Targeted Price Controls on Supermarket Products [‡§]

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Abstract

We study the impact of targeted price controls on supermarket products in Argentina between 2007 and 2015. Using web-scraping methods, we collected daily prices for controlled and non-controlled goods and examined the differential effects of the policy on inflation, product availability, entry and exit, and price dispersion. We first show that price controls have only a small and temporary effect on inflation that reverses itself as soon as the controls are lifted. Second, contrary to common beliefs, we find that controlled goods are consistently available for sale. Third, firms compensate for price controls by introducing new product varieties at higher prices, thereby increasing price dispersion within narrow categories. Overall, our results show that targeted price controls are just as ineffective as more traditional forms of price controls in reducing aggregate inflation.

JEL Codes: E31, D22, L11, L81

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1 Introduction

Many governments consider the use of price controls when inflation rises. In some cases, these price controls are imposed across the board, affecting all goods and causing widespread shortages.[1] Hoping to avoid these negative effects, governments often implement a more subtle form of "targeted" price controls on a limited number of selected goods.[2] Traditionally, these controls have been limited to highly regulated sectors, such as pharmaceuticals, utilities, or gas prices.[3] More recently, the availability of online data, mobile phone apps, and electronic records has dramatically increased the ability of governments to implement, monitor, and enforce targeted price controls in all kinds of consumer goods. In particular, developing countries such as Argentina, Ecuador, Israel, and Panama have in the recent years had some form of targeted price controls for food and grocery products.

Despite the increased interest in the use of targeted price controls, there is little empirical research documenting their economic effects. Are these controls binding? Do they affect prices and inflation of related goods? Can they avoid shortages associated with more generalized controls? What strategies do firms employ to deal with potentially lower profits and better enforcement?

In this paper, we answer some of these questions by studying the rich and volatile experience with price controls in Argentina from 2007 to 2015. These were targeted controls, affecting a selected set of consumer products identified at the barcode level. To help with the visibility and enforcement programs, the government required retailers to display labels identifying individual goods as being under a "government agreement",

[1] Venezuela is a particularly troubling recent case of across the board price controls. The armed forces are in charge of strict price controls and a food supply program. In May 2017, President Maduro announced that he was considering a complete freeze of prices that would be enforced by "people in the streets" (El Nacional (2015)). Nevertheless, the country is experiencing an economic crisis with massive shortages and extreme hyperinflation, as documented in Cavallo (2019).

[2] Targeted controls are also referred to as "selective controls" in the literature (Rockoff (2004)).

[3] For example, developed countries such as Australia, Canada, and Switzerland currently have targeted price control programs for pharmaceutical drugs. Visit http://www.pbs.gov.au/pbs/home for Australia; http://www.pmprb-cepmb.gc.ca/home for Canada.

both in the offline and online stores. We used web-scraping methods to identify these price-controlled goods and track their prices on a daily basis between October 2007 to May 2015. Our data include more than 50 thousand products sold by one of the largest supermarkets, including approximately 1400 goods that were under a price control at some point during this period. These controls were focused on goods that have significant weights in the CPI basket and for varieties sold by leading brands.

With this high-frequency panel of controlled and non-controlled goods, we examine the before-and-after impact of price controls on inflation, product availability, and price dispersion. Our main results are summarized as follows.

First, the impact of targeted price controls on aggregate inflation is small and temporary. At the micro level, controlled goods are sold at government-agreed prices, which are on average 3.3% lower than before the control, but these are compensated by similar price increases soon after the controls are removed. At the macro level, the inflation rate of controlled goods fluctuates between periods of marginally lower and higher inflation relative to other goods, with no significant impact on the aggregate inflation rate.

Second, contrary to common beliefs, we find that controlled goods are seldom discontinued and that their availability is similar to that of non-controlled goods. They have a higher probability of going temporarily out of stock, but stockouts are short-lived and goods are only occasionally discontinued. This suggests that the government's ability to enforce both prices and stocks was effectively enhanced by new monitoring technologies, including an official mobile app that allowed consumers to scan product barcodes and send online complaints to the enforcement agency in cases of price discrepancies or stockouts.

Third, given that price controls are binding in prices and availability, we study how firms might offset lower profit margins. Consistent with the predictions of a standard vertical differentiation model in the presence of price controls, we find evidence that firms expanded their product line with new varieties at higher prices. These new varieties tend

to be associated with additional characteristics that suggest a quality improvement (e.g., milk with "extra calcium"), implicitly reducing the perceived quality of older varieties under price controls. This firm-level strategy raises average prices and price dispersion within good categories with controlled goods, and potentially introduces a welfare cost to consumers by obfuscating choices and increasing search frictions.

Overall, our results suggest that targeted price controls are just as ineffective as more traditional forms of price controls in terms of reducing aggregate inflation, despite the advances in targeting, monitoring, and enforcement technologies. These findings complement a large macroeconomic literature that focuses on the US price and wage controls during Richard Nixon's presidency in the 1970s.[4] Our work is also related to papers that study price controls from a micro or industrial organization perspective. Leffler (1982) provides a model where firms decrease quality until shortages from binding maximum prices are eliminated. Besanko, Donnenfeld, and White (1987) and Besanko, Donnenfeld, and White (1988) find that maximum price regulation can counteract the quality distortion in a monopoly price setting, and that firms may deteriorate quality for lower willingness-to-pay consumers. Raymon (1983) argues that binding price ceilings can decrease quality and consumer welfare in competitive markets, while Kyle (2007) finds that price controls in one market affect entry strategies and the introduction of new products in other markets, consistent with our findings.

The remainder of the paper proceeds as follows. Section 2 describes the price controls in Argentina from 2007 to 2015. Section 3 describes the web-scraping technology and the micro dataset. Section 4 discusses the impact of price controls on inflation and product availability. Section 6 presents evidence of firms' behavior in the presence of controls. Section 8 concludes.

[4] Rockoff (2004) provides an excellent overview of the history of price controls in the United States, ranging from the Revolutionary War to the Vietnam War. Galbraith (1952), Friedman (1966), and Solow (1966), provide early formal treatments on the subject. Helpman (1988) shows that the macroeconomic effects of price controls depend on the market structure. Other papers include U.S. Council of Economic Advisers (1973), Gordon (1973), Gordon (1975), Gordon (1977), Schultze (1975), Darby (1976a), McGuire (1976), Oi (1976), Cox (1980), and Blinder and Newton (1981).

2 Price controls in Argentina

Argentina has a long history of price controls. In 1939, Congress passed a law to prevent stockouts during the Second World War. And although price controls were originally conceived as a temporary means to lower inflation, subsequent governments have continued to rely on various forms of such policy.[5]

We study the recent 2007–2015 period, during which the government experimented with various types of targeted price controls in supermarket products. These price controls were meant to curb inflation, which rose from 10% in 2006 to over 35% in 2016 (according to unofficial estimates).[6] The programs focused on food and beverages, which constitute nearly 40% of the CPI basket. Despite the fact that they did not appear to have much of an impact on the inflation rate, these programs were popular with voters. According to recent consulting and media surveys, 60% of Argentines supported price control policies, and 25% of consumers bought price-controlled goods, which accounted for up to 20% of retailers' revenues in supermarkets.[7]

This period of price controls can be divided into four stages, as summarized in Table 1. Stages 1, 3, and 4 are examples of targeted price controls, and Stage 2 was a temporary freeze of all goods sold by large supermarkets. In all cases, the control price applies to the retail price inclusive of VAT taxes.[8]

Table 1 about here

The first stage lasted six years, from 2007 to 2013, and was characterized by confidential ad hoc price agreements with major supermarkets, which had to freeze prices

[5]See FIEL (1990) for a review of price controls prior to 1990.

[6]In addition to price controls, Argentina's main strategy to deal with inflation was to manipulate the official inflation statistics. See Cavallo (2013) for more details.

[7]The new government elected in 2015 continued the "Precios Cuidados" program. More details can be found at the official government website: `https://www.argentina.gob.ar/precios-cuidados`. For evidence on their popularity, see Telam (2014b); Pagina 12 (2014); El Cronista (2015); Clarin (2016).

[8]Section 3 describes how we identify controlled products. Appendix A.5 shows additional statistics for each of the control stages.

temporarily for selected goods. There were no official press releases or announcements that disclosed the specific products being controlled, but some retailers showed a "government agreement" label next to the product. We use this label to identify controlled products through scraping technologies. News articles throughout the period reported that this policy resulted in major shortages (e.g., Bloomberg (2007)), but we find no evidence of consistent shortages in our data, as we discuss later.

The second (and only non-targeted) stage started in February 2013, when unofficial inflation reached 25%. The government announced that it had reached a new agreement with the largest retailers in Argentina to freeze prices of all products for 60 days, and later extended it for another 60 days until May 31 (Bloomberg (2013)). As before, no official documentation was released. The indiscriminate attempt to control all prices, together with an increased duration of controls, might explain why the number of products available to the public started to decrease around this time, as discussed in Section 5. Prices remained stable for a few weeks but soon started to rise again, prompting the government to adjust its price control policies.

A third stage started in June 2013, when the government lifted the controls on all but 500 products. This time, the government published the names and government-agreed prices for all controlled products, which included food (fresh produce and packaged), beverages, cleaning, and health and personal care items. It first targeted major retailers in Buenos Aires and then expanded throughout the country. Because not all retailers sold the same brands or categories, each supermarket had its own list of 500 product varieties whose prices had to stay constant for six months. This price agreement was formalized under the name "Mirar para Cuidar" (*Look to Care*). The government increased the program enforcement as well as its advertising in public media. "La Campora", a political organization with close ties to the President, developed a web and mobile phone app that allowed "militants" to help monitor and enforce the price controls. Several store

locations were temporarily closed or fined due to shortages.[9]

Figure 1 about here

Figure 1 shows how the government increased the intensity of the price controls starting in 2013, relative to the first stage of targeted controls. We measure the intensity by counting the number of distinct retailer categories (URLs) that had controlled goods during each month.[10]

In December 2013, amid significant changes in the cabinet, the government announced a new stage of price controls called "Precios Cuidados" (*Protected Prices*).[11] Launched in January 2014, it drastically reduced the product list to 100 different goods (194 varieties in total) that were by then common among all major retailers. The duration of the price controls also increased significantly: the median time a product remained under price controls increased from 70 days in the first stage to 183 days in the third stage. In an attempt to facilitate the diffusion of price lists, the new program started with fewer categories and varieties and steadily increased over time. *Protected Prices* also required producers to inform the government of new product introductions that resembled those under control. This clause was added amid criticism that, in previous controls, firms launched similar products or varieties to circumvent maximum prices.[12] We discuss evidence of that strategy in Section 6.

