

The evolution of inflation in Chile since 2000

by

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1 Introduction

In this note we review the evolution of inflation in Chile during the last decade and a half. We analyze it through the lenses of the New Keynesian theory. To do that, we first review evidence that support the importance for the case of Chile of the main channels put forward by this framework: the output gap, inflation expectations, indexation to past inflation and the role of the exchange rate. Based on this evidence, we then provide an interpretation of the inflation process in Chile. We show that, in general terms, the evolution of inflation could be consistently explained by the evolution of those elements. Critical in our explanation is to differentiate between the dynamics of tradable and no-tradable inflation.

This period coincides with the implementation of a full inflation targeting (IT) framework, including a free floating exchange rate and the use of the short nominal term interest rate as the unique monetary policy instrument. In the case of Chile, the IT framework's objective is to have inflation at its target of 3% most of the time, allowing for short-term deviations within a band of $\pm 1\%$. In practice, that means that the Central Bank sets the interest rate in a way consistent with an inflation forecast two years from now at 3%. The period is interesting also because it covers two significant developments in the global economy: the start and end of the so called "super cycle of commodity prices" and the Global Financial Crisis of 2008 – 09 and its aftermath.

We start by describing the evolution of inflation and its main determinants in Chile. In section 3 we briefly review the evidence on the Phillips Curve for Chile and, more generally, on the importance of the output gap, the exchange rate and inflation expectations for the inflation process. We finish this note in section 4 by providing a view of the evolution of inflation through the lenses of the evidence presented in section 3.

2 Evolution of inflation and its determinants since 2000

During a large part of the XXth Century, Chile's economic history, as in many South American, was marked by infructuous attempts to control inflation. The reasons behind

these failures are still an open debate,^{1/} but the fact is that until the second half of the 90's it is difficult to find periods with one-digit inflation. Things changed noticeably afterwards. During the last twenty years, annual inflation has not been above 10% even a single month, and most of the time it has been close to Central Bank's target. Behind this remarkable performance there are two fundamental changes. First, a coherent fiscal policy that, starting in the late 70's, eradicated systematic public sector deficits and, with the implementation and improvements of different fiscal rules, has aligned fiscal expenditures with medium term macroeconomic targets, breaking the cyclical dependence on volatile copper prices and short term economic fluctuations.^{2/} The second element is the independence granted to the Central Bank in 1989 coupled with a clear mandate to keep inflation low and stable. Since it starts in 1990, this mandate was implemented by the new autonomous central bank using some sort of numerical target for inflation. The experience was very successful, and, after ten years, inflation was reduced from above 20% to around 3% in a context of high growth and low unemployment.^{3/} In 2000 the board of the Central Bank considered that the economy was mature enough to implement a full inflation targeting regime, including a free floating exchange rate. This change, supported by the fiscal policies described above, has been the key ingredients to deal with the business cycle in Chile. In this section we describe the evolution of inflation and other relevant macro variables since the implementation of the IT regime in 2000.

Inflation

As it is shown in Table 1, since the full implementation of the inflation targeting regime in 2000, the inflation rate has been on average 3.3%, slightly above the official target of 3%. Hidden behind this average, however, there is an important degree of variability: during the last 15 years inflation has taken values between -2.3% and 9.9%, with a standard deviation of 2.1%. Compared with Advanced Economies, inflation in Chile is more volatile (see Figure 1). Nevertheless, as shown in the same figure, high volatility of inflation is common among Emerging Market Economies. Indeed, when compared with this group of economies Chile ranks among the less volatile.

Figure 2 shows the evolution of inflation since 2000. It is evident from this figure that the period between mid-2007 and 2010 is an interval of particular high volatility. This is not surprising since these years were initially marked by a significant increase in the international prices of both energy and food, and then by the contraction of those prices that followed the Global Financial Crisis. But, even if one takes these years out of the sample, it is still true that inflation has fluctuated quite a bit, ranging between -1 and 6%.

¹ An example of this debate was the intense discussion that took place during the workshop organized by the Central Bank of Chile and the Becker Friedman Institute in December of 2015. In that occasion a group of Chilean economists were invited to discuss the chapter on Chile of the forthcoming book by Timothy Kehoe and Thomas Sargent about fiscal and monetary policy in Latin America.

² Since the early 90s Gross Public debt went from 38% of GDP to less than 10% in the second half of the 2000s. Now it stands about 17% of GDP. More on fiscal policy in this period in Arellano (2005).

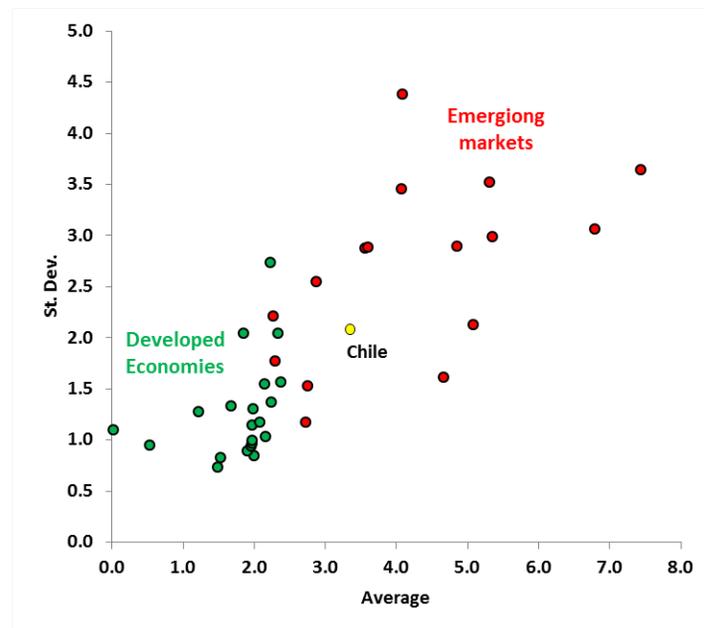
³ On the reduction of inflation in Chile see, for example, Corbo (1998) and Schmidt-Hebbel and Tapia (2002).

