The Effects of Inflation on Relative Price Variability with Different Price Regimes during the Chilean Hyperinflation

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Abstract

We empirically assess the effects of inflation on the variability of relative prices during the Chilean hyperinflation episode in the early 1970s, a period marked by several price controls. Crucially, we study this relationship separating it for products which price was set by the government and those determined by market conditions. To do so, we use unique monthly data on the prices of 23 food products between November 1970 and December 1976. We find a positive impact of inflation on relative price variability. Importantly, this positive relationship is driven by products with a fixed price and not by those determined by market conditions.

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1. Introduction

Governments use price controls typically to maintain affordable prices for the poorer population on "sensible" products, such as gasoline, the rent of apartments, or bread. While this may seem a good idea to increase popularity, it distorts resource allocation. Artificially depressed prices produce shortages as individuals increase demand, and firms reduce supply.

Price controls usually arise in hyperinflationary environments. Prominent examples of this phenomenon are the Chilean experience during the 1970s and the current Venezuelan experience. During the mid-1980s, several economies, such as Argentina, Bolivia, and Brazil, pursued heterodox price plans to mitigate (or eliminate) hyper-inflationary threats. Policies applied during these episodes include wage and price freezes and exchange rate pegging, among others (Blejer & Cheasty, 1988).

Economic theory suggests that relative prices, which are implicitly determined by the price system and its evolution, act as a signal for agents to optimally assign their resources (e.g., how much they work or how much they consume). It then follows that relative price variability may impede economic agents' to allocate their resources appropriately.

In this paper, we empirically analyze the impact of inflation on the variability of relative prices. Our contributions are two-fold. First, we depart from most of the literature by focusing on an economy with hyperinflation, where the government set prices for several goods. We argue that when governments have the power to fix prices, inflation will generate larger relative price variability. To test our hypothesis, we construct a unique data set on 23 food product prices recorded monthly during the Chilean hyperinflation (November 1970 and December 1976). These 23 products represent a subset of the products used to construct the Chilean Consumer Price Index (CPI) and account for near 20 percent of the basket during the period. Second, Chile's economic policy history allows us to explicitly evaluate whether the relationship between relative price variability and inflation is different under contrasting price regimes.

Chilean history during the 70s provides a first-hand example of heterodox policies. Under the many reforms carried out during the government of President Salvador Allende (1970–1973), the creation of "Social Property Areas" (APS) was a breakthrough. Its objective was to establish a predominance of the state in strategic sectors. As a result, many firms were nationalized and became subject to state control. This process was also accompanied by price-fixing schemes to avoid real wage deterioration and the corresponding effect on workers' welfare, derived from unusually large and rising inflation. The Chilean government gradually liberalized prices after a military coup in September 1973.

While successful in the first year, Allende's policies soon failed. In the case of price controls,

while costs were rising owing to government expansions in nominal wages, firms' real revenues were falling. Probably forward-looking firms, expecting not to be able to reset their prices soon enough, found it optimal to make more significant adjustments in prices than those they would have made had they been permitted to set prices freely. This arrangement could have had two consequences. First, it could have generated an accelerated inflationary environment, in which prices increased by more than they would have done with no price-fixing. Second, it could have produced relative price distortions: with individual firms making distinct adjustments, relative prices in the economy may indeed have deviated considerably from free-market equilibrium prices.

Our main result is as follows. In line with most studies, we find that inflation increases relative price variability. However, our results suggest that this effect crucially depends on fixing prices: the positive impact only holds for products with fixed prices during the entire period. Therefore, price-fixing schemes may explain the positive relationship found in the literature.

The rest of this paper is structured as follows. Section 2 discusses the theoretical links between inflation and relative price volatility. In addition, it presents previous results in the literature. In Section 3, we briefly summarize Chile's price-fixing experience. Section 4 presents the data and discusses the evidence emerging from these data. In Section 5, we explain our empirical strategy and discuss our results. Finally, Section 6 concludes the paper.

2. Previous studies

During the last few decades, several works have explored the relationship between inflation and relative price variability, yet there is no consensus on its actual effect. At a purely theoretical level, there are at least three mechanisms through which inflation may affect relative price variability (Aksoy et al., 2013). In menu cost models, firms face a reduction in their real revenues whenever the aggregate price is increasing. To preserve their optimum real price, they need to adjust their nominal price. However, firms cannot immediately do so, because they face a cost whenever they change a price. Furthermore, in all likelihood, these costs vary among firms, which means such price adjustments create relative price distortions (Sheshinski & Weiss, 1977; Rotemberg, 1983; Alvarez et al., 2017).

A second argument stems from signal extraction models, where agents face informational problems confusing changes in absolute and relative prices (Barro, 1976; Cukierman & Wachtel, 1982). For example, an aggregate demand shock would be internalized differently across agents, producing relative price variability.[1] Finally, monetary search models point to an inconclusive link between inflation and relative price variability because of two opposing channels (Peterson & Shi, 2004;

[1] Although the logic of these models is different, observationally, they are almost equivalent. See Bakhshi (2002).

Becker & Nautz, 2012). In both cases, there exist informational asymmetries between buyers and sellers. In the first channel, higher expected inflation reduces the value of fiat money, increasing sellers' market power and relative price variability because buyers have incomplete information about sellers' prices. In the second channel, a given level of inflation reduces buyers' real search cost and relative price variability.

The empirical literature is also inconclusive about the real impact of inflation on relative price variability. In one of the first works on this topic, Parks (1978) argued that inflation positively affects relative price variability and that its unexpected component exerts a larger impact on it than its anticipated component. Cukierman & Wachtel (1982) and Van Hoomissen (1988) provide further evidence on this effect. In a subsequent paper, Stockton (1988) showed that these works were incomplete because causality could run in both directions, and the relationship between the variables is essentially non-linear. In the same vein, Hartman (1991) argued that several restrictions were needed to produce these previous empirical findings and, thus, earlier works conveyed little to no economic information.

Notwithstanding the latter critiques, subsequent research finds that the relationship between relative price variability and inflation in mostly positive (Parsley, 1996; Fielding & Mizen, 2000; Küçük-Tuğer & Tuğer, 2004; Banerjee et al., 2007), with some exceptions that find a negative result (Silver & Ioannidis, 2001; Caglayan et al., 2008). This same research also emphasizes that this relationship may be more complicated than previously thought, owing to the possibility of a U-shape link (Bick & Nautz, 2008; Choi, 2010; Caraballo & Dabús, 2013), a non-linear relationship (Alvarez et al., 2017; Baglan et al., 2016; Rather et al., 2015), possible cross-country differences (Aksoy et al., 2013), and previous models, such as New-Keynesian models, being completely wrong when applied to available data (Nakamura et al., 2016).

