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**The Case of Fluid-Milk Market in Israel**

**By**

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**On the Effectiveness of Price-Ceiling Regulations:  
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**Ziv Bar-Nahum,<sup>1</sup> Israel Finkelshtain<sup>1,2</sup> and Iddo Kan<sup>1,2</sup>**

**Abstract**

We integrate a differentiated goods oligopoly model with a political-economy model to assess the effectiveness of the partial price-ceiling policy in the Israeli fluid-milk market. We estimate minor political influence of the industry on regulators with respect to the price ceilings, and find markups in the regulated segment considerably lower than those in the unregulated one. Compared to a simulated unregulated industry, the prevailing partial price-ceiling regulation is found reducing market prices by 22% and markups by 78%, and increasing social welfare by 12%. The hypothesis of collusion in the unregulated segment is statistically rejected. We show that the combined estimates of political influence and demand substitution across products turn collusion in the laissez-faire segment an inferior strategy from the industry's perspective.

**Key words:** Partial regulation, price ceiling, lobbying, differentiated goods, collusion, fluid milk

**JEL:** D40, D78, L51

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# **On the Effectiveness of Price-Ceiling Regulations: The Case of Fluid-Milk Market in Israel**

## **Introduction**

Price ceilings are a common remedy to market-power abuse.<sup>1</sup> However, political power of the regulated firms and lobbying may impair the effectiveness of the price-controls by capturing the regulatory agency, and in extreme cases regulation could lead to lower welfare levels than laissez-faire markets (Dal Bo 2006). This dilemma has provoked a long lasting controversy in the economic literature (Laguerodie and Vergara 2008), traceable to the medieval debate over a "just price" (de Roover 1958).

Similarly to numerous industries throughout the world (Calzolari and Scarpa 2016), the dairy industry in Israel is subject to price regulations. Specifically to fluid milk, a subset of products, including regular pasteurized 1% and 3% fat fluid milk, are perceived as essential goods, and hence are subjected to maximum prices, whereas fortified and UHT milk products are unregulated. In this paper we develop an empirical framework for assessing the effectiveness of the price-ceiling policy in the presence of political pressures. In particular, the integration of laissez-faire and regulated products in this market enhances variability of markups across observations, which assists in identifying the industry's political influence, and thereby in assessing price-ceiling policies while accounting for regulatory-capture welfare effects.

Partial price regulation was first studied by Braeutigam (1979) in the context of second-best pricing, stressing the role of demand substitution across products in the regulated and unregulated market segments. Ware and Winter (1986) introduced market power to the laissez-faire segment, and Laffont and Tirole (1990) considered policymaking imperfections. Hence, substitution, industry structure and regulation distortions should all be accounted by empirical analyses of the effectiveness of partial price-ceiling regulations. We capture these three elements

by combining the political-economy model developed by Grossman and Helpman (1994) with the empirical industrial organization framework of differentiated-goods oligopoly developed by Berry (1994), Berry et al. (1995), Nevo (2001), and others.<sup>2</sup>

The model considers fluid milk being a differentiated good produced by multi-product firms that concurrently operate in an oligopolistic environment (Lopez and Lopez 2009, Chidmi and Murova 2011, Cohen 2013, Bonnet and Bouamra-Mechemache 2016) and strive for regulatory capture. Specifically, the dairy firms are assumed engaged in an integrated game, involving oligopolistic interactions in the laissez-faire segment of the market and lobbying with respect to price ceilings in the regulated segment, where both policymakers and firms account for the demand substitutions across intra- and inter-segment products. Equilibria in the two segment-specific games are assumed to occur simultaneously: maximum prices emerge as equilibrium in a menu-auction game involving the government and the regulated-product producers, whilst the unregulated prices constitute Bertrand-Nash equilibrium in an oligopolistic pricing game. Adopting the Nested Logit (NL hereafter) demand specification, the model yields a system of estimable structural equations incorporating the demand function and two interrelated segment-specific equilibrium-price equations. The model identifies cost and demand parameters, cross-products demand substitution, and an additional structural parameter commonly used in the political-economy literature to measure the political influence of interest groups (e.g., Zusman 1976, Grossman and Helpman 1994, Finkelshtain and Kislev 1997 and Fredriksson 1997).

Our dataset is a panel of nearly 100,000 observations of monthly-aggregated fluid-milk-product scanner data for the years 2005-2011, comprising 33 products in seven geographical regions, five store types and two population sectors (ultra-orthodox and others). We estimate the model by employing the Generalized Methods of Moments (GMM). Our estimation of the

political-influence parameter indicates that policymakers' preference of social welfare is 16 times larger than that of political rewards from interest groups; this is congruent with many previous estimates (Gawande and Magee, 2012). Despite this statistically-significant evidence for regulatory capture, the industry's political influence is too small to turn the regulation socially unwarranted. Our simulations find that the prevailing partial price-ceiling regulation reduces prices by 22% and increases social welfare by 12% compared to an inclusive unregulated oligopolistic industry. Thus, the market power exercised by the dairy firms in Israel dominates their abuse of political power via lobbying.

In addition to welfare assessments, we analyze two inter-segment implications of the fluid-milk partial price-ceiling policy. The first refers to the aforementioned substitution: lesser political influence entails lower price ceilings, which in turn yields lower unregulated market prices. This regulation-spillover effect is expected in oligopolistic industries: producers of unregulated products reduce prices in response to a reduction in the prices of the substitutive regulated commodities. Substitution implies that governments can affect the prices of all products in a market by regulating only a subset of them.

