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The Time-Varying Degree of Inflation Expectation Anchoring in Bolivia

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Abstract¹

This paper analyzes the time-varying degree of inflation expectations anchoring in Bolivia and, more precisely, whether inflation expectations have been in line with the inflation objectives announced by the Central Bank of Bolivia (BCB, for its acronym in Spanish) and if they have become better anchored over time. Two considerations are particularly relevant in this regard. First, the main sources of information are the BCB survey and Focus Economics survey, which only have data for short and medium-term inflation expectations. Second, monetary policy in Bolivia is under a monetary-targeting regime, so BCB projections represent the main references. The anchoring degree analysis of short-term inflation expectations was performed considering BCB projections, while the medium-term analysis used an implicit inflation target. In both cases, the results indicate there is a high degree of anchoring of inflation expectations in Bolivia, especially during the last four years. This study considers information from July 2005 to June 2017, with monthly frequency.

JEL classifications: E31, E52, E58, C32

Keywords: Inflation expectations, Anchoring degree, BCB projections, Time-varying parameters model

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1. Introduction

The analysis of the behavior of the expectations of inflation of economic agents has been heavily studied in the past, especially with regards to the degree of anchoring of expectations, understood as the ability of monetary policymakers to manage inflation expectations (King, 2005). Theoretical literature and monetary policymakers agree that the anchoring of inflation expectations is of high importance in maintaining price stability, and expectations by private agents play an important role in macroeconomics since they can be a determinant of macroeconomic performance. Inflation expectations not only reflect private agents' perceptions about future inflation, but also directly impact current and future inflation.

Relatedly, a central bank should focus on the management of private expectations through communication for two reasons (Hubert, 2015). First, the expectations channel is one of the subtlest channels of monetary policy, because it depends on private agents' interpretation. As King (2005: 229) notes, "because inflation expectations matter to the behavior of the households and firms, the critical aspect of monetary policy is how decisions of the central bank affect those expectations." Second, given the delay between policy actions and their real effects on macroeconomic variables, central bank communication provides policymakers with a way to promptly affect private expectations to shorten the transmission lag of monetary policy.

According to Blinder et al. (2008), central bank communication can take different forms: statements, minutes, interviews, speeches, or internal macroeconomic forecasts. We will focus on the latter instrument of communication because monetary policy in Bolivia is under a monetary-targeting regime. However, although the BCB does not have an explicit inflation target, its active communication policy and projections, announced twice per year in its Monetary Policy Report, become important reference points for agents at the time of forming their expectations.

Since the inflation expectations of private agents are not generally known, they can be approximated by: i) surveys of inflation expectations of professional forecasters or households and ii) market-based measures of inflation expectations. In the present document, we use information from the survey conducted by the BCB for the period between July 2005 and June 2017. This is a monthly survey of expectations for the rates of inflation (among other variables) for several short-term horizons. Additionally, we use information from the Latin Focus

Consensus Forecast report of Focus Economics to gather data regarding medium-term inflation expectations in Bolivia.

There are not many studies that analyze the degree of anchoring of expectations in Bolivia. We can mention the work of Cerezo and Heredia (2013), who found that there was a greater degree of anchoring of inflation expectations in recent years than between 2008 and 2010. Nevertheless, they also found that expectations were not rational, suggesting that expectations reflect backward-looking behavior.

The main objective of this paper is to analyze the time-varying degree of inflation expectations anchoring in Bolivia. More precisely, we aim to assess whether inflation expectations have been in line with the inflation objectives announced by the BCB, and if they have become better anchored. The anchoring degree analysis of short-term inflation expectations was performed considering the BCB projections, while the medium-term analysis used an implicit inflation target. In both cases, the results indicate there is a high degree of anchoring of inflation expectations in Bolivia, especially during the last four years

In the next section, there is a brief analysis of the behavior of inflation expectations in Bolivia and their stability. Subsequently, we show the results of the estimated models, analyzing the behavior of short-term inflation expectations with respect to the BCB projections, past inflation and other variables that could affect the formation of expectations. Then, the results of the analysis of medium-term expectations are presented. Finally, we present our conclusions.

2. Inflation Expectations in Bolivia

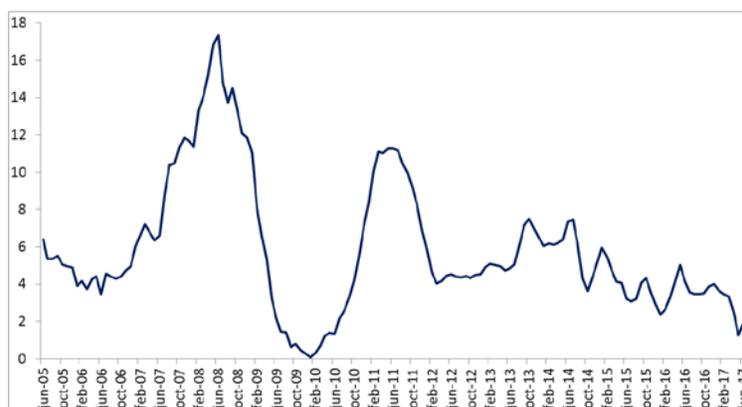
In order to evaluate the evolution of the degree of anchoring of inflation expectations in Bolivia, we consider data from the survey conducted by the BCB for the period between July 2005 and June 2017.² This monthly survey contains information of the expectations of economic analysts, academics, members from financial sector and private business in Bolivia about the future behavior of economic variables of interest for BCB authorities such as inflation, exchange rate, GDP growth, trade balance, and fiscal balance, among others. In the case of inflation expectations, the survey focuses on: i) monthly inflation expected by the end of current month, ii) year-on-year inflation expected by the end of current year, iii) year-on-year inflation expected by the end of next calendar year and iv) one year-ahead inflation expectations.

² Information for previous periods is not available.

It is important to mention that, unlike surveys available in other countries, the BCB survey does not take into account long-term inflation expectations (e.g., five years-ahead expectations). Certainly, this issue restricts, to a certain extent, the variety of econometric analyses that can be implemented. Moreover, in Bolivian financial markets, no inflation-indexed bonds are traded, a feature that makes it impossible to estimate break-even inflation rates for this economy, which are a measure of inflation expectations widely used in topical literature.

Our analysis will be focused on approximately the last 12 years. During this period, important shocks (mainly foreign and supply-side shocks) hit the Bolivian economy and affected domestic inflation behavior (Figure 1). These shocks, along with some developments observed in monetary markets and the macroeconomic framework and changes in the dynamics of the local economy, may have affected the degree of anchoring of inflation expectations.

Figure 1. Evolution of Headline Inflation, Year to Year

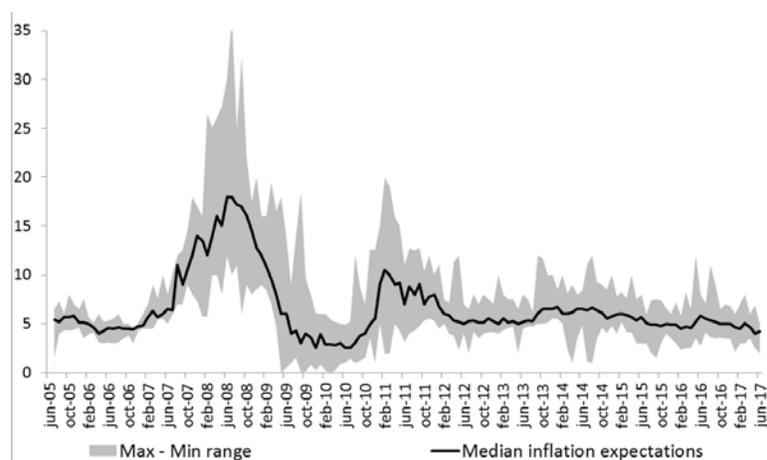


Source: National Statistics Institute.

Between 2007 and 2008, the Bolivian economy went through an inflationary process triggered especially by a shock in international food and energy prices, reaching double-digit inflation rates not observed since the beginning of the previous decade. In this period, expectations of agents were significantly exacerbated, with median inflation expectations placing themselves above observed inflation rates. Subsequently, a process of disinflation took place associated with the global financial crisis in 2009, an episode characterized by a high degree of uncertainty about the performance of the world economy, with effects on Bolivian economic activity. Within this setting, inflation expectations followed a downward trend as well, although their decline was more moderate.

