# Interventions and Inflation Expectations in an Inflation Targeting Economy*

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**Abstract**

In this paper we explore the role that exchange rate interventions may play in determining inflation expectations in Chile. To that end, we consider a set of nine deciles of inflation expectations coming from the survey of professional forecasters carried out by the Central Bank of Chile. We consider two episodes of preannounced central bank interventions during the sample period 2007-2012. Our results indicate, on the one hand, that the intervention program carried out in 2008 had a significant, but relatively short lived, impact on the distribution of inflation expectations at long horizons. On the other hand, the intervention carried out in 2011 shows no relevant impact on the distribution of inflation expectations in Chile.

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**Key Words:** Exchange Rates, Inflation Expectations, Inflation Targeting, Interventions.

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# 1. Introduction

During 1999 Chile announces the adoption of a full fledge inflation targeting regime. Accordingly, a floating regime for the Chilean peso is also adopted. Nevertheless, The Central Bank of Chile also announces that exchange rate interventions may occur if exceptional circumstances justify them. A natural question to analyze is: Are exceptional interventions in conflict with an inflation target? Is the anchorage of inflation expectations in danger when interventions occur? In this paper we address these two questions by analyzing whether the amount of interventions Granger-cause the distribution of inflation expectations.

We consider two episodes of preannounced central bank interventions during the sample period 2007-2012. Our results indicate that the intervention program carried out in 2008 had a significant, but relatively short lived, impact on the distribution of inflation expectations at long horizons. In sharp contrast, the intervention carried out in 2011 shows no relevant impact on the distribution of inflation expectations in Chile.

In the last few decades, an important number of emerging economies have adopted Inflation Targeting Regimes (ITR) for conducting their monetary policy. According to Mishkin (2000), several conditions are required for the adoption of such schemes. In particular, a purely floating exchange rate regime is needed. This is a critical, or at the very least, controversial condition for emerging economies which have a long tradition of using explicit or implicit exchange rate targets aimed at either achieving a low and stable inflation or at improving the competitiveness of their economy. In this regard, in many cases the transition toward a full fledge inflation targeting regime has been a little impure at times, provided that exchange rate interventions have occurred with some frequency.

If we take seriously the well known impossible trinity, small open economies implementing a full fledge inflation targeting regime should refrain themselves from their attempts to explicitly intervene the foreign exchange market. In this context, interventions should be useless and furthermore they might interfere with the inflation target and put in danger the key role that inflation expectations play in this monetary system.

Beyond any theoretical argument, in practice small open economies implementing inflation targeting regimes do occasionally intervene the exchange rate market. The effectiveness of these interventions is subject of current debate and the empirical evidence provides mixed results. Irrespective of how effective interventions may be, they could have the collateral effect of an impact on the distribution of inflation expectations. This is so mainly for two reasons. First, if as a consequence of an intervention there is a shift in the level of the exchange rate, imported inflation will be affected and inflation expectations should reflect this impact. Second, if the intervention is perceived as a policy reaction that is in conflict with the inflationary target, then the monetary authority might loose credibility and inflation expectations might become more reluctant to respond to the actions of a central bank.[*] Important is to say that even if interventions are sterilized these two channels will be present.

The rest of the article is organized as follows. Section two presents a short literature review and a description of the Central Bank of Chile track of interventions. In section three we present our empirical approach and our results. Section four concludes.

[*]It is important to point out that some interventions programs may be perceived as consistent with the inflationary target, so we should not expect any consequence on inflation expectations in this case. It is only when the market perceives that an intervention program is in a conflict with the inflationary target that this channel will be present.

## 2. Brief Literature Review and Interventions in Chile

Most of the empirical literature analyzing exchange rate interventions focus on the impact that these interventions may have on the level of the exchange rate, its volatility or some measures of liquidity, see for instance Tapia and Tokman (2003) and Berganza and Broto (2012). Irrespective of the effectiveness of the intervention in achieving the preannounced goal, the intervention itself may induce some collateral effects on others variables in the economy. For instance, Canales et al (2006) point out that interventions may affect order flow, risk premiums and expectations. Interestingly, even if the intervention fails to create a desired impact on a given variable, it may generate an undesired side effect on another variable. This is extremely relevant in inflation targeting countries because exchange rate interventions "...runs the risk of transforming the exchange rate into a nominal anchor for monetary policy that takes precedence over the inflation target, at least in the eyes of the public" Mishkin (2000). An interesting analysis of interventions in an inflation targeting economy is found in Kamil (2008). He points out that policymakers in many emerging inflation targeting economies are attempting to resist currency appreciation while simultaneously trying to meet their inflation targets. Analyzing the case of Colombia, Kamil (2008) finds that exchange rate interventions were effective during the period 2004-2006, when foreign currency purchases were undertaken during a period of monetary easing. In 2007, however, he founds that interventions were ineffective in slowing down the domestic currency appreciation, as large-scale interventions became incompatible with meeting the inflation target in an overheating economy. In a related article, Ades et al (2002) focus on the possibility that interventions may be considered excessive by the public. The point here is that if interventions are not clearly justified, they could threaten the inflation

target as people may construct the belief that the implicit target of the central bank is different from the one explicitly announced. In the particular case of Chile, Ades et al (2002) find that interventions have not been excessive, as they were aimed to prevent deviations of the exchange rate from its long run equilibrium value, while in other countries, central banks seem to have intervened to any fluctuation of the exchange rate. In a similar line of thinking, we will try to explore whether the amount of preannounced central bank interventions Granger-cause the distribution of inflation expectations and therefore erode the inflationary target. Before moving to the empirical exercises, in the next subsection we provide a brief description of the exchange rate interventions carried out by the Central Bank of Chile since the year 2000.

## 2.1. Interventions in Chile

The inflation targeting regime in Chile was adopted in 1990 in a gradually way because, as Schmidt-Hebbel and Werner (2002) point out, the Central Bank also pursued an exchange rate target between 1984 and 1999, although the inflation target was dominant in Chile's dual nominal anchor system.

In 1999 this scheme was tightened up, when Chile adopts a floating regime for the exchange rate. In this new scenario, the Central Bank reserved the right to intervene the foreign exchange market in exceptional circumstances of excessive depreciation or appreciation of the local currency, which could have potentially negative effects for the economy.[**]

Since 2000, the Central Bank of Chile has intervened the exchange market in four occasions.

[**] As mentioned by De Gregorio and Tokman (2004), the implementation of the free floating scheme was a reasonable thing to do, because the existence of two nominal anchors, inflation and exchange rate, eroded the credibility of the inflation-targeting regime, and undermined its effectiveness.

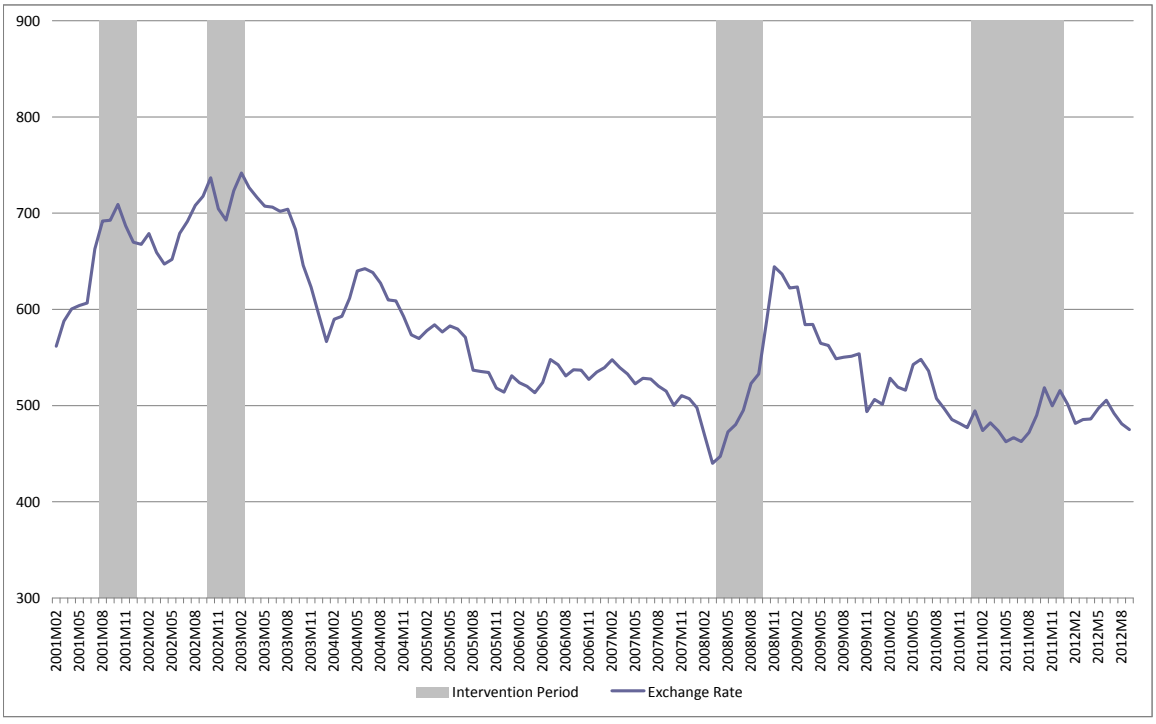
The first two interventions were carried out in 2001 and 2002 and shared several features in common. First, these two interventions were preannounced by a public press release. Second, they were justified on the grounds of a perceived overreaction of the market to the worsening international conditions. Third, they were implemented in the context of an important depreciation of the domestic currency against the American dollar. Fourth, both interventions were characterized by a mixed of two measures: An increase in the supply of Indexed Bonds in Dollars by an amount that could not exceed U.S.$ 2,000 million and the announcement that a total amount of U.S.$ 2,000 million in reserves could potentially be used in direct sales to the market in the upcoming four months. No specific scheduled was settled for any of these two operations, however. Interestingly, the actual amount of direct sales of dollars during the 2002 intervention was exactly zero.

