PROPAGATION OF INFLATIONARY SHOCKS IN CHILE

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1. INTRODUCTION

Whenever a shock hits the price of a specific service or good, it may spread to other prices and thus affect the overall inflation rate by more than the initial effect. This phenomenon is referred to as propagation of inflationary shocks. A general analysis of the propagation mechanism improves the understanding of how individual price changes influence the overall consumer price index (CPI) inflation, which is the relevant measure for several inflation targeting central banks, such as the Central Bank of Chile. While the inflationary effect of mainly oil price shocks and, to a lesser extent, food price shocks has been studied at length in the economic literature, central banks should also know possible propagation effects of shocks to other prices, which may be affected by e.g. tax changes or exchange rate shocks. The present study provides a general analysis of the effect of inflationary shocks in Chile and supplies results of how these effects have changed after September 1999, when an inflation targeting regime was implemented with fully flexible exchange rates.

No theoretical models exist on the propagation of inflationary shocks, which seems to be more an empirical issue. In the present study, it is argued that vector autoregressive (VAR) models are useful for studying propagation of inflationary shocks when the shocks are identified by imposing a Cholesky decomposition such that the shock to a specific price has a contemporaneous effect on the rest of the prices in the basket, whereas the opposite is not the case. In the present context, these models are referred to as propagation models. Chilean price data are utilized for impulse response analyses of a period prior to the implementation of inflation targeting and fully flexible exchange rate, and another containing data from the subsequent period. The results suggest that, in general, the duration of the propagation is shorter after September 1999, but the impact is higher for a couple of divisions. While the shocks to the prices of most of the divisions included in the consumer basket are statistically significant, the effects are quite disperse among divisions. Particularly, propagation is negative after 1999 for two divisions, meaning that the demand effect is dominating.

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Few papers are directly concerned with the propagation of domestic price shocks. The topic has, however, been briefly discussed in the papers of Levin et al. (2004) and Kim and Park (2006), and a more detailed analysis is supplied by Pedersen (2015), who applies a sample of 46 countries to analyze propagation of shocks to food and energy prices. With data spanning the period 1999-2010, he finds that emerging countries are more affected by propagation than advanced ones and that, in general, food price shocks propagate more strongly than do energy price shocks. This is also true in Chile, where the propagation of food price shocks to core prices is more than twice the size of the propagation of energy price shocks.[1]

Although there are few papers concerned directly with the propagation of price changes, several studies are dedicated to the related issues of inflation persistence and pass-through of shocks to international prices. With respect to inflation persistence, Altissimo et al. (2006) report reduced-form estimates in the range of 0.74 to 1.04 for the Eurozone, estimates which fall significantly when allowing for time-variation in the mean. Eurozone estimates for components of the CPI basket indicate that "Miscellaneous goods and services", "Furnishings, household equipment" and "Education" are the most persistent categories, while "Transportation," "Alcoholic beverages, tobacco and narcotics" and "Recreation and culture" are the least persistent. "Clothing and footwear" has negative persistence. Concerning the Chilean economy, studies related to inflation persistence include Agénor and Bayraktar (2003), Céspedes and Soto (2006), De Gregorio (2007), and Pincheira (2009). The first two estimate neoclassical Phillips curves and they find that, with the specifications applied, the coefficient of the lagged inflation rate is 0.52 and 0.45, respectively. Estimating an AR(1) process for the difference between the inflation rate and the target of the central bank, De Gregorio (2007) finds that the coefficient for the first lag is 0.82. Pincheira (2009) evaluates the dynamic of the inflation persistence estimating AR models for different periods. He finds that the persistence of the Chilean inflation increased importantly in the middle of 2007 but tended to decrease again toward the last part of the sample, which ends in 2008.

There exists a huge amount of literature on the pass-through of international price changes to national inflation rates. In the case of Chile, mainly three types of pass-through have been investigated: exchange rate variations, oil price changes and changes in international food prices. Fuentes (2007) has studied the pass-through of nominal exchange rate movements to import prices for four developing countries (Argentina, Chile, Colombia and Uruguay). He estimates several models and finds that the pass-through is fast in the short run and complete within one year. In contrast with similar studies, for example that of Frankel et al. (2005), he finds no evidence that exchange rate pass-through has declined over time. García and Restrepo (2003) apply quarterly Chilean data to estimate a price equation based on a model with imperfect competition. They

1 According to International Monetary Fund (2011), food price shocks are likely to have larger second-round effects if inflation is above target and there is excess demand-side pressure in the economy. This is also the case if the central bank's credibility is weak and the share of food in total consumption is high.

find that a devaluation has real effects but they vanish in the long run. When wage indexation is incomplete, the long-run pass-through is much smaller. Finally, a negative output cap compensates the effect of the devaluation on inflation such that a part of this is not passed on to prices in the short run.

The paper of Álvarez, Jaramillo and Selaive (2008) studies the exchange rate pass-through into 40 disaggregated import prices using monthly data. The authors find evidence consistent with the idea that the pass-through is complete in the long run and that it has not been declining. Furthermore, they report relatively weak evidence of asymmetric pass-through for aggregate import indices, while there seems to be some evidence of asymmetries for capital goods and agriculture.

Utilizing a micro approach, Álvarez, Leyva and Selaive (2008) examine the pass-through of exchange rate changes to components and subcomponents of the CPI. Their model is estimated with monthly data from February 1998 to April 2007. Evidence from this study suggests that only food and transportation prices are significantly affected by the pass-through, but with a high degree of heterogeneity among the products. In a recent study, Justel and Sansone (2015) estimate VAR models with data from 1987 to 2013 and find that the average exchange rate pass-through to total CPI is between 0.1 and 0.2 in the medium term. They argue that the pass-through has been lower after the adoption of inflation targeting. Bertinatto and Saravia (2015) argue, however, that the pass-through is asymmetric in Chile.

De Gregorio et al. (2007) augment the traditional Phillips curve to include oil prices and structural breaks for a set of 34 countries, industrialized and emerging. They find clear evidence of decreasing pass-though in industrial economies and to a lesser degree for emerging ones. The difference in the pass-though, however, is smaller when controlling for the countries' oil intensity.[2] The authors also estimate rolling VAR models for a subsample of 12 countries, including Chile. Impulse-response analyses indicate that the effect of oil price shocks on inflation has fallen for most of these economies. Pincheira and García (2007) estimate several VAR and Panel VAR (PVAR) models with data from Chile and a set of nine industrialized countries. Their impulse-response analyses are conducted in models estimated with headline inflation as well as measures excluding particular components. They find that the pass-through in Chile is less than what is supposed in other studies, for example Medina and Soto (2005), but the responses are in general significantly higher than the average response of the industrialized countries considered in the study. In a recent study, Pedersen and Ricaurte (2014) apply a sign restriction approach and find that the source of the oil price shock is important for the impact in Chilean inflation, such that only demand shocks have a lasting significant impact on the price level.