In the period 2010-2011, new inflationary upsurges were noticed, although of smaller scale and persistence with respect to previous years. In this period, the main explanatory factors were a new rebound in the international prices of commodities and an increase in domestic prices caused by speculative activities after the Government temporarily readjusted fuel prices.³ Beginning in 2012, the behavior of inflation was characterized by moderate fluctuations, exhibiting a downward trend during the last two years. In recent years, temporary hikes can be observed in the behavior of inflation, which are explained by increases of the prices of some foods, whose supply was affected by adverse weather events (like frosts, floods and droughts, among others). The trajectory of inflation expectations reflected a path similar to that of inflation between 2005 and 2011, although from 2012 onward it displayed stable behavior, with a median generally above observed inflation (Figure 2).

Figure 2. Evolution of One Year-Ahead Inflation Expectations



Source: Central Bank of Bolivia.

The stability of inflation expectations is an important issue to consider, since it represents an initial approximation to its anchorage. A useful way to measure stability is through its degree of dispersion⁴ (disagreement or uncertainty). Less dispersion can be interpreted as a signal of a better anchoring of inflation expectations.⁵ For this purpose, we chose the cross-sectional

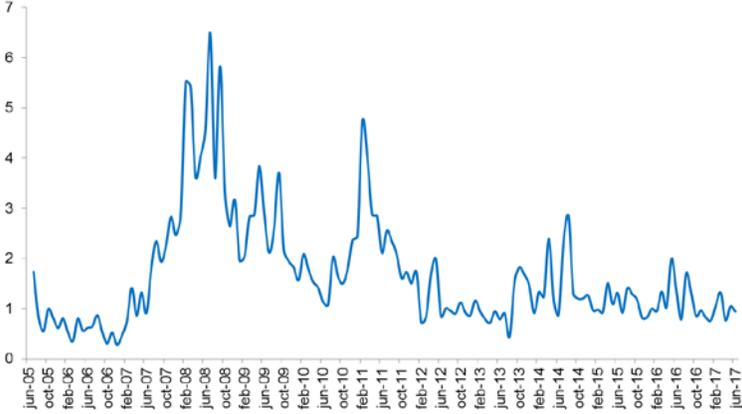
³ It is important to note that fuels are subsidized in Bolivia. In December 2010, the government decided to withdraw the subsidy which generated an environment of uncertainty, causing expectations of inflation to increase. Although the measure was eliminated shortly, important second-round effects were generated during the following months.

⁴ Although, the dispersion of expectations in a survey is a measure of heterogeneity of beliefs rather than a measure of uncertainty (IMF, 2016), both tend to move together (Gürkaynak and Wolfers, 2007).

⁵ Dovern, Fritsche and Slacalek (2009), Capistran and Ramos-Francia (2010), Siklos (2013), and Ehrmann (2015).

standard deviation of inflation expectations (Figure 3). A higher degree of dispersion can be observed between mid-2007 and early 2011.⁶ Afterwards, the degree of dispersion tended to moderate, with a slight rebound between 2013 and 2014.⁷ Except for those years, a lower degree of uncertainty about rates of inflation expected by economic agents can be observed beginning in 2012. Hence, the trajectory of expectations observed in recent years suggests a strengthening of their degree of anchoring over time.

Figure 3. Cross-Sectional Standard Deviation of One Year-Ahead Inflation Expectations



Source: Authors’ calculations based on BCB data.

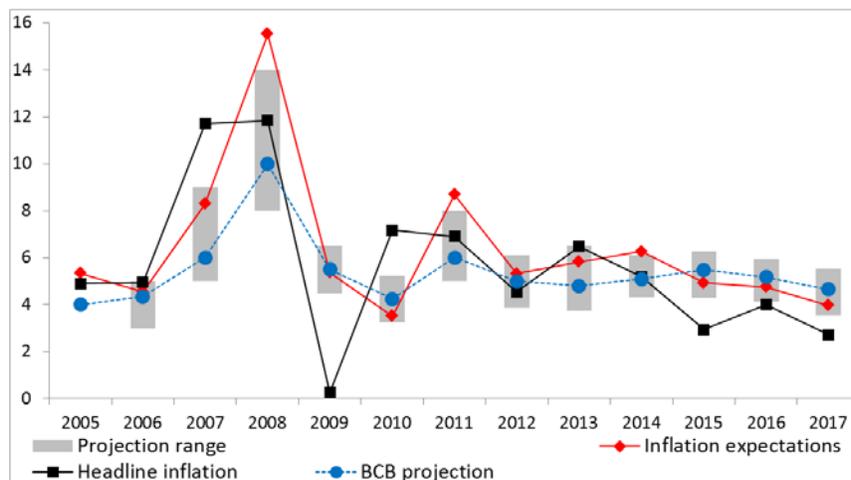
Inflation expectations in Bolivia seem to be more homogeneous in recent years. This homogeneity may reflect the existence of a common reference point that is taken into account by economic agents while forming their inflation expectations. One of these possible reference points is the inflation projection of the Central Bank announced in its Monetary Policy Report twice per year. Between 2005 and 2011, headline inflation and inflation expectations ended the year above the BCB projection, except for in 2009, and, in some cases, even above the projected range (Figure 4). The shocks noted above generated an environment of uncertainty, making it difficult for the BCB and private agents to project inflation. It seems that during this time economic agents mainly considered past headline inflation or possibly other variables to formulate their expectations. In 2012, this situation changed, a result of the expectations of the agents landing closer to the BCB projection, especially between 2015 and 2017. This could

⁶ During this period, Bolivian economy went through different circumstances that caused strong inflationary pressures: increased international commodity prices, economic acceleration, regulated price adjustments and others. All these factors created an environment of uncertainty regarding the future level of prices.

⁷ In 2013 and 2014 inflationary pressures were observed due to the rise in prices of some foods because adverse weather events reduced agricultural supply in local markets.

indicate that there is a significant degree of anchoring of expectations in recent years. This item will be studied empirically in the next section of the paper.

Figure 4. Inflation Expectations, Headline Inflation and BCB Projection



Source: National Statistics Institute and Central Bank of Bolivia.

Note: Inflation expectations are computed as the mean of inflation expectations for a given year. BCB projections and the projection range are computed as the average of the inflation projections announced at the beginning and middle of the year.

3. Empirical Analysis of the Short Term

While this study focuses mainly on assessing the anchoring of short-term inflation expectations over time, it should nonetheless be noted that the behavior of short-term expectations is also relevant to policymakers. According to Łyziak and Paloviita (2016), the credibility of a central bank should not only be measured in terms of its ability to anchor long-term expectations, but also in terms of its ability to affect short and medium-term expectations, since these have an important role in wage adjustments and price-setting by firms.

In addition, another point that must be emphasized is that in Bolivia, monetary policy is not based on an inflation-targeting regime. On the contrary, the monetary regime of Bolivia is one of monetary targeting. However, although the BCB does not have an explicit inflation target, its active communication policy and projections announced twice per year in its Monetary Policy Report become important reference points for agents at the time of forming their expectations.

In a similar vein, the work of Anderson and Maule (2014) assesses the anchoring of short-term inflation expectations in the United Kingdom considering the Bank of England's

inflation projections as one of its determinants. Likewise, Hubert (2015) showed that the projections of the European Central Bank play an important role in the formulation of short and medium-term expectations in the Eurozone.