The interventions of 2008 and 2011 were performed in a very different way. Even though they were also announced in advance, they were justified on the grounds of the benefit that an accumulation of international reserves could bring to the country in circumstances of international financial turmoil. These two interventions were also carried out in a context of an appreciating domestic currency and were implemented via direct purchases of dollars only. In particular, in April 2008, the Central Bank argued that an increase in the level of international reserves would allow to better cope with the possibility of a worsening of the international conditions. In that occasion, the exact mechanism adopted was to increase the level of international reserves by the amount of US$ 8,000 million through daily dollar purchases of US$ 50 million that would span the period from Monday, April 14 to December 12, 2008. Similarly, in January 2011, the Central Bank announced another program of accumulation of reserves with the same basic ob-

jective of being better prepared to face the event of a significant deterioration in the external environment. This time, the basic plan was to acquire a total of U.S.$ 12,000 million during the year 2011 by daily dollar purchases of US$50 million from January 5 to December 2011. While the last intervention in 2011 was carried out as planned, the intervention in 2008 was stopped in September 29, 2008 when only 70 % of the preannounced accumulation of reserves was actually acquired.[***]

Figure 1 displays the evolution of the Chilean peso/dollar exchange rate in the last twelve years. Intervention periods are depicted by four shaded bars.

Figure1: Exchange Rate and Foreign Exchange Intervention Periods




In the next section we will show some empirical exercises aimed at determining a predictive relationship between exchange rate interventions and the distribution of inflation expectations.

[***]It is worth noticing that all the four interventions mentioned in this paper were sterilized to avoid undesired inflationary effects.

# 3. The Empirical Approach

We engage in three different exercises to analyze the relationship between exchange rate interventions in Chile and the distribution of inflation expectations. The first two exercises make use of monthly data for Chilean CPI, monthly amount of dollar purchases carried out by the Central Bank of Chile, a set of covariates and nine deciles of inflation expectations at one, twelve and twenty four months ahead. These deciles are obtained from the Survey of Professional Forecasters (SPF) carried out by the Central Bank of Chile at a monthly basis. While only the 1st, 9th and 5th deciles are publicly available, we make use of all the nine deciles for our analysis.

The third exercise is carried out using daily data of break-even inflation rate as a proxy for inflation expectations. This exercise is carried out to analyze the role that the announcements may have in affecting expectations. At a monthly basis it is hard to detect any impact from the announcements, but we expect better results at a higher frequency. Therefore we also consider an announcement variable which is nothing but an indicator function taking the value of 1 if an announcement of dollar purchases is released, a value of -1 if an announcement of dollar sales is released, and a value of 0 otherwise.

For the first two exercises we consider the period from July 2007 to September 2012. For the daily exercise, we consider the period from January 25 2005 to February 2 2012. We explicitly exclude the interventions carried out in 2001 and 2002 because they are very different from the interventions in 2008 and 2011 and also, in the high frequency analysis, for data availability.

In the next subsections we describe the methodology and results of our exercises.

## 3.1. Seemingly Unrelated Approach

We are interested in the following joint system of equations:

$$\Delta\left[\pi_{ti}^{e}(h)\right]=\delta_{it}\Delta\left[\pi_{ti-1}^{e}(h)\right]+\Delta X_{t-1}^{'}\beta_{ih}+\gamma_{ih}\Delta M_{t-1}+\Phi_{ih}(B)\varepsilon_{it}\ ,\ i=1,.,9 \tag{1}$$

where

$$\begin{array}{rcl}\pi_{it}^{e}(h) & : & \text{Inflation expectations decile } i\ \in\{1,...,9\} \text{ at time } t \\ & & \text{for horizon } t+h \\ M_{t-1} & : & \text{Monthly Interventions in billions of US dollars} \\ X_{t-1}^{'} & : & \text{Covariates} \\ \Phi_{ih}(B) & : & \text{Autorregresive operator} \\ \Delta & : & \text{Differencing operator} \\ (\varepsilon_{1t},...,\varepsilon_{9t}) & : & \text{White noise vector process with variance } \Sigma\end{array}$$

These equations are estimated in differences because the inflation expectation deciles may be extremely persistent. This may pose a problem in a regression with a small number of observations. Figure 2 below shows the median of inflation expectations at 1, 12 and 24 months ahead. This figure shows that inflation expectations at longer horizons are quite persistent. This feature is also shared by other deciles of inflation expectations 2 years ahead, as shown in Figure 3. Figure 4 shows that when taking first differences, the reduction in the persistence of inflation expectations is important, at least for expectations 1 and 12 months ahead.

It is also worth noticing that the disagreement between the different analysts of the SPF is also important as shown in Figure 5. In this picture we plot the difference between the ninth and first decile of inflation expectations. The gap shown in this picture is, at times, substantial.

We estimate the system of nine equations in (1) using a seemingly unrelated approach. Therefore the possible high correlation between the different expectations deciles is explicitly taken into consideration to get more precise estimates of the parameters.

Given the reduced number of observations in our analysis, we consider a relatively low number of covariates. Basically we select those variables that, in our opinion, are the most relevant to describe the evolution of inflation expectations. We use: Chilean year-on-year CPI inflation, monthly average of the Federal Reserve Funds rate, monthly average of the Dow Jones index, monthly World Bank Commodities Index (WBCI) and the projection of the nominal Chilean exchange rate on the CBOE volatility Index (VIX) and the WBCI. To construct this last variable we simply estimate the following regression by OLS:

$$\Delta ER_t = c_0 + c_1 \Delta(VIX_t) + c_2 \Delta(WBCI_t) + u_t$$

and use

$$ERP_t \equiv \widehat{c}_0 + \widehat{c}_1 \Delta(VIX_t) + \widehat{c}_2 \Delta(WBCI_t) \tag{2}$$

as the last covariate in (1).

It is also important to point out that inflation expectations are also expressed in terms of year-on-year variation, so both inflation expectations and inflation are expressed in the same units.