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2 Baumeister et al. (2010) argue that second-round effects are different across oil-importing countries contributing significantly to differences in the overall impact of oil price shocks.

With respect to the pass-through of international food prices,[3] Jalil and Zea (2011) estimate VAR models for five Latin American countries with observations from 2000 to 2010. They find that the full effect of an international food price shock on Chilean headline inflation is felt after a year and that, when controlling for the central bank's reaction, the highest long-run elasticity is found for Chile at 0.81. López et al. (2008) analyze the effects on Chilean inflation of wheat and corn price changes. They find that the half-life of a shock in the international wheat price is 5.2 months, and 7.1 months for corn. These estimates increase significantly when applying models that do not include fundamentals, such as the AR(1) model. A permanent 10% shock in the international prices of wheat and corn has an impact of 0.06 percentage point in the monthly CPI, 0.07 in the CPIX and 0.09 in the CPIX1.[4]

While generally the papers cited above do not directly deal with the issue of propagation of inflationary shocks, they are certainly related. Pass-through studies, however, are concerned with the overall effect of external price shocks, whereas propagation is defined here as the impact that the price of one component of the CPI basket has on the rest of the prices, which, among other things, depends on the persistence of both the component and the rest of the prices. This implies that the pass-through of, say, oil price shocks, has a mechanism, which can be exploited in greater detail when exploring the so-called propagation models which will be utilized in this work.

The rest of the paper is organized as follows: the next section discusses the concept of propagation and introduces an empirical model for analyzing propagation of inflationary shocks. The third section supplies a discussion of the data utilized and the empirical analysis, while the last section offers the conclusions.

II. METHODOLOGY AND MEASUREMENT OF PROPAGATION

After a general discussion of inflation propagation, this section presents the model, which is applied in section III for the empirical analysis of inflation propagation in Chile.

1. Propagation

The propagation mechanism employed in the present analysis is illustrated in figure 1. The inflationary shock to component i may have a direct effect on the rest of the prices in the CPI basket. As an example, consider an oil-price shock, which, via the pass-through mechanism, affects energy prices, say, component

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3 Multi-country studies of pass-through of general commodity price shocks include those of Rigobon (2010) and Pistelli and Riquelme (2010).

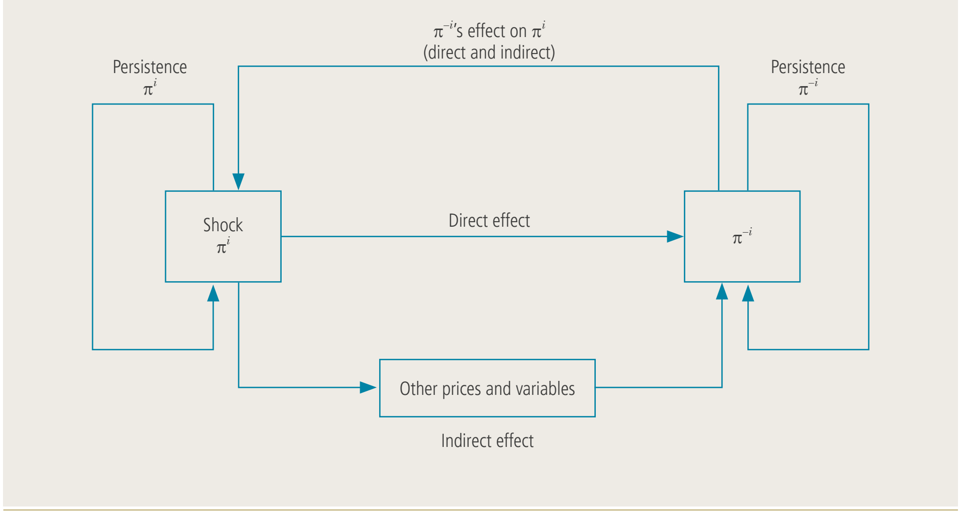
4 CPIX excludes fuels and fresh fruits and vegetables from the CPI, while CPIX1 also excludes fresh meat and fish, regulated utility rates, indexed prices and financial services.

i of the basket. The increased energy prices affect production costs, such that the prices of the final goods increase. This mechanism is referred to as the direct effect in figure 1. On the other hand, increased energy prices may also have an impact on the household budget such that the general demand will decrease putting downward pressure on the prices of goods and services. This mechanism is named the indirect effect in figure 1. The arrow from the inflation of the rest of the basket (π^{-i}) to the inflation of component i (π^{i}) indicates a possible feedback mechanism, which for example could be caused by a cost-push effect. The complete propagation effect is the total effect on π^{-i} of a shock to π^{i} accounting also for the persistence of each of the two components.

Which price shocks could we expect to propagate to other prices? Shocks to prices of items with big weights in the consumer basket are likely to propagate because of their importance in the households' budget. Shocks to low-weight components may, however, also affect other prices if, for example, they are goods or services whose prices are highly visible. For instance, though the item Communication has relatively low weight in the consumer basket, its prices are highly visible to the consumers (e.g. the monthly phone bill) such that a shock to this component could make an impression of general price changes leading to salary increases and, hence, cost-push inflation. In this context, it is important to remember that the analysis in the present paper is made with CPI data, i.e. prices which include amongst other things the salaries paid by firms.

Figure 1

The propagation mechanism



Source: Author's elaboration.
Note: π^{i} refers to the inflation of component i, while π^{-i} is the inflation of the CPI basket excluding component i.

As illustrated in figure 1, in the discussion of propagation it is important to make the distinction from persistence. In the present context, we define persistence as the duration of a shock on the same component that was affected by the shock. On the other hand, propagation is understood as the effect on components other than the one affected by the initial shock. Formally, this can be stated the following ways: Persistence of inflationary shocks: The impact that a shock to price i at time t has on the same price i at time $t+h$ $(h=1,2,3,\ldots)$. Propagation of inflationary shocks: The impact that a shock to price i at time t has on other prices j $(j \neq i)$ at time t+h $(h=0,1,2,3,\ldots)$.

The next subsection outlines the propagation model applied in the empirical analysis.

2. The propagation model

To focus the analysis on the propagation, the empirical model includes the two variables of interest, namely inflation of component i and the inflation rate of the remaining of the basket. Hence, the data vector can be summarized as:

$$x_t = \{\pi^{-i}, \pi^i\},$$

where π^i is the inflation rate of component i, and π^{-i} is the rate of inflation of the total CPI excluding component i.