The government also increased the firms' costs of violating the agreements and implemented tighter and more sophisticated monitoring strategies.[13] The government

[9]See Clarin (2013); Wall Street Journal (2013). These efforts can be interpreted as a new form of bottom-up monitoring technologies (e.g., Olken (2007)). See also Ater and Rigbi (2018) for the effects of price transparency online.

[10]As shown in Section 5, the ups and downs of price controls intensity are not related to data-scraping problems. Although price controls were supposed to be widespread during the second stage, retailers kept identifying a specific set of goods as being under a "government agreement". Our matching algorithm, described in Section 3, identified these goods as "controlled products", and therefore the intensity index is relatively stable during these weeks.

[11]Several high-ranking government officials left around that time, including the Secretary of Commerce, the Minister of Economy, and the Central Bank President. See La Nacion (2013b).

[12]See La Nacion (2013c,a); Clarin (2015).

[13]The government monitored the retailers for stockouts, wrong labeling, incorrect prices, incorrect prod-

developed a website with all product lists and prices, and made the information accessible with a mobile phone app that allowed consumers to scan product barcodes and report stockouts or incorrect prices. Militant groups close to the government posted pictures of CEOs and owners of supermarket chains in the streets and encouraged people to help monitor prices. These strategies were extensively advertised in public media, including radio, television, newspapers, and official press releases.[14][15]

As of the time of writing, *Protected Prices* remains active, with new products and maximum prices announced on a quarterly basis.[16] Price controls remain popular with consumers in Argentina, which is consistent with the experience in the 1970s in the Unites States (Nixon (1978), Blinder (1979)) and in Sweden (Jonung (1990)).

3 Scraped online prices

We use online prices from thousands of products sold online each day from 2007 to 2015 by one of the largest retailers in Argentina in terms of market share.[17] The data were scraped off the Internet by the Billion Prices Project, an academic initiative at Harvard and MIT that collects online prices from hundreds of retailers around the world (Cavallo and Rigobon (2016)).

The scraping software is designed to search the HyperText Markup Language

uct weight. The agreements also stipulated that retailers should not limit purchases of controlled goods per household. Companies and supermarket chains could be subject to temporary store closures and large monetary fines. For evidence on retailers receiving fines see Buenos Aires Herald (2014); Telam (2014a); La Nacion (2015a, 2017).

[14]See La Nacion (2014a,b).

[15]The Israeli government has also faced challenges to enforce targeted price controls. See Globes (2017).

[16]The product list can be found at `https://www.argentina.gob.ar/precios-cuidados`. Opposition leader President Mauricio Macri, who took office after former President Cristina Fernandez de Kirchner in December 2015, broadened the program's scope. See Telam (2016).

[17]The same retailer is also used in Cavallo (2013) and Cavallo (2018). The retailer practices a uniform pricing strategy, i.e. online prices and availability are estimated to be identical across locations. Moreover, prices are estimated to be similar across the online and offline channels (Cavallo (2018)). In fact, the prices of controlled goods instructed by the government must be identical in both channels. We simulated online purchases and did not find that availability changed across locations. Although we lack data from a different retailer, we did not find news articles that reported differentiated enforcement across supermarket chains.

(HTML) public code of a retailer's website and to automatically store the pricing data of all goods on a daily basis. The retailer assigns a unique ID to each product sold online. In the days when the scraping fails (due to software failures or webpage maintenance) prices are assumed to remain constant until the goods are back online. Goods that do not reappear on the website are considered to be discontinued.

We identified price-controlled goods in two ways. First, from 2007 to 2015, the scraping algorithm read a special HTML (ID-specific) tag next to each controlled good sold online. This method accounts for about 75% of the controlled goods in our database. Second, after the government started publishing lists of controlled goods in 2013, we manually identified each of these goods in our database.[18]

3.1 Data description

Table 2 provides summary statistics of the data coverage. We have daily prices for more than 50,000 distinct products from 2007 to 2015, and a yearly average of about 14,000 distinct goods. The supermarket scraped data covers categories such as food, beverages, electronics, household appliances, kitchen utensils, and health and personal care items, which collectively account for about 45% of the CPI weights. See Aparicio and Rigobon (2019) for additional details on web-scraping and decision trees classifiers to categorize product-level data. See Gorodnichenko, Sheremirov, and Talavera (2018) and Cavallo (2018) for related work which document price setting behaviors in the online channel.

Table 2 about here

We label products as controlled if they were affected by a price control for least one day during the scraping period.[19] This results in 1,460 controlled goods, which is about

[18]Figure 8 in the Appendix illustrates a screenshot of the government website.

[19]This implies that controlled and non-controlled products do not switch sample groups. A similar strategy is used in Cavallo (2013) and Rockoff (2004). Controlled-goods in stage 2 are only identified through the HTML flag, although the government tried to impose a generalized freeze (Section 2).

3% of the total products in the database. Although a relatively small set, these goods have a significantly higher weight in the CPI basket, as seen in Table 2.[20]

On average, goods were controlled for six months, with a median of two and a half months. About 25% of the controlled goods had price controls lasting more than seven months; and if a product price was controlled more than once, there were usually no gaps in between. Controlled goods were under price controls about 23% of their time available online. And a stable subset of items consistently remained under price controls throughout the scraping period.[21] Price controls were generally imposed at the existing price level, but in about a third of the cases, the new price was set lower. On average, the price change was -3.3%.

4 Prices and Inflation

To study the impact of price controls on inflation, we construct a simple aggregate price index as a weighted arithmetic average of category indices. Each category index is a Jevons geometric average of all products sold online. If an item is out of stock we assume constant prices. And if an item is discontinued, then it no longer impacts the index. Products that are out-of-stock are momentarily unavailable for online purchase, while discontinued products were no longer offered online until the end of our scraping period. Price changes are weighted using Argentina's National Statistics Office (INDEC) official weights by CPI category. See Cavallo (2013) and Aparicio and Bertolotto (2016) for evidence that online price indices closely track and forecast official CPIs.

Figure 2 shows the price indices and the annual and monthly inflation rates for

[20] In Appendix A.1 we expand on some of the key determinants of price controls, and find that for a unit increase in the CPI weight (i.e. 1 percentage point) the odds of a control increase by 24%. Price controls are less likely in less concentrated or homogeneous markets, as approximated with the number of brands, products, and varieties within the category-URL (i.e. narrow sub-categories). These findings are consistent with the predictions in Cox (1980), who describes the policymakers' problem as maximizing the impact on the price index while reducing enforcement or deadweight costs.

[21] For visual evidence on the duration of price controls, see the histogram in Figure 9 in the Appendix.

three samples: all goods, controlled goods, and non-controlled goods.

Figure 2 about here

The impact of price controls on aggregate inflation is small and temporary. From 2007 to 2015, all price indices had recorded about 400% accumulated inflation. There are periods when the inflation rate of controlled goods appears significantly different than that of non-controlled varieties, as shown in the volatility of the monthly inflation rate in panel (c). These periods are associated with weak or strong periods of price agreements, but the difference was never large enough to have a significant impact on the aggregate inflation rate for all items, as shown in panel (b). The lack of expenditure weights within categories means that we could be underestimating the effects if the government targeted leading brands, but the impact was nevertheless temporary.

Periods of low inflation in controlled goods were quickly followed by higher inflation for those same goods. In particular, controlled goods had lower inflation until 2009 and then much higher inflation in 2010 and 2011.[22]

Table 3 about here

Table 3 shows the micro impact of price controls using product-specific regressions. We calculate the monthly average price for each product, and run regressions of the form:

$$\pi_t^{i,j} = a + \beta D_t^i + \gamma_t + \mu^j + e_t^i \tag{1}$$

where $\pi_t^{i,j}$ is the percent change in monthly price of product i from category j at time t; D_t^i is a price control indicator; and γ_t and μ^j are time- and category- fixed effects, respectively.

[22] A body of literature argues that price controls can indirectly benefit the inflationary process through inflation expectations. See Galbraith (1952), Friedman (1974), Blinder and Newton (1981), Rockoff (2004). Interestingly, inflation expectations remained relatively flat even around key price controls announcements. Figure 10 in the Appendix shows annual inflation rates, inflation expectations, and monetary policy. See also Figure 11 in the Appendix for visual evidence of higher volatility of controlled-goods' annual inflation rate, as well as a measure of "excess" inflation relative to non-controlled sectors.

In column (1) we define an indicator that takes value 1 if the product experienced a price control during month t. The estimate suggests that products have 0.84% lower inflation during the month of price controls. In column (2) we include an indicator if a non-controlled product has a competitor under price controls (defined as in the same narrow category). The point estimate suggests that non-controlled products experience about 0.17% higher inflation when a competitor is under price controls, suggesting that retailers are not able to fully compensate by increasing prices of non-controlled related goods.

Column (3) shows that the effect on inflation is temporary, with prices rising as soon as the price control is lifted. In this case we use an indicator variable that takes a value of 1 if the product experienced a price control at month $t-1$ but not at t. The estimated coefficient suggests that monthly inflation increases by an additional 4.9 percentage points as soon as price controls are lifted.

We next explore whether the effect varies with the duration of the control. We include an indicator that takes value 1 if the product experienced price controls during at least three consecutive months (but not in month t). Controls that lasted less than three months cause an increase of 1.8 percentage points, while those that last more than three months lead to an increase of approximately 5.9 percentage points (adding both coefficients).

Overall, these results suggest that price controls have a temporary effect on the inflation of controlled products. These regressions include results from goods that may have been under price controls multiple times, allowing the firms to act strategically with their pricing. In the next section we explore high-frequency pricing reactions using an event study that focuses exclusively on the first time each product was affected by a price control, i.e., when the impact is presumably higher.