The second inter-segment issue refers to the market structure of the laissez-faire segment. Collusion in that segment is motivated by potential gains to the collaborators, and considerable efforts were devoted to understand how collusion is formed and sustained in the presence of such incentives (e.g., Bernheim and Whinston 1990, Chang 1991, Parker and Röller 1997, Ciliberto and Williams 2014). However, these questions lose their relevancy when collusion benefits vanish. We show that collusion gains can fade away in a partially regulated market with multiproduct firms operating in both market segments. A combination of two factors dictates this result: the industry's political power and the demand substitution across products. Larger

substitution increases firms' gains from collusion in the laissez-faire segment, as well as their incentives to lobby for higher maximum prices. At the same time, however, it increases the government's influence on unregulated prices through the price ceilings. Hence, if the government is sufficiently benevolent, higher unregulated prices ensued by collusion may end up with lower equilibrium price ceilings. Consequently, collusion in the laissez-faire segment may be inferior from the industry's perspective. Our empirical results indicate that this is the case in the Israeli fluid-milk market. Using the empirical testing approach suggested by Verboven (1996) we reject collusion with respect to unregulated products, and by simulations we show that, indeed, the aggregated two-segment producer surpluses under collusion in the laissez-faire segment is lower compared to the oligopolistic-equilibrium alternative. We further compute combined levels of political influence and substitution beyond which collusion becomes the industry's favorable strategy.

The following sections provide an overview of the Israeli dairy sector, describe the integrated industrial-organization-political-economy model, detail the empirical specifications and data, present the estimation results, assess the regulation efficiency, and summarize with some concluding remarks.

### **The Israeli Dairy Sector**

Governmental intervention in dairy industries is widespread throughout the world (see Bonnet and Bouamra-Mechemache 2016, Cakir and Balagtas 2012, Chidmi and Murova 2011), but the Israeli policy of assigning price ceilings to a subset of fluid-milk products is unique, and constitutes an opportunity to investigate the effectiveness of price-ceiling regulations.

Noncompetitive conditions and strong indications for regulatory capture characterize the entire supply chain of the Israeli dairy industry. High import tariffs and geo-political isolation

protect the industry from import (OECD 2010). In addition, according to the Dairy Sector Planning Commandment (2011), milk production is controlled by a system of individual milk-production quotas, with sanctions of fines and 3 months imprisonment for production above the quotas. These quotas are set by the Israeli Dairy Board (IDB), with a strong influence by the industry.<sup>3</sup> The price at the farm-gate, known as the “target price,” is also determined administratively by the IDB, who conducts surveys of dairy-farm profitability every 2 years and uses cost indices for quarterly updates.

Table 1 about here

The processing and marketing levels are highly concentrated, particularly in the processing stage, dominated by the Tnuva Company (see Table 1). By virtue of the Control of Commodities and Services Law (1996), a number of staple fluid-milk commodities are subjected to price ceilings. The share of the regulated products in total dairy market-sales value is about 23% (Kachel 2011). The fluid-milk industry produces four types of regulated products with a share of 70% out of total sales value: regular fresh milk of 3% and 1% fat contents, sold in a 1-liter carton or plastic bag. Products with similar characteristics are also subjected to the regulation (e.g., the 2-liter version of the aforementioned regulated products), with a total market share of nearly 10%. The regulated products and their price ceilings are set by the Price Inspection Committee (PIC)<sup>4</sup> based on classification of product characteristics such as calcium content, package type, etc., but not according to brands; as will be discussed, this regulatory practice casts on the formulation of the equilibrium conditions underlying the price-ceilings political game.

The group of regulated products rarely changes, and during our sample period (2005 to 2011), UHT 3%-fat fluid-milk has been the only product released from price control. On the other hand, the price ceilings are routinely updated. The official procedure of maximum-price



computation integrates elements from both the rate-of-return and price-cap regulations (Armstrong and Sappington 2007): the ceilings should retain the rate-of-return of the producers' capital investment in the range of 6%-12%, where prices are updated at least once a year, or earlier if a price index of a basket of inputs (known as the “Suari” formula) varies by more than 3% (Ministry of Economy and Industry 2016). This decision-making process leaves sufficient room for price bending in favor of interest groups,<sup>5</sup> and there are cumulative evidences for the dominance of political pressures by milk manufacturers,<sup>6</sup> including even illegal practices (State Comptroller of Israel, 2007, 2012). Still, prices of unconfined dairy products are consistently higher (Kachel 2011, Ofek 2012, Flaig et al. 2013); among them is the 250-grams 5%-fat cottage cheese, whose price-increase triggered a consumer boycott—one of the sparks of the “Israeli Social Justice Protest” in 2011 (Hendel et al. 2016). These pros and cons of the price-ceiling policy call for a rigorous empirical analysis.

### **Preliminary Analysis**

We begin by a reduced-form analysis of a small natural experiment. As aforementioned, the UHT 3%-fat fluid milk has been exempted from the regulation. Based on the deregulation timing (May 2008), we conduct a difference-in-difference analysis of the UHT 3%-fat Tnuva 1-liter Carton product, using the Regular 3%-fat Tnuva 1-liter Carton as a control.<sup>7</sup> Table 2 reports a \$0.078/l statistically significant price increase attributable to the regulation exemption. That is, the price would have been nearly 5% lower had the regulation kept in the follow-up period. In addition, we test for a potential regulation-spillover effect on the substitutive unregulated UHT 1%-fat Tnuva 1-liter Carton product, using the unregulated Enriched 1%-fat Tnuva 1-liter Carton product as the control; a statistically significant price increase of \$0.049/l (about 2.7% of the

follow-up price) is ascribable to the substitution effect. These indications motivate a structural analysis of the regulation effectiveness with respect to the entire set of fluid-milk products.