It is assumed that $x_t \sim I(0)$ and that it can be described by a VAR with k lags. To simplify notation, in what follows it is assumed that $k = 1$ and constant terms are omitted. Pre-multiplying the two dimensional VAR in standard form with the matrix B, the following system is obtained:

$$\underbrace{\begin{bmatrix} 1 & \beta_{12} \\ \beta_{21} & 1 \end{bmatrix}}_{B} \underbrace{\begin{bmatrix} \pi_t^{-i} \\ \pi_t^{i} \end{bmatrix}}_{\pi_t} = \underbrace{\begin{bmatrix} \alpha_{11} & \alpha_{12} \\ \alpha_{21} & \alpha_{22} \end{bmatrix}}_{\alpha} \underbrace{\begin{bmatrix} \pi_{t-1}^{-i} \\ \pi_{t-1}^{i} \end{bmatrix}}_{\pi_{t-1}} + \underbrace{\begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \end{bmatrix}}_{\varepsilon_t},$$

where α's and β's denote the parameters to be estimated, $\varepsilon_{it} \sim i.i.d(0,\sigma_i^2)$ and $cov(\varepsilon_1,\varepsilon_2) = 0$. With this notation the errors of the VAR in standard form are:

$$\underbrace{\begin{bmatrix} e_{1t} \\ e_{2t} \end{bmatrix}}_{e_t} = \underbrace{\frac{1}{(1-\beta_{12}\beta_{21})} \begin{bmatrix} 1 & -\beta_{12} \\ -\beta_{21} & 1 \end{bmatrix}}_{B^{-1}} \underbrace{\begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \end{bmatrix}}_{\varepsilon_t}.$$

In the interest of measuring the impact that inflation of component i has on the rest of the CPI basket, it is assumed that π^i contemporaneously affects π^{-i} but not vice-versa, i.e. imposing the restriction $\beta_{21} = 0$, which implies that the VAR becomes

$$\begin{bmatrix}\pi_t^{-i}\\ \pi_t^{i}\end{bmatrix}=\underbrace{\begin{bmatrix}\alpha_{11}-\beta_{12}\alpha_{21} & \alpha_{12}-\beta_{12}\alpha_{22}\\ \alpha_{21} & \alpha_{22}\end{bmatrix}}_{A=\begin{bmatrix}a_{11} & a_{12}\\ a_{21} & a_{22}\end{bmatrix}}\begin{bmatrix}\pi_{t-1}^{-i}\\ \pi_{t-1}^{i}\end{bmatrix}+\underbrace{\begin{bmatrix}\varepsilon_{1t}-\beta_{12}\varepsilon_{2t}\\ \varepsilon_{2t}\end{bmatrix}}_{v_t=\begin{bmatrix}v_{1t}\\ v_{2t}\end{bmatrix}}. \quad (1)$$

From (1) it is evident that an inflationary shock to component i has a contemporaneous effect on the rest of the basket, whereas the opposite is not true. This identification scheme makes the model suitable for analyzing the propagation of inflationary shocks where the object is exactly to evaluate the effect on the rest of the prices from a shock in a particular component.[5]

The covariance of the error terms in (1) is

$$\operatorname{cov}(v_{1t},v_{2t})=\operatorname{cov}(\varepsilon_{1t}-\beta_{12}\varepsilon_{2t},\varepsilon_{2t})=E[\varepsilon_{1t}\varepsilon_{2t}-\beta_{12}\varepsilon_{2t}\varepsilon_{2t}]=-\beta_{12}\sigma_2^2,$$

such that the initial effect on π^{-i} of a unit shock in π^{i} is equal to the correlation of the residuals in the restricted VAR multiplied by the ratio of the standard deviations of the residuals:

$$\kappa=\left.\frac{\partial\pi_t^{-i}}{\partial\pi_t^{i}}\right|_{t=0}=\operatorname{corr}(v_{1t},v_{2t})\frac{\sigma_1}{\sigma_2},$$

whereas the impulse-response coefficients are complex nonlinear functions of the underlying model parameters. In the empirical analysis, the coefficient κ is reported as the initial impact of the propagation, i.e. the initial impact of a unit shock.

III. PROPAGATION OF INFLATIONARY SHOCKS IN CHILE

This section analyzes the propagation of inflationary shocks in Chile by applying the propagation model described in the previous section. The focus is on how shocks to the divisions of the consumer price basket affect the rest of the prices. The following subsection contains a description of the data utilized, while the second subsection presents the empirical analysis.

1. Description of data

The analysis is made with data covering the period from April 1989 to July 2015. From 1989 to 2008, the source of the data is Pedersen et al. (2009).[6] The observations and weights in the consumer baskets utilized from January 2009 to July 2015 are extracted from the web page of the Central Bank of Chile.[7]

5 The empirical results presented in section III are, however, robust to changing the order of the variables and applying the generalized impulse-response approach of Pesaran and Shin (1998).

6 The authors show that, in the overlapping period, there are only small differences between their division's data and those published by Chile's National Statistics Institute (INE).

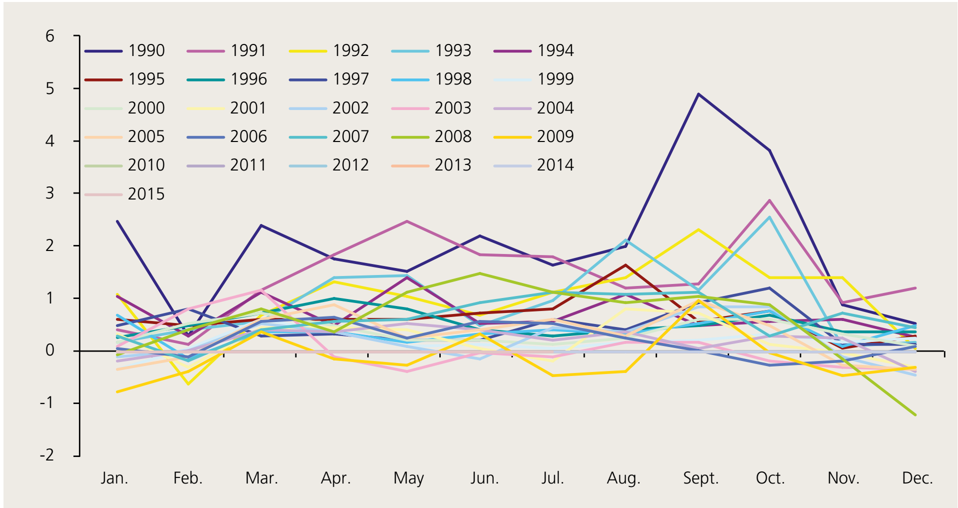
7 Until 2009, the data cover the greater Santiago area and, from January 2010 onwards, the index is compiled with nationwide coverage.

As discussed in the previous section, the analysis of propagation is made by applying impulse-response analyses in models of inflation rates. A natural question, the answer to which is not obvious, is at what frequency these rates should be calculated. One option is to use monthly or quarterly rates, in which case they will most surely be affected by seasonality. Corrections can be made by either using seasonally-adjusted data or including seasonal dummies in the specification. With respect to the first possibility, Maravall (1993) argues that VAR models are not appropriate for modeling seasonally-adjusted series, while Canova (1995) adds that the empirical relevance of this has yet to be demonstrated.

