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Inflation expectation and implicit inflation: does market research provide accurate measures?

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SUMMARY: In recent years bonds indexed to inflation rates have experienced a tremendous growth in trading volumes. These securities have become an important tool for the diversification of investors' portfolios, to liability management and especially to gauge the expectations of monetary authorities. In this environment, this study contributes as it presents an amended methodology to estimate the inflation risk premium and in applying different methodologies in the Brazilian market. The results indicate that implicit inflation measures with or without adjustment of the inflation risk premium return the smallest forecast errors in relation to the IPCA of measurement period.

Keywords: Term structure; inflation expectations; inflation risk premium.

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1. INTRODUCTION

An alternative method of extracting inflation expectations arose from the issuance of financial assets indexed to the price indices of the economy (inflation-indexed bonds). These assets are differentiated from traditional obligations due to the fact that they guarantee an inflation-related yield, plus an interest set at the time of purchase. The simultaneous issue of these securities with others that ensure a given nominal income, for the same maturity, allows the extraction of a measure of inflation built into the prices of these instruments, commonly known as implicit inflation. Although this inflation measure is well grounded in theory, its implementation is still a topic of intense debate due to the existence of risk premiums on existing fixed-rate bonds, for example, the inflation risk premium.

This study has two goals. First, to implement different methods to estimate inflation expectations and an amended methodology to estimate the inflation risk premium. Second, to compare the results with the benchmark currently used to infer the market expectations of inflation.

Specifically, we estimate inflation expectations through the Cash Flow Matching method and compared them with the ones obtained by the Svensson method (1994) and with the expectations collected in surveys. The results indicate that this standard, the survey of market expectations by Gerin[i], is less reliable and more error prone than the methodologies presented.

An important feature of this work is to explicitly consider the existence of an inflation risk premium. To this end, we modified the extraction method of the Durham premium (2007) to estimate this premium and to extract a less distorted measure of implicit inflation (BEIR) commonly used in the literatures. Thus, the inflation risk premium is discounted in the results we presented. These results confirm the usefulness of monitoring expectations via the bond market.

The estimation of inflation expectations embedded in bond prices is an extremely important information for investors, financial institutions and regulators. First, because economic agents build their expectations based on these estimates which, therefore, influence future inflation itself. Second, because in the market for indexed bonds it is possible to visualize forecasts for various maturities, timely updated every business day. Finally, despite the increasingly wide availability of information on market research, most often this information suffers the problem of reflecting the views, but not the bets of institutions. Thus, the participants'

positions in bonds indexed to inflation rates may ensure more accurately the real expectations on the future course of the economy.

In the international market, a series of works seeks to extract inflation expectations through government bonds. Woodward (1990) estimates real interest rates and inflation expectations using the British sovereign bond prices with a fixed interest rate and indexed to inflation on 14 maturities between 1998 and 2024. The author assumes that the inflation risk premium is zero. Deacon and Derry (1994) discuss various methods by which the prices of indexed bonds can be compared with those of fixed rate securities. According to the authors, the best method the charts of curves of spot interest rates for indexed bonds and for bonds with fixed interest rates using cubic spline functions, whereby the expected inflation rate is the difference between the two. They cite the risk premium as important to establish expectations. Breedon (1995) presents the expected effectiveness of the Svensson method (1992) to predict inflationary processes. The results showed that the inflation curve has predictive power, but that it consistently overestimates future inflation. Breedon and Chadha (1997) also found similar results and point to the inflation risk premium and/or errors of expectation as explanations.

Shen and Corning (2001) did not find not good measures of inflation expectations of the market risk, due to a risk premium that is high and variable in time. The authors note that this differential between the rates can become a better measure of expectations if the liquidity conditions in markets for both securities get closer in the future. Alonso, Blanco and Río (2001) estimate the break-even inflation rate - BEIR, or implicit inflation, using French sovereign indexed bonds and suggest that indexed bonds provide invaluable information for policymakers. Scholtes (2002) suggests that the BEIR forecasting performance is better than market research on inflation expectations. Christensen and Reid (2004) find that in the case of the Canadian market, the BEIR was higher, on average, and more variable than the market surveys of inflation expectations in the period between 1992 and 2003. The authors identify market research as a relevant benchmark of inflation expectations and the BEIR as a biased measure due to the presence of risk premiums. The study also highlights that many of the studies in the literature characterize the researches as a comparison benchmark, as did Scholtes (2002), however, it acknowledges that this is not a consensus, due to little incentive that the market has to reveal its information.

In recent years, Brazilian indexed bonds have experienced a tremendous growth in trading volumes and have become tools that enhance the diversification of investors' portfolios, and help in better management of funds' liabilities and of large corporations. This work fills a gap in the Brazilian market, by presenting for the first time, the trading market and ways to extract this information. The results indicate that both the mean square error and the average bias in inflation expectations estimated by the methodologies presented, for the IPCA, returned lower values than those collected by market research.

Moreover, it is worth noting the growing importance of the use of indexed bonds in an attempt to estimate the inflation expectations of financial market participants. In a speech, 2004 Bernanke[ii] emphasized that the inflation expectations of financial market participants are of particular interest to central banks for several reasons. The first, since price stability is a key objective of monetary policy, the Fed allocates substantial resources in forecasting inflation. As financial markets serve to aggregate information from the private sector about the likely future path of inflation, price data and rates of assets can be used to validate and perhaps improve the forecasts of the Fed. Moreover, inflation expectations are of interest to policymakers, regardless of inflation itself. Considerable literature suggests that a successful monetary policy should stabilize or anchor inflation expectations to prevent it from becoming sources of instability by themselves. Finally, Bernanke stressed that knowledge of inflation expectations in financial markets allows the calculation of real interest rates, which is an important indicator of economic conditions and monetary policy implementation.

The paper is divided as follows: in Section 2, we explain the indexed bond market in Brazil, describing the methodology for pricing these securities. In Section 3, we will show methods for the estimation of inflation expectations and a methodology to extract the risk premium. Section 4 presents the results and the last section concludes the paper, highlighting the distortions and premiums inherent in the methodologies used and the results already achieved and possible adjustments and improvements in the estimation of the estimated BEIR in Brazilian financial market instruments.

