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RELATIVE PRICE VARIABILITY AND INFLATION IN FIXED PRICE REGIME

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Relative price variability and inflation in a fixed price regime

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December 31, 2010

Abstract

We study the relation between inflation rate and relative price variability using data of prices on 23 disaggregated food items since 1960 to 2003 in Chile. The behavior of inflation rate is quite variable in that country during that time span and more interestingly, there are periods of time in which prices were determined (fixed) by the economic authorities. We find consistent evidence that a larger inflation rate causes a larger relative price variability and this effect is much larger in periods in which prices were fixed. We interpret that result as firms over-reacting to inflation when setting their relative prices if they assume that it is unlikely to reset their prices in the near future. That result holds even if we follow different econometric approaches and it holds for all the food products considered.

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1 Introduction

Chile has had a long history of inflation, which can be traced back to 1878. At times, as at present for example, inflation has been relatively mild, while at others, as in the early 1970s, it has been bordering on hyperinflation. A large number of studies about its causes -as well as about several of its consequences- exist, and the international literature on the subject is probably as extensive as that about any other inflation in the world.

However, in spite of the former, the effect of inflation on Chiles relative price variability (RPV) has only been explored by Pavez (1990), but using a much shorter data base than the one at present available. This lack of research is surprising, since Chile presents ideal conditions to study the subject. The countrys inflation has been long and variable and a set of relatively reliable economic historic statistics has become available, which cover a broad range of variables, see Díaz, Luders, and Wagner (2009). Moreover, not only have inflation rates varied very significantly, but also institutions. For example, before 1930 and after the early 1970s, prices were free, that is, determined by market forces, while at other times, especially between 1964 and 1974, they were to a large extend fixed by economic authorities. This opens up a whole set of interesting questions in addition to the one about the relationship between inflation and price variability, which will necessarily be the subject of further work.

It has been suggested, among others by Nautz and Scharff (2005), that inflation does affect price variability and that this has welfare consequences. The larger the price variability is, the less useful will be the price system for resource allocation purposes. In fact, larger price variability implies a likely worse allocation of resources. Another way of looking at this phenomena is that it will be necessary to make a much larger effort to extract the same quality of information from a variable relative price system, than from a stable one. And this is costly. Moreover, given risk aversion, an increase in price variability will lower welfare directly.

This paper will focus on the relationship between inflation and price variability. Our hypothesis, based on previous work, is that the higher inflation rates and/or their expectations are, the higher will be price variability. This relationship is, of course, not obvious. In fact, in a classical macro-economic model, relative prices are determined by real factors -available resources, preferences, technology, etc.- while the price level is determined by the quantity of money. Thus inflation rates and relative prices are not related in any way.

There are, however, several ways to explain a relationship between different levels of inflation and relative prices. Here we will only describe its four main approaches to the problem. The first one considers that information is not complete, contrary to the classical model. Agents, for example, confuse general price level changes reflected in sectorial absolute price changes, as relative price changes and

act upon that information. That is, under inflation nominal price changes convey the wrong signal about relative price changes. For example Lucas (1973) , in the context of a rational expectations model, studies the trade-off between real GDP and inflation and concludes, among other things, that countries with a high variance in aggregate demand also experience a high variance in absolute prices. Working along the same line, Vinning and Elwertowski (1976) find that in the USA, between 1948 and 1974, the variance of relative prices was closely related to the variance in the general price level. Since this study was criticized because of its scarce micro-economic base, Parks (1978) develops a multi-market model to take care of the problem. However, in his empirical work, he finds that relative prices change in response to monetary surprises and therefore, that relative price changes are related to unexpected inflation rates.

But inflation might also have an impact on relative prices if it generates menu costs, which are ignored in the classical model. If price adjustments are costly, firms might delay price changes and if this delay is different among different firms, it will affect relative prices. For example, Sheshinski and Weiss (1993) argue that, to save on price adjustments costs under inflation, firms will allow real prices to fall below their real level under price stability and then readjust them to a level above that latter real level. Moreover, with higher inflation rates, this real price range will also increase and with it, relative price variability. The problem compounds if one considers that price adjustment costs might vary from sector to sector and within each sector, among firms. Caraballo, Dabús., and Caramuta (2009), among others, confirm the results of Sheshinski and Weiss (1993). Of course, if relative price variability is caused by menu costs, the relationship has to be between inflation or inflationary expectations and price variability.

A third way in which inflation might be related to price variability is under downwards price inflexibility. The assumption is that prices move easily upwards together with excess demand, but are sticky downwards under excess supply. In this case, one would expect relative price changes to be associated with price level increases, since changes in relative prices might increase the price level while also generating unemployment. Causality in this case is the reverse, from relative price changes to inflation. Peltzman (2000) and Helman, Roiter, and Yoguel (1984) take this approach, which is inappropriate for countries with high inflation rates like Chile. We will therefore not test it.

A last general approach is the existence of exogenous shocks which affect the variance of both variables, relative prices and inflation. This could be the case of a change in the price of grains or electricity, for example, which will affect relative prices and also impact the general price level. In their work on the subject, Cukierman (1979) assumes that this is the channel through which the variance of relative prices is related to that of inflation. Here both variables are affected at the same time. However, as in the previous case, this channel is unlikely to be relevant under relatively high inflation rates as those

which prevailed in Chile between 1960 and 2003.

Moreover, not only have inflation rates varied very significantly, but also institutions. For example, before 1930 and after the early 1970s, prices were free, that is, determined by market forces, while at other times, especially between 1964 and 1974, they were to a large extend fixed by economic authorities. Our data set allows us to study the relationship between inflation and price variability, in the context of fixed prices. This a unique opportunity which we address in this paper.

This paper is developed as follows. Section (2) presents a model that allows us to study the relationship between relative price variability and inflation rate when some nominal prices remain fixed while section (3) discusses the case of Chile since the 1960s, as a way of motivating why the Chilean experience could be used to study our question of interest. Section (4) discusses the data used in this paper while section (5) discusses the methodology and the results. Finally section (6) concludes.

2 Modeling relative price variability

In this section, we discuss the theoretical framework used to study relative price variability.

In our setup, and due to the structure of our data[1], it will be useful to assume a situation in which goods are differentiated and where there is a positive probability for a firm of not being able to reset its prices due to government regulations. A natural framework for our research interest is the literature based on Calvo (1983) in which a fraction of firms cannot reset their prices each period due to some exogenous characteristic of the economy such as menu costs. In our case, some of the firms will not be able to reset prices due to exogenous government policies. The literature uses this type of framework to analyze the evolution of key variables such as inflation rate, the output gap and the interest rate policy set by the central bank. In our case, we focus on relative price variability rather than other macroeconomic variables and we define relative price as the price set at each sub-sector of the economy vis-a-vis the price of the basket good of the economy. We next sketch the main components of the model.

Our model is based on Gertler and Galí (1999). Individuals live infinitely and maximize their expected welfare, which depends on consumption of a final good, real money holdings and leisure. The associated dynamic optimality condition concerning the allocation of resources over time is the following:

[1] As will be explained below, we have available data on different types of goods from the detail of the Chilean CPI index since 1961 to 2005. The period 1961-1975 has many episodes in which the government set the nominal prices of some of these goods.

$$\widehat{y_t} = -\frac{1}{\sigma}\left(\widehat{i_t} - E_t\widehat{\pi_{t+1}}\right) + E_t\widehat{y_{t+1}} \quad (1)$$

where we have imposed market clearing conditions on final goods and where $\widehat{x_t}$ indicates percentage deviations vis-a-vis steady state levels. Equation (1) is the usual IS curve in which the parameter σ is the risk aversion coefficient of the individual's utility function. On the other hand, following Calvo (1983), we assume there is a large number of firms that produce non-homogeneous goods in our economy. We assume that a fraction γ of those firms are restricted to keep their price level constant while the rest of the firms might reset their prices. The firm's price decision, as in Dixit and Stiglitz (1977), corresponds to a monopolistic competition price decisions in which the desired relative price depends on marginal cost.