Lütkepohl (2005) notes that using seasonally-adjusted data may lead to impulse-responses quite different from those estimated with unadjusted data. In the present context of analyzing propagation of inflationary shocks, an impulse-response analysis with seasonally-adjusted data may distort the interpretation of the results. This is so because procedures for seasonal adjustment, such as X12-ARIMA, apply two-sided moving averages in the filtering process, implying that the seasonally-adjusted observation for a given month implicitly incorporates information of previous and subsequent months, casting doubts about the interpretation of the error terms as unanticipated shocks.[8]

Figure 2

Monthly CPI inflation rates



Source: National Statistics Institute (INE).

8 *Callen and Reynolds (1997) have also employed this argument.*

With respect to including seasonal dummies in the model, this relies on the assumption that the seasonal pattern is constant over time. In the period considered in this work, Chile's National Statistics Institute has updated the methodology, and, in particular, the 2008 updating entailed significant changes in the methodology for the compilation of some of the components.[9] For this reason, it is most unlikely that the seasonal patterns have been constant during the period considered in the present work, which is also confirmed by visual inspection of the CPI in figure 2.[10] A pronounced example of the apparent change in seasonality is the October inflation rate, which before 1999 was lower than the September rate only twice, while after 2000 it was lower in 12 of the 15 years examined.

Given the preceding discussion, it was chosen to apply annual inflation rates in the present study, in line with the choice of other authors; for example Pincheira and García (2007). This has also been the choice of studies conducted for other countries, such as that of Lindé (2003). With quarterly Swedish data, he estimates a VAR model and argues that it may be crucial for the empirical analysis to apply annual—rather than quarterly—inflation rates, and as long as inflation is positively autocorrelated, the effects of this choice are small.[11]

The present analysis focuses on the impact of a shock to one component on the rest of the prices in the basket. The inflation rates for the "rest," i.e. the complete basket excluding component i, is calculated as

$$\pi_t^{-i} = 100 * \left(\frac{P_t^{-i}}{P_{t-12}^{-i}} - 1 \right), \quad P_t^{-i} = \frac{P_t - w_{i,t} P_t^i}{1 - w_{i,t}},$$

where P is the aggregate price index, P^i is the price index for component i, P^{-i} is the aggregate index which excludes component i, while $w_{i,t}$ is the weight of component i in the CPI basket.[12]

During the period analyzed, the CPI basket has been changed on four occasions, as shown in table 1, where it can be appreciated that, while the weight of "Food and non-alcoholic beverages" has diminished since 1989, it is still the most important item in the household's budget, followed by "Transport" and "Lodging facilities, electricity, gas and other fuels."

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9 An example is wearing apparel. The compilation of this item included a smoothing parameter up until January 2008, where it was abandoned.

10 Estimations of simple AR(1) models with seasonal dummies reveal substantial changes in the coefficients of the dummies, even when relatively short-time samples are analyzed.

11 The Chilean inflation rates are indeed positively autocorrelated.

12 Pedersen (2009) shows that Chilean inflation rates should be calculated with disaggregated indices, rather than inflation rates, in order to obtain the total CPI.

Table 1

Weights in the total CPI basket

(percentage)

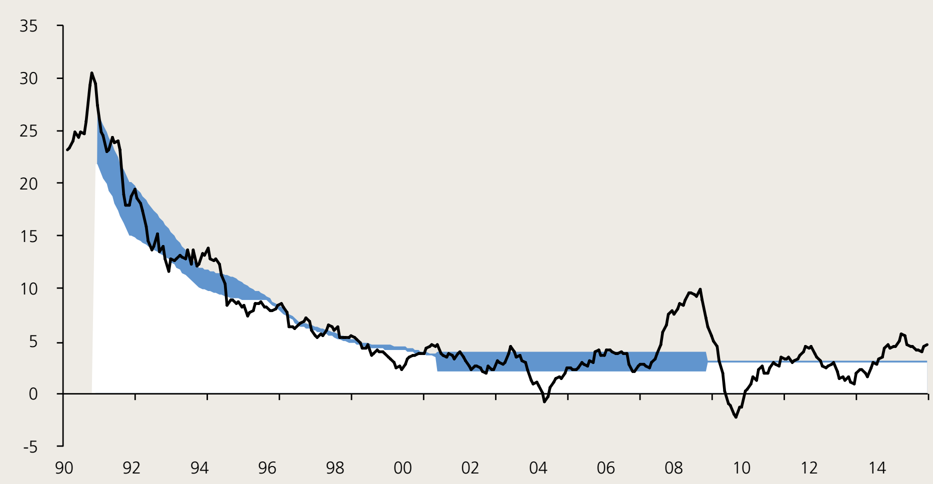
Div.	Name of division	1989	1998	2008	2009	2013
D1	Food and non-alcoholic beverages	28.4	22.2	17.9	18.9	19.1
D2	Alcoholic beverages and tobacco	2.5	2.1	2.1	2	3.3
D3	Clothing and footwear	8.1	7.3	5.1	5.2	4.5
D4	Lodging facilities, electricity, gas and other fuels	16.2	13.7	12.7	13.3	13.8
D5	Furniture, household and household maintenance	7.6	9.5	7.2	7.5	7
D6	Health-care	3.9	6	5.5	5.4	6.4
D7	Transport	15.1	11.7	18.7	19.3	14.5
D8	Communications	1.4	3.1	4	4.7	5
D9	Recreation and culture	5	6.9	9.2	7.5	6.8
D10	Education	3.3	6	6.2	6	8.1
D11	Restaurants and hotels	4.7	4.2	5.9	4.4	4.4
D12	Sundry goods and services	3.8	7.3	5.4	5.8	7.2

Sources: Pedersen et al. (2009) and Central Bank of Chile.
Note: The columns refer to the CPIs with bases April 1989 = 100, December 1998 = 100, December 2008 = 100, average 2009=100, and average 2013 = 100. Names of divisions have changed over time and the ones utilized in the table are current ones.