Table 2 about here

## The Model

We adopt the NL framework developed by McFadden (1978), Berry (1994), and others. Despite the drawbacks of the NL model compared to random-coefficient models (e.g., Berry et al. 1995 and Nevo 2001), it considerably reduces computation burden, and, as shown by Grigolon and Verboven (2014), NL generates sufficiently reliable policy conclusions, which are the focus of our study.<sup>8</sup>

### Demand

Consider a fluid milk industry producing a set  $\Omega$  of  $K$  differentiated products, ( $k = 1, \dots, K$ ), sold in  $T$  markets ( $t = 1, \dots, T$ ). In addition, an outside good, denoted  $k = 0$ , is available for consumption instead of any of the industry's  $K$  goods. Following the NL specification, the  $K + 1$  products are assumed to be grouped into  $G + 1$  categories, where category  $g = 0$  includes only the outside good. Thus,  $\Omega_t$  and  $\Omega_{gt}$  are the sets of all products sold in market  $t$  and those belonging to category  $g$  in market  $t$ , respectively. While the NL formulation is criticized for its reliance on arbitrary product categorization, we adopt the actual shelf-arrangement classification employed in a typical Israeli supermarket.

Let  $\tilde{s}_{kt}$  be the probability to consume product  $k$  in market  $t$  conditional on category  $g$  being chosen:

$$\tilde{s}_{kt} = \frac{e^{\frac{\delta_{kt}}{1-\sigma}}}{D_{gt}^\sigma \left( \sum_g D_{gt}^{1-\sigma} \right)} \quad (1)$$

where  $D_{gt} \equiv \sum_{k \in \Omega_{gt}} e^{\frac{\delta_{kt}}{1-\sigma}}$ , in which  $\delta_{kt} \equiv \mathbf{x}_{kt}\boldsymbol{\beta} - \alpha p_{kt} + \xi_{kt}$  is the mean utility from product  $k$  in market  $t$ ;  $\mathbf{x}_{kt} = (x_{kt}^1, \dots, x_{kt}^U)$  is a vector of  $U$  observable product characteristics;  $p_{kt}$  is the price of product  $k$  in market  $t$ ;  $\xi_{kt}$  represents the mean valuation of unobservable product characteristics, and  $\alpha$ ,  $\boldsymbol{\beta}$ , and  $\sigma$  ( $0 \leq \sigma < 1$ ) are coefficients of interest, where  $\sigma$  represents the level of intra-category substitution across products compared to the substitution across categories. To tie probabilities to observable market shares, define  $q_{kt}$  (liters) as the total sales of product  $k$  at market  $t$ , and let  $M_t = \sum_{k \in \Omega_t} q_{kt}$  ( $k = 0, \dots, K$ ) be the total sales in market  $t$ , and  $Q_{gt} = \sum_{k \in \Omega_{gt}} q_{kt}$  the sales of all category- $g$ 's products in market  $t$ ; then,  $s_{kt} = q_{kt}/M_t$  and  $s_{kgt} = q_{kt}/Q_{gt}$  are, respectively, the market shares of product  $k$  out of the total sales in market  $t$  and out of total sales of the specific category  $g$  comprising product  $k$ . By use of Eq. (1), the estimable NL demand equation becomes

$$\ln\left(\frac{s_{kt}}{s_{0t}}\right) = \mathbf{x}_{kt}\boldsymbol{\beta} - \alpha p_{kt} + \sigma \ln(s_{kgt}) + \xi_{kt} \quad (2)$$

where  $s_{0t} = q_{0t}/M_t$  is the share of the outside good in market  $t$ . Eq. (2) implies that  $q_{kt} = q_{kt}(\mathbf{p}_t)$ , where  $\mathbf{p}_t$  is the vector incorporating the prices of all products in market  $t$ , and

$\frac{\partial q_{kt}}{\partial p_{kt}} < 0$  and  $\frac{\partial q_{kt}}{\partial p_{zt}} > 0$  for all  $z \neq k$ .<sup>9</sup> In addition, the market- $t$ 's consumer surpluses are

$$CS_t = M_t \frac{\ln\left[\sum_g D_{gt}^{(1-\sigma)}\right]}{\alpha} \quad (3)$$

## Supply

The set  $\Omega$  of  $K$  differentiated products is produced by an oligopolistic industry with  $F$  multiproduct firms. A predetermined subset  $\Omega^r$  of  $L \leq K$  products is subjected to administrative price ceilings, while the subset  $\Omega^n$  of  $J = K - L$  products are unregulated. We denote by  $j = 1, \dots, J$  and  $l = 1, \dots, L$  unregulated and regulated products, respectively. Accordingly,  $\mathbf{p} = (\mathbf{p}^n, \mathbf{p}^r)$ , with  $\mathbf{p}^n = (p_1^n, \dots, p_J^n)$  and  $\mathbf{p}^r = (p_1^r, \dots, p_L^r)$  for the non-regulated and regulated products, respectively (for notation brevity, we mark the market index  $t$  only when necessary).

A firm  $f$ ,  $f = 1, \dots, F$ , sells the set  $\Omega_f$  of products ( $\Omega_f \subseteq \Omega$ ), which includes the sets  $\Omega_f^n$  and  $\Omega_f^r$  of non-regulated and regulated products, respectively. Let  $c_k$  and  $C_f$  be, respectively, product- $k$ 's marginal cost and firm- $f$ 's fixed costs; firm- $f$ 's profit is

$$\pi_f(\mathbf{p}) = \sum_{j \in \Omega_f^n} (p_j^n - c_j) q_j(\mathbf{p}) + \sum_{l \in \Omega_f^r} (p_l^r - c_l) q_l(\mathbf{p}) - C_f \quad (4)$$

The firms in the dairy sector are envisaged as engaging in a simultaneous Bertrand game with respect to the prices of the  $J$  unregulated products, and a menu-auction lobbying game with regard to the price ceilings of the  $L$  regulated products. The set of strategies of each firm includes the prices of the laissez-faire set of products  $\Omega^n$ , as well as the choice of political contributions. The latter specifies the political contributions of the firms as a function of the government's vector of price ceilings. The proof of existence of equilibrium in the integrated game is beyond our scope. Rather, we assume pure-strategy equilibrium in the combined game, noting that the necessary conditions for equilibrium in each game constitute necessary conditions for equilibrium in the integrated game, and can therefore be employed to derive structural equations for the empirical analysis.