Figure 2: Intervention Periods and Inflation Expectations, Different Horizons

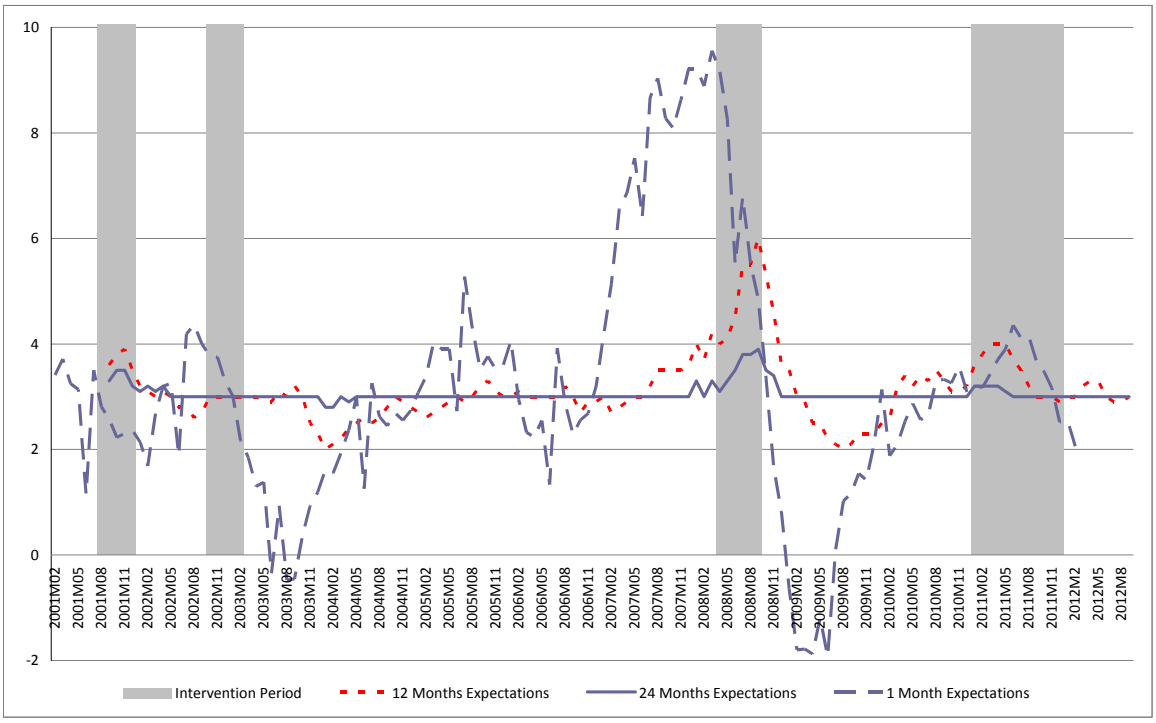



Figure 3: Inflation Expectations by Decile, 2 Years Ahead

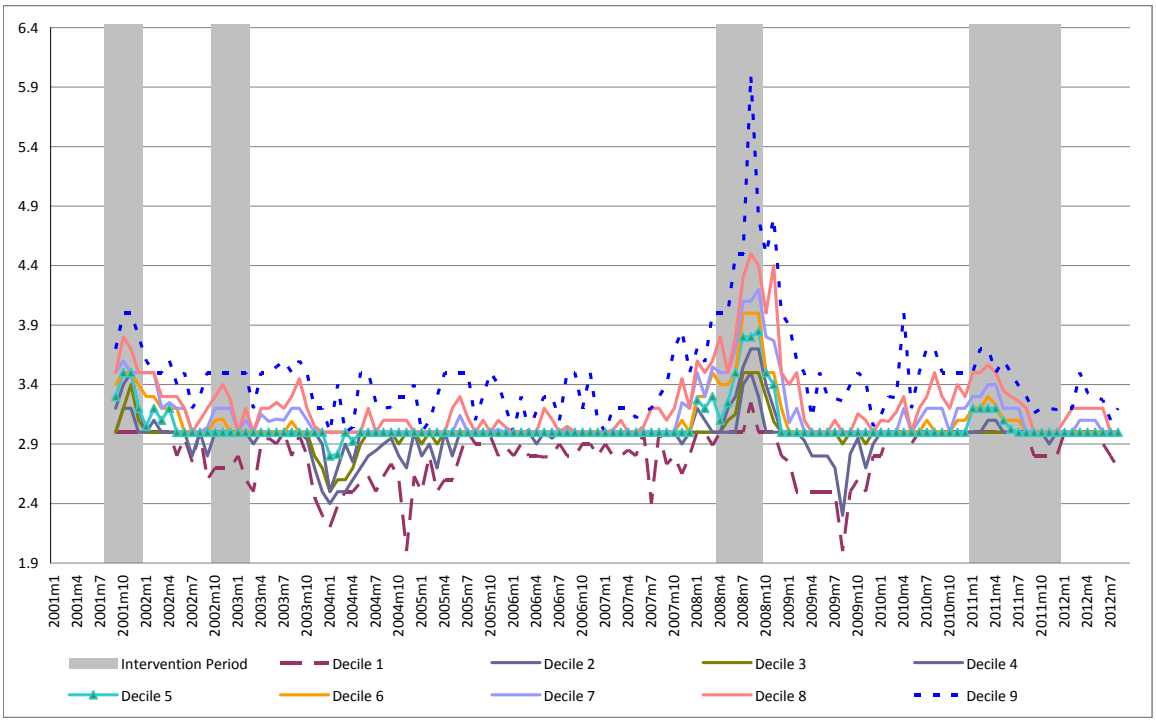


Figure 4: Intervention Periods and Differences of Inflation Expectations

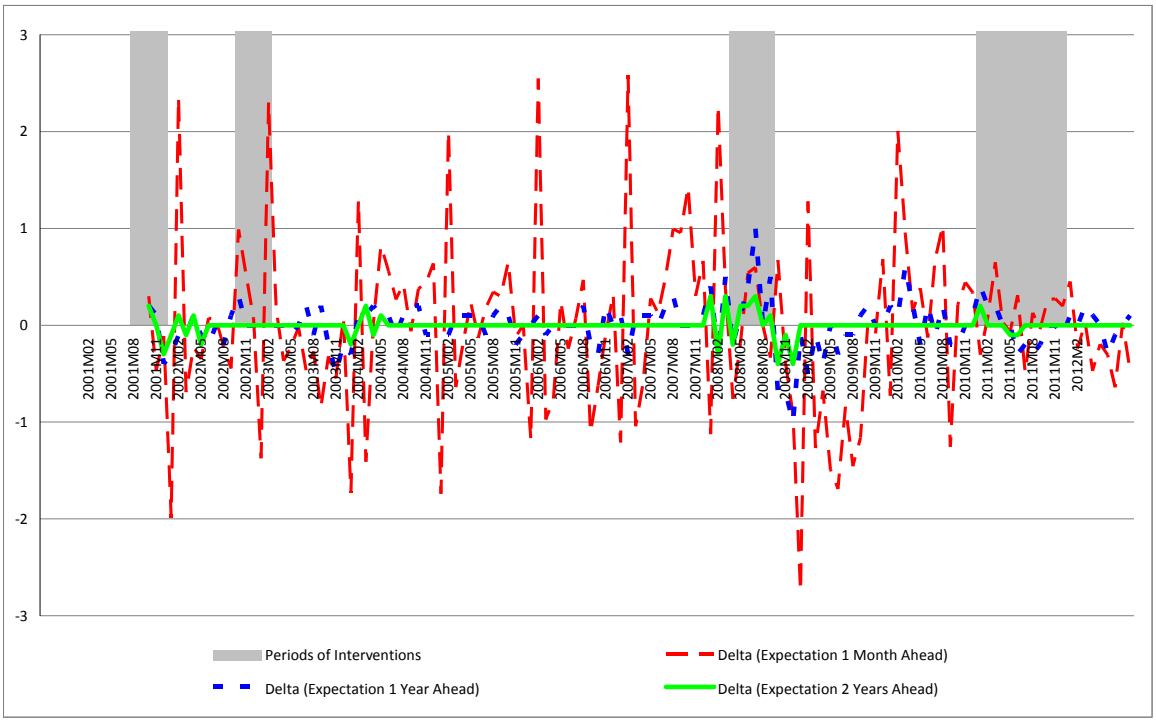
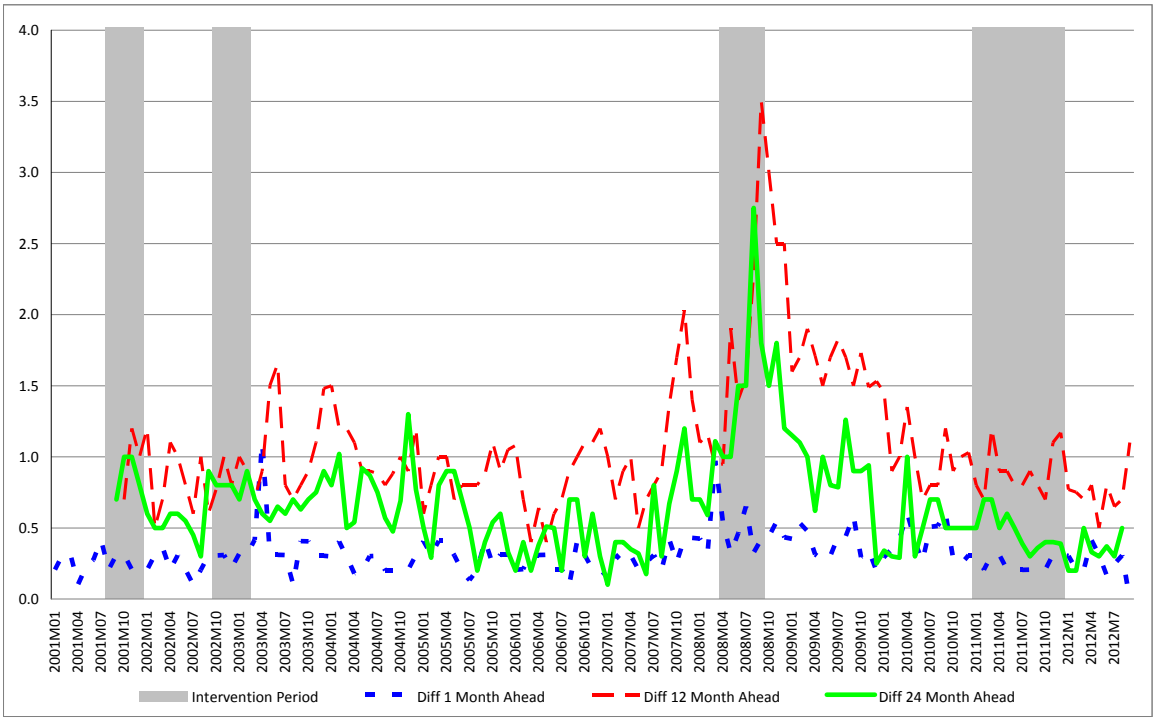



Figure 5: Spread in inflation expectations: Decile 9 - Decile 1




Tables 1-3 below show the results of the estimation of (1). In these tables we report the

$\gamma$ coefficient associated to the intervention variable. We also report its t-statistic, its p-value (Prob) and the $R^2$ of the corresponding equation. Table 1 shows that the amount of interventions do not Granger cause inflation expectations 1 month ahead. In fact, not a single decile seems to be determined by the amount of the intervention.

Table 1: The Intervention Impact on the Distribution of Inflation Expectations ($\gamma_{i1}$)
Granger Causality Analysis with SUR, Expectations 1 Month Ahead

| Dep Variable | Coefficient | Std. Error | t-Statistic | **Prob.** | R2 |
|---|---|---|---|---|---|
| Decile 1 | 0.072 | 0.290 | 0.250 | **0.804** | 0.501 |
| Decile 2 | 0.032 | 0.298 | 0.109 | **0.914** | 0.490 |
| Decile 3 | 0.055 | 0.304 | 0.181 | **0.857** | 0.480 |
| Decile 4 | 0.002 | 0.307 | 0.006 | **0.995** | 0.480 |
| Decile 5 | 0.021 | 0.310 | 0.067 | **0.947** | 0.477 |
| Decile 6 | 0.014 | 0.310 | 0.046 | **0.964** | 0.471 |
| Decile 7 | 0.023 | 0.313 | 0.073 | **0.942** | 0.460 |
| Decile 8 | 0.022 | 0.312 | 0.070 | **0.944** | 0.452 |
| Decile 9 | 0.015 | 0.310 | 0.047 | **0.963** | 0.470 |

Table 2 below shows a quite different view for inflation expectations 12 months ahead as 8 out of the 9 deciles are statistically no indifferent to the amount of interventions at the 10 % level. In terms of the economic interpretation, we see coefficients that are far from negligible. For instance, for the median of inflation expectations one year ahead we obtain a coefficient of 0.313, indicating that an increment of 1 billion dollar in purchases predicts a raise of 31.3 basis points in inflation expectations one year ahead. It is interesting to remark that this impact is the highest when considering the ninth decile. In this case an increment of 1 billion dollar in purchases predicts a raise of 39.4 basis points in inflation expectations one year ahead.

Table 2: The Intervention Impact on the Distribution of Inflation Expectations
Granger Causality Analysis with SUR, Expectations 1 Year Ahead ($\gamma_{i12}$)

| Dep Variable | Coefficient | Std. Error | t-Statistic | **Prob.** | R2 |
|---|---|---|---|---|---|
| Decile 1 | 0.220 | 0.139 | 1.582 | **0.119** | 0.230 |
| Decile 2 | 0.269 | 0.138 | 1.947 | **0.056** | 0.215 |
| Decile 3 | 0.246 | 0.122 | 2.024 | **0.047** | 0.199 |
| Decile 4 | 0.254 | 0.109 | 2.326 | **0.023** | 0.331 |
| Decile 5 | 0.313 | 0.108 | 2.895 | **0.005** | 0.368 |
| Decile 6 | 0.262 | 0.102 | 2.573 | **0.013** | 0.378 |
| Decile 7 | 0.274 | 0.140 | 1.951 | **0.056** | 0.260 |
| Decile 8 | 0.295 | 0.154 | 1.914 | **0.060** | 0.337 |
| Decile 9 | 0.394 | 0.187 | 2.106 | **0.039** | 0.270 |

Table 3 below indicates that the amount of the interventions seems to have an impact on only two or three deciles of the distribution of inflation expectations 2 years ahead. In particular the impact on the median of the distribution is statistically significant with a 89 % confidence level. The economic impact is much lower than in Table 2 yet. For instance, for the median of inflation expectations we obtain a coefficient of 0.082, indicating that an increment of 1 billion dollar in purchases predicts a raise of 8.2 basis points in inflation expectations two years ahead. It is interesting to remark that this impact is the highest when considering the fourth decile. In this case an increment of 1 billion dollar in purchases predicts a raise of 9.5 basis points in inflation expectations two years ahead.