Figure 3

Annual CPI inflation rates

(percentage)

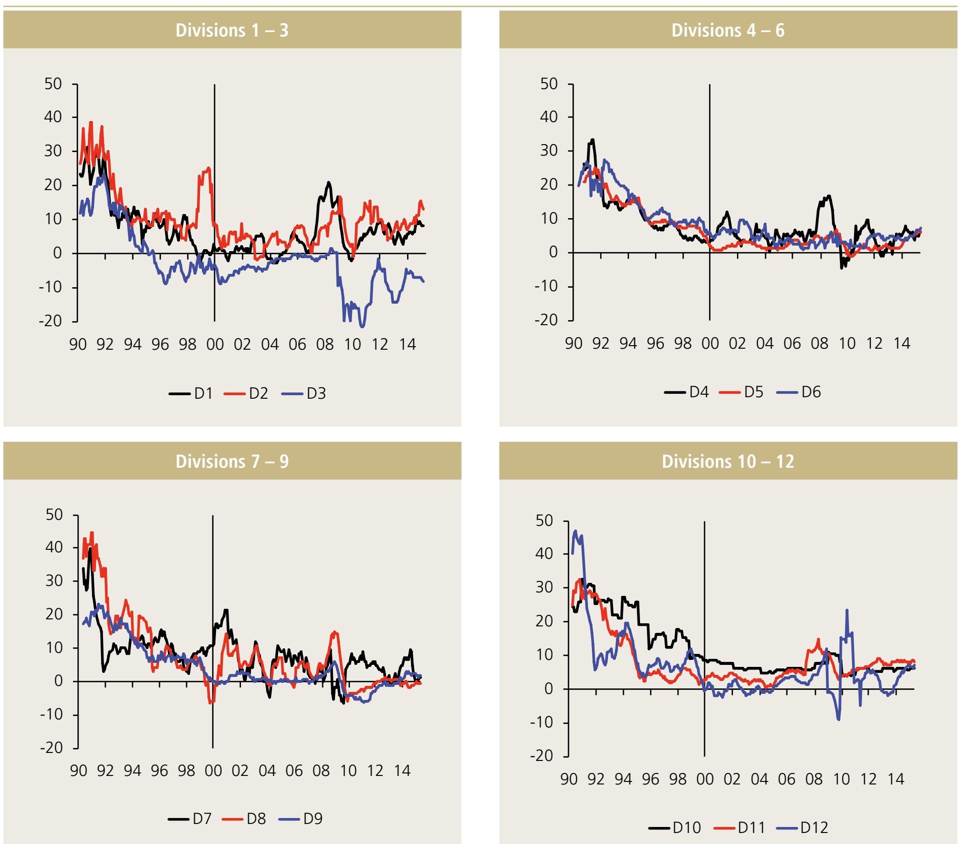


Source: Central Bank of Chile.
Note: Shadows show the inflation target at a given point in time.

Figure 3 presents the aggregate inflation rate, while figure 4 displays the rates of the twelve divisions. In the period analyzed, the Chilean inflation has decreased from an average of close to 11.5% in the 1990s to 3.3% after 2000. This decrease has been generalized across all divisions, but in particular, “Alcoholic beverages and tobacco,” “Transport,” “Communications” and “Sundry goods and services” posted high inflation rates in the early 1990s. Figure 3 also shows the targets of inflation applied by the Central Bank of Chile during the period under consideration. In the beginning of the period the monetary policy was conducted with a decreasing target, but this has been fixed to 3% in the latter part of the period.

Figure 4

Annual inflation rates by division (percentage)



Sources: Pedersen et al. (2009) and Central Bank of Chile.
Note: The vertical lines indicate September 1999.

Descriptive statistics of the overall inflation rate and those of the divisions are reported in table 2 for the full sample and the two subsamples analyzed in the next subsection. While headline inflation in the period under consideration has oscillated between -2% and 30%, the volatility of the individual divisions was higher with the most volatile ones being "Communications" and "Sundry goods and services." In general, the inflation rate was higher and more volatile during the period before September 1999, where all divisions except "Clothing and footwear" showed two-digit average inflation rates.

The methodology described in section II relies on the fact that the time series are stationary. Unit root tests reveal mixed results with respect to this assumption but, as stated by Pedersen (2015), an assumption of non-stationarity would imply that the propagation of a specific price shock is permanent, which is very unlikely. Hence, the study is conducted under the assumption that inflation rates are stationary, but in some cases very persistent, which turns out to be the case for some divisions in the early part of the period. The assumption of stationary inflation rates in Chile has been employed by several other authors, e.g. Pincheira and García (2007).[13]

Table 2

Descriptive statistics

(percentage)

	Full sample				Apr.90 – Aug.99				Sept.99 – Jul.15			
	μ	σ	Min	Max	μ	σ	Min	Max	μ	σ	Min	Max
CPI	6.4	6.2	-2.3	30.4	11.8	7	3.2	30.4	3.3	2.1	-2.3	9.9
D1	7.2	7.3	-3	31.3	11.5	8.5	-2.6	31.3	4.7	5.1	-3	20.8
D2	10.5	8	-1.8	38.9	16.4	9.2	4.1	38.9	7	4.4	-1.8	24.7
D3	-2.3	8.9	-21.5	23.3	4.3	9.6	-8.9	23.3	-6.2	5.4	-21.5	1.8
D4	7.2	6.5	-5.4	33.5	11.5	7.7	2.3	33.5	4.7	3.9	-5.4	16.4
D5	5.7	6.4	-1.8	24.8	12.4	5.9	2	24.8	1.8	1.6	-1.8	5.8
D6	7.9	6.8	0.2	27	14.9	6.3	5.8	27	3.7	1.9	0.2	9.3
D7	7.2	7	-7.5	39.6	11.4	7.5	1.5	39.6	4.7	5.3	-7.5	20.8
D8	6.9	10.7	-7.4	44.3	15.3	12.4	-2.3	44.3	1.9	4.8	-7.4	14.1
D9	3.5	7	-7.2	22.3	10.9	6.1	0.3	22.3	-0.8	2.4	-7.2	5.1
D10	11	8	3.2	32	20	6.4	8.6	32	5.7	1.5	3.2	10.2
D11	7.6	7.5	-0.3	31.8	12.1	10.2	0.7	31.8	4.9	3	-0.3	14
D12	5.8	9.4	-9.8	46.4	12.7	11.2	3	46.4	1.7	4.6	-9.8	22.5

Source: Author's calculations.

Note: The columns "μ" report the mean, "σ" the standard deviation, and "Min" and "Max" the minimum and maximum values, respectively.

13 *The assumption of stationary inflation rates is in accordance with the inflation targeting regime effective in Chile during the period analyzed.*

2. Empirical results

In this subsection, Chilean data are applied to evaluate propagation effects in the CPI. The analysis is conducted with data for the full sample (April 1990 to July 2015) as well as subsamples ending and starting, respectively, with the implementation of the inflation target as the monetary policy anchor and fully flexible exchange rates in September 1999. It is important to emphasize that, while changes in propagation to some extent may be attributed to the monetary policy, it is not postulated that this is the only reason since Chile during the last couple of decades has experienced several structural economic changes emphasizing the implementation of the fiscal rule.[14]

For the propagation analysis, twelve VAR models are estimated for each of the samples under consideration. Since the dynamic properties of impulse-responses may depend critically on the chosen lag length (k), the same k is chosen for all the models, $k = 4$, in order to make the results comparable.[15] To eliminate the effect of outliers on the estimated impulse-response functions, blip-dummies were introduced in the models with the purpose of obtaining residuals which are not skewed compared to the Gaussian distribution[16] and are not affected by serial correlation and heteroscedasticity (table A1 in appendix A).