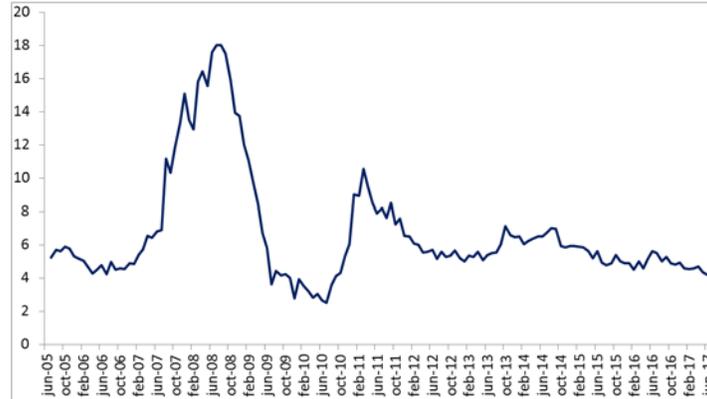
In this context, an econometric model is estimated to analyze the evolution of the degree of anchoring of inflation expectations. Before we start, two aspects must be considered. First, most of the surveys contain “fixed-event” (FE) information (i.e., information always points to a single moment, like the end of the current or next calendar year) on the expectations of different variables, so they constitute an abundant source of information. Notwithstanding their availability, this paper requires the use of “fixed-horizons” (FH) variables (i.e., those that keep an n horizon, such as 12 months ahead) with the purpose of working with econometric models because forecasting horizons of FE forecasts (or expectations) vary from month to month (the horizon shrinks as time passes).

We, therefore, employ a technique that allows us to use the FE information. Following Doovern, Fritsche and Slacalek (2009), we create a FH variable as a weighted average of FE forecasts; the weights are determined by the number of months forecasted in both the current and subsequent years. Denote $F_{y_0,m,y_0}^{fe}(x)$ as the FE forecast of variable x for year $Y0$ made in month m of year $Y0$ and $F_{y_0,m,y_1}^{fe}(x)$ the FE forecast of variable x for year $Y1$ made in month m of year $Y0$. Then $F_{y_0,m,12}^{fh}(x)$ represent the FH forecast 12 months ahead made in month m of year $Y0$. We approximate the FH forecast for the next 12 months as an average of the forecast for the current and next calendar year weighted by their share in forecasting horizon:

$$F_{y_0,m,12}^{fh}(x) = \frac{12 - m + 1}{12} * F_{y_0,m,y_0}^{fe}(x) + \frac{m - 1}{12} * F_{y_0,m,y_1}^{fe}(x) \quad (1)$$

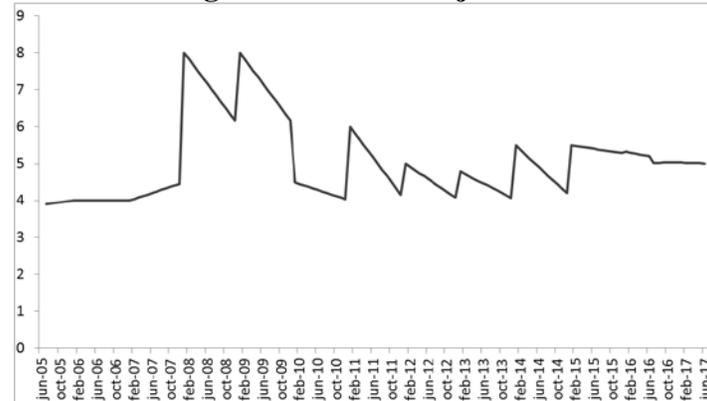
According to Winkelried (2017), a survey that registers FE expectations for horizons $Y0$ and $Y1$ does contain information for expectations at any intermediate horizon; for instance, expectations for 12 months ahead are implicitly contained in current and next year forecast. Therefore, the inflation expectation obtained with this technique (Figure 5) is equal to the inflation expectation one year ahead shown in Figure 2. This technique was also used with the information from the BCB projection for the current and next calendar year (Figure 6).

Figure 5. New One Year-Ahead Inflation Expectations



Source: Authors' calculations based on BCB data.

Fig. 6. New BCB Projection



Source: Authors' calculations based on BCB data.

A second point we should consider is the effect of new inflation information on the formulation of economic agents' expectations. According to Hubert (2015), the effects of central bank inflation projections on private agents are stronger at the beginning of each year than at the end, when much more information is available on the actual behavior of inflation. Consequently, this document mainly considers the projections announced by the BCB at the beginning of each year. However, a second variable was created to reflect the BCB projection, which also includes updates of the projection announced after the first semester of every year, mainly with the purpose of performing robustness analysis.⁸

⁸ Appendix 1 presents the evolution of the BCB projection for the current and next calendar year separated, and the BCB inflation projections constructed using the technique of equation (1) that includes the updates at middle of each year.

3.1 BCB Projection against Headline Inflation

In this section, the specification of the model is based on the methodology applied by Łyziak and Paloviita (2016), who estimate different models to measure the degree of anchoring of inflation expectations for the Euro Zone. The specified equation is as follows:

$$\pi_{t|t+n}^e = \gamma^{proj} \pi_{t+n}^{proj} + \gamma^{\pi} \pi_{t-1} + \mu_t \quad (2)$$

where:

$$\gamma^{proj} + \gamma^{\pi} = 1$$

where $\pi_{t|t+n}^e$ represents the inflation expectations in period t for the horizon $t + n$; π_{t+n}^{proj} is the inflation projection for the horizon $t + n$; π_{t-1} represents observed inflation lagged one period and n is equal to 12 months. Additionally, an error term (μ_t) is included in the equation. Note that, by construction, the sum of the coefficients of the model must be equal to one. If the coefficient γ^{proj} reaches a value as close as possible to one, it would reflect a significant degree of anchoring of expectations.

According to Strohsal, Melnick and Nautz (2015), the central bank's credibility can be gained, but it can also be lost. As a consequence, the degree of inflation expectations anchoring might not be constant over time. Meanwhile, Orphanides (2015) once pointed out that inflation expectations are well anchored until they are not. This means that the degree of anchoring can change over time, so using a model with constant parameters may not be the best option. In that sense, in the present document a time-varying parameter model is estimated, in line with other works such as Demertzis, Marcellino and Viegli (2012) and Strohsal, Melnick and Nautz (2015).

In the name of simplification, we assume that the state parameters follow a random walk process. We use the Kalman filter (Kalman, 1960) to compute the one-step ahead estimates of the means and variances⁹ of the states by maximum likelihood.

The results for this first estimation showed that the coefficient γ^{proj} attained a value close to 0.80, which implies that there is a significant degree of anchoring of short-term expectations in Bolivia (Table 1). On the other hand, the coefficient γ^{π} for lagged inflation is significant at 10 percent.

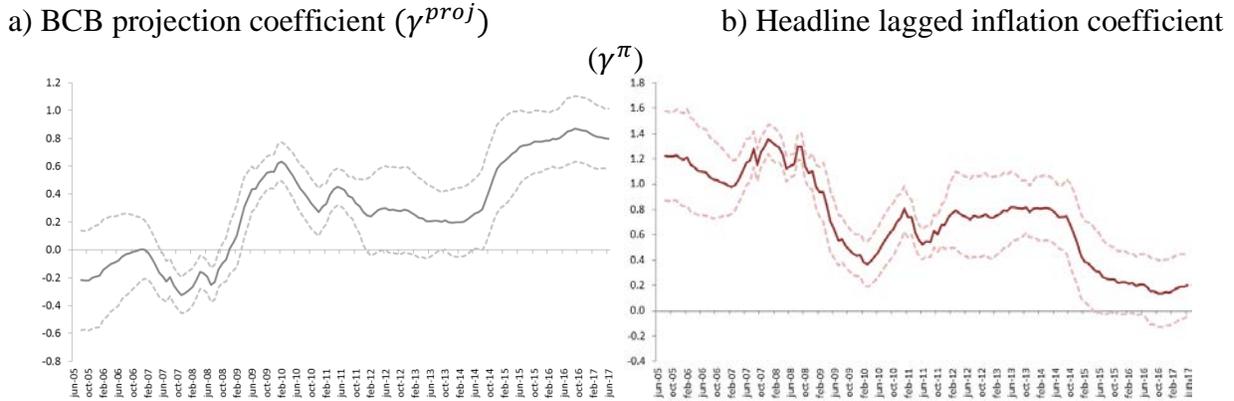
⁹ During the estimation, the variances parameters are expressed in exponential form to ensure that the variances themselves are non-negative.