4.0.1 Effect on first-time controls

We now use high-frequency price data on the first time each controlled-good experienced a price control. In order to determine whether firms increased the price of related goods after price controls were imposed, we split the sample of non-controlled goods into "related" and "unrelated" products. Related non-controlled goods are sold in subcategories that have goods under price controls at the same time. One example of a subcategory could be cereals. Unrelated non-controlled goods are sold in subcategories that had no price controls at all.

The related sample is constructed as follows. Each time an item is controlled for the first time, we randomly select another product from the same subcategory such that: (i) it is in stock that day, (ii) is not controlled during the scraping period, and (iii) has not already been selected as related to another good (i.e., draws without replacement). The unrelated sample is constructed in a similar way but from non-controlled categories. The controlled, related, and unrelated samples comprise 1,460, 1,321, and 1,400 distinct items, respectively.

For each good, we keep prices for 90 days before and after it received the first price control.[23] This method produces a balanced panel for each sample (except for some censored observations in some price spells for discontinued goods). We then compute the 30-day rolling inflation at the good-level and average it across goods each day. This generates an approximation of the average monthly inflation, shown in Figure 3 for a 90-day window around the day the control is first introduced.

Figure 3 about here

This figure highlights three findings. First, consistent with the previous discussion, there were temporary effects on controlled-goods prices. The monthly inflation rate falls to -5% immediately after the control is imposed, and 30 days later the monthly inflation is

[23] We focus on the first event to avoid picking up behaviors that are connected to previous controls, but the results are similar if we make no distinctions for repeated controls.

close to 0% (indicating that prices remain fixed). However, after two months, the inflation rate jumps to +5%, compensating for previous declines.

Second, non-controlled goods in related categories do not have higher inflation rates after the control is first introduced. Their behavior is similar to non-controlled goods in unrelated categories, suggesting that, at least immediately after the first event, firms were not compensating for the controls by increasing prices of related goods. In some cases, the government explicitly monitored the behavior of related goods, which likely limited firms' ability to compensate through the prices of other existing varieties.

Third, related goods do have higher inflation *before* the controls are imposed. Their prices start to rise faster 60 days before the control, and the inflation difference peaks 15 days before the control is imposed. Goods that will later be under a price control, and those in unrelated categories, do not experience similar price increases. One possible explanation is that firms increased prices of some varieties to make potential candidates for a price control appear relatively cheap. Overpricing varieties that were less likely to be under a price control could be a strategy to negotiate a higher price ceiling on the cheap variety.[24]

In summary, first-time price controls on specific goods did not have a downward effect on the inflation rate of related goods in the same categories. In Section 6 we explore whether targeted price controls affected the price of new varieties introduced after a price control takes place.

5 Product availability

Can better monitoring tools for targeted controls prevent the shortages typically associated with more extended types of price controls? In order to answer this we compute a measure of "product availability", defined as the number of items available for sale online on a

[24]See also Blinder (1979) on related overpricing strategies during price controls in the Unites States.

given day.[25] Panel (a) in Figure 4 shows that the retailer sold over 13,000 products per day, of which about 700 were controlled-goods. The flat line between late 2009 and early 2010 is due to a partial scraping failure in our algorithm. Scraping failures are otherwise only occasional and do not affect the data.

Figure 4 about here

The availability of controlled goods was surprisingly stable over time, at around 700 items per day. Although newspapers claimed that price controls produced major stockouts, we found no such evidence in our data. We also simulated online purchases on several occasions and found no shipping delays nor limits on the number of units that could be purchased.[26]

The only major drop in availability occurred when the government imposed a total price freeze in Stage 2 (shaded region). About 100 goods were discontinued during that period, and another 200 disappeared when controls ended. Once the programs became targeted again, in Stage 3, the availability of controlled goods stabilized, though at a much lower level. It is possible that as intensity and duration of price controls increased, retailers decided to discontinue products that were previously controlled.[27]

5.1 Temporary stockouts

Even if the government can prevent retailers from discontinuing goods, we might expect controlled goods to experience frequent stockouts. In this section, we use survival analysis to study the risk of stockouts across samples.

[25] Cavallo (2018) shows that in Argentina, close to 100% of the goods found offline are also available online and have similar prices.

[26] A potential explanation is that price ceilings were being set above the intersection of demand and marginal cost curves in non-competitive industries (Darby (1976b), Helpman (1988)), so profits margins could be smaller but still positive.

[27] These discontinuities explain why availability did not recover. It is also possible that, as a new stringent targeted program developed, firms preferred not to re-introduce controlled products for fear these would be the target of price controls again. In Figure 12 in the Appendix we plot product introductions and discontinuities over time, and show that these were more pervasive when the government increased the intensity of price controls.

The onset of risk, or t_0, is defined as the day each good received its first price control during the scraping period from 2007 to 2015. The end date, or failure event, is the day of the first stockout after the control is imposed. If the scraping package fails, no price observations are recorded for that date. We control for these cases and for right-censored observations (i.e., controlled goods that did not go out of stock by the end of the scraping period).

Panel (a) in Figure 5 shows a histogram of the number of days until the first stockout, that is, we compute the number of days between t_0 and the failure event for each good. We find that controlled goods do experience a relatively faster stockout: one and a half months after the first price control more than 50% of the goods have gone out of stock, compared to 40% in the related non-controlled varieties. Vertical lines depict average days for each sample.

Figure 5 about here

We also estimate the survival function $S(t)$, defined as the survival probability (or in-stock probability) past time t, i.e. the probability of failing after t, for both controlled and related goods. We use the non-parametric algorithm from Kaplan and Meier (1958):

$$\hat{S}(t) = \prod_{j|t_j \leq t} \left(\frac{n_j - d_j}{n_n} \right)$$

Where n_j is the number of goods at time t_j and d_j is the number of stock-out events at time t_j, and where the product is computed over all observed failure times until time t.

Panel (b) in Figure 5 shows similar estimated survival function for both controlled and related goods.[28] We find that the probability of being in stock is about 15% higher for (related) non-controlled goods a month after controls were imposed. The magnitude of this probability seems small, particularly when we consider that the average duration of

[28]Results remain robust to alternative functions, such as the non-parametric Nelson–Aalen cumulative hazard function (Kaplan and Meier (1958)).

a stockout (defined as the number of days out of stock after each product's first control) is only 3 days for controlled good and 2.6 days for related goods

6 New Varieties and Price Dispersion

The previous sections show that targeted controls in Argentina do not significantly affect the aggregate inflation rate, though they do force some firms to sell goods at lower prices and keep them in stock most of the time. So how do firms cope with price controls?[29]

For targeted price controls, an effective strategy might be to introduce new varieties at higher prices while implicitly suggesting to consumers that the older varieties have lower quality.[30] For example, in June 2013 Sancor's *Dulce de Leche, 1kg* was controlled; a few weeks later Sancor introduced *Dulce de Leche, Countryside Style, 400 grams* at a size-adjusted 33% price increase. Examples like these are not easy to find, however, because firms obfuscate the comparisons with complicated product descriptions or package size changes. In Appendix Section A.2 we show that this firm-level strategy is consistent with a vertical differentiation model in the presence of targeted price controls.

We document how the number of non-controlled varieties increases by running the following regressions at the category-URL and month level:

$$Varieties_t^j = a + \beta D_t^j + \gamma_t + \mu^j + e_t^i \tag{2}$$

where $Varieties_t^j$ is the number of non-controlled varieties (in logs) in category-URL j at month t; γ_t and μ^j are time and category fixed effects, respectively; and D_t^j is an indicator

[29]Some firms actually benefited from the price agreements by gaining market share. In principle, these price agreements provided advertising and facilitated product distribution to major retailers throughout the country. For example, an Argentine firm producer of vinegar, mayonnaise, and other dressings reported that 27% of its 2014 sales could be attributed to the *Protected Prices* program, and that these products exhibited a 28% increase in gross sales. Participating in the price agreements allowed the firm to access new retailers and supermarket chains in segments that were previously restricted to major brands. See La Nacion (2015b); Telam (2015).

[30]See Bourne (1919), Darby (1976a), Jonung (1990), Rockoff (2004).

that takes value 1 when category-URL j has at least one product under price controls at month t. The main estimate in column (2) of Table 4 indicates that narrow categories subject to price controls experience a 33.7% increase in new non-controlled varieties.[31]

Table 4 about here

Traditional matched-model price indices, such as those used in Section 4, are unable to capture the price impact of new varieties. The reason is that they are based on the price changes of goods that are present in two time periods, and therefore the price levels of new products are not included in the index computations.

A simple way of detecting the impact of new varieties is by constructing *average price* indices, which measure the average price *level* for all varieties sold each day in a narrowly defined category.[32] We first compute average-price indices for both controlled and non-controlled goods in the same subcategories, and then build aggregate price indices using official CPI category weights. Our data are well suited for this analysis because the web-scraping algorithm adds goods to our sample on the first day they appear on the store.

As Figure 6 panel (a) shows, the inflation rate for non-controlled goods is higher once we account for the price levels of new varieties at the time of introduction. The average-price index has more inflation than the corresponding matched-model (chained) index that uses only price changes, and significantly more inflation than the average-price index for controlled goods.

Figure 6 about here

We also detect higher-priced varieties by looking at price dispersion before and after controls are introduced. This can be seen in Figure 6 panel (b), which plots the price

[31] See also visual evidence of increased activity of product introductions and discontinuities in Figures 12 and 13 in the Appendix.

[32] Parsing out the product description string into grams and liters size per item, we find no evidence that firms systematically reduced package sizes to cope with price controls.

dispersion within subcategories for all goods and the subset of "continuing" goods.[33] Panel (b) shows that price dispersion increases by around 14% during the first weeks post-control. Furthermore, dispersion is primarily driven by new goods following price ceilings and does not revert to its initial levels. In both cases, price dispersion rises a few days before the price control is introduced, but in the sample that includes new varieties (all goods), the dispersion continues to rise after the control is in place.

We formalize the visual evidence of price dispersion using a similar regression to equation (2). In this case, the dependent variable is the category-URL price dispersion, which is defined as the coefficient of variation. The coefficient in column (4) in Table 4 indicates that, relative to the average price dispersion across all narrow categories, targeted price controls lead to 17.7% higher price dispersion.