For the laissez-faire set of products  $\Omega^n$ , following Berry et al. (1995), Goldberg (1995), Verboven (1996), Nevo (2001) and others, the  $J$  unregulated Bertrand-Nash equilibrium prices  $\mathbf{p}^{n*}$  satisfy  $J$  necessary conditions

$$\mathbf{p}^{n*} = \mathbf{c}^n + [\mathbf{\Delta}^{nn}]^{-1} [\mathbf{q}^n(\mathbf{p}) - \mathbf{\Delta}^{nn}(\mathbf{p}^r - \mathbf{c}^r)] \quad (5)$$

where  $\mathbf{\Delta}^{nn}$  is a  $J \times J$  matrix with a typical element  $\Delta_{ij}^{nn} = \Delta_{ij}^{*nn} \circ q_{ij}^{nn}$ , with  $q_{ij}^{nn} = -\partial q_j / \partial p_i$ ,

$i, j = 1, \dots, J$ ,  $\Delta_{ij}^{*nn} = \begin{cases} 1 & \text{if } \exists f : \{i, j\} \subset \Omega_f \\ 0 & \text{otherwise} \end{cases}$  and  $\circ$  is the Hadamard operator (element-by-element

multiplication);  $\mathbf{\Delta}^{rn}$  is a  $J \times L$  matrix with a typical element  $\Delta_{il}^{rn} = \Delta_{il}^{*rn} \circ q_{il}^{rn}$ , with

$q_{il}^{rn} = -\partial q_l / \partial p_i$ ,  $i = 1, \dots, J$ ,  $l = 1, \dots, L$  and  $\Delta_{il}^{*rn} = \begin{cases} 1 & \text{if } \exists f : \{i, l\} \subset \Omega_f \\ 0 & \text{otherwise} \end{cases}$ ;  $\mathbf{c}^n$  and  $\mathbf{q}^n(\mathbf{p})$  are  $J \times 1$

vectors of marginal costs and sales of the unregulated products, respectively, and  $\mathbf{c}^r$  is an  $L \times 1$  vector of regulated product's marginal costs.

Regarding the regulated products, for simplicity we assume that all price ceilings constitute effective upper limits; that is, no firm has an interest to charge below the ceiling of any of its regulated products. We adopt the political-game framework used by Grossmann and Helpman (1994) and others for a non-cooperative political game under complete information, and rely on the micro-foundations developed by Finkelshstein and Kislev (1997): given the unregulated prices  $\mathbf{p}^n$ , the  $L$  equilibrium price ceilings  $\mathbf{p}^{r*}$  are obtainable as a solution to the linear problem

$$\max_{\mathbf{p}^r} R(\mathbf{p}) = \Pi(\mathbf{p}) + aW(\mathbf{p}) \quad (6)$$

where  $\Pi(\mathbf{p}) = \sum_F \pi_f(\mathbf{p})$  is the firms' total profits,  $a$  is a non-negative political parameter which stands for the weight assigned to social welfare by the decision makers, and  $W(\mathbf{p})$  is the social welfare, which sums the consumers' surpluses and producers' profits; using Eq. (3),

$$W(\mathbf{p}) = M \frac{\ln \left[ \sum_g D_g^{(1-\sigma)} \right]}{\alpha} + \sum_F \pi_f(\mathbf{p}) \quad (7)$$

Incorporating Eqs. (4) and (7) into Eq. (6), and recalling that

$$\partial \left( M \ln \left[ \sum_g D_g^{(1-\sigma)} \right] / \alpha \right) / \partial p_l^r = -q_l^r,^{10} \text{ we derive the vector of political equilibrium price ceilings}$$

$\mathbf{p}^{r*}$  as the one satisfying  $L$  first-order conditions

$$\mathbf{p}^{r*} = \mathbf{c}^r + [\mathbf{\Lambda}^{rr}]^{-1} \left[ \frac{\mathbf{q}^r(\mathbf{p})}{1+a} - \mathbf{\Lambda}^{nr}(\mathbf{p}^n - \mathbf{c}^n) \right] \quad (8)$$

where  $\mathbf{\Lambda}^{rr}$  is an  $L \times L$  matrix with a typical element  $q_{hl}^{rr} = -\partial q_l / \partial p_h$ ,  $h, l = 1, \dots, L$ ;  $\mathbf{\Lambda}^{nr}$  is an  $L \times J$  matrix with a typical element  $q_{hj}^{nr} = -\partial q_j / \partial p_h$ ,  $h = 1, \dots, L$ ,  $j = 1, \dots, J$ , and  $\mathbf{q}^r(\mathbf{p})$  is an  $L \times 1$  vector of sales of the regulated products.

