INFLATION DYNAMICS AND DETERMINANTS IN CHILE

December 2020

banco central Chile

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CONTENT

PREFACE

After living with high inflation for much of the last century, the Chilean economy has seen a period of low and stable inflation over the last two decades, while inflationary expectations have remained aligned with the two-year target of 3%. Price stability has been compatible with the use of monetary policy as a counter-cyclical tool, as shown, for example, by its response to try to cushion the adverse effects of the Covid-19 pandemic

In this context, monetary policy conduct has been based on multiple analytical tools and a body of empirical evidence that have helped to better understand inflation and its short- and long-term dynamics. This document adds to our 2017 and 2018 publications on Trend Growth and the Labor Market, and summarizes a wealth of internal and external research on the historical behavior of inflation in Chile, its short and medium-term determinants, and the role of the monetary policy framework in determining inflation expectations. This Supplement is not intended to provide normative answers or policy proposals, but rather to bring to the table elements that can enrich public discussion and motivate future studies.

The analysis contained in this document was coordinated by the Monetary Policy Division of the Central Bank of Chile. The project was led by Andrés Fernández, Economic Research Manager, and Matías Tapia, Head of the Economic Analysis Department. We appreciate the contributions of CBCh economists Miguel Acosta, Rosario Aldunate, Agustín Arias, Marcela Arriagada, Gent Bajraj, Mario Canales, Guillermo Carlomagno, Gabriela Contreras, Pilar Cruz, Claudia de la Huerta, Jorge Fornero, Mariana García, Mario González, Daniel Guzmán, Bernabé López-Martin, Will Lu, Carlos Medel, Pablo Muñoz, Ernesto Pastén, Michael Pedersen, Jennifer Peña, Elvira Prades, Andrés Sansone, Piera Sedini, and Juan Marcos Wlasiuk, plus four external researchers. Valuable comments were provided by Elías Albagli, Director of the Monetary Policy Division, and other members of the Division. Enrique Orellana, Tatiana Vargas and Cecilia Valenzuela carried out the editing process of this document.

The Board

1. INTRODUCTION AND CORE MESSAGES

1.1 Motivation

Under its Constitutional Organic Law, one of the mandates of the Central Bank of Chile (CBCh) is to "ensure the stability of the currency". In practice, this translates into achieving low, stable and predictable inflation. This mandate responds to the notion that the main contribution of monetary policy to the development of the country and the welfare of its population is to avoid the heavy burden of high and volatile inflation, a conclusion solidly supported by theory, international evidence and, above all, by Chile's historical experience.

The emphasis on inflation control as a fundamental mandate of a central bank emanates from the notion, supported by empirical evidence, that, in the long run, monetary policy has the capacity to determine inflation and other nominal variables, including monetary aggregates, nominal interest rates, and the nominal exchange rate, but is unable to permanently affect real variables such as activity or employment, or relative prices such as the real exchange rate, real wages, and real interest rates.

In the short and medium term, however, the presence of price rigidities allows monetary policy to affect the value of real variables and relative prices. This implies that, when properly managed, monetary policy has the potential to be an important tool that contributes to the stabilization of the business cycle, inasmuch as it is adequately fulfilling its fundamental role of ensuring that inflation is low, stable and predictable.

Because of price rigidities, the impact of monetary policy on inflation is neither direct nor immediate, but rather lagged through its effect on real variables such as the activity gap. Thus, within the monetary policy framework of the CBCh, the operating objective is for projected inflation to be at 3% annually over a period of up to two years. This horizon constitutes the maximum period in which the CBCh allows inflation to deviate away from 3%, and accounts for the average lag between changes in the policy instrument and its effects on activity and prices. This permits accommodating concerns about economic volatility, so that monetary policy decisions contribute to business cycle stabilization.

The study of inflation dynamics and determinants is key for the Central Bank to fulfill this mandate, and for the proper conduct of monetary policy, which is why it has been at the center of its research agenda for several decades. Thus, multiple models for forecasting and analyzing inflation have been developed and implemented, which are built and powered by the knowledge and experience generated within the Bank, as well as by the analytical developments and empirical evidence found in the international academic literature.

Although the responsibility for measuring the main inflation indicator -the CPI- falls on the National Statistics Institute (INE), the CBCh has made significant efforts in measurement, both in developing core inflation indexes and in delivering accurate and timely indicators of inflation expectations. This, in order to enhance the understanding and forecasting of two-year inflation trends, which are key variables in the inflation targeting framework that guides monetary policy in Chile. Recently, this has been complemented with the use of innominate microdata, so as to deepen the analysis of price dynamics in the economy from a disaggregate perspective, inputting relevant information to analyze the heterogeneity in behavior across different agents.

This Supplement to the December 2020 Monetary Policy Report presents the results of this research, together with evidence taken from the international literature, and synthesizes them to deliver an analysis and characterization of inflation and price dynamics in Chile from an empirical standpoint. It pays special attention to the role of the external sector in price dynamics, which is key in a small open economy, such as Chile, and to the crucial role played by inflation expectations and the Central Bank's communication within an inflation-targeting regime as has been in place in Chile over the past few decades.

1.2 Structure and characteristics

The structure of this document contemplates, on Chapter 2, a discussion of the importance of having low, stable inflation and the way long-term price movements are determined. It also presents a brief overview of Chile's inflation history. It also discusses how the existence of short-term price rigidities provides a role to the Phillips curve as a reference framework for inflation dynamics, which is the basis of the mechanism through which monetary policy contributes to the stabilization of the business cycle and the convergence of inflation to its target. In addition, evidence of these rigidities is presented from Chile's price microdata.

Chapter 3 discusses the importance of external shocks in the short-term dynamics of inflation, the way in which exchange rate movements are transmitted to domestic prices, and their implications for the conduct of monetary policy. The chapter then describes how changes in technology and trade patterns associated with the globalization process have affected relative prices in recent decades. Finally, Chapter 4 addresses the importance of inflation expectations in determining inflation, and the role of Central Bank communication. It also presents evidence of the behavior and measurement of inflation expectations in Chile and its degree of anchoring to the inflation target. Another topic is the effect of using monetary instruments to influence inflation expectations.

The data sources analyzed throughout this Supplement include aggregate and historic statistics obtained from surveys and financial markets in Chile and around the world, plus microdata bases taken from surveys and an array of administrative records. The use of disaggregated data complements the aggregate information, and allows to analyze in detail topics such as the behavior of individual prices in response to different shocks, the heterogeneous impact of the globalization process on different types of goods, and the differences in the behavior of expectations among agents. This reinforces the value of information obtained from microdata, particularly administrative records, and illustrates the enormous gains for public policy analysis and evaluation from the use of these types of records.

The evidence presented here is largely based on research conducted within the CBCh, both past and present. In this sense, this document reflects the experience accumulated over the years in the process

of inflation analysis and forecasting, and the contribution of many people who have passed through the Bank, both at the Monetary Policy Division and at other areas. It also reflects the willingness of institutions that, through agreements with the Central Bank of Chile, have collaborated in the provision of statistics and information, such as the National Institute of Statistics and the Internal Revenue Service.

This Report is not meant to address aspects of the current status of inflation in Chile, and in no way is it intended to exhaust the discussion around its behavior, but rather to bring to the table an analytical discussion and empirical facts that will motivate future debate and research.

This work is encompassed within the Central Bank's efforts to improve its understanding of the Chilean economy, and to incorporate this new knowledge into its analytical framework and modeling strategy, in line with international best practices. In addition, this Supplement fulfills a public role, making available to analysts, academics and the interested public a body of evidence and analysis that can enrich the public policy debate and help to better interpret the behavior of our economy. During 2021, complementary technical material, including data, minutes and estimation codes, will be made available to the public on the Bank's website www.bcentral.cl.

1.3 Core messages and results

This Supplement's main messages are presented below.

1. High and volatile inflation imposes a substantial burden on economic growth and the population's welfare by causing uncertainty, eroding efficiency and investment, and having regressive effects. As over the long-term inflation is associated with excessive growth in the money base, its average behavior depends critically on monetary policy. Therefore, the greatest contribution of central banks to society is to ensure low, stable inflation.

2. High and volatile inflation was a persistent and recurrent phenomenon over a good part of the twentieth century in Chile. For most of the period, this may be explained by the subordination of monetary policy to fiscal funding objectives. The autonomy of the Central Bank, with an explicit objective of price stability, coupled with fiscal discipline have been paramount in having low and stable inflation over the past twenty years. It is interesting to confirm that this occurred in tandem with one of the longest periods of high growth in Chilean history.

3. The existence of rigidities in price adjustments, documented with evidence of prices at the micro level, implies that in the short- and medium-term monetary policy can have real effects. In this context, the Phillips curve, which links inflation to real activity, future inflation expectations and the external sector, remains empirically valid in Chile as a valuable tool for analyzing and forecasting inflation in the short term, despite the difficulties in estimating it correctly and the doubts about the stability of its parameters put forward in other countries.

4. The short- and medium-term dynamics of Chilean inflation are highly influenced by the external sector. Indeed, about half of the variance of inflation in Chile over the last three decades can be explained by external factors. For this reason, a monetary policy framework that controls inflation over a two-year horizon, but tolerates transitory deviations associated with exchange rate fluctuations and other shocks, allows the primary objective of price stability to be achieved without exacerbating the volatility of activity and employment.

5. Under a flexible exchange rate regime, the nominal exchange rate is a crucial adjustment variable in the response to external shocks that hit the economy, and is therefore a mechanism by which they are transmitted to inflation. There is evidence that, in Chile, the pass-through coefficient from the nominal exchange rate to inflation is relatively small by international standards, and has declined over time. However, there are differences in the pass-through depending on the shock that originates the forex movement and the type of goods it affects. Low average pass-through levels are typically associated with a highly credible inflation target. This has been central to the conduct of monetary policy in Chile, as it has facilitated the implementation of a counter-cyclical policy to respond to external shocks, such as the adverse terms of trade shocks experienced between 2014 and 2015 with the plunge in commodity prices.

6. From a longer-term perspective, external factors have influenced relative prices. Changes in Chile's trade structure, associated with a greater preponderance of lower-cost imports from Asia, have been relevant in understanding these dynamics. A persistent decline in the price of goods relative to services has been observed both in Chile and most economies during the last two decades.

7. Inflation expectations play a central role in the conduct of monetary policy, both because of their direct effect on inflation and because of the importance of anchoring such expectations to the Central Bank's target. To the extent that inflation expectations remain anchored, monetary policy will be effective and can perform the aforementioned counter-cyclical role.

8. In recent years, progress has been made in understanding the formation of inflation expectations. One lesson from this is that central bank communication helps agents to have a better understanding of the conduct of monetary policy, leading to more precise and less divergent expectations. This explains why the CBCh uses various channels to communicate its evaluation of the state of the economy, as well as the rationality with which it uses its policy instruments to achieve the inflation target.

9. Consistency in messages, actions and objectives, as well as a credible macroeconomic policy framework, have been instrumental in anchoring inflation expectations. Under the different alternative methodologies with which inflation expectations have been measured in Chile, they have remained anchored to the CBCh target (i.e., 3% during the two-year policy horizon) for much of the last two decades.

The contents of this Supplement complement existing evidence, enriching the Bank's vision on topics such as the dynamics of individual price adjustments, the structural factors that have led to significant changes in relative prices, or the way in which monetary policy surprises can affect inflation expectations. They also examine possible future research areas, such as the evolution of the Phillips curve and its application at the sector and firm level; the determinants of the pass-through coefficient, including the role of companies' sales margins; or the implications of the dispersion in inflation expectations for household and firm decisions and the effects of monetary policy.

We hope that the material in this Supplement will be a valuable input to a better understanding of the dynamics of inflation in Chile, and therefore will help in the conduct and analysis of monetary policy and the challenges it faces over time.

2. INFLATION AND MONETARY POLICY IN CHILE

This chapter presents an overview of the behavior of inflation in Chile and its determinants. After discussing the definition and measurement of inflation, as well as the economic costs associated with it, the chapter discusses the central role that monetary policy plays in its long-term behavior. This is illustrated through a brief history of inflation in Chile since the second half of the last century, emphasizing the role played by institutions at different moments in time and their influence on the management of monetary policy. The behavior of Chilean inflation in recent decades is also contrasted with the inflationary dynamics observed in the rest of the world.

The chapter then examines the role that price rigidities play in the short-term relationship between inflation and economic activity, and their importance for short-term inflation dynamics and the stabilizing and counter-cyclical role of monetary policy. First, it analyzes the evidence of price rigidities in Chile using information on individual price behavior, and discusses how this relates to the existence of a short-term relationship between real activity and inflation. Then, the chapter presents a statistical analysis of the behavior of inflation in the short- and medium-term, characterizing the importance of different types of shocks in explaining inflation dynamics. Third, it discusses the validity and effectiveness of the Phillips curve as an analytical framework and a tool for predicting short-term inflation.

The main message of this chapter is twofold: First, high inflation imposes significant costs on economic growth and the welfare of households. Over the long run, evidence from the world and Chile is quite conclusive in that inflation is always associated with monetary policy. Thus, the main contribution that monetary policy can make to the population's welfare is to guarantee low, stable inflation.

High inflation was a persistent and recurrent phenomenon over much of the last century in Chile. For much of the period, the source of inflation was the subordination of monetary policy to fiscal financing needs. As in other countries, stopping the persistence of inflationary cycles required cutting off the regular dependence of public finances on monetary financing. This was attained through an explicit objective of price stability and the independence of monetary policy management from the political process. Equally important was the series of fiscal reforms that cut the link between the needs of the Treasury and money creation. This has meant that in recent decades, in Chile as in several other economies, inflation has remained low and relatively stable.

The second message deals with the determinants of inflation in the short and medium term. The existence of rigidities in the price adjustment process, as documented with evidence from microeconomic data for Chile, shows that the prices of individual goods do not automatically adjust to shocks, allowing monetary policy to influence real variables in the short term, and establishing

a link between real activity and inflation. Thus, shocks to aggregate demand, aggregate supply or in the external sector have inflationary effects in the short and medium term, and thus explain a significant percentage of the variance of inflation.

One conceptual framework to represent these relationships is the Phillips curve, which establishes that short- and medium-term inflation depends on real activity, future inflation expectations and the external sector. This relationship is the main mechanism that characterizes how monetary policy affects real activity and inflation dynamics in the policy horizon, thus being a pivotal piece of the monetary policy framework of central banks in general, and of the CBCh in particular. There is evidence that the Phillips curve is still empirically valid in Chile as a useful tool for analyzing and forecasting inflation in the short term.

2.1. The importance of inflation and the role of monetary policy

2.1.1 Inflation: definition and measurements

Inflation is defined as the sustained increase over time in the general price level of goods and services in an economy. More specifically, inflation is a generalized increase in the prices of the economy's goods and services in terms of one unit of measure - the country's currency - that occurs consistently over time. Inflation, a nominal phenomenon, does not refer to permanent changes in relative prices - a change in the price of one good or group of goods relative to the rest, as may occur in response to phenomena such as technological change - which is a real phenomenon. In the short term, inflation can be affected by the temporary impact on prices of one-off events —such as seasonal fluctuations in product availability and costs that can affect the prices of fruits and vegetables— which do not affect their long-term determinants.

To measure the general level of prices and services in an economy, the traditional strategy is to use price indexes. These are indicators that capture prices of a broad set of goods and services, weighted by different criteria. One widely used international indicator is based on a consumer basket, which in Chile's case is represented by the Consumer Price Index (CPI), calculated by the National Statistics Institute (INE). The CPI measures, on a monthly basis, the prices of a basket of goods and services representative of household consumption, and includes both prices of domestic goods and services and prices of imported products. Therefore, its movements reflect the increase in the price level of the country's consumer basket, and is a measure of the relevant inflation experienced by households[1/].

Like any measuring tool, the consumer price index has its limitations. For one, the household consumer basket changes over time, in response to changes in preferences, relative prices or income shocks. Consumers can be expected to substitute against those goods that become more expensive, or to adjust the composition of their basket as their income varies. While

1/ Defining prices in terms of household consumption is not the only possible choice. Thus, aside from the CPI, Chile and other economies use other indexes such as the Producer Price Index (PPI) and the CPI deflator, which in turn also includes a specific consumption deflator. Conceptually, the movements in these indicators also capture definitions of inflation and can thus deliver valuable information to complement the CPI content.

the CPI consumer basket is adjusted periodically[2]/ to reflect changes in the composition of household spending, the frequency of these adjustments is unlikely to capture every change in consumption patterns, so measured inflation may differ in the short term from the inflation actually experienced by consumers[3]/. Additionally, the consumer basket can vary significantly across households, so in the short and medium term, actual inflation may be different for households of different socioeconomic levels or demographic composition, although in the long term it will be similar for all. Finally, in the short term the CPI may be influenced by more volatile prices, by specific prices subject to seasonal factors or by relative price adjustments, all factors that may cause temporary fluctuations in the index that do not represent sustained price variations. This has led to the complementary use of "core inflation" indicators, which can better measure the trend of inflation, isolating the effect of transitory shocks (Box 2.1).

While it is good to keep these limitations in mind when analyzing inflation, the CPI is probably still the measure that best combines reliability, representativeness, and ease of communication as a measure of the relevant inflationary process. Moreover, in longer horizons, these distinctions lose relevance, as all indicators will tend to converge to trend inflation which, in turn, is determined by monetary policy.

Box 2.1: Measuring core inflation

Although the CPI is an easily understood and communicated indicator, it is a highly volatile measure of inflation, which makes it difficult to use it to capture medium-term inflation trends (core inflation). Traditionally, one way to address this problem has been to exclude categories of goods that on average present significant short-term fluctuations, such as food and energy, by defining a CPIEFE ("excluding foods and energy"), and use this indicator as a proxy for core inflation.

Carlomagno *et al.* (2021) document the limitations of inflation EFE as a measure of core inflation and propose alternative measures with better properties, which are now in use at the CBCh's monetary policy evaluation. The limitations of the CPIEFE as a measure of core inflation lie in the fact that, being a fixed exclusion indicator, i.e., by always excluding the same components: food and energy, the resulting indicator can keep in the CPI basket prices of CPI components that, being neither food nor energy, are highly volatile because they are systematically affected by transitory supply shocks, and exclude from the basket less volatile food or energy components that are not affected by these shocks. This limitation is typical of fixed-exclusion indicators, because the exclusion criterion does not come from a criterion of optimality, but from an ex-ante defined broad category.

In effect, the comparison of statistical properties suggests that the use of complementary indexes to the CPIEFE can contribute relevant information for the understanding of the medium-term inflationary trends. Carlomagno *et al.* (2021) propose a procedure to select the components to be excluded from the CPI basket, based on the desirable statistical properties that an indicator of core inflation should have (i.e., bias, volatility, persistence, relationship with the output gap and predictive power). This procedure also allows for the construction of an optimal measure of fixed or variable exclusion. Based on these properties, they suggest that the optimal inflation

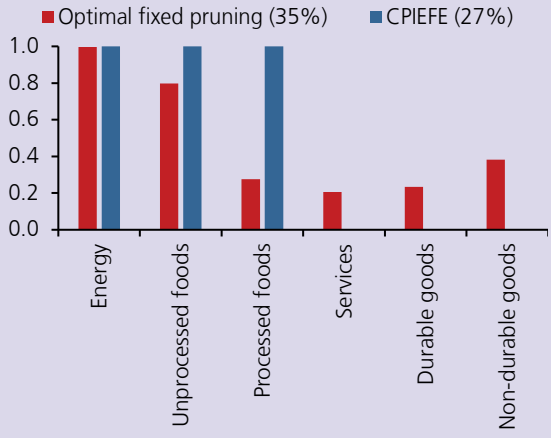
2/ In 2009, the INE adopted a policy to update the CPI basket with a new consumption survey and revise its calculation methodology every five years, i.e., a higher frequency than the ten-year span that had been used historically. See Box IV.1 in the March 2019 Monetary Policy Report. This new frequency is consistent with what developed countries use and the methodological recommendations of the IMF.

3/ Generally speaking, measured inflation is likely to overestimate actual inflation, as it does not fully account for the improvements in quality of the products nor the fact that consumers substitute products as relative prices change. These two phenomena reduce the average effective cost of the goods and services consumed.

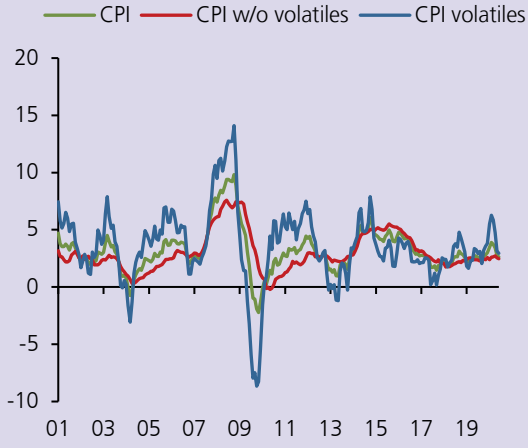
indicator is the average of the variable exclusion measures. However, since communicating this type of indicator could be more difficult, a fixed-exclusion indicator based on these criteria may be desirable. Within the fixed-exclusion criteria, a CPI measure without volatile components (CPI without volatile components, referred to as the core indicator as from March 2020) performs significantly better than the CPIEFE, because the excluded percentage affects the different groupings of goods in the basket to a different degree, resulting in a noticeably less noisy indicator than the CPI (figure 2.1).

FIGURE 2.1 CORE INFLATION MEASURES

Percentage of exclusion by category: CPIEFE v. CPI with optimal fixed pruning (CPI w/o volatiles)



CPI and CPI w/o volatiles, 2001-2020 (annual change, %)



Source: Carlomagno, Fornero and Sansone (2021).

2.1.2 Costs of inflation

The pricing system is fundamental in the economy, as it provides a metric of the relative scarcity of goods and services, allowing a more efficient allocation of resources to those uses where they are most valued. Similarly, changes in relative prices should guide the reallocation of resources over time. When inflation is high and volatile, it is difficult to distinguish changes in relative prices —which should lead to the reallocation of resources— from changes in absolute prices, which keep relative prices constant and therefore do not generate a change in the efficient allocation. This weakens the informative function of the price system and makes it difficult for households and firms to make decisions[4]/.

Additionally, high and unstable inflation introduces uncertainty about the future evolution of the prices of goods and services, as well as the behavior of financial assets, affecting investment and financial market development[5]/. It also generates the need to allocate resources to developing hedging instruments, such as indexed assets, to cover for possible losses in a more uncertain environment[6]/.

4/ See the works of Fischer (1993), Tommasi (1994), White (2006), and Mishkin (2008).

5/ See Fischer (2016), Huizinga (1993) snd Pindyck and Solimano (1993).

6/ This can also affect areas such as the fiscal situation, due to its effect on the value of the tax base, if it is not indexed. See Box 2.2 about indexation in Chile.

All this suggests that high inflation has adverse effects on long-term economic growth, by reducing efficiency and factor accumulation. These adverse effects are magnified if high inflation comes with higher volatility. There is abundant evidence of a significant negative association between inflation and the level and efficiency of investment and economic growth over the long run[7]/.

In terms of equality, inflation is regressive, as it hits hardest lower-income groups, who consume a bigger portion of their income and have less access to the financial market, so they maintain proportionally more money balances whose value is eroded by inflation. Furthermore, a greater share of their income are labor earnings, which tend to react to inflation with a lag, as opposed to capital income, which adjusts more quickly[8]/.

For all these reasons, high inflation reduces welfare, both because of its adverse effect on growth and thus on household income, as for the way it affects purchasing power, particularly that of the poorer households that are more dependent on the labor market. Therefore, the main contribution of a central bank to society is ensuring low, stable inflation.

2.1.3 What determines long-term inflation?

Over the long run, the behavior of the economy's real variables, e.g., GDP growth, is not affected by the behavior of inflation, which is associated with monetary policy, but it depends on its interaction with other real variables, including factor accumulation and technological development. Similarly, the persistence of high, volatile inflation in an economy cannot be linked in the long term to real factors such as its productive structure or the degree of competition in its markets, but rather to the way monetary policy is implemented.

There is ample empirical evidence suggesting that, over the long term, movements in the money base are positively correlated with inflation, but not with real activity, which is consistent with the notion that inflation depends on monetary policy in long horizons[9]/. This correlation is especially strong during periods of high inflation, which are associated with particularly high growth in the quantity of money, which have been recurrent in Latin American history[10]/. In contrast, the correlation between growth in the money base and inflation is weaker in those countries where inflation is low and stable [11]/.

If inflation is costly, and at the same time can be completely controlled by monetary policy in the long run, why do many countries end up with high levels of inflation on a sustained basis? In other words, what is the fundamental cause that leads to an accelerated growth in the money supply and ultimately to inflation? A natural candidate is the need for fiscal financing, and the use of monetary issuance as a form of revenue. Under this logic, the ultimate responsibility for inflation would be the need for

7/ There is abundant literature on the relationship between inflation and economic performance. See, among others, De Gregorio (1993) and Aksoy *et al.* (2017) on the link between the level and volatility of inflation. Pindyck y Solimano (1993) and De Gregorio (1996) establish a relationship between investment and inflation. See also Fischer (1993), Bruno and Easterly (1998), and López-Villavicencio and Mignon (2011) for a direct relationship between growth and inflation.

8/ For a literature review of inflation and equality, see De Gregorio (1998), Easterly and Fischer (2001), Erosa and Ventura (2002), and Albanesi (2007), among others.

9/ See Friedman and Schwartz (1963) and Berentsen *et al.* (2008). McCandless and Weber (1995) examine data from 110 countries between 1960 and 1990, finding that the correlation between changes in the monetary base and inflation is between 0.92 and 0.96, while the correlation between changes in the monetary base and real GDP growth is negligible.