Equation (2) indicates that price decisions of firms (measured as a deviation vis-a-vis steady state) depend on current inflation rates, current marginal costs plus the future expected relative price decisions. This last term appears because the firm when resetting its relative price considers the possibility of not being able to change the relative price in the future. Therefore they partially adjust the current relative price considering that effect.

$$\widehat{p_t*} = (1-\gamma\beta)(\widehat{p_t} + \widehat{mc_t}) + \gamma\beta E_t\widehat{p_{t+1}*} \quad (2)$$

On the other hand, equation (3) is the aggregate price index relation that depends on the price behavior of firms that are not allowed to reset their prices plus the price behavior of firms that are allowed to change their prices in the current period.

$$\widehat{p_t} = \gamma\widehat{p_{t-1}} + (1-\gamma)\widehat{p_t*} \quad (3)$$

Using equations (2) and (3), we obtain:

$$\widehat{p_t*} - \widehat{p_t} = (1-\gamma\beta)(\widehat{mc_t}) + \frac{\gamma\beta}{1-\gamma}E_t\widehat{\pi_{t+1}} \quad (4)$$

Equation (4) indicates that deviations in relative prices in a specific sector depend on pressures from its own real marginal costs plus expectations about future inflation rate. While the first term arises

from the supply side' s pressures note that the second term drops from the equation when $\gamma = 0$ (i.e. when all firms can reset their prices). This term becomes relevant when there is a positive probability that firms in that sector cannot adjust their prices. In this, firms which are currently setting their prices might decide to over-adjust prices and include in their price setting future inflation, to account for the possibility that they will not be able to adjust prices in the future. The second term in equation (4) provides a direct channel by which inflation might affect relative prices. However, there might be other indirect channels throughout inflation impacts relative prices. As marginal cost is a key variable in determining a firm's price behavior, we will turn next to analyze marginal cost fundamentals.

Firms produce goods based on a linear homogeneous production function that depends on labor only. In that case, marginal costs tend to increase when real wages grow faster than productivity. It follows that deviation of marginal costs vis-a-vis its steady state level can be written as:

$$\widehat{mc_t} = \widehat{w}_t - z_t \tag{5}$$

where $\widehat{mc_t}$ and $\widehat{w}_t$ are the deviations of marginal cost and real wages respectively. From the individual's labor supply, we might write wage rate as in:

$$\widehat{w}_t = \sigma \widehat{y_t} - \phi(\frac{n_{ss}}{1-n_{ss}})\widehat{n}_t \tag{6}$$

which indicates that the larger is the expansion of economic activity, the larger is the associated wage rate, also the larger the individual's labor supply effort, the smaller is the wage rate, where $-\phi$ is the parameter associated with labor supply in the individual's utility function. Note that using the marginal cost definition, equation (5), plus the Euler equation, (1), and the wage rate obtained from the individual's labor supply (6), the marginal cost's deviation, $\widehat{mc_t}$, can be written as:

$$\widehat{mc_t} = (\sigma + \phi\frac{n_{ss}}{1-n_{ss}})E_t\widehat{y_{t+1}} + (1+\phi\frac{n_{ss}}{1-n_{ss}})z_t - (1+\frac{\phi}{\sigma}\frac{n_{ss}}{1-n_{ss}})\left(\widehat{i_t} - E_t\widehat{\pi_{t+1}}\right) \tag{7}$$

In equation (7), pressures on marginal costs arise due to larger economic activity, as indicated by the terms $E_t\widehat{y_{t+1}}$ and z_t, both of them with positive coefficients. The real interest rate $\widehat{i_t} - E_t\widehat{\pi_{t+1}}$ depresses aggregate demand and thus lowers the pressures on marginal costs. In that equation, inflation rate has a positive effect on marginal costs as it lowers the real interest rate, conditional on the path of the nominal interest rate. This is a reasonable assumption if the Central Bank follows an interest rate rule.

Replacing equation (7) on (4) we get the following expression for relative price deviations:

$$\begin{aligned}\widehat{p_t*} - \widehat{p_t} &= \left[(1-\gamma\beta)(\sigma+\phi\frac{n_{ss}}{1-n_{ss}})\right] E_t\widehat{y_{t+1}} + \left[(1-\gamma\beta)(1+\phi\frac{n_{ss}}{1-n_{ss}})\right] z_t - \left[(1-\gamma\beta)(1+\frac{\phi}{\sigma}\frac{n_{ss}}{1-n_{ss}})\right]\widehat{i_t} \\ &+ \left[(1-\gamma\beta)(1+\frac{\phi}{\sigma}\frac{n_{ss}}{1-n_{ss}}) + \frac{\gamma\beta}{1-\gamma}\right] E_t\widehat{\pi_{t+1}} \qquad (8)\end{aligned}$$

Equation (8) indicates that the effect of inflation on the deviation of relative prices has two sources. In fact, the inflation coefficient has a component - $(1-\gamma\beta)(1+\frac{\phi}{\sigma}\frac{n_{ss}}{1-n_{ss}})$- which represents larger marginal cost pressures through as individuals increase aggregate demand when they face a lower real interest rate. A second component corresponds to firms that anticipate future inflation and increase relative prices as they might not be able to adjust prices in the future. Note that both former components are positive and that as γ approaches zero, the second component converges to zero, indicating that the more probable is price setting the larger would be the impact of inflation on relative prices.

The variability in relative prices is obtained from (8) and is:

$$\begin{aligned}\sigma_p^2 &= \left[(1-\gamma\beta)(\sigma+\phi\frac{n_{ss}}{1-n_{ss}})\right]^2 \sigma_y^2 + \left[(1-\gamma\beta)(1+\phi\frac{n_{ss}}{1-n_{ss}})\right]^2 \sigma_z^2 + \left[(1-\gamma\beta)(1+\frac{\phi}{\sigma}\frac{n_{ss}}{1-n_{ss}})\right]^2 \sigma_i^2 \\ &+ \left[(1-\gamma\beta)(1+\frac{\phi}{\sigma}\frac{n_{ss}}{1-n_{ss}}) + \frac{\gamma\beta}{1-\gamma}\right]^2 \sigma_\pi^2 \qquad (9)\end{aligned}$$

where σ_j is the variance of the j^{th} variable[2]. Equation (9) indicates that the larger the inflation variance, the larger is relative price variability. Note that the impact of the variance of inflation depends on the parameter γ. In fact as γ converges to one, the impact of the variance of inflation becomes quite large converging to ∞. The intuition for that result is that as it becomes less likely to be able to reset prices in the future, firms over-react to changes in inflation rate.

3 Price setting regimes in Chile

Before the 1930s Chile had, as most economies in the World, an open market economy, in which in general free markets determined prices. This was certainly the case for all those products in our sample, which are basic food staples.

The country was probably the hardest hit during the Great Depression years; export values fell

[2]We neglected the covariance terms for simplicity

by over 80 per cent and real GDP dropped by over 45 per cent. In a previously commodity export driven economy, severe shortages of goods and services arose. Moreover, the crisis generated extreme political instability, after over a Century of relatively stable governments, and in 1931-1932 these latter lasted only a few month and generally came to power as the result of military coups. One of these governments-known as the 100 day socialist one- pressured the Central Bank -after the gold standard had been abandoned- to adopt very expansionary policies, which resulted in high inflation rates.

A natural reaction to these shortages and sharp price increases was the creation of the Commissary of Subsistence and Prices[3]. This Commissary was entitled to allocate goods and services and fix their prices, as well as supervise the whole system. The main aim of the Commissary was to make basic food items available to the general population at reasonable prices.

After a brief period in which prices were again fixed in the market, in 1939, a democratically elected Popular Front government adopted an import substitution economic development strategy, which lasted until 1973. This strategy included fixing of some key prices and therefore DL 520 was revived. More than a decade later and still under the same strategy, the Commissary was raised to the rank of a Superintendence and a few years later it became the Directorate of Trade and Industry (DIRINCO), always with about the same mission and instruments, including the right to fix prices[4].

And prices they did fix and increasingly so up to the military government of 1973-1989. In 1965 and 1966 limits were set to price increases of products of "prime necessity", but the latter were "declared to be all those articles and services which serve as the basis for determining the consumer price index[5]. Even so, price index percentage changes in 1965 and 1966 were slight higher than authorized price increases[6]. The following government made an effort to centralize the Chilean economy, but also to generate a big increase in workers purchasing power. To that end, massive increases in nominal wages and the money supply were accompanied by price fixing. At the end of that government, in 1973, more than 3000 product prices were explicitly fixed[7]. The result of this policy was huge scarcity, the development of black markets and queues everywhere, since people seemed to be willing to stock every think possible and as much as feasible.

Decree Law 522, published on October 15th, 1973, about a month after the military coup, established a new price policy. Most prices would be freely set in the market, although -reflecting public opinion of the time- the Decree Law stated that they would consider a number of cost items. A number of products -thirty three- would still be fixed by DIRINCO on the basis of cost studies. These 33 items

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

[4]For a fascinating description of existing price distortions in Chile in the 1950s, read Harberger (2000)

[5]Supreme Decree N1379, October 1966, Art. 11.