Inspecting Eqs. (8) and (5), the markups (right elements in the respective right-hand sides) are interlinked through the matrices of substitutions between products that face different regulation policies,  $\mathbf{\Lambda}^{rn}$  and  $\mathbf{\Lambda}^{nr}$ . In other words, Eq. (5) is the laissez-faire Bertrand-Nash oligopolistic-equilibrium prices given the regulated prices  $\mathbf{p}^r$ , and Eq. (8) represents the political equilibrium prices given the unregulated prices  $\mathbf{p}^n$ . We assume the existence of a simultaneous equilibrium such that the joint solution to both equation systems forms the set of equilibrium prices  $\mathbf{p}^* \equiv (\mathbf{p}^{n*}, \mathbf{p}^{r*})$ :

$$\mathbf{p}^{n*} = \mathbf{c}^n + \Delta^{nm^{-1}} \left[ \mathbf{q}^n(\mathbf{p}^*) - \Delta^m \left[ I - \Delta^{rr^{-1}} \Delta^{nr} \Delta^{nm^{-1}} \Delta^m \right]^{-1} \Delta^{rr^{-1}} \left[ \frac{\mathbf{q}^r(\mathbf{p}^*)}{1+a} - \Delta^{nr} \Delta^{nm^{-1}} \mathbf{q}^n(\mathbf{p}^*) \right] \right] \quad (9a)$$

$$\mathbf{p}^{r*} = \mathbf{c}^r + \left[ I - \Delta^{rr^{-1}} \Delta^{nr} \Delta^{nm^{-1}} \Delta^m \right]^{-1} \Delta^{rr^{-1}} \left[ \frac{\mathbf{q}^r(\mathbf{p}^*)}{1+a} - \Delta^{nr} \Delta^{nm^{-1}} \mathbf{q}^n(\mathbf{p}^*) \right] \quad (9b)$$

From Eqs. (9) we derive estimable structural pricing equations; however, let us first discuss a few implications of these equilibrium conditions. Consider the interpretation assigned to the inter-product substitution matrices  $\Delta^{nn}$  and  $\Delta^{mm}$  in Eq. (5) versus  $\Delta^{rr}$  and  $\Delta^{nr}$  in Eq. (8). Given the assumed oligopolistic structure of the laissez-faire segment, the matrixes  $\Delta^{nn}$  and  $\Delta^{mm}$  incorporate the substitution between every unregulated product and the products produced by the same firm only. On the contrary, the matrixes  $\Delta^{rr}$  and  $\Delta^{nr}$  incorporate the substitution between the regulated products and all the other industry's products. This structure stems from the specific price-ceiling regulation: the government sets maximum fluid-milk prices based merely on product characteristics. Since brands are not discriminated, all firms benefit from lowering the price ceilings of all regulated products, implying no rivalry across firms. Accordingly, we shape the equilibrium conditions based on the following two corollaries from Grossmann and Helpman (1994) (p. 846-7): (1) “...a lobby that faces no opposition from competing interests captures all of the surplus from its political relationship with the government,” and (2) “...with no political rivalry between the special interests, each industry group captures all of the surplus from its own political relationship with the government.” This political equilibrium results with a collusion-like solution. Indeed, highly concentrated industries such as the Israeli dairy firms are expected to utilize joint-lobbying economies of scale (Mitra 1999, Bombardini 2008), and the price ceilings themselves may facilitate collusion in the regulated segment by serving as a focal point for tacit agreements among firms (Knittel and Stango 2003). On the other hand, producers of

differentiated goods tend to lobby separately (Bombardini and Trebbi 2012). Owing to the non-rivalry property, the price-ceiling equilibrium conditions resemble a collusive solution, regardless of whether firms explicitly corporate lobbying efforts or not.

Note that firms may collude in the laissez-faire segment; perfect collusion implies a special case of  $\Delta^m$ , denoted  $\tilde{\Delta}^m$ , in which the typical elements are  $\tilde{\Delta}_{ij}^m = q_{ij}^m \equiv -\partial q_j / \partial p_i$  for all  $i, j = 1, \dots, J$ . However, unlike the regulated-segment's collusion-like outcome, which results from political-economy equilibrium conditions even in the absence of actual collusive lobbying, a cartel solution in the laissez-faire segment does not satisfy equilibrium conditions.

Our settings so far imply that welfare in the partially regulated fluid-milk market depends on the set of regulated products  $\Omega'$ , the level of collusion in the laissez-faire segment, the cross-products demand substitution, and the political parameter  $a$ . To illuminate the welfare implications of  $a$ , consider a fully regulated versus a pure laissez-faire market: in view of Eqs. (9), the equilibrium under a whole-market regulation rests in the competitive-cartel range of solutions, whereas under a completely unregulated market only the oligopolistic-cartel range is valid.<sup>11</sup> This implies that a policy that sets an inclusive price-ceiling regulation (i.e.,  $\Omega' = \Omega$ ) enlarges the range of possible equilibria so as to include the competitive one, and thereby enables the highest level of social welfare; however, it doesn't guarantee the realization of social welfare levels higher than those obtained under an entire laissez-faire regime, as the rank of the two policies depends on  $a$ . This holds true for any partial regulation regime ( $\Omega' \subset \Omega$ ). In relation to Stigler's (1971) theory, if policy makers are sufficiently willing to be captured, firms may even favor the maximum-price policy.

Inspecting Eq. (9b), larger levels of  $a$  induce lower regulated prices. Eq. (9a) shows that, as long as regulated products are substitutes to unregulated ones ( $\Delta^m \neq \mathbf{0}$ ), also the unregulated



prices become lower as  $a$  grows; this is an intuitive response of oligopolistic firms to the reduction in the prices of their products' regulated substitutes. Thus, by regulating a portion of a market, policy makers can exploit the spillover-substitution effect to reduce unregulated prices.

