Targeted Price Controls on Supermarket Products

Diego Aparicio and Alberto Cavallo (2019)

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.¹ We then run simple Logit binary regressions of the controlled dummy on a series of covariates.²

Table 1 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

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¹Once 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.

²Results remain very similar under probit or OLS regressions, as well as using pooled category-level data. Table 2 shows the results for the OLS specification.
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 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 1: Determinants of Price Controls

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<td>38,908</td>
<td>38,908</td>
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</table>

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 2: Determinants of Price Controls

<table>
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</table>

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).\(^3\) The indirect utility from consuming good \(i\) is given by

\[
U(\theta, s_i, p_i) = \theta s_i - p_i
\]

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

Although the monopolist cannot observe \(\theta\) and perfectly discriminate, she can supply combinations of quality and price given the distribution of tastes and the market size.\(^4\) We assume the monopolist supplies one good, and faces a fixed cost \(f_i\) per good 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 \(p^m = \frac{2}{9\alpha}\).\(^5\) 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 \(D(s^m, \bar{p}) > \hat{D} \equiv D(s^m, p^m)\gamma\), with \(\gamma > 1\), be an upper bound to the aggregate demand


\(^4\)Note that \(\theta\) 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 heterogenous income (a higher \(\theta\) denotes a lower marginal utility of income).

\(^5\)See proof in Section A.3.1.
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 \( \alpha \).

*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 \( \theta_L \) 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. 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.\(^6\)

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.\(^7\)

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\(^6\)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.

\(^7\)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.
Figure 1 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 $\theta^m$ 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.\(^8\)

\(^{8}\)See Section 6 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. \( p^*(s) = \frac{s(1+\alpha)}{2} = \arg \max \left\{ (1 - p) (p - \alpha s^2) \right\} \). In stage one, quality is chosen to maximize \( \pi(p^*(s), s) \). This yields \( p^m = \frac{2}{\gamma \alpha} \) and \( s^m = \frac{1}{3 \alpha} \). (The alternative solution \( p^m = \frac{1}{\alpha} \) and \( s^m = \frac{1}{3 \alpha} \) does not satisfy the second order conditions)

\( \hat{\theta} = \frac{2}{3} \). Fixed costs \( f_1 \) and \( f_2 \) are such that the firm decides to introduce one good. This holds as long as \( f_2 > \frac{1}{\alpha} \frac{2}{675} \).

A social planner who maximizes aggregate surplus would set a price such that \( \max_p \int_{p/s}^1 (\theta_s - \alpha s^2) d\theta \). And then choose quality to maximize \( AS(p(s), s) \). 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 \( \bar{s}^m \) is lower than \( s^m \). Let \( \pi(\bar{p}(\tau, \alpha), s) - \pi(\bar{p}(\tau, \alpha), s^m) \) be the extra profit when \( s \) can be re-optimized. Replace \( s^m = \frac{1}{3 \alpha}, \bar{p} = \frac{2}{\gamma \alpha} \tau, \) 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 \( \alpha \). 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 \( (\tau, s) \), and \( T \) and \( S \) can be thought of as convex. Then it can be shown that \( \pi(\tau, \alpha, s) \) has increasing differences in \( (\tau, s) \). In other words, the extra benefit of increasing \( s \) (quality) is higher when \( \tau \) is higher.

Under the new price \( \bar{p} \), the firm would like to set a lower quality \( \bar{s} < s^m \) regardless of cost \( \alpha \). 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 War 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.

\footnote{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 \( \pi = D(\bar{p}, \tau, \gamma) \left( \frac{1}{3\alpha} \right) (2\tau - 1) - f_1. \) Where \( D(\bar{p}, \tau, \gamma) = \min \left\{ \left( 1 - \frac{2}{3} \tau \right), \left( 1 - \frac{2}{3}\right) \right\} \) 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 \( \alpha, \tau, \) and the fixed cost differential across firms.