7 Differences across Stages

In Table 5 we replicate the main empirical analyses for each of the price control stages to document their differences.

Table 5 about here

During the first stage, products under price controls experienced a temporary 0.78% decline in monthly inflation, a 27% probability of a stockout, and a 32% increase in price dispersion within subcategories, in line with the average across all stages.

Stage 2, the only non-targeted phase, was more successful in bringing aggregate inflation down temporarily (as shown in Figure 2), but led to an increase of 2.37% monthly inflation for those products which experienced targeted price controls at some other time. This suggests that the retailers utilized the "freeze" as an opportunity to anticipate (and

[33] We compute price dispersion as the coefficient of variation, i.e. standard deviation of prices over average prices, per week and URL. We then averaged these URL-level time series for each week, six months before and after the first control.

possibly obfuscate) price increases in those goods that they expected to be controlled in the future.

Stage 3 was the targeted phase with the strongest enforcement, which significantly reduced the inflation rate of targeted goods while simultaneously reducing the probability of a stockout. This was, not surprising, also the period where a large fraction of goods were discontinued, as seen in Figure 4.

Finally, stage 4 appears to be the least successful phase of targeted controls, suggesting that the ability to enforce price controls had fallen dramatically by this time. This period also coincides with a new president in office, changes to the basket of controlled products, and potential right-censoring for controlled products introduced towards the end of the data collection.

8 Conclusions

During the past ten years, Argentina has experienced various forms of targeted price controls in which the government set price ceilings for specific supermarket goods. We use web-scraping technologies to collect online prices from one of the largest retailers in the country, and we construct a detailed micro panel dataset with more than 50,000 goods, which we use to evaluate the impact of price controls.

We show that, although targeted price controls focused on goods with high CPI weight, they had minor and temporary effects on aggregate inflation. While these controls were binding, both in price and product availability, firms introduced new varieties at higher prices to compensate for reduced profit margins.

Our results suggest that new technologies, such as the Internet and mobile phones, allow governments to better enforce targeted price controls programs, but this does not make them an effective policy to reduce aggregate inflation. The effects are small and short-lived, and they do not spill over to non-controlled goods. Furthermore, firms adjust

to targeted price controls by using strategies that may obfuscate consumer options and increase price dispersion.

Future research should explore the welfare losses associated with additional search frictions, administrative enforcement costs, and price-obfuscation strategies in the retail industry.

Figures

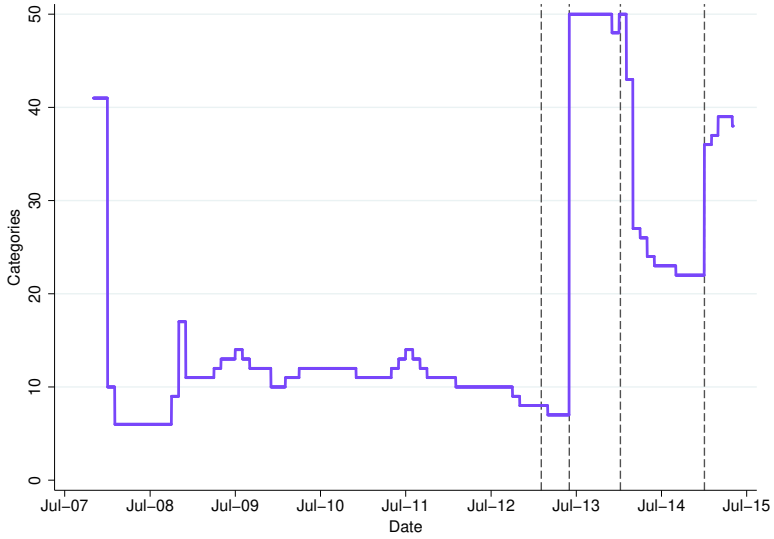
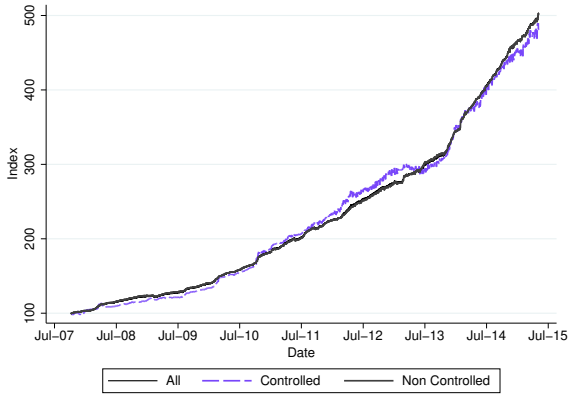
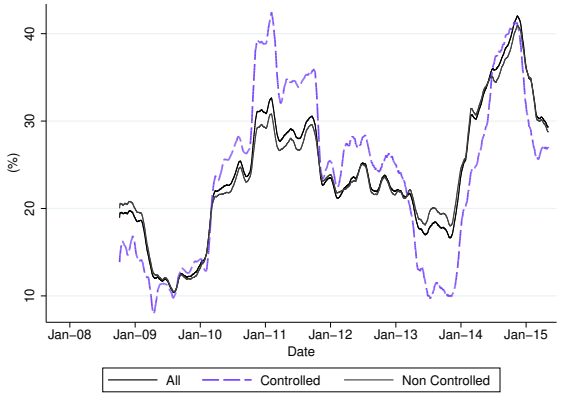


Figure 1: Intensity Index

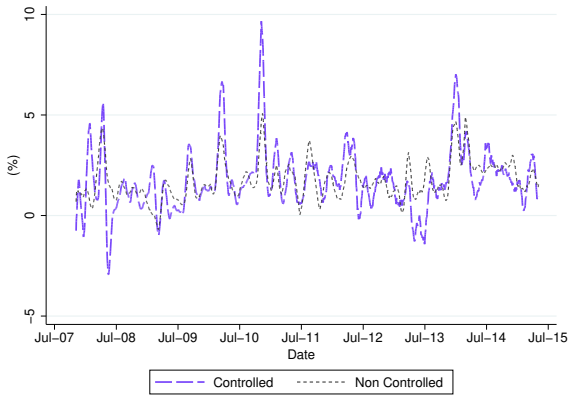
Notes: Retailer's narrow categories under price controls. Vertical notes denote the four main events in the timeline as described in the main text.



(a) Price Index



(b) Annual Inflation Rate



(c) Monthly Inflation Rate

Figure 2: Price Index and Inflation Rates for Different Samples

Notes: The price index is calculated using official weights by CPI categories and unweighted geometric averages of price changes for subcategories without official weights. The annual and monthly inflation rates are computed using a 30-day moving average of the price index.

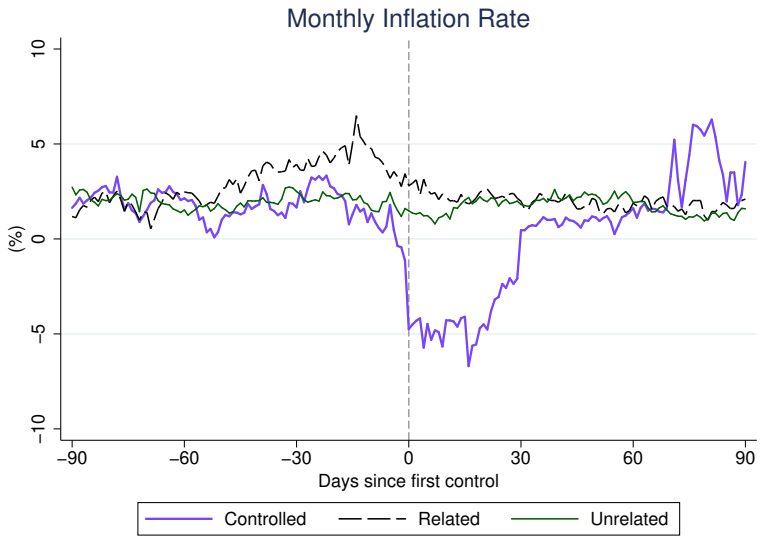
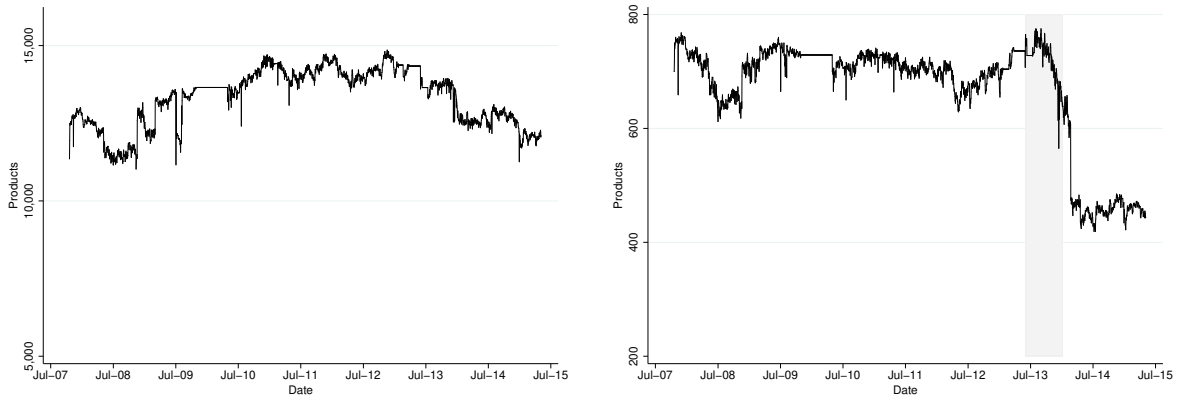
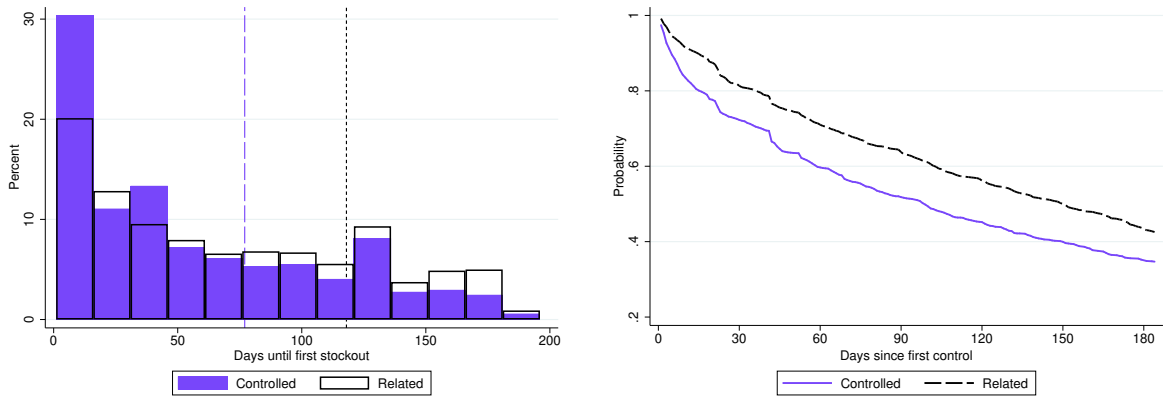


