Assessing inflation targeting during crisis periods: An application to the Chilean economy

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Abstract

This paper investigates the ability of inflation targets to control inflation during the Asian and Subprime crises using the Chilean case. To this end, we use time-varying modeling to estimate inflation persistence from 1990 to 2022 through a Phillips-curve specification. Our results show that inflation targeting has effectively decreased persistence since this implementation began in the 1990s. Nevertheless, the Asian and Subprime crises introduced significant instability in inflation persistence. After the Asian crisis, inflation targeting effectively decreased persistence; however, this was not the case after the Subprime crisis. Therefore, our results suggest that the Subprime crisis had deep consequences on the ability of the Chilean monetary policy to control inflation.

JEL classification: C22, E31, E52
Keywords: Inflation persistence, Subprime crisis, Asian crisis, Time-varying parameters

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1 Introduction

Once again, inflation has become an issue in developed and developing countries because of the stabilization policies introduced in response to the recessionary impact of the covid-19 pandemic. This performance occurs after more than thirty years of low and stable inflation together with high economic growth and low volatility of output in a context of a strategy for a monetary policy where many countries have implemented full fledge inflationary targets (henceforth IT). Moreover, there have been considerable efforts to evaluate the performance of IT and the efficiency of monetary policy over this period, including in their samples both developed and developing countries with important findings which support the use of inflation targets (Svensson, 2010). The review of the issues and the empirical evidence conclude that inflation targeting has been conducive to lower inflation in the long run, inflation being less sensitive to external shocks like cost-push and exchange rate misalignments. These results are stronger when reaching the target at the stationary state and in emerging and developing economies (Mishkin and Schmidt-Hebbel, 2007; de Mendonça, and de Guimarães e Souza, 2012; Schmidt-Hebbel and Carrasco, 2016).

Additionally, it has been reported that inflation targets have accomplished significant gains in the efficiency of monetary policy in terms of lower output and inflation variability. In fact, macroeconomic performance is a benefit caused by the implementation of inflation targeting, especially in developing countries (Walsh, 2009; Fratzscher et al., 2020). Following the methodology of the monetary policy efficient frontier, Cecchetti et al. (2006) produce empirical evidence which demonstrates that monetary policy under inflation targeting has reduced the inflation and output variability from a better performance of monetary policy as the volatility gets closer to the optimal monetary policy and thus to its efficiency frontier. At the same time, the evidence also demonstrates that the magnitudes of the shocks decrease, and hence the efficiency frontier is much closer to the origin. Similar conclusions are found from single country-studies like Chile and Indonesia (Ochoa, 2009; Purwanda and Rochana,

2017).

Reducing inflation and its impact on output volatility will be an issue following the Covid-19 pandemic and the inflationary environment allowing testing IT strategy in its efficacy and costs of bringing inflation under control and back to its stationary state together with the efficiency of monetary policy. Indeed, this scenario of economic instability represents the opportunity to test the efficiency of monetary policy under IT. In evaluating IT during economic instability, the case of Chile is relevant and a strong case since it is a small open economy, fully dependent on oil imports and hence sensible to oil price shocks and exchange rate volatility. At the same time, Chile has been having a full fledge inflationary targets for the last 30 years and therefore making it possible to evaluate the strategy during different periods of economic instability (Morandé, 2001).

The objective of this paper is to investigate the efficiency of inflation targeting to control inflation during economic instability caused by a crisis period. For this purpose, we use the case of Chile, which has successfully implemented inflation targeting since the beginning of the 1990s with long periods of stable and low inflation. Among the periods of economic instability, we include in our sample the Asian crisis of 1997-1998, the Subprime crisis and Great recession of 2008-2009, and lately, the political crisis of October 2019 and the Covid-19 pandemic 2020. Our contribution is to provide empirical evidence about how the ability of inflation targets to control inflation differs depending on the nature of the shock introduced by the economic crisis.

To assess the efficiency of inflation targeting, we evaluate the inflationary persistence during the events selected for that purpose using monthly data from January 1990 to July 2022. It is expected that a successful IT strategy should increase persistence in inflation during a period of economic instability, followed by a reduction of inflation persistence once inflation converges to its target. We evaluate inflation persistence by estimating a Phillips curve for Chile and using the Kalman filter to estimate time-varying parameters following the methodology introduced by Khalaf and Kichian (2003). Our results show that inflation

targeting decreased persistence after the Asian crisis; however, this was not the case after the Subprime crisis. In fact, Chilean inflation persistence has yet to reach levels before the Subprime crisis. These findings suggest that the efficiency of inflation targeting to control inflation depends on the nature of the shock introduced by the economic crisis. This outcome opens the door to investigating the key factors of economic crises that affect the efficiency of inflation targeting to decrease inflation persistence.