2. THE BRAZILIAN SECURITIES MARKET

In the Brazilian market, indexed public securities, currently traded based on economic rates or indices, are the National Treasury Notes –NTN. Currently two government securities

indexed to economic indices are the NTN-B and the NTN-C, linked respectively to the Broad Consumer Price Index – IPCA and to the General Market Prices Index – IGP-M. The IPCA is the guideline of the inflation rate goals adopted in the second half of 1999.

The nominal value of a NTN-B is updated by the IPCA variation of the previous month,[iii] from the security's date of issue, paying interest semiannually. The first coupon to be paid includes the full rate for six months, regardless of the settlement date of purchase. The interest rate is set at the time of issuance of the security, as an annual percentage rate that is applied to the adjusted nominal value of the security. In practice, all issued NTN -B have a semiannual coupon of 6% per year.

The traded volume and the stock of NTN-B have significantly increased since 2006. One factor that appears to be essential for this growth was the stimulus generated by the tax exemption granted to foreign investors for the purchase of government securities.[iv] In December 2008 its financial value in the stock of domestic Federal Public Debt – DPMFi – federal debt held by the public totaled $ 299 billion, representing 23.6 % of this stock. Figure 1 below shows the annual monetary value traded and the stock of NTN-B in the domestic federal debt (DPMFi).

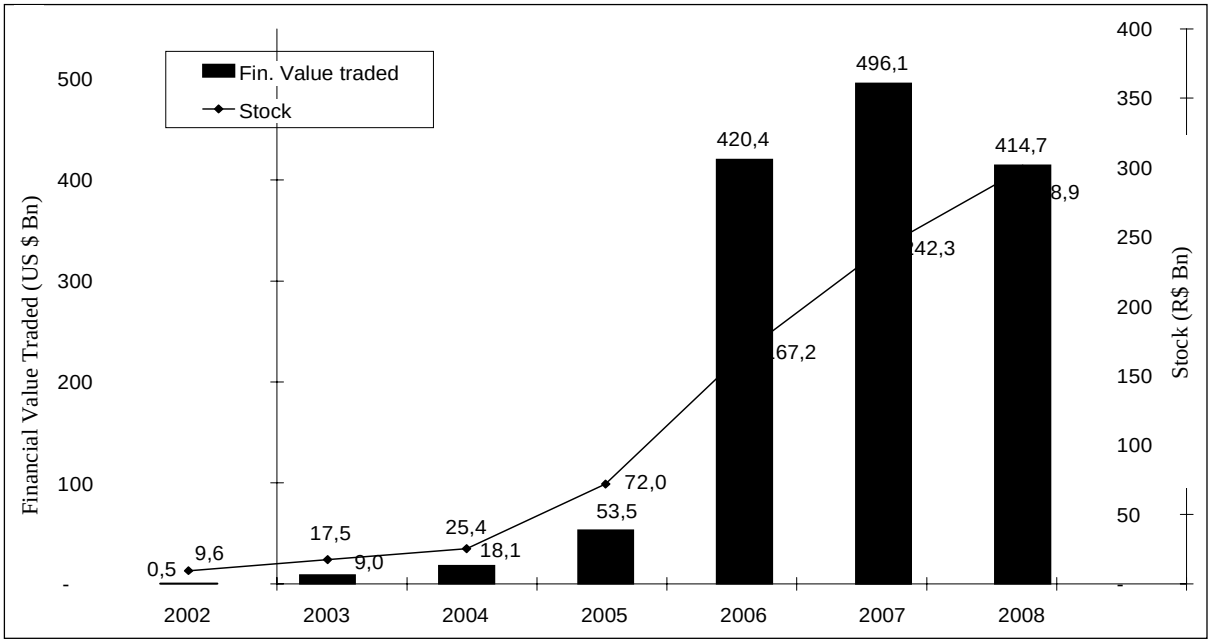


Figure 1 - Annual Financial Value Traded and Stock of the NTN-B in the DPMFi
Source: STN and Bacen

The financial value traded of the NTN-B jumped from R$53.5 billion in 2005 to R$420.4 billion in 2006, while the stock of these securities which was R$72 billion at the end of 2005, rose to R$167.2 at the end of 2006.

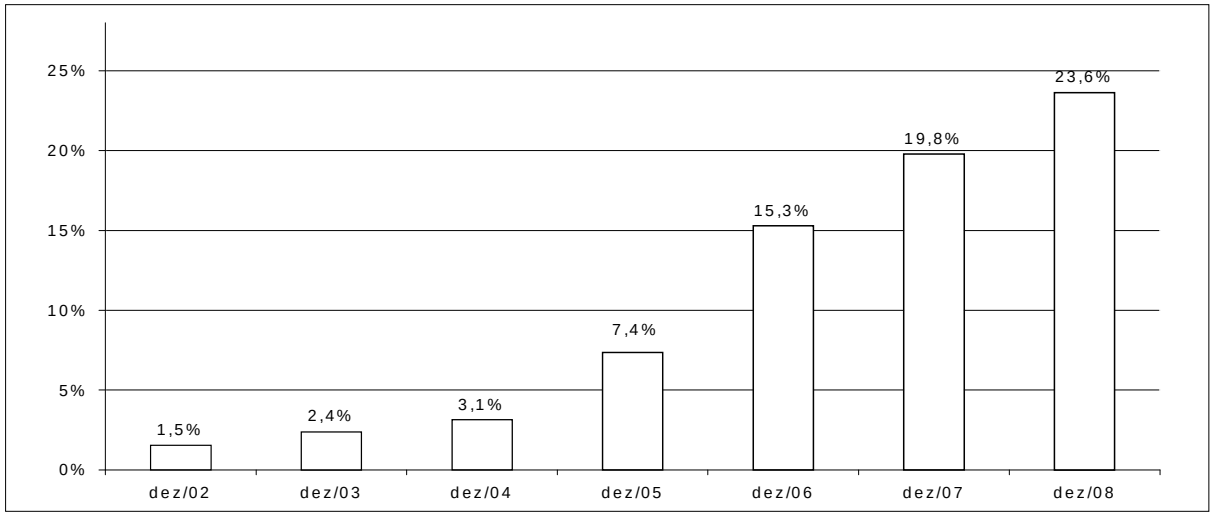


Figure 2 - Relative Participation of the NTN-B in the Stock of the DPMFi
Source: STN

The increase in the stock of these papers reflected a growing participation of the NTN-B in the stock of federal public debt. If at the end of 2004, the NTN-B represented only 3.1% of the financial stock of the outstanding DPMFi, at the end of 2005 and 2006 their participation amounted 7.4% and 15.3% respectively, as shown in Figure 2. In December 2008, the NTN-B already represented 23.6% of the outstanding financial stock of the DPMFi, equivalent to a financial value of R$299 billion.