Likewise, Eq. (9b) implies that if unregulated products are substitutes to regulated products ( $\Delta^{nr} \neq \mathbf{0}$ ), exogenous changes that alter the unregulated prices would cast on the regulated ones. One of the potential changes is the emergence of collusion in the laissez-faire segment; that is, when  $\tilde{\Delta}^{nr}$  replaces  $\Delta^{nr}$ . Later on we show empirically that, for a given  $\Delta^{nr}$ , there may be a threshold level of  $a$  beyond which collusion with respect to unregulated products ends up with lower regulated prices. The intuition in a political-economy context is as follows: if prices in the unregulated segment become higher due to collusion, a benevolent government (i.e., with a large-enough level of  $a$ ) would lower the price ceilings so as to attract consumption of regulated products, and thereby impose lower non-regulated prices through the substitution effect; in contrast, captured regulators would support the industry's interests by setting higher price ceilings. This implies that both the substitution effect and the industry's political influence may dictate whether collusion with respect to unregulated products is warranted or not: if under collusion the regulated prices are sufficiently low compared to their non-collusion counterparts, the overall producer surpluses in the market may also be lower. Thus, by regulating a portion of a market's products, policymakers may inhibit collusion in the unregulated segment.

### Empirical Framework

We now employ the NL specifications to Eqs. (9) so as to derive a system of estimable structural price equations based on observations in  $T$  markets. Following Verboven 1996, Fershtman and Gandal 1998, and others, suppose that the price of any product  $k$  in category  $g$  ( $g = 1, \dots, G$ ) is set by the relevant agents (i.e., firms and regulators) while accounting for the product's

substitutability only with respect to other products included in category  $g$ . Let  $\Omega_{fgt}^n$  and  $\Omega_{fgt}^r$  be, respectively, the non-regulated and regulated sets of firm- $f$ 's products belonging to category  $g$  and sold in market  $t$ , and  $\Omega_{gt}^n = \sum_F \Omega_{fgt}^n$  and  $\Omega_{gt}^r = \sum_F \Omega_{fgt}^r$  are the respective sets of all non-regulated and regulated products in a category. Farther define  $V_{fgt}^n = \Psi_{gt} \sum_{j \in \Omega_{fgt}^n} q_{jt}$ ,  $V_{fgt}^r = \Psi_{gt} \sum_{l \in \Omega_{fgt}^r} q_{lt}$

and  $V_{gt}^r = \Psi_{gt} \sum_{l \in \Omega_{gt}^r} q_{lt}$ , where  $\Psi_{gt} = \frac{\sigma}{Q_{gt}} + \frac{1-\sigma}{M_t}$ . Then, Eqs. (9) become

$$\frac{p_{jt}^{n*}}{1+v} = \mathbf{c}_{jt} \boldsymbol{\gamma}^n + \frac{1-\sigma}{\alpha(1+v)} \left[ \frac{1}{1-V_{fgt}^n} + \frac{V_{fgt}^r}{1-V_{fgt}^n} \frac{\frac{1}{1+a} + \sum_F \frac{V_{fgt}^n}{1-V_{fgt}^n}}{1-V_{gt}^r - \sum_F \frac{V_{fgt}^r V_{fgt}^n}{1-V_{fgt}^n}} \right], j=1, \dots, J \quad (10a)$$

$$\frac{p_{lt}^{r*}}{1+v} = \mathbf{c}_{lt} \boldsymbol{\gamma}^r + \frac{1-\sigma}{\alpha(1+v)} \frac{\frac{1}{1+a} + \sum_F \frac{V_{fgt}^n}{1-V_{fgt}^n}}{1-V_{gt}^r - \sum_F \frac{V_{fgt}^r V_{fgt}^n}{1-V_{fgt}^n}}, l=1, \dots, L \quad (10b)$$

where  $v$  is the VAT rate (which does not affect costs);  $\mathbf{c}_{jt}$  and  $\mathbf{c}_{lt}$  are vectors of observable cost characteristics and  $\boldsymbol{\gamma}^n$  and  $\boldsymbol{\gamma}^r$  are the corresponding vectors of cost parameters. Eqs. (10) can be merged into a unified system of estimable price equations

$$\frac{p_{kt}^*}{1+v} = \mathbf{c}_{kt} \boldsymbol{\gamma} + \frac{1-\sigma}{(1+v)\alpha} \left[ \frac{1-d_k}{1-V_{fgt}^n} + \left( \frac{V_{fgt}^r (1-d_k)}{1-V_{fgt}^n} + d_k \right) \frac{1+\lambda + \sum_F \frac{V_{fgt}^n}{1-V_{fgt}^n}}{1-V_{gt}^r - \sum_F \frac{V_{fgt}^r V_{fgt}^n}{1-V_{fgt}^n}} \right] + \omega_{kt}, k=1, \dots, K \quad (11)$$

where  $d_k$  is a product-specific indication variable which equals 1 if  $k \in \Omega^r$  and 0 if  $k \in \Omega^n$ ;

$\lambda \equiv -a/(1+a)$  (hence  $-1 < \lambda \leq 0$ ) is the coefficient through which the parameter  $a$  is

identified, and  $\omega_{kt}$  is the error term which incorporates unobservable cost factors, imperfections of market- and political-equilibrium conditions, etc.

In case of perfect collusion in the laissez-faire segment, Eq. (11) becomes

$$\frac{P_{kt}}{1+\nu} = \mathbf{c}_{kt}\boldsymbol{\gamma} + \frac{1-\sigma}{(1+\nu)\alpha} \left[ \frac{1-d_k}{1-V_{gt}^n} + \left( \frac{V_{gt}^r(1-d_k)}{1-V_{gt}^n} + d_k \right) \frac{1+\lambda + \frac{V_{gt}^n}{1-V_{gt}^n}}{1-V_{gt}^r - \frac{V_{gt}^r V_{gt}^n}{1-V_{gt}^n}} \right] + \omega_{kt}, \quad k=1, \dots, K \quad (12)$$

where  $V_{gt}^n = \Psi_{gt} \sum_{j \in \Omega_{gt}^n} q_{jt}$ . Following Gasmi et al. (1992) and Verboven (1996) one can test for the

presence of collusion in the unregulated segment by nesting Eqs. (11) and (12):