Table 3: The Intervention Impact on the Distribution of Inflation Expectations
Granger Causality Analysis with SUR, Expectations 2 Years Ahead ($\gamma_{i24}$)

| Dep Variable | Coefficient | Std. Error | t-Statistic | **Prob.** | R2 |
|---|---|---|---|---|---|
| Decile 1 | -0.053 | 0.068 | -0.775 | **0.442** | 0.184 |
| Decile 2 | 0.015 | 0.075 | 0.204 | **0.839** | 0.045 |
| Decile 3 | 0.056 | 0.031 | 1.798 | **0.077** | 0.310 |
| Decile 4 | 0.095 | 0.038 | 2.478 | **0.016** | 0.303 |
| Decile 5 | 0.082 | 0.050 | 1.648 | **0.105** | 0.257 |
| Decile 6 | -0.004 | 0.059 | -0.074 | **0.942** | 0.232 |
| Decile 7 | 0.041 | 0.070 | 0.587 | **0.560** | 0.278 |
| Decile 8 | -0.118 | 0.105 | -1.118 | **0.268** | 0.247 |
| Decile 9 | 0.076 | 0.153 | 0.499 | **0.619** | 0.258 |

Tables 1-3 display the results when estimating (1) with the full sample. Let us recall that during our sample period the Central Bank of Chile carried out two interventions programs. Accordingly, the results in tables 1-3 may be considered as an average impact of the two interventions programs. We may as well try to explore the impact of each of the programs. To that end we decompose the intervention variable in two components, the first and second intervention, so we now consider the following model

$$\Delta\left[\pi^{e}_{ti}(h)\right] = \delta_{it}\Delta\left[\pi^{e}_{ti-1}(h)\right] + \Delta X'_{t-1}\beta_{ih} + \gamma^{(1)}_{ih}\Delta M^{(1)}_{t-1} + \gamma^{(2)}_{ih}\Delta M^{(2)}_{t-1} + \Phi_{ih}(B)\varepsilon_{it}\ ,\ i = 1,.,9 \quad (3)$$

which is exactly the same as (1) with the only difference that now we have two intervention variables:

$$M^{(1)}_{t} \ : \ \text{Monthly Interventions during 2008 in billions of US dollars} \quad (4)$$

$$M^{(2)}_{t} \ : \ \text{Monthly Interventions during 2011 in billions of US dollars} \quad (5)$$

The two corresponding parameters

$$\gamma_{ih}^{(1)} \ \& \ \gamma_{ih}^{(2)}$$

will help us to decompose the impact of each intervention on the distribution of inflation expectations. Tables 4-6 next, show the results of $\gamma_{ih}^{(1)}$ in the joint estimation of the system in (3).

Table 4: The 2008 Intervention Impact on the Distribution of Inflation Expectations Granger Causality Analysis with SUR, Expectations 1 Month Ahead, ($\gamma_{i1}^{(1)}$)

| Dep Variable | Coefficient | Std. Error | t-Statistic | **Prob.** | R2 |
|---|---|---|---|---|---|
| Decile 1 | 0.373 | 0.449 | 0.830 | **0.410** | 0.505 |
| Decile 2 | 0.301 | 0.462 | 0.651 | **0.517** | 0.492 |
| Decile 3 | 0.305 | 0.471 | 0.647 | **0.520** | 0.483 |
| Decile 4 | 0.178 | 0.477 | 0.372 | **0.711** | 0.481 |
| Decile 5 | 0.205 | 0.481 | 0.426 | **0.672** | 0.479 |
| Decile 6 | 0.254 | 0.482 | 0.528 | **0.599** | 0.474 |
| Decile 7 | 0.220 | 0.486 | 0.454 | **0.652** | 0.461 |
| Decile 8 | 0.194 | 0.484 | 0.401 | **0.690** | 0.453 |
| Decile 9 | 0.189 | 0.482 | 0.392 | **0.697** | 0.471 |

Table 5: The 2008 Intervention Impact on the Distribution of Inflation Expectations Granger Causality Analysis with SUR, Expectations 12 Months Ahead, ($\gamma_{i12}^{(1)}$)

| Dep Variable | Coefficient | Std. Error | t-Statistic | **Prob.** | R2 |
|---|---|---|---|---|---|
| Decile 1 | 0.295 | 0.220 | 1.343 | **0.184** | 0.241 |
| Decile 2 | 0.253 | 0.222 | 1.138 | **0.260** | 0.204 |
| Decile 3 | 0.384 | 0.189 | 2.035 | **0.046** | 0.223 |
| Decile 4 | 0.380 | 0.170 | 2.243 | **0.029** | 0.353 |
| Decile 5 | 0.486 | 0.165 | 2.955 | **0.004** | 0.407 |
| Decile 6 | 0.442 | 0.155 | 2.845 | **0.006** | 0.418 |
| Decile 7 | 0.333 | 0.221 | 1.505 | **0.137** | 0.249 |
| Decile 8 | 0.364 | 0.243 | 1.498 | **0.139** | 0.324 |
| Decile 9 | 0.219 | 0.311 | 0.704 | **0.484** | 0.276 |

Table 6: The 2008 Intervention Impact on the Distribution of Inflation Expectations
Granger Causality Analysis with SUR, Expectations 24 Months Ahead, ($\gamma_{i24}^{(1)}$)

| Dep Variable | Coefficient | Std. Error | t-Statistic | **Prob.** | R2 |
|---|---|---|---|---|---|
| Decile 1 | -0.037 | 0.110 | -0.334 | **0.739** | 0.220 |
| Decile 2 | 0.119 | 0.125 | 0.950 | **0.346** | -0.064 |
| Decile 3 | 0.232 | 0.044 | 5.319 | **0.000** | 0.462 |
| Decile 4 | 0.350 | 0.056 | 6.195 | **0.000** | 0.400 |
| Decile 5 | 0.321 | 0.064 | 5.027 | **0.000** | 0.404 |
| Decile 6 | 0.153 | 0.088 | 1.731 | **0.089** | 0.245 |
| Decile 7 | 0.185 | 0.109 | 1.700 | **0.094** | 0.269 |
| Decile 8 | -0.215 | 0.167 | -1.289 | **0.202** | 0.292 |
| Decile 9 | 0.130 | 0.263 | 0.493 | **0.624** | 0.275 |

Tables 4-6 confirm our previous results with some subtleties. When considering expectations one month ahead Tables 1 and 4 basically provide the same information, that is to say, the interventions have no impact on the distribution of inflation expectations. We do find some meaningful discrepancies in Tables 2 and 5 yet. While Table 2 shows a statistically significant impact in almost all of the nine deciles of inflation expectations, Table 5 only shows a statistically significant impact in deciles 3, 4, 5 and 6. Interestingly, in these deciles the economic impact is higher than those reported in Table 2. In particular, the impact is the highest when considering the median of the distribution of inflation expectations. In this case an increment of 1 billion dollar in purchases predicts a raise of 48.6 basis points in inflation expectations one year ahead, which is much higher than the 31.3 basis points shown for the same decile in Table 2.

Finally when comparing Tables 3 and 6 we see important differences around the median of the distribution of inflation expectations two years ahead. Table 6 shows a much higher impact of the intervention both economically and statistically speaking. For instance, the maximum impact reported in Table 3 is less that 10 basis points whereas the maximum impact reported in Table 6 is 35 basis points.

In sharp contrast with the remarkable results reported in Tables 4-6, Tables 7-9 show figures indicating that the intervention carried out in the year 2011 did not have much effect on the distribution of inflation expectations. In fact, the only statistically significant figure reported in these tables correspond to the impact of the interventions on the ninth decile of the distribution of inflation expectations one year ahead. For the rest of the deciles and expectations horizons, no statistically significant impact is detected whatsoever.

Table 7: The 2011 Intervention Impact on the Distribution of Inflation Expectations Granger Causality Analysis with SUR, Expectations 1 Month Ahead, ($\gamma_{i1}^{(2)}$)

| Dep Variable | Coefficient | Std. Error | t-Statistic | **Prob.** | R2 |
|---|---|---|---|---|---|
| Decile 1 | -0.114 | 0.360 | -0.316 | **0.753** | 0.505 |
| Decile 2 | -0.135 | 0.371 | -0.365 | **0.716** | 0.492 |
| Decile 3 | -0.102 | 0.378 | -0.268 | **0.789** | 0.483 |
| Decile 4 | -0.112 | 0.383 | -0.292 | **0.772** | 0.481 |
| Decile 5 | -0.098 | 0.386 | -0.253 | **0.801** | 0.479 |
| Decile 6 | -0.138 | 0.386 | -0.357 | **0.723** | 0.474 |
| Decile 7 | -0.105 | 0.389 | -0.269 | **0.789** | 0.461 |
| Decile 8 | -0.090 | 0.388 | -0.231 | **0.818** | 0.453 |
| Decile 9 | -0.098 | 0.386 | -0.254 | **0.801** | 0.471 |

Table 8: The 2011 Intervention Impact on the Distribution of Inflation Expectations Granger Causality Analysis with SUR, Expectations 12 Months Ahead, ($\gamma_{i12}^{(2)}$)

| Dep Variable | Coefficient | Std. Error | t-Statistic | **Prob.** | R2 |
|---|---|---|---|---|---|
| Decile 1 | 0.161 | 0.176 | 0.917 | **0.363** | 0.241 |
| Decile 2 | 0.261 | 0.178 | 1.462 | **0.149** | 0.204 |
| Decile 3 | 0.145 | 0.150 | 0.966 | **0.338** | 0.223 |
| Decile 4 | 0.163 | 0.135 | 1.200 | **0.235** | 0.353 |
| Decile 5 | 0.185 | 0.132 | 1.404 | **0.165** | 0.407 |
| Decile 6 | 0.139 | 0.124 | 1.121 | **0.267** | 0.418 |
| Decile 7 | 0.216 | 0.174 | 1.246 | **0.217** | 0.249 |
| Decile 8 | 0.220 | 0.191 | 1.155 | **0.252** | 0.324 |
| Decile 9 | 0.417 | 0.248 | 1.682 | **0.098** | 0.276 |