Table 3 reports the main results of the analysis of propagation of inflationary shocks in the twelve divisions of the Chilean CPI, while graphs comparing the responses in the two subsamples are included in appendix B. The first thing to note is that shocks to prices of three of the twelve divisions do not propagate statistically significantly to the rest of the prices in the consumer basket in any of the subsamples. These are “Alcoholic beverages and tobacco” (D2), “Health-care” (D6) and “Sundry goods and services” (D12). “Education” (D10) propagates significantly only in the second subsample, and the effect is only instantaneous in this case.

“Food and non-alcoholic beverages” (D1), the division with the highest weight, propagates positively, and while the effect is higher in the second subsample, the duration of the propagation is longer in the first subsample. When interpreting these results, it should be remembered that the second subsample includes the boom-bust period of commodity prices. The fact that the duration of the effect is shorter in the second period may be attributed to faster monetary policy reactions, though it should be noted that when taking into account the simulated confidence bands, the effect is statistically significantly in only one month, namely 35 months after the shock to the prices of D1. A similar situation

14 See, for example, Pedersen (2008) for a description.

15 The Bayesian information criteria suggest between one and four lags for models estimated. Kilian (2001) argues that including more lags than suggested by this relatively conservative criterion may result in more accurate impulse response estimates. Estimations of robustness show that the results presented do not change significantly when including up to six lags.

16 Juselius (2006) states that the estimated coefficients of VAR models are more sensitive to non-normality due to skewness than to excess kurtosis.

is observed for D11 "Restaurants and hotels," which to some extent is affected by commodity price swings too. In this case, the effect of propagation is higher than for D1 even though the weight in the consumer basket is substantially lower. A possible explanation is that an important part of the costs of inputs in D11 is wages and, hence, a cost-push shock to the prices in this division may have an impact that is more general to all prices. For D1 the difference in the impacts in the two subsamples is not statistically significantly.

The two divisions that are most affected by changes in international oil prices are "Lodging facilities, electricity, gas and other fuels" (D4) and "Transport" (D7). The duration of the propagation of the shock to D4 is longer in the first subsample and the impact is higher, statistically significantly so 25 to 45 months after the initial shock. On the other hand, a shock to the prices of D7 does not propagate statistically significantly the first period, while the impact in the second sample is positive. A possible explanation may be the increasing weight of this division in the consumer basket, even though it decreased with the latest revision. In any case, the simulated confidence intervals indicate that the effects in the two subsamples are not statistically significantly different.

"Clothing and footwear" (D3) and "Furniture, household and household maintenance" (D5) include imported goods and are to some degree affected by exchange rate movements, D3 more than D5. For both divisions the propagation was positive in the first period and non-significant in the second, except for a negative instantaneous impact for D3, the only moment where the impact is significantly different in the two subsamples. The fact that the propagation is not statistically significant in the second subsample may be ascribed to the change of the monetary policy and for D5 the difference is significant in months 2-3 and 22-43 after the shock.

Finally, two divisions have positive propagation the first period and negative the second; "Communication" (D8) and "Recreation and culture" (D9), i.e. the demand effect dominates the second period. The importance of these two divisions increased considerably during the period analyzed from a total consumption weight of 6.4% to 11.8%, which may be part of the explanation for this phenomenon.

Why do some shocks propagate more than others do? The fact that the three divisions with weights higher than ten percent experience positive propagation and the four divisions for which propagation is not statistically significant have relatively small weights in the CPI basket could suggest a relation between the CPI weight and propagation. On the other hand, the divisions with the highest degree of propagation (D5 and D11) have relatively small weights suggesting that this is not the case. This is supported by regressions of the weights on the maximum impact yielding non-statistically significant slopes. Hence, CPI weights may be part of the explication, but other factors such as visibility of prices and labor insensitivity in the production process may play a role as well. The important issue of determining which factors explain the propagation of an inflationary shock would probably require an analysis with more disaggregated data than those applied in the present analysis. This topic is left to future research.

Table 3

Propagation of unit shocks to D1 - D12

	Effect in the months indicated (percentage points)					Months with significant effect		
	0	3	6	12	24	Max	First	Last
				D1				
Full sample	**0.06**	**0.15**	**0.18**	**0.18**	**0.16**	**0.18** (8)	0	36
90:4 – 99:8	**0.09**	0.09	**0.13**	**0.16**	**0.14**	**0.16** (11)	4[(a)]	53
99:9 – 15:7	0.03	**0.24**	**0.33**	0.19	-0.04	**0.34** (5)	3	11
				D2				
Full sample	0.00	0.04	0.01	-0.02	-0.05	-0.06 (35)		
90:4 – 99:8	0.01	0.03	-0.01	-0.04	-0.10	-0.43 (120)		
99:9 – 15:7	-0.01	0.05	0.05	0.00	-0.03	0.05 (4)		
				D3				
Full sample	0.06	**0.15**	**0.16**	**0.15**	**0.13**	**0.16** (6)	1	54
90:4 – 99:8	**0.14**	**0.16**	**0.16**	**0.15**	**0.12**	**0.16** (4)	3[(a)]	37
99:9 – 15:7	**-0.05**	0.03	0.07	0.06	0.01	0.08 (7)	0	0
				D4				
Full sample	**0.14**	**0.22**	**0.32**	**0.41**	**0.36**	**0.42** (14)	0	72
90:4 – 99:8	**0.17**	0.13	**0.32**	**0.55**	**0.49**	**0.55** (12)	4	49
99:9 – 15:7	**0.10**	**0.23**	**0.33**	**0.33**	0.05	**0.36** (9)	0	18
				D5				
Full sample	0.03	**0.74**	**0.93**	**0.81**	**0.59**	**0.93** (6)	2	61
90:4 – 99:8	0.13	**1.10**	**1.05**	**0.82**	**0.66**	**1.16** (4)	1	50
99:9 – 15:7	-0.14	0.10	0.41	0.29	-0.32	0.50 (7)		
				D6				
Full sample	0.03	-0.04	-0.06	-0.08	-0.08	-0.08 (19)		
90:4 – 99:8	0.05	0.02	-0.06	-0.16	-0.22	-0.22 (25)		
99:9 – 15:7	0.00	-0.07	-0.12	-0.14	-0.08	-0.14 (11)		
				D7				
Full sample	**0.05**	**0.08**	**0.08**	0.11	0.12	0.12 (20)	0	3
90:4 – 99:8	0.02	-0.01	-0.01	**0.08**	0.12	0.12 (23)		
99:9 – 15:7	**0.05**	**0.13**	**0.13**	0.04	-0.05	**0.14** (4)	0	6
				D8				
Full sample	0.02	0.02	-0.02	-0.07	-0.09	-0.09 (20)		
90:4 – 99:8	-0.04	0.03	0.10	**0.12**	**0.11**	**0.12** (11)	7	25
99:9 – 15:7	**0.06**	0.01	-0.12	**-0.27**	-0.10	**-0.27** (13)	8[(a)]	21
				D9				
Full sample	-0.08	-0.08	-0.04	-0.02	-0.01	-0.20 (2)		
90:4 – 99:8	-0.11	0.07	0.19	**0.32**	**0.41**	0.45 (120)	8	51
99:9 – 15:7	-0.04	-0.13	-0.27	-0.48	**-0.44**	**-0.52** (16)	15	30
				D10				
Full sample	-0.05	-0.04	-0.03	-0.01	0.02	-0.05 (4)		
90:4 – 99:8	-0.06	-0.04	-0.05	-0.04	-0.03	-0.06 (0)		
99:9 – 15:7	**0.15**	0.08	0.00	-0.13	-0.07	**0.15** (0)	0	0
				D11				
Full sample	**0.16**	**0.61**	**0.61**	**0.57**	**0.39**	**0.67** (5)	0	35
90:4 – 99:8	**0.13**	**0.58**	**0.49**	**0.41**	**0.30**	**0.59** (4)	0	34
99:9 – 15:7	**0.21**	**0.72**	**0.80**	**0.52**	0.02	**0.80** (5)	0	15
				D12				
Full sample	-0.01	-0.06	-0.01	0.05	0.09	0.09 (26)		
90:4 – 99:8	0.18	-0.05	0.04	0.10	0.11	0.18 (0)		
99:9 – 15:7	-0.07	-0.03	-0.01	-0.02	-0.04	-0.07 (0)		