10/ Several separate studies for countries like Chile, Colombia, Ecuador, Mexico, Paraguay, and Venezuela find that during the periods of accelerated monetary growth, they exhibited higher inflation levels. See Caputo and Saravia (2019); Sánchez *et al.* (2005); Cueva and Díaz (2018), Meza (2018), Charotti *et al.* (2019), and Restuccia (2018)).

11/ Haldane (1997), Grauwe and Polan (2005) and Benati (2009).

fiscal funding, a normally highly persistent situation that can become an almost structural factor, with high inflation resulting from the inability to adjust the fiscal balance by other means and the subordination of monetary policy to that objective, given the institutional framework of the economy. As will be seen in the next section, the fiscal origin of inflation was a recurrent reality in Chile during an important part of the last century, with persistent fiscal imbalances whose monetization by the CBCh resulted in significant and persistent inflationary pressures[12]/.

The main reason for this separation between real and nominal variables in the long term lies in the flexibility to adjust prices over this horizon[13]/. Thus, any movement in a nominal variable —such as the amount of money in an economy—-will, in the long run, always be offset by a movement of the same proportion in the price level. In the short and medium term, the existence of rigidities in the price adjustment process, discussed in the final section of this chapter, creates a relationship between real activity and inflation, where movements in the labor market, consumption, or investment can affect inflation, temporarily diverting it from its long-term trajectory. Inflation can also be directly affected by other shocks, both internal and external, which can explain a significant part of its short-term fluctuations, and whose persistence can be long if inflation has a significant degree of inertia. In an economy like Chile, which is open and with a floating exchange rate, the exchange rate also plays a central role, both as an adjustment variable in the presence of external and internal shocks, and in the way it responds to monetary policy decisions[14]/. These short- and medium-term inflation movements are presented in the final sections of this chapter and in the following chapters of this document.

2.2. Chile's inflation experience

This section presents a brief account of Chile's inflation over the last century, stressing the inflationary problem that characterized the country for decades, and describing how, upon abandoning the use of money creation to finance fiscal needs, inflation began its convergence to the low and stable levels where it has remained over the last two decades. This process is in line with generalized inflation reduction observed worldwide.

2.2.1 A brief chronicle of inflation in Chile: 1925-2019

During most of the twentieth century, coexistence with high and volatile inflation was a recurring problem in the Chilean economy. The average annual inflation between 1925 (the year the Central Bank was created) and 2000 was 43% (standard deviation of 93%), a number that shoots up to an average of 86% (standard deviation of 133%) for the period 1950-1980. In this context, the search for mechanisms to control what seemed to be an endemic problem was at the center of public debate, at least since the 1940s, and was a key element in the economic agenda of most governments at the time[15]/.

12/ As will be discussed below, a recurrent response was to fix prices, including the exchange rate, in an attempt to rein in inflationary pressures, typically ending up in a balance of payments crisis that eventually acknowledged the exchange rate lag.

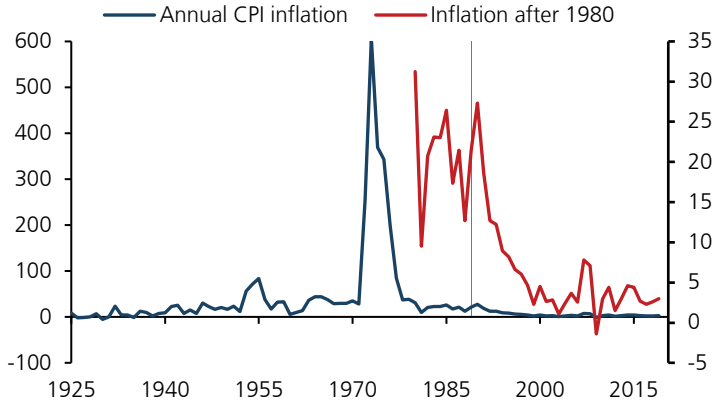
13/ There are additional reasons for this separation, including limited access to and/or processing of information, or the characteristics inherent to the expectation formation process, as will be seen later in this chapter and in Chapter 4, respectively.

14/ For example, an expansionary monetary policy can be transmitted to prices via an exchange rate depreciation. If exchange rate adjustment is not allowed, it can end up translating into an exchange rate crisis that triggers abrupt inflation, often in the midst of a recession, which tends to distort the causality of inflation.

15/ For a deeper review of Chile's inflation history and main causes, see Morandé and Noton (2004), Rosende and Tapia (2015), Caputo and Saravia (2019), and Carrasco (2020). This section is largely based on the contributions of their work.

The inflationary problem became increasingly acute over time, peaking in the first half of the 1970s. At the time, annual inflation averaged almost 300%, with a historical peak of nearly 600% in 1973 (Figure 2.2). From the second half of the 1970s onwards, inflation no longer approached three digits, but remained at relatively high levels for the next fifteen years. It only began a sustained decline in 1990, coming close to 3% at the turn of the century, where it has remained since. Therefore, the recent experience, characterized by low and stable inflation, continues to be an exception in the context of the long history of Chilean inflation, and is an achievement that could only be achieved by the end of the twentieth century.

FIGURE 2.2 CPI INFLATION: 1925-2019
(annual change, percent)



Sources: EH-Cliolab and National Statistics Institute (INE).

The subordination of monetary policy to the needs of fiscal funding covered by the creation of money explained, to a large extent, the dynamics of inflation until the mid-1970s. For a large part of the century, the financing of fiscal deficits could be directly associated with the behavior of money creation, with the Central Bank financing governments that spent more than what they raised[16]/[17]/. The corporate governance of the Central Bank, which at different times and throughout successive reforms included representatives of the central government, the private sector, and other organizations, probably did not help to make inflationary control a priority. In contrast, the administration of monetary policy gradually became dependent on the needs and interests of different groups[18]/.

16/ As discussed in Morandé and Noton (2004), during part of the twentieth century the Central Bank of Chile also used monetary issuance to grant credit to privates, which was also a source of inflation. See also Zahler and Budinich (1976).

17/ Since its second Organic Law (1953), the CBCh was authorized to grant credit to the Treasury and was obliged to discount bills of exchange drawn by the Caja Autónoma de Amortización de la Deuda Pública, which was in charge of the General Treasury of the Republic. The latter had to do so for the term, conditions and amount stipulated by law. In addition, other special laws could force it to discount other State instruments. This was repealed in 1979. Later on, with the 1980 Constitution and the enactment of the current Organic Law, the prohibition of direct and indirect fiscal financing is absolute, the sole exception being a case of war. In 2020, through an amendment to the Constitution and the Organic Law, the CBCh can acquire fiscal instruments in the open market under exceptional circumstances, which does not imply fiscal financing.

18/ For further detail on the historical evolution of the CBCh's institutional and legal framework, see Corbo and Hernández (2005).

Figure 2.3 illustrates this point, showing the relationship between seigniorage (the income obtained from the issuance of money, calculated as the rate of money creation multiplied by the actual monetary balances) and the fiscal deficit from 1960 to 2019. As can be seen, the trajectory of money issuance follows almost perfectly the Treasury's funding needs up until the mid-1970s. Figure 2.4 complements the analysis by showing the joint movement of money and inflation in the hyperinflation episode of the early 1970s, as well as the clear positive correlation in the last century between the rates of money growth and inflation.

These figures are suggestive, and consistent with the previously discussed notion that, at high levels of inflation, the correlation with the growth of money is high—which is not the case when inflation is low and stable. However, a better measure of the response of monetary policy to fiscal needs can be obtained by looking at the magnitude of Central Bank loans to the Treasury during the first half of the 1970s (Figure 2.5)[19]/.

The persistence of high inflation derived from money creation being used to solve fiscal problems is explained, in part, by the lack of structural solutions to the problem of fiscal deficits, which led to the failure of various stabilization programs, such as that derived from the recommendations of the Klein-Saks mission in the mid-1950s or the adoption of a fixed exchange rate in the early 1960s. Furthermore, there was no consensus on the causes of inflation in the public debate, with the vision of its origin being primarily associated with monetary policy coexisting with other opinions that attributed a leading role to the exchange rate, to factors associated with the productive and consumer structure of the economy (the structuralist theory) or directly to reasons such as speculation[20]/. This made it difficult to find a consensual mechanism to address the inflationary problem and led to the use of tools such as price controls, which did not address the underlying issue and only introduced more distortions.

The powerful fiscal adjustment program of the mid-1970s broke, de facto, the need to use money as a source of fiscal financing (Figure 2.3), by eliminating the tight relationship between seigniorage and fiscal deficits observed in previous decades, although institutionally the dependence of the Central Bank on the central government did not disappear. This process of fiscal consolidation was the first step in a path, interrupted at least between 1982 and 1983, to make fiscal policy deliberately neutral with respect to the cycle, which would culminate two decades later with the adoption of a fiscal rule that, as will be seen, was important for the consolidation of low inflation as from the year 2000[21]/.

Despite the absence of direct fiscal pressure, inflation remained moderately high —although lower than in the past— reaching an annual average of 24%. Meanwhile, it also became significantly more stable, with a standard deviation of 8%[22]/. There are several reasons that may explain the persistence of relatively high inflation between 1976 and 1990. First, its high degree of inertia, associated with the widespread indexation mechanisms that the inflationary history had generated (Box 2.2). Thus, despite the adoption of a fixed exchange rate in 1979, inflation declined only

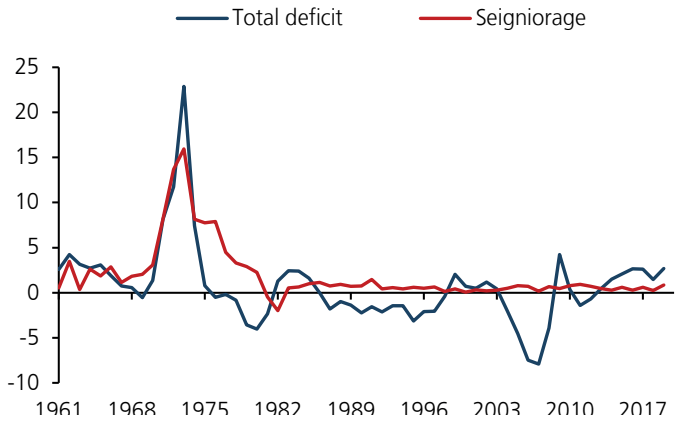
19/ As discussed by Carrasco (2020), the sharp increase in loans to the Treasury in 1989 was mainly an accounting procedure due to a restructuring of the CBCh's balance sheet, which changed the classification of operations associated to the response to the 1983 banking crisis.

20/ See, for example, Sunkel (1958), Pinto (1963), and Campos (1961).

21/ The first step in this sense was the creation of the Copper Stabilization Fund in the late 1980s as part of the conditions for an SAL loan by the World Bank.

22/ The inflation figures of the time must be taken with caution. Cortázar and Marshall (1980) discuss how official statistics underestimated inflation between 1976 and 1978 by around 10-20% per year.

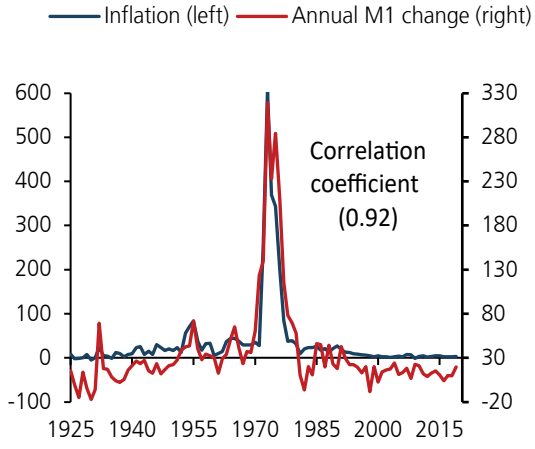
FIGURE 2.3 TOTAL FISCAL DEFICIT AND SEIGNIORAGE: 1961-2019
(percent of GDP)



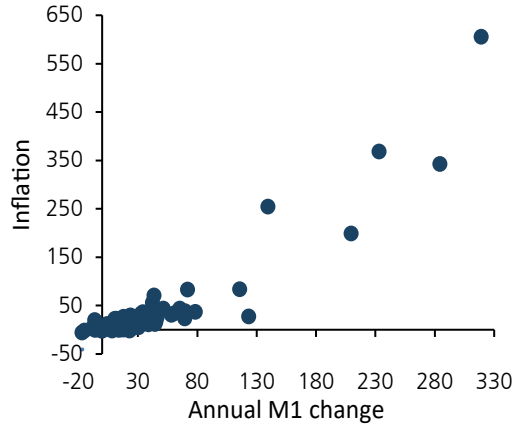
Source: Caputo and Saravia (2019).

FIGURE 2.4 MONETARY AGGREGATES AND INFLATION IN CHILE

Inflation and money growth
(average annual change, %)

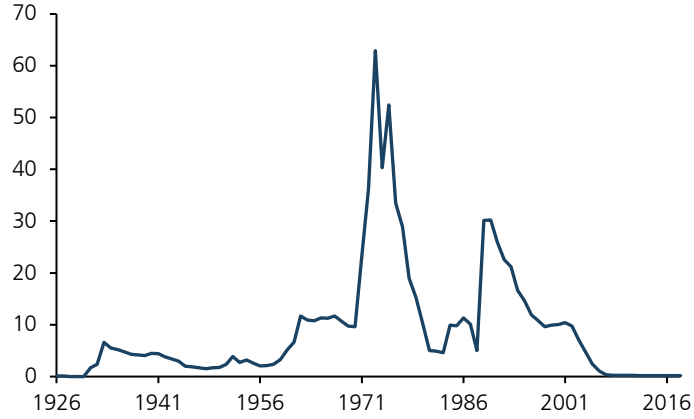


Inflation to money growth ratio
(average annual change, %)



Sources: EH Cliolab, Central Bank of Chile and INE.

FIGURE 2.5 CENTRAL BANK OF CHILE'S LOANS TO THE TREASURY
(percent of nominal GDP)



Source: Filippi, Román and Villena (2015) updated.

slowly in the following years. Bringing down inflation was also made difficult by the opening of the capital account, which created an endogenous and significant increase in the quantity of money, in parallel with a sharp fall in interest rates. After the abandonment of the exchange rate peg in 1982 and the associated devaluation, inflation climbed back to around 20% for the rest of the decade. Second, the absence of an explicit nominal anchor, except in the 1979-82 fixed exchange rate period, prevented the monetary authority from drastically reducing future inflation expectations. Third, and particularly after the 1982 devaluation and the severe recession and exchange rate crisis of 1982-83, further reductions in inflation were not a priority, with policy efforts aimed at recovering activity, rebuilding the financial system, and normalizing external payments. In fact, inflation accelerated significantly at the end of the decade in the context of a rapidly expanding economy, hitting 27% in 1990[23]/.

The legal autonomy conferred to the Central Bank in 1989 laid the legal foundations of the institutional framework that, from then on, formally consolidated the conduct of an autonomous monetary policy, separated from potential fiscal needs. Autonomy also changed the corporate governance of the Central Bank, eliminating the existing dependence on the central government, and establishing an independent Board of five members, appointed by the President of the Republic with the approval of the Senate, who serve for ten-year terms, renewable on a staggered basis. This institutional framework has two key elements: on the one hand, it gives the CBCh the mandate to ensure the stability of prices in the economy and, on the other, it prohibits the direct financing of the Treasury. The Organic Law also assigns the CBCh role in financial stability, mandating it to ensure the normal functioning of the internal and external payments system.

23/ For further detail, see Corbo and Hernández (2005).

Beginning in 1990, a process of gradual reduction of inflation began[24]/ through the publication of inflation forecasts that, over time, and to the extent that they were validated by actual inflation, evolved to a partial inflation targeting regime. The choice of a gradual strategy reflected the risk that a strategy aimed at a faster and more aggressive reduction of inflation could have significant real costs in the context of an economy with high inflationary inertia and where the Central Bank had to build a reputation that would allow it to generate confidence and credibility by matching its inflation projections, thus allowing it to affect expectations and the mechanisms for determining prices and wages. The inflationary objective explicitly coexisted with an exchange rate target reflected in a floating band, which translated into allowing a gradual reduction of the real exchange rate that would help to reduce inflation without incurring major costs in lost activity or generating an imbalance in the external accounts[25]/.

Over time, the annual inflation targets provided a nominal anchor to the economy, and their fulfillment gradually consolidated the credibility of the monetary policy's commitment to move towards lower inflation, thus allowing for an adjustment in agents' inflation expectations[26]/.

Thus, inflation fell steadily during the 1990s, from 27% in 1990 to 3%, the figure chosen as the long-term inflation target[27]/. The Central Bank's inflation targeting scheme attained its maturity with the formal and full adoption of a permanent target of 3% over a two-year horizon, and with the establishment of a floating exchange rate regime, after a gradual process of exchange rate flexibility during the 1990s. The adoption of a floating exchange rate was a particularly significant fact for the management of monetary policy from that moment onwards, because until then the control of inflation was also subject to the management of the exchange rate[28]/.

As mentioned above, the process of inflation reduction, and the consolidation of low inflation expectations, was largely helped by the development of the local financial market and a balanced fiscal policy, which would culminate in the adoption of a fiscal rule in 2001. Even in a context of autonomy and absence of subordination, an unbalanced fiscal policy path, due to its effects on spending, financial markets and agents' expectations, would have made it very difficult to control inflation and build the credibility of macroeconomic institutions.

Under the inflation targeting scheme, average annual inflation over the last twenty years has been 3.2%, with a standard deviation of 2.5%. In addition, and as will be seen in Chapter 4, two-year inflation expectations have remained anchored to the 3% target virtually all the time. In light of the historical experience of decades with high and volatile inflation environments, this is an achievement of Chile's macroeconomic institutional framework, associated not only with monetary institutions but also with the operational framework of fiscal policy, and has been a factor of stability with major consequences for the households' welfare.

24/ Although the inflationary reduction strategy was gradual, in 1990 the Central Bank aggressively raised the interest rate, signaling its goal to avoid a further acceleration of inflation and to begin building its credibility (see Ffrench-Davis and Laban (1994)).

25/ Another important tool was the policy of indexing public wages that explicitly adopted a framework of projected inflation for the year plus productivity gains, rather than being based on past inflation.

26/ See Schmidt-Hebbel and Tapia (2002) for details of the monetary strategy employed.

27/ For a discussion of the choice of 3% as the target level, see "Monetary Policy in an Inflation-Targeting Framework" (Central Bank of Chile, 2020).

28/The duality of these two objectives —exchange rate and prices— revealed its limitations in responding to strong external shocks, such as the Asian crisis of 1998. See De Gregorio (2004) for details.

Box 2.2: Indexation in Chile

Indexation is a price adjustment mechanism that allows to generate contracts whose terms of reference are tied to a specified indicator, such as past inflation or a stable currency. Credits at different horizons, investment instruments, pension and health contracts, insurance and labor contracts are some examples of indexed contracts. Indexation arises as a natural response to the need to have financial assets and instruments capable of preserving the real value of goods and services over time, in contexts of high and volatile inflation. In Chile, the persistent inflation that was characteristic of the country throughout t he twentieth century led, in 1967, to the creation of the Unidad de Fomento (UF), whose use became widespread with the development of the financial market from the 1970s and 1980s (Shiller, 2002). Evidence suggests that, in Chile, indexation to past inflation contributed to the deepening of the financial market, as it generated a totally new hedging mechanism against inflationary risk (Walker, 2002), and also prevented the dollarization of the economy (Herrera and Valdés, 2004). The indexation of the tax base also helped in the process of fiscal consolidation.

Even though indexation facilitates the operation of economic and financial activities in inflationary environments, it can also make the task of reducing inflation more difficult by introducing a significant degree of inertia. The literature suggests that indexation mechanisms can contribute to keeping inflation at high levels, and to favor its persistence due to second-round effects. This is so because temporary variations in prices are propagated and maintained over time by the automatic adjustment mechanism in wages and other prices (Lefort and Schmidt-Hebbel, 2002; Walker, 2002), as reflected in the case of Chile in the early 1990s, and how important it was that the adjustment mechanisms began to be anchored to expected rather than past inflation.

Under indexation, in the event of an adverse supply shock (for example, a rise in food costs) that pushes up the price level, the value of the indexed goods will rise mechanically, with no change in the production costs of those goods. This not only amplifies the inflationary effect of the initial shock, but weakens the relative price adjustment (Briault 1995). It is expected that, the greater the degree of indexation, the greater the importance of second-round effects on the persistence of inflation. De Gregorio (2019) notes that the use of indexation in Latin America was a factor that made the control of inflation harder in the region, as discussed in the case of Chile. On the other hand, Perez-Ruiz (2016) suggests that, in economies that managed to control inflation, the benefits of indexation are diluted and its costs increase.

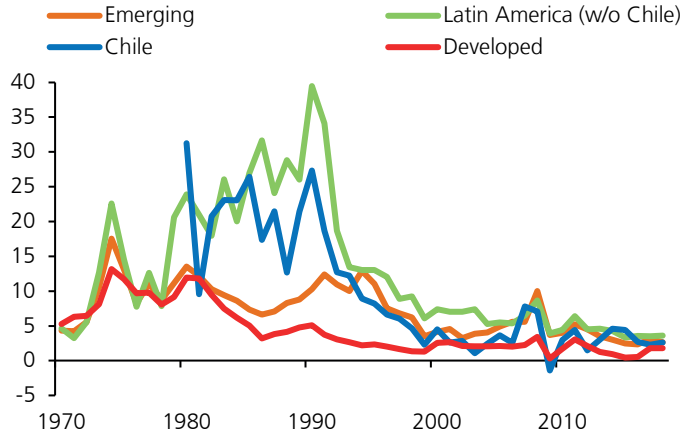
Nowadays, indexed contracts are still used extensively, despite the fact that inflation in Chile has been low and stable for two decades, and the Central Bank changed its policy instrument from an indexed rate to a nominal rate more than 15 years ago. What explains this phenomenon? In the absence of studies that have analyzed this apparent puzzle, this document only raises a couple of hypotheses. First, it is possible that the insistence on the use of indexed assets and contracts stems from the inertia and habit formation of a market equilibrium that has remained stable for a long time, in a context of low and predictable inflation in which there is also no very significant benefit in moving to the use of other types of instruments. In addition, despite the positive inflationary history of the last decades, it is possible that the historical experience of inflation continues to affect the risk perception of the agents, who prefer not to expose themselves to scenarios of a future resurgence of inflation.

2.2.2 Chile's inflation in the global context

In order to have a better analysis of the evolution of inflation in Chile in the last decades it is useful to look at the international experience, and compare it with Chile's. When analyzing the evolution of inflation around the world over the past decades, more often than not the countries' evidence shows a sustained downward trend. Indeed, the annual median of headline inflation (as measured by the CPI) has declined from roughly 17% in 1974 to around 2.4% in 2018. For emerging and developing economies, this fall has been from 17.5% in 1974 to 2.6% in 2018[29]/. In other words, the successful experience of inflation reduction in Chile can be encompassed within a global phenomenon, in which a very significant number of countries — but not all— managed to reduce their average inflation quite significantly.

This can be appreciated in figure 2.6, which illustrates that the Chilean experience was similar to the experience of other emerging countries and Latin America. Thus, for example, while in 1991 the median inflation in Latin America was 34%, well above that of developed countries, by 2000 this median was close to 6%, with a reduction path qualitatively similar to that of Chile and the median of emerging countries. Over the last twenty years, median inflation in these groups of countries has remained relatively stable, except for the inflationary episode of 2008, with differences between groups that are today far smaller than in the past.

FIGURE 2.6 INFLATION BY GROUPS OF COUNTRIES, 1970-2017
(median annual change, percent)



Source: Based on data from Ha *et al.* (2019).

The main structural explanation, consistent with the Chilean experience, is the adoption of best practices in the institutional design and conduct of monetary and fiscal policy —possibly associated with a better understanding of the ultimate determinants of inflation—, and consensus on the limits of what monetary policy can do in the short and long term. This has translated into improvements in the institutional framework of central banking and the design of monetary policy management schemes. As will be shown in more detail in Chapter 4, this has been reflected in higher levels of central bank independence and greater transparency in the conduct of monetary policy[30]/.

29/ See Ha *et al.* (2019).

30/ There is an extensive literature about the link between inflation and autonomy, both in cross section as in the effects of changes over time. See Eijffinger and De Haan, (1996), Sturm and De Haan (2001), Acemoglu *et al.* (2008), Crowe and Meade (2008), Klomp and De Haan (2010a, 2010b), Maslowska (2011), Dincer and Eichengreen (2014), Trabelsi (2016), and Kokoszczynski and Mackiewicz-Liyziak (2020). In general, the result is that a higher degree of autonomy (and transparency) is associated with lower levels of inflation, although the exact quantitative effect is sensitive to the specification, methodology, and countries under analysis.

It is quite possible that, as will be discussed in Chapter 3, the reduction in inflation was also helped by global supply shocks, changes in the structure of world trade, and technological advances[31]/. These medium-term disinflationary shocks brought down the prices of some types of goods, but they don't have the capacity to, by themselves, reduce the inflation trend, which over the long run remains anchored to monetary factors and the institutional framework.

2.3. Evidence of short-term inflation determinants and the Phillips curve

2.3.1 Price rigidities and implications for monetary policy

As noted above, in the long run all prices are flexible, so changes in monetary policy that affect the quantity of money in circulation will eventually translate entirely into price changes. Conversely, in the short term there are rigidities in the price adjustment process, causing monetary policy to have real effects. In the presence of price rigidities, changes in the nominal policy interest rate of the Central Bank translate into changes in the real interest rate. This movement in the real interest rate influences consumption and investment decisions and, therefore, output and employment, which can deviate from their long-term equilibrium. As prices adjust, real variables gradually converge to that equilibrium. In this way, the existence of price rigidities in the short term allows monetary policy to temporarily influence the behavior of the real variables of the economy and, under appropriate management, help reduce their volatility. For this reason, monetary policy can be an important counter-cyclical tool, smoothing over time the trajectory of GDP around its trend, in a context in which the CBCh's fundamental role of inflation stability is fulfilled[32]/.