However, if \( \tau \) or \( f_2 \) is low enough, the monopolist is better off introducing a new higher price-quality good.\(^{10}\) This allows to capture the excess demand via market segmentation, i.e. discriminate between different \( \theta \)-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 \( \theta_L \) and \( \theta_H, \) namely \( D_L = \frac{\Delta p}{\Delta s} - \frac{p_L}{s_L} \) and \( D_H = \tilde{\theta} - \frac{\Delta p}{\Delta s}. \)

Formally, the firm’s problem can be stated as follows\(^{11}\): \( \max \pi \left( s_H, p_H(s_H), \tau, \alpha, \gamma \right) \) subject to the constraints (1) \( p_L = \bar{p}_L, \) (2) \( s_L = s^L, \) (3) \( p_H > p_L, \) (4) \( s_H > s_L, \) and (5) \( \theta < \theta_L < \theta_H < \tilde{\theta}(\gamma) < \bar{\theta}, \) where we set \( \theta = 0 \) 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.

\(^{10}\)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.

\(^{11}\)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 \( \theta_L \) and \( \theta_H. \) 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.
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 \( p_L = \frac{3}{25a}, s_L = \frac{1}{5a}, \) and \( p_H = \frac{7}{25a}, s_H = \frac{2}{5a} \). 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 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: \( p_H = \bar{p}_L + \frac{\alpha}{2} + \frac{\bar{s}_L - s_L^2}{2} \). 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 \( \alpha \) 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:

\[
\max_{s_M,s_H} \left( \frac{\Delta p_M(s)}{\Delta s_M} - \frac{p_L}{s_L} \right) (p_L - \alpha s_L^2) + \left( \frac{\Delta p_H(s)}{\Delta s_H} - \frac{\Delta p_M(s)}{\Delta s_M} \right) (p_M(s) - \alpha s_M^2) + \left( \vec{\theta} - \frac{\Delta p_H(s)}{\Delta s_H} \right) (p_H(s) - \alpha s_H^2) - f_1 - f_2 - f_3 \text{ subject to} \begin{cases} p_L = \bar{p}_L, \quad s_L = s_L^m = \frac{1}{5a}, \\ \bar{p}_L < p_M < p_H, \quad s_L < s_M < s_H, \quad \text{and} \quad \vec{\theta} < \theta_L < \theta_M < \vec{\theta}(\gamma) < \theta_H < \vec{\theta}. \end{cases}
\]

We set \( \vec{\theta} = 0 \) and \( \vec{\theta} = 1 \).

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 \( q_L = a_L - b_Lp_L + cp_H \) and \( q_H = a_H - b_Hp_H + cp_L \), 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 3 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 3: Timeline of Price Controls

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<td></td>
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<td>Stage 2</td>
<td>Stage 3</td>
<td>Stage 4</td>
</tr>
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<td>No</td>
<td>Yes</td>
<td>Yes</td>
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<tr>
<td>(iii) Same Goods all Retailers</td>
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</tr>
<tr>
<td>(iv) Target Number of Products</td>
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<td>All</td>
<td>500</td>
<td>100</td>
</tr>
</tbody>
</table>

Information obtained from our data:

| (iv) Goods Identified | 651 | - | 599 | 660 |
| (v) CPI Categories    | 47  | - | 50  | 50  |
| (vi) Median Days Controlled<sup>a</sup> | 70  | - | 183 | 35  |
| (vii) Percent of Time Under Controls<sup>b</sup> | 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).<sup>a</sup>Median days under price controls is computed during the stage-specific period (row (i)).<sup>b</sup>Percent of time under price controls is computed during the stage-specific period and non-missing observations (in stock for sale).<sup>c</sup>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 2: Example of Controlled Products in the City of Buenos Aires

Notes: Screenshot from the official government website for 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. The website is still active as of September 2019.

A.6.2 Histogram Price Control Days

Figure 3: 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 4: 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 5: 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 categories. A benchmark price index is computed using non-controlled categories. 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 6: Introductions and Discontinuities

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

Figure 7: 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.
References