Table 1. Results from Time-Varying Parameter Model 1

	Projections	Past inflation
Coefficient	0.80	0.20
<i>RMSE</i>	0.13	0.12
<i>z-Statistic</i>	6.28	1.66
<i>p-value</i>	(0.00)	(0.09)

A strength of state-space models is that they permit observe the evolution of the different coefficients over time. It can be seen that the value of the coefficient γ^{proj} was negative between mid-2005 and late 2008 (Figure 7a), in line with the overshooting of expectations that took place then. In this period the anchoring degree of expectations was null. Later, an improvement in the degree of anchoring of expectations can be observed as of 2009,¹⁰ reaching values near 0.6 until mid-2010, when it fell again because of a new inflationary rebound. The BCB projections coefficient reflected stable behavior around 0.25 from 2012 until mid-2014. In July 2014 this coefficient begins important growth, reaching 0.80 in the last two years under consideration.

Figure 7. Evolution of Coefficients in Model 1



Note: Smoothed coefficient $\pm 2RMSE$.

In the case of headline lagged inflation (Figure 7b), the highest values were observed between 2007 and 2008 when it reached values higher than one, which shows the exacerbation of expectations during this time. Later, values tended to decrease and seemingly lose importance in the formulation of agents' expectations.

¹⁰ It is also interesting to note that the degree of anchoring of expectations did not decline in time of the international financial crisis, something that was analyzed in different documents such as Galati, Poelhekke and Zhou (2011), Autrup and Grothe (2014), and Nautz and Strohsal (2015). However, this does not imply that in that period there was a greater degree of central bank credibility.

Appendix 2 contains the results using the updated BCB projection under this specification. The results obtained are similar to those found with Model 1; there also exists a significant degree of anchoring of short-term expectations with respect to updated BCB projections. These first results showed that short-term inflation expectations are anchoring,¹¹ since the BCB projection had a bigger impact on economic agents than headline inflation. However, information from other variables may affect the formulation of expectations.

3.2 BCB Projection against Other Variables

Economic agents are exposed to a great diffusion of local and international information, especially in light of advances in communication. This means that the behavior of other variables may affect the formulation of private agents' expectations. Relatedly, there exists a strand of literature that investigates how inflation expectations respond to macroeconomic news (Beechey and Wright, 2009, and Beechey, Johanssen and Levin, 2011), though with a long-term focus. Since short-term inflation expectations respond to observed inflation, they should be more sensitive to changes in other variables. With the objective of analyzing the effects of information from other variables on the behavior of inflation expectations, in this section we make estimates with different models, including a broad set of external variables in addition to BCB projections and observed inflation.

$$\pi_{t|t+n}^e = \beta_1 \pi_{t+n}^{proj} + \beta_2 \pi_{t-1} + \beta_m X_t(L) + \mu_t \quad (3)$$

Once again $\pi_{t|t+n}^e$ represents one year-ahead inflation expectation; π_{t+n}^{proj} is the BCB inflation projection for the horizon $t + n$; where n is equal to 12 months and π_{t-1} represents observed inflation lagged one period. We include X_t , which represents the battery of different external variables used to estimate the models; some of them will be introduced with lags. Additionally, an error term (μ_t) is included in the equation.

In order to guide our selection of external variables, we follow the works of Celasun, Gelos and Prati (2004), Cerisola and Gelos (2005), Bevilaqua, Mesquita and Minella (2007), and

¹¹ This result does not imply that inflations expectations are rational; that issue is not analyzed in this study.

Carrasco and Ferreiro (2013). The variables chosen were output gap,¹² one year-ahead expectations of nominal depreciation,¹³ and expectations of fiscal balance in percent of GDP.¹⁴

We also incorporate other variables that may be related to the characteristics of the Bolivian economy, such as shocks from climatic events¹⁵ (as food represents an important part of the CPI in Bolivia, nearly 28 percent) and external shocks¹⁶ (as previously noted, the Bolivian economy was exposed to major external shocks during the last decade).¹⁷ In the case of inflation expectations and BCB projections, we use the variables created in the previous section.

As in the previous section, for the estimation we use time-varying parameter models with different specifications, and we suppose that the state parameters of all the variables follow a random walk process. The results of the different models' specifications can be observed in Table 2.

Table 2. Determinants of Short-Term Inflation Expectations

	Model 2	Model 3	Model 4	Model 5
BCB projection	0.74 (0.00)	0.75 (0.00)	0.74 (0.00)	0.73 (0.00)
Inflation (t-1)	0.29 (0.06)	0.29 (0.07)	0.28 (0.08)	0.28 (0.09)
Nominal depreciation Expectations	0.20 (0.76)	0.21 (0.75)	0.21 (0.75)	0.20 (0.77)
International food price index (t-1)	0.01 (0.77)	0.01 (0.75)	0.01 (0.75)	0.004 (0.81)
Output gap (t-2)		0.29 (0.36)		0.30 (0.35)
Climatic events			-0.03 (0.91)	-0.06 (0.82)
Fiscal Balance / GDP Expectations				-0.03 (0.43)

Note: The values in parentheses represent the p-values.

¹² The information was obtained from the Global Index of Economic Activity (IGAE, for its acronym in Spanish) which represents a proxy variable of economic activity in monthly frequency, minus its trend value (where the trend is approximated through a Hodrick-Prescott filter).

¹³ Most of the documents use movements in the nominal exchange rate; however, in Bolivia, the exchange rate has been fixed since 2011, and it is an important variable since it works as a nominal anchor. For this reason, we use economic agents' expectations of future depreciation.

¹⁴ We use expectations of fiscal balance as a proxy of the primary fiscal balance in order to have a variable with monthly data. For this case and the expectations of nominal depreciation we use the information from the BCB survey employing the technique of equation (1).

¹⁵ We employ the Multivariate ENSO (El Niño/Southern Oscillation) Index (MEI) of the United States National Oceanic and Atmospheric Administration (NOAA) as a proxy variable to reflect the changes in the weather condition.

¹⁶ The Food Price Index of the International Monetary Fund (IMF) was considered. International food price shocks have a significant impact on inflation in Bolivia because of the high share of food in the country's CPI.

¹⁷ We also use other variables like IGAE growth YoY, economic agents' expectations of economic growth and the IMF international energy price index; none of these, however, showed satisfactory results.

We created four different models, and in each one the BCB projection remained the most important explanatory variable with coefficients around to 0.74, close to those obtained in Section 3.1. Also, lagged inflation was significant (at 10 percent) in all models, with a coefficient near 0.28. The remaining variables were not statistically significant. The least relevant were the international price food index,¹⁸ the climatic event variable,¹⁹ and expectations of the fiscal balance in percent of GDP. The lagged output gap displayed a high coefficient, but it was not significant.²⁰

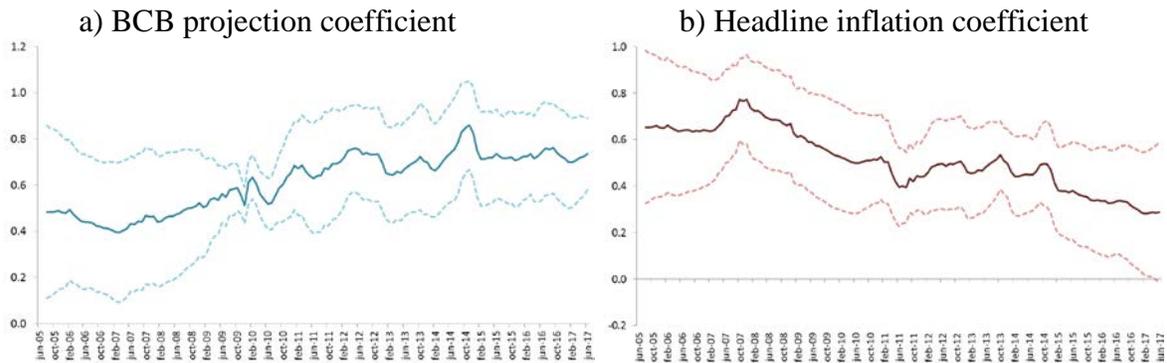
The evolution of the coefficients of the BCB projection and headline inflation is similar to that found in Section 3.1 (Figure 8). It can be observed that headline inflation had a greater impact on inflation expectations between 2005 and 2010, while BCB projections had a greater effect in recent years. The effect of BCB projections at the beginning of the sample, however, are around 0.45 (in the model used in Section 3.1, the coefficient was close to 0 during this period). Meanwhile, the coefficient of observed inflation was near 0.65 (in the results of previous model, it was near 1).