What explains the price rigidities in the short term? The academic literature has discussed how different kinds of frictions at the microeconomic level can lead to prices that adjust only gradually in the face of shocks to the economy. First, after different forms of economic shocks, price changes can lead to different types of costs, which will cause them to adjust less frequently and converge only gradually towards a new equilibrium. Second, economic agents may face different types of information frictions, such as the existence of imperfect information on overall economic conditions, in addition to the costs and delays associated with acquiring the necessary information for firms' pricing decisions. This type of friction delays the price adjustment process because it implies a gradual learning process by economic agents[33]/.

31/ See Rogoff (2003), Lowe (2017) and Yellen (2017).

32/ The literature has labeled this "the divine coincidence." See Blanchard and Galí (2007).

33/ An important class of models considers that price changes depend on the time passed, without an explicit modelling of the determinants of that process. Classic inter-temporal nominal adjustment model references include Taylor (1979, 1980) and Calvo (1983). An alternative branch of models factors in price adjustment costs ("menu costs"), so in this case the prices will be modified according to economic conditions. Dotsey and King (2005) discuss this type of theoretical framework and its implications). Among imperfect information theories, it is worth noting the seminal work of Lucas (1972). In a related manner, there are works that study the relevance of the slow dissemination of information about macroeconomic conditions for the behavior of prices, including the works of Mankiw and Reis (2003), Ball, Mankiw, and Reis (2005), and later works by these authors. Walsh (2010) presents an introduction of this literature and the development of some of the main models which, in addition, has provided new breakthroughs in more recent years.

2.3.2 Short-term inflation determinants

As discussed in section 2.1, in the long run inflation depends entirely on monetary policy, which has no real effects except —indirectly— through the adverse impacts on growth and welfare that a high inflation rate can cause. Therefore, monetary policy cannot be a direct source of economic growth or job creation, but it can generate the conditions for a better performance thanks to its capacity to provide a stable macroeconomic environment with low inflation.

In the short run, however, the situation is different. The price frictions mentioned in subsection 2.3.1 not only imply that monetary policy can affect activity, but they also establish a link between real activity and inflation, where movements in the labor market or in aggregate demand can have inflationary effects in the short and medium term, with monetary policy affecting inflation through different transmission channels[34]/. Moreover, over those horizons, price dynamics are affected by the impact of other shocks, associated with both external factors (e.g., commodity prices, the dynamism of the world economy, international interest rates) and domestic factors (e.g., supply and demand shocks), in addition to heterogeneous spillover effects between different categories of goods[35]/. Therefore, short-term inflationary dynamics can depend on a multitude of factors, and having a measure of their relative importance is valuable both for the analysis and for the better conduct of monetary policy.

One of the advantages of working with structural models is that they can approximate the response of macroeconomic variables, such as inflation, to the specific shocks experienced by the economy. Figure 2.7 illustrates this advantage, showing the historical decomposition of the evolution of CPI inflation without volatile items, measured with respect to the target, in light of the shocks considered in the XMAS model, i.e., the structural projection model of the Central Bank of Chile[36]/. It is a good illustration of how, in the short and medium term, inflation is affected by a wide range of shocks that generate important deviations with respect to its long-term trend. Sometimes these complement each other, as was the case in 2007-2008 when demand, external and monetary policy shocks generated positive deviations of inflation from its trend, while at other times they move in opposite directions, as can be seen for the external and monetary policy shocks of 2009-2010[37]/.

Interestingly, the decomposition also provides a narrative of the role that different shocks have played over time. For example, external shocks were mainly associated with increases in inflation until 2009, while since then they have been associated with disinflationary pressures, in line with the discussion presented in Chapter 3. This is quite different from the case of labor shocks, a significant source of disinflationary pressures in the mid-2000s, which have lost importance in the last decade, aside from changing signs. It can also be seen that the strong migratory shock experienced by the Chilean economy in the last five years, whose effect on inflation was a priori ambiguous as it caused changes in both supply and demand, ended up having a disinflationary component associated with lower cost pressures, albeit of a limited magnitude. Finally, it can be seen how monetary policy shocks have most of the time helped to raise inflation, counteracting the effects of shocks in the opposite direction.

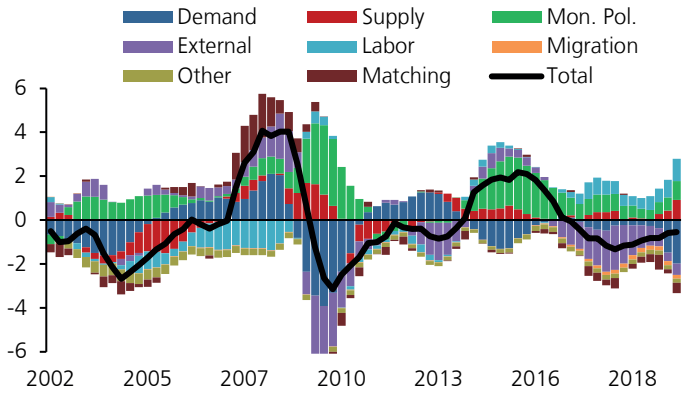
34/ For a discussion on Chile's monetary policy pass-through channels, see "Monetary Policy in an Inflation-Targeting Framework" (Central Bank of Chile, 2020).

35/ Pedersen (2016) suggests that, in general, the duration of inflationary shocks has been shorter from 1999 on, the year in which the full-fledged inflation targeting regime was adopted, together with a floating exchange rate. In addition, this evidence would imply that, when the economy is hit by an inflationary shock, e.g., a rise in the price of oil or foods, it is important to know its dynamic of propagation over different goods.

36/ For a detailed presentation of the CBCh's projection models, see "Use of Macroeconomic Models" (Central Bank of Chile, 2020).

37/ Monetary policy shocks should be understood as movements in the central bank's policy rate that are not anticipated by a simple rule that links movements in this rate with inflation and the activity gap. Chapter 4 will address these shocks in more detail. With respect to externally-driven shocks, Chapter 3 will present a more extensive analysis of them.

FIGURE 2.7 HISTORICAL BREAKDOWN OF CPI WITHOUT VOLATILES (*)
(deviation from target, annual change, percent)



(*) Shocks grouped as follows. External: trading partners' GDP, external rate, interest rate parity, copper and oil price, external inflation; Supply: productivity; Labor: job destruction and leisure preference; Demand: fiscal, consumption, investment; monetary policy; migration; matching in labor market.

Source: XMAS-model-based estimates.

Table 2.1 illustrates these mechanisms more systematically, by calculating the percentage of unconditional variance of inflation forecasting errors that can be associated with different types of shocks. This is a valuable input for the conduct of monetary policy, which, according to the CBCh's policy framework, should only respond to shocks that affect inflation persistently and therefore have a greater weight in forecasting errors. In the case of headline inflation, the most important factors are external, which is to be expected given the degree of openness of the economy and the importance of commodities in both exports and imports, which motivates the more detailed analysis of the external forces affecting inflation in Chile presented in Chapter 3.

TABLE 2.1 UNCONDITIONAL VARIANCE DECOMPOSITION, CPI WITHOUT VOLATILES AND TOTAL: 2002-2020(*)

	Demand	Supply	MP	External	Labor	Cummulative
Without volatiles	0.38	0.10	0.10	0.36	0.06	1.00
Total	0.20	0.33	0.06	0.37	0.03	1.00

(*) The table shows the forecast error variance decomposition of inflation related to each of the structural shocks in the XMAS model.

Source: Estimations based on the XMAS model.

Supply shocks associated with movements in total factor productivity are also very important, as they alone explain one-third of the total variance. The importance of these shocks is dramatically reduced when the more volatile items are excluded from the inflation figure. One example of this is what happens with shocks associated with food prices, most of which only have short-term effects on inflation variability and therefore do not call for a major policy response. In contrast, aggregate demand shocks[38]/ —-which together with external shocks explain almost 75% of the variance of inflation without volatility— affect the activity gap more persistently and with more lasting effects on inflation, making policy responses necessary.

2.3.3 The Phillips Curve

One way to rationalize the short-term relationship between inflation and its short-term determinants is through the Phillips curve (PhC)[39]/, one of the most important concepts in the modern macroeconomic analysis framework and in monetary policy design and implementation.

In its different versions, the PhC is associated with a positive short to medium-term relationship between a definition of inflation (e.g., in levels, deviation from expected inflation) and a measure of real activity (level of output, output gap, employment). This assumption is at the core of the neo-Keynesian approach that currently serves as a paradigm among central banks for modeling inflationary dynamics and monetary policy.

The PhC can be defined as an equilibrium relationship that, in the short term, links inflation to the output gap (the deviation of actual GDP from the potential level it would have in an economy without price frictions), with other relevant determinants such as inflation expectations (which will be discussed in detail in Chapter 4), past inflation (associated, for example, with indexation mechanisms such as those discussed in 2.2) and the exchange rate/external prices (an important factor for a small and open economy like Chile, as will be discussed in Chapter 3). As an illustration, for the case of the semi-structural model of the CBCh (MSEP), a version of the Phillips curve can be expressed as

$$(1)\ \pi_t = \gamma_f E_t \pi_{t+1} + \gamma_b \pi_{t-1} + \lambda x_t + \delta(\Delta s_t - \gamma_f E_t \Delta s_{t+1}) + u_t$$

where $E_t \pi_{t+1}$ is the inflation expectation in period t of future inflation in t+1, π_{t-1} is past inflation, x_t is the output gap, and $(\Delta s_t - \gamma_f E_t \Delta s_{t+1})$ is the unexpected movement in the nominal exchange rate.

This equation illustrates, in a simplified way, an analytical framework to explain inflation's behavior in the short term, and how it can be affected by different internal and external factors. Additionally, it provides a representation of the way in which monetary policy can affect inflation at various margins, through the effects that its instruments can have on the output gap, inflationary expectations and the exchange rate. This expression rationalizes the conceptual basis for understanding how monetary policy can play a counter-cyclical role in the short and medium term, while keeping inflation low and stable becomes the fundamental objective in the long term.

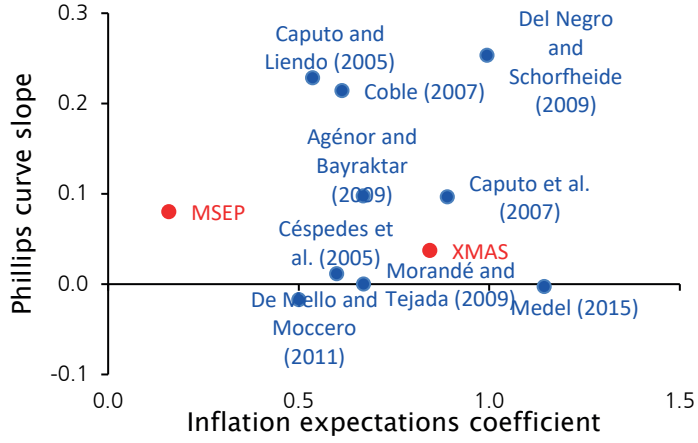
38/ Demand shocks are defined as unanticipated changes in consumption, investment and government spending. Box IV.1 of the December 2017 Monetary Policy Report discusses the importance of the propagation of different types of shocks on inflation.

39/ The Phillips curve was named by Samuelson and Solow (1960) in recognition of the work of New Zealand economist A.W. Phillips, who in 1958 documented empirically the negative relationship between unemployment and wage inflation in the United Kingdom between 1861 and 1957. Over time, this concept became generalized as a relationship between different measures of activity and nominal variables. A more detailed discussion of the historical evolution of the PhC can be seen in Contreras, Giuliano and Tapia (2016).

These properties make the Phillips curve part of the toolkit associated with the forecasting and analytical process of the CBCh, and of most central banks around the world. Therefore, a large empirical literature has estimated the parameters of the Phillips curve, with special attention to the activity parameter (λ in equation (1)), and its predictive and analytical power.

Figure 2.8 summarizes a series of estimates for Chile with respect to two of the key parameters of the Phillips curve: the effect of the real activity indicator (λ) and the importance of future inflation expectations (γ_f in equation (1)). These results are contrasted with the Phillips curves associated with the Central Bank of Chile's projection models already mentioned: the Semi-Structural Projection Model MSEP and the Structural Model XMAS[40]/

FIGURE 2.8 ESTIMATED PHILLIPS CURVE COEFFICIENTS FOR CHILE (*)



(*) Red dots correspond to models regularly used by the CBCh in its analyses.

Source: Contreras *et al.* (2016), updated.

Despite differences between the estimation methodologies and the exact definition of the variables used, the results suggest that the magnitude of the relationship between quarterly inflation and the output gap is relatively low (average 0.1), quite smaller than the magnitude of the coefficient of inflation expectations, which is around 0.7 (Figure 2.8). This does not imply that the gap is of little importance for inflation, due to its high degree of persistence[41]/, the impact is observed not only over one period, but is sustained over a relatively long time. Although the Central Bank's model estimates are similar in terms of the inflation-activity relationship, there is a substantial difference in the importance of inflationary expectations, which is relatively low in the MSEP model[42]/.

40/ Again, the MSEP model explicitly includes a PhC with inflation expectations in its equations, which can be directly estimated using historical data.

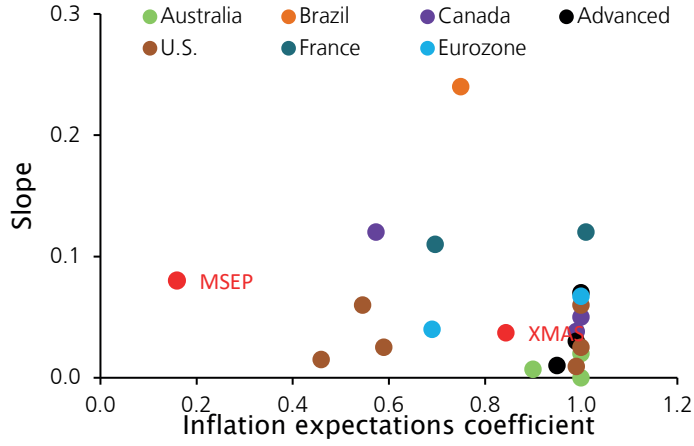
41/ For the statistical properties of the activity gap in Chile, see Arroyo-Marioli *et al.* (2020)

42/ For details, see Contreras, Giuliano, and Tapia (2016)..

In general, the evidence for Chile reflects the importance of inflationary expectations as determinants of inflation, and justifies their key role in the design of the inflation targeting scheme that governs monetary policy. The result also shows that the output gap is significant for inflation —in line with what the neo-Keynesian analysis framework suggests— but the coefficient is quantitatively small, although its cumulative effect is important due to the gap's persistence.

A comparison across countries yields a similar result to that of the previous figure, with similar magnitudes found in different estimates made for multiple economies (Figure 2.9). In other words, Chilean and international evidence suggests that the coefficient connecting changes in activity to changes in quarterly inflation is typically close to or below 0.1, while the coefficient of the inflation expectations component is typically higher.

FIGURE 2.9 ESTIMATED PHILLIPS CURVE COEFFICIENTS, INTERNATIONAL COMPARISON

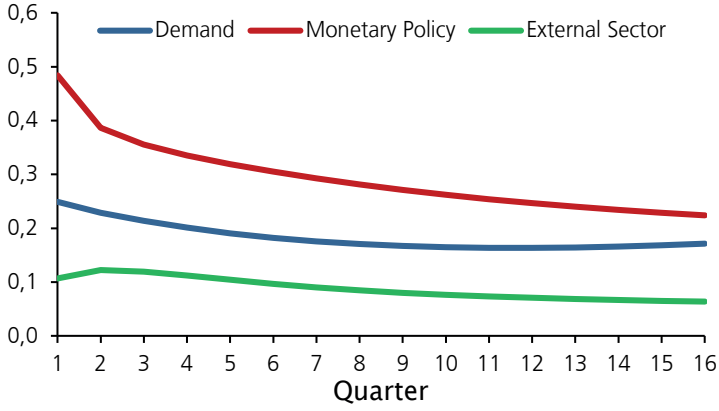


(*) Red dots correspond to models regularly used by the CBCh in its analyses.
Source: Contreras *et al.* (2016), updated.

The XMAS structural model does not incorporate the relationship between activity and inflation as a reduced-form equation associated with a specific Phillips curve, but rather implicitly derives it as an equilibrium relationship in response to the various shocks that the economy faces. Thus, the relationship between the output gap and inflation is not an unconditional parameter, but depends on the specific shock, which enhances the understanding of the economic rationale of the reduced form relationship presented by the Phillips curve. This is shown in figure 2.10, which shows the relationship between quarterly inflation and the GDP gap predicted for different types of shock in this model[43]/. Although the implicit elasticities are fairly limited in all cases, converging to values between 0.1-0.3 over a two-year horizon, the correlation is significantly higher when the economy is hit by a monetary policy shock than when the shock comes from the external sector. In addition, and as mentioned, the cumulative effect on inflation is not negligible, insofar as the gap is persistent and therefore the positive correlation remains for several quarters. This is consistent with the pass-through mechanisms via aggregate demand that are part of the analytical framework that guides monetary policy.

43/ Measured as the ratio between the cumulative impulse-response functions for the two variables.

FIGURE 2.10 ELASTICITY OF INFLATION TO THE ACTIVITY GAP IN THE XMAS MODEL, BY TYPE OF SHOCK (*)



(*) Elasticity defined as the ratio between the cumulative impulse-response functions for the two variables.
Source: Contreras *et al.* (2016), updated.

Around the world, extensive recent literature has raised questions about the validity of the Phillips curve as an analytical framework and predictive tool, based on the apparently poor response of inflation in the U.S. and much of the developed world to the drop in economic activity during the 2008-2009 global financial crisis and the subsequent recovery process. This phenomenon has been explained in different ways, from a structural change in the inflation-output relationship associated with the greater capacity of central banks to anchor inflation expectations to the target, to problems in the way the activity indicator is being measured. Although a detailed review of this debate exceeds the limits of this Supplement, this discussion illustrates a relevant point: since it is not a structural relationship, but an equilibrium object, the empirical estimation of the PhC must be constantly reviewed, because structural changes in the economy will be reflected in changes in the estimated parameters[44]/.

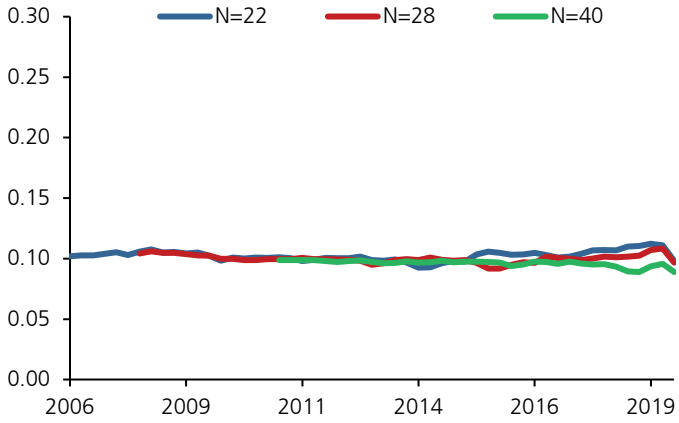
Figure 2.11 provides evidence in that direction for Chile, as it shows the result of estimating the effect of a 1% shock to the activity gap on inflation EFE with different moving windows (22, 28, 40 months). The results do not indicate a significant change in the relationship between the gap and inflation in the sample, suggesting that the estimated impact of a shock of this magnitude —two thirds of the standard deviation of the gap— has remained stable over the past fourteen years. This points to a Phillips curve whose activity coefficient has been stable, and which does not seem to show signs of the "flattening" described in the international literature.

In addition, recent debate has focused also on the challenges of correctly estimating the Phillips curve, and the sensitivity of the results to the estimation methodology and the exact definition of the variables used, making it difficult to estimate their fundamental parameters[45]/. This suggests that both empirical and analytical interpretations of the Phillips curve should be done with care, taking into account the technical problems associated with being able to accurately estimate its parameters.

44/ A good starting point for reviewing the recent debate can be found in the contributions contained in "Changing Inflation Dynamics, Evolving Monetary Policy" (Castex, Galí, and Saravia, eds, Central Bank of Chile, 2020). See also Kuttner and Robinson (2010), Matheson and Stavrev (2013), and Blanchard *et al.* (2015) for the hypothesis of greater capacity of central banks to anchor inflation expectations to the target. In addition, Coibion and Gorodnichenko (2015) document in more detail the problems in the way the activity indicator is being measured.

45/ For a discussion of the econometric problems of the estimation, see Mavroeidis *et al.* (2014), who note that "[…] almost any parameter combination that is remotely close to the range considered in the literature can be generated by some specification that cannot be objected to a priori […]". Another difficulty is the estimation of the activity gap in real time, as discussed in Figueroa, Fornero and García (2019).

FIGURE 2.11 IMPACT OF A 1% GAP SHOCK ON Y-O-Y CHANGE IN CPIEFE ONE YEAR OUT (*)



(*) Rolling estimation of semi-structural model (MSEP). N=22: Window 1 = 2001.Q3 - 2006.Q4 ; N=28: Window 1 = 2001.Q3 - 2008.Q2; N=40: Window 1 = 2001.Q3 - 2011.Q2.

Source: Box "Changes in inflation dynamics and Monetary Policy," in December 2018 Monetary Policy Report (updated).

However, despite its methodological limitations and the difficulties associated with estimating it, the Phillips curve continues to be a useful instrument for analyzing inflation in the short term. This comes in part from its forecasting power of Chilean inflation, which is superior to alternative statistical methodologies for some categories of goods[46]/, but, above all, from its ability to provide a simple but powerful conceptual framework that contributes to the interpretation of the explanatory factors of inflation. Thus, the Phillips curve is useful as a reference framework to articulate monetary policy options and decisions. Therefore, it is convenient to use it as an important, but by no means exclusive, tool to understand inflationary dynamics and its relation to the set of policies available to central banks.

2.3.4 Price Rigidities in Chile: microdata evidence

We have documented the importance of the Phillips curve as an analytical and empirical framework to study inflation dynamics in Chile, and the way in which, conceptually, the existence of price rigidities is a key assumption of this approach. Therefore, a relevant question is to what extent is there direct evidence of price rigidities in Chile. The use of price microdata from which the CPI is constructed provides an answer to this question. The databases, publicly available on the INE website, contain anonymized price information for each month at the variety-establishment level, based on the sample collected and processed by the INE to calculate the CPI[47]/.

46/ See, for example, Fornero and Naudon (2016), Medel (2017), and Marcel *et al.* (2017).

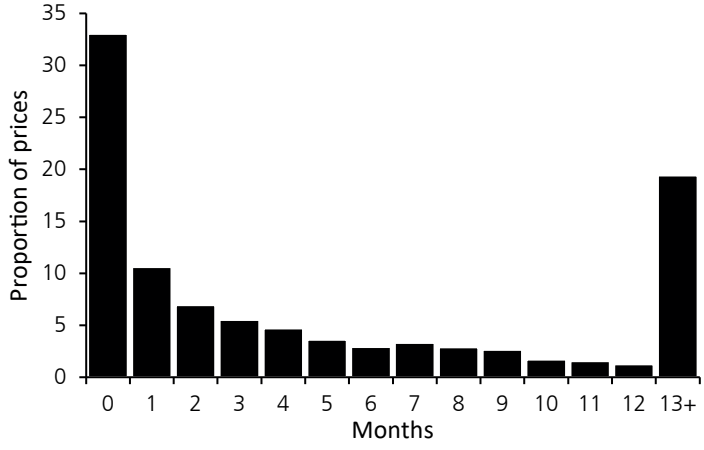
47/ This subsection is based on Canales and López-Martín (2021). A variety is defined as a set of pre-established attributes or specifications, such as brand, description, size, and content, among other characteristics. The publicly available database does not include the education and communications sub-groups. Within some sub-groups, specific products are unavailable. Thus, some 67% of the total 2018 basket is finally available (each database is associated with a revision of the consumer basket). The data includes price information from 5,094 establishments and 1,274 varieties, on average, although these figures vary from month to month. Although data can be collected with different frequencies (especially those that show greater variability), the database considers the monthly average for each variety-establishment.

The microdata is used to calculate three statistics widely used in the international literature: the duration of price changes, the frequency of these changes, and their magnitudes[48]/. The exercise uses the publicly available database for the period from January 2014 to December. The exercise also looks at the different components of the consumer basket is also obtained, in order to analyze differences in their behavior.

The first two statistics —i.e., duration and frequency of changes— are directly associated with the existence of price rigidities, by showing to what extent prices do not automatically adjust to the shocks to the economy. The third statistic —the magnitude of such changes— helps to better characterize the dynamics of the inflationary process, understanding how aggregate movements can be decomposed into infrequent movements of a large magnitude or a greater number of movements of small magnitude. As discussed in Box 2.3, Chile's wealth of price microdata is also useful for analyzing price behavior in specific events, and particularly in response to macroeconomic shocks[49]/.

Figure 2.12 illustrates the first of these statistics. It shows how, as of November 2018, a significant percentage of prices had not adjusted for a significant time, consistent with the notion that many prices change very slowly. While only a third of the prices had adjusted that month, 70% of them had not, with nearly 20% of them having been constant for more than a year.

FIGURE 2.12 HISTOGRAM OF DURATION OF INDIVIDUAL PRICES (MONTHS) AT NOV. 2018



Source: Canales and López-Martin (2021).

48/ Some references in the literature analyzing data from different countries include: Álvarez *et al.* (2019), Cortés Espada *et al.* (2012), Dhyne *et al.* (2005), and Klenow and Malin (2011). In particular, Medina *et al.* (2007) analyze Chilean data for the period 1999-2005.

49/ Although Box 2.3 centers on two particular shocks (social crisis and pandemic), a more recent macroeconomic shock with inflationary effects has been related to the withdrawal of part of pension funds (see Box IV.1 in December 2020 Monetary Policy Report). Additionally, Canales and Lopez-Martin (2021) analyze the behavior of different margins of individual prices against fluctuations of the exchange rate and different measures of risk and uncertainty. Additionally, Canales and Lopez-Martin (2021) analyze the behavior of different individual price adjustment margins in the face of exchange rate fluctuations and different measures of risk and uncertainty.