3. Historical Context

After gaining independence in the early 19th Century, Chile maintained its relatively open, free-market economic system, with prices determined by the market, until the Great Depression.

The Great Depression hit the Chilean economy particularly hard: its exports fell by over 80 percent, and real GDP dropped by over 50 percent. Then, a period of political instability followed in the 1930s. A critical government during this period was the ",100-day socialist". This government induced the Central Bank to develop a highly expansionary monetary policy after it had suspended convertibility and gone off the Gold Standard. To control the resulting price increases, the "Commissary of Subsistence and Prices," Decree Law 520 (DL520)[2], was created.

[2]Decree Law 520 of 1932, Socialist Government.

This institution was in charge of fixing prices and supervise the overall price system to make necessities available to the population at "reasonable" prices.

Between 1933 and 1938, market conditions determined prices. In 1938, a center-left coalition ruled the country and began to adopt an import substitution development strategy that lasted until 1973. This strategy included the fixing of an undetermined number of critical prices.

However, in the second half of the 1960s, as part of an anti-inflationary program of the Christian Democratic government in power at the time, prices were fixed for goods and services that served as the basis for determining the consumer price index.[3]

Inheriting a slow-growing economy and an inflationary environment, the Marxist government of Salvador Allende (leading a coalition of, among others, Communists and Socialist political parties) made an effort to transform the then mixed-market economy into a centralized economy. Aggregate demand increased and prices were fixed to achieve both product expansion and relative price stability. To prevent prices from rising with wages, the government implemented a much stronger battery of price-fixing schemes, covering more than 3000 products at one point (Wisecarver, 1986).

During his first year in office, Allende's government reduced inflation: the average inflation rate between 1970 and 1971 was around 23 percent. At the beginning of 1972, inflation began to rise at elevated rates of the order of 25 to 40 percent. The second semester of that year witnessed an impressive increase in inflation: 114 percent in September, 143 percent in October, 150 percent in November, and 163 percent in December.

Allende's government ended with the military coup of September 11, 1973. On October 15, 1973, the military regime established a new price policy under Decree-Law 522. Most prices would be determined by market forces, although 33 items would still be fixed by Directory of Trade and Industry (DIRINCO), based on cost studies.[4]. Also, there was a limited group of 18 other "informed" product prices, usually industrial products produced locally by monopolies. Based on this decree, the military regime freed almost 3000 prices at once in late 1973. Later on, prices would move from fixed to informed, and then back to free, including the prices of our sample of basic foodstuffs (see the next section). Then, to avoid moves in the other direction, from free prices to informed and fixed prices, Decree-Law N3529 was promulgated in December 1980. At that time, almost all prices were free, determined by market conditions, except those of some public utilities.

[3]Supreme Decree N1379, October 1966, Art. 11. Even then, the percentage changes in the price index in 1965 and 1966 were slightly higher than authorized price increases. Indeed, the average inflation rate under the government of President Frei Montalva is estimated to have been around 27 percent.

[4]These items included bread, flour, sugar, oil, milk, coffee, tea, and some types of beef, among the products included in our sample, in addition to public utility services, gasoline, motorized vehicles, and copper, among others. See Wisecarver (1986) or Decree Law 522 for a detailed description of the items. Decree-Law 522 can be downloaded from http://www.leychile.cl/Navegar?idNorma=194744. Moreover, DIRINCO was the name that replaced the Commissary of Subsistence and Prices established in the 30s.

Today, Chile has one of the most open economies to international trade, with a maximum import duty of 6 percent, and an average duty of less than 1 percent. It implies that prices of tradables tend to be heavily influenced by international market conditions.

4. Data and Evidence

4.1. Data Description

We collected monthly data for 23 food products between November 1970 and December 1976. These data come from the Statistical Yearbook ("Anuario Estadístico") and the Synthesis of the Statistical Yearbook ("Síntesis del Anuario Estadístico") of the National Institute of Statistics (Instituto Nacional de Estadísticas, INE). The products are as follows: oil, garlic, peas, onions, rice, sugar, coffee, tea, flour, eggs, milk, lettuce, butter, oranges, apples, bread, potatoes, bananas, cabbage, carrots, and three types of meat. These products are a small subset of the current set of goods used in the Chilean CPI basket.

The data consist of the current price per unit of each item in each month. We also use several macroeconomic variables available for the entire analysis period at a monthly frequency. We obtain data on national economic activity from Díaz (2006). We use the real stock index, which is the real value of a general portfolio of stocks traded in the Chilean economy, as a proxy for productivity. These data come from Díaz (2006). As a measure of relevant external conditions of the Chilean economy, we use (i) the nominal copper price, provided by the Chilean Copper Commission (Comisión Chilena del Cobre), and (ii) the nominal exchange rate (Chilean pesos per US$ dollar), taken from the statistical database of the Chilean Central Bank (Banco Central de Chile). From this latter source, we also extracted data on the money supply (M1). Finally, we measure inflation using the CPI index reported by Wagner & Díaz (2008), which is the official CPI index, adjusted based on data reported by Cortázar & Marshall (1980) for the 1970s.

4.2. Evidence on Price Controls, Relative Price Variability, and Inflation

In this subsection, we provide raw evidence of price-fixing in our sample. We then show how these price-fixing schemes may be related to relative price variability and inflation. Thus, this subsection provides the basis for our empirical approach and the results discussed in Section 5.

We start by showing evidence of price-fixing. As discussed in Section 3, we divide our main sample into two subsamples, which we refer to as pre-liberalization and post-liberalization samples. The pre-liberalization period ranges from November 1970 to September 1973. Allende's government imposed several price controls during this period that ended abruptly with the military coup on

September 11, 1973. The post-liberalization sample ranges from October 1973 to December 1976. In this period, the military regime conducted several structural reforms in different areas, one of these being price liberalization. Although price liberalization was a priority, it was not carried out all at once: of the 23 products in our sample, the prices of 11 were kept fixed, even after the military coup, and only later were gradually freed.[5]

We choose the period between November 1970 and December 1976 in our analysis for three main reasons (though we acknowledge that this choice may not be without controversy). First, it allows us to isolate several informational gaps in terms of price-fixing before Allende's government. For instance, during Frei-Montalva's government (1964–1970), some product prices were fixed. At some point during his term, all product prices in the CPI became fixed. However, we have no information on fixed prices before this point. Therefore, we rule out the period before 1970 because we cannot correctly assign prices to a specific regime.