This paper is organized as follows. Section 2 presents the methodology, Section 3 shows the data used in this article, Section 4 discusses the main results, and Section 5 concludes this paper.

2 Methodology

We follow Khalaf and Kichian (2003) to estimate Chilean inflation persistence through a Phillips curve specification. First, a linear model is estimated. Second, a coefficient stability test is performed by following Kim and Nelson (1989). Finally, and post rejecting the null hypothesis of stability, a Kalman filter provides a theoretical framework to study the behavior of coefficients over time. Thus, in the first stage, we estimate the following Phillips curve for the Chilean economy as follows:

$$\begin{aligned}(\pi_t - \overline{\pi}) = \alpha(\pi_{t-1} - \overline{\pi}) + \beta\pi_t^e + \gamma(y_{t-1} - \overline{y}) \\ + \delta(z_{t-1} - \overline{z}) + \varepsilon_t\end{aligned} \tag{1}$$

Where π_t, π_t^e, y_t, and z_t are the annual inflation, inflation expectations, annual economic growth, and annual growth of the exchange rate during period t, respectively. Variables $\overline{\pi}$, $\overline{y}$, and $\overline{z}$ correspond to the annual inflation target, potential economic growth, and equilibrium depreciation, respectively. Thus, the model in equation (1) includes, on the one hand, domestic shocks; the deviations of economic growth from its potential value and deviations of annual inflation from its target value, and, on the other hand, external shocks; deviations of the annual growth of exchange rate from its equilibrium value. ε_t is a structural shock

on the aggregate supply, which is independent and identically distributed with variance σ_{ε}^2. This shock can be interpreted as a cost that deviates real wages from their equilibrium values. Finally, α , β, γ, and δ are the coefficients of the model.

The specification in equation (1) includes lagged inflation to capture a backward-looking component (Rojas, 2005) and also includes inflation expectations to capture a forward-looking component[1] (Rojas, 2005; Maka and Barbosa, 2014). Furthermore, deviations from the annual growth include inflationary pressures from shocks to domestic production. Similarly, small and open economies like the Chilean economy are vulnerable to external shocks through changes in international prices, which are captured by deviations from the equilibrium value of the exchange rate. The specification in equation (1) also considers that lags on different inflationary pressures do not have to be the same. For instance, agents can assign greater importance to the forward-looking component, especially when inflation has reached its stationary equilibrium.

In the second state, we follow Kim and Nelson (1989) to test structural changes in the OLS parameters of our model in equation (1). Regressing $\hat{\varepsilon}^2/\hat{\sigma}_{\varepsilon}^2$ on the squared variables of the model multiplied by the number of observations, one can obtain the explained sum of squares divided by two, which is chi-squared distributed with four degrees of freedom. Then, we can test the null hypothesis of stable coefficients.

In the final stage, and after rejecting the null hypothesis of stability, we use the Kalman filter to capture continuous structural changes in the coefficients of the model by assuming unstable parameters, which follows a random-walk process, i.e.:

$$\begin{aligned}(\pi_t - \overline{\pi}) = \alpha_t(\pi_{t-1} - \overline{\pi}) + \beta_t \pi_t^e + \gamma_t(y_{t-1} - \overline{y}) \\ + \delta_t(z_{t-1} - \overline{z}) + \epsilon_t\end{aligned} \tag{2}$$

Where,

[1]Note that in the long run, backward and forward-looking coefficients add up to one.

$$\alpha_t = \alpha_{t-1} + \mu_t \tag{3}$$

$$\delta_t = \delta_{t-1} + \omega_t \tag{4}$$

$$\beta_t = \beta_{t-1} + \eta_t \tag{5}$$

$$\varphi_t = \varphi_{t-1} + \upsilon_t \tag{6}$$

The model in equation (2) is the measurement equation that describes the dynamic between the observed and unobserved state variables. Transition equations (3), (4), (5), and (6) describe the dynamic of the state variables. Variable μ_t, ω_t, η_t and υ_t are i.i.d variables with variances σ^2_μ, σ^2_ω, σ^2_η, and σ^2_ν, respectively. The error term ϵ_t is assumed to be orthogonal to each of the error terms in the state equations. Following Kim and Nelson (1999), these equations can be used to set up the prediction equations in the Kalman filter algorithm and the respective updating equations through the conditional forecast error and its conditional variance. This information allows us to set up the log-likelihood function for Gaussian initial values of the coefficients whose maximization provides estimates for time-varying parameters.