Table 2.2 presents the remaining two statistics. It reveals an important degree of heterogeneity in the average behavior among the different sub-groups. The sub-groups with the highest frequency of price changes[50]/ are foods, beverages and transportation, where approximately 40-50% of individual prices are adjusted each month. The sub-groups with the lowest frequency of price changes are clothing and restaurants, with proportions below 20%. In line with what is expected given the existence of positive trend inflation, the frequency of positive price changes is higher than negative ones for almost all the sub-groups.

Table 2.2 shows that, while positive price changes are more frequent than negative changes, the opposite is true for magnitudes: the average magnitude of price reductions is greater than that of increases, a fact that has also been documented in other countries (see footnote 48). In addition, there is a tendency for the sub-groups where the total frequency of price changes is higher to show lower magnitudes of price adjustments, on average and in absolute terms.

In short, recent microeconomic evidence for Chile, as well as for other countries and previous studies for Chile, suggests that price adjustments are not automatic, but rather a gradual process subject to a significant degree of frictions, which is heterogeneous for different types of goods (see footnote 48). This is consistent with the conceptual framework used to analyze short- and medium-term inflationary dynamics.

TABLE 2.2 AVERAGE FRECUENCIES AND MAGNITUDES OF PRICE CHANGES BY CATEGORY OF GOODS AND SERVICES IN THE CPI (*)

Category	2014:01 - 2018:12 Frecuency of changes		2014:01 - 2018:12 Magnitud of changes	
	Positive	Negative	Positive	Negative
Food	0.292	0.246	0.104	-0.113
Beberages	0.279	0.206	0.081	-0.090
Apparel	0.067	0.088	0.207	-0.248
Housing	0.172	0.117	0.059	-0.060
Home	0.129	0.098	0.132	-0.153
Health	0.164	0.058	0.091	-0.168
Transportation	0.221	0.163	0.051	-0.061
Culture	0.108	0.101	0.135	-0.149
Restaurants	0.067	0.015	0.095	-0.137
Other G&S	0.130	0.084	0.149	-0.188

(*) The average frecuency and magintud of price changes for all categories within a division is calculated each month, then the average is taken for the whole period.

Source: Canales and López-Martin (2021) based on INE data.

49/ The frequency of price changes is the proportion of prices that, by variety, are adjusted each month with respect to the previous one, considering those variety-establishment observations that were registered in two consecutive months..

2.4 Conclusions

This chapter has discussed how high and volatile inflation imposes severe costs on the economy. Given that theory, empirical evidence, and the Chilean historical experience show that in the long run inflation can be completely controlled by monetary policy, ensuring price stability with low and predictable inflation is the Central Bank's greatest contribution to society.

In the short and medium term, however, the existence of price rigidities, as shown for Chile by anonymized microdata, implies that monetary policy can have real effects, which allows it to play a stabilizing role. In this context, the short-term dynamics of inflation are related to the behavior of real variables. This is expressed conceptually and empirically in the Phillips curve, which is still empirically valid in Chile as a valuable tool for analyzing inflation.

Box 2.3 Chile's mechanism of price adjustment to macroeconomic shocks

In addition to allowing the degree of nominal rigidities to be quantified, price microdata also represent a valuable source of information for understanding how the pricing mechanism is affected by macroeconomic shocks. This box shows evidence, using high-frequency microdata, to characterize how the price formation process in Chile was affected by two recent events: the social crisis of October 2019 and the Covid-19 pandemic that broke out in March 2020. The main finding is that both episodes caused a temporary and significant reduction in the frequency of price adjustments.

Aruoba *et al.* (2021a) use a daily database of prices in actual product transactions, obtained from digital invoices from the retail sector between July 2018 and January 2020. This was provided by the Internal Revenue Service to the Central Bank of Chile, guaranteeing the anonymity of firms, to document the behavior of prices during the episode of the social crisis that broke out on 18 October 2019. Table 2.3 reports adjustment statistics in weekly average from Friday 18 October to Thursday 24 October, and so on until 28 November (seven weeks total). The last row of the table reports general statistics comparable to the period before the protests. The numbers suggest that, in response to the shock, the pricing mechanism changed. The frequency of price changes was lower, both upward and downward, especially during the first weeks of the crisis. There is also evidence that the magnitudes of the changes were affected in both directions in some of the weeks after 10/18.

TABLE 2.3 DESCRIPTIVE STATISTICS OF WEEKLY PRICE ADJUSTMENTS (*)
(retail transactions, electronic invoicing; 18/10/19 - 28/11/19)

	Percentage of increases	Percentage of decreases	Magnitude of increase	Magntud of decrease
Week 1	0.92	0.91	13.32	8.16
Week 2	1.04	1.03	12.04	8.37
Week 3	1.25	0.55	10.47	8.68
Week 4	0.73	0.76	10.1	10.83
Week 5	1.39	1.3	12.88	10.1
Week 6	1.03	0.92	12.99	7.97
Week 7	2.39	1.38	15.79	11.37
Before 18/10/19*	**1.51**	**1.34**	**12.51**	**9.47**

(*) Same sample of products before and after 18/10/19.

Source: Aruoba *et al*. (2021a) based on SII data.

In a similar vein, Peña and Prades (2021) use posted online data, which are collected by the Central Bank of Chile through web scraping techniques, to analyze pricing behavior during the social crisis and during the pandemic. In line with the evidence of transaction prices associated with digital invoicing, the results show that the frequency of price adjustments fell significantly in both episodes, especially since the beginning of the pandemic, although there is a high degree of heterogeneity among different goods (table 2.4). In July 2020, as mobility restrictions were gradually lifted, most of the monitored products returned to their usual pricing patterns, in terms of both frequency and adjustment size distribution.

TABLE 2.4 FREQUENCIES OF PRICE CHANGES AND IMPLICIT DURATIONS BY DIVISIONS WITH PRICES OBTAINED THROUGH WEBSCRAPING TECHNIQUES (*)

Product grorp	Weight in CPI basket		pre-shocks	Social crisis outbreak	Onset of pandemic and mobility constraints	Gradual easing of constraints
			2019:07-2019:10	2019:10-2020:03	2020:03-2020:07	2020:08-2020:10
1. Foods and beverages	12.2%	Frecuency	0.325	0.303	0.283	0.321
	(19.3%)	Duration (months)	2.8	3.0	3.4	2.9
2. Alcoholic beverages	2.8%	Frecuency	0.414	0.286	0.273	0.338
	(4.8%)	Duration (months)	2.5	3.3	3.6	4.0
5. Household	0.8%	Frecuency	0.592	0.481	0.341	0.537
	(6.5%)	Duration (months)	1.3	1.7	3.3	1.9
6. Health	1.7%	Frecuency	--	0.187	0.069	0.090
	(7.8%)	Duration (months)	--	5.4	16.3	19.6
7. Transportation	2.9%	Frecuency	--	0.654	0.471	0.401
	(13.1%)	Duration (months)	--	0.9	1.6	2.0
9. Recreation and culture	0.4%	Frecuency	--	0.515	0.424	0.705
	(6.6%)	Duration (months)	--	1.4	1.8	0.8
12. Miscelaneous goods and services	1.3%	Frecuency	--	0.349	0.303	0.393
	(5.2%)	Duration (months)	--	2.7	3.8	2.2

(*) For each product group included in the CPI calculation, the weight of the basket for the products/varieties for which information is available is shown in column (1) and compared with the official weight of each group. This gives an idea of the coverage of the database, which totals 21%. There is no information in the pre-shock periods for the categories of health (6), transportation (7), recreation and culture (9) and miscellaneous goods and services (12) because data collection started in December 2019. The table reports the average frequency for each product group/period, meaning the percentage of products that change price each month, its implicit duration, and the average number of months that the products' prices do not change.

Source: Peña and Prades (2021).

3. INFLATION IN CHILE: CONSIDERATIONS FOR A SMALL OPEN ECONOMY

Chile is a small economy open to the world, so it cannot isolate itself from external factors, nor from their potential implications for domestic macroeconomic variables, including inflation. This impact can be both direct, via the effects of exchange rate movements on domestic prices, and indirect, via the effects that such movements have on aggregate demand in Chile and the associated inflationary pressures. In the long term, external factors will be important to understand the dynamics of relative prices, but inflation will continue to be controlled by the conduct of monetary policy.

This chapter studies the relevance of these external factors for inflationary dynamics in Chile. The main messages are threefold. First, short- and medium-term dynamics are highly influenced by what happens in the world. As a matter of fact, nearly half of the variance of inflation in the last three decades can be explained by external shocks. Among the most important are those that materialize through fluctuations in the terms of trade and risk premiums. Both have general equilibrium effects that influence inflation considerably. First, through the direct impact on the exchange rate and its transmission to domestic prices, and then through its effects on income, which are expressed through variations in aggregate demand. These impacts also operate in opposite directions and at different horizons. For example, a fall in the terms of trade and/or an increase in risk premiums first generates a depreciation of the nominal exchange rate which, when transmitted to domestic prices, puts upward pressure on inflation. Then, the negative effect on income exerts an opposite pressure on inflation, through a fall in aggregate demand.

A second area that this chapter explores is the pass-through coefficient (PTC) of the nominal exchange rate to inflation. The magnitude of this coefficient in Chile is relatively small compared to other countries, and has fallen over time, in line with changes in the monetary policy framework from 1990 onwards. The credibility of monetary policy, and the anchoring of expectations to the inflation target —which will be reviewed in Chapter 4—emerge as key determinants of the PTC, though not the only ones. The PTC also depends on the type of shock caused by the forex movement, higher when the depreciation is generated as a response to a risk premium shock—like those exposed in this chapter— or a monetary policy shock —see Chapter 4— than when it responds to a variation in external prices, which has an effect on inflation that counteracts the nominal exchange rate effect. The low PTC currently present in Chile, in addition to helping to adjust relative prices, facilitates monetary policy-making by preventing it from having to respond aggressively to an exchange rate depreciation and gives room to conduct a counter-cyclical monetary policy. This is achieved thanks to the credibility of the monetary policy that has allowed to anchor inflation expectations in the face of adverse external shocks.

Finally, the chapter addresses more structural phenomena of external factors influencing relative price dynamics in Chile. On one hand, it documents a change in the composition of Chilean imports, where the growing role played by Asia, and China in particular, stands out. This change, coupled with a long-

term drop in the prices of these imports, has been an important force in the relative price dynamics that Chile has faced and, therefore, a relevant factor in explaining short-term inflationary dynamics. In this regard, the chapter also documents how significant movements in relative prices between goods and services have occurred. Indeed, in Chile, as in many other countries, the relative price of goods has systematically fallen with respect to services in recent decades, thus becoming another important factor driving inflationary dynamics.

3.1. Effects of external shocks on the short- and medium-term inflation dynamics in Chile

Given that the degree of trade and financial integration between countries has increased significantly in recent decades, it is only natural to think that external factors play an important role in explaining short- and medium-term inflation dynamics. In this context, the literature studying small open economies has emphasized the importance of external shocks, especially on commodity prices and global interest rates, to explain a significant percentage of the variability of the business cycle and, therefore, of inflation[1]/. Quantifying the role of these external factors is important for the response of monetary policy to such shocks, as will be discussed in detail below.

There is a long list of studies on Chile that have quantified the importance of external factors in domestic inflation through direct effects (via the nominal exchange rate) as well as indirect (via changes in income). They find that the external factors explain a considerable part of changes in inflation[2]/. Thus, for example, in the XMAS model of the CBCh external factors explain a little more than a third of the variance of inflation between 2012 and 2020 (see Table 2.1). Other recent work, using a VAR methodology with commodity and financial risk shocks as external factors, finds that these shocks explain about 50% of the variance of inflation in Chile between 1990 and 2018[3]/.

Complementing these studies, and in order to estimate the effects of specific external shocks on inflation and other macroeconomic variables, an approach is presented that allows two particular shocks to be identified: i) increases in the copper price caused by shocks to world demand for the mineral; and ii) increases in Chile's sovereign risk premium caused by shocks to the risk premium of U.S. corporate bonds[4]/.

1/ See Céspedes *et al.* (2006).

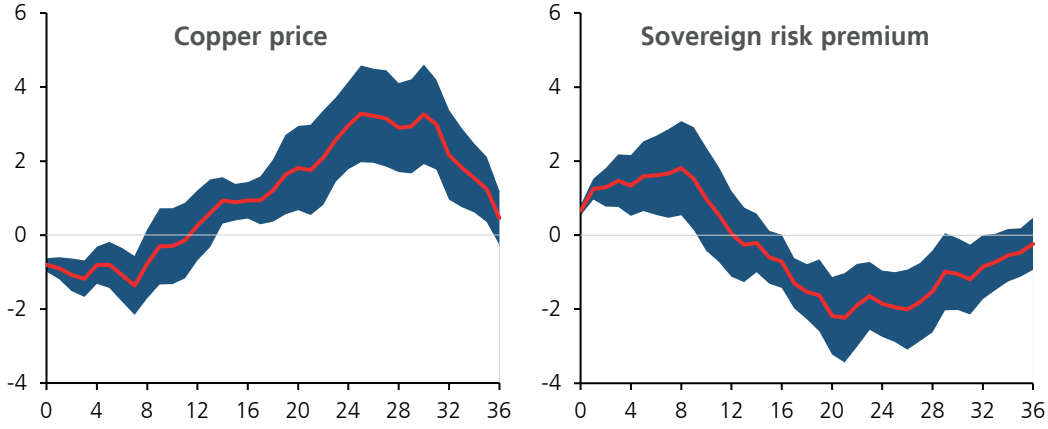
2/ Caputo and Herrera (2017); Corbo (1998); Naudón and Vial (2016); Albagli *et al.* (2015); Albagli *et al.* (2016); Albagli *et al.* (2019).

3/ See Fernandez and Muñoz (2021), based on the methodology of Fernandez et al (2017). The relevance of commodity prices leans on previous studies which have found that fluctuations in these variables (especially copper) have a significant impact on inflation in Chile. Thus, Medina and Soto (2007) estimate that in Chile a 10% increase in the copper price generates a 0.03 percentage point increase in inflation in the short term, which is almost zero after two and a half years. See also the studies by Medina (2010) and Pedersen (2015).

4/ The results are from Aldunate *et al.* (2021). To identify these shocks to global copper demand, copper price movements are separated according to whether they are shocks to copper supply, global aggregate demand or specific copper demand. The latter is used as an instrument of copper price —ensuring that the movement of this price is not associated with Chile's country-specific phenomena. To identify the shocks to the sovereign risk premium, an exogenous shock to the risk premium of corporate bonds in the U.S. market is estimated. This shock is used as an instrument of the sovereign risk premium in Chile, thus preventing domestic factors from being reflected in the variable's behavior.

Figure 3.1 shows that a positive shock of one standard deviation of the copper price, originating in the world demand for copper, appreciates the peso and implies a reduction in inflation of around one percentage point (pp) during the first seven months. Subsequently, it increases consecutively until it reaches a peak close to 3pp between 24 and 32 months after the occurrence of the shock. Conversely, a negative financial shock equivalent to an increase of one standard deviation of the sovereign risk premium (i.e., a worsening of external financial conditions), depreciates the exchange rate and implies an increase in inflation close to 1.5pp during the first eight months[5]/. Subsequently, a negative effect on inflation is observed, falling close to 2pp between 20 and 26 months after the shock.

FIGURE 3.1 CHILEAN INFLATION'S IMPULSE-RESPONSE FUNCTIONS TO EXTERNAL SHOCKS (*)



(*) Response in months. To compute the results, the local projection method is used. The shock is equivalent to a one standard deviation increase in the copper price (instrumented by the shock to global copper demand) in the left panel; and an increase in the sovereign risk premium (instrumented by a shock to the U.S. corporate risk premium), in the right panel. The confidence interval is +/- 1 standard deviation. Source: Aldunate *et al.* (2021).

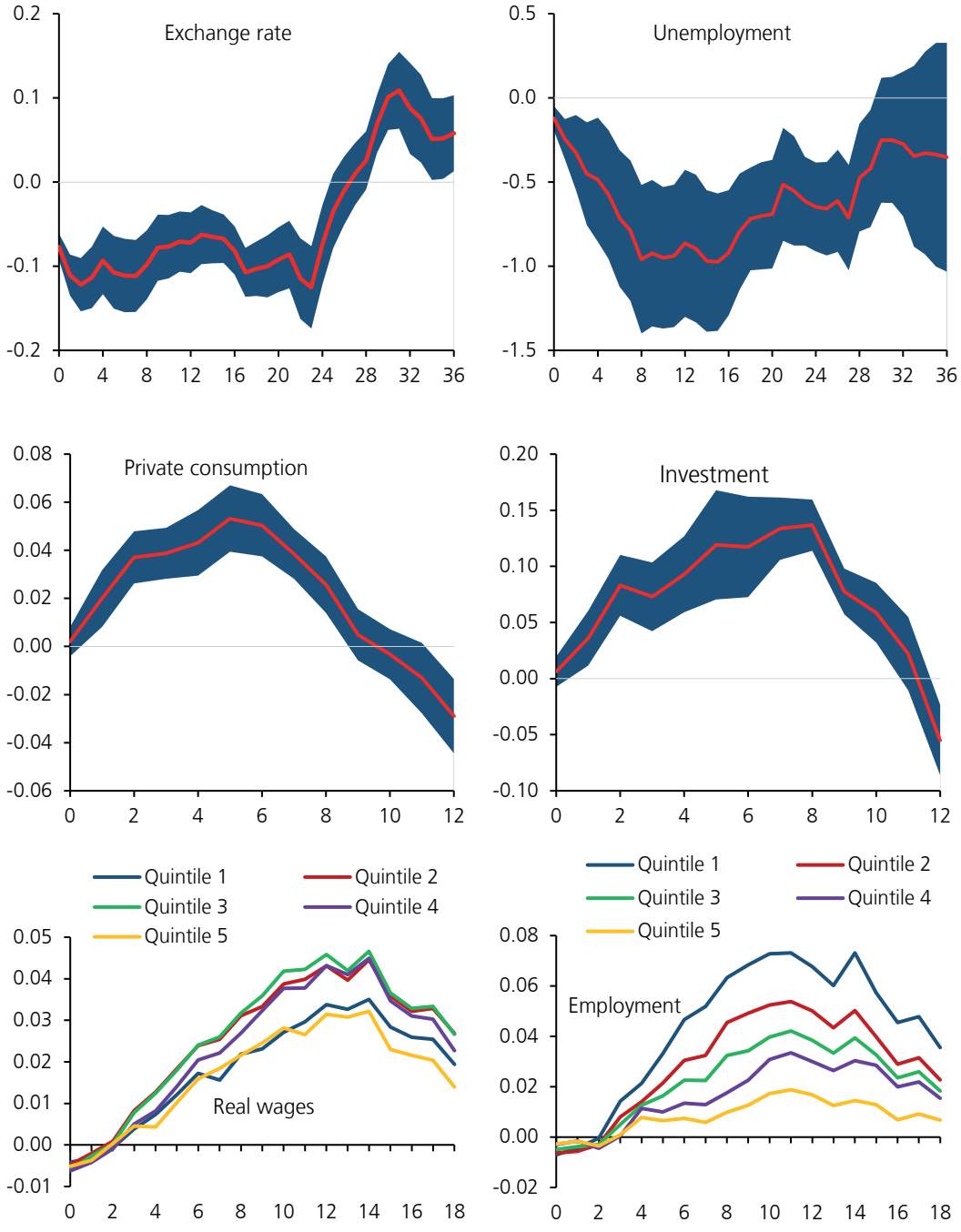
Figure 3.2 shows the estimated effects of a positive shock to the copper price on other macroeconomic variables, thus allowing to envision how this shock spreads over the rest of the Chilean economy[6]/. On impact, the initial drop in the inflation rate is seen to be accompanied by a significant appreciation of the nominal exchange rate, thus implying a pass-through of the drop in the exchange rate to domestic prices. Subsequently, the positive shock to the copper price is accompanied by an increase in investment, a significant and sustained increase in private consumption and a drop in the unemployment rate. Therefore, in a second phase, the effects on income predominate, and they explain the increase in the inflation rate derived from aggregate demand pressures[7]/.

5/ For the case of the copper price (in logs and deflated by US inflation) a one standard deviation shock corresponds to 0.37. For the risk premium (in percentage), a one standard deviation shock corresponds to 0.56.

6/ A constraint to the generalization of these results is that they occur in the context of the commodities' super cycle, the extent and intensity of which was unusual, and may have intensified the response of mining investment. See the discussion of the super cycle in Fernandez, Schmitt-Grohé and Uribe (2020).

7/ As noted above, these results may be influenced by the strong response of mining investment to prices observed during the commodities' super cycle.

FIGURE 3.2 IMPULSE-RESPONSE FUNCTIONS ASSOCIATED TO AN INCREASE IN THE COPPER PRICE (*)



(*) Response in months, except for consumption and investment, where quarters are used. To compute the results, the local projection method is used. The shock is equivalent to a one standard deviation increase in the copper price, instrumented by an exogenous shock to world copper demand. The confidence interval is +/- 1 standard deviation. The variables are measured in logs, except for the unemployment rate which is in percent. The results by quintile correspond to information on formal salaried income, the first (fifth) quintile being the lowest- (highest-) income workers. Source: Aldunate *et al.* (2021)

The use of administrative microdata at the level of the labor relationship between employees and employers makes it possible to enrich the understanding of the channels through which this shock affects aggregate income in Chile, particularly because it provides evidence of the heterogeneous effect of this shock on the different quintiles of formal salaried income. As the last row of Figure 3.2 shows, the drop in the unemployment rate is consistent with an increase in the employment level for all formal salaried income quintiles, with the first (fifth) quintile corresponding to workers with lower (higher) incomes. Nevertheless, there is a monotonic relationship between the shock and the magnitude of the effect on employment by quintile: the greater the impact on employment, the lower the quintile's income. The real wage effect is an inverted U, with a more limited impact on quintiles first and fifth and a greater effect on income in quintiles second, third, and fourth. Therefore, this shock has important effects on the labor market, which are positive and heterogeneous across the different formal wage income quintiles[8]./

Figure 3.3 repeats the exercise for the negative financial shock associated with an increase in Chile's risk premium resulting from movements in the U.S. capital market. The timing and dynamics are similar to those associated with copper price movements. Initially, a significant pass-through of the exchange rate to domestic prices is again observed as the increase in inflation is accompanied by an exchange rate depreciation. Afterwards, although the exchange rate continues to depreciate, inflation begins to fall, hand in hand with movements in other macroeconomic variables. Actually, there is a fall in private consumption and investment, and also an increase in the unemployment rate. Here again, there is a heterogeneous impact on the labor market: while employment of workers in the highest quintile is the least affected, workers in the lowest quintile are the hardest hit by the shock. Again, while real wages in the extreme quintiles respond little, the adverse wage impact is stronger in the middle quintiles.

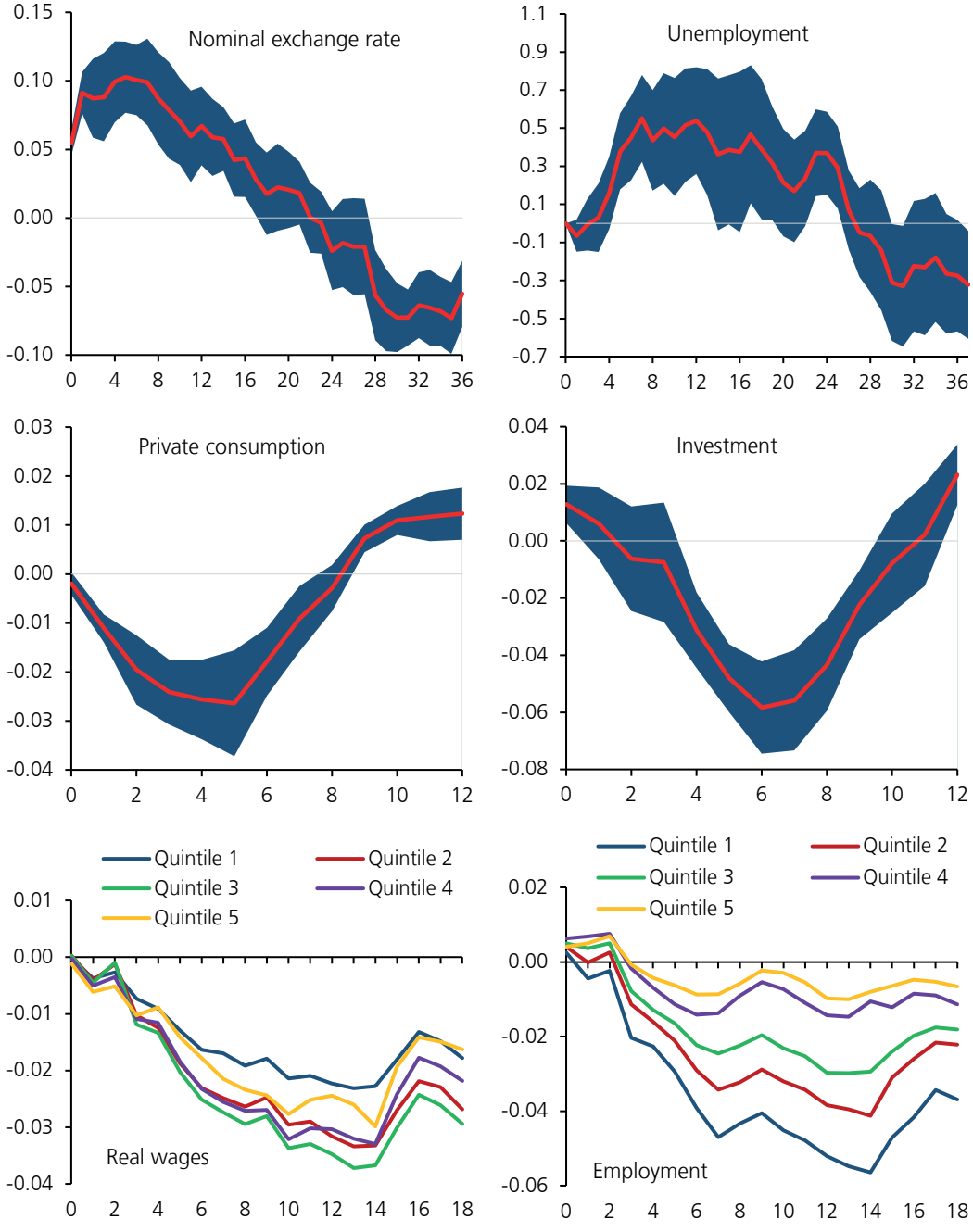
Summing up, external factors have a considerable effect on inflation in Chile in the short term. Two variables that channel well the way external shocks spill over into the local economy are the terms of trade and the risk premium in Chile. The short-term effect is associated with the transmission of exchange rate movements to domestic prices, while in the medium term the initial effect is reversed by the impact of the change in income on aggregate demand, which exerts inflationary pressure in the other direction. These pressures are captured importantly in the labor market, where there are considerable effects on real wages and employment, but with significant heterogeneity among the different income quintiles.