The second reason for limiting our formal analysis to 1970–1976 is because market conditions determine almost all prices after 1976. As a result, we cannot correctly identify a treated sample. A problem arises because all products have fixed prices before the military coup; some products have fixed prices while others have free prices between the military coup and 1976. Moreover, all product prices were free after 1976. In randomized control trial language, we would have a period with (i) no treatment, (ii) treated/non-treated, and (iii) all treated. Thus, to correctly identify the "treatment," we rule out the period after 1976.

The third reason is that the Chilean Central Bank effectively became independent toward the end of the military regime (1989), with its main goal becoming price stability. Subsequently, the rate of inflation began to decline gradually to its target rate of between 2 and 4 percent per year. This reduction was achieved in the early 2000s and has remained at that level since. This structural transformation must have affected the relationship between inflation and relative prices for reasons not related to the price-fixing mechanism. Therefore, if we consider this period, it would create several biases in our estimates that we are unable to solve with the data at hand.

This sort of randomized experiment allows us to define a treated and a non-treated group.[6] Our treated group (L) corresponds to items with fixed prices in the pre-liberalization period, but not in the post-liberalization period. Conversely, the non-treated group (F) corresponds to items with fixed prices during both periods. Hence, the treatment should read as "liberalization" rather than "fixing". This classification does not alter our results and allows us to define groups cleanly.

[5]These products were flour, bread, oil, milk, butter, sugar, coffee, tea, and three types of meat. Coffee is a particular case because it was not completely fixed, but "informed." We chose to include it in the list of liberalized prices. However, our main results are not affected by this choice.

[6]Note that we are using the same terminology as that of the difference-in-differences (DiD) literature. However, we do not explicitly take a DiD approach, given that we are not sure if the common parallel-trends assumption applies in our context.

Figure 1 shows the evolution of the price levels of flour, rice, bread, and cabbage, to get a sense of how price fixing arises in our data. After September 1973, flour and bread prices were kept fixed while rice and cabbage prices were liberalized. For ease of analysis, we indexed each price to its observed value in November 1970. Filled-dot lines represent items that belong to the non-treated group, while unfilled-dot lines correspond to items in the treated group.

Panel A shows clear evidence of price intervention in the pre-liberalization period. In particular, products of this latter sample present a staggered price structure, which suggests the presence of price-fixing (although cabbage showed a low degree). Note that price variations are relatively small in this period.

Things seem to be different when we consider the post-liberalization period, as shown in Panel B of Figure 1. Here, all products exhibit price increases that are significantly larger than those in the pre-liberalization period.[7] At first sight, there does not seem to be a staggering structure in any of the prices shown. However, this is not precisely accurate, as shown in Panel C, where we focus on the period between October 1973 and December 1974. Clearly, in this period, flour and bread prices were both fixed, because they continue to show a staggered structure, even after the military coup and the policy intervention. This result is consistent with the timing of the reforms explicitly stated in the law at that time discussed in Section 3.

How does price intervention translate into relative price behavior? To answer this question, denote $P_{i,t}$ as the nominal price of item i at time t. In addition, let P_t be the aggregate price level at time t. Thus, we can define the relative price of product i at time t ($R_{i,t}$) as $R_{i,t} = P_{i,t}/P_t$. Figure 2 shows the evolution of this ratio for the same four products as before. Again, we have indexed these values using the prices in November 1970.

As expected, before the military coup, the relative prices of these four products were continually declining. On average, relative prices in September 1973 were 20 percent of their value in November 1970 (see panel A of Figure 2).[8] In contrast, as shown in panel (B), these same relative prices experienced a significant increase after liberalization. For instance, the relative price of flour at the end of our sample was around two-and-a-half times its observed value in November 1970. Furthermore, this coefficient was almost two for rice, and around one for bread and cabbage. We can observe these increases in greater detail in panel C of Figure 2.

The previous evidence suggests that relative price variability (i.e., changes in relative prices over time) could have been different between the pre-liberalization and post-liberalization periods.

[7] For example, the rise in the price of flour was around 5000 times higher than its observed value in November 1970 in the post-liberalization period, while it was at most two-and-a-half times higher in the pre-liberalization period.

[8] Cabbage was an exception, because its price behavior was erratic during this period. We choose to show this price because the government of the time fixed it. However, the data suggest that, despite the intention of setting this price, it was not particularly successful in doing so.

To determine whether this was truly the case, we define relative price variability (hereafter, RPV) as follows:

$$RPV_{it} = \frac{\sigma_{it}}{\mu_{it}} = \frac{\sqrt{\sum_{t-11}^{t}(R_{it} - \mu_{it})^2/12}}{\sum_{t-11}^{t} R_{it}/12}. \quad (1)$$

This is commonly known as the coefficient of variability, and is defined as the ratio of the standard deviation (σ_{it}) to the mean (μ_{it}) of relative prices in a 12-months period.

Our definition of RPV is slightly different from the one used in the literature. Most works define RPV as the second moment of micro-level inflation, where macro-level inflation (defined as the weighted average of micro-level inflation) is the average measure in the calculation. Accordingly, there is a unique measure for RPV representing all goods in a certain period. In contrast, we have this measure at the item level. We follow this approach as it allow us to distinguish RPV among products that are subject to price-fixing and those that do not. Also, it improves our capacity to control for nonlinearities in the data that are likely to arise, given the military regime intervention in several key areas.

Figure 3 shows the behavior of RPV and of monthly and annual inflation between November 1970 and December 1976. For RPV, we plot the median RPV in each month, distinguishing between prices of fixed and free products in our sample. We call "fixed-price products" as those with prices that were kept fixed after the military coup. Conversely, "free-priced products" are those that were set free following the policy intervention, even though they were fixed before the military coup. As a result, the median RPV of free-price products needs a careful interpretation because it shows the median RPV behavior of those prices that were liberalized after September 1973, and not the median RPV behavior of all free-price products.[9].

Note that these series show an interesting pattern: while the median RPV for fixed-price products was well below that of free prices during the first year of Allende's government (1970–1973), the former surpassed the latter by the middle of the second year of his government, reaching a maximum gap by the end of 1972. In the post-liberalization period, the median RPV for fixed-price products was consistently below that of free-priced products. We also observe that annual and monthly inflation rates began to increase during the second semester of 1972 at accelerating rates: more than 800 percent in the case of annual inflation, and almost 80 percent in the case of monthly rates. These rates then show a declining trend during the post-liberalization period.