[6]See Wisecarver (1986)

[7]Ibid. Prices were fixed even for such tems as chalet-type dog houses and woollen gloves for small children.

included bread, flour, sugar, oil, milk, coffee, tea and some types of beef, among the products included in our sample, besides public utility services, gasoline, motorized vehicles, copper, and others. Finally, there would be a limited group of 18 other "informed" product prices, usually industrial products locally produced by monopolies.

On the basis of Decree Law N522 about 3000 prices were freed at once. Later on prices would move from fixed to informed and then to free, including prices of our sample of basic food stuffs. However, to avoid moves in the other direction, in December 1980 Decree Law N3529 prohibited them. At that time almost all prices were free, determined by supply and demand conditions, except those of some (parts of) public utilities. Moreover, Chile has today one of the most open economies to international trade, the maximum duty being 6 per cent and the average duty less than 2 per cent, implying that prices of tradables tend to be heavily influenced by international market conditions.

4 Data

4.1 Relative price variability and price setting regime identification

We obtain monthly data of 23 food products from 1961 to 2003. Our source of data are the "Anuarios Estadísticos" and the "Síntesis del Anuario Estadístico" of the Chilean Instituto Nacional de Estadísticas (INE). Our products are: oil, garlic, peas, onions, rice, sugar, coffee, tea, flour, eggs, milk, lettuce, butter, oranges, apples, bread, potatoes, bananas, cabbage, carrots, plus three types of meat. [8]

We have just defined a series of prices for each product over time. Let $R_{it} = \frac{P_{it}}{P_t}$ be the relative price of item i at time t, where P_{it} is the nominal price while P_t is the aggregate price index. We define the coefficient of variability of relative prices as:

[8]The data consists of the current price of each item in each month. The data was not recorded in a consistent form mainly for three reasons. First, because Chile changed its currency three times since 1961, prices are valued in three different currency units. Second, reported unit prices differ sometimes in unit of measure employed, for instance, some items were measured per kilogram in some periods while in others they were measured per 100 grams. To obtain a consistent series of data we used the following corrections. Between 1960 and 1962 the Chilean currency was "Old pesos", while since 1963 until September 1975 the Chilean currency was "Escudos" and thereafter "Pesos". To correct this problem, we used the following equivalences: 1 peso equals 1000 escudos and equals 1.000.000 old pesos. The second correction relates to changes in measurement units. In the case of eggs, before May 1989 the reported price corresponds to 1 egg while after May 1989 they were measured by dozen of eggs. Similarly before May 1989, both butter and tea were measured per kilograms while after May 1989 their price correspond to 250 grams. Garlic and potatoes changed their unit of measure in January 1999. In the case of garlic, its initial unit of measure was per unit while after January 1999 it was measured per three units. Potatoes were measured per kilogram and later per 2 kilograms. We make a transformation of prices to take account of the changes in unit of measure. A third problem is the increase in varieties of products over time. In fact in each category of products, slightly different products were recorded in the CPI basket, such is the case of rice, in which we now have rice type 1 and rice type 2, while in 1978 we had just one type of rice. To obtain one price for rice, we add up the prices in each category, weighting them by using the weights defined in the CPI basket.

$$CV_{it} = \frac{SD_{it}}{\mu_{it}} = \frac{\sqrt{\sum_{t}^{t+11}(R_{it} - \mu_{it})^2/12}}{\sum_{t}^{t+11} R_{it}/12} \tag{10}$$

Equation (10) indicates that the coefficient of variability is defined as the ratio of the standard deviation and the mean of relative prices in a period of 12 month. Table (1) provides summary statistics of the data set by item while table (2) provides summary statistics of relative price variability by year. The first set of rows corresponds to the descriptive statistics of the coefficient of variability (CV_{it}). We observe that fruits and vegetables have a larger relative price variability compared to other more durable goods such as tea, coffee, rice or sugar. Further, the variability in the data is really large; as noted in the minimum and maximum values of relative price variability shown in the table.

[Insert Tables (1) and (2) about here]

To identify periods in which items face a fixed price regime, we set as an identifying rule the following criterion which tries to identify periods in which nominal prices remained constant. An item faces a period in a fixed price regime if one of the following conditions holds:

1. Three consecutive months of constant nominal prices

2. More than 4 months in which nominal prices remain constant during the last 12 months

We use the idea of three consecutive months of constant nominal prices -this is criterion (1)- because if nominal prices were fixed by the government, three consecutive months of fixed nominal prices would allow to control inflation at least during a quarter, which seems a natural short term target for governments. The idea of criterion (2) is that if the government controls prices for a significant number of months during each year, such that it allows the government to control at least partially the inflation rate. Table (3) presents the fraction of time each item satisfies either criterion (1) or (2) during the whole period in the sample. Some of the items present large numbers such is the case of Rice, Flour, Bread, Oil, Milk, Butter and Sugar which are important items in the food basket of families -see Teitelboim (1990)- and thus are goods whose prices government might more likely want to control because they effect the poorest individuals of the economy. Table (4) shows the fraction of time different items of the sample face a period of fixed prices as we have defined. The data shows two clear regimes. The first regime occurs before 1975 and corresponds to a period in which many items faced fixed prices, reaching almost 51% of our sample by 1973. Since 1975, and coinciding with the moment when the government freed prices in the economy as discussed in section (3), very few items appeared in our calculations to belong

to a fixed price regime. In fact, a large fraction of years after 1975 have mean value equal to zero, as shown in the table, but in a few years these mean values are small and near zero, suggesting that our measure of fixed price regime is not perfect.

[Insert Tables (3) and (4) about here]

4.2 Other macroeconomic variables and some graphical correlations

The specification in equation (9), which will be the base for our empirical exercise, includes some macroeconomic variables different than the variance of inflation rate such the variability of economic activity, the nominal interest rate and productivity. We obtain data of economic activity on a monthly basis from Díaz (2006). Data on interest rate were obtained on a yearly basis from Wagner and Díaz (2008) and correspond to average nominal interest rates charged on short run loans. Later we decomposed that series to get one on the monthly basis by using the ECOTRIM package, see Eurostat (1999). As a measure of productivity, we include a real stock index that corresponds to the real value of a general portfolio of stocks traded in the Chilean economy. Its source is Díaz (2006).

As measure of inflation we use the CPI index. According to García and Freyhoffer (1969) (1969) and Cortázar and Marshall (1980), the data in the official CPI was miss-reported in some of the years in 10960s and 1970s. Our source of data is Díaz, Luders, and Wagner (2009) which use their data in those years.

To construct the variability of each of these variables, we follow a procedure similar to the one specified in equation (10).

An initial idea of the potential relationship between relative price variability and inflation variability might be observed in figures (1) to (7), which provide plots of the raw correlation between both variables. Figure (1) provides the plot of average relative price variability vis-a-vis inflation variability while figure (2) to (7) provide similar plots but for selected items. The figures show the relationship in periods of fixed prices and free price regime.

The figures clearly suggest a positive association between the variables. In the case of figure (1), which corresponds to average relative price variability, a clear positive relationship between relative price variability and inflation variability. However data of the free price regime is quite concentrated and it is not possible to clearly distinguish the underline relation between inflation variability and relative price variability. To do so, we present the other figures, in which it is possible to clearly distinguish the described relationship. Note that the slope of the relationship between inflation variability and relative price variability seems to be larger in periods in which prices are fixed, as it becomes quite clear

in the case of Flour, Bread, Butter and Sugar. This observation is in line with the larger coefficient of inflation variability in equation (9) as discussed in section (2).

[Insert Figures (1) to (7) about here]

5 Estimation methodology and results

Last section showed some raw evidence of the potential relationship between inflation variability and relative prices variability, both a free price regime and a fixed price regime. In this section, we measure that relationship.

To do so, we assume the following linear model:

$$CV_{it} = \psi_i + CV(\pi_t)\beta + CV(\pi_t)\mathbf{1}(Fix_{it})\gamma + \delta(L)x_{it} + \epsilon_{it} \tag{11}$$

where i indexes item categories while t indexes time. In equation (11) $CV(\pi_t)$ corresponds to the variability of inflation rate, while $\mathbf{1}(Fix_{it})$ is an indicator function, which has a value of one when nominal prices are set in a fixed price regime. This variable varies across item and time, $\delta(L)$ indicates lag-polynomials while ϵ_{it} is a well-behaved error term. The set of variables x_{it} are macroeconomic controls in our empirical setup and include the variability of nominal interest rate, the variability of economic activity and the variable of the real stock index as a proxy for the variability on the productivity of the economy.