Table 9: The 2011 Intervention Impact on the Distribution of Inflation Expectations
Granger Causality Analysis with SUR, Expectations 24 Months Ahead, ($\gamma_{i24}^{(2)}$)

| Dep Variable | Coefficient | Std. Error | t-Statistic | **Prob.** | R2 |
|---|---|---|---|---|---|
| Decile 1 | -0.086 | 0.088 | -0.981 | **0.331** | 0.220 |
| Decile 2 | -0.009 | 0.097 | -0.090 | **0.929** | -0.064 |
| Decile 3 | -0.017 | 0.031 | -0.535 | **0.595** | 0.462 |
| Decile 4 | 0.009 | 0.041 | 0.224 | **0.823** | 0.400 |
| Decile 5 | -0.006 | 0.049 | -0.127 | **0.899** | 0.404 |
| Decile 6 | -0.031 | 0.068 | -0.456 | **0.650** | 0.245 |
| Decile 7 | 0.007 | 0.085 | 0.077 | **0.939** | 0.269 |
| Decile 8 | -0.079 | 0.130 | -0.603 | **0.549** | 0.292 |
| Decile 9 | -0.009 | 0.200 | -0.044 | **0.965** | 0.275 |

Results in Tables 1-9 suggest that the interventions in 2008 and in 2011 had different implications over the distribution of inflation expectations. The full sample results reported in tables 1-3 are probably significant mainly as a consequence of the intervention carried out in 2008. This distinction is important as the macroeconomic conditions surrounding both interventions were very different. It is possible that the high levels of inflation preceding the 2008 intervention may have created an inappropriate environment for an intervention to take place without collateral damage.

Thus far we have investigated whether the interventions carried out in 2008 and 2011 in Chile had an impact on the distribution of inflation expectations or not. In the next section we further explore the nature on these impacts. In particular we place our attention on the duration of the impact via an impulse-response analysis.

## 3.2. Impulse-Response Analysis

Our previous analysis offers an answer to the question about the predictive power of the interventions on the distribution of inflation expectations. With tables 1-9 we have shown that interventions do have the ability to predict some changes in the distribution of inflation expectations. We now focus on the dynamic response of the distribution of inflation expectations to an intervention shock. In particular we would like to known something about the persistence of this response. To that end we estimate a reduce VAR using several endogenous and exogenous variables. Table 10 next, shows the variables that we use in our VAR specification:

Table 10
Variables Included in the VAR Analysis

| Endogenous Variables | Exogenous Variables |
|---|---|
| $\pi^e_{ti}(h)$ | $Food_t$ |
| $M_t$ | $Fed_t$ |
| $\pi_t$ | $ERP_t$ |
| | $Oil_t$ |

where

$\pi^e_{it}(h)$ : Inflation expectations decile $i \in \{1, ..., 9\}$ at time $t$ for horizon $t + h$

$M_t$ : Monthly Interventions in billions of US dollars

$\pi_t$ : Year-on-year CPI inflation rate

$Food_t$ : Year-on-year Food Price Index inflation rate

$Fed_t$ : Monthly Average of the Federal Reserve Funds rate

$ERP_t$ : Projection of the nominal Chilean exchange rate according to (2)

$Oil_t$ : Year-on-year Oil price inflation rate.

We estimate a VAR(1) with the variables in first differences just as we did with the previous exercise (SUR). We consider only a first order VAR due to our small sample size. First we run

a total of 27 VARs, one for each inflation expectation decile and horizon. Then we split the intervention variable $M_t$ into its two components $M_t^{(1)}$ and $M_t^{(2)}$ defined in (4) and (5). Then we estimate again a total of 27 VARs, one for each inflation expectation decile and horizon but replacing the intervention variable $M_t$ by its two components $M_t^{(1)}$ and $M_t^{(2)}$.

Figures 5-7 show non-orthogonalized impulse response functions and their respective 90 % confidence bands for every single inflation expectation decile when we run the VAR(1) with the intervention variable $M_t$. The shock is 1 billion of dollar purchases. These figures indicate that the impact on inflation expectations is relatively short-lived, as after a few months the response is not statistically significant at the 10 % significance level.

Figure 5: The Intervention Impact on the Distribution of Inflation Expectations
Expectations 1 Month Ahead, Full Sample

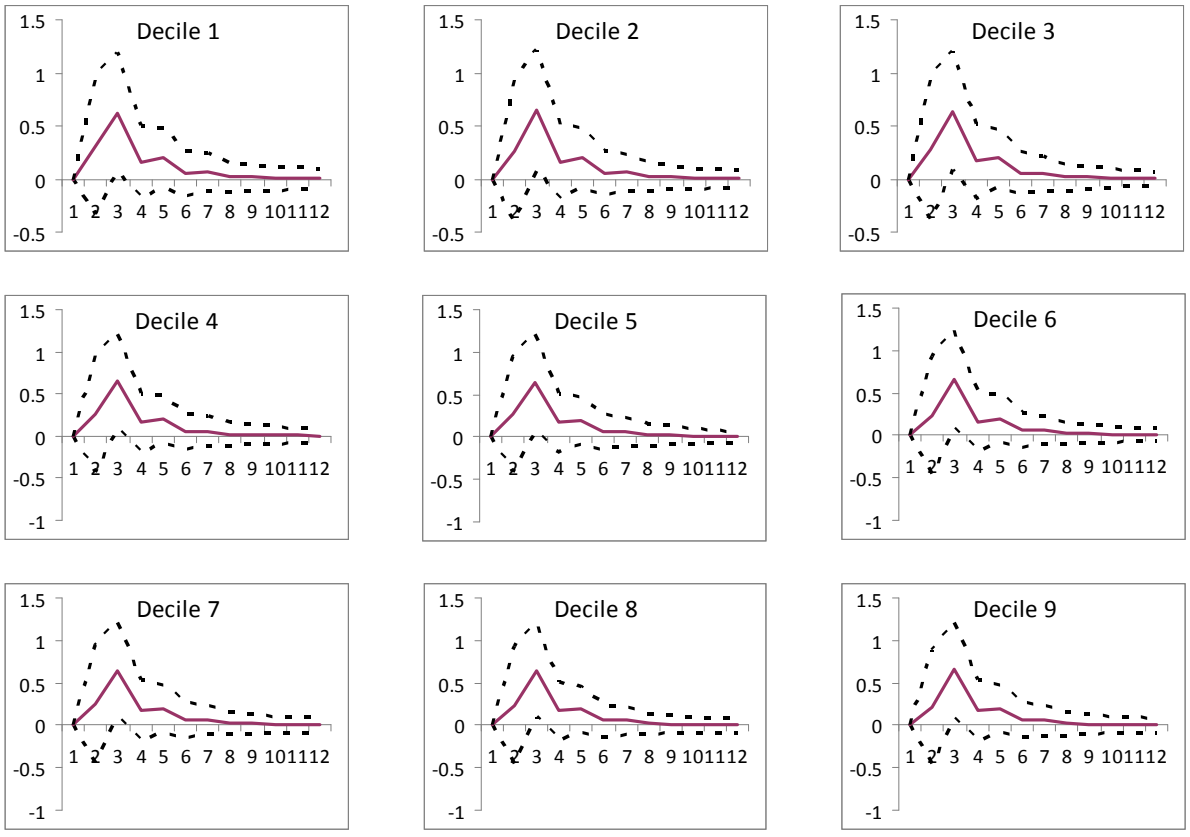


Figure 6: The Intervention Impact on the Distribution of Inflation Expectations
Expectations 12 Months Ahead, Full Sample