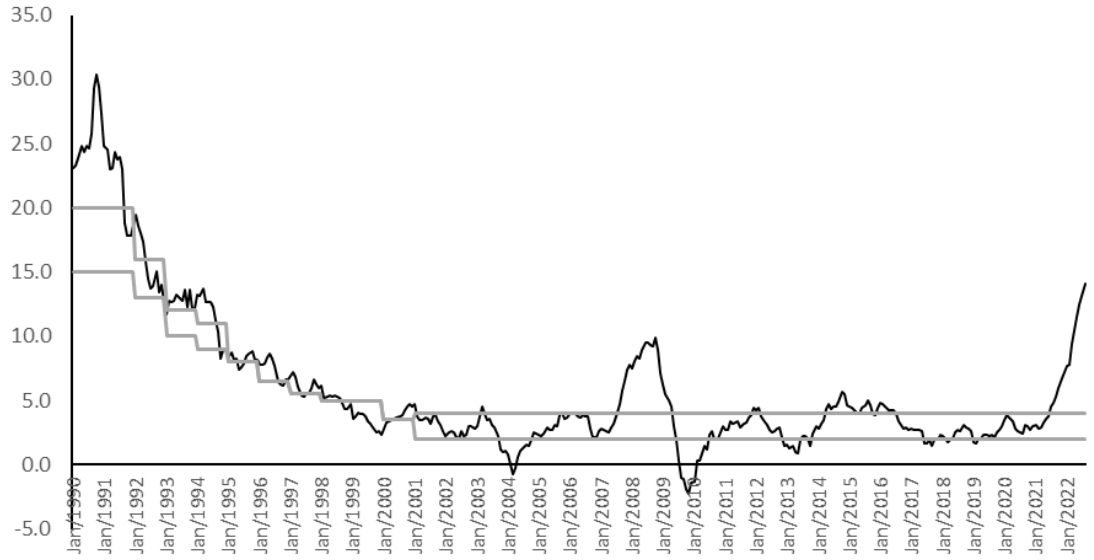
3 Data

We use monthly data from January 1990 to July 2022, which allows us to cover the Asian crisis in 1997, the Subprime crisis in 2008, the Chilean political crisis in 2019, and the Covid-19 pandemic in 2020. We use the annual growth of the CPI as our proxy for inflation, survey expectations as a proxy for inflation expectations, the annual growth of the monthly economic activity index as a proxy for economic growth, and the annual growth of the nominal exchange rate as a proxy for external inflationary pressures (Mishkin and Schmidt-Hebbel,

2007). Note that a small and open economy like Chile is constantly affected by variations in the nominal exchange rate (Ochoa, 2009). The data source for these variables is the Central Bank of Chile, whose information is freely available at https://si3.bcentral.cl/siete/. It is worth mentioning that inflation expectations are available from January 2000; thus, we use the core annual inflation as expectations before 2000. As is expressed in the model in equation (1), and following Castro (2011), we subtract the inflation target from the annual inflation as our dependent variable (Box et al., 2015). Moreover, we follow the Hodrick and Prescott (1997) to obtain the growth component of annual economic growth (Castro, 2011; Cecchetti et al., 2006) as a proxy for the output gap. Figure 1 presents Chilean inflation and its minimum and maximum annual targets. During the Asian crisis, we can observe that Chilean inflation had a decreasing trend to its stationary value, which was reached at the beginning of the 2000s. By contrast, the Subprime was accompanied by a significant increase in inflation (above the annual target) and a significant decrease after this crisis (below the annual target). A similar inflation increase is observed during the current Covid-19 pandemic crisis, where annual inflation is notably above the target inflation. These features are in line with annual economic growth (Figure 2), where negative economic growth is observed during the Asian crisis, Subprime, and Covid-19 pandemic crises. While economic growth had important decreases during these crisis periods, it is positive in the majority of the sample periods outside these crises. The exchange rate, on the other hand, had erratic behavior with an important increase (compared with the rest of the periods) during the Subprime crisis and post-pandemic crisis (see Appendix A). Inflation expectations show a decreasing trend during the 1990s and an increase during the Subprime crisis, relative stability from 2010 to 2020, and an important increase during the current Pandemic period (see Appendix A). Finally, we seasonally adjusted the series used in the estimations of this paper[2] and use their first differences since these are stationary (see Table 1).