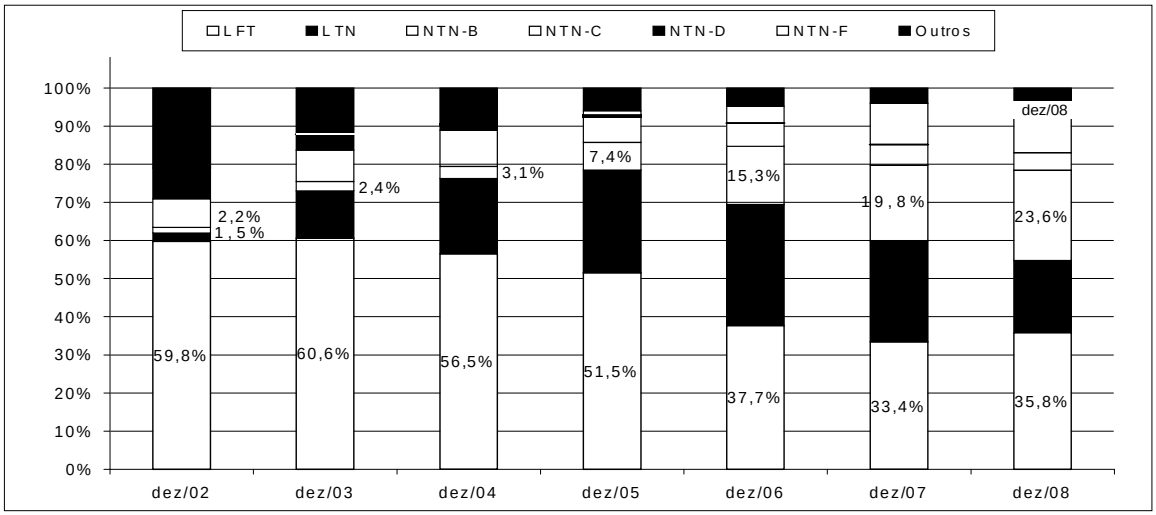


Figure 3 - Relative Participation of the Securities in the Stock of the DPMFi
Source: STN

Figure 3 shows the surprising increase of the relative participation of the NTN-B in the stock of the DPMFi at the end of each year, mainly to the detriment of the participation of securities indexed to the Selic rate.

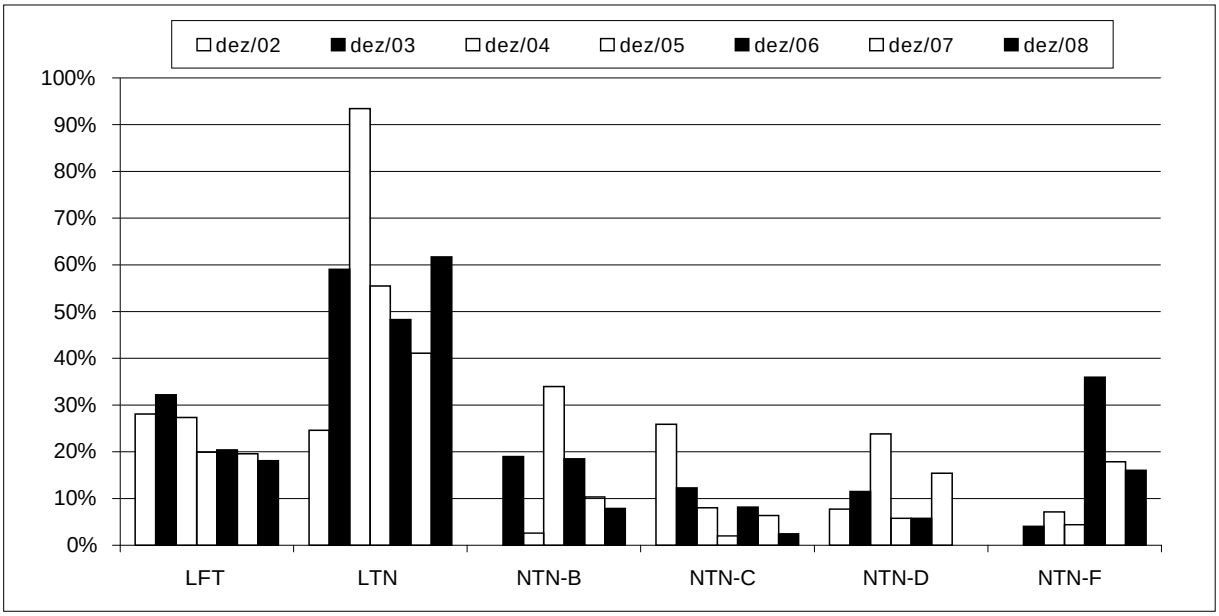


Figure 4 – Turnover of the Main Securities of the DPMFi
Source: STN and Bacen.

Even so, when we examine the turnover[v] of the main securities making up the DPMFi, we notice in Figure 4 that the NTN-B have a good space to develop its secondary market and its liquidity, in comparison, for example with the LFT, LTN and even with the NTN-F. Among the factors that enable this increase in liquidity and of the relative participation of the NTN-B in the DPMFi, that occurred in the last 3 years, we can mention: (i) better macroeconomic conditions in Brazil; (ii) the strategy of lengthening the federal public debt[vi]; (iii) greater participation of foreign and domestic in the public securities market; and (iv) new issues of NTN-B in the period from eight different maturities offered in December 2004 to thirteen at the end of 2006.[vii]

The expansion of the market and the liquidity of the NTN-B in recent years, can be considered a fundamental factor for the development and for the success of inflation expectation estimation techniques, enabling the construction of term structures at actual inflation rates and of implicit inflation in the prices of public securities and thus generating an additional source of information about market expectation.