¹⁸ During 2007-2008 and 2010-2011, international food prices rose exponentially, so national producers decided to sell most of their production to foreign markets, generating a shortage in local markets. This caused an increase in the prices of some foods (like sugar) or inputs (such as soybeans that are important for poultry farms), which translated into an inflationary process. However, in recent years international food prices have fallen and shown less dynamism; in addition, limits were applied to exports in order to ensure supply to local markets. These factors may have diminished the index's relationship with local food prices, so this variable turned out to be not significant in the formulation of expectations.

¹⁹ The sign of the coefficient of climatic events was negative in the models. Since the MEI was used as a proxy variable, when it presents negative values it denotes the presence of the La Niña phenomenon. This phenomenon can generate heavy rains, floods and landslides, especially in the eastern part of Bolivia, where most of the agricultural production is located. Therefore, it can be inferred that when the La Niña phenomenon occurs, the inflation expectations of economic agents would increase, although not significantly. This variable's lack of significance is possibly explained by the fact that the effects of climatic events generally affect food prices of food for no longer than three months; prices subsequently decrease as supply normalizes in local markets. Economic agents thus do not expect there to be a constant rise in prices in following months.

²⁰ It is worth mentioning that, unlike the rest of the variables, the IGAE information is available to the general public with a greater lag time. In that sense, the output gap entered the model with a lag of two periods.

Figure 8. Evolution of the Coefficients in Model 2

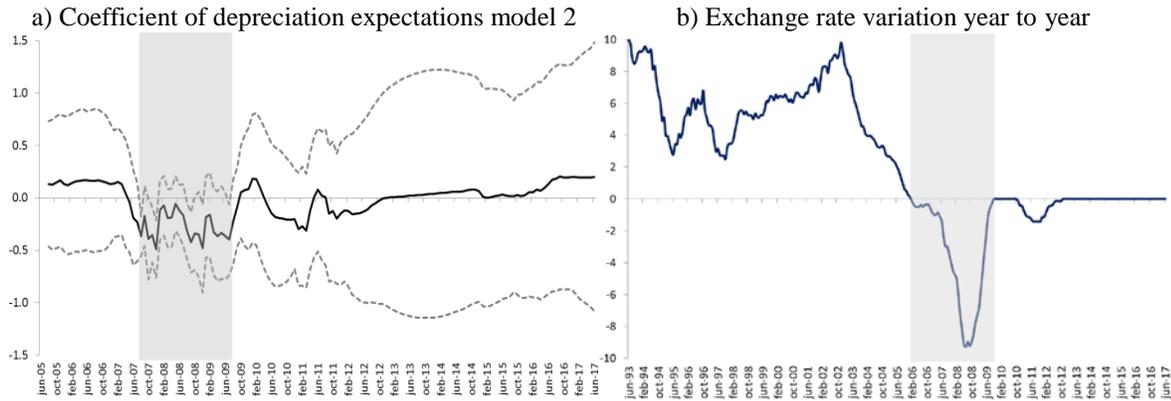


Note: Smoothed coefficient \pm 2RMSE of Model 4.

It seems that the inclusion of other explanatory variables simply tended to reduce the explanatory value of observed inflation over inflation expectations. Most of the additional variables also work as determinants of headline inflation; this could be the reason why none of them are significant, since their impacts are already contained in the path of the inflation. The evolution of this last variable reflects the impacts of imported inflation, demand pressures or climatic events. Therefore, the agents maybe only need to see the path of inflation, which already includes a lot of additional underlying information.

A special analysis deserves depreciation expectations, although these were found to be non-significant, there was a time when they had a more relevant role. The exchange rate in Bolivia has been under a crawling-peg regime since the late 1980s, and during the 1990s the local currency was continually depreciated in order to maintain the country's external competitiveness. This caused a significant process of dollarization (Berg and Borensztein, 2000), and a high pass-through effect (Laguna, 2010). In addition, in such a situation the population becomes accustomed to seeing depreciation as a normal process of the economic system (Humérez and De la Barra, 2007). However, this pattern changed radically after 2006. In 2007 and 2008 the local currency appreciated in order to mitigate the effects of the external environment on internal prices (Figure 9b). This measure had the effect of reducing expectations of inflation (Figure 9a), illustrating the important role of exchange policy in maintaining price stability.

Figure 9. Exchange Rate in Bolivia



Note: Smoothed coefficient \pm 2RMSE of Model 2.

Since 2011 the exchange rate has remained stable in order to anchor expectations and contain external inflationary pressures. This may have caused agents to stop considering the exchange rate as a relevant variable for the formation of their expectations in recent years.

The inclusion of other variables did not affect the previous results from Section 3.1, and it supports the possibility that short-term inflation expectations are anchoring in Bolivia. However, it would be good to analyze whether BCB announcements have effects on the inflation expectations of a longer horizon, such as the medium term.

4. Empirical Analysis in the Medium Term

Although, our main analysis has been done with the BCB survey and, therefore, with short-term information; there are other sources where anyone can find information on the expectations of economic agents. Most of the research papers on this topic consider data from international private companies that conduct surveys on different variables in a large number of countries. In this case we choose to use the information provided by the Latin Focus Consensus Forecast²¹ report from Focus Economics.²² While the large sample size allows us to study the expectations

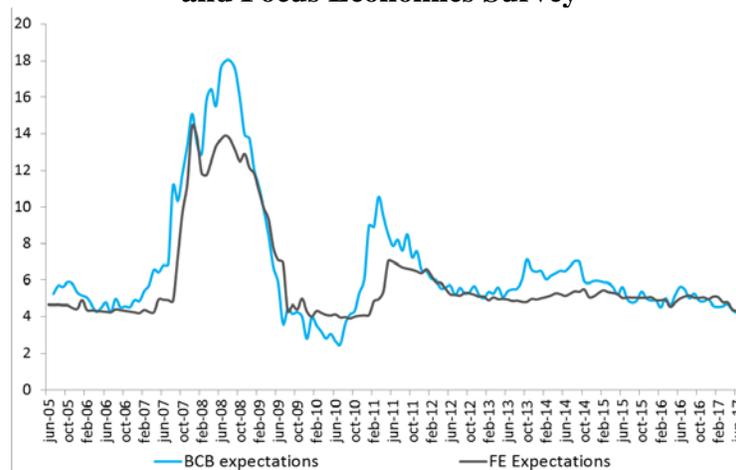
²¹ The Latin Focus Consensus Forecast report is a monthly publication, which contains macroeconomic projections from nearly 200 different sources. It covers approximately 30 macroeconomic indicators per country for a five-year forecast horizon including economic activity (GDP), industrial production, business confidence, consumer confidence, inflation, monetary policy decisions and exchange rate movement.

²² Focus Economics is a company that has information on economic forecasts for many key indicators in 127 countries. Its reports draw on many economic and commodities price forecasts and on economic analysts around the world.

of private agents, we chose this database mainly because it offers information not only on forecasts for the current and next calendar year, but also for years further ahead.²³

In order to compare the information offered by the Focus Economics survey with the BCB survey, we use the technique from equation (1) in Section 3 to transform the data of inflation expectations for the current and next calendar year. The series obtained reflect similar behavior in general terms (Figure 10). Between 2007-2008 and 2010-2011 both series show an increase, although one of less magnitude in the case of Focus Economics expectations. Since 2012, both series have stabilized, except for a slight increase in BCB expectations between 2013 and 2014, and from 2015 on they present similar values. By performing a cross correlation analysis considering the whole sample (July 2005 - June 2017), a high level of correlation (0.92) was obtained. Therefore, the Focus Economics information on inflation expectations can be considered a complement to BCB survey data.