Figure 3: 90-day window before and after the first price control



(a) All Goods (b) Controlled Goods

Figure 4: Product Availability

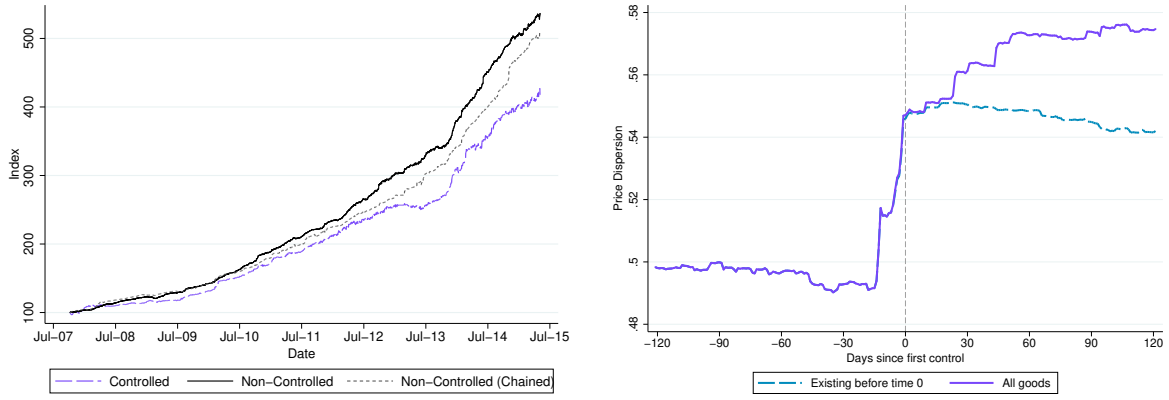


(a) Days Until the First Stockout

(b) Probability of Being In-Stock

Figure 5: Stockout behavior

Notes: Histogram computed for less than six months for better visualization. Median days until first stockout in vertical lines. Kaplan-Meier survival function is computed for all months, but axis is also restricted to six months.



(a) Price index using average prices

(b) Price dispersion

Figure 6: Price Index and Price Dispersion

Notes: In Panel (a), "Controlled" and "Non-Controlled" are average price indices as described in the text; "Non-Controlled (Chained)" is a standard chained or matched-model price index.

Tables

Table 1: Timeline of Price Controls

		Isolated Controls	Total Freeze	*Look to Care*	*Protected Prices*
		Stage 1	Stage 2	Stage 3	Stage 4
(i)	Period	Oct 2007 to Feb 2013	Feb 2013 to May 2013	June 2013 to Nov 2013	Jan 2014 to May 2015
(ii)	Public Information	No	No	Yes	Yes
(iii)	Same Goods all Retailers	No	No	No	Yes
(iv)	Target Number of Products	–	All	500	100

Notes: Stage 2 is excluded because the government aimed to freeze all food products and did not officially disclose the identifiers of controlled products. Our scraping algorithm identified a limited number of controlled goods (Section 3). Our data ends in May 2015, but the *Protected Prices* program continued after that. Details about the programs are in Section 2 in the main text.

Table 2: Summary Statistics

		All Goods	Non-Controlled	Controlled Goods
(i)	Time period	October 2007 to May 2015	October 2007 to May 2015	October 2007 to May 2015
(ii)	Observations (with price)	15,796,787	15,139,656	657,131
(iii)	Distinct goods	51,779	50,319	1,460
(iv)	Distinct brands	3,518	3,466	438
(vi)	Retailer's categories[a]	964	963	302
(vi)	CPI categories	75	75	54
(vii)	Total CPI weight	44.6	44.6	39.7
(viii)	Average CPI weight per category	0.859	0.802	0.923
(ix)	Average CPI weight per product	0.860	0.853	1.094
(x)	Average CPI weight per product[b]	0.001	0.001	0.034
(xi)	Median control time	-	-	75 days
(xii)	Median control events[c]	-	-	2 times
(xiii)	Percent of time under control[d]	-	-	23%
(xiv)	First control at higher price[e]	-	-	6%
(xv)	First control at lower price	-	-	32%
(xvi)	First control at same price	-	-	51%
(xvii)	Average price change at control[f]	-	-	-3.3%

Notes: [a] Website retail categories (e.g. dairy), which are broader than URL-based retail subcategories (e.g. yogurt). [b]Weighted by number of products in each category (e.g., if a category weights 3 and there are 10 products, then each product's weight is 0.3), then averaged across all goods. [c]Number of (non-consecutive) times a product received price controls, and then median across controlled goods. [d]Calculated using non-missing observations (in stock for sale). [f]Fraction of controlled goods whose first control was set at a higher price, relative to its last available price without controls. Similarly for (xv) and (xvi). The remaining fraction are new items and have no price change available. [e]Based on the average price ten days before and after the first control.

Table 3: Effect of price controls on product-specific monthly inflation

	Product Inflation			
	(1)	(2)	(3)	(4)
Product controlled	-0.837***	-0.793***		
	(0.073)	(0.073)		
Product w. controlled competitor		0.165***		
		(0.024)		
Control lifted			4.904***	1.802***
			(0.334)	(0.452)
Extended control lifted				4.052***
				(0.608)
Category FE	YES	YES	YES	YES
Time FE	YES	YES	YES	YES
Observations	1,546,383	1,546,383	1,546,383	1,546,383

Notes: Observations are aggregated to the product and month level. Dependent variable is the percentage change in the product-specific monthly average price. Estimates remain quantitatively similar if covariates are added sequentially or all together. Robust standard errors in parenthesis. *** p<0.01, ** p<0.05, * p<0.1.

Table 4: Effect of price controls on non-controlled varieties and price dispersion

	NC Varieties		Price Dispersion	
	(1)	(2)	(3)	(4)
$\mathbb{1}\{$*Controlled this month*$\}$	0.418***	0.337***	0.052***	0.083***
	(0.0866)	(0.0708)	(0.018)	(0.019)
π_t				-0.002
				(0.003)
Constant	2.497***	1.404***	0.466***	0.750***
	(0.0313)	(0.0154)	(0.010)	(0.004)
Category FE	NO	YES	NO	YES
Time FE	NO	YES	NO	YES
Observations	65,276	65,021	68,077	67,771

Notes: Observations are aggregated to the category-URL and month level. In columns (1) and (2) the dependent variable is the log number of distinct (non-missing) non-controlled goods. In columns (3) and (4) the dependent variable is the coefficient of variation. We let $\mathbb{1}\{$*Controlled this month*$\}$ take 1 when a price ceiling affects any good on a certain URL-month. π is the online-measured monthly inflation rate. Coefficient remains similar if we control for inflation volatility and exchange rate depreciation. Categories are CPI sub-categories. Standard errors clustered at the URL level in parenthesis. *** p<0.01, ** p<0.05, * p<0.1.

Table 5: Inflation, Stockout, and New Varieties By Stage

	Isolated Controls	General Freeze	*Look to Care*	*Protected Prices*	
	Stage 1	Stage 2	Stage 3	Stage 4	All Stages
A - Monthly inflation:[a]					
(i) Products controlled	-0.78	2.37	-1.96	-0.43	-0.84
B - Probability of stockout:[b]					
(ii) 30 days after	0.27	0.23	0.20	0.42	0.28
C - New varieties:[c]					
(iii) Products controlled	0.32	-0.28	0.49	0.51	0.34

Notes: [a]Coefficient from the regression of product-specific monthly inflation rate (in percentage) on an indicator that takes 1 if the product received a price control during month t. Sample restricted to each stage period. The regression follows equation (1) in the main text, which includes category and time fixed effects. All coefficients are statistically significant at the 1% level. Complete estimates for the entire period are shown in Table 3. [b]Kaplan-Meier inverse probability of survival. This reproduces the survival analysis in Panel (b) of Figure 5. [c]Coefficient from the regression of category-URL non-controlled varieties (in logs) on an indicator that takes 1 if the product received a price control during month t. Sample restricted to each stage period. The regression follows equation (2) in the main text, which includes category and time fixed effects. All coefficients are statistically significant at the 1% level (except the coefficient from stage 2 which is not statistically significant).

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Targeted Price Controls on Supermarket Products
Diego Aparicio and Alberto Cavallo

A Online Appendix

A.1 Determinants of price controls

We expand on some of the key determinants of price controls. In relation to the price-wage control in the United States, Cox (1980) argues that policymakers balance between two forces: control industries with higher weight on the price index, while minimizing enforcement or inefficiency costs. One might expect that the degree of price controls is increasing in: the CPI weight of a given good, elastic demand or inelastic supply, industry concentration, or more homogenous goods. See also Galbraith (1952). The scraping technology applied to the selective program in Argentina offers an attractive setting to test for these determinants.

We formalize the analysis as follows. For each good sold online by the retailer, we manually matched each URL-based category with the official CPI categories from Argentina's NSO. This allows to obtain good-level weights. Industry concentration is approximated by the number of distinct available brands (or products) per URL, and homogenous goods are approximated by the average number of varieties per brand-URL. A good's brand is recognized by parsing out the scraped product description and keeping a string of letters with special font.[34] We then run simple Logit binary regressions of the controlled dummy on a series of covariates.[35]

Table 6 shows the results. $Controlled$ is a dummy variable equal to 1 if the good had a price control; *CPI Weight* is a good's CPI weight, which in our sample ranges from 0.03% to 6%; $Products$, $Brands$, and $Varieties$ are the number of distinct goods, brands, and varieties (in tens) per subcategory.