$$\frac{P_{kt}}{1+\nu} = \mathbf{c}_{kt}\boldsymbol{\gamma} + \frac{1-\sigma}{(1+\nu)\alpha} \left[ \frac{1-d_k}{1-\phi V_{gt}^n - (1-\phi)V_{fgt}^n} + \left( \frac{(\phi V_{gt}^r - (1-\phi)V_{fgt}^r)(1-d_k)}{1-\phi V_{gt}^n - (1-\phi)V_{fgt}^n} + d_k \right) \frac{1+\lambda + \phi \frac{V_{gt}^n}{1-V_{gt}^n} + (1-\phi) \sum_F \frac{V_{fgt}^n}{1-V_{fgt}^n}}{1-V_{gt}^r - \phi \frac{V_{gt}^r V_{gt}^n}{1-V_{gt}^n} - (1-\phi) \sum_F \frac{V_{fgt}^r V_{fgt}^n}{1-V_{fgt}^n}} \right] + \omega_{kt}, \quad k=1, \dots, K \quad (13)$$

where  $\phi$  ( $0 \leq \phi \leq 1$ ) is a coefficient based on which collusion is rejected ( $\phi = 0$ ) or not ( $\phi = 1$ ).

## Data

Our data is a panel of monthly aggregated quantities and values of fluid-milk sales in Israel during the period January 2005 – November 2011, differentiates 33 products, seven geographical zones, five types of stores and two demographic sectors (ultra-Orthodox and others), as collected by StoreNext Ltd. Products are defined based on characteristics (fat content, package type, manufacturer, etc.), and a market is a combination of area, store type, sector, and month,

altogether 4,897 markets. An observation is a product in a market, amounting to 97,276 observations in total, of which about 60% are of regulated products. As aforementioned, product categorization is based on the customary shelf arrangement in Israeli supermarkets: regular and fortified fresh milk packaged in a 1-liter carton; regular fresh milk in a 1 liter bag; regular fresh milk in a 2-liter plastic jug, and UHT milk.

Similar to Nevo (2001), Villas-Boas (2007), Cohen (2013) and others, we define the outside good so as to adjust the total consumption to the potential one, which is the number of consumers in a market multiplied by the recommended consumption per consumer.<sup>12</sup> Additional cost-related variables were obtained from the Israeli Ministry of Agriculture and Rural Development, the Dairy Board, and the Central Bureau of Statistics. Market prices were calculated by dividing total sale values by total quantities for both regulated and unregulated products.

Table 3 reports summary statistics. Noteworthy, the prices of unregulated fluid-milk products are about 45% higher than those of regulated products. These price differences are also reflected in Table 3 by the fact that the price paid by ultra-Orthodox consumers (comprising 19% of the observations) is considerably lower than that paid by other consumers, due to the preference of this low-income sector to regulated goods.

Table 3 about here

## **Estimation**

We apply GMM to estimate simultaneously the system of demand Eq. (2) and price Eq. (11), while accounting for nonlinearity and cross-equation restrictions associated with the parameters  $\alpha$  and  $\sigma$ , and possible correlations between the errors  $\xi_{kt}$  and  $\omega_{kt}$  due to unobserved quality characteristics. A main challenge in the estimation of the above model is related to potential endogeneity of the price and of the intra-category share in the demand equation, and that of the

firm's category share in the pricing equation. We employ dummy variables to control for the region, quarter, ultra-orthodox consumers and type of shop, as well as all products' observable characteristics and processor fixed effects; hence, the error term  $\xi_{kt}$  stands for unobserved deviations from the overall mean valuation of a milk product with specific characteristics. Such shocks may represent unobservable product characteristics, promotions, conveyance of new nutritional information to consumers, etc. As some of those factors may be correlated with the error term in the pricing equation, this is a source for potential endogeneity of the product's price in the demand equation.

Three distinguished sets of instruments were suggested in the literature to handle the endogeneity issue (e.g., Berry et al. 1995, Fershtman and Gandal 1998, Nevo 2001, Villas-Boas 2007, Cakir and Balagtas 2012, and Richards et al. 2013): cost shifters, prices of the specific product in other markets, and instruments based on product characteristics that are considered predetermined and hence exogenous. In our case, the exogeneity of the product characteristics seems especially plausible. First, the fluid-milk industry is characterized by a stable list of the main products, and during our sample period 16 products were introduced with accumulated market share of only 1.7%. Even in those occasions, the product characteristics are uncorrelated with the temporal demand shock in a specific region and store type. Second, the products subjected to price ceilings are well defined by the decree, including all the observable characteristics (fat content, package size, etc.). Hence, the characteristics of those products are uncorrelated with demand or pricing shocks.

There are two instruments for the price in the demand equation which are unique to the regulation regime in the Israeli dairy industry: the first are the regulated prices, which are updated by the regulator, who does not observe the demand or pricing shocks (as verified by

personal conversations with the regulator and his staff). The second instrument is the target price, paid by dairies to the farmers for the raw milk, which accounts for about 50% of the combined dairy and retail cost, and hence is obviously correlated with the milk price.<sup>13</sup> In addition, our data include an indication for ultra-orthodox markets, which serves as an instrument for market shares in the price equation.

Regarding identification, as will be detailed later, changes in a range of variables allow us to capture costs attributable to the production, processing and marketing stages, where the dummy variable for ultra-Orthodox markets serves as a demand shifter, which therefore helps to identify these cost elements. But the challenge specific to this study refers to the identification of the political parameter  $a$ . Inspecting Eqs. (10),  $a$  is identified owing to the variability of markups across observations, which, under our NL specifications, is considerably enhanced in a partial regulation regime. To comprehend this identification-advantage, compare Eqs. (10) to the single pricing equation obtained under a fully regulated market

$$\frac{p_{kt}}{1+\nu} = \mathbf{c}_{kt}\boldsymbol{\gamma} + \frac{1}{(1+\nu)(1+a)\alpha\left(1-\frac{Q_{gt}}{M_t}\right)} + \omega_{kt}, \quad k = 1, \dots, K \quad (14)$$

While under partial regulation the markups of unregulated products vary between firms within a category in a market (see Eq. (10a)), a whole-market regulation induces markup variability only across categories in a market.