In summary, the last two figures highlight two interesting facts. First, RPV of fixed-priced products was below that of free-priced products in the period following the military coup. Interestingly, this was not the case in the pre-liberalization period, where the RPV of fixed-priced products

[9]The distinction matters because all prices in our sample were fixed in the period before the policy intervention. It means that there were no prices of free products available to calculate their median RPV during this period.

was well above that of free-priced products. Second, inflation rates were highest immediately after the military coup, although they had been increasing since at least the second year of Allende's government. Despite these two facts, there are no other evident relationships from simple inspection of both figures. We return to this issue in Section 5.

[Insert Figure 1 to 3 about here]

5. Assessing the Effects of Inflation on Relative Price Variability

In this section, we outline and implement our empirical approach to assess how inflation affects relative price variability under different price regimes. Of particular interest to us is whether this effect depends on the price regime experienced by the products.

We start by running the following regression separately for each product:

$$RPV_t = \gamma_0 + \gamma_1 \pi_t + \gamma_2 D_t + \gamma_3 D_t \pi_t + \mathbf{Z_t}\boldsymbol{\zeta} + \varepsilon_t, \qquad \forall i \tag{2}$$

where RPV_t is the relative price variability of product i at time t, π_t is the monthly inflation rate, $\mathbf{Z}_t = \left[\Delta log(Imacec_t), \Delta log(IGPA_t), \Delta log(CopperPrice_t), \sum_{j=2}^{12} d_j\right]$ is a 1×14 vector of time variant controls, where Δ represents the difference with respect to the previous month, $Imacec_t$ is a monthly activity index, $IGPA_t$ is a index general stock price index, d_j takes the value of one if the observation belong to month j, and zero otherwise, $\boldsymbol{\zeta}$ is a 14×1 vector of parameters associated with the time variant controls, and D_t is equal to one after liberalization, and zero otherwise. Finally, ε_t is an i.i.d error term.

Table 1 shows the result of this equation. We estimate the model using ordinary least squares with Newey-West standard errors. Before liberalization, inflation positively affects RPV for all fixed-price products but showed no clear pattern for free-priced products (column (1)). For example, it was positive for potato but negative for cabbage, and even close to zero for peas. Column (5) provides the additional impact of inflation on RPV after liberalization (γ_3). Nine of the thirteen products showed a decrease in their RPV sensitivity to inflation after the liberalization occurred. This result is also evident for fixed price products since eight out of ten products showed a decline in this relationship.

Now, consider columns (7) and (8) of Table 1. This column tests whether the relationship between RPV and inflation was different from zero after the liberalization. Column (7) is the point estimate, while column (8) is the probability that point estimates are statistically indistinguishable from zero. Ten out of the thirteen products which price was liberalized show no impact of inflation on RPV after the liberalization. In contrast, this relationship was statistically different from zero

and positive for all fixed-price products after the liberalization. This last result illustrates the possibility that the relationship between RPV and inflation is positive for fixed-price products after the liberalization process.

[Insert Table 1 about here]

We test this last result running a regression of the form:

$$RPV_{it} = \chi_i + \rho_1 D_t + \rho_2 D_{it} + \phi_1 \pi_t + \phi_2 D_i \pi_t + \phi_3 D_t \pi_t + \phi_4 D_{it} \pi_t + \mathbf{Y_t \Gamma} + \varepsilon_{it} \quad (3)$$

where RPV_{it} is the relative price variability of product i at time t, π_t is the monthly inflation rate, χ_i is a product-fixed effect, D_t is equal to one after the liberalization, and zero otherwise, D_i is equal to one if the product was liberalized, and zero otherwise, $D_{it} = D_i \times D_t$. $\mathbf{Y}_t = \left[\Delta log(Imacec_t), \Delta log(IGPA_t), \Delta log(CopperPrice_t), \sum_{j=2}^{12} d_j, \sum_{i=2}^{23} \sum_{j=2}^{12} d_j d_i\right]$ is a $1 \times K$ row vector of time variant controls, Δ represents the difference with respect to the previous month, $\mathbf{\Gamma}$ is a $K \times 1$ column vector of parameters associated with the time variant controls, where K is the number of control variables included, d_j takes the value one if the observations belong to month j, and zero otherwise, and d_i takes the value one if the observation belongs to product i, and zero otherwise. We include their interaction to account for the possibility that products differ in their seasonality patterns. Finally, ε_{it} is an i.i.d error term.

Our key parameters of interest are ϕ_i with $i = \{1, 2, 3, 4\}$. ϕ_1 provides the impact of inflation on RPV for fixed-price products before liberalization. $\phi_1 + \phi_2$ shows the impact of inflation on RPV before the liberalization for products with free prices after the military coup. $\phi_1 + \phi_3$ is the impact of inflation on the RPV for fixed-price products after the liberalization. Finally, $\phi_1 + \phi_2 + \phi_3 + \phi_4$ shows how inflation affects the RPV of products with free prices after the liberalization. The latter coefficient corresponds to products with free prices, while the rest correspond to products with fixed prices.

Table 2 shows the estimated results from equation 3. In all columns, we estimate the models using product fixed-effects to control for time-invariant product characteristics. Columns (1) and (2) suggest that the relationship between RPV and inflation is, on average, positive (0.577). Columns (3) and (4), on the other hand, provide several insights about this relationship and its behavior when prices are fixed or free. ϕ_1 is positive and statistically significant in both columns, indicating that inflation positively affected RPV for fixed-price products before the liberalization. ϕ_2 is negative, which suggests that the impact of inflation on RPV for liberalized prices before their liberalization was smaller than its impact on the RPV of fixed price products. This combined effect ($\phi_1 + \phi_2$)

is statistically significant (at a 90 percent) since the p-value of the joint test is 0.02 in column (3) and 0.06 in column (4).

Let us consider what happened to this relationship after the liberalization. Consider the parameter ϕ_3. We can see that it is negative and statistically significant in both columns (3) and (4). This parameter is similar to an aggregate time shock (or structural break) that affected the relationship for all products after liberalization. The last row of Table 2 provides the impact of inflation on RPV for liberalized products after liberalization, $(\phi_1 + \phi_2 + \phi_3 + \phi_4)$. Here, we cannot reject that it was zero in both columns. This result suggests that inflation does not have an impact on RPV on free-priced products after liberalization. In the previous row, we test whether this relationship was different for fixed-price products after the liberalization $(\phi_1 + \phi_3)$. In this case, we reject the hypothesis that this effect was zero.