Table 1
Inflation summary statistics 2000 - 2015
(%)

	Headline	Core	Goods (core)	Services (core)	Food	Energy
Average	3.3	2.5	-0.2	4.3	4.8	7.0
Median	3.2	2.5	-0.1	4.4	4.3	7.6
Est. Dev.	2.1	1.5	2.3	1.5	5.1	9.5
Max	9.9	7.0	4.9	8.6	20.8	33.5
Min	-2.3	-1.6	-6.1	0.2	-3.0	-18.1

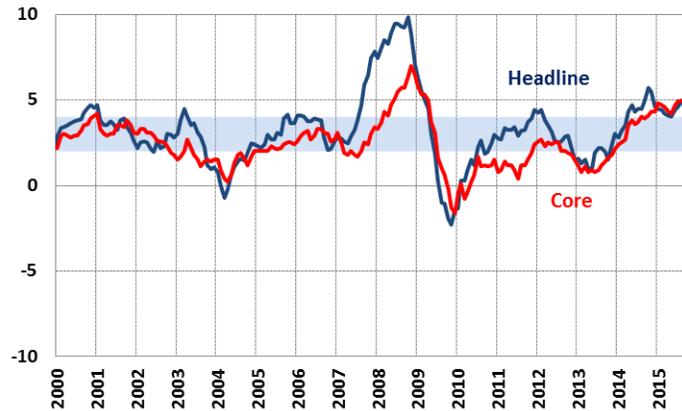
Note: Monthly data from 2000:01 – 2015:11. Core inflation excludes food and energy items and represents 72.2% of the total in the last CPI basket. Good (core) and Service (core) represent 28.6% and 43.6% of the total respectively. Food represents 19.1% and energy 8.7%.

Figure 1
Inflation average and inflation volatility
(%)



Note: The sample is monthly data from 2000:1 to 2015:11. Developed Economies includes: Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Israel, Italy, Japan, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom, and United States. Emerging Markets includes: Chile, China, Colombia, Czech Republic, Estonia, Hungary, Iceland, India, Indonesia, Korea, Latvia, Mexico, Peru, Poland, Slovak Republic, Slovenia, and South Africa.

Figure 2
Annual headline and core inflation
(%)



Note: Monthly data from 2000:01 – 2015:11. Core inflation excludes food and energy items and represents 72.2% of the total in the last CPI basket.

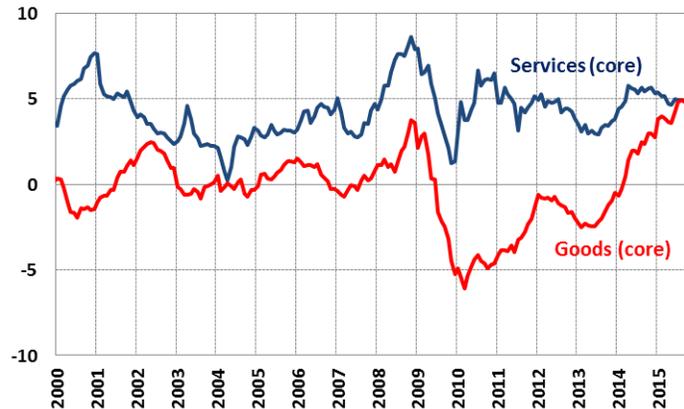
Table 2
Contribution to variance of inflation
(%)

	Core	Goods (Core)	Services (Core)	Food	Energy
Share of variance	50.3	27.6	22.8	40.5	9.2
Share of CPI basket	72.3	28.6	43.6	19.1	8.7

Note: Monthly data from 2000:1 to 2015:11. The contribution is computed using the fact that if $y = \sum x_i$, then $Var(y) = \sum Cov(y, x_i)$. The share of variance is equal to $COV(\pi_{CPI}, \pi_X) / V(\pi_{CPI})$, where X is the incidence of the element X on CPI inflation. Share of CPI basket as in 2013 basket.

Part of this variance is related to the presence of some very volatile items in the CPI basket, such as food and energy. Indeed, as shown in Table 1, the standard deviation of these items is 2 and 4 times the standard deviation of the headline inflation. Table 2 complements this point. It shows the contribution to the variance of the headline inflation of four different sets of CPI items. The table makes clear that the contribution of food and energy to the variance of inflation is larger than their respective shares in the CPI basket. In the case of food, it contributes to 40% of the variance with just 20% of the weight in the index.

Figure 3
Annual goods and services inflation
(%)



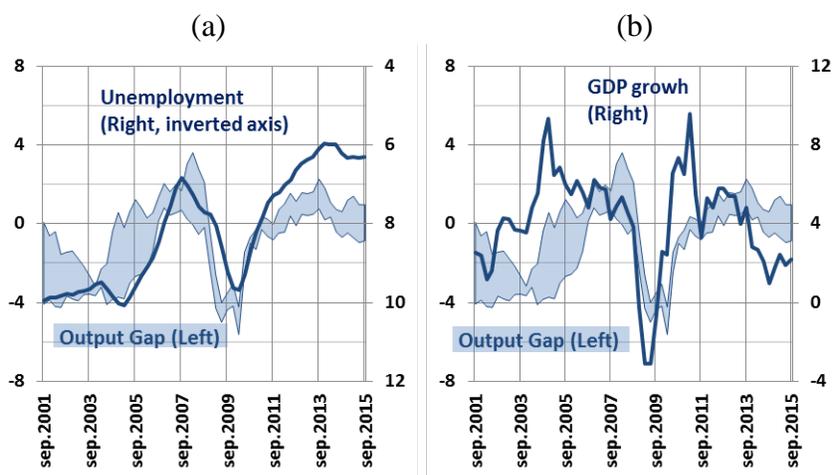
Note: Monthly data from 2000:01 – 2015:11. Good (core) and Service (core) represent 28.6% and 43.6% of CPI basket respectively.

To better understand the behavior of core inflation and the dynamics of headline inflation, it is important to distinguish between tradable and non-tradable items within core inflation. This separation is to some extent arbitrary, since in every item of the CPI basket there are tradable and non-tradable components. Nonetheless, especially in a small open economy, the determinants of inflation of each of these items could be quite different. In particular, non-tradable items are more driven by domestic developments and then more related with excess or lack of demand. On the other hand, tradable items are more exposed to foreign competition and so to international prices and the evolution of the exchange rate. In practice, in small open economies “tradables” are mostly “goods” while “non-tradables” are mostly “services”, so we separate core items in these two groups. In terms of share of CPI, these groups represent 28.6% and 43.6% respectively (40% and 60% of core CPI index).