3. METHODOLOGIES OF EXTRACTION OF IMPLICIT INFLATION

Implicit inflation or break-even inflation rate (BEIR) is defined as the spread between the yield of conventional security with fixed interest rate and the average yield of a security indexed to the inflation rates, with a fixed interest rate for the same maturity. Even though it is a simple concept, the BEIR is not a perfect measure of the market's inflation expectation. While the purchaser of an indexed security does not worry with the inflation rate, the investor of a fixed rate security will demand a yield that compensates for the expectation of loss of purchase power. Thus, in practice, this spread captures the expected inflation rate as well as other risks and distortions. Among these risks, the main one is called inflation risk premium, resulting from the variations in the price indices assumed by the investor who purchases the preset security. Among the distortions, we have the imperfect indexation of securities in some markets, different taxation and market segmentation.

In Brazil, Matsumura and Moreira (2006) estimate inflation expectations considering the ratio between the INPC x DI swap, and the DI x PRE swap. The authors consider the risk premium constant. Pinheiro, Vicente and Almeida (2007) also consider that the risk premium of the difference between the rates is constant and therefore can be disregarded in the calculation. In a world where investors are indifferent to risk, only actual returns matter. Thus, bonds with higher yields would be the most sought after, which would cause an adjustment in prices so that fixed-rate and inflation-linked bonds would end up with the same rate of actual income.

In this world, the difference between the securities is an accurate measure of inflation expectations. The assumption that the inflation risk premium can be disregarded means implicitly assuming that inflation is a measure extracted in a world neutral to risk. In Brazil we adopt two ways of estimating inflation expectations contained in federal securities indexed to inflation. Since only the estimation by Svensson uses a model for the yield curve, only in this case, was it possible to derive the inflation risk premium. In the two methodologies we used the NTN -B, precisely because these securities have the same indexer used in the System of Inflation Rate Goals managed by the Central Bank.

The methods utilize the market interest rates [viii] of the last business day of the months between September 2003 and March 2009. Over this period, we noticed a significant increase in the issuance of new fixed rate bonds and the lengthening of maturities during 2006. As we shall

see later, these features are one of the possible causes that explain the variations in the estimation of inflation expectations in this work.

The table in Annex A details the new issues said lengthening of the securities used in the estimations at the end of each year, specifying the number of maturities traded in the secondary market, the longer maturities and the business days of these lengthened securities. Subsequently, we used the method of extracting the Durham premium (2007) to estimate the inflation premium and extract an implicit measure of inflation (BEIR) that is less distorted.

3.1 ESTIMATION BY CASH FLOW MATCHING

In this method we estimate inflation expectations using the one proposed by Sack (2000) called inflation composition measure, and by Christensen, Dion and Reid (2004) called Adjusted BEIR[ix]. The calculation involves the choice of a maturity of the indexed security and trying to match it with the closest fixed rate security to determine the interest rate differential. The effects of jumps that occur in the estimates due to the non-simultaneous trading of futures contracts of DI-1 day are minimized. Given the interrelationship between this market and the LTN market, which assemble defensive and active strategies with positions held in both markets, the futures curve is a reference in the negotiations of fixed rate securities, which are traded in points (premium or discount) compared to the DI futures curve. This is a good methodology in the absence of an effective estimation of the fixed-rate government securities curve.

The developed methodology creates synthetic LTNs, of the same maturity and cash flow of the NTN-Bs.

3.2 ESTIMATION BY THE SVENSSON PARAMETRIC MODEL

The second method of estimation of inflation expectations estimates continuous curve of inflation expectations, allowing the calculation of expectations for different time horizons. In the model for estimation of nominal and actual yield curves, the model proposed by Svensson (1994) was used. This dynamic was chosen for the results in the Brazilian market described in Almeida et al (2007).

3.3 CALCULATION OF THE INFLATION RISK PREMIUM

Initially, following Durham (2007), we suppose that the instantaneous nominal term interest rate in an horizon *t*, given by f_t^N, is determined from the expectation of the actual term

interest rate S_t^R, the expectation of the future inflation rate, π_t^e, the actual premium of the term interest rate, p_t^R, and the premium of the inflation risk, p_t^π:

$$f_t^N = (S_t^R + \pi_t^e) + (p_t^R + p_t^\pi) \quad (1)$$

In nominal terms, the instantaneous nominal term interest rate in the horizon *t* can also be given by the sum of nominal expected short-term rate, S_t^N and the nominal premium, p_t^N. Thus, we have:

$$S_t^N = (S_t^R + \pi_t^e) \quad (2)$$

$$p_t^N = (p_t^R + p_t^\pi) \quad (3)$$

The presentation through these equation shows that it is possible to extract S_t^N e p_t^Nestimating a term structure, like Vasicek (1977) of the curve of government nominal securities. However, in order to obtain the risk premium, we still need a curve of actual interest rate. Similar to the instantaneous nominal term interest rate, we have

$$f_t^R = S_t^R + p_t^R \quad (4)$$

Finally, with the risk premium it can then be stated by:

$$p_t^\pi = p_t^N - p_t^R \quad (5)$$

Following Durham (2007), Kim and Wright (2005) and Langetieg (1980), we assume that the factors-object that influence the nominal price of securities follow a multivariate Ornstein-Uhlenbeck process. This means, in Equation 4, for example, that the risk premium is given by the difference between the instantaneous nominal interest rate instant the end of the period *n*, and the short-term rate of period *n*.[x] The estimates of the Vasicek model variables were implemented by applying an estimation methodology by a model of state space of Duan and Simonato (1999) to the methodology of Durham (2007).