Coefficients are expressed in terms of the odds ratio. Consider, for instance, the specification in column (3). For a unit increase in the CPI weight (i.e. 1 percentage point), the odds of a control increase by 24%. The sign is consistent with the statistics in Section 3 showing that controlled-goods have a higher CPI weight relative to the other goods. The

[34]Once we obtain the number of brands (products), varieties, and good-level weights, we collapse the panel data into a cross-section by taking the average over time at the good level. One observation per ID is appropriate in our case since these variables tend to be stable over time. Controlled-goods only use information through the first price control to take into account that the number of varieties or products is affected once firms receive price controls. See Section 6.

[35]Results remain very similar under probit or OLS regressions, as well as using pooled category-level data. Table 7 shows the results for the OLS specification.

estimates also suggest that if the number of products in the URL increases by 10, i.e. a more competitive industry, the odds of a control decrease by over 7%. Price controls are also less likely the more varieties of the good.

Table 6: Determinants of price controls

	(1)	(2)	(3)	(4)	(5)	(6)
Controlled						
CPI Weight	1.232**	1.242**	1.237**	1.222*	1.280**	1.260**
	(0.120)	(0.132)	(0.129)	(0.127)	(0.133)	(0.127)
Products			0.929***			
			(0.0224)			
Brands				0.799***		0.778***
				(0.0639)		(0.0646)
Varieties					0.575***	0.522***
					(0.123)	(0.107)
Sector FE	NO	YES	YES	YES	YES	YES
Observations	38,908	38,908	38,908	38,908	38,908	38,908

Notes: Coefficients from Logit regressions expressed as odds-ratio. Dependent variable is an indicator that takes 1 if the product received a price control. Sectors are CPI broad categories. Standard errors clustered at the URL level in parenthesis. *** p<0.01, ** p<0.05, * p<0.1.

Table 7: Determinants of price controls

	(1)	(2)	(3)	(4)	(5)
Controlled					
CPI Weight	0.00876*	0.00764	0.00821*	0.00938*	0.00890*
	(0.00488)	(0.00498)	(0.00487)	(0.00486)	(0.00485)
Products		-0.00159***			
		(0.000490)			
Brands			-0.00475***		-0.00545***
			(0.00152)		(0.00169)
Varieties				-0.0136***	-0.0167***
				(0.00486)	(0.00499)
Sector FE	YES	YES	YES	YES	YES
Observations	38,908	38,908	38,908	38,908	38,908

Notes: Dependent variable is an indicator that takes 1 if the product received a price control. Standard errors clustered at the URL level in parenthesis. *** p<0.01, ** p<0.05, * p<0.1.

A.2 A model of price controls

We introduce a simple model to motivate the effects of targeted price controls on firms' pricing behavior. See Section 6 in the main text for the empirical evidence.

We assume consumers have unit demands per unit of time and preferences separable in quality and price (i.e. no income effects).[36] The indirect utility from consuming good i is given by

$$U(\theta, s_i, p_i) = \theta s_i - p_i \tag{3}$$

And zero if no good is purchased. Where s and θ stand for quality level and willingness-to-pay for quality. Consumers have heterogenous tastes over quality. We assume θ is uniformly distributed over the interval $[\underline{\theta}, \bar{\theta}]$ and a density of 1. For simplicity we report results for $\underline{\theta} = 0$ and $\bar{\theta} = 1$.

Although the monopolist cannot observe θ and perfectly discriminate, she can supply combinations of quality and price given the distribution of tastes and the market size.[37] We assume the monopolist supplies one good, and faces a fixed cost f_i per good

[36] Vertical differentiation models have become a standard framework in industrial organization since Mussa and Rosen (1978), Gabszewicz and Thisse (1979), Shaked and Sutton (1982), Tirole (1988), Moorthy (1988), and Cheng and Peng (2014).

[37] Note that θ can be reinterpreted as the inverse of the marginal rate of substitution between income and quality (Tirole (1988)). Therefore the above preferences can reflect consumers with identical tastes but

and variable quadratic costs of quality improvement $C(s)$, with $C'(s) > 0$ and $C''(s) > 0$. We assume the standard form $C(s) = \alpha s^2$.

The firm's problem can be described as a two-stage game: the monopolist chooses quality in the first stage and prices in the second. This sequence of decisions makes sense in our micro context. Once the retailer introduces good i, a salient quality attribute s is presumably fixed throughout the life of a good, whereas the price can more easily be updated.

In the absence of price controls, the optimal monopolist quality and price are $s^m = \frac{1}{3\alpha}$ and $p^m = \frac{2}{9\alpha}$.[38] Relative to a social planner who maximizes aggregate surplus, the monopolist supplies the same quality but serves half the market. Specifically, the social planner chooses $p^{sp} = \frac{1}{9\alpha}$ and thus $\hat{\theta}^{sp} = 1/3$, while $\hat{\theta}^m = 2/3$.

Now imagine that, with the intention of reducing prices to increase the pool of consumers for an essential good, the government imposes a binding price ceiling $\bar{p} = \tau p^m$, with $0 < \tau < 1$. We assume that firms are subject to capacity constraints. In other words, if $\bar{p}$ is set too low, the firm cannot possibly serve the entire demand. We thus let $D(s^m, \bar{p}) > \tilde{D} \equiv D(s^m, p^m)\gamma$, with $\gamma > 1$, be an upper bound to the aggregate demand that can be satisfied. To offset its impact, a firm could readjust quality or introduce a new good. These results are explained in the following Remarks.

Remark 1. *If price $\bar{p} < p^m$ is fixed but quality s is flexible, the monopolist downgrades quality regardless of the cost of quality improvement α.*

Proof. See Section A.3.2. □

Remark 2. *The monopolist benefits from introducing a new, higher price-quality variety. A new good also deters a rival firm from entering the market to steal excess demand.*

Proof. See Section A.3.3. □

The monopolist can reduce the price-ceiling burden by introducing a new and more expensive variety. This strategy results in higher profits relative to a wait-and-see (continue selling one good), and it prevents a rival firm from entering and exploiting a distorted product line. Let $\bar{p}_L$, s_L, and θ_L stand for the incumbent's price, quality, and marginal consumer for the (original) low-quality good. Then an entrant could introduce a better-quality good, H, and set p_H and s_H such that $\theta_H = \theta_L$, and steal the entire market.

heterogenous income (a higher θ denotes a lower marginal utility of income).

[38] See proof in Section A.3.1.

Where $\theta_H = \frac{\Delta p}{\Delta s}$ and $\theta_L = \frac{p_L}{s_L}$. Recall that $p_H > p_L = \bar{p}$ is possible, because price ceilings affect a subset of goods.[39]

Depending on the price ceiling, the capacity constraint, and the cost advantages, the monopolist can optimally crowd the product line, relative to an entrant that needs to position a new product. Moreover, that a monopolist may attenuate the impact of price controls through new products can be related to an extensive literature on brand proliferation and entry deterrence.[40]

Figure 7: Marginal consumers

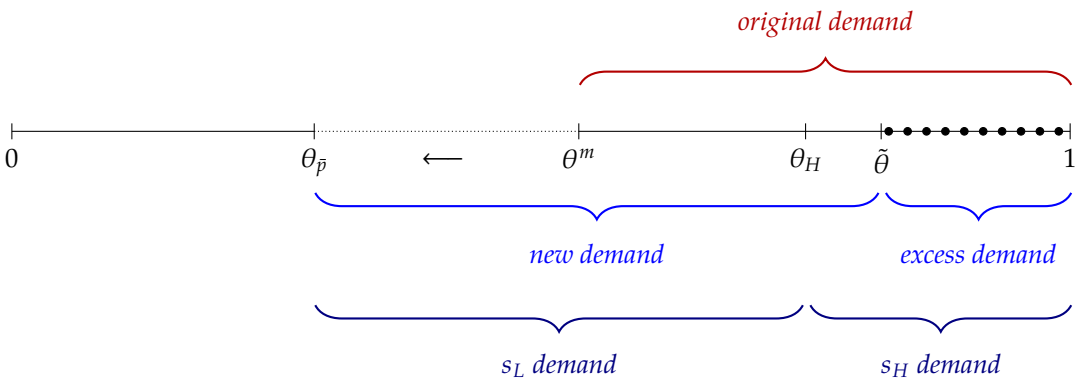

Figure 7 illustrates the main intuitions from the model. Initially, the firm sells a single good at price p^m, and demand is $1 - \theta^m$. A price ceiling $\bar{p} < p^m$ lowers the marginal consumer for the (original) low-priced s_L good from θ^m to $\theta_{\bar{p}}$. A sufficiently low price ceiling binds the capacity constraint and generates excess demand $(1 - \tilde{\theta})$ for the controlled good. To deter entry and benefit from the high willingness-to-pay consumers, the monopolist is incentivized to segment the market with a new and more expensive good s_H. This increases price dispersion within controlled categories. Introducing a new good is Subgame Perfect Nash Equilibrium (SPNE): it is only after the price control that the firm is better off supplying a second good. Interestingly, that price controls can increase market share is consistent with anecdotical evidence reported in the news.[41]

[39]The monopolist would prefer to discontinue the controlled good and introduce a similar variety. Alternatively, she could introduce a second good and, once controls are removed, discontinue the controlled good. We abstract from dynamic considerations but note that a richer model might consider strategic responses that depend on the expected duration of price controls and the probability of getting caught cheating. See Section A.4.

[40]See Caves and Porter (1977), Schmalensee (1982), and Urban, Carter, Gaskin, and Mucha (1986) on the advantages of pioneering brands, and Lutz (1997) on the monopolist's ability to deter (or accommodate) entry under vertical differentiation. See Hay (1976) and Schmalensee (1978) on brand proliferation.