The behavior of the inflation of both goods and services is shown in Figure 3. It is evident that they have been very different, with both series cycling around their own, but quite dissimilar, mean. In particular, since the introduction of a full inflation targeting regime in 2000, the average inflation of non-tradables has been 4.3% compared to only -0.2 core goods (see Table 1). Services inflation is also less volatile than goods inflation and as it is shown in Table 2, despite the fact that its weight in CPI is 1.5 times the weight of goods, its contribution to headline inflation is basically the same.^{4/}

⁴ The behavior of the relative price of tradable and non-tradable in Chile is not different from what has been seen in other countries. See for example, Jacobs and Williams (2014) who report similar behavior in Australia, Steenkamp D (2013) in New Zealand, Coto-Martinez and Reboredo (2014) for several OECD countries and Altissimo et al (2011) for some Euro Area countries.

Figure 4
Output Gap, Unemployment Rate and GDP Growth
(%)



Note: Quarterly data from 2000:1 to 2015:3.

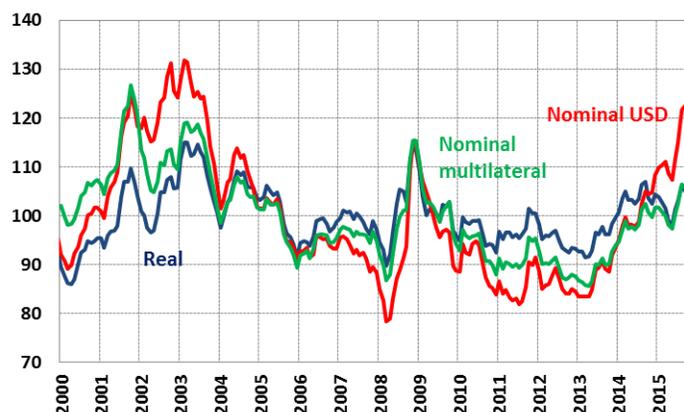
The Output gap

The output gap is probably the most mentioned determinant of inflation, however, in practice, its use is subject to a large degree of uncertainty, since it is very difficult to measure in real time. There are two sources of problems; first GDP data are routinely revised, since new and better information is known. Second, adding new data typically change – many times quite a bit – the outcome of the filters commonly used to compute the output gap, this problem is sometimes called “the end-of-sample bias”. As shown by Orphanides (2002), Borio et al. (2014) and other authors, the second issue is what really makes a difference.

To confront this point, at the Central Bank of Chile we run a number of models for output gaps that consider different pieces of information. In particular, we run three models. The first model combines standard HP-filter with an IS curve and Neo Keynesian Philips Curve (NKPC). The second model allows for a more general formulation for the trend, uses information from de labor market and forecasts of the main variables to minimize “the end-of-sample bias”. Finally, we also run an SVAR designed to identify short and long run shocks to output. As pointed out by Orphanides (2002), these types of corrections do not solve the whole problem, but at least our analysis suggests that they decrease de bias⁵. In any case, at the end monetary policy considerations take into consideration the results of these models as well as a number of other factors, such as the evolution of expectations, actual and expected current account balances (as indicators of domestic expenditure gaps).

⁵ See Central Bank of Chile (2015b).

Figure 5
Nominal and Real Exchange Rates
(Period average =100)



Note: Monthly data from 2000:01 – 2015:11.

The light blue area in Figures 4a and 4b depicts the range of evolution of the output gap estimates since 2000, and the blue line represents the unemployment rate (inverted axes) in panel (a), and the annual GDP growth rate in panel (b). It is possible to identify five periods. The aftermath of the Asian crisis, during the early part of the 2000's, is characterized by a negative output gap, a high rate of unemployment and a low rate of growth. Next, the four years previous to the Global Financial crisis of 2008 – 2009 were marked by remarkable recovery of growth and a reduction of the unemployment rate that pushed the output gap from around -3% to over 3%. This outstanding performance coincides with the beginning of what later will be dubbed the “super cycle of the commodity prices”, with long-lasting effects on the Chilean economy, especially through a delayed increase in investment in the mining sector. The effects of the Global Financial Crisis determined the evolution of the output gap during the period that goes from 2008 to 2010. However, in clear contrast with the Asian crisis, a mix of good macroeconomic management and the rapid recovery of the price of copper allowed a fast recuperation of activity, which pushed the output gap back to positive numbers very quickly. Finally, since mid-2013 we have seen a period of lower growth, but still low unemployment. Even though this combination of activity and labor market performance is somewhat puzzling, we think it is consistent with a decline in potential output, which was partly hidden by the effects of the boom in commodity prices⁶ and with some degree of labor hoarding common in deceleration periods.⁷ Anyway, what we think is that, in spite of the low rate of growth, the output gap is only slightly negative⁸.

⁶ See Central Bank of Chile (2015a).

⁷ The idea of “labor hoarding” is an old one. It basically said that since it is costly for firms to adjust employment, they respond to short-run fluctuations in demand by changing the degree of effort they required from their workers. See for example, Burnside et al (1993) and Sbordone (1996). Meza and Quintin (2007)

The exchange rate

In small and open economies like Chile, a relevant share of the goods that are consumed (around 40% in the case of Chile) as well as many intermediate goods, are imported. The retail prices of those goods are strongly related with the evolution of international prices and the exchange rate. It is also the case that many locally produced goods face competition from abroad, and their prices are also related with international prices. Empirical evidence suggests that both the exchange rate and the international price of goods are important, however the evolution of the former is particularly relevant when prices are invoiced in dollars, a common feature of emerging markets (Gopinath, 2015).

Figure 5 shows the evolution of the nominal exchange rate against the US, the multilateral nominal exchange rate and the real exchange rates. The last two are a trade based weighted average, deflated by the CPI in the case of the latter. The co-movement is evident, but in periods characterized by global appreciation of the US dollar, such as the latest one, and during the early 2000's, the price of the US dollar tends to move faster than both the multilateral and real counterparts. What is remarkable about this period of almost free floating of the nominal exchange rate is the relative stability of the real exchange rate, in a period characterized by wide swings in commodity prices and capital flows. With the exception of a few brief periods, the real exchange rate fluctuated just within a 10% band.

In line with our discussion on the output gap, it is possible to distinguish five periods⁹: a large depreciation related to a large extent to the strengthening of the dollar during the early 2000; an intense real and nominal appreciation starting around 2003 strongly related with the beginning of the super cycle of commodity prices; a sharp but short lived depreciation as a consequence of the GFC; a new period of appreciation related with the recovery in the price of copper and the increase in global liquidity; and finally an intense period of depreciation linked to the end of these two elements.