3.2. The role of the exchange rate and the pass-through coefficient

As documented in the previous section, the pass-through coefficient (PTC) (i.e., the percentage of an exchange rate change that is transmitted to local prices over a given time horizon) is a key indicator of how the economy responds to shocks. Thus, a high PTC not only means that inflation can be highly volatile in the short and medium term, moving quite in tandem with the exchange rate, but also makes it difficult to adjust relative prices —the real exchange rate— in response to shocks from abroad.

8/ These results are in line with previous estimates of the effects on aggregate demand, particularly investment, of this type of shock in Chile using alternative methodologies. Through a structural VAR and a dynamic and stochastic equilibrium model, Fornero, Kirchner, and Yany (2016) estimate that a positive shock to the copper price appreciates the real exchange rate, reduces inflation, and increases output and investment. In their work, the authors emphasize how the magnitudes of these effects depend on the agents' perception about the persistence of the shock.

FIGURE 3.3 IMPULSE-RESPONSE FUNCTIONS ASSOCIATED TO AN INCREASE IN CHILE'S SOVEREIGN RISK PREMIUM (*)



(*) Response in months, except for private consumption and investment, where they are quarters. To compute the results, the local projection method is used. The shock is equivalent to a one standard deviation increase in the sovereign risk premium, instrumented by an exogenous shock to the U.S. corporate risk premium. The confidence interval corresponds to +/- 1 standard deviation. Variables are measured in logarithm, except for the unemployment rate which is in percent. The results by quintile correspond to information on formal salaried income, the first (fifth) quintile being the lowest (highest) income workers. Source: Aldunate *et al.* (2021).

Therefore, the correct measurement of the PTC from the exchange rate to prices is crucial for monetary policy analysis and decision making, by providing a metric of how variations in the nominal exchange rate translate into changes in inflation in the short and medium term.

This section presents a review of the evidence for Chile regarding the PTC. It first shows estimates of its level and evolution over time and places it in the international context. It also discusses the possible determinants that have been studied in recent literature, where the degree of credibility of the inflation target and the currency in which a country's imports are invoiced stand out. This is complemented by an analysis of how the PTC varies depending on the shock experienced by the economy, similar to the discussion in Chapter 2 regarding the relationship between the activity gap and inflation. Finally, it discusses the implications of Chile's low PTC for the conduct of monetary policy.

3.2.1. The pass-through coefficient in Chile: estimates, cross-country comparison, and possible determinants

Table 3.1 shows a long list of estimates of Chile's PTC. Despite some dispersion, because of differences in methodology and periods of analysis, on average the results suggest that the PTC one year out lies between 0.1 and 0.15. In other words, a 10% depreciation of the nominal exchange rate would be associated, within one year, with an increase in CPI inflation between 1% and 1.5%.

Figure 3.4 illustrates how Chile's PTC has changed over the past three decades[9]/ For the period 1990-99, when there was still a floating band, the one-year PTC was around 32%, which fell to 24% in the following decade. During the last decade, the pass-through coefficient fell to 15%. This is consistent with the notion that the PTC decreased significantly after the adoption of the full-fledged inflation-targeting and floating exchange rate regime, consistent with the increased credibility of the Central Bank[10]/

How does Chile's pass-through coefficient compare in the international context? Figure 3.5 compares Chile with a sample of 62 developed and emerging countries during the period 2000-2015 for which the PTC is calculated using a common methodology[11]/. Emerging countries are characterized by having a higher PTC than developed countries. In the comparison, Chile's PTC appears as relatively low, below the average of developed countries, both in the short term (12 months) and in the medium term (24 months). Indeed, the estimated PTC for Chile in the short term is 0.06 and 0.11 in the medium term, while the average for developed countries is 0.18 and 0.21, respectively.

The literature has pointed to the credibility of a central bank's inflationary objective as one of the fundamental determinants of the PTC. The anchoring of expectations not only reduces the coefficient, but typically concentrates inflationary effects in relatively short periods, to the extent that the so-called "second-round effects" —linked to indexation mechanisms and/or the effects of higher short-term inflation on medium-term expectations—remain limited when the inflation target is credible. In effect, the low persistence of these shocks is consistent with the inflationary target over a two-year horizon

9/ These results draw from Albagli *et al.* (2020), whose methodology follows closely Albagli *et al.* (2015) and Justel and Sansone (2016). A monthly VAR model is used to estimate the nominal ERPT coefficient to the CPI.

10/ Albagli *et al.* (2020), based on the model of Arias and Kirchner (2019), show how the PTC is smaller in a case where inflation expectations are anchored—a proxy for credibility—than in a de-anchoring case. For details on the degree of expectations anchoring in Chile, see Chapter 4.

11/ The figure is taken from Carrière-Swallow *et al.* (2016).

TABLE 3.1 ESTIMATES OF PASS-THROUGH COEFFICIENT TO CPI IN CHILE AT ONE-YEAR HORIZON

	Sample	Methodology	PTC
Mihaljek and Klau (2000) (1)	1991.II-2000.III	OLS	0.07
Hausmann *et al.* (2001)	1990-1999	OLS	0.18
Bravo and García (2002)	1986.1-2000.12	VEC	0.10
Morandé and Tapia (2002) (2)	1996.1-2001.11	VAR	0.15
Noton (2003) (1)	1986.I-2001.I	OLS	0.10
De Gregorio *et al.* (2005)	1994.1-2002.12	OLS	0.10
Choudhri and Hakura (2006)	1979.I-2000.IV	OLS	0.35
Ca' Zorzi *et al.* (2007)	1980.I-2003.IV	VAR	0.35
Edwards (2007) (1)	1994.III-2005.IV	OLS	0.01
Mihaljek and Klau (2008) (1)	1994.I-2006.II	OLS	0.03
Álvarez *et al.* (2008)	1998.2-2007.4	VAR	0.08
De Gregorio (2009)	1996.1-2006.1	OLS	0.05
BBVA Research (2014)	1986.1-2013.4	OLS	0.10
BBVA Research (2015)	1986.1-2015.4	OLS	0.14
Bertinatto and Saravia (2015)	2001.1-2014.9	OLS	0.14
Albagli *et al.* (2015)	2000.1-2015.12	VAR	0.19
Mujica and Saens (2015) (1)	1986.I-2009.IV	OLS	0.17
Borensztein and Queijo (2016)	1999.11-2015.12	VAR	0.04
Carriere-Swallow *et al.* (2016)	2000-2015	OLS	0.06
Justel and Sansone (2016)	1986.1-2013.12	VAR	0.14
Pérez-Ruiz (2016)	1999.1-2015.12	VAR	0.09
Sansone (2016)	2008-2013	Calibration	0.15
Aguirre and González (2019)	1970-2015	OLS	0.08
Albagli *et al.* (2020)	2010-2019	VAR	0.15
Mean			**0.13**
Standard deviation			**0.09**

(1) Short-term pass-through.(2) 16-month pass-through.

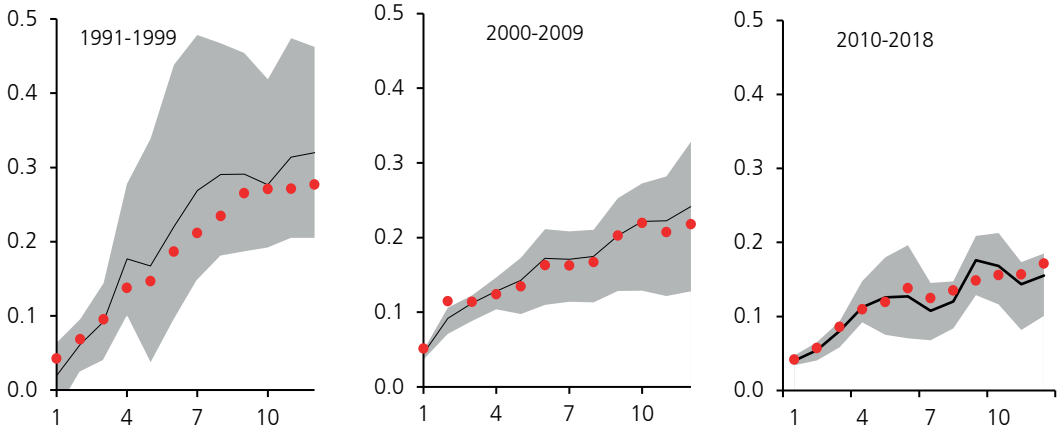
Source: Contreras and Pinto (2016), updated.

in Chile, as it allows for monetary policy decisions that are, in general, independent of the impact that the exchange rate has on short-term inflation[12]/. This would be in line with the evidence presented in Figure 3.5 insofar as emerging economies are generally characterized by lower levels of credibility of their inflation targets, compared to developed countries. Likewise, international evidence has also found that PTC has fallen in those Latin American countries where inflation expectations have been more anchored to the central bank's target. The fall in Chile's PTC documented in Figure 3.4 and presented in Chapter 4 on the high degree of anchoring of expectations in Chile over the last two decades, point to the conduct of monetary policy as an important determinant of Chile's PTC[13]/.

12/ Indeed, Albagli *et al.* (2015), Sansone (2016), and Giuliano and Luttini (2020), document that a significant part of the ERPT to prices occurs within the first year. Albagli *et al.* (2020) further discuss the consistency of the two-year inflation target with the transience of the inflationary effect of exchange rate shocks, in a context of high credibility of the inflation targeting regime.

13/ See Borenzstein and Queijo (2016); Carrière-Swallow et.al. (2016).

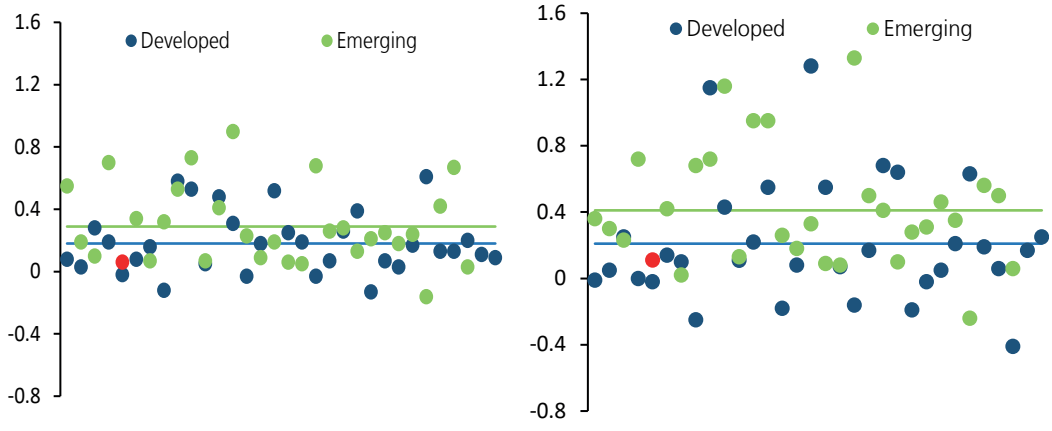
FIGURE 3.4 EVOLUTION OF THE PASS-THROUGH COEFFICIENT AT ONE YEAR (*)
(months)



(*) The results are based on a VAR model for Chile with endogenous and exogenous blocks, following the work of Albagli, Naudon, and Vergara (2015) and Justel and Sansone (2016). The red dots show the estimated PTC results with the effective subsample data; the black lines and gray area show the median estimates and the range of interquartile estimates of 5 thousand block-bootstrap replications.

Source: Albagli *et al.* (2020), using data from the CBCh, FRED, FAO, and Bloomberg.

FIGURE 3.5 ESTIMATIONS OF EXCHANGE RATE PASS-THROUGH COEFFICIENTS IN DEVELOPED AND EMERGING ECONOMIES, AT 12 AND 24 MONTHS (*)



(*) Left-hand panel, 12-month pass-through; right-hand panel, 24-month pass-through. The lines show the averages; the red dot is Chile.

Source: Carrière-Swallow *et al.* (2016).

Although Chile's PTC is low in the global context and there is evidence that it has continued to fall, it still exceeds that of some economies facing external shocks similar to those that have hit Chile. One interesting example that illustrates this point is what happened after the exchange rate adjustments after the end of the commodities super cycle of 2014-2015[14]/ This episode was characterized by a nominal depreciation of the Chilean peso of around 30%, accompanied by a considerable rise in inflation, above the inflation target, from an annual average of 3% in 2013 to 4.6 in 2014 and 4.4%

14/ This is the path followed by Albagli *et al.* (2015) whose results are reported here.

in 2015. The dynamics of inflation in Chile associated with the end of the aforementioned super cycle contrasted with that of other commodity exporting countries that are highly integrated into international trade. Australia, for example, saw a much more moderate increase in inflation during that episode. Although both countries suffered a nominal exchange rate shock of similar magnitude and a comparable deterioration of the terms of trade, the PTC estimated for Chile and Australia in this episode was 0.19 and 0.03, respectively.

A possible explanation for Chile's PTC not being even lower may lie in the way the prices of imports are determined in the country. A recent and influential line of research, which has shed light on the main forces affecting the PTC, has documented how the currency in which imports are invoiced is a relevant factor in determining the coefficient. The PTC is higher in countries with a larger share of imports invoiced in U.S. dollars, compared to countries where imports are invoiced either in local currency or in a different one[15]/.

This line of investigation is relevant in the case of Chile, since, similarly to most emerging countries, a very important fraction (over 90%) of its imports are invoiced in dollars, irrespective of the country of origin, and there are no imports invoiced in Chilean pesos[16]/.This contrasts with significantly lower values for other countries such as Australia, where a little more than half of imports are invoiced in dollars, being, therefore, a force that may explain the differences in PTC between Chile and Australia and, in general, may shed light on why the Chilean coefficient has not fallen even more over time. There is evidence that, in the short term (up to one year), the bilateral peso/dollar exchange rate is more relevant in determining the PTC dynamics relative to the importance of the fluctuation of the bilateral exchange rate with the currency of the exporting country X (peso-X, being X different from the USD). Thus, the PTC in the frontier of movements in the peso/dollar exchange rate after one quarter is high, at 0.73, while for the peso-X exchange rate it is only 0.1. In the medium term (after 24 months), both the bilateral peso/X exchange rate and the bilateral peso/dollar exchange rate play a similar role in determining the PTC, although the effect of the former is marginally higher in this time horizon. This means that, in the medium term, a multilateral depreciation —in which the peso loses value against the group of currencies of the trading partners— has a much higher pass-through coefficient than a bilateral depreciation, in which the peso loses value against the dollar, but not against other currencies. This is so because when the peso depreciates against the dollar but not against other currencies, the prices of imports from other countries initially rise, —as the contracts are fixed in dollars. As months go by, trading partners tend to lower their prices charged in dollars, which reduces cost pressures and the PTC. When the peso depreciates unilaterally, this second effect of lowering prices in dollars by the partners does not materialize, because their currencies have not changed in value with respect to the dollar.

Finally, another important dimension when trying to understand the forces that shape the PTC in Chile is the heterogeneity that may exist among the different components of the CPI. Evidence shows that exchange rate movements have been more important —at least in terms of their direct impact— in the tradable goods categories where imported components are more significant, than for non-tradable goods or services, whose prices may have little direct relationship with the exchange rate [17]/. As shown in Figure 3.6, there is significant heterogeneity among the PTC of the subclasses. At a more aggregate level (left panel), Food and Energy PTC is more than twice the average PTC, while

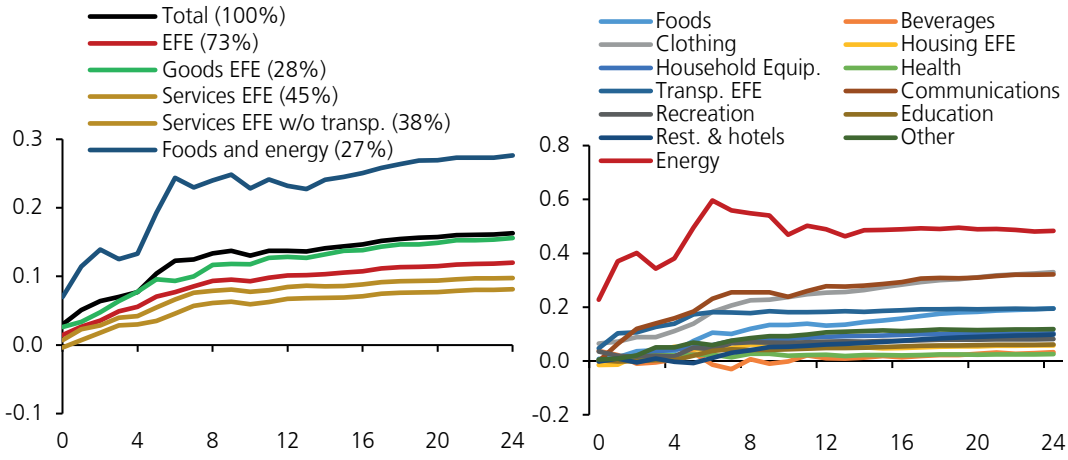
15/ This literature has proposed the U.S. dollar as the dominant currency (Gopinath *et al.* 2020; Gopinath, 2015).

16/ These results come from the study of the National Customs Service microdata for the period 2004-2015 (see Giuliano and Luttini, 2020).

17/ The results draw from an update of Contreras and Pinto (2016), who extend the general methodological framework of Justel and Sansone (2016) for a sample of 130 CPI subclasses, calculating for each of them a specific PTC.

that of services excluding foods and energy (EFE) is less than half. The more disaggregate view in the right panel exacerbates the differences. While the one-year PTC in energy —some of whose prices are regulated by formulas that explicitly include the nominal exchange rate— is around 0.5 and that of clothing around 0.25, the exchange rate impact on the prices of services such as health or education is virtually zero. This emphasizes how exchange rate movements are associated with significant changes in relative prices, facilitating the economy's adjustment process[18]/.

FIGURE 3.6 PASS-THROUGH COEFFICIENT FOR GROUPS OF GOODS
(ponderación (weight in CPI of estimated VARs for 130 subclasses)



(*) VAR variables are log differences of Imacec (GDP), sectoral wages (Wi), monetary policy rate (MPR, in differences), nominal bilateral exchange rate (BER), price of each subclass (Pi) and general prices (CPI). Each VAR has the same exogenous block composed of US GDP, Fed funds rate, WTI price, food price, copper price and U.S. CPI of the respective subclass. Source: Contreras and Pinto (2016), updated to 2019.

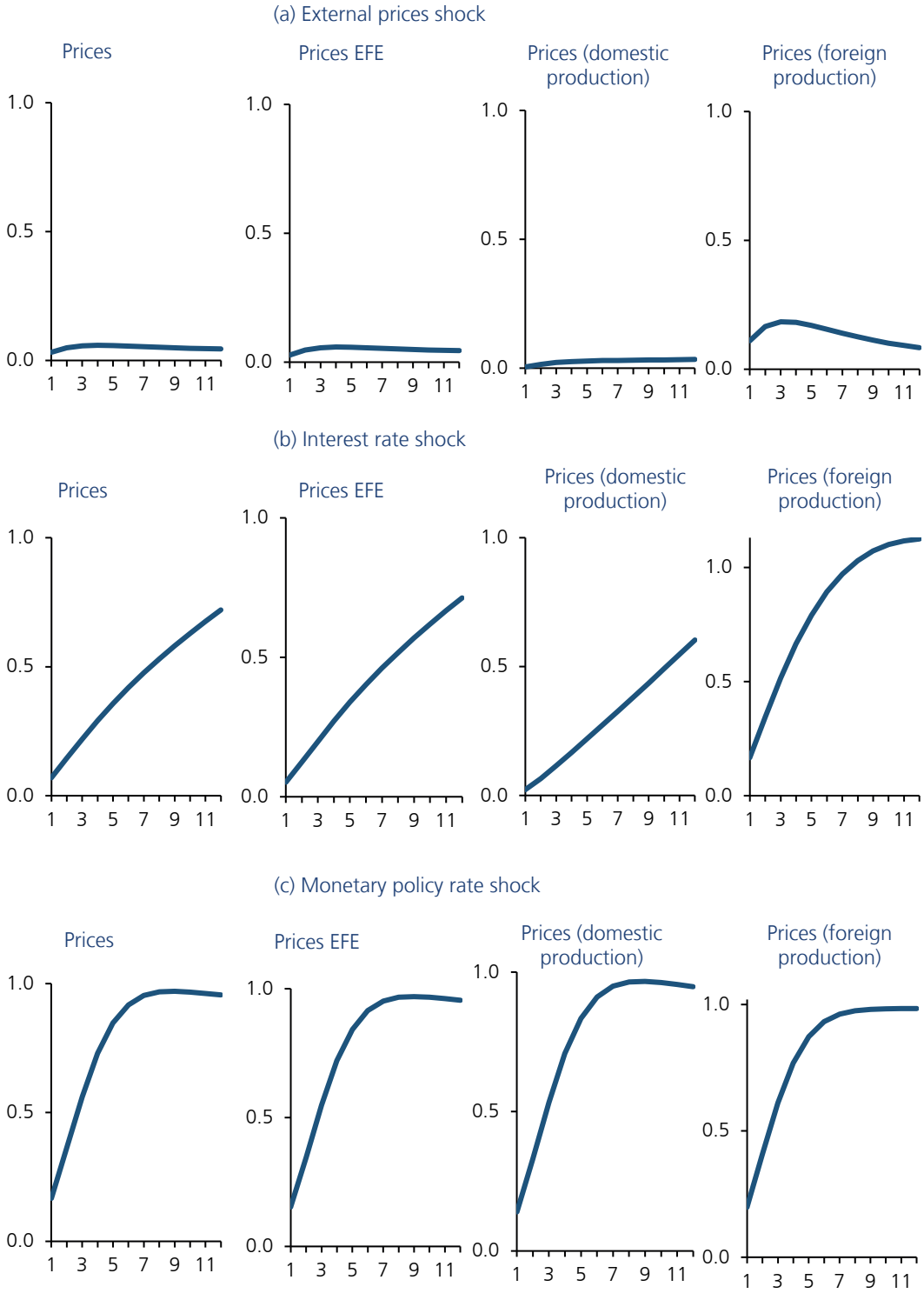
3.2.2. The pass-through coefficient in the face of different types of shocks

The PTC estimates presented in the previous section calculate the effect of an autonomous exchange rate shock —that is, of an exchange rate movement not generated by other variable considered in the empirical model, which may be relevant to explain exchange rate dynamics[19]/. One limitation of this approach, however, is the economic interpretation of the estimated PTC, since both the CPI and the exchange rate are variables that adjust to different shocks hitting the economy —such as the terms-of-trade or financial shocks presented at the beginning of this chapter. Since the PTC is an equilibrium result, its magnitude may be different according to the type of fundamental shock that causes an exchange rate adjustment, so it is worth complementing the analysis with an approach that allows to isolate the different shocks, as well as their general equilibrium effects on the exchange rate and inflation.

18/ Another factor that may explain the PTC, which has not yet been explored in detail for Chile, is the market power of the firms. In particular, a low PTC could be associated with a high market power of firms, which may react to an increase in the cost of imported goods by reducing markups in order not to lose such share (partially offsetting the price effect of the marginal cost increase). Amiti *et al.* (2019) and Pérez Cervantes (2020) find evidence of this channel for Belgium and Mexico, respectively.

19/ Indeed, Justel and Sansone's (2016) VAR decomposition shows that the autonomous shock is an important determinant of exchange rate movements, explaining about 50% of the exchange rate variation.

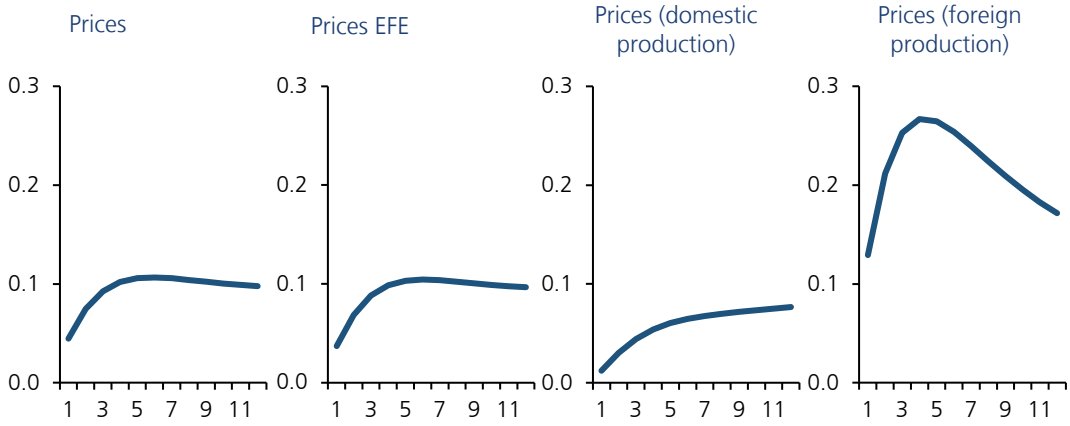
FIGURE 3.7 CONDITIONAL PASS-THROUGH COEFFICIENTS - XMAS MODEL (*)



(*) Panels a, b, and c document PTCs at horizons between 1 and 12 quarters, for four alternative prices, and conditional on three different types of shocks: (a) external prices; (b) interest rates; (c) monetary policy rate.