4. RESULTS

The result tries to evaluate the predictive power of these inflation estimates, comparing the results with market research surveys and with the actual IPCA occurred in the period. The big surprise verified in this study's results is to demonstrate that the estimates of inflation expectations are closer than those of Gerin for the years 2006, 2007 and 2008. This result can be explained by the fact that the inflation risk premium is relatively low, consistent with Durham

(2006) and Christensen, Lopez and Rudebusch (2008) or even the possibility that the market research surveys enclose premiums that do not match the values of securities traded, given that these surveys do not represent financial bets.

The evaluation of the predictive power of inflation estimates drawn from government bonds was performed by two procedures. At first, we differentiated the estimates and the inflation rate of the period, following the procedure proposed by Breedon (1995). In the second procedure, we did a direct comparison, without any differentiation or other treatment, the estimated inflation 12 months ahead with the inflation that occurred in the same period.

4.1 VARIATION OF THE INFLATION EXPECTATIONS

Following the comparison presented in Lowenkron and Garcia (2007), we compared the risk premium with the result of the difference between the break-even inflation and expected inflation, estimated through the forecasts of the Gerin research. Table 1 presents the root mean square error and the correlation between the measures.

Table 1 – Root Mean Square Error (RMSE) and the Correlation of Risk Premiums of Estimated Inflation and the Result of the Difference between Break Even Inflation and Expected Inflation

Inflation Risk Premium	RMSE	Correlation
1 Factor Model	0.1649%	0.69
3 Factor Model	0.2298%	0.41

Source: Research data.

The Table shows that the 1 Factor model produces the smallest average error, as well as the highest correlation with the reference adopted. In their work, Lowenkron and Garcia (2007) regress the risk premium dependent variable with a series of independent financial variables. The same experiment was conducted with the series generated by 1 and 3 Factor models. The results are presented in Table 2.

Table 2 – Regression of the 1 and 3 Factor Models. NS means that the variable is not significant at the 5% significance rate

Variable	1 Factor Model	3 Factor Model
AR(1)	0.77	0.72
Foreign exchange	0.33%	2.10%
Selic w. 6 month lag	-0.07%	-0.28%
IPCA 15	0.15%	**NS**
Adjusted R2	**0.87**	**0.65**

Source: Research data.

The results show a premium that is higher, the higher the devaluation of the real and the lower the Selic rate with a 6 month lag. The IPCA-15 which only explains the 1 Factor model, is

the proxy used in this research resulting in an inflation surprise, based on the above-described work. The higher this inflation surprise, the higher the risk premium.

After estimating the premium, we used the predictive power of changes in expected inflation to examine how well the inflation estimates derived by the Cash Flow Matching and the Svensson methods predict future changes in inflation, discounted or not of the inflation risk premium. This variation in expected inflation (or inflation in the period) will be defined as the difference between the current level and the expected inflation (or inflation in the period) and the average expected inflation (or average inflation) over the next *n* months, i.e.:

$$\Delta\pi_t = \pi_t - \sum_{i=t+1}^{t+n} \frac{\pi_i}{n} \qquad (6)$$

where: $\Delta\pi_t$ is the variation in expected inflation (or inflation in the period); π_t is the expected inflation (or inflation in the period) at time *t*; *n* is the period of the calculation of the average expected inflation (or average inflation).

The variation of expectations and the inflation for the next twelve months allows us to compare the implicit inflations with Gerin's expectation, collected in a market research survey. Thus, in equation (6) we define *n* as 12. Figure 5 shows the results.

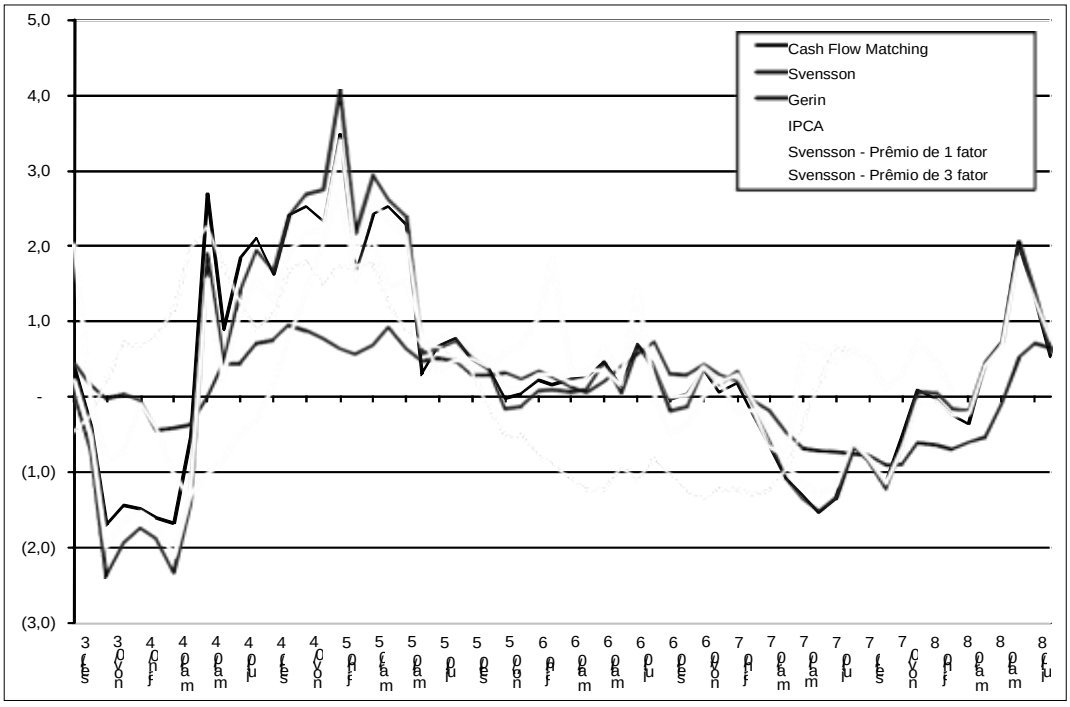


Figure 5 – Variation of Inflation Expectation and the IPCA for the period – 12 months ahead
Source: Research data.

In general, changes in implicit inflation, whether estimated by Svensson or by the Cash Flow Matching methods, tend to overestimate the actual changes in the inflation index. This result is in agreement with those obtained by Breedon (1995) for the English market and confirms the existence of possible premiums that could distort the estimates implicit in government bonds.