Inflation expectations

Figure 6 shows the evolution of the inflation expectations for the one year and the two years from now indicators. The numbers are taken from the Survey of Economic Analysts. Since in our IT framework policy is operationalized by trying to have two year inflation forecast at 3%, the two year from now inflation expectation is a closely watched indicator¹⁰. As shown by the red line in Figure 5 and in Table 3, during the last 172 months (all the period covered by this survey) this indicator has been exactly three percent 85% of the time, and above 3,5% only 1.7% of it. So far it has never been outside the range of 2% to 4%, not even in late 2008, when headline inflation reached close to 10%. This in spite of

study the behavior of several Latin American and Asian economies during the Tequila crisis of 1994 -1995, and report that that labor hoarding could account for much of the behavior of hours during this episode.

⁸ See Central Bank of Chile (2015c) for a discussion of the evolution of different measures of economic slack during the last cycle.

⁹ Indeed, correlation between both the real and the nominal exchange rate with the output gap is large, ranging between -0.3 and -0.6.

¹⁰ For this purpose we also compute different measures for expected inflation implicit in financial asset prices, as well as other surveys.

Figure 6
Inflation expectations one and two years from now



Note: Monthly data from 2001:09 – 2015:12.

Table 3
Inflation expectations one and two years from now

	One year from now	Two years from now
Average	3.1	3.0
St. Dev.	0.6	0.1
Max	6.0	3.9
Min.	2.0	2.8
% of time at 3%	28.5	84.9
% of time out of [2.5% - 3.5%]	20.3	1.7
% of time out of [2% - 4%]	5.2	0

Note: Monthly data from 2001:09 – 2015:12.

the fact that the one year inflation expectation has been very volatile, reflecting the fact that, as mentioned in section 2, inflation is relatively volatile in Chile

The fact that the one year inflation expectation has been fairly volatile, but the two years inflation expectation not, it is commonly taken as a reflection of credibility in the Central Bank commitment and ability to bring inflation back to its target. If this is the case, shocks that affect inflation should be viewed as transitory and should therefore not influence long-term inflation expectations. The anchoring of inflation after the IT regime has been

highlighted in various studies^{11/} and is a central piece of our monetary policy strategy. This allows us to respond with flexibility when we think shocks are transitory. However, the experience of 2008 (more on this in Section 4) shows that credibility is not something that should be taken for granted. Indeed, credibility risks arise in periods when inflation is far away from its target, or when it remains beyond the band.

3 Inflation determinants

In this section we present evidence that shows the relevance of the main determinants of inflation in Chile. We organize the discussion around the elements of a small open economy version of the New Keynesian Phillips Curve^{12/}. In this context, the dynamics of inflation is related to the evolution of the output gap, exchange rate, inflation expectation, past inflation and the price of foreign goods. More formally, the relation among these variables and current inflation is typically described by an equation of the following type:

$$\pi_t = \rho E_t \pi_{t+1} + (1 - \rho) \pi_{t-1} + \beta x_t + \alpha \Delta q_t + \varepsilon_t,$$

Where π is the inflation rate, x represents the output gap, q is the real exchange rate or something related with relative prices of foreign goods and ε is a residual term. In this equation ρ is a parameter related with how forward looking influence the inflation process; β represents the slope of the NKPC; and α describes the degree of exchange rate pass-through and is typically associated with the degree of openness.

As noted by Mavroeidis et al (2014) in their extensive review of the literature, the estimation of this kind of equation is subject to a lot of uncertainty, since "seemingly innocuous specification changes lead to big differences in point estimates." (p. 172). In particular, the pervasive problem of weak instruments led these authors to conclude, that at least using macro data, it is not possible to get a reasonable assurance about the value of those parameters. This of course does not imply the NKPC is neither valid nor relevant, since there are good theoretical arguments behind this formulation, but that it is difficult to pin down the parameters. Having this in mind, we do not attempt to do a new estimation, but present the main conclusions from several studies already done for Chile within this framework.^{13/}

¹¹ See, for example, De Pooter et al (2014), Rusticelli et al (2015) and Davis (2014).

¹² As derived, for example, in Galí and Monacelli (2005). See also Razin and Yuen (2002) and Mihailov et al. (2011), In the case of Chile there is large literature that supports the NK models, see for example, Medina and Soto (2007), Caputo et al (2007) and Caputo (2009), all of them written while the authors were at the Central Bank

¹³ The most comprehensive analysis is Cespedes et al (2005). See also Pincheira y Rubio (2015) and Caputo (2009). At the Central Bank of Chile we have redo much of those estimations and main results remain valid.

Output gap

Different estimations of the NKPC for the case of Chile show that the output gap has a positive and significant effect on inflation, but that this effect is relatively small.^{14/} This conclusion is not different from what has been found in other countries. More precisely, in the case of Chile the coefficient β is typically somewhat below 0.2, meaning that, all the rest constant, a 1% increase in the output gap implies a less than 0.2% increase in (annualized) quarterly inflation.^{15/} Of course, this does not mean that the output gap does not matter for inflation, since it is the present value of all future output gaps what really matters, so, provided changes in the output gap are persistent, the impact could be much larger.

Noticeably, there is some evidence that shows that the NKPC is now flatter than in the 90's^{16/}, in line with what has been found in several other countries.^{17/} These changes are typically attributed to gains in Central Bank's credibility.

Exchange rate

In any small open economy, especially if its production structure is more concentrated in commodities, an important part of consumption goods are produced abroad or face a relevant degree of competition from foreign producers. In this context, it is not surprising that the exchange rate has an important role in the inflation's dynamic. What is surprising is that many studies of the NKPC in Chile do not consider explicitly the role of the exchange rate. Anyway, models used at the Central Bank are consistent with an exchange rate pass-through (ERPT) of around 0.1% – 0.2% in a year. As shown in Albagli et al (2015), this number is high when compared with developed economies, but not that different from coefficients founds in other emerging markets.¹⁸

Justel and Sansone (2015) use data from 1987 – 2013 to analyze the level of ERPT into the CPI and more disaggregate data: domestic energy, food and core consumer prices. They find that ERPT to headline inflation in Chile is around 15% in a year and around 10% for core CPI. Both in the headline and the core CPI the effect of exchange rate movement takes

¹⁴ It is possible that the problems with the measurement of the output gap could be behind these small coefficients, after all, if one is using the incorrectly measured output gap makes sense that it does not appear as very significant. However, it is important to notice that studies that used real time an ex post output gap typically coincide in finding low output gap elasticities.