Source: Based on García and García-Cicco (2020).

FIGURE 3.8 UNCONDITIONAL PASS-THROUGH COEFFICIENTS - XMAS MODEL (*)



(*) The unconditional PTC presented here is calculated as the weighted average of the PTCs using all the shocks considered in the XMAS model.

Source: Based on García and García-Cicco (2020).

Using the CBCh's structural model (XMAS, already discussed in Chapter 2), to identify the main shocks that generate exchange rate variations, external price, interest rate and monetary policy rate shocks are found to be the three most important ones in explaining the variance of the exchange rate[20]/ Figure 3.7 shows the equilibrium PTCs associated with these shocks on the total CPI, the CPIEFE, and price indexes of domestically and foreign-produced goods. In turn, the conditional PTCs associated with these shocks are different from each other. While the PTC is relatively small in response to an external price shock, it is relatively high for the other two, especially for the monetary policy rate shock. Thus, for a given observed devaluation, the inflationary impact will be very different depending on the type of shock that motivated the devaluation. Interestingly, the unconditional coefficient to CPI derived from the model as a weighted average of the PTCs associated with the individual shocks is around 0.1, in line with the estimation results of the previous section (see Figure 3.8).

3.2.3. Monetary policy implications

Under a float, in which the exchange rate facilitates adjustments in relative prices in the face of external shocks, countries can have the benefits of free capital mobility and, at the same time, implement an independent monetary policy. This is the logic behind the monetary policy framework adopted in Chile, which considers the inflation target as the nominal anchor of the economy.

However, some countries may face a dilemma when dealing with negative external shocks that result in exchange rate depreciation. On the one hand, the inflationary and financial stability effect could lead to an increase in the MPR to stabilize the currency. On the other, the adverse effect on activity of the external shock could call for a reduction in the policy rate to alleviate the effects on economic activity and inflation associated with this shock, similar to those presented above on

20/ The results of this exercise follow the work of García and García-Cicco (2020). Another paper using a structural approach to shed light on the determinants of Chile's PTC is Sansone (2016), who studies the role played by distribution margins using a neo-Keynesian model.

aggregate demand[21]/. What a central bank chooses to do in the face of this quandary is closely related to the determinants of the size of the PTC, in particular the degree of credibility of monetary policy, as will be discussed in the next chapter.

The first alternative is directly related to what the literature has labeled the "fear of floating," characteristic of countries with shallow financial markets and high exchange rate mismatches, where asset prices and corporate and financial sector balance sheets can be very vulnerable to exchange rate depreciations, and so, very costly[22]/. Thus, when the PTC is high, and therefore the inflation response is very significant, the effects of external shocks on economic activity cannot be counteracted through countercyclical monetary policy, as this would considerably jeopardize the achievement of the inflation target.

Those countries that, on the contrary, have managed to build highly credible monetary policy and inflation-targeting framework, and that have deep financial markets, can benefit more from a flexible exchange rate. In such economies, exchange rate fluctuations contribute to macroeconomic adjustment by facilitating the reallocation of resources among different sectors, while inflationary consequences remain limited in magnitude and persistence due to the low PTC, and financial effects are mitigated by the use of hedging instruments.

The evidence presented in this section suggests that this has been the case in Chile in the past few decades, insofar as the consolidation of the inflation-targeting regime and expectations anchored to the target has allowed to reduce the PTC[23]/. At the same time, the greater development of domestic financial markets has allowed for the compression of exchange rate mismatches in the balance sheets of local agents by finding greater financing opportunities within the country, as well as contributing to the deepening of the hedging market through derivative instruments, which reduces the uncertainty associated with fluctuations in the forex market[24]/.

A good example of how Chile has been able to deal with shocks that generate exchange rate depreciation using countercyclical monetary policy was the episode experienced around 2014-2015 with the fall in commodity prices, including copper, which affected several Latin American commodity-exporting economies. Although in Chile the activity gap widened considerably, the exchange rate depreciated, and inflation reacted moderately upward, inflation expectations over the policy horizon remained anchored. This allowed for a countercyclical monetary policy response with reductions in the MPR, without sacrificing the inflation objective. Thus, the negative pressures on economic activity associated with this shock were mitigated in Chile, which recovered faster than its peers in the region[25]/. This is in sharp contrast with the macroeconomic adjustment that took place in Chile during the Asian crisis, under a rigid inflation target and an exchange rate band[26]/.

21/ Rojas *et al*. (2020) describe in detail this dilemma faced by emerging economies.

22/ The work of Calvo and Reinhart (2002) was pioneer in identifying this fear of floating.

23/ Edwards (2006) and Mishkin and Schmidt-Hebbel (2007) also suggest that the inflation-targeting regime has contributed, by increasing the credibility of monetary policy, to moderating the PTC in Chile.

24/ Albagli *et al.* (2020) study this phenomenon in detail for the case of Chile.

25/ Rojas *et al*. (2020) estimate a VAR and a DSGE for Brazil, Chile, Colombia and Mexico, and find that the only country that has applied countercyclical monetary policy in the face of exchange rate depreciations is Chile. They argue that, given the country's institutional conditions, this policy is more effective in mitigating external shocks. For more literature on commodity shocks, see García, Guarda, and Kirchner (2017).

26/ See Albagli *et al*. (2020) for a comparison of the macroeconomic adjustment in Chile during the Asian crisis and the Global Financial Crisis.

3.3. Globalization, relative prices, and inflation

So far, this chapter has addressed the effects of external factors on inflation over a short- and medium-term horizon. Longer-term trends of these external factors, such as globalization or changes in a country's trade structure, may also have considerable effects on prices. Since, as argued in Chapter 2, inflation in the long run is a phenomenon associated with monetary policy, such long-run external forces will be reflected in relative price changes between local and external goods. Studying these forces is the objective of this last section.

One of the consequences of the process of globalization and trade integration worldwide that began in the early 1990s, was the growing presence of the emerging economies of Southeast Asia in international markets. In light of this, this section analyzes the impact of the irruption of emerging markets, particularly China and other Asian economies, on the dynamics and evolution of prices in Chile. The evidence suggests that globalization process has translated into increased competition, pushing down prices, costs and margins, which has temporarily affected the inflation trajectory[27]/.

Although Chile's commercial opening stayed relatively stable between 2005 and 2015[28]/, with an imports to GDP ratio of around 30%, there were important changes in the composition of imports, both in the type of products, with final products replacing intermediate inputs, and in their origin, as Asia increased its weight (see Figure 3.9). To the extent that this has allowed access to inputs and products at a lower cost, it is to be expected that this has been transmitted, to a greater or lesser extent, to final consumer prices, exerting greater competitive pressure on local producers[29]/.

To evaluate the impact of these new trading partners on the evolution of prices in the Chilean economy, advantage is taken of the availability of granular data from the Customs Office in Chile, where information is available on the value of imports, the quantities imported, and their origins. This makes it possible to study the main channels through which greater commercial integration affected final prices, either by substitution towards lower-priced products or by the changes in prices that these same imported goods have undergone over time.

In practice, the substitution channel from local to imported products is of little relevance for all the goods groups studied in the case of Chile. However, the imported inflation channel, which reflects changes in the composition of imports and the behavior of inflation in the countries from which goods are purchased, is noteworthy, especially for certain product groups such as Foods and non-alcoholic beverages and Home furnishings and equipment (see Table 3.2). Ceteris paribus, the result in Table 3.2 suggests that inflation was on average 0.34% lower each year as a result of deflationary pressures from abroad[30]/.

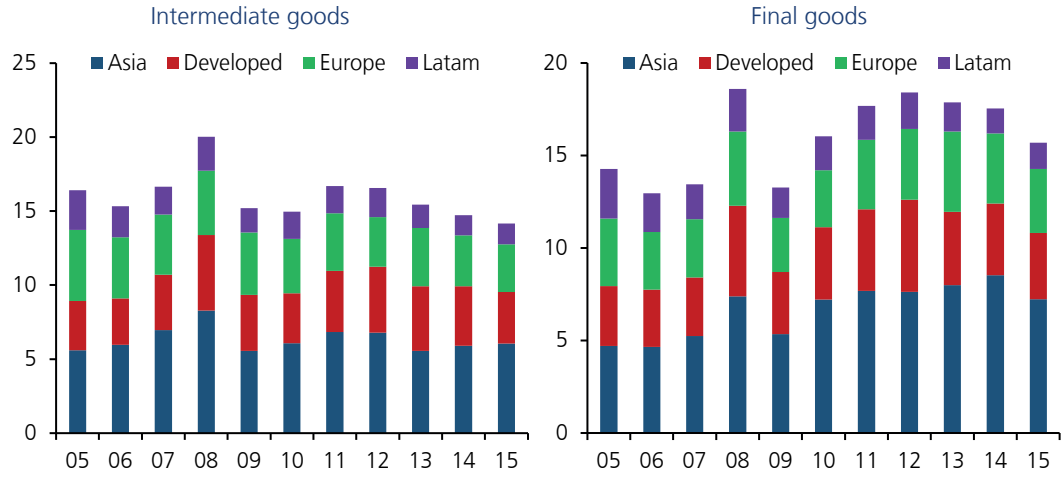
27/ Much of the evidence comes from Prades (2021). Yellen (2006) and De Gregorio (2019) point out that one of the main channels through which external factors affect domestic inflation is the reduction in the prices of imported goods and services caused by globalization, and its implications for the increase in local competition and productivity.

28/ The sample is associated to the availability of input-output data tables among OECD countries.

29/ The majority view in the specialized literature is that globalization has put downward pressure on prices through several channels, including: the irruption of Asia into international markets (for the U.S., see Amiti *et al.*, 2020), increased competition and margin squeeze (Guerrieri *et al.*, 2010), by increased participation in global value chains (Auer *et al.*, 2017), and by the spread of shocks resulting from increased linkages in the procurement of foreign inputs (Auer *et al.*, 2019), among others. However, there is no consensus regarding the implications of globalization on inflation dynamics and monetary policy. See, for example, Bems *et al.* (2018) for an empirical analysis for emerging economies which finds that the role that global factors play in inflation remains limited, and domestic determinants and monetary policy anchoring dominate. See also the recent –and more theoretical—work of Comín and Johnson (2020).

30/ Carluccio *et al.* (2018), using French customs data very similar to those available for the Chilean economy, estimate the impact of a greater presence of imports of Asian origin on the evolution of consumer prices in France, finding that, all else being equal, between 1994 and 2014, CPI growth was 0.17 pp less per year.

FIGURE 3.9 WEIGHT OF INTERMEDIATE IMPORTS OVER GDP BY GEOGRAPHICAL AREA OF ORIGIN
(percent of GDP)



Source: Prades (2021) based on OECD ICIO database.

TABLE 3.2 EFFECT OF IMPORTS COMPOSITION IN THE CPI'S EVOLUTION (*)

Groups of goods and services	**Total contribution to CPI**	**Annual contribution to CPI**
	(percentage points)	
Foods and non-alcoholic beverages	-0.63	-0.06
Tobacco and alcoholic beverages	-0.06	-0.01
Clothing and footwear	-0.08	-0.01
Housing, water, electricity, and gas	0.00	0.00
Household furnishings and equipment	-2.15	-0.20
Health	0.00	0.00
Transportation	0.00	0.00
Communications	0.00	0.00
Recreation and culture	-0.43	-0.04
Education	0.00	0.00
Restaurants and hotels	0.00	0.00
Miscelaneous goods and services	-0.41	-0.04
Effect on total CPI	-3.75	
Annual effect on CPI		-0.34

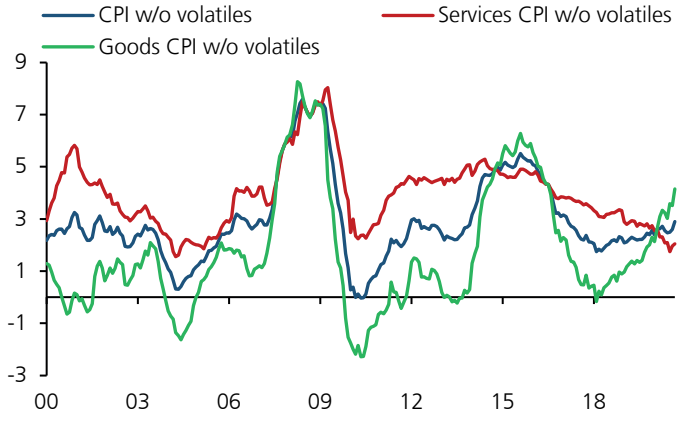
(*) Using the methodology of Carluccio *et al.* (2018), the effect on the CPI associated with imported inflation is estimated, which includes both changes in imports composition -by country of origin and type of product— and the behavior of inflation in countries from which goods are bought. The column to the left shows the 2005-2015 cumulative effect, and the one to the right shows the average annual effect in the same period.

Source: Prades (2021) based on Customs Office data.

It is important to interpret this result correctly in the light of the messages of this Supplement, being clear about its limitations as a simple partial equilibrium accounting exercise. The findings do not imply that, in a world without negative price pressures through imports, inflation in Chile would have been 0.34% higher each year for ten years. As mentioned in Chapter 2, over a long horizon inflation is determined by monetary policy. Monetary policy, therefore, would have been able to maintain the decade's average inflation around the 3% target anyway, irrespective of the behavior of external prices.

To further delve into the dynamics of relative prices in the long run, Figure 3.10 provides additional evidence on the important changes in relative prices that have occurred in Chile by comparing the annual inflation rates of goods and services for the CPI without volatiles over the last twenty years. It can be seen that, for almost the entire period, goods inflation has been lower than services inflation, so that the relative price of goods has fallen systematically. Indeed, non-volatile CPI inflation averaged 2.94% between 2000 and 2020, but this masks an important heterogeneity between services inflation (3.96%), and non-volatile goods inflation (1.76%).

FIGURE 3.10 INFLATION OF GOODS AND SERVICES IN CHILE, 2000-2020
(annual change, percent)

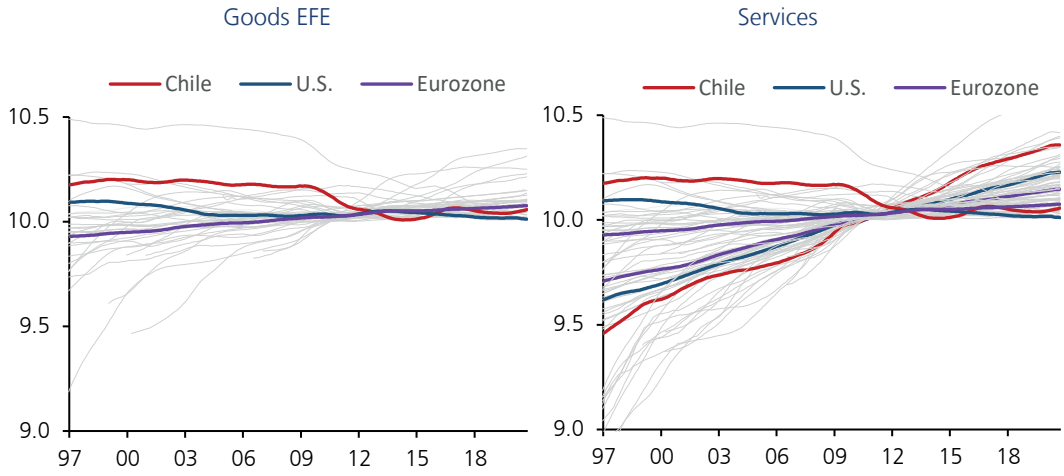


Sources: Central Bank of Chile and National Statistics Institute (INE).

Figure 3.11, comparing the evolution of the price indexes for goods and services excluding foods and energy (the CPIEFE) for a group of 35 reference countries, from 1997 to September 2020, shows that this phenomenon has not been specific to Chile, but a worldwide pattern[31]/ The harmonized European system (HIPC, used by countries of the European Union and Great Britain) is used for all countries, to make the price indexes comparable. It can be seen that, in Chile and in almost every country, the evolution of prices of goods EFE is very different from that of services, which grow more rapidly, making evident the tendency to a change in the relative price between the two. This is emphasized in Figure 3.12, which shows the evolution of the medians (across countries) of 12-month CPI inflation, goods EFE and services. With few exceptions, during the last twenty-three years the median inflation of services in the sample of countries significantly exceeded the median inflation of goods EFE. Thus, the average gap was 2.11%, pointing to an overall, systematic, and sustained fall in the relative price of goods minus foods and energy (EFE) to services.

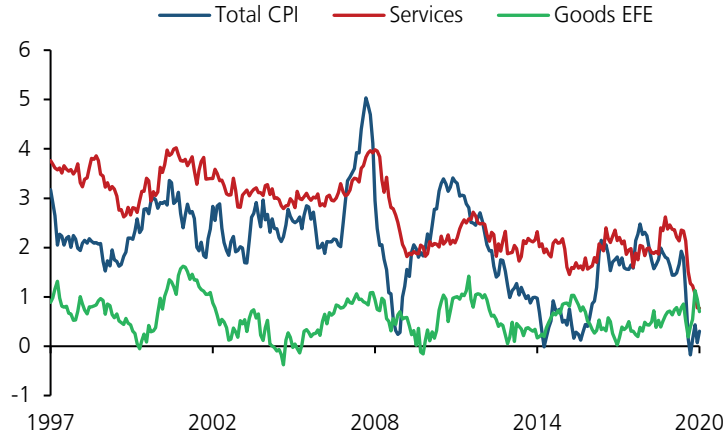
31/ That is, for clarity of presentation, foods and energy are excluded from this figure and the next. These results are based on Bajraj, Carlomagno and Wlasiuk (2021). The sample includes Austria, Belgium, Bulgaria, Czech Republic, Croatia, Denmark, Estonia, Finland, France, Germany, Great Britain, Greece, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Turkey, Japan, Korea, Canada, United States, Mexico, Colombia, Brazil, Peru and Chile. Although most of the series are available as from January 1996, some countries were added to the base later.

FIGURE 3.11 GOODS AND SERVICES PRICE INDEXES, INTERNATIONAL COMPARISON (*)
(harmonized series, ln, jan2010=100)



(*) Price indexes use the harmonized methodology and baskets (HICP), applying Eurozone weights to all countries. Series not available for all countries. Moving average of the last twelve months. Series measured in logs. Source: Bajraj, Carlomagno, and Wlasiuk (2021).

FIGURE 3.12 GOODS AND SERVICES INFLATION, 1997-2020, MEDIAN AMONG COUNTRIES
(harmonized series, dlog 12 months, percent)



(*) Price indexes use the harmonized methodology and baskets (HICP), applying Eurozone weights to all countries. Series not available for all countries. Moving average of the last twelve months. Source: Bajraj, Carlomagno, and Wlasiuk (2021).

These results suggest that, in the last two decades, the inflationary process in the world has been associated with significant changes in relative prices, with dynamics common to many countries. These divergences can be associated with both supply and demand factors. On the supply side, the relative fall in the price of manufactured goods —of a tradable nature between countries— may be associated with the changes in world trade patterns discussed at the beginning of this section, as well as with the fact that the productivity gains that may have occurred during this period may have been more intense in the technologies that produce these types of goods. On the demand side, it is possible that the relative increase in the prices of services reflects a greater intensity of demand for them, associated both with higher income levels and the process of demographic change[32]/

In short, this section points to the existence of global factors that have been important in explaining the evolution of relative prices in Chile and the world, which have reflected significant changes in the cost structure, particularly those associated with the production of goods. Although, as explained earlier, this is not a factor that determines the long-term inflationary trend of the economy, it has been associated with forces that, for a given monetary policy path, have kept upward pressures on prices in check, and have been the reflection of welfare gains associated with the benefits of international trade and the process of technological development.

3.4. Conclusions

This chapter has discussed how the external sector plays an important role in the short- and medium-term dynamics of inflation in Chile, a small and open economy. Thus, external factors explain a significant proportion of the variance of inflation, which is consistent with a monetary policy framework that allows for temporary and limited fluctuations in inflation in response to shocks, ensuring its convergence to the 3% target over a two-year horizon, without exacerbating output volatility. Within this policy framework, the nominal exchange rate plays a crucial role in the economy's ability to adjust to external shocks. The low ERPT to inflation coefficient observed in Chile, associated with the anchoring of expectations around the inflation target, gives monetary policy room to play a countercyclical role in response to these shocks.

From a longer-term perspective, changes in Chile's trade structure have been important for the dynamics of relative prices. As in the rest of the world, over the last two decades the prices of goods relative to the prices of services has fallen significantly.

32/ This is studied in detail in the recent works of Eickmeier and Kuhnlenz (2018), Bai and Stumpner (2019), and Amiti *et al*. (2020).

4. INFLATION EXPECTATIONS AND MONETARY POLICY IN CHILE

More often than not, economic decisions are based on expectations about future variables. In the case of inflation, how households and firms foresee its evolution going forward will affect decisions like wage adjustments and other important production costs. Moreover, in a context of price rigidities as discussed in Chapter 2, changes in contemporaneous prices will have an important anticipatory component that will generate a Phillips curve where current inflation depends on future inflation expectations in addition to contemporaneous costs.

Given its importance, this chapter examines inflation expectations, their relationship with headline inflation and implications for the conduct of monetary policy. The first section of this chapter provides a conceptual discussion of the importance of expectations for inflation and monetary policy, and reviews evidence on how the communication of monetary policy affects expectations. The second section presents evidence on the measurement and determinants of inflation expectations in Chile, their anchoring to the inflation target over the last two decades, and how surprises in monetary policy decisions can influence inflation and inflation expectations.

The analysis of inflation expectations is a particularly important issue for a country like Chile, where a long inflationary history in the twentieth century led to the widespread use of indexation mechanisms in determining prices and wages. Given these conditions, compliance with the CBCh's annual inflation projections, which would eventually become the current inflation target, was crucial for agents to start factoring the target into their decision making. This was an influential element in the disinflation process of the 1990s to break the inertia of the past, and to keep inflation levels low and stable[1]/. Moreover, a credible monetary policy, which allows keeping inflation expectations anchored to the target, is crucial in a small open economy with a flexible exchange rate, as it helps to maintain a low pass-through coefficient. This allows the exchange rate to act as a useful adjustment mechanism and allows monetary policy to play a countercyclical role.

This chapter contains three main messages. First, inflation expectations play a fundamental role in the conduct of monetary policy, because of both their impact on inflation and the importance of their anchoring for the effectiveness of monetary policy. If inflation expectations are anchored to the target, monetary policy has greater degrees of freedom to conduct countercyclical policy.

Second, the Central Bank's communication to the market can help agents to better understand how the economy operates, leading to more informed expectations and facilitating the conduct of monetary policy. Therefore, the CBCh's monetary policy framework assigns a central role to

1/ A good example of this change were the wage negotiations of the public sector, which went from being indexed to past inflation, to be based on the CBCh's inflation projections. See Corbo (1998).

communication and transparency.

Third, the range of measurements of inflation expectations in Chile shows that, on average, their historical behavior has been anchored to the Bank's 3% target, although with significant dispersion over shorter horizons. The degree of anchoring has been high and stable over the last two decades. Only on one occasion, when CPI inflation almost touched 10% per year in 2008, were there significant deviations from the target over the two-year horizon. In these cases of de-anchoring, the CBCh has had the tools to take action. This stems from the characteristics of the monetary policy framework and the built-in credibility, in which exchange rate flexibility plays a central role by expanding the responsiveness of monetary policy.

4.1. Inflation expectations and monetary policy

This section presents a comprehensive analysis of inflation expectations. The first part discusses their relationship with monetary policy, addressing why agents' expectations are important in determining inflation in the short and medium term. The second part discusses the mechanisms through which central banks can affect inflation expectations, with communication being a determining factor. Based on this background, the third part discusses the role of communication and transparency in the case of the Central Bank of Chile.

4.1.1. Importance of expectations for inflation and monetary policy

As was discussed in Chapter 2, inflation expectations play a key role in the analytical framework of the neo-Keynesian Phillips curve—a fundamental instrument in central banks' toolkit—, as it is a critical determinant of short- and medium-term inflation. The mechanism operates directly: wage setting and pricing decisions, the signing of contracts, and the determination of financial asset prices and conditions depend on the expected future inflation. Thus, high inflation expectations will cause agents to set their wages and prices in such a way as to hedge against expected inflation. This will push the nominal value of wages and prices upwards, directly affecting present inflation and validating the initial expectation. This mechanism is one of the main causes behind the high degree of inertia observed in inflation data worldwide.

Aside from their direct effect via inflation, expectations are crucial for monetary policy to be conducted effectively. Central banks cannot take agents' reactions to their decisions as given. On the contrary, the behavior of households and firms adjusts to the policy actions taken, and to the information that the monetary authority communicates regarding its objectives and the use of its instruments. This emphasizes, once again, the need to clearly and transparently communicate the monetary policy framework and decisions.

As summarized in Box 4.1, understanding how expectations are generated is at the heart of the research agenda of modern macroeconomics by academics and central banking technicians. Among the main findings of this agenda is that firms and households do not always base their expectations on the conjuncture, especially in environments where inflation is low and stable. Moreover, expectations are heterogeneous, due either to different mechanisms of expectation formation or to differences in the information available among agents. This makes it necessary for central banks to have measuring instruments that allow them to accurately gauge how expectations move over time and how they react to the shocks affecting the economy[2]./

2/ One important limitation of this literature is that part of it is associated to countries with a history of fairly low and stable inflation, which may hinder the application of some of its conclusions to high-inflation environments.