Source: Author's elaboration.

Note: Bold numbers indicate statistically significant values. The columns "0" to "24" report the responses after 0, 3, etc. months. "Max" is the maximum response in absolute value with the month in parentheses. "First" and "Last" are the first and last months of the longest period with significant responses. (a) Also significant subsamples before the period indicated.

IV. CONCLUSIONS

The analysis in this paper is concerned with the propagation of inflationary shocks. So far, little research has been concerned with this important issue, while many studies have focused on the related topics of inflation persistence and pass-through effects. It was argued that VAR models of dimension two are suitable for a general analysis of propagation of inflationary shocks. The data vector consists of the component that is affected by the shock (i) and the rest of the CPI basket. The shocks are identified by a Cholesky decomposition such that the “rest” component is affected contemporaneously by a shock to component i, but not vice-versa.

The empirical analysis was conducted with annual Chilean inflation rates such that seasonal adjustment filters would not affect the results. The results suggest that when analyzing propagation of inflationary shocks, it is important to consider shocks to several prices of the consumer basket and not merely those that are affected by the commodity price shock, which has been the principal focus in the literature on inflationary effects. Furthermore, propagation of shocks is not always positive, since the demand effect dominates when the shock hits prices of some components of the consumer basket. This should be taken into account when evaluating policy options to respond to price shocks.

In general, the results suggest that the duration of inflationary shocks is shorter after 1999, but it is higher for the two divisions that to some extent are affected by shocks to food prices. On the other hand, the propagation impact is lower in the second subsample for the prices mostly affected by oil price shocks. Shocks of prices of divisions containing a great deal of imported goods, and hence are affected by exchange rate shocks, propagate positively to other prices in the first subsample, but not significantly so in the second. Finally, shocks to prices of two divisions, where an important part is services, propagate positively in the first subsample and negatively in the second. The results advocate that appropriate policy actions, as a response to increasing inflation rates, have to begin with a thorough analysis of the origin of the shock in order to evaluate, firstly, which are the prices affected by the original shock and, secondly, given the results of this analysis, what can be expected with respect to possible second-round effects.

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APPENDIX A

CHARACTERISTICS OF THE PROPAGATION MODELS

Table A1

Model specification

	Dummies	Autocorrelation		ARCH(12)		Skewness	
		LM(1)	LM(4)	Eq.1	Eq.2	Eq.1	Eq.2
D1	6, 10, 12, 18, 23, 32, 33, 34, 42, 43, 44, 53, 55, 83, 91, 119, 221, 238, 239.	0.05	0.14	0.06	0.12	0.31	0.06
D2	6, 10, 14, 18, 27, 30, 42, 43, 44, 55, 93, 94, 103, 105, 117, 142, 154, 239, 243.	0.22	0.11	0.06	0.05	0.06	0.3
D3	6, 7, 10, 14, 18, 26, 30, 43, 44, 226, 231, 232, 251, 256, 262.	0.14	0.17	0.05	0.19	0.89	0.14
D4	6, 9, 10, 18, 22, 23, 26, 30, 32 35, 43, 44, 55, 56, 169, 217, 224, 233, 234, 245, 246, 255.	0.54	0.27	0.12	0.05	0.07	0.17
D5	6, 18, 22, 31, 33, 42, 43, 44, 232, 239.	0.37	0.33	0.11	0.08	0.78	0.19
D6	6, 10, 12, 14, 18, 22, 30, 43, 44, 46, 229, 232, 284.	0.05	0.34	0.14	0.11	0.99	0.07
D7	6, 10, 14, 17, 18, 20, 22, 23, 26, 30, 33, 42, 43, 44, 56, 163, 225, 236.	0.74	0.38	0.05	0.06	0.5	0.93
D8	6, 9, 10, 14, 18, 22, 24, 32, 35, 42, 43, 51, 63, 77, 114, 170, 223, 237, 239.	0.09	0.85	0.51	0.07	0.2	0.21
D9	6, 18, 19, 22, 24, 26, 27, 29, 30, 31, 44, 63, 73, 75, 105, 109, 232, 235, 238, 250.	0.83	0.62	0.1	0.06	0.36	0.41
D10	6, 10, 14, 17, 18, 30, 33, 42, 43, 44, 56, 57, 69.	0.73	0.79	0.15	0.06	0.7	0.24
D11	6, 18, 23, 26, 29, 30, 31, 32, 33, 40, 43, 49, 57, 208, 210, 220, 222, 237, 238, 250.	0.82	0.2	0.07	0.06	0.15	0.36
D12	6, 10, 18, 19, 25, 30, 41, 43, 44, 100, 103, 127, 227, 228, 238, 239, 240, 244, 245, 246, 250, 256, 257.	0.07	0.26	0.06	0.13	0.21	0.08

Source: Author's elaboration.

Note: Di (i = 1,2,…,12) refers to the propagation model for division i. The column "Dummies" reports the dummies included in the model such that the number denotes observations after March 1990. LM(1) and LM(4) are p-values for the multivariate tests of no autocorrelation. ARCH(12) and Skewness report p-values for the univariate tests of no ARCH of order 12 and no skewness in the distribution of the residuals, where Eq. (1) refers to the division reported in column 1 and Eq. (2) to the rest of the consumer basket.