¹⁵ Mavroeidis et al (2014) reports that most common numbers for developed economies are even lower than this. Moreover, they show that, depending on the set of instrument, it is possible to find numbers that goes from negative to positive values.

¹⁶ See Cespedes et al, (2005) and Morandé and Tejada (2008).

¹⁷ See Simon (2013).

¹⁸ In Albagli et al (2015), the authors analyse a sample of 48 developed and emerging market economies and show that the exchange rate pass-through (ERPT) is typically higher in the latter, and that within the group of emerging market economies Chile has a high level of ERPT. Indeed, they claim that the higher degree of ERPT of Latin-American countries coupled with the high exchange rate depreciation associated with the end of the boom of the commodity prices could explain why this region has had high levels of inflation in a context of very low inflation in the rest of the world.

three to four quarters to be fully passed. Regarding the ERPT evolution, they find that it has decreased since the establishment of an inflation targeting regime and has remained fairly stable afterwards. They also report a significant effect of changes in the exchange rates of Food and Energy prices, with a ERPT close to 10% and 50% respectively.

Bertinatto and Saravia (2015) analyzed possible asymmetries in ERPT. Interestingly, they report that the ERPT depends on how persistent is the exchange rate movement and also on the sign of the movement. In particular, they find that the ERPT has been larger in devaluations than in appreciations of the peso^{19/}, and that the ERPT is larger the more persistent is the change in the exchange rate. The authors fail to find a significant relation between the level of ERPT and the output gap, but, according to them, this result should be taken carefully. In fact, even though in the literature there is not a consensus about the importance of the output gap for the ERPT, several studies have found a positive relationship. For example, Ben Cheikh (2013) in his study of 12 euro Area countries find that ERPT to CPI inflation depends positively on economic activity, so, when real GDP is growing above some threshold, the ERPT becomes larger. Similar results are reported by Goldfajn and Werlang (2000) and Brun-Aguerre et al (2012).

Of course, the degree of exchange rate pass-through (ERPT) varies considerably across goods, since (i) different amounts of local input of services are added to their prices, (ii) in some cases it is possible for consumers to switch from imported goods to lower-quality local versions; and (iii) there also differences in the amount of intermediate foreign goods used by in local goods.^{20/}

In the case of Chile, Álvarez, Jaramillo and Selaive (2008) used monthly disaggregated import price to show that import prices both at the border and at the wholesale level, present a high degree of ERPT in the long run; that the ERPT has not declined, and that in the short-run wholesale prices seem to be less sensitive to exchange rate variations. On the other hand, Álvarez, Leyva and Selaive (2008) using monthly data for the period from December 1998 to April 2007, and prices for 156 items corresponding to the CPI basket, find that: food and transport components exhibit significant degrees of ERPT, but with a high heterogeneity within elements in each category. They also report small ERPT for the other categories of the CPI.

Past and future inflation

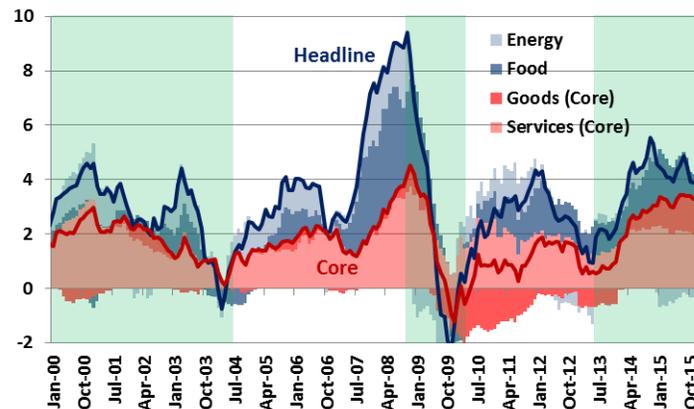
Finally, regarding inflation expectations evidence shows that they are relevant, with a ρ coefficient in between 0.5 – 0.6.^{21/} That means the backward-looking component in the NKPC is still relevant, in fact, typically a little bit above what is found in developed economies (Céspedes et al., 2005). Importantly, there is evidence that show that, compared to the 90's, the inflation has become less persistent, a phenomena that has been associated

¹⁹ Similar results are reported in Delatte et al. (2012).

²⁰ See Burstein and Gopinath (2014) for a complete survey of the relation between local and foreign prices.

²¹ Determining the empirical relevance of inflation expectation for current inflation rate it is difficult, not only because of the identification problems discussed by Mavroeidis et al (2014), but also because if inflation expectations are well anchored they have very little movement and then it is difficult see how change in them affect current inflation.

Figure 7
Inflation and its components
(%)



Note: Monthly data from 2001:09 – 2015:12. Core inflation (red line) represents 72.2% of the total in CPI (2013 basket) and is the sum of Good (core) and Service (core), which represent 28.6% and 43.6% of the total CPI respectively. Food represents 19.1% and energy 8.7%.

with the implementation of the inflation targeting regime and the enhancement of credibility associated with this process (Simon, 2013). Nevertheless, indexation to past inflation is still an extended practice in many contracts, including wages, housing rentals and medium and long term credit, including mortgages.

Credibility has been also important in shaping the slope of the Phillips Curve. According to several studies the reduction in the ERPT, indexation and the sensitivity of inflation to the output gap is related to the increase in credibility (Cespedes et al 2005), a result which is in line with the evidence for other economies.

Regarding past inflation, as discussed by Herrera and Valdés (2005), indexation has been a long practice in Chile.²² Of course, this phenomena is today less pervasive than in the 90's. For the case of wages, for example, Banco Central de Chile (2013), shows that in the short run between 15% and 35% of past inflation pass to wages, far below what was in the past, but still a significant amount.

Finally, inflation expectations itself are not independent from past inflation. In particular, at the Central Bank we have found certain evidence that prolonged periods away from a range of 1% around the inflation target affect one-year inflation expectations. In particular, using a panel of 44 countries with some sort of inflation objective, it is found that after 12 month out of a range of 1% around the inflation objective, the sensitivity of one year inflation expectation to past inflation ($\partial\pi_t/\partial\pi_{t-1}$) goes up from 0.16 to 0.21, while the sensitivity to inflation surprises rises from -0.05 to 0.1.