Our focus is to consistently estimate the coefficient β. In the above specification, we include control variables as a way of controlling for potential omitted variables bias while we include lag-polynomials as a way of capturing potential dynamics in the relationship.

We next discuss our results. Tables (5) to (8) show the result for the different items. In these tables, we include as controls the variability of inflation, the variability of the nominal interest rate, the variability of economic activity and the proxy for the variability of productivity. The results are generally quite consistent among the different items. The coefficient on the variability of inflation is generally positive and significant, with the exception of Garlic which is the unique item in which that coefficient is negative. A 1% increase in inflation variability increases relative price variability between 0 and 0.24%. This last value is quite large in view of the fact that on average price dispersion is 16% in our sample (see the last row of table (1)).

[Insert Tables (5) to (8) about here]

Tables (9) to (11) provide estimates using the complete set of data. Table (9) has six different columns. The first three correspond to OLS estimates while columns 4 to 6 include fixed effects. The six columns include seasonal dummies. The columns differ in the inclusion of the control variables. As can be seen in the table, the coefficient on inflation variability is robust to the estimation method and the inclusion of additional controls. The signs on the other control variables is positive and significant as expected. The magnitude of the coefficient on inflation variability indicates that a 1% larger variability in the inflation rate would produce a larger variability in relative prices of between 0.13% and 0.18%. Table (10) provides a similar exercise, but it includes as additional control de interaction between inflation variability and the fixed price regime. The coefficient on inflation variability (not including the interaction) becomes slightly smaller ranging between 0.08 and 0.16, but remains highly significant. More interestingly, as expected, the coefficient on inflation variability under fixed price regime (the interaction) is significant and positive with magnitudes in between 0.05 and 0.13, which indicates that in periods in which the government tended to fix nominal prices, the variability in relative prices increased considerably due to the variability in inflation, as firms over-reacted to inflation variability in response to the possibility that they were not allowed to reset their prices in the near future. Finally, table (11) provides a similar exercise but including 12 lags of the additional controls variables (variability in economic activity, interest rate and the proxy for productivity). The estimates on the coefficient of inflation variability remains positive and generally significant while the coefficient on the interaction term remains highly significant and its magnitudes is very similar to the estimates in table (10).

[Insert Tables (9) to (11) about here]

6 Conclusion

Our study confirms previous work about the strong and positive relationship between inflation rate variability and price variability. It takes advantage of the unique Chilean economic policy experience of the last several decades and the availability of reliable statistical information over that period, to explore the above described relationship under two types of regimes: one in which prices were increasingly being set by government (1962-1973) and another one were these prices were set by free and increasingly international- markets (1973-2005). The results -robust to different specifications, estimation methods and time span of data- suggest that for any given inflation rate variability, price variability is higher under a government fixed price regime. This result, which is counter-intuitive, can however be explained because firms, expecting inflation and government reluctance to increase prices, will strive at any given time for larger price increases than their counterparts in free markets.

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Figure 1: Average Relative Price and Inflation rate