[Insert Table 2 about here]

A common concern in this setup is that of endogeneity. In our case, this is plausible since we are studying higher-order moments of the price distribution. It could be the case that a larger RPV may induce distortions in the allocation of resources affecting inflation. In such a case, they may be jointly determined and can potentially bias our estimated parameters. To account for this fact, we instrument the inflation rate by the monthly growth rate of the money supply (g_{Mt}) and the monthly growth rate of the nominal exchange rate (g_{et}). These seek to capture different sources of inflation: one from tradables (nominal exchange rate) and one from non-tradables (money supply). Formally, we estimate an equation of the form:

$$RPV_{it} = \chi_i + \rho_1 D_t + \rho_2 D_{it} + \phi_1 \hat{\pi}_t + \phi_2 D_i \hat{\pi}_t + \phi_3 D_t \hat{\pi}_t + \phi_4 D_{it} \hat{\pi}_t + \mathbf{Y_t \Psi} + \varepsilon_{it}, \tag{4}$$

where the ϕ parameters have the same interpretation as in equation 3, D_i, D_t and D_{it} are as defined before, χ_i are product-fixed effects, $\mathbf{Y_t}$ is a row vector of $1 \times K$ control variables that change over time (including monthly product dummies to account for product-specific seasonality patterns), Ψ is a column vector of $K \times 1$ parameters associated with the controls, and ε_{it} is an i.i.d error term.

The estimated aggregate price $(\hat{\pi}_t)$ is obtained from the estimates of the following regression:

$$\pi_t = \lambda_0 + \eta_1 g_{Mt} + \eta_2 g_{et} + \sum_{j=2}^{12} \iota_j d_j + \xi_t, \tag{5}$$

such that

$$\hat{\pi}_t = \hat{\eta}_0 + \hat{\eta}_1 g_{Mt} + \hat{\eta}_2 g_{et} + \sum_{j=2}^{12} \hat{\iota}_j d_j$$

.

where we include monthly dummies ($\{d_j\}_{j=2}^{1}2$) to account for seasonality patterns and ξ_t is an i.i.d error term.

Table 3 shows the results after correcting for the possible endogeneity. This table is qualitatively identical to Table 2. Although we observe some minor changes in the parameters, these do not change the meaning and importance of the results from Table 2. What this IV correction does is to reinforce the idea that inflation affects RPV only in the presence of price-fixing.

[Insert Table 3 about here]

To be clear, let us consider the parameters estimated from Table 2.[10] In particular, consider the last three rows of this table. Here, we test whether the linear combinations of these parameters are statistically different from zero. It turns out that these tests provide useful insights into the behavior of the relationship between inflation and RPV: the parameters statistically different from zero are always associated with some price-fixing. To see this, we summarize these linear combinations in Table 4. For instance, it is positive for fixed-price products after liberalization. It is also positive for fixed-price products before liberalization. Finally, it is positive (although less so) for free-priced products before the liberalization, when the government fixed them. The only case where we do not find such a relationship is when we consider free-priced products after the liberalization. We can now state the main result of this paper: the positive impact of inflation on RPV comes exclusively from the existence of fixed-price products, and not from those determined by market conditions.

[Insert Table 4 about here]

6. Conclusion

In this paper, we confirm previous results on the positive relationship between inflation and RPV. We take advantage of a natural experiment and unique monthly price data on 23 food products for the Chilean economy between November 1970–December 1976 to analyze the presence of price-fixing during the early 1970s, and its subsequent removal after the military coup of September 11, 1973. Importantly, not all prices were liberalized after 1973, since a significant portion remained fixed during the period of analysis. This timing allowed us to employ a difference-in-differences approach.

Our results suggest that the channel through which inflation affects RPV depends crucially on the presence of price-fixing policies. Indeed, we analyze whether this relationship differs across

[10] Since they do not differ from the parameters we found in Table 3, this choice is irrelevant for our exercise.

regimes, and we find that it only holds for products with fixed prices both before and after liberalization. Also, it holds for products with liberalized prices before the policy intervention, when the government maintained them fixed. Nevertheless, this relationship is not statistically different from zero for prices that were set free after the liberalization.

Although it is not the main focus of this paper, we now provide a possible rationale for our result. We hypothesize that forward-looking firms made more significant price adjustments under a fixed-price regime than in a free-market environment because they expected to be constrained in their pricing decision for a while. As a result, product prices jumped when firms were able to update their prices (as given by the government threshold). These discrete jumps contributed to increase relative price variability because they did not occur at the same time for each product. Since inflation was rising during this period at accelerated ways, not just due to price-fixing, it is intuitive that inflation mainly affects RPV of fixed-price products those that suffer the most from hyperinflation. Therefore, we highlight that whether prices are fixed or determined by market conditions is crucial for our understanding of how inflation impacts RPV.

Note that many governments often set prices in regulated industries, which might be a possible driver of existing results in the literature. Recently, some countries have applied extensive price-fixing policies, e.g., in Latin America, Argentina until the end of 2016, and Venezuela to the present, like Chile in the late 1960s and early 1970s. Our analysis suggests that these price-fixing policies might cause a significant increase in relative price fluctuations, which distort economic resource allocations and ultimately impacts welfare.

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Table 1. Relative Price Variability–Inflation Relationship Per Product

Liberalized Prices

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	γ_1	S.E.	γ_2	S.E.	γ_3	S.E.	$\gamma_1+\gamma_3$	$H_0:\gamma_1+\gamma_3=0$
Rice	1.208	(0.36)	0.240	(0.17)	-0.699	(0.34)	0.509	0.02
Eggs	0.619	(0.16)	0.180	(0.09)	-0.572	(0.23)	0.047	0.84
Garlic	-0.336	(0.24)	0.044	(0.07)	0.309	(0.27)	-0.027	0.87
Peas	-0.006	(0.29)	0.176	(0.09)	-0.071	(0.27)	-0.077	0.81
Onions	0.803	(0.14)	0.157	(0.06)	-0.749	(0.14)	0.054	0.65
Lettuce	-0.302	(0.28)	0.108	(0.06)	0.294	(0.28)	-0.008	0.93
Potato	1.611	(0.52)	0.247	(0.15)	-1.327	(0.68)	0.284	0.46
Cabbage	-0.510	(0.25)	0.218	(0.04)	0.359	(0.24)	-0.151	0.18
Carrot	-0.137	(0.28)	0.355	(0.08)	-0.091	(0.26)	-0.228	0.34
Apples	1.126	(0.33)	0.208	(0.07)	-0.856	(0.35)	0.270	0.02
Oranges	-0.312	(0.30)	0.029	(0.08)	0.345	(0.31)	0.033	0.65
Bananas	0.272	(0.80)	0.460	(0.23)	-1.069	(0.74)	-0.797	0.33
Coffee	1.637	(0.39)	0.153	(0.12)	-0.942	(0.37)	0.695	0.00