²² See also Jadresic (1998) and the references cited therein.

4 A view of the inflation process

Figure 7 depicts the evolution of headline inflation and the incidence of each of its components: goods, services, food and energy. The shaded areas divide the period under analysis into five different sub-periods in which the direction of inflation changed. Table 4 shows the numbers for average inflation in each of these sub-periods and the values of other several macroeconomic variables.

The first sub-period covers the initial four years of the 2000's. During this time Headline inflation and, even more clearly, Core inflation were in a decreasing path. Behind this behavior there is a sluggish economy that is still fighting to recover from the Asian Crisis and its aftermath, as well as an external environment marked by unfavorable terms of trade (high oil and low copper prices) and adverse external financial conditions. In this context, unemployment remained high and quarter by quarter the output gap got more negative. This situation took its toll on the non-tradable inflation, approximated in our analysis by the inflation of services, which transits from numbers above 7% at the end of 2000 to a value close to zero at the beginning of 2004.

The newly released free-floating exchange rate also played a role, helping the economy to absorb the negative external shocks and pressuring up inflation. Specifically, there was a significant depreciation of the peso in both nominal and real terms during this period, in part as a response of a series of cuts in the monetary policy rate – it passed from 8.5% to 1.75% – in an environment of a global appreciation of the US dollar. The movement of the exchange rate put some pressure on inflation, especially on tradable items such as food, energy and goods, but, in a context of a flimsy economy, inflation remained contained. Core inflation that had ended 2000 above 4%, was below 1% by the beginning of 2004. Headline inflation was somewhat higher, only because the price of oil increased quite a bit in response to conflict in Middle East, including the Iraq war of 2003.

It was in the middle of this frustrating landscape when the price of copper started to rise and what later was dubbed the “super cycle of commodity prices” changed the course of the Chilean economy for the next decade. Interestingly, at the beginning, the change was viewed as a transitory phenomenon and correspondingly most of the Government extra income was saved, and there was not significant change in investment. The recently implemented fiscal rule played an important role here, since these savings were viewed as the counterpart of the expenditure levels maintained during the previous period of low copper prices. The fiscal balance went from -0.5% to 7.8% of GDP between 2003 and 2007.

However, as the time passed, both the government and the firms became convinced that high copper prices were here to stay. Consequently, internal demand increased, especially the investment in the mining sector, helping to close the output gap and reducing unemployment. In particular, at the output gap went from almost -3% at the beginning of to only -1% in 2005. By the end of period (2008:3) it was 1.2%. Not surprisingly, non-tradable inflation climbed from 1.1% in 2004:2 to 7.6% in 2008:3 with nominal wage growth that scaled from around 3% to over 8% during the same period.^{23/}

²³ Of course, the rise in energy and other natural resources imported inputs also played a role in the acceleration of inflation in the non-tradables sector.

Table 4
 Macroeconomic variables in selected sub-periods
 (% , average)

Panel (a): Inflation

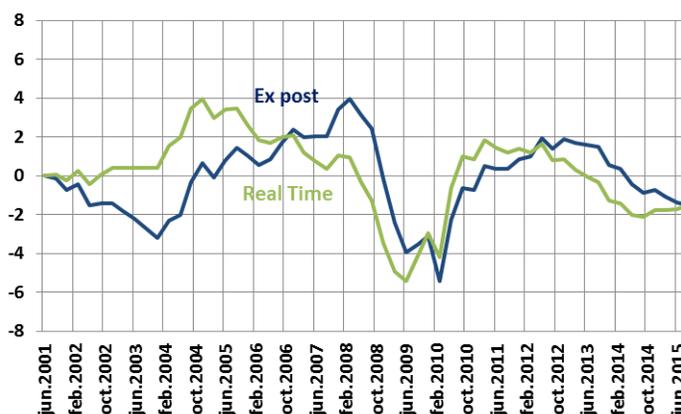
	Headline	Core	Goods (core)	Services (core)	Food	Energy
2000:1 - 2004:1	2.9	2.5	0.1	4.0	1.3	11.6
2004:2 - 2008:3	4.3	2.8	0.5	4.0	6.5	10.9
2008:4 - 2010:1	2.4	2.6	-0.8	5.0	5.8	-4.2
2010:2 - 2013:2	2.6	1.4	-2.8	4.6	5.8	5.2
2013:3 - 2015:3	3.9	3.6	2.0	4.8	6.7	0.8

Panel (b): Other Macro Variables

	NER	RER	UR	Employment	GDP	Output Gap
2000:1 - 2004:1	5.6	4.6	9.8	2.1	3.8	-2.4 [-1.4 ; -2.8]
2004:2 - 2008:3	-5.8	-1.5	8.5	2.9	5.8	0.1 [-2.9 ; 1.2]
2008:4 - 2010:1	8.6	1.8	8.7	0.5	-0.3	-3.5 [-1.1 ; -5.1]
2010:2 - 2013:2	-3.2	-1.9	7.4	4.4	5.8	0.1 [-2.1 ; 1.1]
2013:3 - 2015:3	13.2	4.4	6.2	1.7	2.4	0.4 [1.4 ; 0.2]

Note: Quarterly data from 2001:3 – 2015:3. All data are period averages. In the case of the output gap the numbers in brackets are the values of the output gap at the beginning and end of each period.

Figure 8
 Ex post and real time output gap of non-natural resources sectors
 (%)



Note: Monthly data from 2001:09 – 2015:12. Output gap computed using an HP filter with lambda 1600.

The boom of commodity prices came with two additional developments that affected inflation during this second period. First, a sharp nominal appreciation of the peso, and to less extent real, that helped to keep the goods inflation under control. Second, it was not only the price of copper that was skyrocketing, but also the price of other goods, including food and oil. In this context, with the exception of some months at the end of 2006 marked by the reduction in the price of oil plus a transitory slowdown in activity, inflation was steadily increasing and, by the end of 2008, headline inflation reached almost 10%. At this point, for the first time since the full implantation the IT regime, inflation expectations two years from now were significantly above the 3% target, meaning that the market doubted the capacity of the Central Bank to bring inflation back to its target.