An important point is the movement of gradual convergence of market expectations (Cash Flow Matching and Svensson) and of the expectations collected in research (Gerin) over the period examined, reaching very similar dynamic from mid 2005 and lasting until early 2008[xi]. This is a strong indicator that the greater liquidity and participation of indexed bonds in the public debt profile, mainly occurring during 2006, increased the relevance of the information contained in government securities and brought improvements in the estimates of the expectations implicit in these securities.

4.2 INFLATION EXPECTATIONS 12 MONTHS AHEAD

Regarding the inflation expectations for the next 12 months, by comparing the implicit inflation expectations estimated by the Gerin expectations, we noticed that the latter have lower forecasting errors compared to the IPCA of the period 12 months ahead until 2005, according to the results of Tables 3 and 4. The Kruskal Wallis nonparametric test of equality of means was applied and rejected the null hypothesis in all the years in Cash Flow Matching, Svensson and Gerin methodologies.[xii] For the years 2006 to 2008, the methodology of Svensson, with or without adjustment of the inflation risk premium, showed the best results.

Table 3 – Root of the Mean Square Error of Expectations relative to the IPCA of the period 12 months ahead

Expectations / Periods	Jan. 2004 to Jul. 2008	2004	2005	2006	2007	Jan. 2004 to Jul. 2008
Cash Flow Matching	1.66	2.17	1.84	0.92	1.82	0.99
Svensson	1.71	2.26	2.00	**0.88**	1.79	**0.94**
Svensson – 1 Factor Premium	1.78	2.13	2.36	1.26	**1.59**	0.95
Svensson – 3 Factor Premium	1.67	**1.39**	2.15	1.48	**1.59**	1.62
Gerin	**1.37**	**1.39**	**1.02**	0.90	2.04	1.11

Source: Research data.

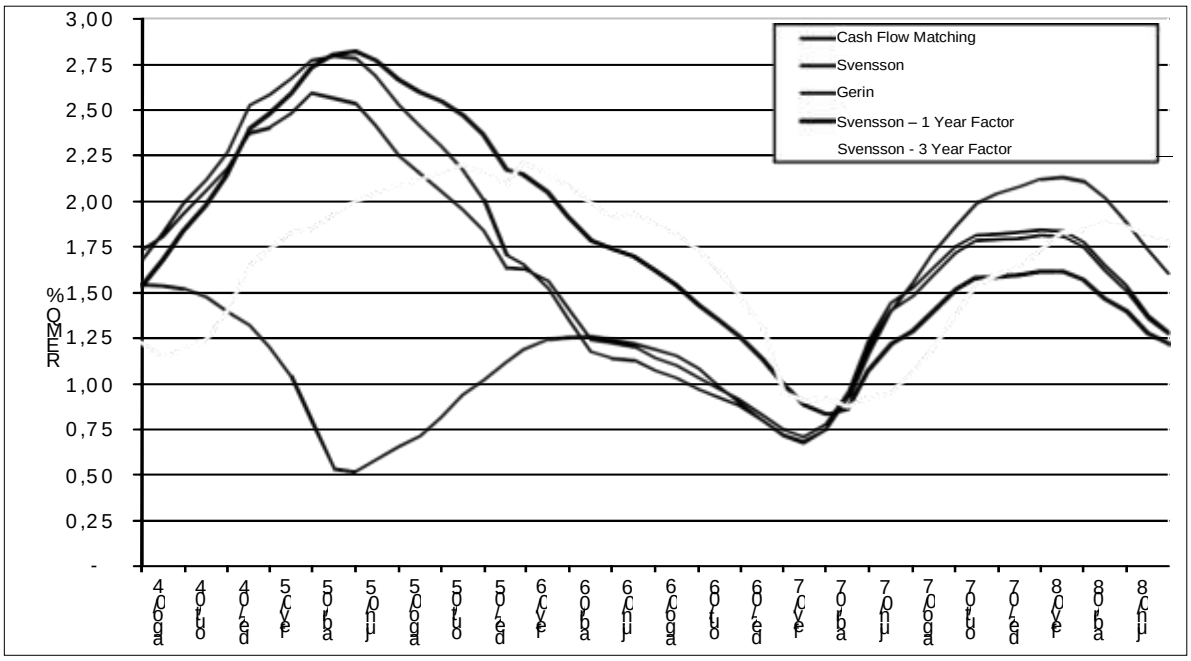
Table 4 – Average of the Bias of Expectations relative to the IPCA of the period 12 months ahead (in percentage points)

Expectations / Periods	Jan. 2004 to Jul. 2008	2004	2005	2006	2007	Jan. 2004 to Jul. 2008
Cash Flow Matching	0.51	1.65	1.68	0.60	(1.64)	(0.93)
Svensson	0.52	1.55	1.78	**0.58**	(1.58)	**(0.79)**
Svensson – 1 Factor Premium	0.76	1.47	2.26	1.02	**(1.38)**	0.26
Svensson – 3 Factor Premium	0.15	0.06	2.11	0.97	(1.47)	(1.46)
Gerin	**(0.36)**	**(0.97)**	**0.86**	0.64	(1.90)	(1.48)

Source: Research data.

Another interesting fact, when we analyze the forecast errors in each year, is the significant reduction in the expectations estimated directly in the price of public securities. Both the mean square error as well as the average bias in inflation expectations estimated by Cash Flow Matching and by Svensson in relation to the IPCA returned smaller values than those collected by the Gerin expectations for the years 2006, 2007 and 2008. Among the factors that may have contributed to this improvement we can mention the greater liquidity in the market of indexed government bonds and the issuance of new bonds with different maturities that occurred over recent years. Figure 6 presents these results.

Figure 6 – Root of the Mean Square Error of the Expectations in relation to the IPCA of the Period – 12 months



ahead (12 month moving window)
Source: Research data.