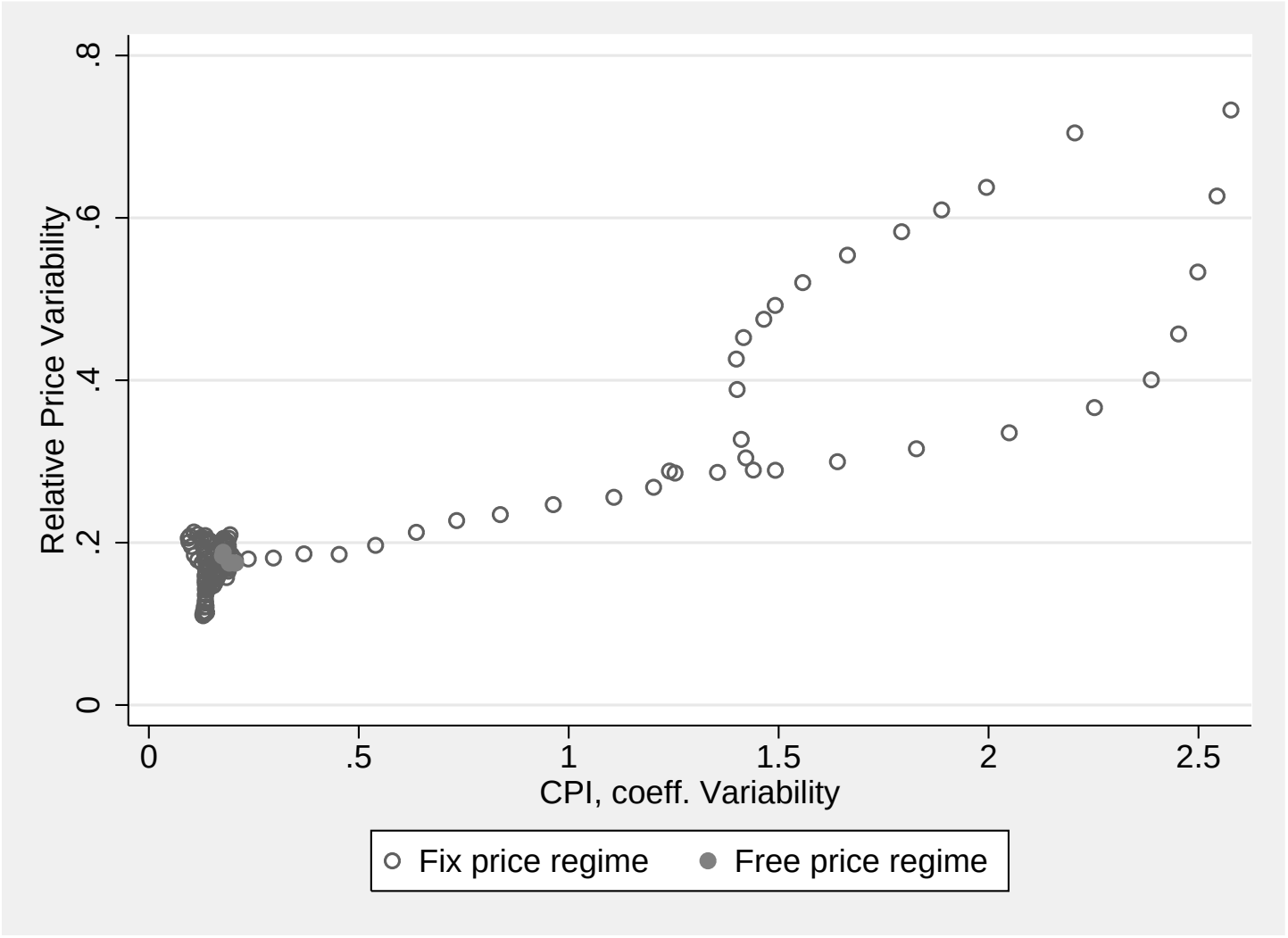

Figure 2: Rice

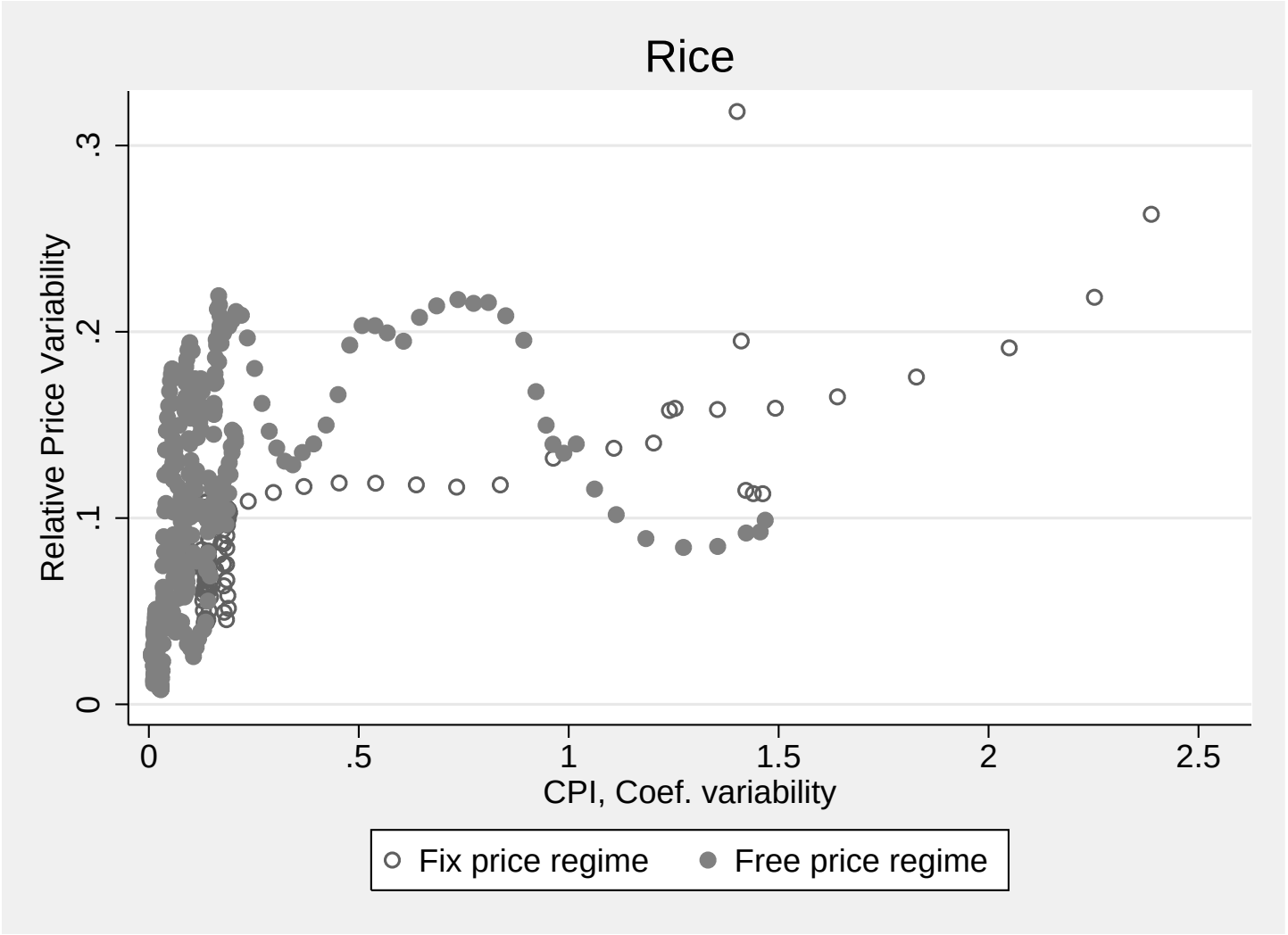

Figure 3: Flour

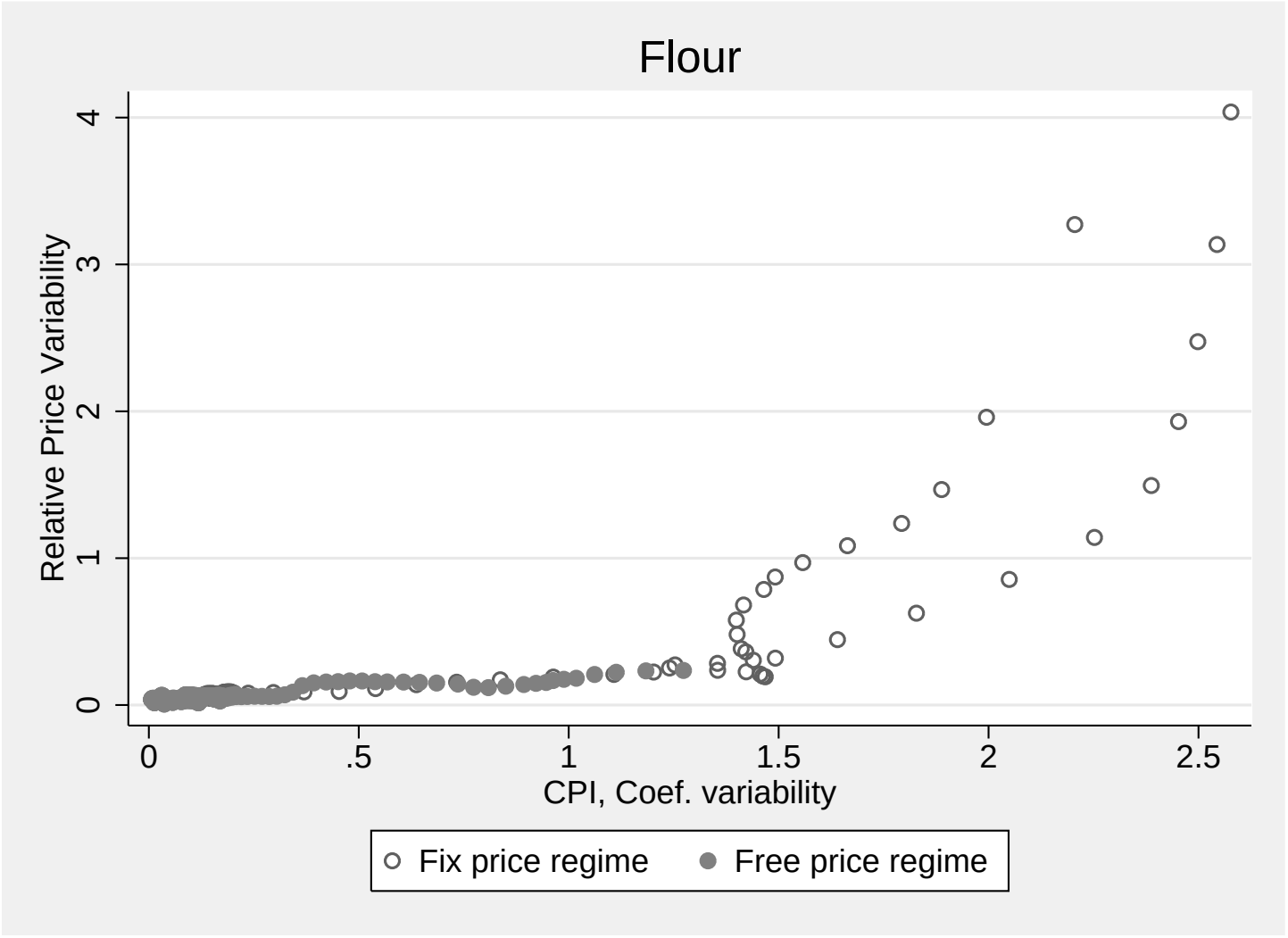

Figure 4: Bread

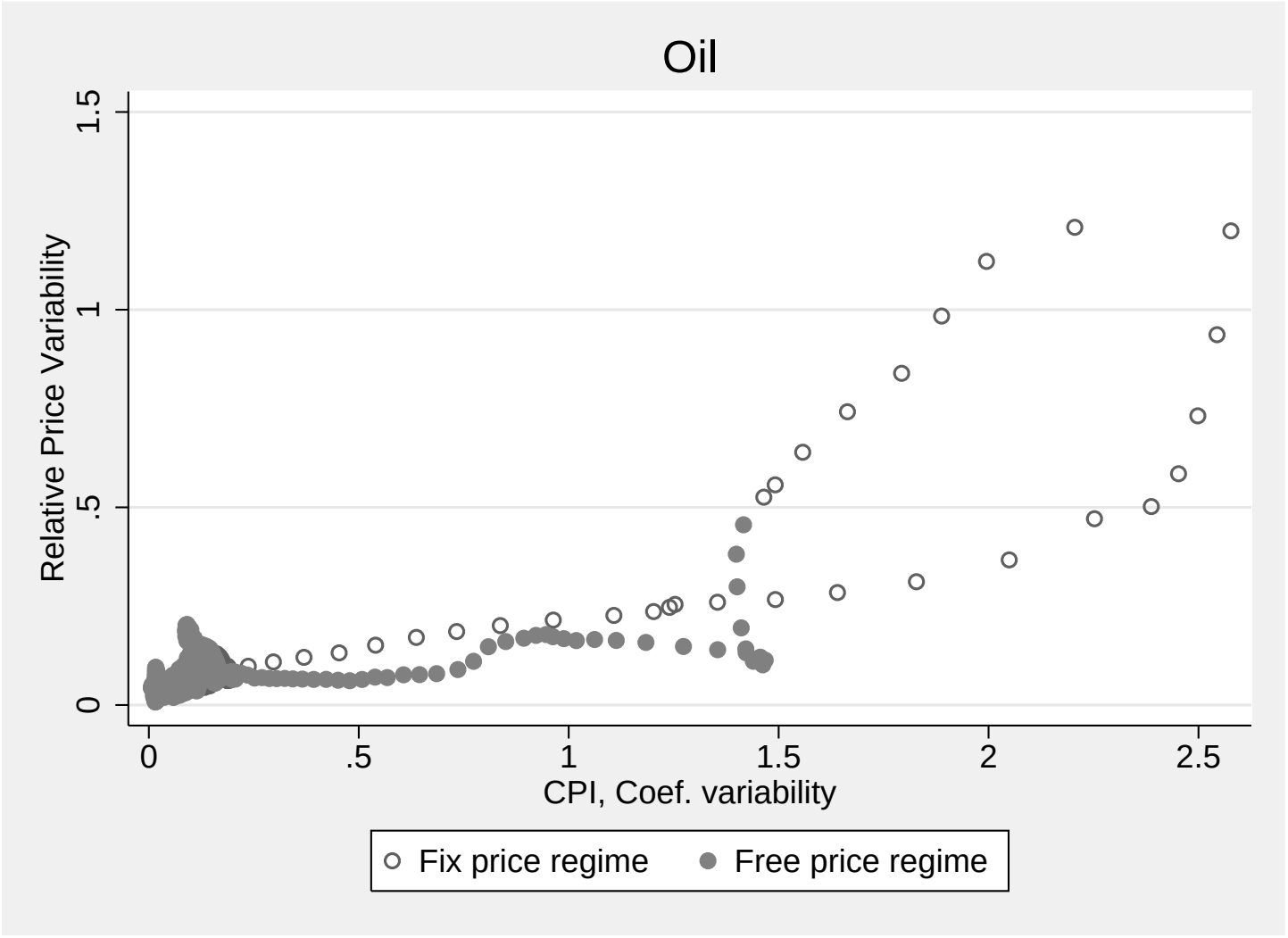

Figure 5: Milk

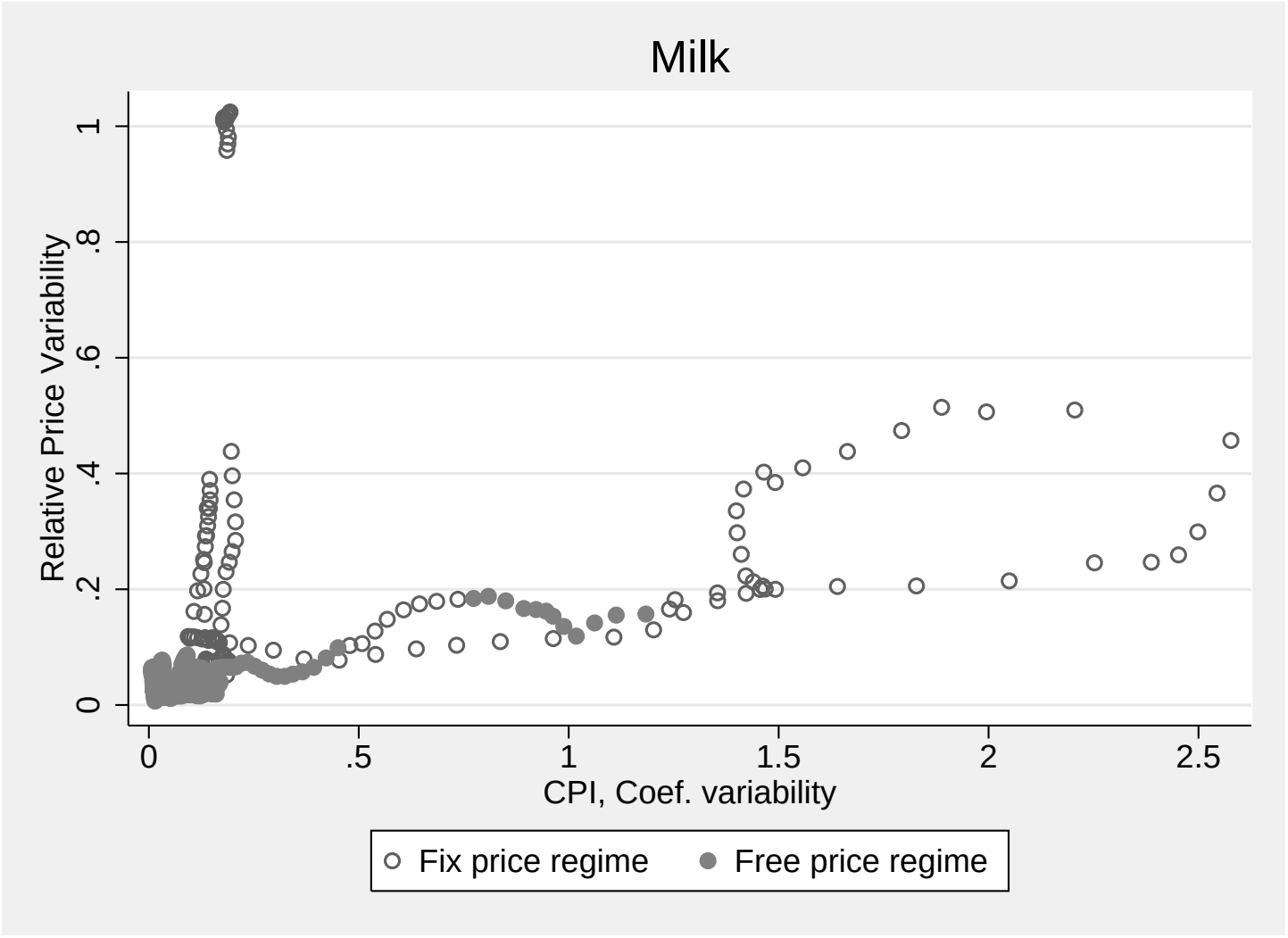

Figure 6: Butter

Figure 7: Sugar

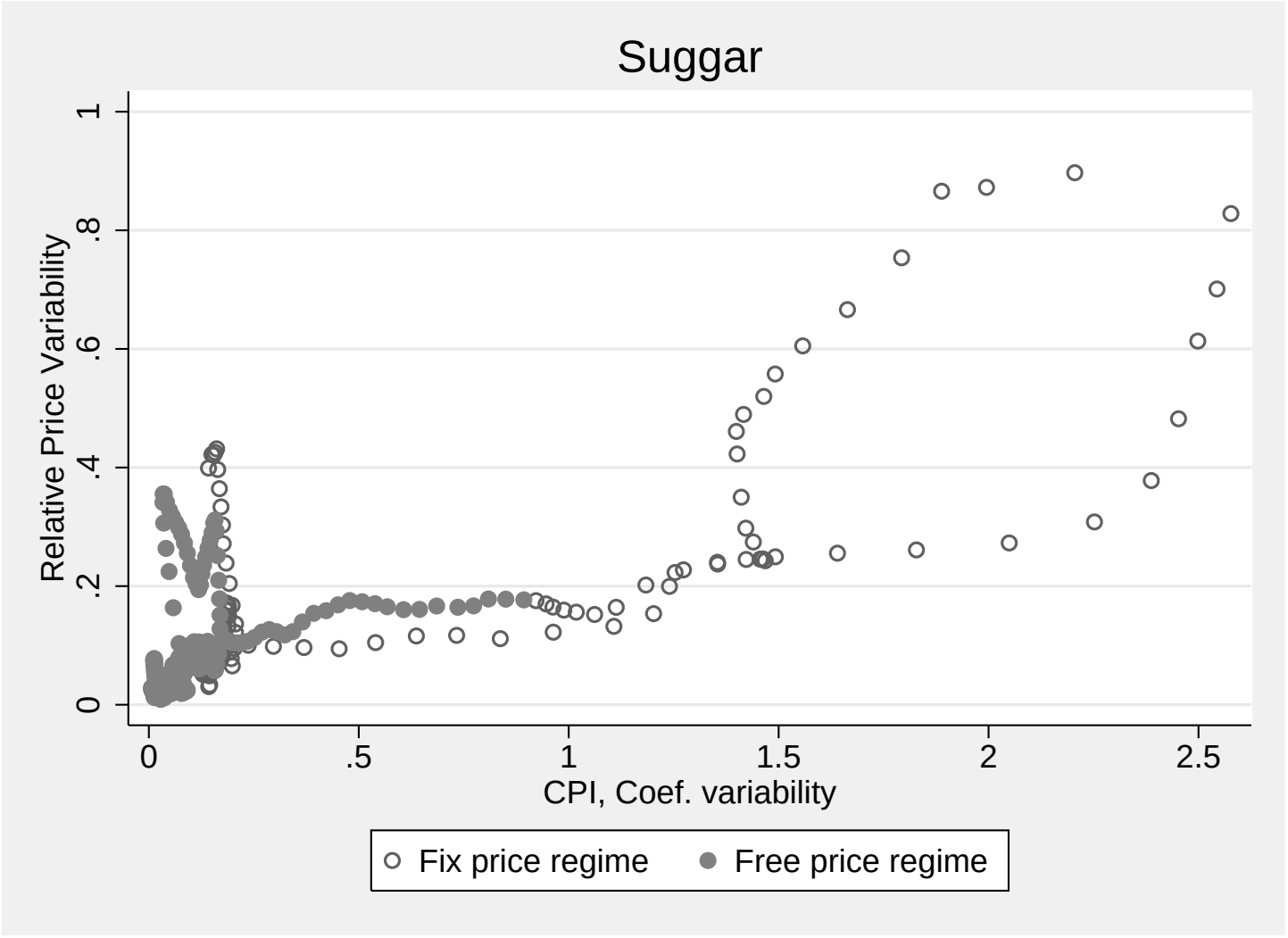

Table 1: **Summary Statistics, Relative Price Variability, by product**

code	mean	sd	min	max	N
Rice	0.09	0.06	0.01	0.32	503.00
Flour	0.11	0.34	0.01	4.04	517.00
Bread	0.08	0.11	0.01	0.75	517.00
Meat (1)	0.09	0.10	0.01	0.68	517.00
Meat (2)	0.08	0.09	0.01	0.54	517.00
Meat (3)	0.09	0.09	0.01	0.57	517.00
Oil	0.09	0.13	0.01	1.21	517.00
Eggs	0.10	0.06	0.02	0.44	517.00
Milk	0.10	0.16	0.01	1.02	517.00
Butter	0.08	0.12	0.01	1.12	517.00
Garlic	0.21	0.15	0.01	0.75	517.00
Peas	0.22	0.10	0.04	0.55	517.00
Onions	0.36	0.25	0.02	1.95	517.00
Lettuce	0.20	0.11	0.02	0.58	517.00
Potatoes	0.25	0.23	0.04	1.74	517.00
Cabbage	0.23	0.11	0.06	0.61	517.00
Carrots	0.16	0.12	0.01	0.69	517.00
Apples	0.32	0.14	0.09	0.66	517.00
Oranges	0.26	0.13	0.08	0.68	517.00
Bananas	0.13	0.20	0.02	1.37	517.00
Sugar	0.11	0.13	0.01	0.90	517.00
Coffee	0.10	0.13	0.01	1.23	517.00
Tea	0.12	0.18	0.00	1.31	517.00
Total	0.16	0.17	0.00	4.04	11877.00

Source: Own calculations.

Table 2: **Summary Statistics, Relative Price Variability, by year**

year	mean	sd	min	max	N
1962	0.16	0.14	0.01	0.75	276.00
1963	0.19	0.18	0.03	1.02	276.00
1964	0.18	0.18	0.05	1.01	276.00
1965	0.17	0.12	0.06	0.54	276.00
1966	0.12	0.09	0.03	0.43	276.00
1967	0.14	0.10	0.02	0.45	276.00
1968	0.18	0.13	0.03	0.56	276.00
1969	0.20	0.16	0.04	0.65	276.00
1970	0.19	0.15	0.02	0.83	276.00
1971	0.24	0.19	0.05	1.13	276.00
1972	0.47	0.44	0.09	4.04	270.00
1973	0.45	0.22	0.10	1.47	268.00