Fixed Prices

	γ_1	S.E.	γ_2	S.E.	γ_3	S.E.	$\gamma_1+\gamma_3$	$H_0:\gamma_1+\gamma_3=0$
Flour	1.678	(0.57)	0.247	(0.22)	-0.587	(0.51)	1.091	0.00
Bread	0.460	(0.28)	-0.002	(0.09)	0.069	(0.33)	0.529	0.00
Meat 1	0.876	(0.32)	0.239	(0.07)	-0.502	(0.27)	0.374	0.01
Meat 2	0.777	(0.29)	0.213	(0.06)	-0.456	(0.24)	0.321	0.01
Meat 3	0.367	(0.31)	0.125	(0.06)	-0.056	(0.27)	0.311	0.00
Oil	1.427	(0.40)	0.172	(0.09)	-0.997	(0.40)	0.430	0.00
Milk	0.280	(0.20)	0.042	(0.06)	0.011	(0.23)	0.291	0.01
Butter	1.052	(0.30)	0.159	(0.08)	-0.500	(0.29)	0.552	0.00
Sugar	0.789	(0.38)	0.183	(0.09)	-0.373	(0.39)	0.416	0.00
Tea	1.412	(0.47)	0.194	(0.12)	-0.742	(0.48)	0.670	0.00

Note: Results estimated from a regression of the form: $RPV_t = \gamma_0 + \gamma_1\pi_t + \gamma_2 D_t + \gamma_3 D_t\pi_t + \mathbf{Z_t}\boldsymbol{\zeta} + \varepsilon_t$ for each product i separately; Z_t is a vector of time-variant controls that includes $\Delta Log(Imacec)$, $\Delta Log(IGPA)$, $\Delta Log(Copper\ Price)$) and monthly dummies. Product-specific price regression estimated with the Newey–West standard errors with 12 lags.

Table 2. Relative Price Variability Results: Baseline Model (Dep. Var: RPV)

VARIABLES	(1) FE	(2) FE	(3) FE	(4) FE
Monthly Inflation [ϕ_1]	0.577***	0.577***	0.868***	0.916***
	(0.08)	(0.09)	(0.14)	(0.16)
D_i*Monthly Inflation [ϕ_2]			-0.398*	-0.482*
			(0.21)	(0.26)
D_t*Monthly Inflation [ϕ_3]			-0.443***	-0.457***
			(0.11)	(0.12)
D_{it}*Monthly Inflation [ϕ_4]			0.076	0.101
			(0.18)	(0.21)
Liberalization Period (D_t)			0.162***	0.162***
			(0.03)	(0.03)
D_{it}			0.032	0.031
			(0.04)	(0.04)
Observations	1,702	1,702	1,702	1,702
Time-Variant Controls	✓	✓	✓	✓
Product × Month Dummies		✓		✓
$\phi_1 + \phi_2 = 0$ (p-value)			0.02	0.06
$\phi_1 + \phi_3 = 0$ (p-value)			0.00	0.00
$\phi_1 + \phi_2 + \phi_3 + \phi_4 = 0$ (p-value)			0.25	0.44

Note: Robust (clustered by product) standard errors are presented in parentheses. Significance levels: * 10%, ** 5%, *** 1%. D_t is equal to one after the liberalization, and zero otherwise, D_i is equal to one if the product was liberalized, and zero otherwise and $D_{it} = D_i \times D_t$. Time-variant controls include $\Delta Log(Imacec)$, $\Delta Log(IGPA)$ and $\Delta Log(Copper\ Price)$ and monthly dummies. Δ denotes the first-difference with respect to the previous month.

Table 3. Relative Price Variability Results: IV Model (Dep. Var: RPV)

VARIABLES	(1) OLS	(2) FE	(3) FE	(4) FE	(5) FE
Panel A: First Stage					
Money Supply (M1)	0.339***				
	(0.12)				
Nominal Exchange Rate	0.286***				
	(0.04)				
Panel B: Second Stage					
Monthly Inflation IV [ϕ_1]		0.574***	0.574***	0.770***	0.830***
		(0.08)	(0.09)	(0.11)	(0.12)
D_i*Monthly Inflation IV [ϕ_2]				-0.397**	-0.503**
				(0.15)	(0.19)
D_t*Monthly Inflation IV [ϕ_3]				-0.330***	-0.331***
				(0.08)	(0.08)
D_{it}*Monthly Inflation IV [ϕ_4]				0.036	0.038
				(0.11)	(0.13)
Liberalization Period (D_t)				0.163***	0.162***
				(0.02)	(0.03)
D_{it}				0.031	0.033
				(0.04)	(0.04)
Observations	74	1,702	1,702	1,702	1,702
Time-Variant Controls		✓	✓	✓	✓
$\phi_1 + \phi_2 = 0$ (p-value)				0.01	0.04
$\phi_1 + \phi_3 = 0$ (p-value)				0.00	0.00
$\phi_1 + \phi_2 + \phi_3 + \phi_4 = 0$ (p-value)				0.39	0.76
Product × Month Dummies			✓		✓