Analyzing the dynamics of squared errors and biases of the expectations in relation to the IPCA of the period 12 months ahead, in Figure 7, we see again the convergence of market expectations collected in the Gerin survey. That is, our results confirm the superiority of inflation expectations derived from our proposed methodology in relation to the average opinion of the market. The proposed methods reduce the difference between expected inflation and actual inflation. This may indicate that the inflation risk premium is very low in Brazil, or that market research survey embodies higher premiums than the actual traded securities[xiii].

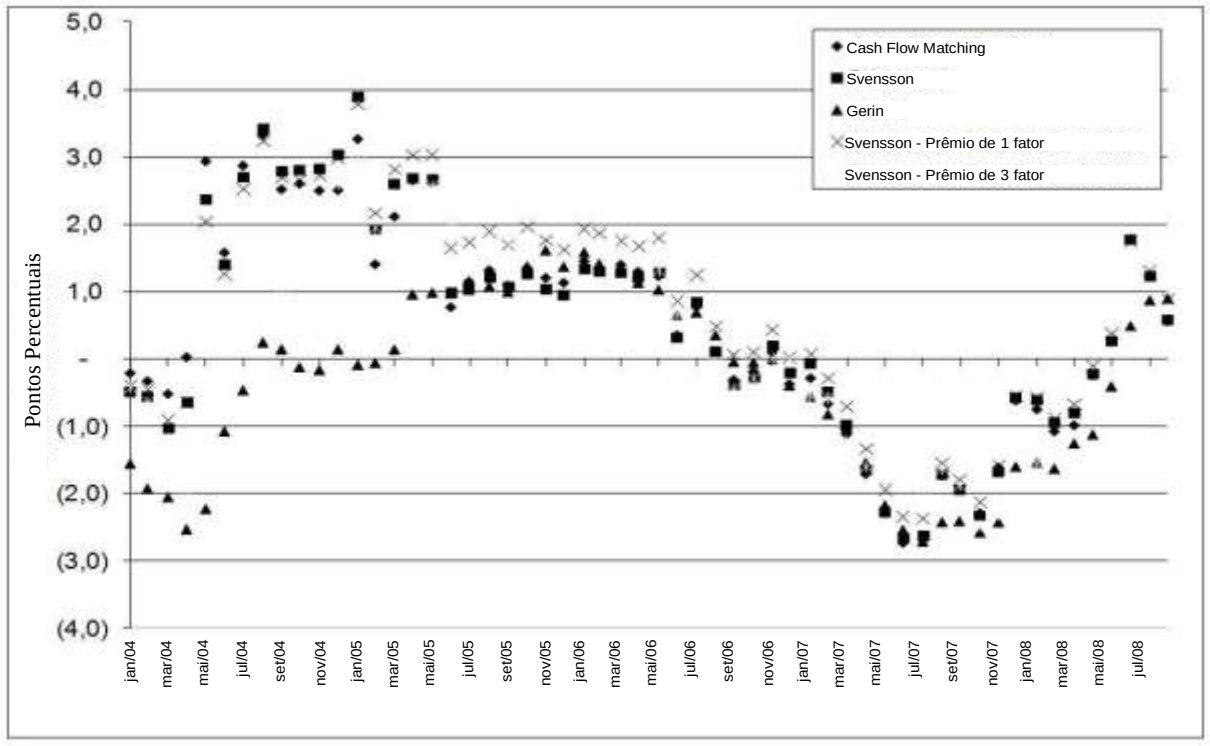


Figure 7 - Bias of the Expectations in Relation to the IPCA 12 months ahead
Source: Research data.

5. CONCLUSION

The aim of this paper was to present methodologies for the estimation of inflation expectations and inflation risk premium in Brazil to compare them with the benchmark used to infer the market expectations of inflation. The estimation of inflation expectations from the prices at which the bonds are being traded in the market can become a more valuable source of information for the monetary authority.

The results show that the estimated inflation expectations are closer than those of the Gerin model for the years 2006, 2007 and 2008. This fact is explained by the inflation risk premium being relatively low in Brazil and the fact that the market research surveys embody higher premiums than the traded securities themselves.

The estimates generated here can be useful in analyzing the anchoring of inflation expectations, that is, how credible is the monetary policy and also to evaluate the predictive power of this information about future inflation levels. The results demonstrate the usefulness of monitoring expectations via the bond market, although the difficulty of measuring the inflation risk premium for inflation is taken in account.

Moreover, these results have great importance for the market players. Estimates of inflation embedded in government bonds allow participants to estimate alternative scenarios for the term structure of nominal and actual interest rates, impacting in different ways the various sectors of the real economy and directly influencing the pricing of real and financial assets. So, besides being a major reference on the evolution of inflation expectations in the country, these estimates have an important role in the decisions of investors. Moreover, the behavior of inflation implicit in the NTN-Bs allows market participants to use this information to improve the management of their portfolios and to calibrate models of asset pricing from the decomposition of risks associated with the securities and the conduction of monetary policy.

We should emphasize that our results should be carefully analyzed, especially since it is only after 2006 that indexed bonds started to have a significant representation in public debt, with consequent increases in their liquidity and trading volumes.

REFERENCES:

ALMEIDA, C., R. GOMES, A. LEITE e J. VICENTE (2007). Does Curvature Enhance Forecasting? Working paper, Central Bank of Brazil, 155.

ALONSO, F., R. BLANCO and A. DEL RÍO (2001). Estimating inflation expectations using French government inflation-indexed bonds, Banco de España, Working Paper Series No. 0111.

BERNANKE, B. S. (2004). What policymakers can learn from asset prices, Remarks by Governor Ben S. Bernanke before The Investment Analysts Society of Chicago, Chicago, Illinois, April 15, 2004.

BREEDON, F. J. (1995). Bond prices and market expectations of inflation, Bank of England, Quarterly Bulletin, May, pp. 160-165.

BREEDON, F. J., and J. S. CHADHA (1997). The information content of the inflation term structure, Bank of England, Working Paper Series No. 75.

CHRISTENSEN, I., F. DION and C. REID (2004). Real returns, inflation expectations and the break-even inflation rate, Bank of Canada, Working Paper Series No. 2004-43.