Figure 10. Evolution of Inflation Expectations from BCB Survey and Focus Economics Survey



Source: Authors' compilation based on Central Bank of Bolivia and Focus Economics data.

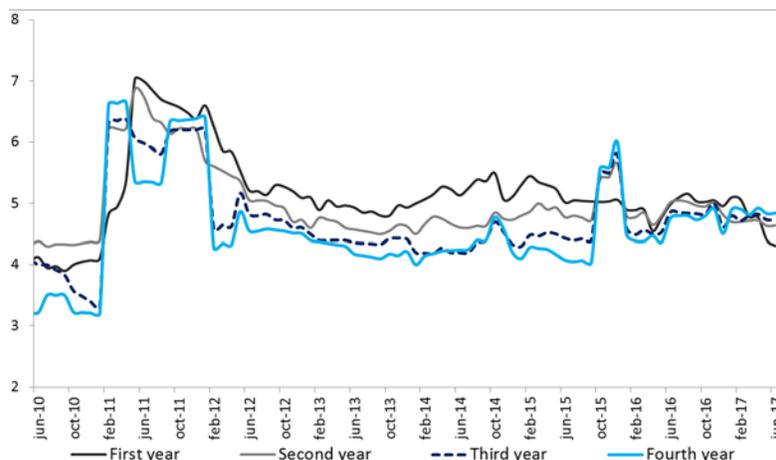
The forecast information of interest in the Focus Economics surveys, conducted with a monthly frequency, is that from April 2010.²⁴ We gathered information for the current year, the next calendar year, and the third, fourth, and fifth years ahead, so we have data on inflation expectations up to five years ahead. Although the information is on fixed-event variables, in

²³ There exist other institutions that provide information about economic forecast; one of the most famous is Consensus Economics. Nevertheless, in the case of Bolivia its report has only forecast information for the current and next calendar year of the variables of interest for the present document.

²⁴ There exists forecast information for the current and next calendar year for a longer period, but not for the rest of the years.

order to work with these data we also convert them into fixed-horizon variables using the technique from equation (1) in Section 3. We end with information on inflation expectations for the current year (first), the next calendar year (second), and the third and fourth years (Figure 11). The last years would be used to study the degree of anchoring in the medium term.²⁵

Figure 11. Inflation Expectations from Focus Economics



Source: Authors' compilation based on Focus Economics data.

The four variables show high values between 2011 and the beginning of 2012, and later they reflect more moderate behavior, similar to that observed with expectations from the BCB survey. A rebound can be observed by the end of 2015 for all cases, except the first year. In the last six months, the inflation expectations at the second, third, and fourth years stabilize around 4.78 percent, while the expectations for the present year (first year) fall to 4.31 percent.

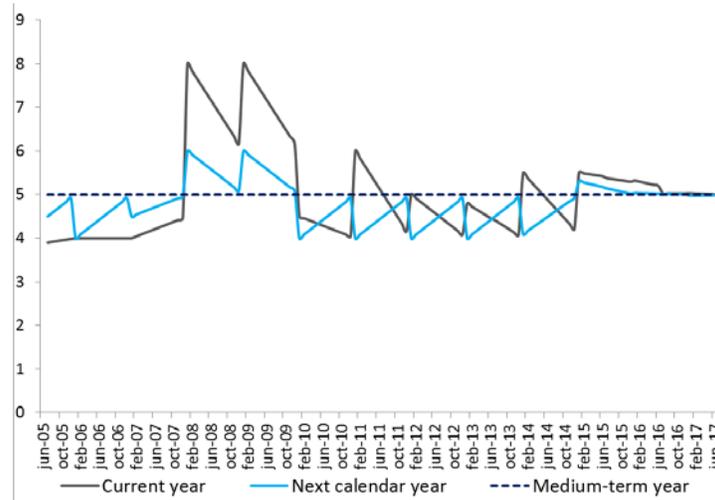
In the case of BCB projections, we have the projections for the current and next calendar year from the Monetary Policy Reports. The BCB does not undertake projections for longer periods in their reports, which poses a challenge for analyzing the degree of anchoring in the medium term. To deal with this issue, we use an implicit inflation target as a reference for inflation expectations in the medium term.²⁶ We considered the level of inflation that is normally used in the medium-term projections for internal analysis in the BCB. In this case, it would be

²⁵ Although most of the literature defines the medium term as beginning with the fifth year ahead (Carrasco and Ferreiro, 2013; IMF, 2016), this document defines the medium term as beginning with the second year ahead (Łyziak and Paloviita, 2016).

²⁶ There exist research papers that have used implicit inflation targets such as Mumtaz and Theodoridis (2017).

precisely 5 percent,²⁷ which is in line with the projections made for the Economic and Social Development Plan 2016–2020 for Bolivia. As in the previous case, we take fixed-event variables and use equation (1) to change them to fixed-horizon variables (Figure 12).

Figure 12. BCB Projections for the Medium Term



Source: Authors' compilation based on BCB data.

With the variables prepared, the first step was to analyze the behavior of short-term inflation expectations (current year) in order to compare the results with those obtained with the expectations from the BCB survey in Section 3.1²⁸ with equation (2). The results show an important role of headline inflation, especially in 2007, 2008, and 2011 (Figure A5b). Nevertheless, since 2012 the coefficient of BCB projections (degree of anchoring) has reflected an upward trend with slight fluctuations, reaching a value of 0.83 at the end of the sample (Figure A5a). The results have the same observed pattern as those obtained in Section 3.1, showing a greater degree of anchorage in recent years. This shows the importance the BCB's projections acquired in the last few years, not only for local economic agents but also for foreign forecasters.

In order to compare the results from the degree of anchoring of inflation expectations in the short term and medium term, we use the same time-varying parameter model from equation (2) with the same assumptions from the previous section. We introduce the inflation expectations

²⁷ Also, this level has been used as reference for the next calendar year's projections in the BCB Monetary Policy Report since 2015.

²⁸ The results of Model 6 can be found in Appendix 3.

by year horizon with the respective BCB projection; for example, the BCB projection for the first and second year will be included in the models with the inflation expectations for the current and next calendar year, respectively. Meanwhile, the implicit inflation target will be introduced into the models with inflation expectations for the third and fourth years. Thus, we have four models, the results of which appear in Table 3.

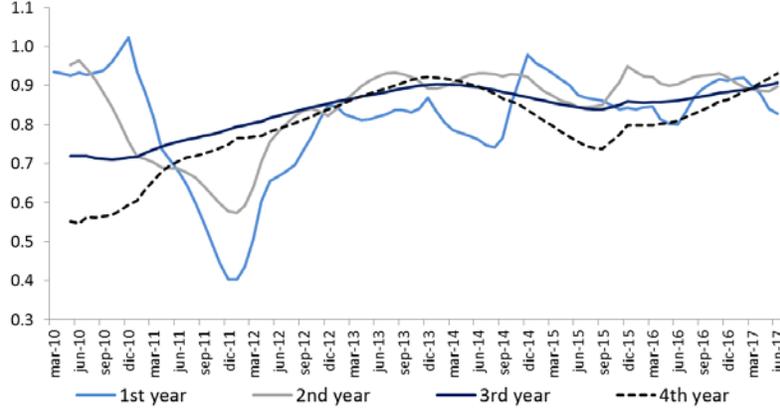
Table 3. Degree of Anchoring of Inflation Expectations in the Short Term and Medium Term

	Model 6	Model 7	Model 8	Model 9
	First year (current year)	Second year (next year)	Third year	Fourth year
BCB projection (implicit target)	0.83 (0.00)	0.90 (0.00)	0.91 (0.00)	0.93 (0.00)
Past inflation	0.17 (0.09)	0.10 (0.19)	0.09 (0.45)	0.07 (0.65)

Note: Values in parentheses represent p-values.

The results show a greater degree of anchoring in the medium term than in the short term, in line with the results of Carrasco and Ferreiro (2013), Strohsal, Melnick and Nautz (2015) or IMF (2016). The coefficient of past inflation becomes smaller and not significant in the second, third, and fourth years. Meanwhile the degree of anchoring (coefficient of BCB forecast) is stronger in recent years; it is a difference of almost 10 percentage points between the coefficients in the first and fourth years. The coefficients for the first and second years reflect more volatile behavior over the time (Figure 13). In all of these cases, an improvement in the degree of anchoring can be seen since 2012, with higher or lower fluctuations. The degree of anchoring of inflation expectations is generally greater in the medium term than in the short term.