From Figure 9 it is apparent that the surprising surge in the price of food was an important part of the inflation escalation, but core inflation, that excludes food, was also increasing at a fast rate. Indeed, between mid-2007 and the end of 2008 core inflation went from 1.9% to 6.6%. Looking backward, it is not very difficult to explain this behavior: all inflation determinants were tilting up: the output gap was at its highest level in years and increasing; the peso was appreciating, but the Central Bank decided to intervene buying dollars in an attempt to curb what was seen as a too low real exchange rate (it was also a good opportunity to increase International Reserves), finally actual and expected inflation started climbing very fast.

But with the information at hand at that time, things looked somewhat different, in fact this episode is a good example of the limitation imposed by real time data. To start with, computations of the output gap done with data until 2007 show an economy with more slack than the computations done with later data. This point is shown in Figure 8, where we computed the real-time and the ex-post output gap for the non-natural resources sectors, a measure of GDP more related to inflation. From the figure is clear the “end-of-sample” problem discussed in previous section. For 2007 and the initial part of 2008, the real time measure indicates a gap close to zero, after incorporating all the data until 2015 the computation of the gap shows that it was between 2 and 4%, a considerable difference. Second, it was reasonable to expect a more important effect of the appreciation of the peso since ERPT in the 90s was much higher. Finally, the magnitude and persistence of the increase in the international prices of agricultural commodities came as a surprise. These considerations highlight the importance of keeping in mind the limitations imposed by the data and their interpretation when doing monetary policy.

By the second part of 2007 the Central Bank decided to start a contractive monetary policy and during the next year and a half raised the monetary policy rate (MPR) from 5% to 8.25%. However, inflation proved to be very stubborn. In a really worrisome development, by September 2008 the monetary policy rate had been increased by 300 bps., but during the same month inflation expectation for two years from now reached 3.9%, the highest level ever.

The Global Financial Crisis changed the game. Unemployment increased to almost 11% in a few months and the output gap went back to negative numbers in one quarter. In this context non-tradables inflation passed from 8% to less than 2% by the end of 2009. Interestingly, and probably reflecting the dependence of inflation to the past, inflation took a little bit more to react relative to activity. The reduction in the price of oil and the null food inflation helped too. The peso depreciated quite a bit at the beginning of this period,

keeping goods inflation in positive territory during the last quarter of 2008 and the first half of 2009, but the low level of activity and the later appreciation of the peso, sent goods inflation into negative territory. In this context, inflation reached -2% by the end of 2009. A mix of good policies and good fortune²⁴ put the economy back on track very fast. Monetary and fiscal policies were extremely counter cyclical; with a MPR that went to 0.5% in few months and a fiscal deficit that reached 4.4% of GDP. This was of course possible because of credibility of the Central Bank that, even though scratched by the upsurge of inflation, was fundamentally intact, and a history of sound fiscal policy. The lucky part was a strong rebound in the price of copper, facilitated by the stunning Chinese's responses to the crisis. Copper prices recovered from a minimum of around 1.5 USD per pound to 3.5 by April 2010. This finally convinced everybody that the "Super- cycle" was here to stay, bringing mining investment to record highs, which in turn facilitated the reestablishment of internal demand growth. The output gap recovered also very fast, reaching positive numbers by the end of 2011. In this environment, the non-tradables inflation recovered rapidly to around 5%, a level above its average in the first decade of the 2000s.

The years between 2010 and mid-2013 were also years of a weak dollar, in large part a consequence of the unprecedented expansiveness of monetary policy in the United States and the still high commodity prices. The associated appreciation of the peso pushed down the local price of tradable goods.^{25/}

By mid-2013 the landscape started to change. Fed Chairman Ben Bernanke announced that US monetary policy was close to start its normalization, and even though it took a long time until we saw the first increase of the Fed Funds rate, the mood in emerging markets changed for good. Additionally, China's economy started showing the first signs of growth moderation and, consequently, the price of commodities began to decline. In the case of copper, as in several other industrial commodities, the expansion of supply resulting from the previous investment boom also played a role. In this context the growth rate in Chile shrunk significantly, coinciding with major reductions in investment plans of the large mining multinationals. At almost the same time, after more than a year with inflation (CPI and core) below the band, the Central Bank began to signal a relaxation of monetary policy. The first cut of the MPR came into effect in October 2013 and was followed by other 3 additional cuts, for a total reduction of 100 bps by November 2014. The peso depreciated substantially.

Since mid-2013, the nominal exchange rate has depreciated more than 45%. This is one of the largest and more persistent periods of depreciation of the last 30 years. Not surprisingly, the effect on inflation has been large, especially in the evolution of the tradables inflation which climbed from -2.5% to 5% between June 2013 and November 2015. The ERPT, then, has been a critical element in the evolution of inflation. Recent evidence suggests that

²⁴ Bad luck also "helped": the 2010 earthquake induced the incoming government to further relaxation of the fiscal policy in order to facilitate the reconstruction. Infrastructure under private concessions was insured and reconstruction was largely financed by reinsurance abroad.

²⁵ The inflation of the tradable goods reached -6% in March of 2010. It is difficult to explain such a deflation rate appealing only to the behavior of the exchange rate. In fact, we know that there were some problems with the measurement of prices of some goods, for example clothes, that introduced a downward bias to inflation during 2010. However, even after those problems were solved, goods inflation remained at a very low level. On average between 2011 and 2013:6 it was -2%.

the ERPT has remained within a range of values coherent with historic patterns, but at the highest values within that range. This is consistent with the empirical evidence discussed above, since the ERPT tends to be larger when the depreciation is very persistent.

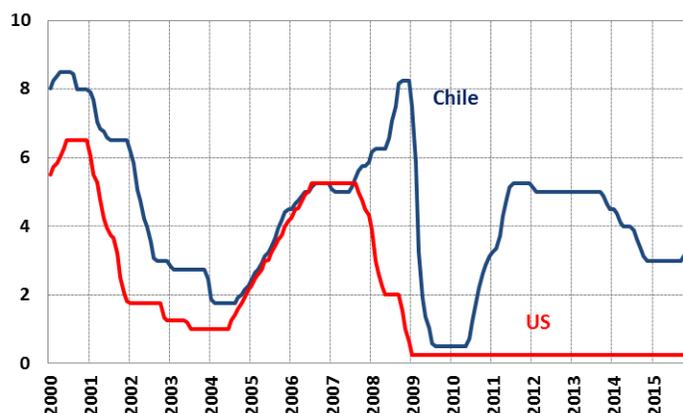
In spite of the decline in the growth rate, the output gap has remained contained. Two factors explained this. First, by mid-2013 it was in a clear positive territory. Second, potential growth has declined as the economy gets wealthier and productivity growth in Natural resources based sectors slows down or even fall, as in the case of mining. Our calculations show that Chile's medium term growth is around 3.5%, considerably less than the 5% estimated at the beginning of the 2000's. On top of that, several shocks and the necessity to reallocate resources between sectors after the end of the fall in commodity prices, have temporarily dampened the potential growth to a number closer to 3%. This is consistent with the fact that, in spite of low growth, the labor market remains relative tight, with an unemployment rate around 6%, a net job creation of around 2% and wages that keep growing in the vicinity of 6%. In this context, it is not surprising that non-tradables inflation has not decreased.^{26/}