1974	0.28	0.14	0.07	0.74	276.00
1975	0.28	0.20	0.07	1.31	276.00
1976	0.25	0.23	0.05	1.37	276.00
1977	0.16	0.13	0.04	0.61	276.00
1978	0.13	0.09	0.03	0.50	276.00
1979	0.14	0.11	0.02	0.48	276.00
1980	0.13	0.12	0.01	0.48	276.00
1981	0.19	0.26	0.01	1.75	276.00
1982	0.20	0.25	0.03	1.95	276.00
1983	0.13	0.12	0.01	0.57	276.00
1984	0.13	0.11	0.03	0.46	276.00
1985	0.14	0.13	0.02	0.48	276.00
1986	0.11	0.09	0.01	0.38	276.00
1987	0.13	0.14	0.02	0.64	276.00
1988	0.15	0.16	0.02	0.75	276.00
1989	0.13	0.11	0.02	0.54	276.00
1990	0.16	0.14	0.01	0.66	276.00
1991	0.13	0.12	0.02	0.58	276.00
1992	0.11	0.10	0.01	0.51	276.00
1993	0.09	0.08	0.01	0.47	276.00
1994	0.10	0.13	0.01	0.69	276.00
1995	0.10	0.13	0.00	0.69	276.00
1996	0.10	0.15	0.01	0.93	276.00
1997	0.08	0.07	0.01	0.30	276.00
1998	0.09	0.08	0.01	0.37	276.00
1999	0.07	0.06	0.01	0.32	276.00
2000	0.07	0.05	0.01	0.23	276.00
2001	0.07	0.06	0.01	0.28	276.00
2002	0.09	0.07	0.01	0.29	276.00
2003	0.07	0.07	0.01	0.32	276.00
2004	0.06	0.07	0.01	0.33	276.00
2005	0.06	0.07	0.01	0.32	23.00
Total	0.16	0.17	0.00	4.04	11877.00

Source: Own calculations.

Table 3: **Summary Statistics, Fix price regime, by item**

code	mean	sd	min	max	N
Rice	0.23	0.42	0.00	1.00	528.00
Flour	0.26	0.44	0.00	1.00	528.00
Bread	0.28	0.45	0.00	1.00	528.00
Meat (1)	0.03	0.18	0.00	1.00	528.00
Meat (2)	0.03	0.17	0.00	1.00	528.00
Meat (3)	0.04	0.19	0.00	1.00	528.00
Oil	0.25	0.43	0.00	1.00	528.00
Eggs	0.13	0.33	0.00	1.00	528.00
Milk	0.30	0.46	0.00	1.00	528.00
Butter	0.24	0.43	0.00	1.00	528.00
Garlic	0.09	0.28	0.00	1.00	528.00
Peas	0.15	0.36	0.00	1.00	528.00
Onion	0.06	0.25	0.00	1.00	528.00
Lettuce	0.09	0.28	0.00	1.00	528.00
Potatoes	0.08	0.27	0.00	1.00	528.00
Cabbage	0.02	0.12	0.00	1.00	528.00
Carrots	0.03	0.18	0.00	1.00	528.00
Apples	0.00	0.00	0.00	0.00	528.00