CHRISTENSEN, J., J. LOPEZ and G. RUDEBUSCH, (2008). Inflation expectations and risk premiums in an arbitrage-free model of nominal and real bond yields, Working Paper Series 2008-34, Federal Reserve Bank of San Francisco.

DEACON, M., and A. DERRY (1994). Deriving estimates of inflation expectations from the prices of UK Government bonds, Bank of England, Working Paper Series No. 23.

DURHAM, J. (2006). "An estimate of the inflation risk premium using a three-factor affine term structure model," Finance and Economics Discussion Series 2006-42, Board of Governors of the Federal Reserve System (U.S.).

DUAN, J. C. e SIMONATO, J. G. (1999). Estimating exponential affine term structure models by kalman filter, Review of Quantitative Finance and Accounting 13, 111-135.

LOWENKRON, A.; GARCIA, M.G.P. (2007). Monetary policy credibility and inflation risk premium: a model with application to Brazilian data, April, working paper PUC-RIO.

MATSUMURA, M. e MOREIRA, A. (2006). Effect of macro shocks over the Brazilian yield curve with no arbitrage models. Discussion Paper 1210, Instituto de Pesquisa Econômica Aplicada (IPEA).

MUSIELA, M. e RUTKOWSKI, M. (2005). Martingale Methods In Financial Modeling, Springer Verlag NY.

PINHEIRO F., VICENTE V. e ALMEIDA C.(2007). Um Modelo de Fatores Latentes com Variáveis Macroeconômicas para a Curva de Cupom Cambial. (A Model of Latent Factors with Macroeconomic Variables for the Foreign Exchange Coupon Curve) Revista Brasileira de Finanças, Vol. 5, No 1 (2007).

SACK, B. (2000). Deriving inflation expectations from nominal and inflation-indexed Treasury yields, Board of Governors of the Federal Reserve System, Finance and Economics Discussion Series No. 2000-33.

SACK, B. and R. ELSASSER. 2004. Treasury Inflation-Indexed Debt: A Review of the U.S. Experience. FRBNY Economic Policy Review 10(1): 47–63.

SCHOLTES, C. (2002). On market-based measures of inflation expectations, Bank of England, Quarterly Bulletin, Spring, pp. 67-77.

SHEN, P., and J. CORNING (2001). Can TIPS help identify long-term inflation expectations?, Federal Reserve Bank of Kansas City, Economic Review, fourth quarter, pp. 61-87.

SVENSSON L. (1994). Estimating and Interpreting Forward Interest Rates: Sweden 1992-1994, NBER Working Papers 4871, National Bureau of Economic Research, Inc.

WOODWARD, T. G. (1990). The real thing: a dynamic profile of the term structure of real interest rates and inflation expectations in the United Kingdom, 1982-89, Journal of Business, 63 (3), pp. 373-398.

Annex A

Table - Information about the Remuneration of Selected Public Securities

Securities / Date	Dec/30/03	Dec/30/04	Dec/29/05	Dec/28/06	Dec/27/07	Dec/30/08
LTN						
Number of maturities	6	6	9	8	8	7
Date of the last maturity	7/1/2005	7/1/2006	7/1/2008	1/1/2009	1/1/2010	1/1/2011
Business days of the last maturity	378	391	653	525	525	525
NTN-F						
Number of maturities	1	1	3	4	8	7
Date of the last maturity	1/1/2008	1/1/2008	1/1/2012	1/1/2014	1/1/2017	1/1/2017
Business days of the last maturity	1,003	783	1,566	1,829	2,350	2,090
Fixed Rate (LTN and NTN-F)						
Number of maturities	7	7	12	12	16	14
NTN-B						
Number of maturities	7	8	10	13	14	14
Date of the last maturity	15/11/2033	5/15/2045	5/15/2045	5/15/2045	5/15/2045	5/15/2045
Business days of the last maturity	7,504	10,532	10,272	10,012	9,751	9,491

Source: Research data.

Notes:

[i] Executive Administration of Investors Relation of the Central Bank of Brazil. The survey of market expectations was started in May 1999 as part of the transition to the inflation targeting regime . Iss goal is to monitor the evolution of the market consensus of the main macroeconomic variables, in order to generate inputs for the decision-making process of monetary policy.

[ii] What Policymakers Can Learn from Asset Prices, April 15, 2004, for The Investment Analysts Society of Chicago, Chicago, Illinois.

[iii] The United Kingdom has a lag of 8 months and the United States has a lag of 4 months. It is noteworthy that the greater the lag of the security's index, the greater the risk of the security purchaser not being fully protected from inflation, because said purchaser may win or lose the difference between the inflation rate in the period between the lag and the purchase of the paper and the rate between the lag's last months and the payment of principal.

[iv] With the publication on February 15, 2006, of the MP 281, converted into Law 11,312 of 6/27/2006, which unburdens income earned by foreign investors in federal government securities.

[v] Turnover was calculated as the result of the division of financial volume traded in December by the financial stock of the security on December 31.

[vi] Since the NTN-B are indexed to the IPCA and consequently conserving the purchasing power of its investors, these securities are usually utilized by investors with long-term horizons, such as pension funds and insurers.

[vii] More details in the Table of Annex A.

[viii] The reference rates estimated daily by Andima in the secondary market of federal public securites were utilized as input data in the estimates.

[ix] Both authors address the difference in duration between the fixed rate and the indexed rate to estimate the BEIR. While Sack used a STRIPS portfolio of fixed rate bonds with liquidity and duration similar to the indexed securities, Christensen, Dion and Reid have synthetic fixed rate bonds with the same cash flows of indexed bonds, from the estimation of a fixed rate curve.

[x] The instantaneous nominal term interest rate of period *n*, according to Musiela and Rutkowski (2005) is given by the derivative of the price of the security relative to maturity.

[xi] Because differences in expectations and the inflation rate use the estimates for the next 12 months, the convergence of expectations was actually in level from mid 2006 and remained until early 2009.

[xii] The p-values were 0.037; 0.021; 0.041; 0.032 e 0.044, for the years 2004 to 2008, respectively.

[xiii] In fact, we often find in the literature that studies analysts' forecasts, a strong upward bias in their forecasts. In this sense, our result suggests an alignment with the results found in previous works.