Box 4.1: Evidence of and theory about expectations formation[3]/

In the 1970s, the adoption of the assumption of full information and rational expectations (FIRE) revolutionized the way macroeconomics was understood and modeled. Under this paradigm, economic agents have full information when making economic decisions, insofar as they have perfect knowledge of the most relevant macroeconomic variables (e.g., other agents' decisions, equations and parameters that capture the dynamics of the economy, et cetera) and use it in the best possible way. However, both survey and experimental evidence suggests that in reality expectations diverge from the FIRE paradigm (Mankiw *et al.*, 2003; Croushore, 1997; Mehra, 2002).

Based on this evidence, efforts have been made to improve our understanding of the process of expectations formation of both individuals and firms. The general conclusion is that expectations differ systematically from FIRE, although there are differences across the various types of individuals. Thus, the expectations of households and firms are significantly different from those of professionals in the financial system, and they depart even further from the FIRE assumptions (Carroll, 2003). Indeed, inflation expectations of households and firms tend to be higher than those of professionals, and they also show a significant divergence between measures of past inflation and expectations of future inflation (Coibion *et al.*, 2020). In addition, there are demographic factors that correlate with prediction errors, projections are correlated with households' own experience, and lower-income households show greater dispersion in their projections. It has also been found that these biases vary according to the business cycle and the level of inflation in the economy, because individuals tend to do less monitoring of the economic status in environments where inflation is low and relatively more stable (Coibion *et al.* 2018).

Evidence obtained from participants in controlled experiments also suggests that the formation of economic expectations differs from FIRE. In general, large heterogeneity in participants' expectations is observed, suggesting different mechanisms of expectations formation, such as simple rules, adaptive learning, and rational expectations (Hommes, 2011).

In response to this evidence, different alternative analytical approaches have emerged that have enriched macroeconomic modeling by allowing the inclusion of deviations from FIRE. These approaches restrict the amount of information that agents have, either because of availability concerns or because of limitations in information processing capacity. Some examples are the sticky information model, the noisy information model and the rational inattention model. The sticky information theory claims that expectations are updated infrequently due to the costs of doing so, but that updates are consistent with FIRE (Mankiw and Reis, 2002). In contrast, noisy information and rational inattention theories suggest that agents use less information because of cognitive and other constraints in processing it (Woodford, 2002; Sims, 2003). In the former, agents observe the correct value of the variable, but with an error that they cannot perfectly identify. In the latter, the same agents, given their cognitive constraint, optimally choose which information they will pay attention to.

There are other theories that also deviate from FIRE, which are characterized by modeling less rational agents. One such theory is learning models in which agents gradually learn the parameters and, in general, the structure of the economy, just as econometricians do (Slobodyan and Wouters, 2012; Eusepi and Preston, 2018). An application for Chile, with agents learning when forming their inflation expectations, will be presented later in this chapter. Other such theories postulate the existence of adaptive expectations or theories of limited rationality (Gennaioli and Shleifer, 2010; Gabaix, 2014).

3/ This box is based on García-Schmidt (2021).

4.1.2. Central banks, their communication strategies and the formation of inflation expectations[4]/

For many years, opacity was a valued attribute in the conduct of monetary policy. This paradigm has changed dramatically since the 1990s, and today there is virtual consensus on the advantages of transparency and disclosure of information.

There is abundant evidence that, with some heterogeneity, households and professional agents can understand the basic economic relationships behind the actions of central banks, such as the Taylor rule, which represents the response of the monetary policy rate to inflation and activity, or the Phillips curve, described in Chapter 2. Therefore, appropriate communication by the Central Bank of the arguments behind its decisions helps agents to understand the functioning of the economy and make better decisions[5]/.

Of course, there are great challenges in trying to provide clear information on the conduct of monetary policy, especially when it is directed to households and firms rather than to a specialized audience. However, international evidence shows that improvements in central bank communication have brought positive effects, such as greater predictability and stability of inflation. This facilitates the conduct of monetary policy and enhances its effectiveness. As a consequence, an appropriate implementation of the inflation targeting framework uses monetary policy instruments to bring projected inflation to the target within the specified time horizon, while clearly communicating to the market how the target will be achieved, thus anchoring inflation expectations. The evidence suggests that the adoption of an inflation target, under conditions in which the institutional framework enables its credibility (for example, in a context of a sustainable fiscal trajectory), anchors expectations among professionals, making them more dependent on the target and less on the past[6]/.

4.1.3. The Central Bank of Chile's inflation targeting framework and monetary policy communication

The CBCh's monetary policy framework acknowledges the key role of inflation expectations by assigning a central role to communication and transparency. This has two motivations. First, it is a necessity that arises from its accountability to society stemming from its autonomy. Second, it helps agents understand the policies that the Bank adopts to meet the target and, in this way, affects the process of inflation expectations formation. Indeed, and in line with the evidence discussed in the previous section, the ability to convey the rationality of the inflation forecast and the way in which the CBCh responds to make it consistent with the inflation target is essential for the credibility of monetary policy, for maintaining price stability and for anchoring inflation expectations.

4/ This section draws from García-Schmidt (2021).

5/ For further detail, see Carvalho and Nechio (2014), Dutra (2017), Dräger *et al.*, (2016), Lamla and Vinogradov (2019), Coibion *et al.* (2020), and Binder (2017).

6/ In this regard, the evidence indicates that the adoption of inflation targets only affects the expectations of households that pay more attention to the central bank, but not the general public. For more details, see Blinder *et al.* (2008), Svensson (2010), Johnson (2003), Levin *et al.* (2004), and Binder (2017).

Box 4.2: Recent evidence on the effects of the CBCh's communication

Good communication by central banks about the rationality of their monetary policy decisions is a fundamental element for their effectiveness. Evidence gathered from the literature has found that communication can, by itself, affect financial markets, increase the predictability of monetary policy and help achieve macroeconomic objectives (Blinder *et al.* 2008). This has led in recent years to research resources being devoted to documenting and better understanding this communication, so that it can be thus improved. Studies by Hansen and MacMahon (2015), Schmeling and Wagner (2019) and Cieslak and Schrimpf (2019) have found that communication affects domestic interest rates and stock returns. A 2018 study by the International Monetary Fund shows that greater transparency and better communication are associated with a more predictable policy and better-anchored inflation expectations.

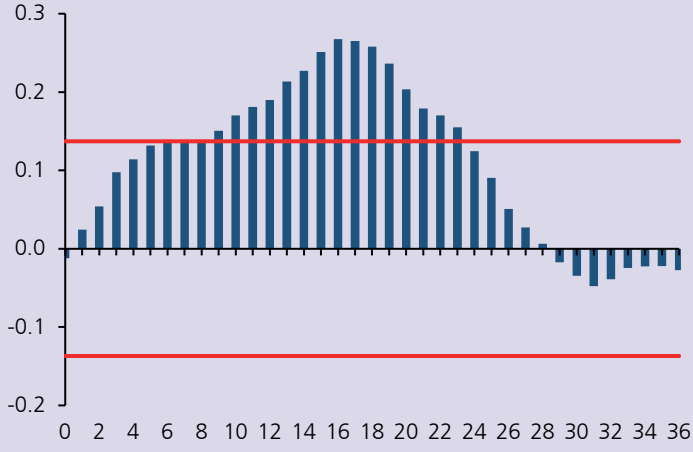
For the case of Chile, González and Tadle (2021) study the information content of monetary policy meeting statements. They find that, beyond the MPR information they contain, the way the decision is communicated has effects on the real economy.

The authors construct a bias index based on linguistic methods, which measures movements in the tone or bias of monetary policy statements. A higher index indicates a more contractionary tone or bias, as it shows more concern about increases in inflation and/or activity. Similarly, a lower index would indicate a more expansionary monetary policy tone or bias, motivated by lower inflation or slower growth.

Figure 4.1 illustrates the cross-correlation between the Bias Index and the MPR, with monthly data between 2001 and 2019, by showing the correlation between the former and subsequent movements of the latter. It can be observed that the correlation is maximized at month 16th, implying that the language of the statements provides important information to forecast future movements.

The authors also find that surprises in the bias index —calculated using the residual of explanatory regressions of the index with macroeconomic variables— have real effects on the domestic stock market, as measured by the return on the selected stock index IPSA and short-term interest rates. This occurs even after including the effect of surprises on MPR movements, pointing to the existence of an information channel in monetary policy pass-through.

FIGURE 4.1 CROSS-CORRELATION BETWEEN MPR AND BIAS INDEX

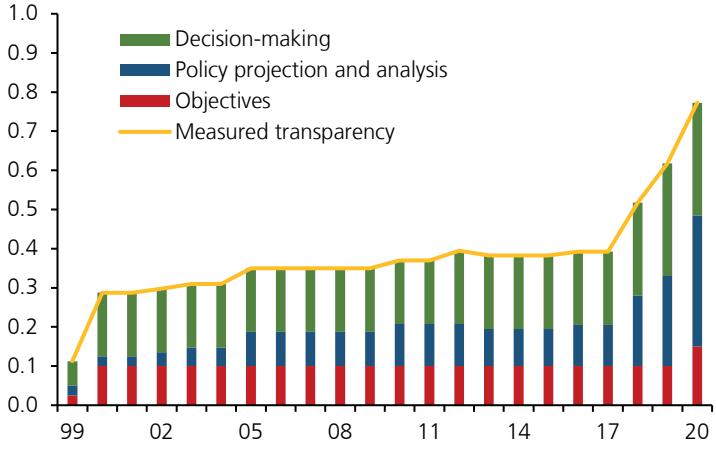


Source: González and Tadle (2021).

For this purpose, the CBCh uses multiple communication instruments, such as monetary policy meeting statements and minutes, the Monetary Policy Report and related presentations, as well as the delivery of information through reports that make transparent its analysis and projection methodologies[7]/. Box 4.2 discusses in more detail how the communication delivered through one of these instruments, the monetary policy meeting statements, provides valuable information regarding the expected path of monetary policy and the Central Bank's view on the future prospects for the economy.

The movement towards greater transparency in monetary policy conduct over the last two decades in Chile is shown in Figure 4.2, which presents an index of the evolution of the CBCh's level of transparency[8]/. The index considers three dimensions: transparent objectives, the characteristics of the policy forecasting and analysis system, and the decision-making process. As can be seen in the figure, the publication of the MP Report and the adoption in May 2000 of an inflation-targeting monetary policy framework with a flexible exchange rate constituted a first significant change, to which improvements in the communication of the forecasting and analysis system contributed later, such as the publication of the MEP projection model starting in 2003. Transparency gains have accelerated between 2018 and 2020 on all fronts. Thus, there have been improvements in the policy decision-making process, independent consulting and assessments have been sought, and the update of the Monetary Policy Framework, together with the new Financial Policy Framework, increased the degree of transparency regarding the objectives. In addition, very significant changes have been made in the communication of the forecasting and analysis system through milestones such as the publication of the CBCh's Macroeconomic Models and Projections book and the use of a corridor for the future monetary policy path.

FIGURE 4.2 CENTRAL BANK OF CHILE'S TRANSPARENCY INDEX, 1999-2020



May 2000. First MP report.

2003. MEP model and Policy Projection and Analysis System published.

2018. Updated MP decision-making process and External Evaluation Committee.

2019. Updated MP framework published with greater emphasis on financial stability.

2020. Models book published; Central models published with codes; MPR path corridor published.

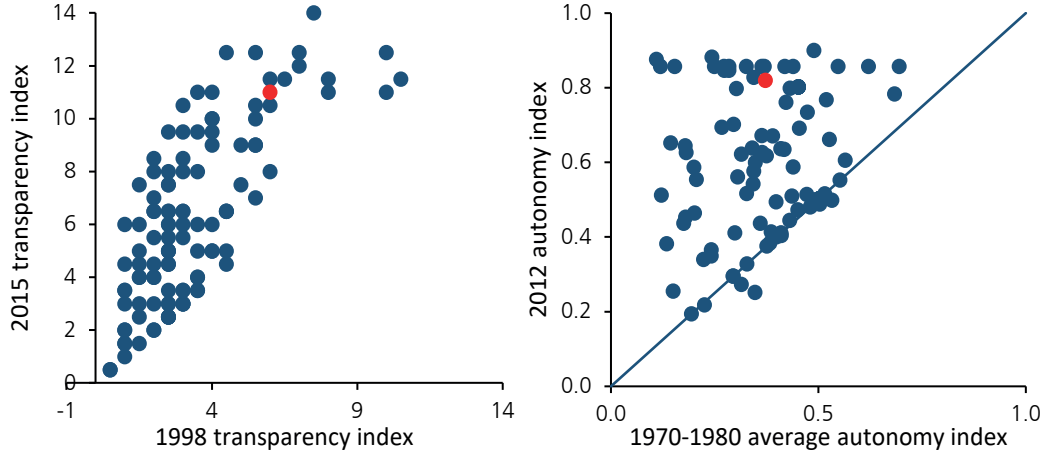
Source: Fornero (2021), based on methodology of Al-Mashat *et al.* (2018).

7/ There is direct evidence that this communication affects expectations in Chile. Pedersen (2015) finds that short-term expectations are influenced by the projections made by the Central Bank. Cruz *et al.* (2020) find that the communication of Business Perception Reports (IPNs) is highly correlated with investment expectations.

8/ The transparency index used was built by Al-Mashat *et al.* (2018) and updated for the Central Bank of Chile by Fornero (2021).

The left-hand side panel of Figure 4.3 reaffirms that the increase in transparency observed in Chile in recent decades is an international phenomenon, as it compares an indicator of central bank transparency in 1998 with the one observed in 2015[9]/. In 2015, transparency was higher than in 1998 in the vast majority of countries, and in many of them with very significant increases. In 2015, the CBCh was at the upper end of the distribution of countries, a relative position that, as documented earlier, has increased in later years. The panel to the right of Figure 4.3 shows that this increase in transparency went hand in hand with a rise, also considerable, in the indicators of central bank autonomy in the world. This also was the case in Chile, consistent with the need to increase transparency (and improve communication) in the context of a society that grants greater autonomy to central banks[10]/.

FIGURE 4.3 EVOLUTION OF CENTRAL BANKS' TRANSPARENCY AND AUTONOMY (*)



(*) Left panel: each dot represents a country and its central bank's transparency indexes in 1998 and 2015, taken from Dincer *et al.* (2019). Right-hand panel: each dot represents a country, and autonomy indexes come from Garriga (2016). The red dots indicate the data for Chile.

Sources: Dincer *et al.* (2019) and Garriga (2016).

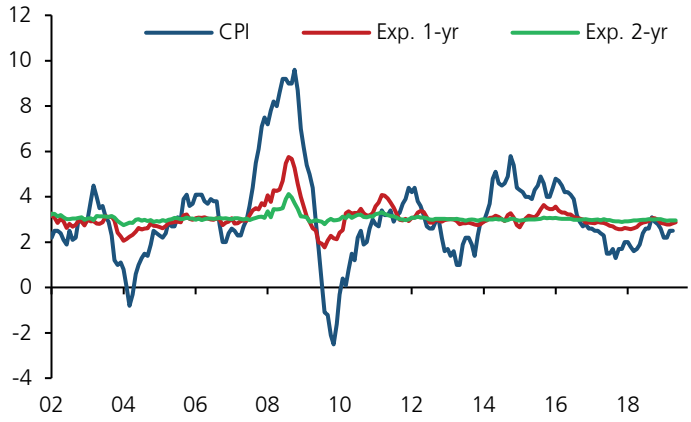
The transparency and communication strategy followed by the CBCh are some of the factors that have contributed to keeping inflation expectations very close to the 3% target for most of the time, beyond temporary fluctuations in actual inflation (Figure 4.4). The most important episode of deviation occurred shortly before the 2008-2009 financial crisis, when there was a major shift in one-year inflation expectations in the context of inflation reaching its peak of more than a decade. At that time, two-year inflation expectations, directly associated with the inflation target horizon, approached 4%, deviating significantly from the value of around 3% at which they remained almost permanently for the rest of the time. This episode is discussed in more detail in the following section.

9/ This exercise uses the index for a broad sample of countries built by Dincer *et al.* (2019) for the period 1998–2015.

10/ The autonomy index comes from Garriga (2016), who reconstructs the index of Cukierman, Webb, and Neyapty (1992). This index is defined in four dimensions: Governor and Board member characteristics (i.e., appointment, dismissal, and tenure); policymaking powers; central bank objectives; and central bank constraints in loaning to the public sector. The components are combined into a weighted index for 182 countries, between 1970 and 2012, ranging from 0 (lowest) to 1 (highest). The figure illustrates the dispersion of the autonomy index, where the X axis shows this indicator's average between 1970 and 1980, while the Y axis shows the indicator in 2012.

FIGURE 4.4 INFLATION AND EXPECTATIONS (*)

(annual change, percent)



(*) Inflation expectations corresponding to the median in Economic Expectations Survey (EES).

Sources: Central Bank of Chile and National Statistics Institute (INE).

4.2. Inflation expectations in Chile: measures and determinants

This section examines in depth the measurement and determinants of inflation expectations in Chile in three dimensions. First, it presents the different instruments that exist to measure inflation expectations in Chile, and analyzes their behavior over the last two decades. Subsequently, evidence on the anchoring of inflation expectations in the country is discussed. Finally, it documents how monetary policy decisions have affected both actual and expected inflation.

4.2.1. Measuring expectations

In order to correctly assess the behavior of inflation expectations, adequate measuring instruments are needed. In Chile, as elsewhere in the world, two types of instruments are used. First, surveys that consult different types of agents (households, companies, analysts, market operators) about their expectations about the future behavior of inflation. The questions in the surveys may have different degrees of accuracy, from qualitative criteria (e.g., if the respondent expects prices to rise by more or less than some benchmark) to questions that ask for a specific quantitative value (e.g., what the respondents expect the inflation rate to be in twelve months). Second, financial instruments, where the spreads between different types of instruments can be associated, due to arbitrage considerations, with inflationary expectations at different horizons. Thus, for example, for instruments of similar risk and defined at a common horizon, the difference between nominal interest rates and real rates (UF-indexed) should reflect the inflation expectation for that horizon, so that at the margin both instruments deliver the same expected real flow[11]/. The expectations measured in this way are not, therefore, the opinion of a particular agent, but transactions whose prices reflect the implicit inflation expected by the agents involved.

11/ It should be kept in mind that a measure of breakeven inflation—the nominal rate minus the real rate at a given maturity—does not perfectly represent an inflation expectation, because there are term premiums in between that are not equivalent for both types of rates. See Gürkaynak *et al.* (2010).

Table 4.1 reports the characteristics of the seven surveys that measure inflation expectations in Chile. For each one, it shows the institution responsible, its frequency, the public interviewed, the year of implementation, and the questions asked. Four of them (the two conducted by the Central Bank, plus those of Bloomberg and Consensus Forecast) focus on the professional opinion of experts and/or agents participating in the financial market, while the remaining three focus on firms and households. In this sense, these surveys provide complementary information, showing both the expectations of agents with a higher degree of sophistication and information in their projections[12]/, and those of agents, such as households and firms, whose expectations may be less informed and/or elaborated, but still significant for inflation, due to the importance of their decisions for the macroeconomic aggregates. Most surveys provide information on inflation expectations for up to two years (consistent with the operational definition of the CBCh's inflation target), although the Economic Expectations Survey (EES) provides information for up to three years.

TABLE 4.1 INFLATION EXPECTATIONS SURVEYS

Survey	EES	FTS	IMCE	Bloomberg Forecasts	Consensus Forecasts	IPEC	Uchile
Entity	CB of Chile	CB of Chile	ICARE	Bloomberg	Consensus	GfK Adimark	Microdata center, Universidad de Chile
Frequency	Monthly	16 times per year (*)	Monthly	Monthly	Monthly	Monthly	Quarterly
Repondents	Experts	Financial traders	Companies	Financial traders	Instituciones Económicas/ Financieras	Persons	Households
Survey began in	2000	2009	2003	2018	1993	1981	2001
Type of questions	Quantitative	Quantitative	Qualitative/ quantitative (varies by sector)	Quantitative	Quantitative	Qualitative Quantitative	Qualitative Quantitative
Questions about price changes	Inflation (% CPI change) in: current month (monthly change) next month (monthly change) 11, 22, and 35 months (annual change) Dec. current year (annual change) Dec. next year (annual change)	Inflation (% CPI change) in: Current month (monthly change) Next month (annual change) In two months (monthly change) 12 months ahead (1-12) Next 12 months (13-24)	How do you think that --on average-- the selling prices of your company's products will evolve in the next 3 months with respect to the current month? How do you think that --on average-- the prices of the inputs used by your company will evolve in the next 3 months with respect to the current month?	CPI (Dec-to-Dec % change) This year Next year In two years	Consumer prices (Dec-to-Cec % change): This year Next year	By how much do you think the prices of goods will increase within the next 12 months?	By how much do you think prices will evolve in the next 12 months?

(*) Survey taken twice per each monetary policy meeting, which take place 8 times a year.

12/ Pedersen (2020) shows how participants in the Financial Traders Survey base their expectations mainly on models and financial market information.

Table 4.2 shows how measures of inflation expectations are obtained with information on financial assets. The richness of the maturity structure of assets allows calculating a wide range of inflation measures, from the very short term (one to two months) to medium- to long-term measures (five years). While asset-based inflationary measures have the advantage of reflecting the decisions of agents who actually made a financial transaction —and not just an opinion— they have the trade-off that they can be inaccurate due to the difficulty of correctly estimating the term premium differential.

TABLE 4.2 INFLATION EXPECTATIONS BASED ON FINANCIAL ASSETS (*)

Inflation measure	**Inflation expected current month**	**Inflation expected next month**	**Inflation expected 1 year ahead**	**Inflation expected 2 years ahead**	**Inflation expected 3 years ahead in 2 years' time**
Asset	**Inflation insurance**	**Inflation insurance**	**Spot Swap**		**Bond 3 in 2**
Source	**BDE**	**BDE**	**BDE**	**BDE**	**BDE**
Calculation	Midpoint between purchase and sale price over UF change in specified term.	Midpoint between purchase and sale price over UF change in specified term.	Difference between nominal and real exchange rates of instruments of similar risk and maturity (benchmark bonds and overnight index swap in pesos and UF)	Difference between nominal and real exchange rates of instruments of similar risk and maturity (benchmark bonds and overnight index swap in pesos and UF)	Traded rates

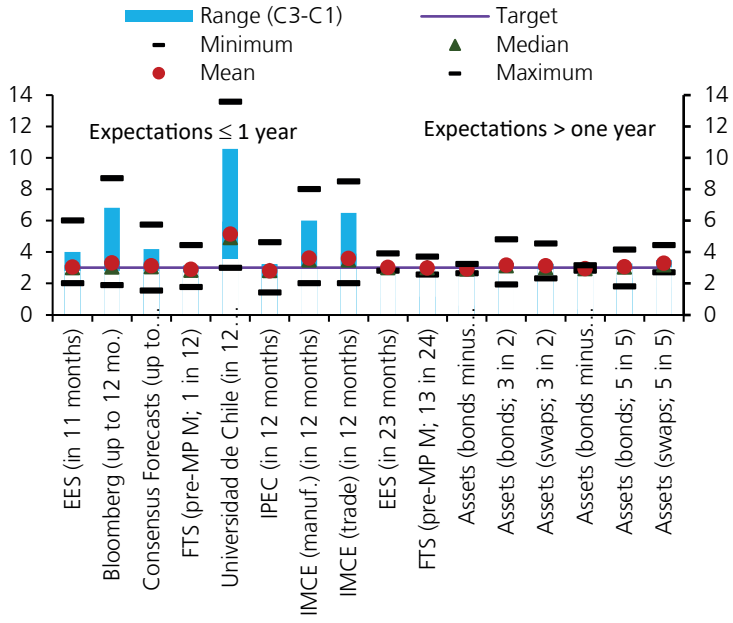
Inflation measure	**Inflation expected 5 years ahead in 5 years' time**	**Inflation expected 3 years ahead in 2 years' time**	**Inflation expected 5 years ahead in 5 years' time**	**Inflation expected 3 years ahead in 2 years' time, no premium**	**Inflation expected 5 years ahead in 5 years' time, no premium**
Asset	**Bond 5 in 5**	**Swap 3 in 2**	**Swap 5 in 5**	**Swaps and bonds**	**Swaps and bonds**
Source	**BDE**	**BDE**	**BDE**	**BDE + Risk America**	**BDE + Risk America**
Calculation	Traded rates	Traded rates	Traded rates	Overnight index swap rates (BDE) + Nominal and real zero bond rates (Risk America)*	Overnight index swaps (BDE) + Nominal and real zero bond rates (Risk America)*

(*) Calculated using model of Beyzaga and Ceballos (2017).

BDE: Statistical data base of the Central Bank of Chile.

Figure 4.5 provides a comparison based on historical information of various measures of expectations in Chile at different horizons[13]/. The measures are ordered according to the time horizon they cover, from the eleven months of the EES to the five-year measures associated with swaps. For each measure, both the average expectation and the distribution of expectations are shown, which allows seeing the degree of dispersion (discrepancy) among agents.

FIGURE 4.5 INFLATION EXPECTATIONS, SELECTED AGENTS (*)
(annual change, percent)



(*) For each survey and financial asset, all information available since 2001 is used.
Source: Medel (2021).

A couple of results stand out: first, the averages of all measurements are close to 3%, consistent with the nominal anchor role of the CBCh's inflation target at longer horizons. Moreover, this suggests that, at least on average, the different measuring methodologies come close to capturing the same unobservable variable. The exception is the Household Survey conducted by the University of Chile, which shows 12-month average inflation expectations above 3%. This is consistent with evidence from other countries, discussed in Box 4.1, which shows that household inflation expectations are higher and move further away from the inflation target in contexts of stable prices[14]/.

