Mean	-1.37	0.52			0.,05	0.08	0.25	
	S.D	0.13	0.16			0.02	0.04	0.03	
UCSV-RV 2Y	Mean	-1.67	0.56			0.05	0.06	0.20	
	S.D	0.15	0.17			0.02	0.03	0.02	
UCSV-RV 3Y	Mean	-1.78	0.63			0.05	0.05	0.19	
	S.D	0.15	0.17			0.02	0.02	0.02	
UCSV-RV-BE 1Y	Mean	-0.80	0.56	0.92	0.79	0.10	0.08	0.25	0.05
	S.D	0.21	0.14	0.22	0.04	0.04	0.04	0.03	0.01
UCSV-RV-BE 2Y	Mean	-1.10	0.42	1.05	0.80	0.08	0.12	0.20	0.03
	S.D	0.23	0.12	0.26	0.05	0.03	0.06	0.02	0.01
UCSV-RV-BE 3Y	Mean	-1.26	0.38	1.45	0.73	0.08	0.12	0.20	0.03
	S.D	0.17	0.08	0.26	0.05	0.03	0.05	0.02	0.00

6 Conclusion

This paper used the main models in Chan and Song (2018) to obtain estimates of trend inflation and its stochastic volatility for Brazil during the period 2005-2024. The main conclusion is that stochastic volatility is mildly correlated with inflation disagreement. D´Amico and Orphanides (2014) also document moderate correlations between ex-ante measures of inflation uncertainty and model-based ex-post measures of macroeconomic risk for the U.S.

For Brazil, there are periods when inflation disagreement climbs but the dynamics were not reflected in higher stochastic volatility. This was particularly true for the period 2012-2013. In contrast, during the 2008 Global Financial Crisis, stochastic volatility measures rose sharply, but inflation disagreement remained stable. Mertens (2016) also documents the rise in stochastic volatility in the 2008 GFC for the U.S.

In terms of trend inflation, the measures from the UCSV-RV and UCSV-RV-BE initially fell, following the low inflation readings in 2006. Afterwards, there is an overall upward trend, reaching a peak during the 2014-2016 recession. Trend inflation fell significantly during 2017-2019, a movement that ceased during the COVID-19 outbreak. In the final years of the sample, the UCSV-RV model shows trend inflation contained and stable, while there is an uptick in trend inflation from the UCSV-RV-BE model, alongside the rise in BEIRs in the last quarter of 2024.

The Bayesian estimates of the parameters of the UCSV-RV and UCSV-RV-BE models show evidence of a negative bias in the relationship between the realized volatility of BEIRs and the stochastic volatility of trend inflation and a positive bias in the relationship between the level of BEIRs and trend inflation. The estimates of the slopes show a stronger relationship between trend inflation and the level of BEIRs.

This paper contributes to the literature on the recent history of inflation in Brazil and sheds light on the relationship between stochastic volatility and inflation disagreement as proxies for inflation uncertainty.

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