[41]See footnote 29 in the main text for an example describing how price controls provide free advertising and facilitate access to new markets. In this model we assume consumers are perfectly informed about the attributes of the good; however, one might also think of advertising as a new margin to attract consumers under product differentiation (Grossman and Shapiro (1984)).

A.3 Proofs

A.3.1 Single-Product Monopolist

In the single product case with an uncovered market, demand is given by $\bar{\theta} - \hat{\theta}$, where $\hat{\theta}$ stands for the marginal consumer for which $\theta s - p \geq 0$. In stage two, price is set to maximize profits given quality, i.e. $p^*(s) = \frac{s(1+\alpha s)}{2} = \arg\max \left\{ \left(1 - \frac{p}{s}\right)\left(p - \alpha s^2\right) \right\}$. In stage one, quality is chosen to maximize $\pi\left(p^*(s), s\right)$. This yields $p^m = \frac{2}{9\alpha}$ and $s^m = \frac{1}{3\alpha}$. (The alternative solution $p^m = \frac{1}{\alpha}$ and $s^m = \frac{1}{\alpha}$ does not satisfy the second order conditions) Then $\hat{\theta} = \frac{2}{3}$. Fixed costs f_1 and f_2 are such that the firm decides to introduce one good. This holds as long as $f_2 > \frac{1}{\alpha}\frac{2}{675}$.[42]

A social planner who maximizes aggregate surplus would set a price such that $\max_p \int_{p/s}^{1} \left(\theta s - \alpha s^2\right) d\theta$. And then choose quality to maximize $AS\left(p(s), s\right)$. This yields $p^s = \frac{1}{9\alpha}$ and $s^s = \frac{1}{3\alpha}$, and thus $\hat{\theta} = \frac{1}{3}$. (The alternative solution $p^s = p^s = \frac{1}{\alpha}$ does not satisfy the second order conditions)

A.3.2 Proof of Remark 1

When $\bar{p}$ is fixed and exogenously set below p^m, the new optimal $\tilde{s}^m$ is lower than s^m. Let $\pi\left(\bar{p}(\tau, \alpha), s\right) - \pi\left(\bar{p}(\tau, \alpha), s^m\right)$ be the extra profit when s can be re-optimized. Replace $s^m = \frac{1}{3\alpha}$, $\bar{p} = \frac{2}{9\alpha}\tau$, and $s = \frac{1}{3\alpha}x$, where x is positive but finite. Then it can be shown that the profit difference is negative when $x > 1$, and does not depend on the cost α. Alternatively, one can think of the profit function $\pi(\tau, \alpha, s)$ in terms of monotone comparative statics. $\pi(\tau, \alpha, s)$ is a twice continuously differentiable function in (τ, s), and $\mathcal{T}$ and S can be thought of as convex. Then it can be shown that $\pi(\tau, \alpha, s)$ has increasing differences in (τ, s). In other words, the extra benefit of increasing s (quality) is higher when τ is higher.

Under the new price $\bar{p}$, the firm would like to set a lower quality $\tilde{s} < s^m$ regardless of cost α. The price is fixed, exogenously set by the government, and the product must be supplied. For instance, when $\tau = 0.9$, the new quality is about 7% lower. Although we cannot empirically measure quality, it is worth noting that quality downgrades substituting for price increases were common in past experiences. For instance, see Bourne (1919) on France in the years following the French Revolution, Darby (1976a) on the 1970s U.S. wage-price controls, Rockoff (2004) on the US during the World World II, or Moon and Stotsky (1993) on rent control programs in the US. However, downgrading quality, particularly in essential goods, can be costly in terms of reputation and fines.

[42] We assume costs take the standard form $C(s) = \alpha s^2$, and that they are independent of the quantity supplied. Convex quality costs are common in the literature (e.g., Mussa and Rosen (1978), Besanko, Donnenfeld, and White (1987)).

A.3.3 Proof of Remark 2

When the firm waits-and-sees, i.e. sit tight and wait until the price control is over, she obtains a profit equal to $\pi = D(\bar{p}, \tau, \gamma)\left(\frac{1}{9\alpha}\right)(2\tau - 1) - f_1$. Where $D(\bar{p}, \tau, \gamma) = \min\left\{\left(1 - \frac{2}{3}\tau\right), (1 - 2/3)\gamma\right\}$ to account for possible capacity constraints. However, wait-and-see is not SPNE, because a potential entrant now has extra incentives to serve the higher willingness-to-pay for quality consumers. In particular, the entrant would like to set s_H and p_H such that $\theta_H = \frac{\Delta p}{\Delta s} = \theta_L$, while also satisfying (1) $s_H > s_L$, (2) $p_H > p_L = \bar{p}$, (3) $\theta_H < 1$, and thereby steal the entire market. The extent to which an entrant can enter depends on α, τ, and the fixed cost differential across firms.

However, if τ or f_2 is low enough, the monopolist is better off introducing a new higher price-quality good.[43] This allows to capture the excess demand via market segmentation, i.e. discriminate between different θ-tastes for quality consumers. Let s_L and $p_L = \bar{p}$ denote the original's single-product optimal quality and afterwards controlled price, respectively. And then let s_H and p_H be the second product's optimal quality and price, respectively. The demand for good L and H are given by the marginal consumers θ_L and θ_H, namely $D_L = \frac{\Delta p}{\Delta s} - \frac{p_L}{s_L}$ and $D_H = \bar{\theta} - \frac{\Delta p}{\Delta s}$.

Formally, the firm's problem can be stated as follows[44]: $\max_{s_H} \pi\left(s_H, p_H^*(s_H), \tau, \alpha, \gamma\right)$ subject to the constraints (1) $p_L = \bar{p}_L$, (2) $s_L = s^m$, (3) $p_H > p_L$, (4) $s_H > s_L$, and (5) $\underline{\theta} < \theta_L < \theta_H < \tilde{\theta}(\gamma) < \bar{\theta}$, where we set $\underline{\theta} = 0$ and $\bar{\theta} = 1$. The firm's response is SPNE in the sense that it introduces a new good that, in the absence of price controls, it decided not to introduce.

A.4 Multi-product monopolist

We briefly mention the case of a multi-product monopolist. Consider a two-good monopolist that supplies a low quality good s_L at price p_L, and a high quality good s_H good at price p_H. In the absence of price controls, it can be shown that the optimal prices and qualities are $p_L = \frac{3}{25\alpha}$, $s_L = \frac{1}{5\alpha}$, and $p_H = \frac{7}{25\alpha}$, $s_H = \frac{2}{5\alpha}$. Now consider a price ceiling $\bar{p}_L < p_L$ on the low-priced good. Intuitively, the response depends on the trade-off between extra profits from introducing a third good, the magnitudes of fixed costs and

[43] Our model differs from previous work which focus on across-the-board price controls, e.g. Raymon (1983), Besanko, Donnenfeld, and White (1987), Besanko, Donnenfeld, and White (1988). For instance in Besanko, Donnenfeld, and White (1987) the monopolist offers a continuous quality array, and $p(\theta) < \bar{p}$, $\forall\theta$. The price controls that we study are only binding for a subset of goods.

[44] For simplicity it is assumed that the firm does not leave "holes" in the demand line when introducing a new good, i.e. no excess demand between θ_L and θ_H. Where $\tilde{\theta}$ stands for the maximum willing-to-pay consumer that can be supplied under binding capacity constraints. The same condition is used in A.4 for the multi-product monopolist.

quality costs, the lost excess demand from capacity constraints, and harshness of the price ceiling. The firm may want to re-adjust s_H and p_H, possibly through a price decrease and quality downgrade, wait-and-see if she is compelled to serve the excess demand, or finally introduce a third variety resulting in higher average non-controlled prices.

Formally, that the monopolist may want to decrease p_H leaving s_H constant follows from the first-order condition for p_H in the two-goods' problem: $p_H = \bar{p}_L + \frac{\Delta s}{2} + \frac{\alpha(s_H^2 - s_L^2)}{2}$. The first-order condition for s_H does not depend on p_L. If changing prices are subject to no product holes (serve excess demand), depending on the harshness of $\bar{p}_L$, costs α and f_i, and the degree of capacity constraints, the firm could either wait-and-see, i.e. ration supply for controlled-good s_L with no price changes, or introduce a third variety, possibly resulting in higher average quality at the expense of higher non-controlled price dispersion and higher average prices.

The constrained three-goods problem can be stated as follows:
$\max_{s_M, s_H} (\frac{\Delta p_M(s)}{\Delta s_M} - \frac{p_L}{s_L})(p_L - \alpha s_L^2) + (\frac{\Delta p_H(s)}{\Delta s_H} - \frac{\Delta p_M(s)}{\Delta s_M})(p_M(s) - \alpha s_M^2) + (\bar{\theta} - \frac{\Delta p_H(s)}{\Delta s_H})(p_H(s) - \alpha s_H^2) - f_1 - f_2 - f_3$ subject to (1) $p_L = \bar{p}_L$, (2) $s_L = s_L^m = \frac{1}{5\alpha}$, (3) $\bar{p}_L < p_M < p_H$, (4) $s_L < s_M < s_H$, and (5) $\underline{\theta} < \theta_L < \theta_M < \tilde{\theta}(\gamma) < \theta_H < \bar{\theta}$. We set $\underline{\theta} = 0$ and $\bar{\theta} = 1$.

The firm's problem with targeted price ceilings could be extended in several ways. A multi-firm problem would be better addressed using both horizontal and vertical differentiation, i.e. consumers have heterogeneous preferences over brands and quality, respectively. From stylized demands for differentiated products, where $q_L = a_L - b_L p_L + c p_H$ and $q_H = a_H - b_H p_H + c p_L$, one notes that the effects of price controls are not straightforward. The effects depend on price or quantity competition, strategic complements or substitutes, and the capacity constraints. Other domains to enhance the analysis are, for example, the effects of advertising, costly consumer search, consumer switching costs, anticipated and unanticipated price ceilings, and overshooting from costly price changes or stickiness. Aggressive price ceilings, even below marginal costs, can be related to literature on loss-leaders (Lal and Matutes (1994)).

A.5 Timeline of Price Controls

Table 8 shows summary statistics by stage. We find that, despite changes in the number of products under price controls, the government overall targeted a consistent basket of products and CPI categories. The observed changes in control time are also consistent with changes in the programs' intensity and the products' availability for sale.