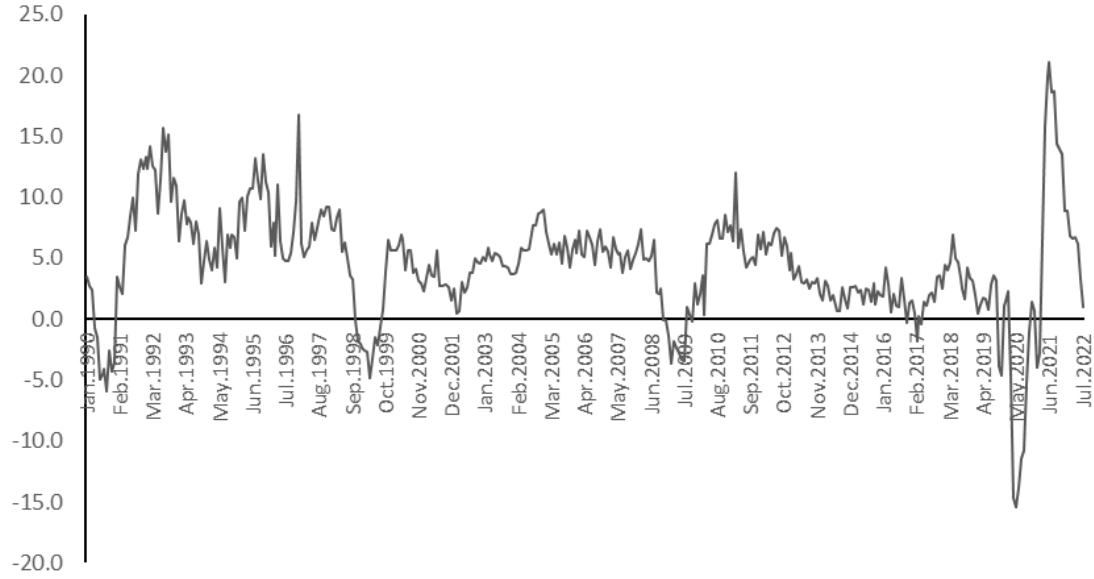
[2]Following the Bravo et al. (2002), we use X-12 ARIMA to seasonally adjust the series used in this paper.

Figure 1: Evolution of Chilean annual inflation



Notes: Maximum and minimum annual targets for annual inflation are shown in gray
Source: Own computation with data retrieved from the Central Bank of Chile

Figure 2: Evolution of Chilean annual Economic growth



Source: Own computation with data retrieved from the Central Bank of Chile

Table 1: Stationarity test

Variable	Phillip-Perron test		Dickey-Fuller test		
	Case	Statistic	Lags	Case	Statistic
Inflation	1	-60.48***	3	1	-17.30***
Inflation expectation	1	-48.39***	3	3	-14.67***
Economic growth	1	-23.05***	3	1	-13.31***
Exchange rate	1	-16.18***	11	1	-10.24***

Notes: *, **, and *** imply significance at the 10%, 5%, and 1% level of significance. Case 1, 2, and 3 correspond to a specification without constant and trend, specification with constant, and specification with constant and trend, respectively. Schwarz information criterion is minimized to choose the number of lags in the Dickey-Fuller test.

4 Results

First, we estimate a linear model and perform the test proposed by Kim and Nelson (1989). Table 2 shows the estimates for the model in equation (1). Besides the model with all variables in equation (1), we also perform the test for a model with a constant and one of the explicative variables in equation (1). Table 1 shows that the null hypothesis of stable coefficients is rejected at the 1% level of significance for all estimated specifications, which supports the use of time-varying coefficients[3]. Therefore, we proceed to estimate the model in equations from (2) to (6). Our coefficient of interest is α_t which provides us with the evolution of the inflation persistence during the sample period.

Figure 3 shows the inflation persistence over the period in analysis in this paper. We also show the 95% confidence interval for this measure, which is helpful in identifying periods of high (outside the interval) persistence and stable persistence (inside the interval). This interval is computed using a rolling window of the last twelve periods. As is expected, we observe different shocks which significantly increase persistence as well as time periods with

[3]We also estimate the Phillips curve with the number of lags that minimizes the Akaike information criterion through a ARDL model whose results also reject the null hypothesis for all specifications in Table 1. These results can be obtained from authors upon request.