These are complex times for monetary policy in Emerging Markets Economies. The end of the boom of commodity prices and of the indiscriminate liquidity has obliged our countries to confront the "reality" faster than previously expected. We already discussed the impact of the reduction in the price of copper on the economy and, in particular, on inflation. We would like to finish this section with some words about the possibility of pursuing an independent monetary policy in the context of increasing US interest rates.

Theoretically, provided that one is willing to let the exchange rate move, foreign monetary policy puts no limits to local central banks that put in place a free floating exchange regime. In practice, the experience of Chile shows that this is possible, at least to some extent. Figure 8 shows the evolution of the Chilean and the US monetary policy rates (MPR) since 2000. From the graph it is clear that during the last 8 years movement in both rates have not been related: when the MPR in the US started to decline at the onset of the GFC, the MPR was increasing in Chile to curb inflation. During 2009 the local MPR was aggressively cut, but in contrast to what happened in the US, by mid-2010 the Central Bank of Chile started to increase local rates since the economy was in a clear path of growth. Finally in 2013, few months after Chairman Bernanke talked about the beginning of the normalization of monetary policy in the US, MPR was cut in Chile to confront the slowdown related with the end of super high commodity prices. As we mentioned before, the real exchange rate fluctuated within a limited range during these periods of policy divergence, with almost no intervention in foreign exchange markets.

²⁶ There is also evidence that shows that the tighter the economy, the larger is the ERPT. This could have also played a role, since, as was mentioned before, the downward correction to the potential rate of growth implied the recognition that there was less slack in the economy. Actually, the ERPT has been somewhat above of what was previously expected, a fact that coincided with the revision in of the potential growth.

Figure 9
Monetary Policy Rates
(%)



Note: Monthly data from 2001:09 – 2015:12.

The other side of the coin is, of course, the evolution of the nominal exchange rate, which in the case of Chile has shown important swings, as was discussed above. Is this a reasonable monetary policy? Well, in these matters one size definitely does not fit all, so it is not possible to make unconditional recommendations. In the case of Chile, the financial situation of different agents, in particular the absence of large currency mismatches, allows us to let the exchange rate to be the main shock absorber. A role that is particularly important in an economy that requires significant changes in relative prices and where the degree of indexation to past inflation is rather high.

Monetary independence, of course, does not mean either zero correlation with foreign MPR, or that international financial conditions are irrelevant. Regarding the first point, it is clear from Figure 9 that during the early 2000 there was a high degree of correlation between US and Chilean MPR. This is not strange, since during those years the business cycles in both economies were more or less in tune.

Regarding the second point there has been a lot of debate in recent years.^{27/} Our view is that international financial conditions are more relevant in a more financial integrated world, but this situation does not eliminate the benefits of an independent monetary policy. In particular, there is convincing evidence that long term interest rates in Emerging Markets are affected by developments in international markets, and that the Fed monetary policy has an important role here.^{28/} So local financial conditions do depend on what the Fed does. However, the idea that local MPR has to react mechanically to changes in the US MPR is

²⁷ See Rey (2015a), Rey (2016) and Obstfeld (2015).

²⁸ For instance, Fed monetary policy has an effect, either through its impact on expected future short term interest rates or on term premium, on long run interest rates.

far from obvious. The best reaction to a movement in the Fed Funds rate will depend on the medium-term inflationary impact of those movements, and that, in turn, will depend on many other elements that shape the economic landscape.

5 Concluding Remarks

The evolution of the Chilean economy during the last 10 years has been marked, to a grand extent, by the boom of commodity prices and, after 2008, by the GFC and the response of developed countries and China to that episode. The impact of these events on the internal demand and on relative prices has left a clear mark on the evolution of tradable and non-tradable inflation.

In this note we reviewed the evolution of the main determinants of inflation in Chile and the empirical evidence that links those variables with the dynamics of inflation. We show that, despite the fact that there are important concerns about New Keynesian theory, in particular about the ability to identify relevant elasticities in the Phillips Curves, in the case of Chile the empirical evidence is broadly consistent with the relevance of the determinant of inflation highlighted by this theory: the output gap, the exchange rate, inflation expectations and past inflation. Particularly important to understand the evolution of inflation in Chile is to distinguish between the behavior of tradables and non-tradables inflation.

Consistently our account of the evolution of inflation in Chile shows that periods of low activity, high unemployment and negative output gaps, coincide with low levels of inflation, especially in non-tradable items.

Exchange rate matters too. It is true that ERPT is today lower than in the 90's, but it is still significant. Periods of changes in relative prices are typically accompanied by relevant movements in the exchange rate that transmit to local prices, especially in traded goods.

In the same vein, indexation to past inflation is today less important than in the 90, but its effects could be seen in wages, cost of credit and rents. Finally, expectations matters too. In the case of Chile they have been well anchored most of the time, helping to keep inflation under control.

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Annex A

Housing prices in the CPI Index

In Chile, the price of houses is not part of CPI Basket, but it enters indirectly through the rental value of housing.^{29/} The monthly rental value of housing (houses and apartments) is obtained as a geometric mean of rents reported by a sample of households. There is no imputation of the implicit cost of living in a home in the case of people who own the place where they live. This may cause a bias in the measure of housing costs as long the cost of owning a house is different from the cost of renting a house. There is also an underweighting of housing in the CPI basket.

The Central Bank of Chile computes a housing price index (IPH) based on unnamed Internal Revenue Service administrative records, corresponding to effective housing transactions nationwide. The index considers breakdowns by type of property (houses and apartments) and geographical areas. The IPH is released with a lag of six months and it is not used in the computation of the CPI.^{30/}

²⁹ The price of houses is not included because they are classified as an asset (investment) rather than as a durable consumer good.

³⁰ See Banco Central de Chile (2014)