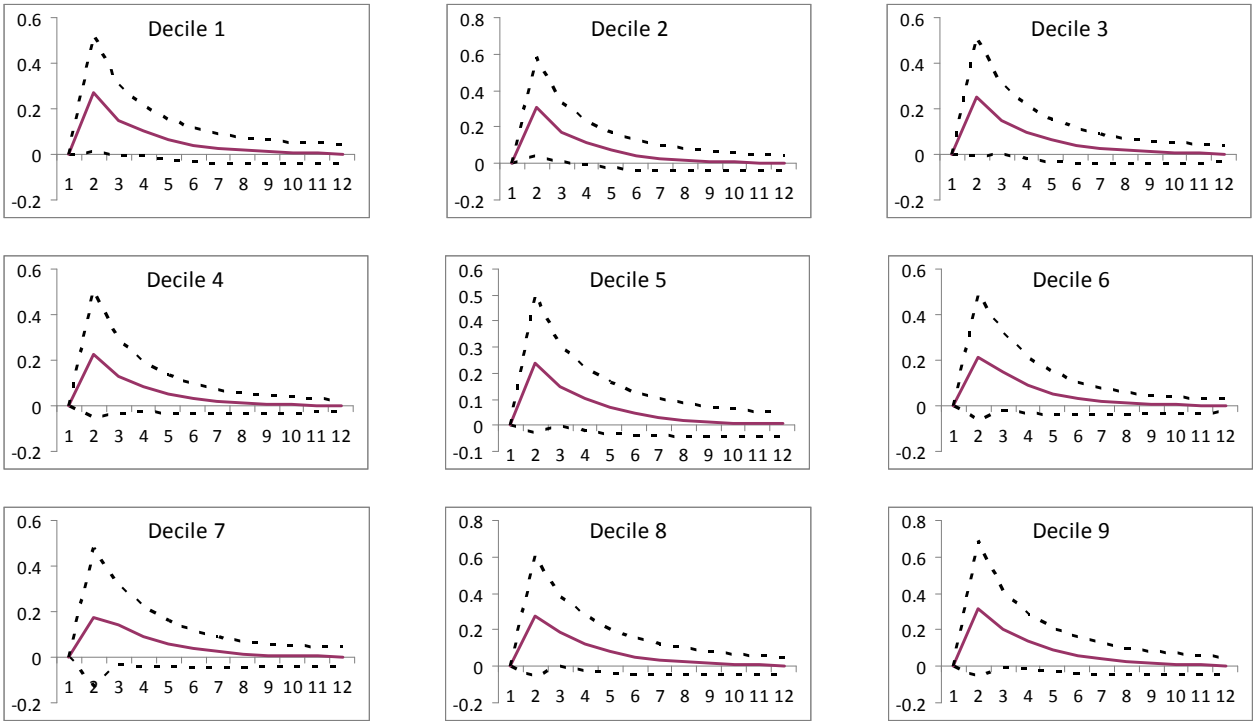
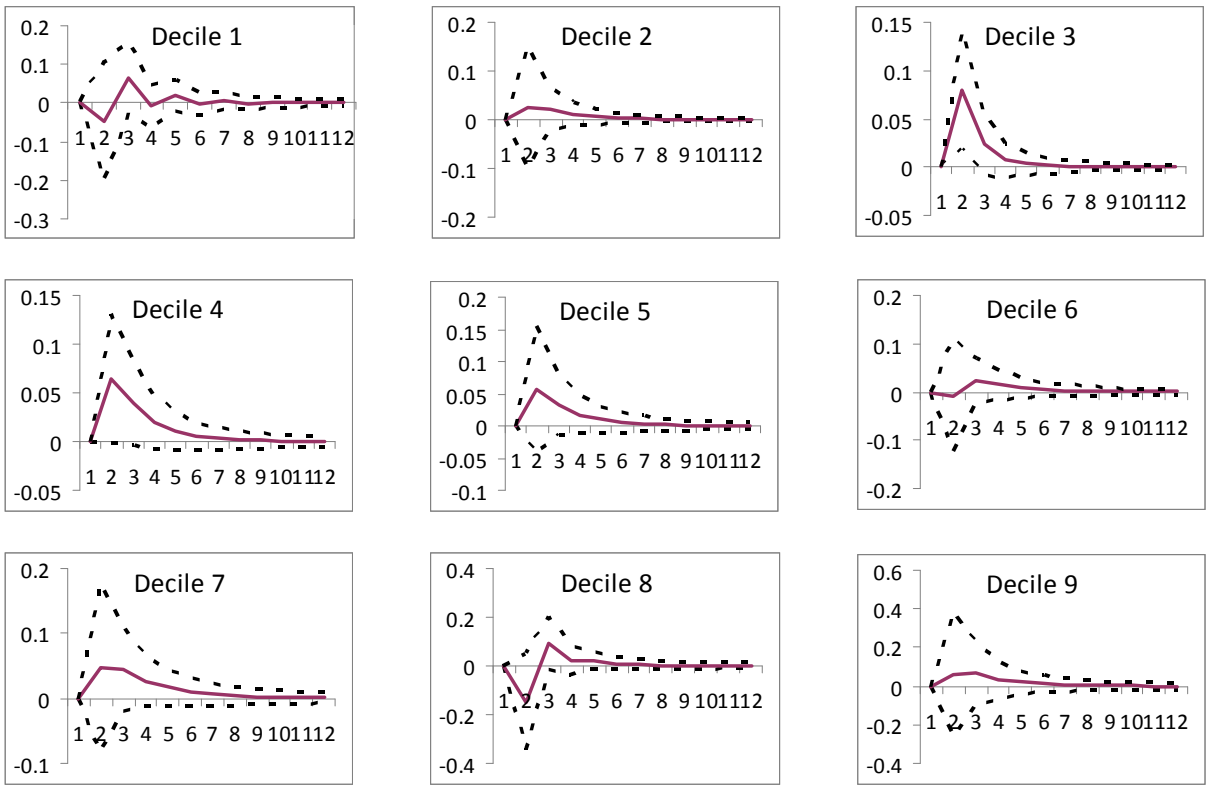



Figure 7: The Intervention Impact on the Distribution of Inflation Expectations
Expectations 24 Months Ahead, Full Sample



Figures 8-13 show non-orthogonalized impulse response functions and their respective 90 % confidence bands for every single inflation expectation decile when we split the intervention variable $M_t$ into its two components $M_t^{(1)}$ and $M_t^{(2)}$. This allows us to analyze the impact of the two intervention periods separately. Figures 8-10 show impulse-response functions after a 1 billion dollar intervention shock in 2008. Figures 11-13 show impulse-response functions after a 1 billion dollar intervention shock in 2011. While the impact of the intervention in 2008 is still reported as much higher than that of the intervention in 2011, Figures 8-10 corroborate the findings reported in Figures 5-7 as the impact on inflation expectations is relatively short-lived. Actually, after six months the response is not statistically significant at the 10 % significance level.

Figure 8: The 2008 Intervention Impact on the Distribution of Inflation Expectations

Expectations 1 Month Ahead

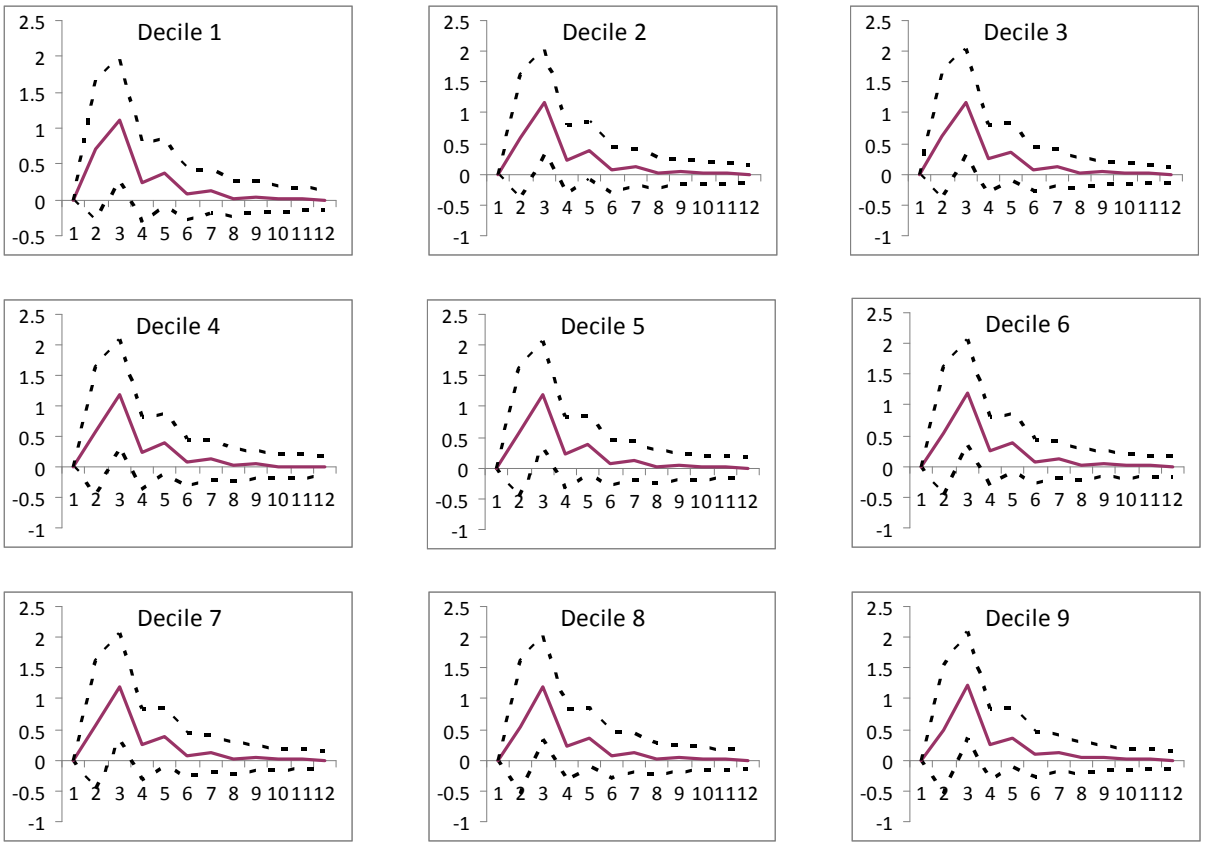


Figure 9: The 2008 Intervention Impact on the Distribution of Inflation Expectations