Table 2: Stability parameter test for linear specification

Estimated parameters					χ^2
Constant	α	β	γ	δ	
-0.049	0.001**				660.1***
(0.099)	(0.0004)				
-0.094		0.007***			652.6***
(0.101)		(0.0024)			
0.019			-0.016		669.6***
(0.100)			(0.461)		
0.024				-2.1E-6	668.5***
(0.110)				(1.8E-5)	
-0.085	2.0E-4	0.007**	-0.174	-9.7E-7	652.1***
(0.120)	(0.001)	(0.003)	(0.460)	(1.8E-5)	

Notes: *, **, and *** imply significance at the 10%, 5%, and 1% level of significance. Standard errors are shown between parathesis.

volatility changes. At the beginning of the 1990s, there were different sample periods with significant persistence. This finding is an expected outcome since the inflation-target focus was starting to be implemented as a method of inflation control. During 1995 and 1996, inflation persistence showed a stable pattern suggesting the first positive effects of inflation targeting. Nevertheless, we observe a significant increase in persistence during 1997, which seems to be driven by the Asian crisis. This outcome evidences that the monetary authority lost efficiency during this economic crisis. It is word mentioning that post-Asian crisis, from 1998 to 2002, inflation persistence showed remarkable stability suggesting that the inflation targeting effectively controlled inflation after the shock introduced by this crisis. Similar to the Asian crisis, in 2003, there was a shock whose effects disappeared fast from the inflation evolution. Therefore, our results show that the inflation targeting was an effective method of inflation control during the 1990s, even after an economic crisis.

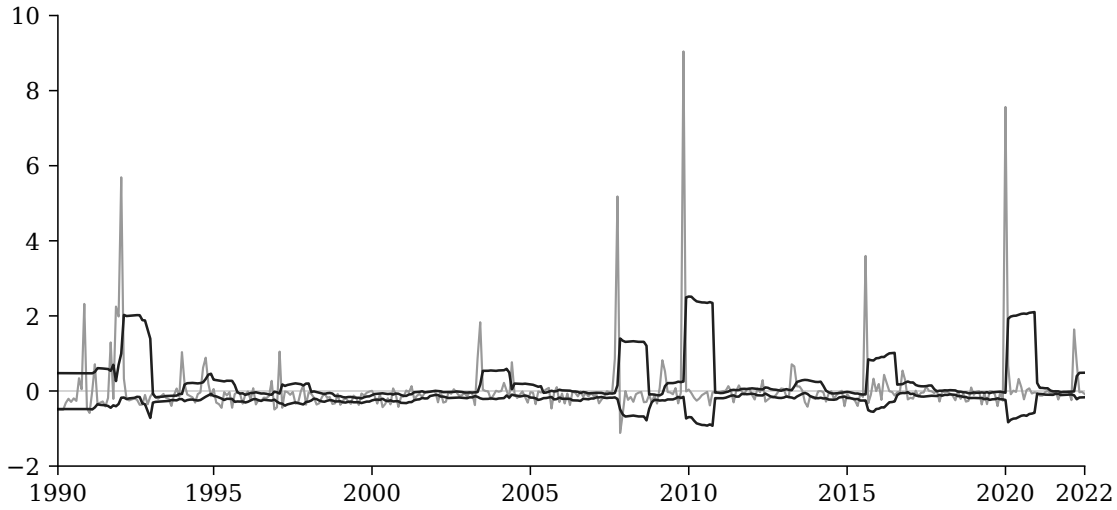
The above discussion contrasts with the consequences of the Subprime crisis, which shows the highest increase in magnitude during the sample period is observed in 2009. Moreover, we observe an increase in volatility of the inflation persistence after the Subprime crisis with different episodes where inflation persistence significantly increases. In fact, we can observe

stable periods only during 2014 and from 2017 to 2019, contrasting with more extended periods of stable inflation persistence before the Subprime crisis. This result suggests that the Subprime crisis impacted the ability of inflation targeting to control inflation since persistence did not stabilize after this shock. Thus, one can ask why the Chilean monetary authority was able to deal with the consequences of the Asian crisis, but it did not have the same outcome after the Subprime crisis. We also observe an increase in inflation persistence in 2019 and 2022, coinciding with the social crisis in Chile and the Covid-19 pandemic. Nevertheless, we do not have posterior periods to evaluate whether inflation persistence stabilizes after this shock. As a result, the information in Figure 3 reveals that the inflation targeting positively affects inflation control by decreasing persistence even after an international shock like the Asian crisis. However, the effect on inflation persistence seems to depend on the magnitude and type of the shock since the Subprime crisis (the highest impact on inflation persistence) shows a long-lasting effect.