Oranges	0.00	0.00	0.00	0.00	528.00
Bananas	0.02	0.12	0.00	1.00	528.00
Sugar	0.30	0.46	0.00	1.00	528.00
Coffee	0.13	0.34	0.00	1.00	528.00
Tea	0.13	0.33	0.00	1.00	528.00
Total	0.13	0.33	0.00	1.00	12144.00

Source: Own calculations.

Table 4: **Summary Statistics, Fix price regime, by year**

year	mean	sd	min	max	N
1962	0.20	0.40	0.00	1.00	276.00
1963	0.35	0.48	0.00	1.00	276.00
1964	0.46	0.50	0.00	1.00	276.00
1965	0.45	0.50	0.00	1.00	276.00
1966	0.43	0.50	0.00	1.00	276.00
1967	0.47	0.50	0.00	1.00	276.00
1968	0.45	0.50	0.00	1.00	276.00
1969	0.44	0.50	0.00	1.00	276.00
1970	0.41	0.49	0.00	1.00	276.00
1971	0.37	0.48	0.00	1.00	276.00
1972	0.41	0.49	0.00	1.00	276.00
1973	0.51	0.50	0.00	1.00	276.00
1974	0.25	0.43	0.00	1.00	276.00
1975	0.03	0.17	0.00	1.00	276.00
1976	0.01	0.10	0.00	1.00	276.00
1977	0.01	0.10	0.00	1.00	276.00
1978	0.00	0.00	0.00	0.00	276.00
1979	0.01	0.12	0.00	1.00	276.00
1980	0.00	0.00	0.00	0.00	276.00
1981	0.00	0.00	0.00	0.00	276.00
1982	0.00	0.00	0.00	0.00	276.00
1983	0.00	0.00	0.00	0.00	276.00
1984	0.00	0.00	0.00	0.00	276.00
1985	0.00	0.00	0.00	0.00	276.00
1986	0.00	0.00	0.00	0.00	276.00
1987	0.00	0.00	0.00	0.00	276.00
1988	0.00	0.00	0.00	0.00	276.00
1989	0.00	0.00	0.00	0.00	276.00
1990	0.00	0.00	0.00	0.00	276.00
1991	0.06	0.23	0.00	1.00	276.00
1992	0.03	0.16	0.00	1.00	276.00
1993	0.00	0.00	0.00	0.00	276.00
1994	0.00	0.00	0.00	0.00	276.00
1995	0.03	0.18	0.00	1.00	276.00
1996	0.04	0.20	0.00	1.00	276.00
1997	0.04	0.20	0.00	1.00	276.00
1998	0.04	0.20	0.00	1.00	276.00
1999	0.02	0.13	0.00	1.00	276.00
2000	0.00	0.00	0.00	0.00	276.00
2001	0.00	0.00	0.00	0.00	276.00
2002	0.00	0.00	0.00	0.00	276.00
2003	0.00	0.00	0.00	0.00	276.00
2004	0.00	0.00	0.00	0.00	276.00
2005	0.00	0.00	0.00	0.00	276.00
Total	0.13	0.33	0.00	1.00	12144.00

Source: Own calculations.