Expectations 12 Months Ahead

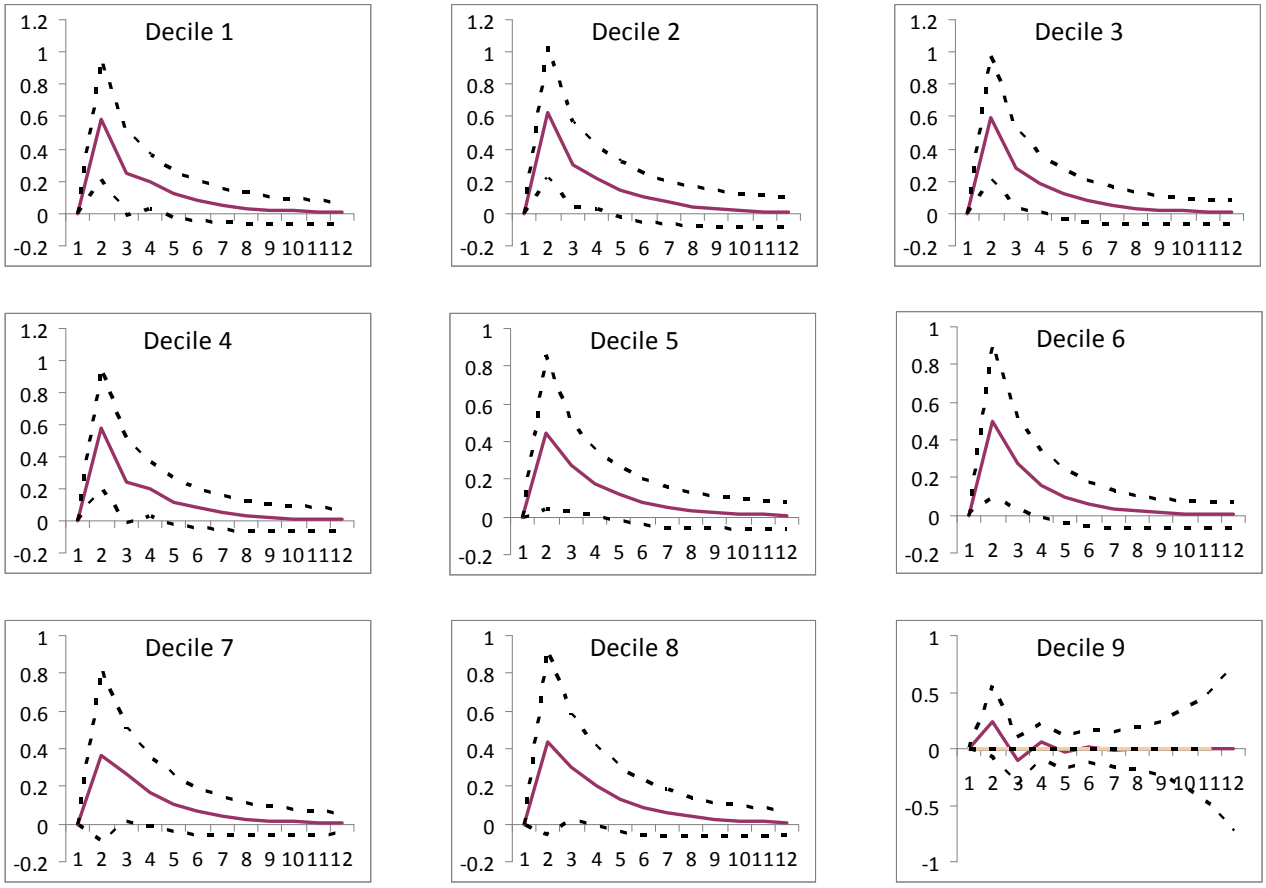


Figure 10: The 2008 Intervention Impact on the Distribution of Inflation Expectations

Expectations 24 Months Ahead

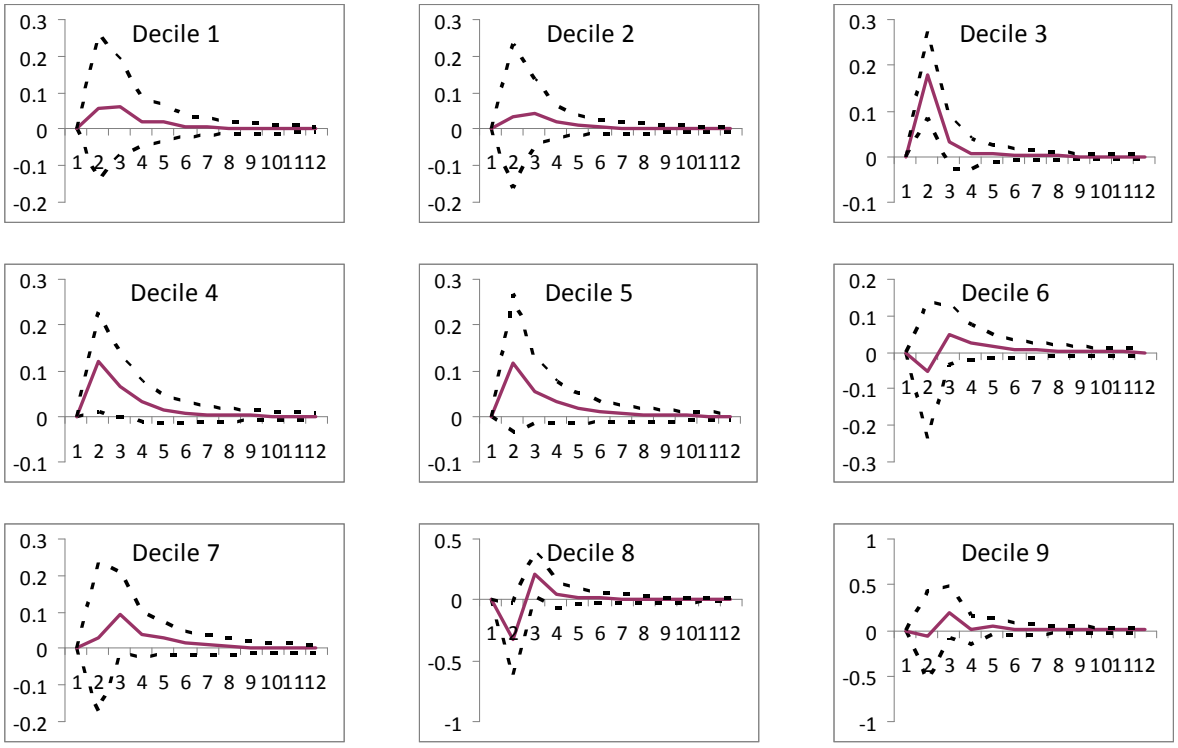


Figure 11: The 2011 Intervention Impact on the Distribution of Inflation Expectations

Expectations 1 Month Ahead

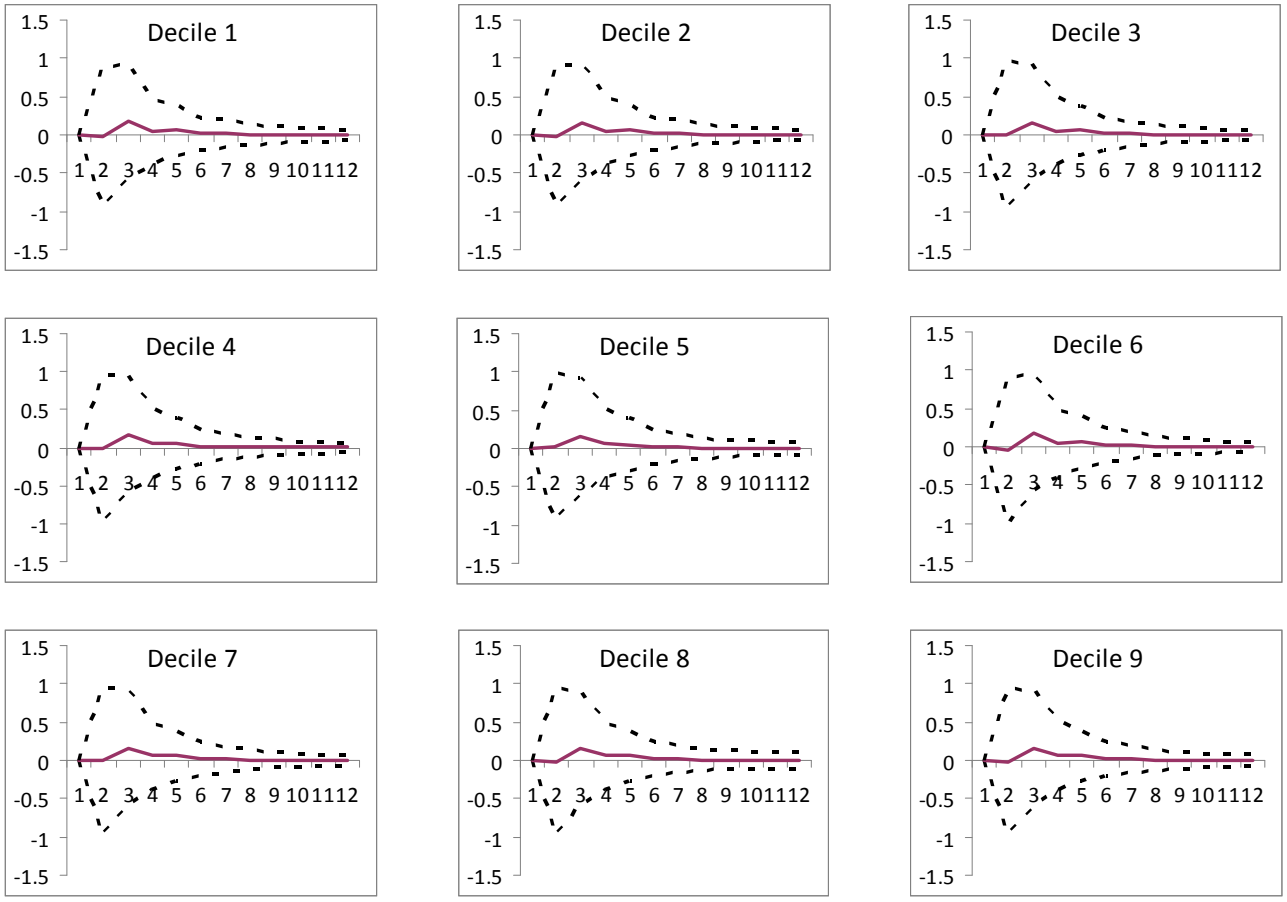


Figure 12: The 2011 Intervention Impact on the Distribution of Inflation Expectations