To clarify our findings, we compute the standard deviation of inflation persistence during the first years of implementing inflation targeting and during the crisis periods. We observe the highest volatility during the Subprime crisis and the Covid-19 pandemic. Performing the robust Leven's test for the standard-deviations differences, our results show significantly higher volatility during the beginning of the implementation of inflation targeting (1990-1994) and the Subprime crisis compared to the Asian crisis. Note that Chile started to implement inflation targeting in 1990, which was followed by a period of consistent decrease in inflation until achieving the long-run goal of 3% in 2003. In fact, the annual inflation rate in 1990 was 26%, while in 2000 was 3.8%. Our results are consistent with this evidence since high volatility at the beginning of the 1990s may show when the central bank was building credibility to implement inflation targeting. In this context, our results reveal that the shock introduced by the Subprime crisis caused an inflation-persistence volatility equivalent to the one existing from 1990 to 1994. This evidence supports that the Subprime crisis had profound consequences on the Chilean inflation persistence and impacted the ability of

inflation targeting to control inflation.

Figure 3: Chilean inflation persistence



Note: Black lines represent the confidence interval at the 95%.
Source: Authors' estimations

Table 3: Standard-deviation difference test

Time period	**1990-1994**	**1997-1998**	**2007-2009**
1990-1994	-	-	-
1997-1998	4.93**	-	-
2007-2009	1.32	4.00**	-
2019-2022	0.01	2.32	0.61

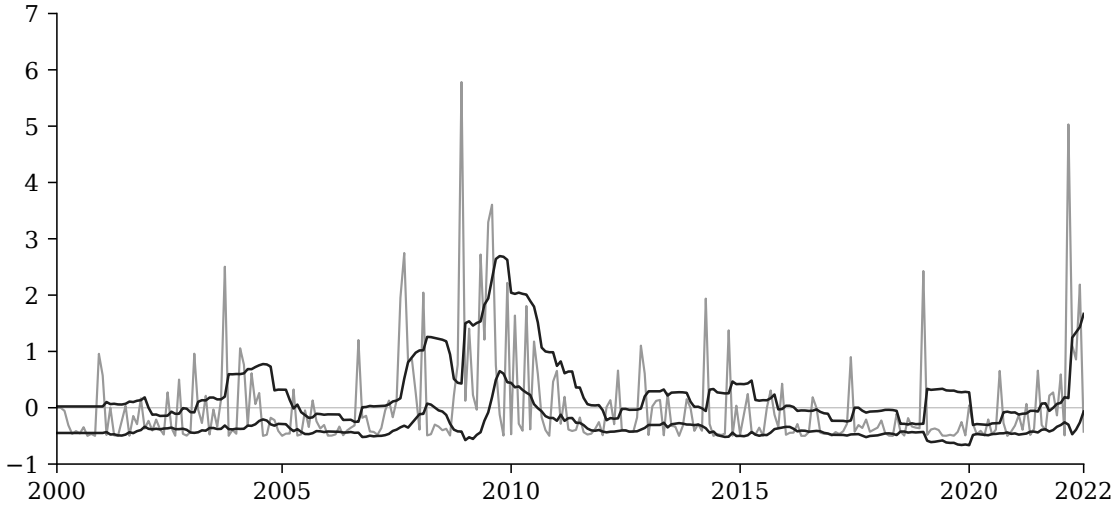
Notes: *, **, and *** imply significance at the 10%, 5%, and 1% level of significance.

We perform three robustness checks for our results. First, we do not have expectations observations during all our sample period which could drive our results. Thus, we re-estimate our model in equations from (2) to (6) using the sample period from February 2000 to July 2022, where data on expectations surveys is available. Figure 4 presents inflation persistence showing that the Subprime crisis was the main shock during this sample period. Although we do not have the Asian crisis period in these results, we observe the high persistence after the Subprime crisis with different significant deviations in the evolution of this variable,

suggesting that the ability of monetary policy to control inflation decreases considerably after this shock. Second, we forecast inflation with an ARIMA model[4] to obtain a proxy for expected inflation instead of using survey data. This method provides observations for all our sample periods; however, note that this is a backward-looking approach. Inflation persistence is presented in Figure 5, which shows similar dynamics as previous results. There was high persistence at the beginning of the implementation of inflation targeting which decreased until the Asian crisis. We also observe a significant deviation at the beginning of the 2000s; however, similarly to previous results, a decrease in persistence before the Subprime crisis suggests an efficient monetary policy at this period. There was a significant increase during the Subprime crisis, with different significant deviations after this crisis period. Finally, we use seasonal dummies instead of seasonally-adjusted series in our model in equations from (2) to (6) to check the robustness of our results. Figure 6 shows this robustness check for inflation persistence, whose temporal evolution maintains the main characteristics of previous estimates. Inflation persistence has decreased since implementing inflation targeting with a relatively stable period before the Subprime crisis. Nevertheless, there are significant deviations in inflation persistence after this crisis period. Note that in this case, we have more significant decreases than in previous exercises. Therefore, the robustness checks presented here support a change in the evolution of inflation persistence after the Subprime crisis, suggesting deep effects on the Chilean monetary policy since this crisis period.