Table 5: **Relative price variability, by item**

VARIABLES	Rice cvp	Flour cvp	Bread cvp	Meat (1) cvp	Meat (2) cvp	Meat (3) cvp
CPI, Coef. variability	0.00	0.44***	0.17***	0.18***	0.16***	0.13***
	(0.01)	(0.03)	(0.02)	(0.01)	(0.01)	(0.01)
Economic activity, Coef. variability	0.34***	-1.24***	-0.04	0.09*	0.18***	0.15***
	(0.05)	(0.18)	(0.09)	(0.05)	(0.04)	(0.05)
Interest rate, Coef. variability	0.05***	0.52***	0.05	0.04**	0.03*	0.02
	(0.02)	(0.07)	(0.03)	(0.02)	(0.02)	(0.02)
Stock prices, Coef. variability	0.19***	0.48***	-0.06	0.06***	0.04*	0.12***
	(0.02)	(0.08)	(0.04)	(0.02)	(0.02)	(0.02)
Observations	503	517	517	517	517	517
R^2	0.364	0.725	0.404	0.779	0.770	0.729
N	503	517	517	517	517	517
ll	843.7	157.7	524.2	840.7	886.6	842.3

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 6: **Relative price variability, by item**

VARIABLES	Oil cvp	Eggs cvp	Milk cvp	Butter cvp	Garlic cvp	Peas cvp
CPI, Coef. variability	0.17***	0.05***	0.21***	0.20***	-0.07***	0.06***
	(0.01)	(0.01)	(0.03)	(0.01)	(0.03)	(0.01)
Economic activity, Coef. variability	-0.29***	0.27***	-0.41***	-0.24***	0.28*	0.47***
	(0.07)	(0.04)	(0.15)	(0.05)	(0.15)	(0.08)
Interest rate, Coef. variability	0.25***	0.08***	-0.14**	0.14***	0.09	0.10***
	(0.02)	(0.02)	(0.06)	(0.02)	(0.05)	(0.03)
Stock prices, Coef. variability	0.16***	0.02	-0.09	0.12***	0.31***	-0.03
	(0.03)	(0.02)	(0.07)	(0.02)	(0.07)	(0.04)
Observations	517	517	517	517	517	517
R^2	0.757	0.487	0.151	0.841	0.064	0.248
N	517	517	517	517	517	517
ll	670.7	908.5	241.7	840.7	264.4	548.4

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 7: **Relative price variability, by item**

VARIABLES	Onion cvp	Lettuce cvp	Potatoes cvp	Cabbage cvp	Carrots cvp	Apples cvp
CPI, Coef. variability	0.13***	0.01	0.22***	0.05***	0.18***	0.03
	(0.04)	(0.02)	(0.04)	(0.02)	(0.01)	(0.02)
Economic activity, Coef. variability	0.18	0.60***	0.14	0.64***	0.62***	0.45***
	(0.24)	(0.09)	(0.21)	(0.09)	(0.08)	(0.12)
Interest rate, Coef. variability	-0.36***	0.05	-0.06	0.04	-0.21***	0.22***
	(0.09)	(0.03)	(0.08)	(0.03)	(0.03)	(0.05)
Stock prices, Coef. variability	0.26**	0.25***	-0.06	0.18***	0.07**	0.14**
	(0.11)	(0.04)	(0.10)	(0.04)	(0.04)	(0.06)
Observations	517	517	517	517	517	517
R^2	0.099	0.310	0.151	0.359	0.579	0.216
N	517	517	517	517	517	517
ll	14.35	502.6	78.13	522.3	575.9	350.9

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 8: **Relative price variability, by item**

VARIABLES	Orange cvp	Bananas cvp	Sugar cvp	Coffee cvp	Tea cvp
CPI, Coef. variability	0.03	0.24***	0.15***	0.18***	0.16***
	(0.02)	(0.03)	(0.01)	(0.01)	(0.02)
Economic activity, Coef. variability	-0.06	-0.27	0.01	-0.28***	0.02
	(0.12)	(0.17)	(0.08)	(0.07)	(0.12)
Interest rate, Coef. variability	-0.23***	-0.33***	-0.00	0.14***	0.09**
	(0.05)	(0.07)	(0.03)	(0.03)	(0.04)
Stock prices, Coef. variability	0.37***	0.10	0.26***	0.23***	0.44***
	(0.06)	(0.08)	(0.04)	(0.03)	(0.05)
Observations	517	517	517	517	517
R^2	0.153	0.215	0.575	0.747	0.573
N	517	517	517	517	517
ll	355.4	174.0	549.8	658.5	386.9

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 9: **Relative price variability**

	OLS	OLS	OLS	FE	FE	FE
CPI, Coef. variability	0.18***	0.17***	0.14***	0.18***	0.17***	0.13***
	(0.00)	(0.00)	(0.01)	(0.00)	(0.00)	(0.00)
Economic activity, Coef. variability		0.06*	0.07**		0.06**	0.07**
		(0.03)	(0.03)		(0.03)	(0.03)
Interest rate, Coef. variability		0.04***	0.03**		0.04***	0.03***
		(0.01)	(0.01)		(0.01)	(0.01)
Stock prices, Coef. variability			0.16***			0.16***
			(0.02)			(0.01)
Observations	11877	11877	11877	11877	11877	11877
R^2	0.209	0.210	0.218	0.266	0.268	0.277
N	11877	11877	11877	11877	11877	11877
ll	5291	5298	5353	7207	7216	7292
Number of code				23	23	23

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 10: **Relative price variability**

	OLS	OLS	OLS	FE	FE	FE
CPI, Coef. variability	0.16***	0.15***	0.11***	0.13***	0.13***	0.08***
	(0.00)	(0.01)	(0.01)	(0.00)	(0.00)	(0.01)
CPI*$\mathbf{1}(Fixed)$	0.06***	0.05***	0.06***	0.12***	0.12***	0.13***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Economic activity, Coef. variability		0.07**	0.08**		0.08***	0.09***
		(0.03)	(0.03)		(0.03)	(0.03)
Interest rate, Coef. variability		0.04***	0.02		0.02**	0.00
		(0.01)	(0.01)		(0.01)	(0.01)
Stock prices, Coef. variability			0.17***			0.19***
			(0.02)			(0.01)
Observations	11877	11877	11877	11877	11877	11877
R^2	0.215	0.216	0.224	0.299	0.300	0.312
N	11877	11877	11877	11877	11877	11877
ll	5334	5339	5404	7476	7482	7591
Number of code				23	23	23

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 11: **Relative price variability**

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
VARIABLES	cvp	cvp	cvp	cvp	cvp	cvp	cvp
CPI, Coef. variability	0.16***	0.16***	0.11***	0.13***	0.09***	0.04*	0.04
	(0.00)	(0.01)	(0.01)	(0.00)	(0.01)	(0.03)	(0.03)
CPI*$\mathbf{1}(Fixed)$	0.06***	0.06***	0.06***	0.13***	0.13***	0.13***	0.13***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Observations	11877	11601	11601	11601	11601	11877	11601
R^2	0.215	0.232	0.243	0.321	0.329	0.388	0.392
N	11877	11601	11601	11601	11601	11877	11601
ll	5335	5289	5372	7419	7492	8286	8065
Number of code				23	23	23	23

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1