Second, averaging the surveys' expectations hides heterogeneity among different agents. This is especially reflected in household expectations, which foresee inflation one year out from close to 3% to nearly 14%, much higher than the maximum of the rest of the surveys. To a lesser extent, this dispersion is observed across companies (IMCE survey) and even among experts or market traders, although within the latter groups it is to be expected that there are fewer differences in access to information and in inflation forecasting methodologies. Dispersion falls significantly as the horizon lengthens, as can be seen in the 11-month and 23-month EES and FTS surveys. This, again, is associated with the importance of the nominal target anchor for the two-year horizon.

13/ This analysis is based on the work of Medel (2021), who takes all the historical information available for each survey since the year 2000.

14/ See, for example, the case of New Zealand in Coibion *et al.* (2018).

Summing up, there is a wide range of inflation expectations measurements in Chile. Despite their methodological differences, on average, expectations are anchored around the 3% target over the two-year monetary policy horizon, although with a significant degree of dispersion over shorter horizons. The issue of anchoring expectations is discussed in more detail below.

4.2.2. Anchoring expectations

So far, it has been demonstrated that inflation expectations have historically stood at around the CBCh's inflation target of 3%, especially at horizons longer than one year (Figure 4.4), and this is robust to the different measures of expectations at hand (Figure 4.5).

A question that arises naturally from this observation is, what is the mechanism that generates this anchoring of expectations and how can it be affected by different types of shocks? The anchoring of expectations to the target allows temporary fluctuations in inflation not to feed back to wages and prices, thus preventing a temporary inflationary shock from affecting medium- and long-term inflation dynamics[15]/. Thus, under anchoring, the response of medium- and long-term inflation expectations to temporary deviations of inflation from expectations is nil or very limited. On the contrary, in an economy where anchoring is weak, agents will react to temporary deviations of inflation by correcting their medium- and long-term expectations considerably. Thus, the degree of anchoring of inflation expectations can be measured by the sensitivity of these expectations to incoming information. A priori, this anchoring may vary over time, in response, for example, to changes in the conduct of monetary policy.

To obtain a quantitative measure of this mechanism, a simple model is estimated that explains the variation of long-term expectations[16]/ as a function of past forecasting errors:

$$\Delta E_{t-1}\left(\pi_{t+23}\right) = \rho_t\left(\pi_{t-1} - E_{t-2}\left(\pi_{t-1}\right)\right) + \varepsilon_t$$

where π_t is inflation in month t and $\Delta E_{t-1}\left(\pi_{t+23}\right)$ captures the change in long-term expectations (23 months) between t-1 and t. Thus, parameter ρ_t is a direct approximation to the degree of anchoring: the lower this coefficient, the lower the effect on long-term inflation expectations of short-term inflation surprises. Note that this parameter is explicitly allowed to be time-varying, to accommodate the idea that the anchor may vary as agents receive new information[17]/.

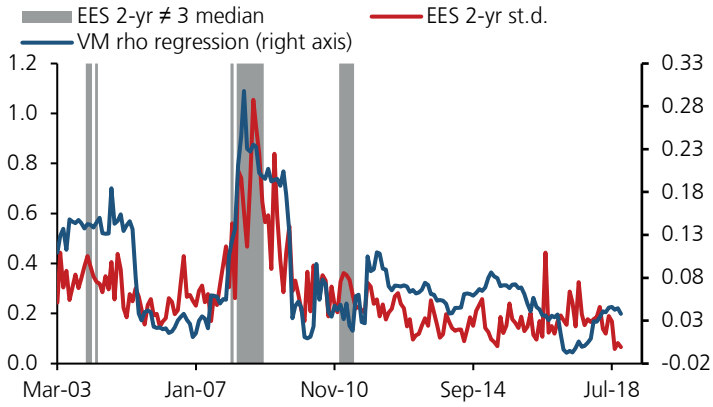
Figure 4.6 presents the results of estimating ρ_t with monthly data from the EES, using 24-month moving windows. The episodes where the median of inflation expectations in the surveys has drifted away from the target (shaded area) coincide with episodes where ρ_t increases. Additionally, these have been episodes in which the dispersion of the two-year inflation expectations in the EES has increased as well. Thus, the correlation between these two variables is approximately 0.7.

15/ This way of defining anchoring of expectations is of common use by central bankers. See, for example Draghi (2014).

16/ Defined as inflation expected two years out in the EES.

17/ The exercises in the rest of the section are based on the model of Arias and Kirchner (2019). Like any model, this reduced-form representation is a simplification of reality that attempts to capture a specific mechanism, and that does not explicitly incorporate mechanisms that may be important in the case of Chile such as the copper price or indexation. As will be discussed below, this exercise is then built into a structural model that allows to better capture the omitted mechanisms.

FIGURE 4.6 DISPERSON IN INFLATION 2-YEAR EXPECTATIONS AND SENSITIVITY OF EXPECTATIONS TO INFLATIONARY SURPRISES, 2003-2019 (*)



(*) Blue line represents 2-year inflation expectations' sensitivity coefficient to forecast error of inflation taken from OLS regression. Red line indicates standard deviation of 2-year inflation expectations as per EES. Shaded areas mark periods in which 2-year expected inflation is greater than 3%.

Source: Arias and Kirchner (2019).

The imperfect anchoring of expectations or the variation of the anchoring over time in response to macroeconomic shocks can be interpreted under the prism of an expectations formation process where there is adaptive learning (see Box 4.1). Under this logic, agents use reduced-form models to project future inflation, which they re-estimate each period as new information becomes available. The degree of anchoring of expectations is naturally captured by the intensity with which projection models are updated by agents in the face of forecast errors. When the degree of de-anchoring is relatively high, the adjustment is greater, causing inflation surprises to have a greater impact on expected long-term inflation. This can occur in scenarios where there are doubts about the monetary authority's commitment to meeting the target, or skepticism about the ability of monetary authority to achieve inflation convergence over the two-year horizon[18]/.

In this context, the degree of model adjustment depends on the accumulation of forecast errors. Faced with a significant string of inflation surprises, agents will begin to distrust their projection models more, making them more sensitive to short-term information. It is precisely this varying intensity that conceptualizes the degree of de-anchoring. Figure 4.7 confirms this intuition, showing that periods with higher cumulative forecast errors coincide with a higher sensitivity of two-year expectations to inflation surprises[19]/.

18/ This mechanism was first illustrated in detail in Carvalho *et al.* (2017).

19/ Arias and Kirchner (2019) have built this learning structure into a structural model into a simplified version of the XMAS model mentioned in the previous chapters, thus generating a structural measure of de-anchoring, which is very close to the empirical measure obtained from the regressions of inflation expectations and surprises presented here. This reinforces that the fact that anchoring of inflation expectations in the Chilean economy has been high and stable over the last two decades, except for one-off episodes (see also Medel, 2018, for a similar view). Moreover, it suggests that having models that incorporate alternative mechanisms of expectations formation is valuable for the conduct of monetary policy (see Box 4.1).

FIGURE 4.7 FORECAST ERRORS AND SENSITIVITY OF EXPECTATIONS TO INFLATIONARY SURPRISES, 2003-2019 (*)

(*) Blue line represents 2-year inflation expectations' sensitivity coefficient to forecast error of inflation taken from OLS regression. Red line indicates moving average (15 months) of inflation forecast errors. Shaded areas mark periods in which 2-year expected inflation is greater than 3%.

Source: Arias and Kirchner (2019).

The results of this exercise also point to the 2008 inflationary episode as one in which expectations were de-anchored, which is consistent with Figure 4.3, which marks that year as the highest deviation in the last two decades of expectations from the target, something particularly unusual in a two-year horizon. This episode was characterized by a rapid and sustained acceleration of inflation in the first months of the year, above the range defined by the Bank (+/- 1%), and higher than expected by both the Central Bank and the market, in a context of a sharp increase in commodity prices around the world. Even in a scenario of high uncertainty due to the onset of the global financial crisis, the Central Bank reacted quickly by raising interest rates in view of the risk of not meeting the target and the evidence that inflationary expectations were moving away from it[20]/. In the latter part of the year and early 2009, the deterioration of domestic activity resulting from the external shock caused by the financial crisis significantly reduced inflationary pressures. This facilitated an increase in the degree of anchoring, which allowed the CBCh to adopt an aggressively countercyclical policy, with a very substantial reduction in the monetary policy rate[21]/.

The lessons taught by this episode in terms of the effects of deviations from the inflation target on the anchoring of expectations are systematically confirmed by international evidence. Table 4.3 presents the results of an exercise where the deviations of inflation expectations one year ahead from the target are regressed for a broad sample of countries with explicit inflation targets, using a series of macroeconomic controls, consistent with the Phillips curve described in Chapter 2, as well as with variables associated with the past behavior of inflation with respect to the target, and the tolerance range usually defined by them. It is clear that the number of months that inflation remains outside the tolerance range has an effect on one-year inflation expectations, particularly for countries with a formal band. Thus, one month of deviation increases one-year inflation expectations by one basis point for countries without a tolerance range and twice as much for those with a band[22]/.

20/ De-anchoring also occurred in the midst of a sterilized intervention program, oriented at increasing the CBCh's reserves by purchasing U.S. dollars.

21/ The minutes of the monetary policy meetings of the time, available on www.bcentral.cl, highlight the importance assigned to the behavior of expectations in the discussions of the Board during this episode.

22/ The quantitative effects are, however, limited, because it is necessary to be above the band for 47 months to increase one-year inflation expectations by 1%. This suggests that, on average, in the period under analysis, the degree of anchoring was significant, and that temporary deviations of inflation from the target had limited effects on expected future inflation.

TABLE 4.3 DETERMINANTS OF DEVIATIONS OF ONE-YEAR INFLATION EXPECTATIONS FROM TARGET, 44 COUNTRIES, 2000-2018 (1)

	Countries with inflation target or objective				Countries with inflation-targeting scheme				Countries with tolerance range	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
GDP gap (%, t-1)	0.045***	0.043***	0.049***	0.044***	0.053**	0.053**	0.054**	0.054**	0.052**	0.053**
Y-o-y NER depreciation (%, t-1)	-0.002	-0.002	-0.002	-0.002	0.003	0.002	0.004	0.004	0.003	0.004
NER depreciation (t-1) x EME Dummy	0.010**	0.010**	0.010**	0.010**	0.007	0.008	0.008	0.009	0.008	0.009
Taylor rule residual (%, t-1)	-0.021	-0.019	-0.021	-0.018	-0.039**	-0.040**	-0.041**	-0.041**	-0.045**	-0.047**
Y-o-y WTI oil inflation (%, t-1)	0.001***	0.002***	0.002***	0.002***	0.002**	0.002**	0.002**	0.002**	0.002**	0.002**
Y-o-y FAO foods inflation (%, t-1)	0.003	0.003*	0.003*	0.003**	0.006**	0.006**	0.007***	0.007***	0.006**	0.007***
Y-o-y inflation (%, t-1)	0.330***	0.361***	0.307***	0.366***	0.299***	0.270***	0.257***	0.272***	0.296***	0.255***
Y-o-y inflation (%, t-1) X range		-0.060		-0.100**		0.026		-0.016		
Change in y-o-y inflation (%, t-1)	-0.045	-0.159***	-0.017	-0.169***	-0.014	-0.086***	0.029	-0.102***	-0.010	0.033
Change in y-o-y inflation (%, t-1) X range		0.187**		0.244***		0.081		0.141***		
No. cumulative months outside range	0.013***	0.009***			0.020***	0.009***			0.022***	
No. months (t-1) x range dummy		0.013**				0.013**				
Sum of inflation deviation outside range (%, t-1)			0.010***	0.005***			0.014***	0.008**		0.015***
Sum of deviation (%, t-1) x range dummy				0.009**				0.007		
R2	0.671	0.675	0.680	0.689	0.623	0.625	0.649	0.650	0.625	0.651
N° countries	44	44	44	44	24	24	24	24	21	21
N° observations	8905	8905	8905	8905	5013	5013	5013	5013	4467	4467

(1) Estimated in unbalanced panel with fixed effects and robust standard errors for 44 countries and 228 months: 8 220 observations. (*) p<10%, (**) p<5%, (***) p<1%.

Source: Contreras (2021).

4.2.3. Monetary surprises, inflation, and inflation expectations

Greater transparency in the conduct of monetary policy, particularly under inflation targeting schemes, has made monetary policy decisions more predictable, contributing to their credibility and the anchoring of expectations. This is reflected, for example, in the information provided by central banks on the expected future path of their policy rates. Given this, movements in the monetary policy interest rate are—in general—correctly anticipated by agents, and are therefore incorporated into asset prices and the decision-making process of households and firms before they materialize.

However, despite their high predictability, not all monetary policy decisions are perfectly anticipated by the market. In some cases, monetary policy may take agents by surprise with decisions that they had not foreseen and therefore were not incorporated in their decisions or in asset prices. There can be many reasons for these surprises, ranging from news that alters the set of information available to the monetary authority, to differences of interpretation between the central bank and the market regarding the optimal response to the economic situation, to less frequent phenomena such as the revision of structural parameters that may lead to a re-scaling of the policy rate structure.

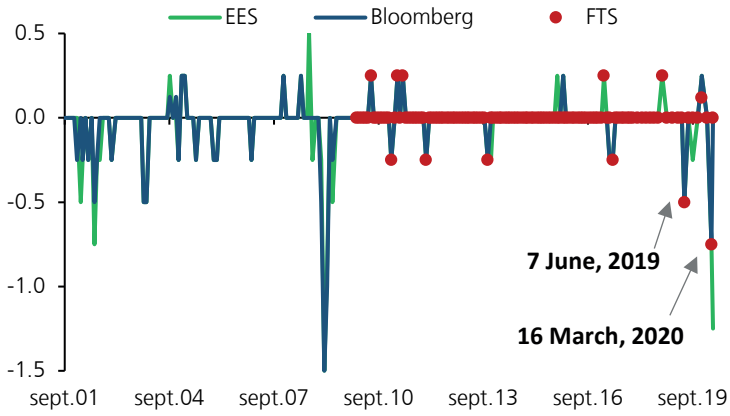
These monetary policy surprises are a valuable object of study to understand the transmission channels of monetary policy to inflation expectations, in addition to other variables, which is more difficult in the case of anticipated movements that are already embedded in decisions and prices before they occur. This section presents evidence on the way monetary policy surprises in Chile have had effects on inflation and the process of inflation expectations formation[23]/.

Figure 4.8 shows measures of monetary policy surprises for Chile from 2001 to 2020, using MPR expectations obtained from three surveys: the EES, the FTS, and Bloomberg. It can be seen that the three surveys behave similarly, and that monetary policy surprises have been limited. However, in the last year and a half there have been two significant surprises. The first is associated with the review of structural parameters conducted by the CBCh in June 2019, where the MPR was lowered due to the reassessment of potential GDP, the activity gap, and the neutral interest rate. The second was in March 2020, with a more aggressive reduction of the MPR than anticipated during the special monetary policy meeting that was called in response to the effects of the rapid spread of Covid-19 in Chile and the world.

Figure 4.9 contrasts the surprise measures obtained from Bloomberg with those that can be obtained from MPR swaps at different horizons. Although the information from swaps is noisier, it confirms previous evidence, showing how monetary surprises became more bounded in the last decade, except for the June 2019 and March 2020 episodes. Another important finding is that the surprises have had an effect on the entire swap curve, causing movements from three months to two years (the last of the analyzed maturities).

23/ The pioneer work in this literature on the identification of currency surprises and their propagation mechanisms is Christiano, Eichenbaum, and Evans (1999). The results for Chile presented in this section in particular come from Aruoba *et al*. (2021b).

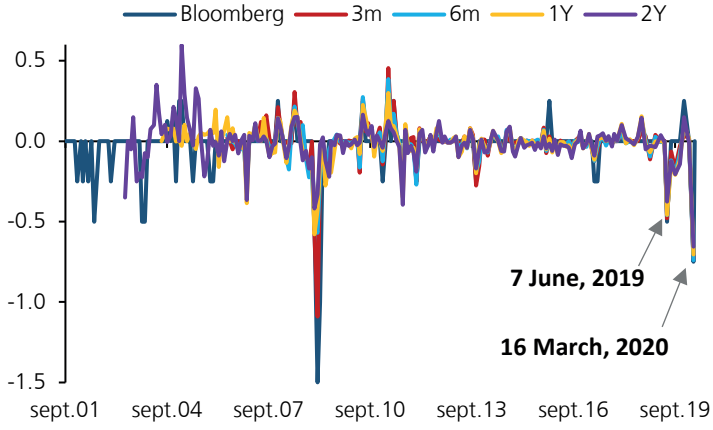
FIGURE 4.8 THREE MEASURES OF MONETARY SURPRISES IN CHILE WITH HIGH-FREQUENCY AND SURVEY DATA (*)



(*) Monetary surprise defined as the difference between the effective MPR determined at the monetary policy meeting and the rate expected according to the EES, the FTS, and Bloomberg.

Source: Aruoba *et al.* (2021b).

FIGURE 4.9 ALTERNATIVE MEASURES OF MONETARY SURPRISES IN CHILE WITH HIGH-FREQUENCY AND SURVEY DATA (*)



(*) Monetary surprise defined as the difference between the effective MPR and the expected MPR according to measurements by Bloomberg and 3-month, 6-month, 1-year, and 2-year swaps.

Source: Aruoba *et al.* (2021b).

Importantly, the existence of monetary policy surprises is not incompatible with the central role given to transparency and information in the monetary policy framework. In the two recent episodes, the surprise was due to new information, which the public and market agents had not yet been able to process, justifying immediate and unanticipated movements to ensure compliance with the inflation target. Both were justified and transparent surprises, associated with meeting the target and anchoring inflation expectations. This is essentially different from a policy aimed at systematically trying to surprise the population. This, by its very nature, is not sustainable over time, as agents would adjust their expectations accordingly. A strategy along these lines would end up undermining the credibility of the central bank, the stability of inflation expectations and the ability to implement countercyclical monetary policy.

What are the effects of these monetary surprises and what is their transmission on the other macroeconomic variables of the Chilean economy, particularly inflation and inflation expectations? To answer this question, we use the surprises derived from the Bloomberg survey (Figure 4.8) in a monthly dynamic model for four variables: the CPI, the non-mining Imacec, the nominal exchange rate, and the MPR[24]/.

Figure 4.10 shows the impact of a contractionary monetary surprise (i.e., a one-standard-deviation increase in the MPR) on prices, activity, the exchange rate, the monetary policy rate and two measures of inflation expectations. The monetary surprise has the expected impact on prices, which fall over a prolonged period, although the effect occurs with a long lag, only around two years. The negative effect on activity, on the other hand, occurs earlier, during the first half of the year, and also lasts for a long time. The monetary surprise also has a persistent effect on the MPR itself, which remains at a higher level for almost two years. The effect on the exchange rate is not statistically different from zero. This possibly reflects two counterbalancing forces: while the outlook for a slowdown in future activity leads to a nominal depreciation, the increase in rates leads to an appreciation. This, in line with the discussion in Chapter 2, shows that the transmission mechanism of monetary policy in Chile is the traditional one: new information about a more contractionary behavior of monetary policy leads to a slowdown in economic activity and inflation.

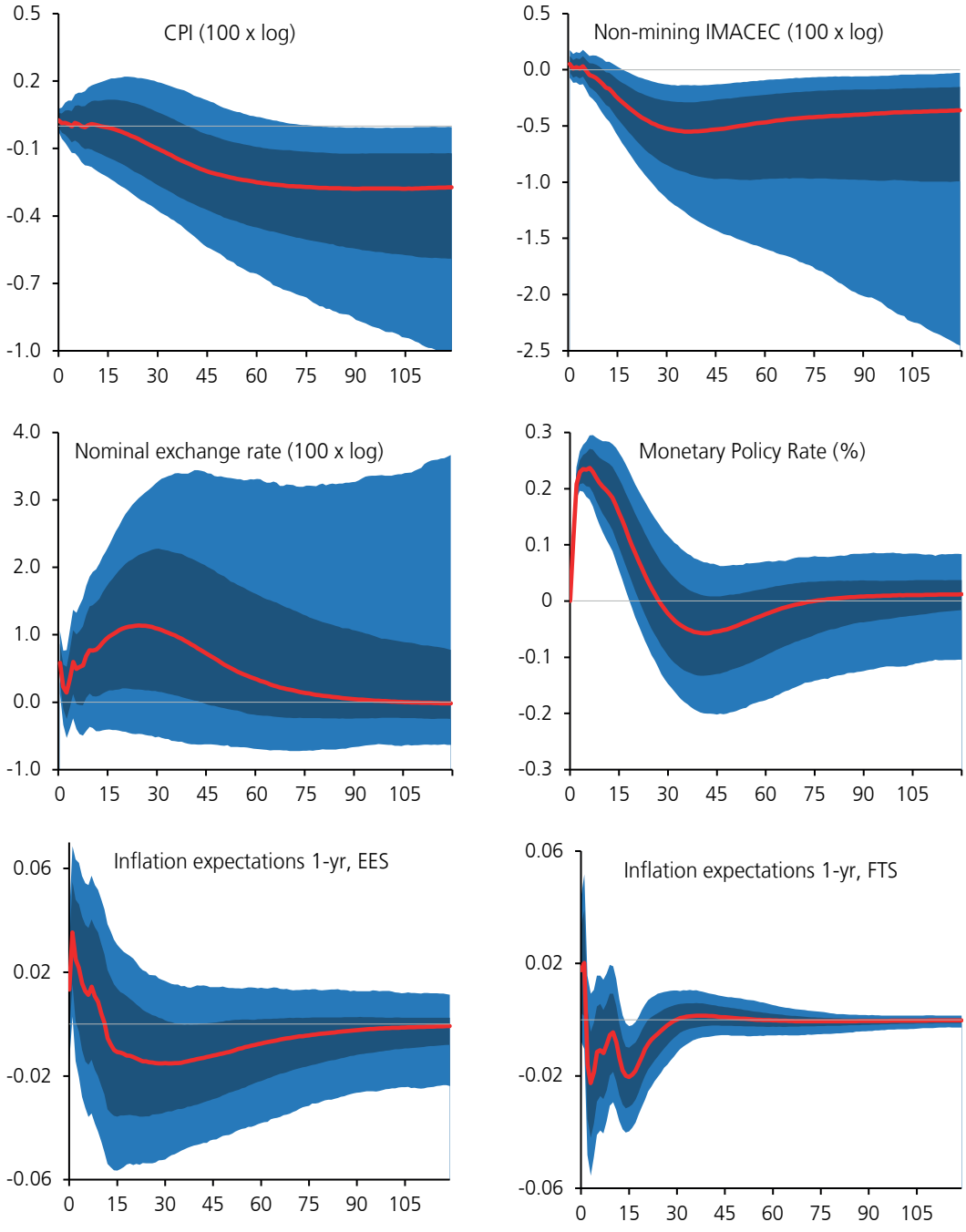
The last two quadrants of Figure 4.10 show the dynamics of one-year inflation expectations, measured through the EES and FTS surveys. Although the initial response is an increase in inflation expectations —possibly related to the information content of the monetary surprise—[25]/, this movement is reversed after a few months, and the downward response of one-year inflation expectations is aligned with lower economic activity and lower inflation. Thus, moving the MPR can be used as an instrument to affect inflation expectations and support their anchoring around the CBCh's target[26]/.

24/ The MPR surprises are used as instruments in a traditional SVAR with monthly frequency in the four aforementioned variables. The model is estimated over the period 2001-2020, thus covering the CBCh's inflation-targeting period. The use of instrumental variables in SVAR models was introduced by Stock and Watson (2012) and applied to monetary surprises by Gertler and Karadi (2015) and Ramey (2016), among others. This allows cleaning the residuals of the estimated monetary policy rule so that the researcher employs only the variation in these residuals explained by movements in monetary surprises. The model is estimated with Bayesian methods. For more detail, see Aruoba *et al.* (2021b).

25/ The information content of monetary surprises, such as those constructed here, has been recently studied by Jarocinski and Karadi (2020) for the United States. The authors stress that monetary policy surprises can simultaneously incorporate information on the policy stance and the assessment of the state of the macroeconomy. This latter information channel may result, for example, in policy rate increases revealing that the state of the economy is better than anticipated by the market, causing agents to revise upward their inflation expectations. Although the results in Figure 4.10 seem to suggest that such a channel exists in Chile, formal study is left for future research.

26/ A complementary analytical strategy is to look at the detail of individual FTS responses and how they are affected by monetary policy surprises (Pedersen, 2020). The evidence suggests a high degree of heterogeneity in the effect of monetary policy surprises on one-year inflation projections. Two-year inflation expectations, on the other hand, seem to be unaffected by monetary policy surprises for any type of trader.

FIGURE 4.10 EFFECT OF A ONE-STANDARD-DEVIATION MONETARY SURPRISE (*)



(*) Impact of a 1-st-dev contractionary monetary surprise (raised MPR). Results come from a traditional SVAR estimated monthly between 2001 and 2020 with four variables: the CPI; the non-mining Imacec; the nominal exchange rate; and the MPR. The one-year inflation expectations come from the EES and the FTS surveys and their dynamics are documented in the lower panels.

Source: Aruoba *et al.* (2021b).

4.3 Conclusions

This chapter has discussed how inflation expectations play a central role in the conduct of monetary policy, both because of their direct effect on inflation and because of the importance of anchoring inflation expectations to the Central Bank's target. The latter is key for monetary policy to be effective and countercyclical. To achieve this, central bank communication and transparency play a very important role.

In the case of Chile, the consistency between messages, actions and objectives, as well as a credible macroeconomic policy framework, have served the purpose of anchoring inflation expectations, which have remained aligned with the Central Bank of Chile's target for most of the last two decades. In addition, in the event of possible episodes of de-anchoring, the CBCh's has at its disposal the necessary instruments to respond to such episodes.

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