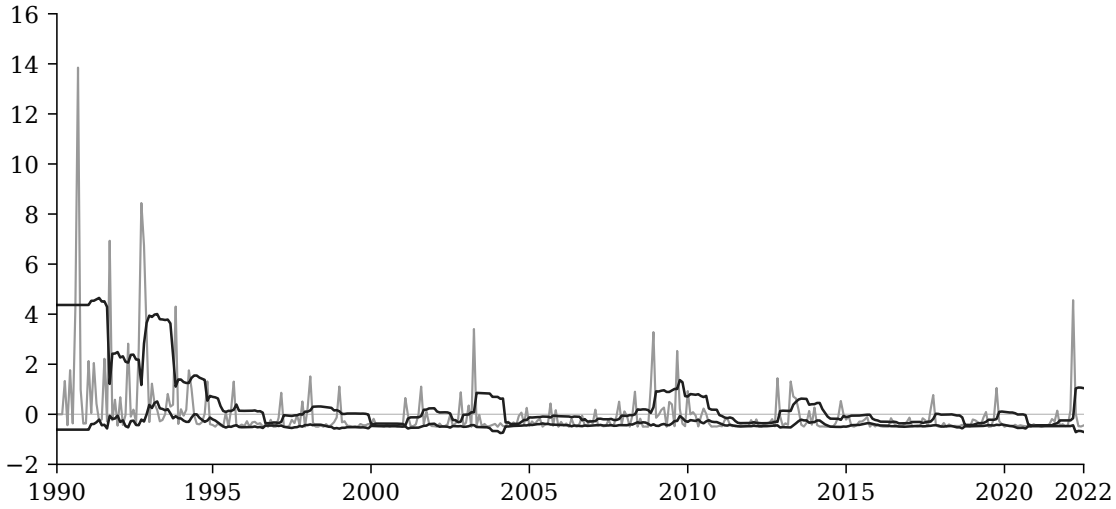
[4]We use an ARIMA (1,0,1)x(1,1,0) for monthly CPI data from 1928:03 to 2022:07 by following the Box and Jenkins methodology (see Box et al., 2015).

Figure 4: Chilean inflation persistence subsample estimates



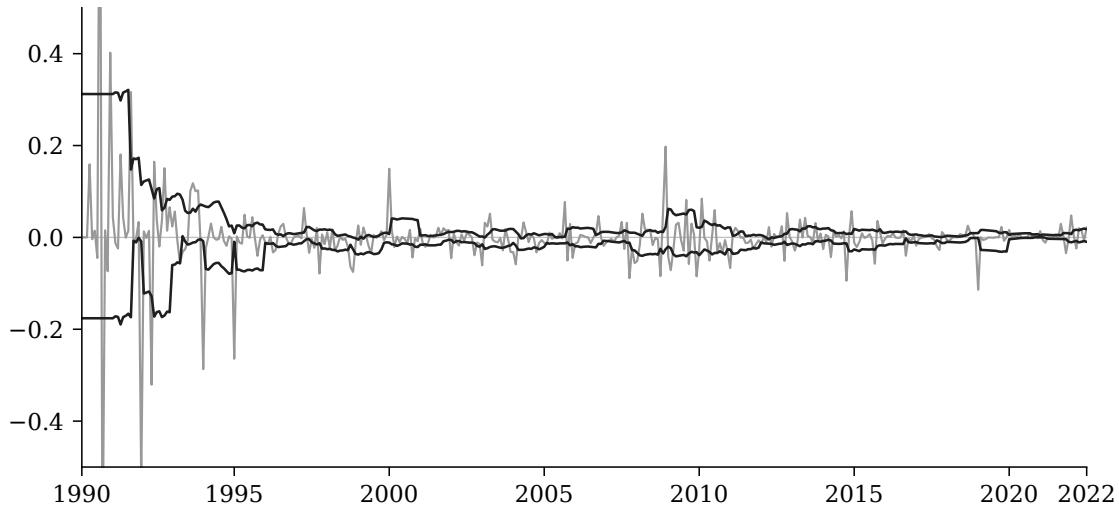
Note: Black lines represent the confidence interval at the 95%.
Source: Authors' estimations.