Figure 13. Coefficients of BCB Projections for Different Year Horizons



Source: Authors' compilation based on BCB data.

The BCB does not publish an inflation target for medium-term. Nevertheless, as Strohsal, Melnick and Nautz (2015) mentioned, inflation targets do not have to be officially announced to be effective. Many central banks, including the European Central Bank or the U.S. Federal Reserve, do not publish official inflation targets but are able to communicate the level of their inflation objective to the markets.

Although inflation expectations appear to be well anchored in the medium term with respect to past inflation, there is a strand of literature that postulates that long-term (medium-term) expectations should not respond to changes in short-term inflation expectations either (Jochmann, Koop and Potter, 2010; Łyziak and Paloviita, 2016). In that sense, we additionally create a model to study if there is a relationship between medium-term and short-term inflation expectations using the information from Focus Economics.

If medium-term inflation expectations are well anchored, they should not respond to changes from short-term inflation expectations. In this case, following the work of Strohsal, Melnick and Nautz (2015), medium-term inflation expectations²⁹ ($\pi_{m,t}^e$) are a function of observed inflation (π_{t-1}), short-term expectations³⁰ ($\pi_{s,t}^e$) and the implicit inflation target (π^*):

$$\pi_{m,t}^e = \alpha_1 \pi_{t-1} + \alpha_2 \pi_{s,t-1}^e + \alpha_3 \pi^* + \epsilon_t \quad (4)$$

where:

$$\alpha_1 + \alpha_2 + \alpha_3 = 1$$

²⁹ As a reference of medium-term we choose the inflation expectations for the fourth year of Focus Economics.

³⁰ As a reference of short-term we choose the inflation expectations for the first year of Focus Economics, in order to work with the same survey sample.

If $\alpha_1 > 0$ it means that medium-term inflation expectations follow past inflation. If $\alpha_2 > 0$, the information from short-term inflation expectations is relevant for the medium term. With these considerations, medium-term inflation expectations will show a greater degree of anchorage as long as the value of α_3 is close to 1. For inflation expectations to be perfectly anchored it is necessary that $\alpha_1 = \alpha_2 = 0$.

As in the previous cases, a time-varying parameter model is used with monthly data from April 2010 to June 2017. The state parameters follow a random walk process for simplification and variances parameters are expressed in exponential form. The Kalman filter is used to compute the one-step ahead estimates of the means and variances of the states by maximum likelihood. The results of the estimation are shown in Table 4.

Table 4. Degree of Anchoring of Inflation Expectations in the Medium Term, Model 10

Past inflation	Short-term expectations	BCB implicit target
alpha 1	alpha 2	alpha 3
0.03	0.25	0.71
(0.82)	(0.17)	(0.00)

Note: Values in parentheses represent p-values.

Figure 14. Evolution of Coefficients in Model 10

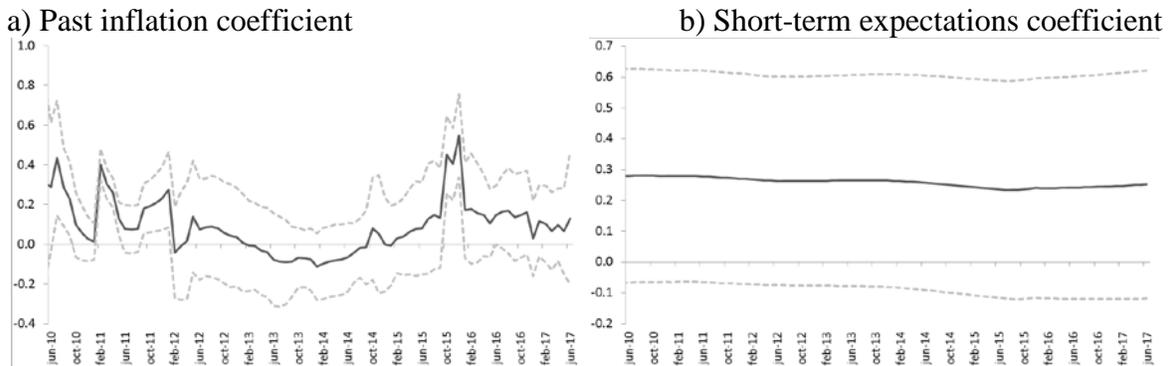
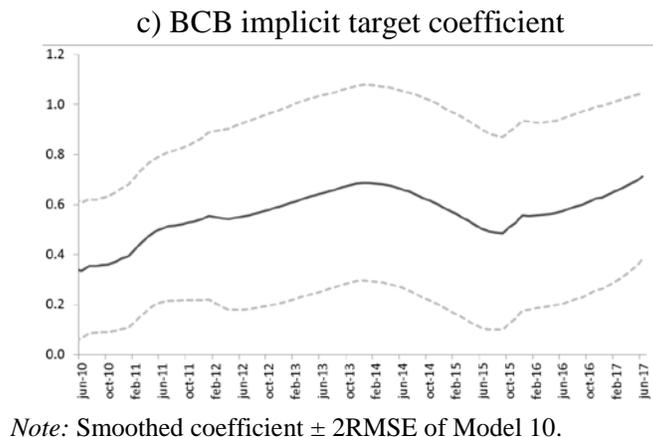


Figure 14, continued



The past inflation coefficient (Fig. 14a) shows erratic behavior over time, reaching its highest values during 2010 and the end of 2015, in the last months its value decreased to 0.03, a low and insignificant value. The short-term expectations coefficient (Fig. 14b) displays a value of about 0.25 for the whole sample, being almost constant. However, it is not significant; the effect that this variable could have on medium-term expectations seems to be already rescued with the information of past inflation so it does not present any significant changes to its behavior.

Finally, the BCB implicit target coefficient (Fig. 14c) exhibits an upward trend, similar to those observed in other models, with a temporary fall between the second quarter of 2014 and the third quarter of 2015. This coefficient rose from 0.34 in mid-2010 to 0.71 in mid-2017. Under this specification, medium-term inflation expectations reflect a high degree of anchoring since past inflation ceased to be significant and short-term inflation expectations did not have a significant effect throughout the analysis period.

5. Some Considerations Regarding the Results

The results obtained show that there could be a significant degree of anchoring of inflation expectations in Bolivia, both in the short and medium-term, mainly since 2014. In the case of short-term expectations, it is quite noticeable that BCB's projections have greater effect than observed inflation and other variables, unlike other studies that indicate that past inflation has a high relevance in this time horizon (Łyziak and Paloviita, 2016). However, in the medium term (fourth year), as expected, there is a greater degree of anchoring than in the short term (first

year). It is also remarkable considering this result was obtained with two different samples (BCB survey and Focus Economics survey).

This behavior indicates a significant improvement in the degree of credibility of the BCB, and it could be associated with several factors. These include the adoption of a more active role by the monetary authority (with a higher degree of intervention in the money market and a more active communication policy), a stable macroeconomic environment, and the progress made in the process of financial de-dollarization.

During the 1990s and the first five years of the 2000s, almost all of the loans and deposits in the financial system were denominated in U.S. dollars because people in Bolivia had greater confidence in the dollar to carry out their daily transactions. This situation can be attributed to the constant depreciations during this period, which led to a loss of the value of the local currency. In 2006, when the Bolivian appreciated, the degree of financial dollarization in Bolivia began to decrease. This aspect, with other measures applied by the local authorities, allowed the de-dollarization process to accelerate. This in turn created a more favorable environment for monetary policy and a greater role for the BCB in local economic activity. While 97 percent of loans were made in dollars at the beginning of 1998, by mid-2017 this figure had fallen to 2.7 percent (Figure 15). In the same period, deposits in dollars declined from 92.7 percent to 15.6 percent. These developments apparently helped to create a more predictable environment for economic agents.