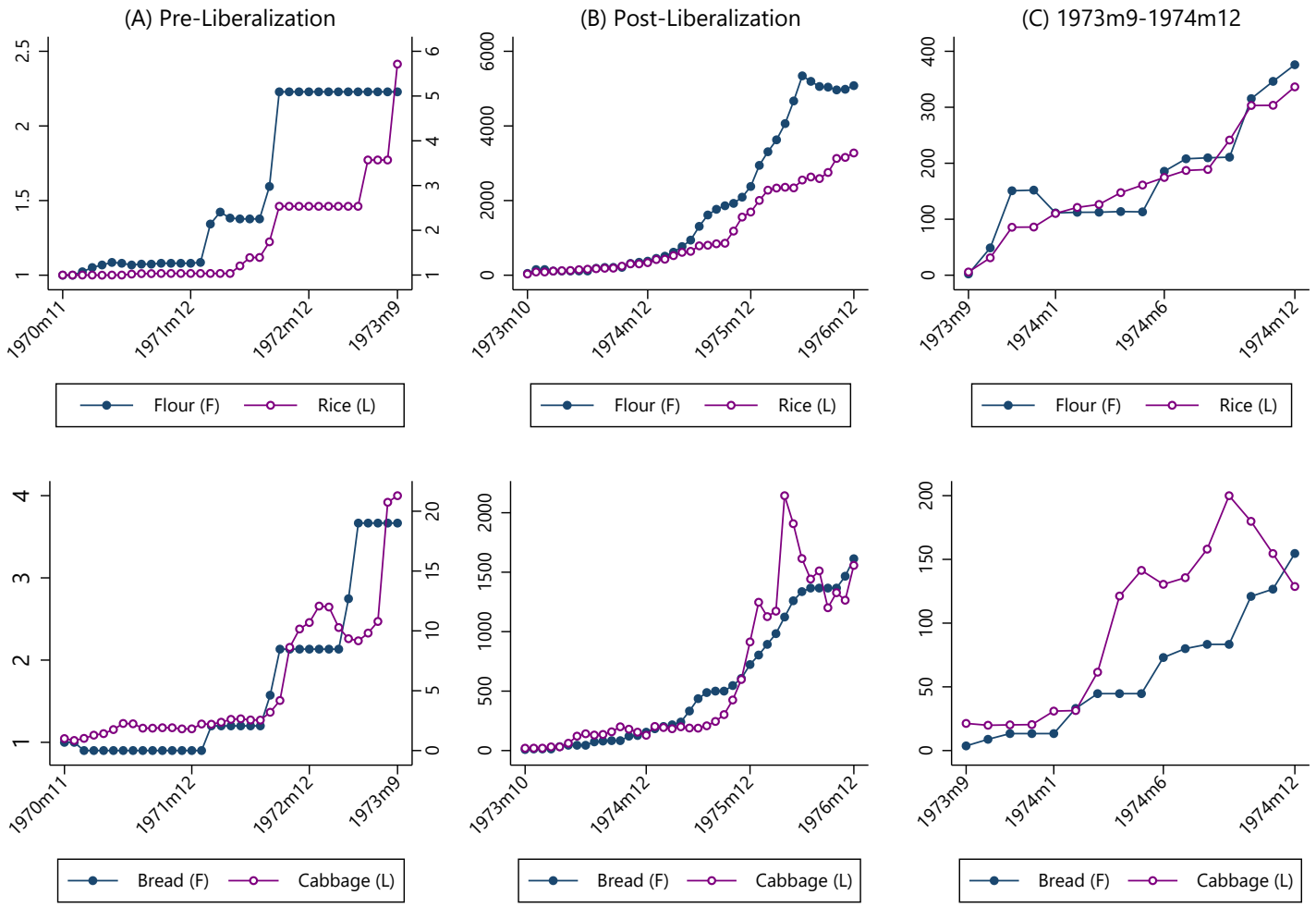
Note: Robust (clustered by product) standard errors are presented in parentheses. OLS columns standard errors are computed using the Newey–West procedure with 12 lags. Significance levels: * 10%, ** 5%, *** 1%. D_t is equal to one after the liberalization, and zero otherwise, D_i is equal to one if the product was liberalized, and zero otherwise and $D_{it} = D_i \times D_t$. Time-variant controls include $\Delta Log(Imacec)$, $\Delta Log(IGPA)$, and $\Delta Log(Copper\ Price)$ and monthly dummies. Δ denotes the first-difference with respect to the previous month. Panel A shows the first-stage regression using the Newey–West standard errors with 12 lags. Both M1 and the Nominal Exchange Rate are expressed as growth rates with respect to previous month. The first-stage includes monthly and yearly dummies. Panel B shows the results associated with the second-stage regression using estimates obtained in the first stage.

Table 4. Summary Impacts of Inflation on Relative Price Variability

	Before	**After**
	ϕ_1	$\phi_1 + \phi_3$
Fixed	0.916^{***}	0.458^{***}
	(0.16)	(0.07)
	$\phi_1 + \phi_2$	$\phi_1 + \phi_2 + \phi_3 + \phi_4$
Liberalized	0.434^{**}	0.077
	(0.22)	(0.10)

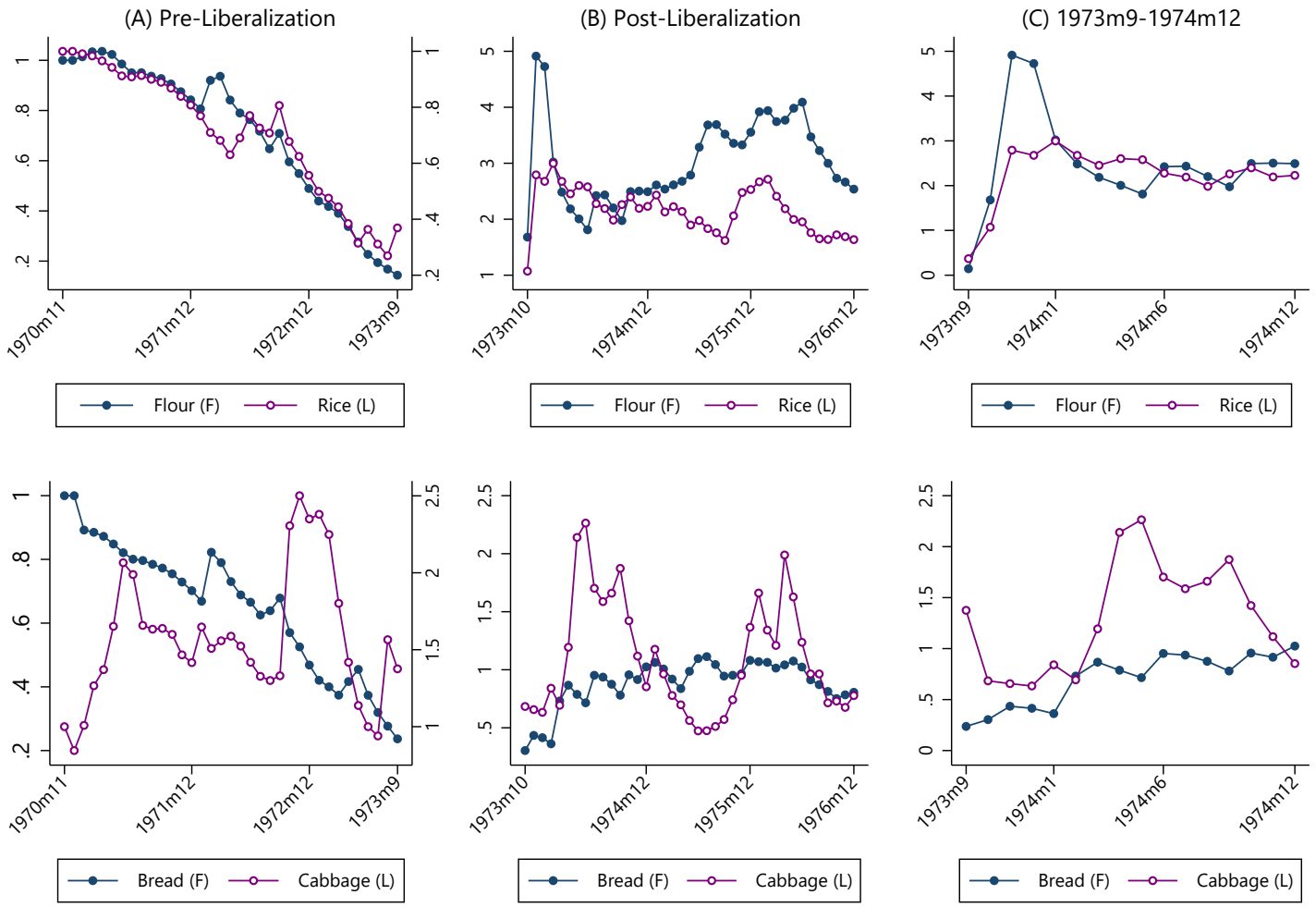
Note: Standard errors are presented in parentheses. These were computed using the delta method. Significance levels: * 10%, ** 5%, *** 1%. Parameters correspond to those from column (4) of Table 2.