Expectations 12 Months Ahead

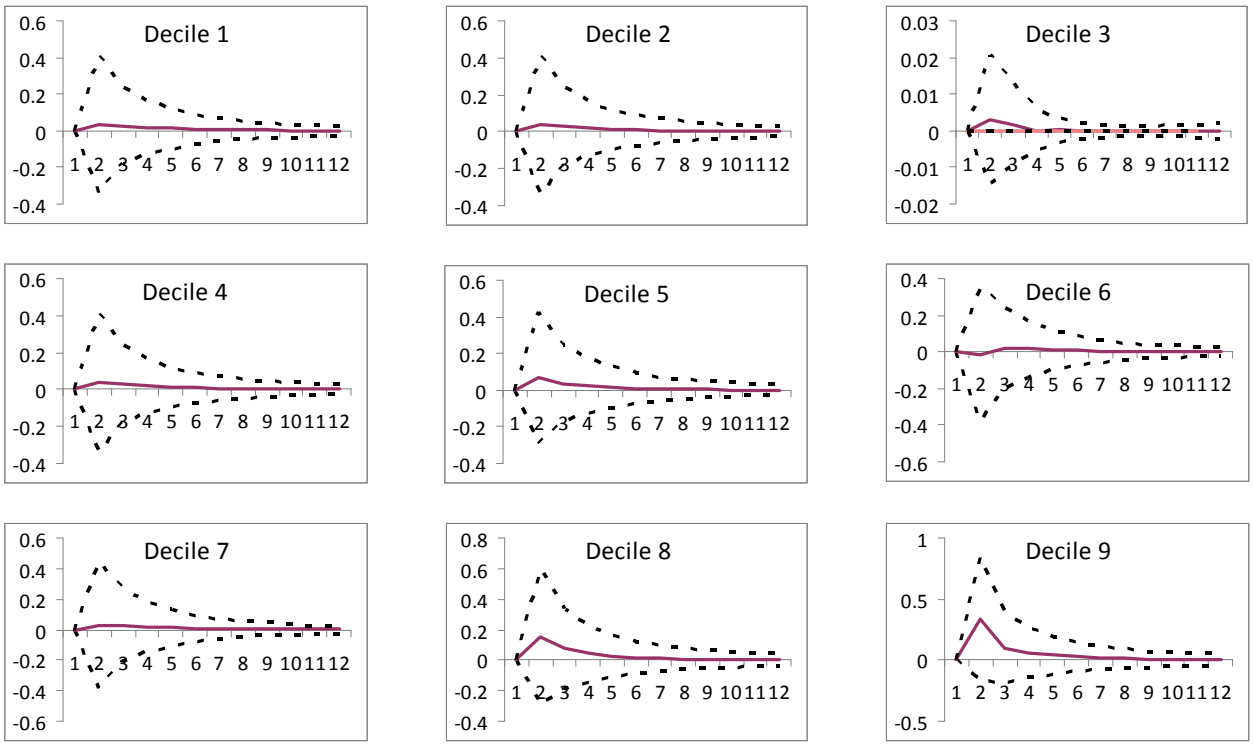
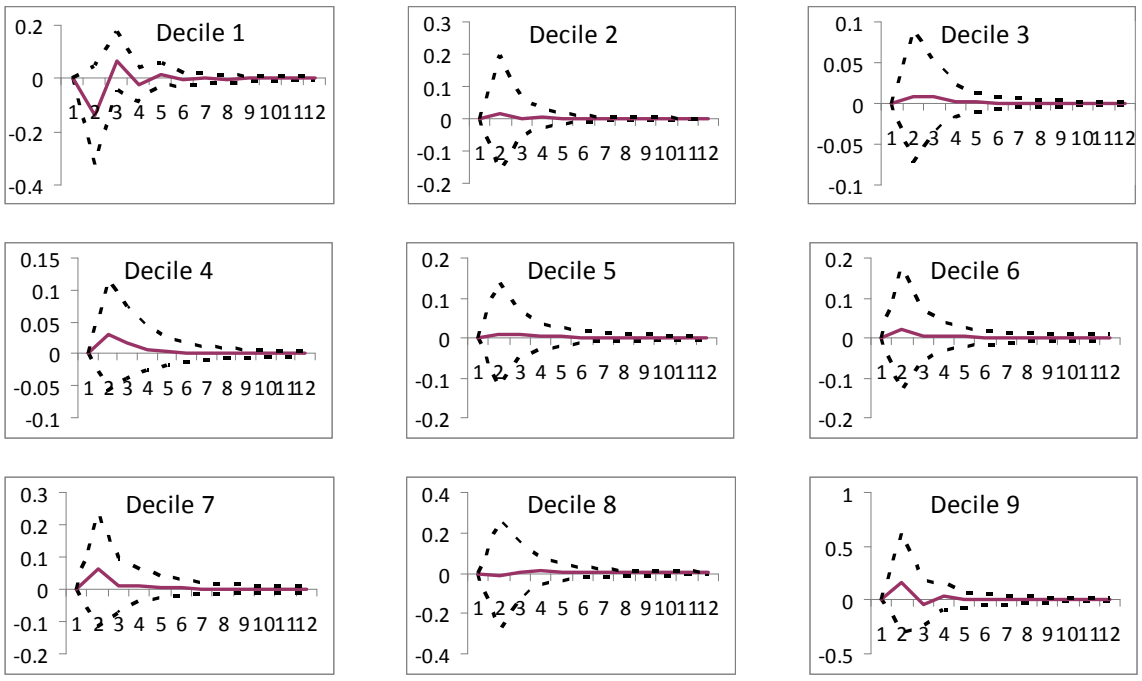


Figure 13: The 2011 Intervention Impact on the Distribution of Inflation Expectations

Expectations 24 Months Ahead




## 3.3. Daily Analysis

In this section we show some results based on daily data. We estimate the effect of exchange market interventions on a measure of break-even inflation rate. We consider a measure that should be interpreted as an expectation of the inflation that will be accumulated during one year, starting 12 months from the current period. We use this variable as a proxy of the two years ahead inflation expectations. We consider the following specification:

$$\pi_t^{b-e} = \delta + \rho_1 \pi_{t-1}^{b-e} + \rho_2 \pi_{t-2}^{b-e} + \gamma_M M_{t-1} + \gamma_D D_{t-1} + \alpha A_{t-1} + \theta \pi_{t-1}^{M} + \varepsilon_t$$

where $\pi_t^{b-e}$ is break-even inflation rate at day $t$, $M_t$ is the daily amount of intervention at day $t$ , $D_t$ is a dummy variable that takes the value of 1 if $M_t \neq 0$ or 0 otherwise, $A_t$ is a categorical

variable that captures the effect of the announcements by taking the value of 1 when the Central Bank publicly announces the beginning of a new intervention program, the value of -1 if the program is suddenly stopped in a date different than that originally planned, and 0 otherwise. The variable $\pi_t^M$ is the actual rate of inflation at month $t-1$. Finally, $\varepsilon_t$ is a white noise.

Our OLS estimations are shown in Table 11. The results show that the amount of interventions does not Granger-cause break-even inflation rate. Instead, the announcement shows an incremental effect close to 40 basis points on inflation expectations, similar in size to the effect reported in our monthly analysis. These results suggest that the mere intervention announcement tend to raise inflation expectations around 40 basis points the very next day after the announcement takes place.

Table 11: The Impact of Exchange Rate Interventions Announcements on Break-Even Inflation Rate

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| Variable | $\pi_t^{b-e}$ | $\pi_t^{b-e}$ | $\pi_t^{b-e}$ | $\pi_t^{b-e}$ | $\pi_t^{b-e}$ | $\pi_t^{b-e}$ |
| $\pi_{t-1}^{b-e}$ | 0.703** | 0.703** | 0.701** | 0.701** | 0.703** | 0.703** |
| | [16.885] | [16.866] | [16.769] | [16.754] | [16.885] | [16.866] |
| $\pi_{t-2}^{b-e}$ | 0.245** | 0.245** | 0.241** | 0.241** | 0.245** | 0.245 |
| | [5.920] | [5.912] | [5.858] | [5.854] | [5.920] | [5.912] |
| $M_{t-1}$ | 0.078 | 0.080 | 0.076 | 0.078 | - | - |
| | [1.659] | [1.710] | [1.623] | [1.676] | - | - |
| $D_{t-1}$ | - | - | - | - | 0.039 | 0.040 |
| | - | - | - | - | [1.659] | [1.710] |
| $A_{t-1}$ | - | 0.411** | - | 0.396** | - | 0.411** |
| | - | [22.326] | - | [14.927] | - | [22.326] |
| $\pi_{t-1}$ | - | - | 0.004 | 0.004 | - | - |
| | - | - | [0.779] | [0.734] | - | - |
| $\delta$ | 0.150** | 0.151** | 0.149** | 0.150** | 0.150** | 0.151** |
| | [3.535] | [3.552] | [3.454] | [3.472] | [3.535] | [3.552] |
| No. Obs. | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 |
| $R^2$ | 0.883 | 0.883 | 0.883 | 0.883 | 0.883 | 0.883 |
| Prob(F-stat) | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |

$t$-Statistics are shown in [...]. (*) (**) significative at 5 % and 1 %.

# 4. Conclusions

Exchange rate interventions are controversial for a number of reasons. Part of this controversy is related to the huge amount of resources that are typically involved. They are also controversial because it is not entirely clear if they are successful in fulfilling the implicit or explicit goal of the intervention policy and the empirical evidence provides mixed results in this respect. In the case of inflation targeting countries, there is an additional source of controversy: Irrespective of their effectiveness, interventions may have the collateral effect of an impact on the distribution of inflation expectations. This is so mainly for two reasons. First, if as a consequence of an intervention there is a shift in the level of the exchange rate, imported inflation will be affected and inflation expectations should reflect this impact. Second, if agents take seriously the impossible trinity, the inflation target may loose credibility and inflation expectations may be more reluctant to respond to the actions of the monetary authority. This may happen because it could be not entirely clear whether monetary policy actions are focused on the inflationary target or on any other target related to the level of foreign reserves or to the level or volatility of the exchange rate.

As in many small open economies with an inflation target, monetary authorities in Chile have decided to intervene the exchange rate market in four occasions since the year 2000. Using data from the last two intervention periods in Chile, we have placed our attention on the linkage between the amount of exchange rate interventions and the distribution of inflation expectations in Chile. With a multiple equation method we have found that the amount of the intervention Granger-cause several deciles of the distribution of inflation expectations at longer horizons. Notwithstanding the above, our results suggest that the interventions in 2008 and in 2011

had different implications over the distribution of inflation expectations. Whereas the impact during the intervention program in 2008 is both economically and statistically significant, the impact during the 2011 program is almost negligible. This distinction is important as the macroeconomic conditions surrounding both interventions were very different. It is possible that the high levels of inflation preceding the 2008 intervention may have created an inappropriate environment for an intervention to take place without collateral damage.

These results seem to show that the side effects of exchange rate interventions over the distribution of inflation expectations may naturally depend on the economic environment in which they are implemented. Well aware of the possible conflict between an inflationary target and forex interventions, monetary authorities in Chile have explicitly left room for occasional interventions in exceptional circumstances of excessive depreciation or appreciation of the local currency. According to our results the last intervention episodes in Chile posed no serious threat to the inflation target. Nevertheless, they also suggest that the important misalignment of the distribution of inflation expectations that happened in 2008 might be partially explained by the exchange rate intervention program carried out in that year.

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