Figure 5: Chilean inflation persistence using ARIMA forecasts



Note: Black lines represent the confidence interval at the 95%.
Source: Authors' estimations.

Figure 6: Chilean inflation persistence using seasonal dummies



Note: Black lines represent the confidence interval at the 95%.
Source: Authors' estimations.

5 Conclusions

We study inflation persistence in Chile to assess the ability of inflation targeting to control inflation from January 1990 to July 2022. Using a Phillips-curve specification for the Chilean economy, we reject the null hypothesis of parameter stability. Thus, we use a time-varying specification to estimate the evolution of the inflation persistence during our sample period. Our results show that inflation targeting has efficiently decreased inflation persistence since the beginning of its implementation. Despite the Asian crisis introducing instability in inflation persistence, suggesting a loss of control over inflation during this crisis period, inflation persistence decreased after this shock. This evidence shows that inflation targeting efficiently controlled inflation after the Asian crisis. The Subprime crisis, on the other hand, also introduced significant instability in inflation persistence; however, its effects on inflation instability seem to be long-lasting compared to the Asian crisis. This result suggests that the Subprime crisis had deep consequences on inflation persistence which has decreased the ability of the Chilean monetary policy to control inflation.

Our results have a policy implication for policymakers. The monetary authority should

be aware that the efficiency of inflation targeting has decreased after the Subprime crisis, and then its causes should be studied in detail to recover the stability of inflation persistence before this crisis. This implies that inflation targeting should be complemented with additional actions once the causes behind the loss of efficiency of inflation targeting can be clarified. In this context, the ability of inflation targeting could be overestimated, which could bring consequences to the Chilean economy (or other similar emerging economies). For instance, interest rate increases could not have expected results on inflation as before the Subprime crisis resulting in an economy with excessively high-interest rates and the adverse effects that action can have on the economy.

The result obtained in this paper opens the door for studying the cause behind why the Subprime crisis (or similar shocks) had a significant impact on the ability of inflation targeting to control inflation. Similarly, studying the characteristics of the Chilean economy in its experience using inflation targeting can help to understand the consequences of the Subprime crisis on inflation persistence. For instance, a flexible exchange rate regime (Buffie et al., 2018), macroeconomic policies focused on specific economic sectors such as the banking sector (Kim and Mehrotra, 2018), or food price shocks (Gelos and Ustygova, 2017) have been signaled as a source of risk for inflation targeting; however, there can be different causes explaining the results of this paper which need to be investigated. This topic is a future line of research proposed by the findings of this paper.

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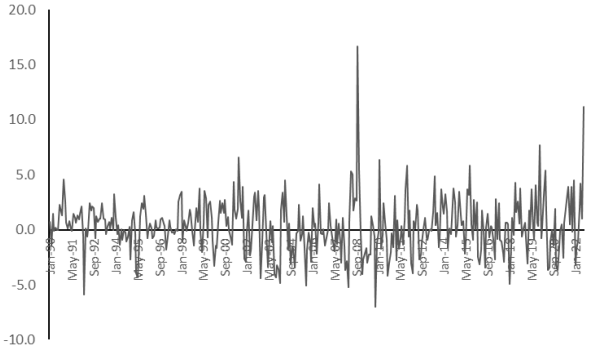
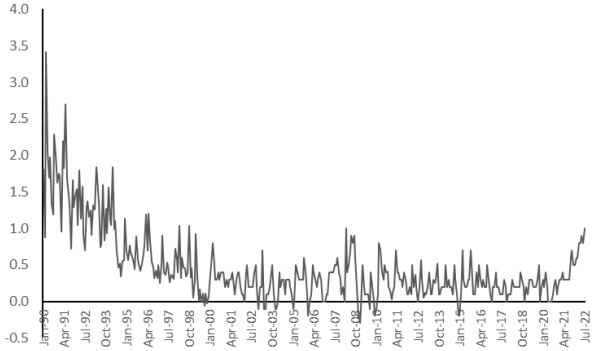
A Data

Nominal exchange rate



Inflation expectations



Notes: Nominal exchange rate and inflation expectations corresponds to the annual growth rate and the monthly growth rate, respectively.
Source: Own computation with data retrieved from the Central Bank of Chile.