Figure 1. Price-level behavior of selected products between 1970m11–1976m12



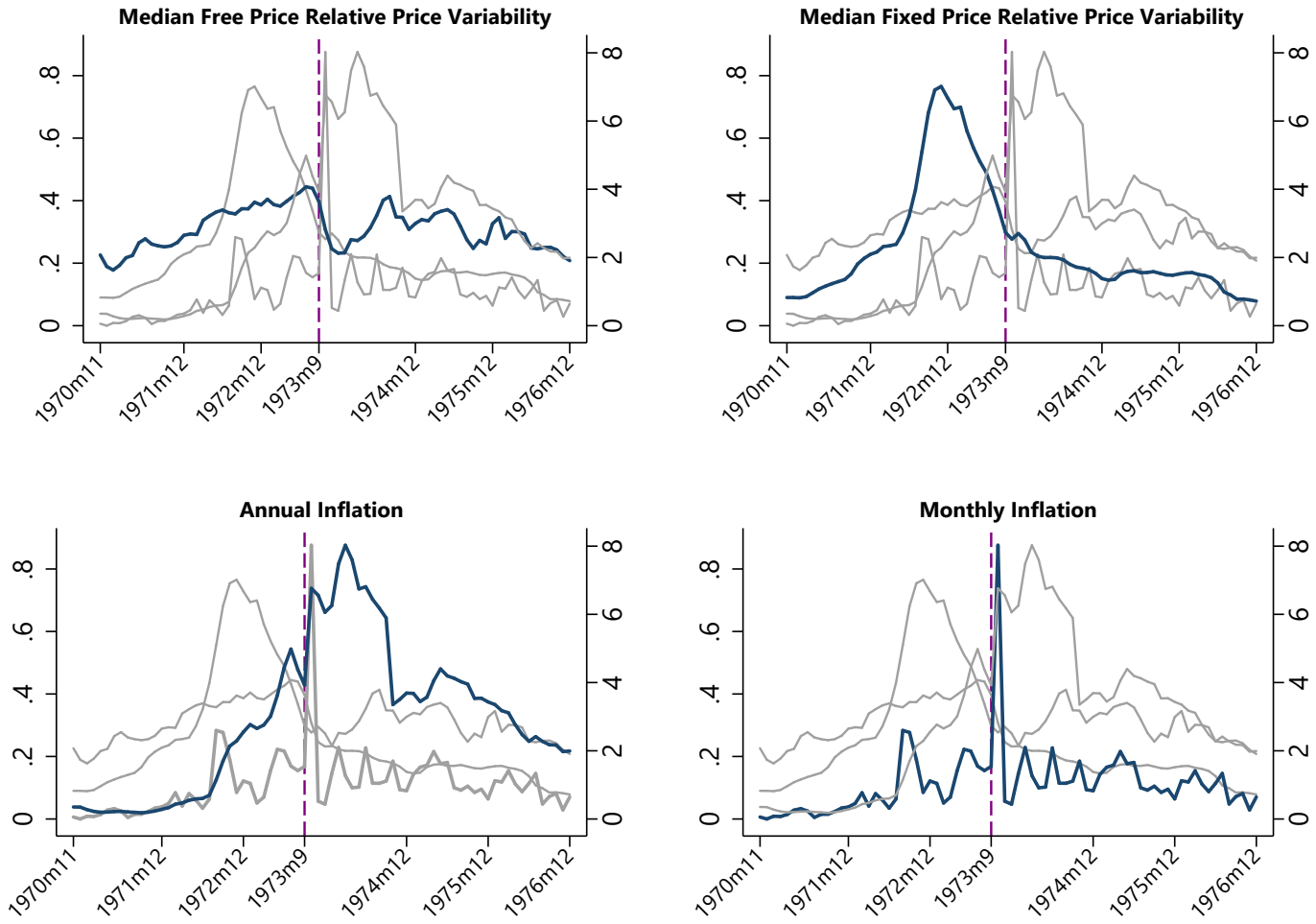
Note: In the pre-liberalization column, the left Y-axis shows the scale of the blue line, while the right Y-axis plots the scale of the purple line. The X-axis denotes time. For ease of interpretation, both prices are indexed by their value in November 1970.

Figure 2. Relative price behavior of selected products between 1970m11–1976m12



Note: In the pre-liberalization column, the left Y-axis shows the scale of the blue line, while the right Y-axis plots the scale of the purple line. The X-axis denotes time. For ease of interpretation, both relative prices are indexed by their value in November 1970.

Figure 3. Median relative price variability, and monthly and annual inflation (1970m11–1976m12)



Note: The thickest lines correspond to the series outlined in the title of each graph. The dashed line corresponds to the month when the military coup occurred (September, 1973). The left Y-axis shows the scale of the median RPV for fixed and free prices, and also for monthly inflation. The right Y-axis corresponds to the scale of the annual aggregate inflation. The X-axis denotes time.