Table 8: Timeline of Price Controls

		Isolated Controls	Total Freeze	*Look to Care*	*Protected Prices*
		Stage 1	Stage 2	Stage 3	Stage 4
(i)	Period	Oct 2007 to Feb 2013	Feb 2013 to May 2013	June 2013 to Nov 2013	Jan 2014 to May 2015[c]
(ii)	Public Information	No	No	Yes	Yes
(iii)	Same Goods all Retailers	No	No	No	Yes
(iv)	Target Number of Products	–	All	500	100
Information obtained from our data:					
(iv)	Goods Identified	651	-	599	660
(v)	CPI Categories	47	-	50	50
(vi)	Median Days Controlled[a]	70	-	183	35
(vii)	Percent of Time Under Controls[b]	22%	-	83%	44%

Notes: Stage 2 is excluded because the government aimed to freeze all food products and did not officially disclose the identifiers of controlled products. Our scraping algorithm identified a limited number of controlled goods (Section 3). [a]Median days under price controls is computed during the stage-specific period (row (i)). [b]Percent of time under price controls is computed during the stage-specific period and non-missing observations (in stock for sale). [c]Our data ends in May 2015, but the *Protected Prices* program continued after that. Details about the programs are in the main text.

A.6 Appendix Figures

A.6.1 Price Controls' Government Website

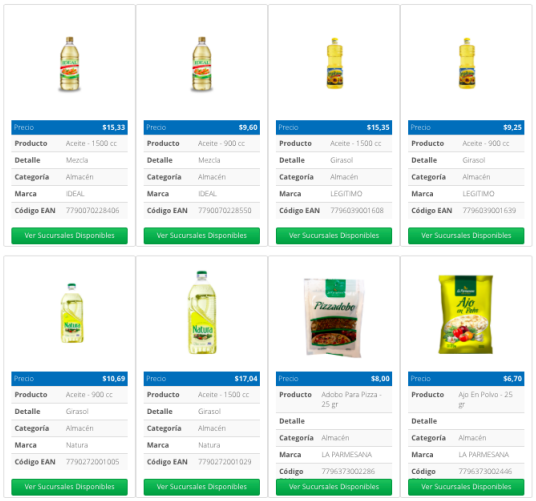

Figure 8: Example of controlled-goods in the City of Buenos Aires

Notes: Screenshot from the official government website on the targeted price control program. The list of controlled-goods include product details, price, and a sample picture. This allows a unique match against the online scraped database. Source: http://precioscuidados.gob.ar. Retrieved on July 14th, 2015.

A.6.2 Histogram Price Control Days

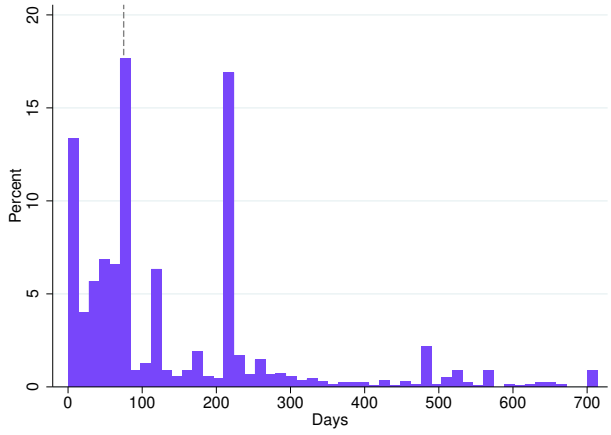

Figure 9: Histogram of Price Control Time

Notes: Axis restricted to two years for better visualization. Vertical line depicts a median control time of 75 days (average close to 120 days). Note that the estimates from this measure are subject to right-censoring, in particular for the most recent price control programs. Our scraping period stops in May 2015 but hundreds of products are still being controlled. The spike around 220 control days is driven by controlled-goods from stage 3.

A.6.3 Annual Inflation Rate and Monetary Policy

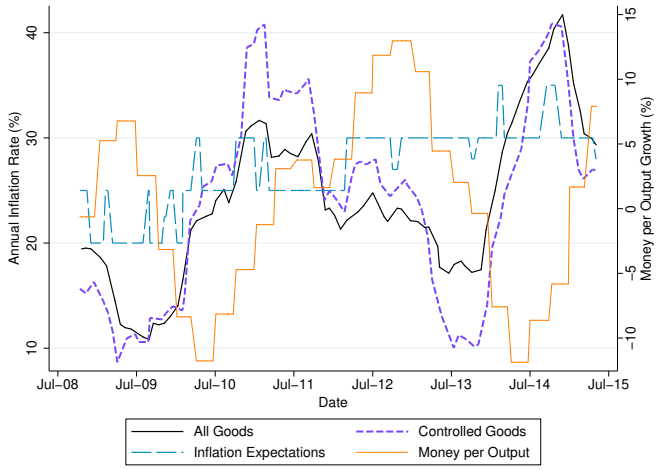

Figure 10: Price Controls and Money per Output

Notes: Median inflation expectations (next 12 months) surveyed by Universidad Torcuato Di Tella. Money per output calculated as the ratio of M2 to GDP. M2 is obtained from the Ministry of Finance and GDP from INDEC. Price indices computed as described in the text.

A.6.4 "Excess" Annual Inflation Rate

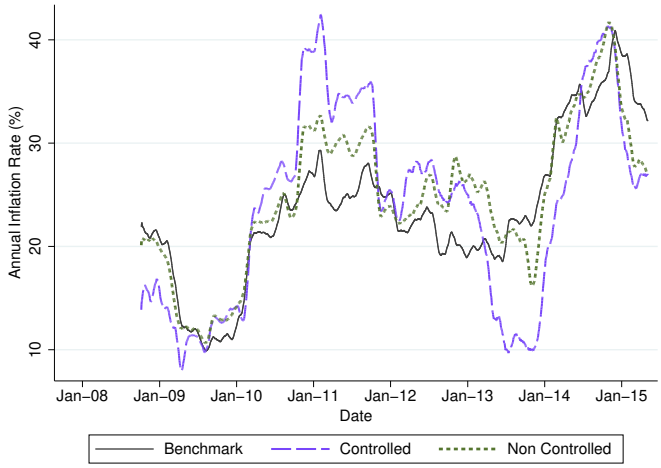

Figure 11: Excess Inflation

Notes: This figure shows greater inflation volatility for controlled-products. This is greater both relative to non-controlled products as well as a benchmark. Online price indices for controlled and non-controlled products are computed restricting the sample to controlled category-URLs. A benchmark price index is computed using non-controlled category-URLs. This provides a measure of "excess" inflation relative to categories that never received targeted price controls. Price indices are weighted using official weights by CPI categories.

A.6.5 Product Introductions and Discontinuities

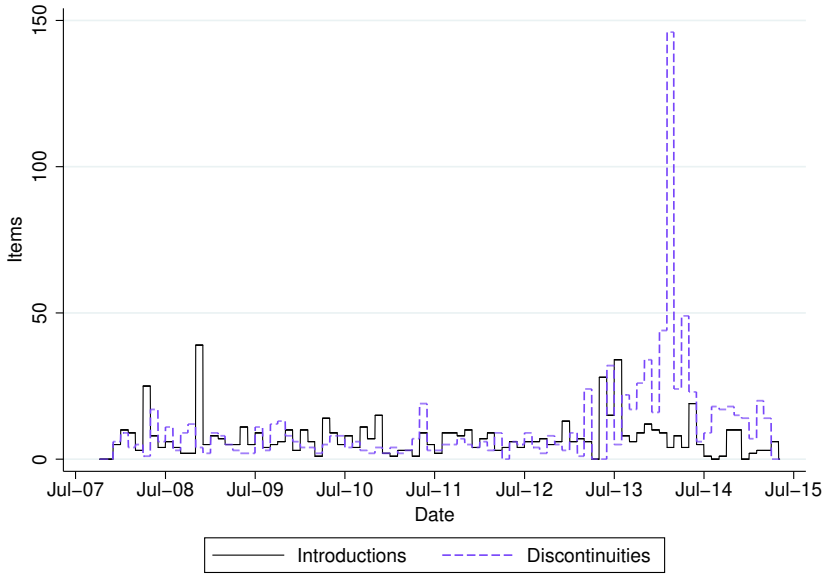

Figure 12: Introductions and Discontinuities

Notes: Calculated at the monthly level for controlled-goods.

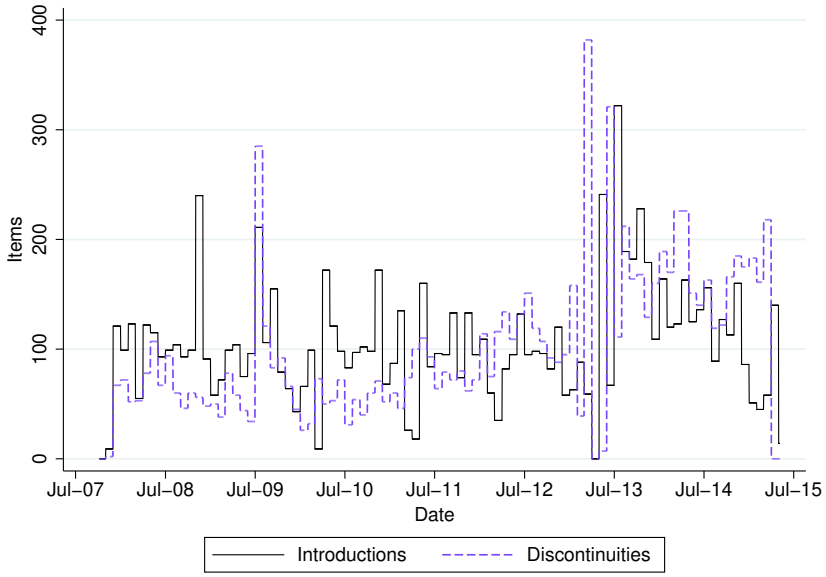

Figure 13: Introductions and Discontinuities

Notes: Calculated at the monthly level for non-controlled goods, restricting the sample to the same brands and retailer's categories that received price controls.