Figure 15. Percentage of Dollarization of Financial Loans



Source: Central Bank of Bolivia.

6. Conclusions

This study with different specifications of time-varying parameters models shows that a high degree of anchoring of inflation expectations in Bolivia could exist. Our main analysis was performed considering information from the BCB survey, which was complemented with data from Focus Economics survey. Considering the limitations of these data sources, our study focuses mainly on the analysis of the short and medium-term expectations, obtaining good results in both cases.

The results show that the BCB's projections, presented in its Monetary Policy Report have a significant effect on short-term inflation expectations, unlike other studies that indicate that past inflation has a high relevance in this time horizon (Łyziak and Paloviita, 2016). The anchoring of short-term inflation expectations for central banks is not of less importance since these have a relevant role in wage adjustments and price setting by firms. It is remarkable that we found a high level of anchoring degree with two different samples (BCB survey and Focus Economics survey).

In the case of medium-term inflation expectations, we use an implicit inflation target of five percent for time horizons longer than two years. Also, we use information from Focus Economics, which has data on inflation expectations up to five years ahead. Following the work of Łyziak and Paloviita (2016) and Strohsal, Melnick and Nautz (2015), we found that past inflation and short-term expectations do not have a significant impact. Meanwhile, the implicit target would be the main reference for the formulation of medium-term inflation expectations.

This research paper represents a first step in understanding the behavior of inflation expectations in Bolivia. There are not many studies that have analyzed their conduct or how they react to the announcements made by the BCB about the future trajectory of inflation. Since 2006, the BCB has actively participated in press conferences, seminars and presentations in order to forge a closer relationship with the population in general (academics, experts, students, reporters, and others). The results of this paper show that the BCB's projects may have exerted a greater influence on agents' inflation expectations in recent years. However, more studies should be carried out to understand and evaluate better the capacity of the BCB to anchor the inflation expectations of the Bolivian population.

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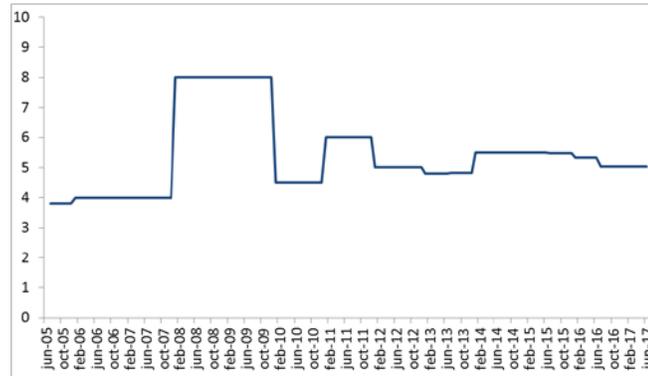
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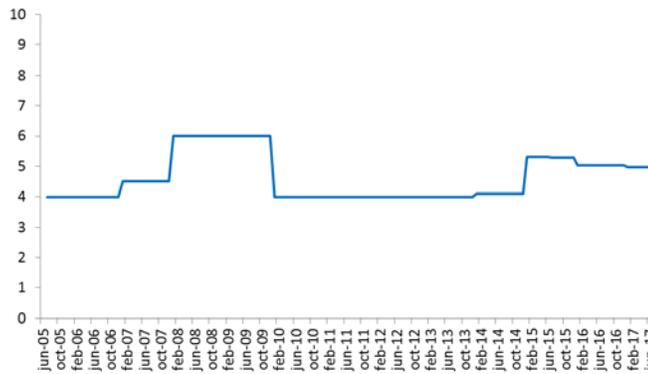
Appendix 1. BCB Projections

Figure A.1. BCB Projection (inflation by the end of current year)



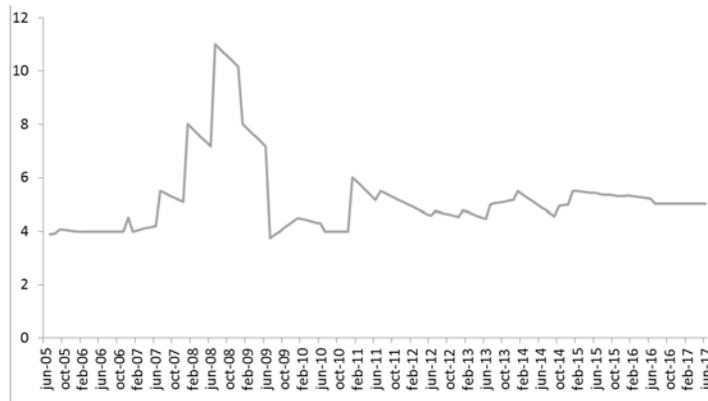
Source: Central Bank of Bolivia.

Figure A.2. BCB Projection (inflation by the end of next calendar year)



Source: Central Bank of Bolivia.

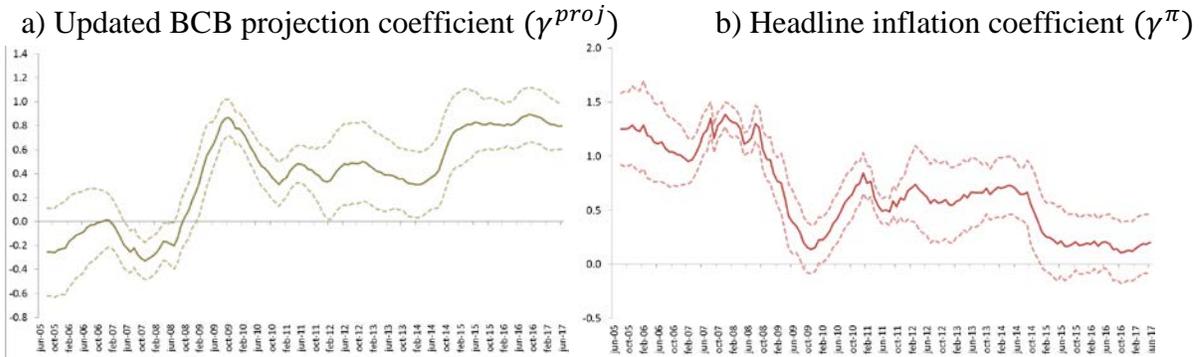
Figure A.3. Updated BCB Projection (inflation by the end of current year)



Source: Central Bank of Bolivia.

Appendix 2.

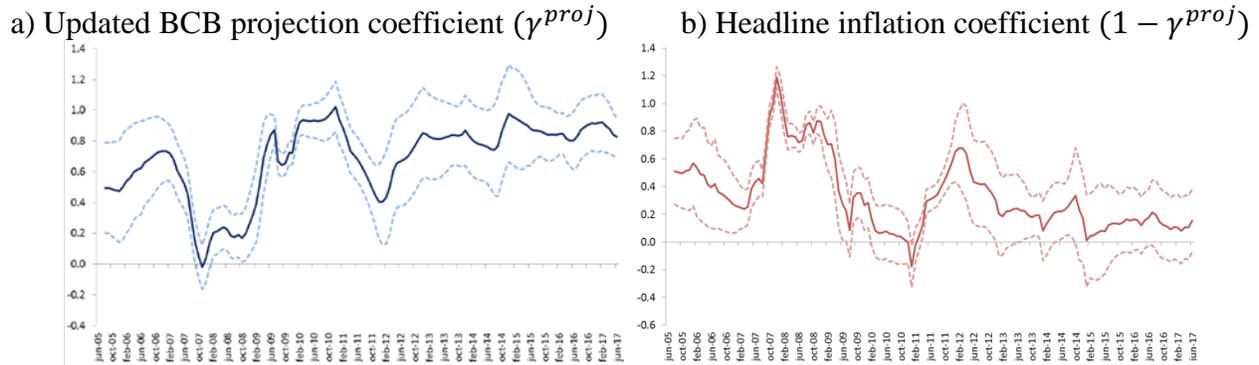
Figure A.4. Evolution of Coefficients in Alternative Model 1



Note: Smoothed coefficient \pm 2RMSE.

Appendix 3.

Figure A.5. Evolution of Coefficients in Model 6



Note: Smoothed coefficient \pm 2RMSE