APPENDIX B

IMPULSE-RESPONSES FOR THE TWO SUBSAMPLES WITH THE RESPECTIVE 95% CONFIDENCE BANDS

Figure B1

Responses of CPI- from a unit shock to D1 – D12

(percentage points)

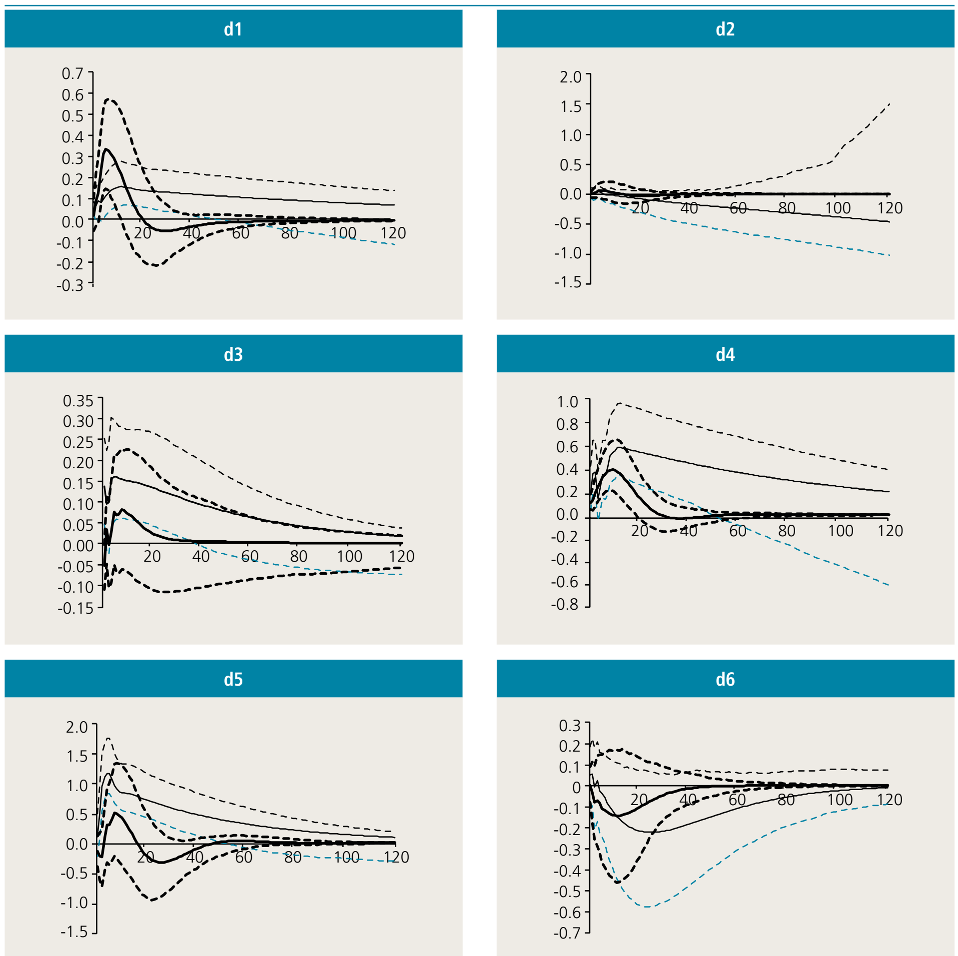
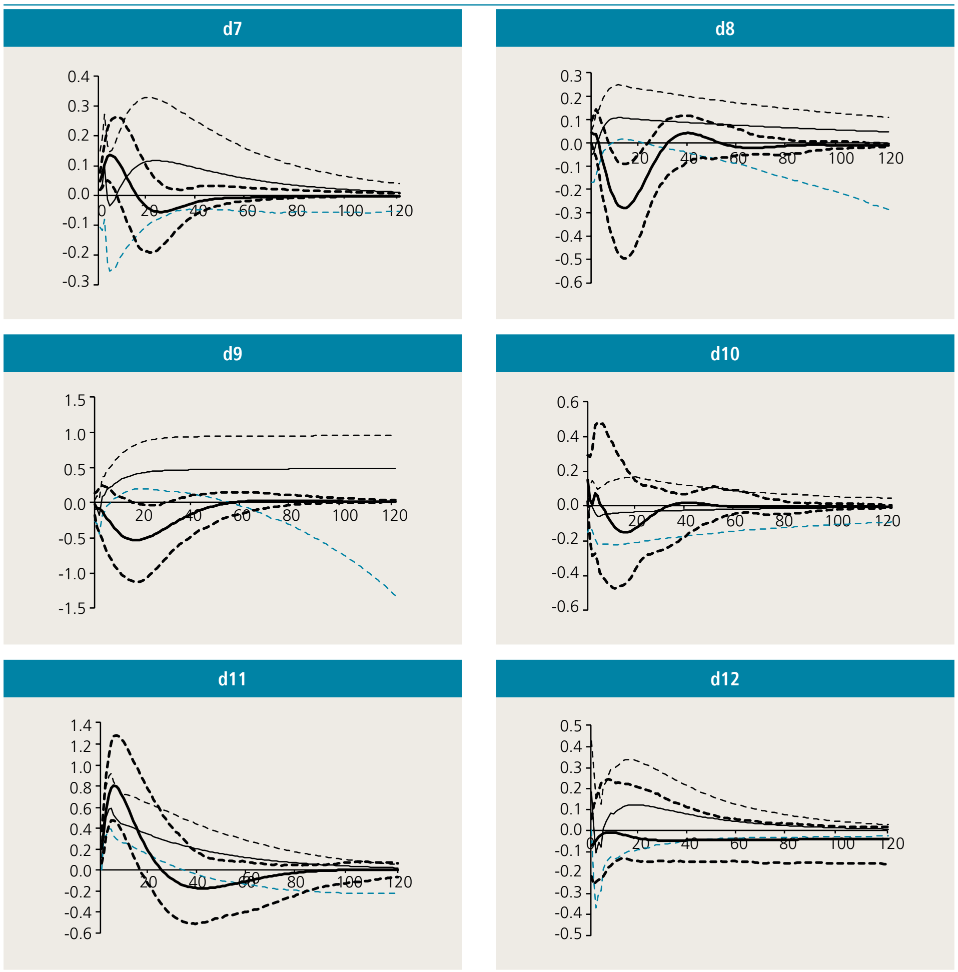


Figure B1 (cont'd)



Source: Author's elaboration.

Note: Thin lines are from the first subsample (April 1990 – August 1999), while thick lines are from the second subsample (September 1999 – July 2015). Dashed lines indicate 95% confidence bands bootstrapped with 2000 replications as described by Hall (1992).