Prior to reporting the detailed estimation results, we turn to testing for collusion in the laissez-faire segment. Comparing the generalized  $R^2$  values (Pesaran and Smith 1994) for an oligopolistic model (Eq. 11) versus the cartel one (Eq. 12), we obtain for the demand (price) equation  $R^2=0.72$  (0.83) under oligopoly versus  $R^2=0.68$  (0.81) under cartel. Thus, the goodness

of fit is better under the assumption of an oligopoly. Indeed, a formal test based on  $\phi$  in Eq. (13) yields rejection of collusion in favor of the oligopoly hypothesis.

Table 4 reports the estimation results; we discuss the demand first. The overall-sample own-price elasticity is -4.37. As expected, the average elasticity of regulated products (-3.88) is considerably lower than that of the unregulated ones (-8.09), but both resemble estimates obtained by other studies in which milk is modeled as a differentiated good (Bonnet and Bouamra-Mechemache (2016), France: -8.22 to -4.22; Dhar and Foltz (2005), US: -4.40 to -1.04; Jonas and Roosen (2008), Germany: -10.2 to -0.96; Chidmi and Murova (2011), US: -9.8 to -4.3; Cohen (2013), US: -6.8 to -3.1; Lopez and Lopez (2009), US: -8.52 to -1.89; Kinoshita et al. (2002), Japan: -6.67 to -9.19; Canan and Cotterill (2006), US: -0.87 to -5.16).

The estimates reported for fluid milk based on homogenous-goods models are considerably lower (Chidmi et al. (2005), US: -0.61; Cakir and Balagtas (2012), US: -0.56 to -0.16; Bouamra-Mechemache et al. (2008), France: -0.15, Italy: -0.01). To neutralize the substitution effect on the magnitude of the price elasticity we simulate a simultaneous 1% price increase of all products. This exercise yields an elasticity of -1.27 for the overall price effect on milk consumption, which is considerably lower than the estimates that allow cross-product substitution, but larger than the above homogenous-goods based estimates. In terms of within-category substitution, we find a statistically significant  $\sigma = 0.525$ , indicating that the substitution across products within-categories is larger than the substitution between categories.

Table 4 about here

Regarding the product attributes, *ceteris paribus*, the Israeli consumer prefers as follows: milk with larger fat contents; enriched over regular milk, which by itself is preferred over UHT

milk and 1-liter carton packs more than 2-liter plastic jugs. In addition, consumers favor standard kosher milk produced by Tnuva.

The variables in the pricing equation explain marginal costs throughout the entire supply chain: the target price represents the impact of raw-milk production costs; energy and labor indices, as well as product characteristics and geographical regions, capture the combined role of dairies' production, distribution, and transportation costs; dummies for store types stand for the retailers' costs of shelf space and in-store labor. In addition, dummy variables for years explain technological changes. The estimated coefficients indicate that, as expected, costs increase with fat content, and it is more costly to produce UHT and fortified milk than regular milk. Wage impact on costs is found to be nine times higher than that of energy; this is consistent with the "Suari" formula for production costs. We could not reject the hypothesis that the target-price's coefficient equals one, indicating about 1:1 ratio of processed/raw milk, which is consistent with processing technology.<sup>14</sup> Recalling that the target price is the farm-gate producer's price, the markup term in Eq. (11) represents the combined markups of the processors and retailers.

Our estimate of the political parameter  $\lambda$  is -0.94, with a statistically-significant difference from the lower bound of -1 which indicates perfectly-benevolent governance. We test the robustness of this finding with respect to IV specifications for the price in the demand equation. Table 5 reports the main structural parameters,  $\lambda$ ,  $\alpha$  and  $\sigma$ , estimated under the baseline and three alternative models, each omits one of three IV types: the cost-related variables (target price, VAT, cost indicators, etc.), an indicator variable of regulated products, and the regulated-products' average price. While the estimates of  $\alpha$  and  $\sigma$  exhibit sensitivity to the exclusion of regulated-products fixed effect,  $\lambda$  is more robust. In particular, all tests yield estimated  $\lambda$  levels with 95% confidence intervals above -1. Noteworthy, the  $\lambda = -0.94$  estimate obtained in the



baseline is the highest, implying the lowest political morality level. Though, the weight assigned by policymakers to social welfare,  $a \equiv -\lambda/(1+\lambda)$ , is nearly 16 times larger than that given to political gains; this weight is considerably low compared to the numerous estimates in the context of trade and protection, which report that policymakers are valuing social welfare even thousands of times more than that of political-campaign contributions (Gawande and Magee, 2012). On the other hand, it is larger than the weights estimated by Lopez and Matschke (2006) in the context of protection of the US food-processing industries and by Zusman and Amiad (1977) for the Israeli milk-production sector during the 1960s.

Table 5 about here

### **Regulation Efficiency**

We are now in a position to evaluate the effectiveness of the partial price-ceiling regulation in the Israeli fluid-milk industry. We commence by directly using the estimation results, and then proceed with simulations.

Inspecting the markups reported in Table 4, the maximum-price policy significantly reduces producers' average markup on the regulated products to about a fifth of that of the unregulated ones; in terms of percentage out of the prices, the markups on regulated products are in the range 1.94-8.28% compared to 11.38-26.95% for non-regulated products. Moreover, while our estimates for the unregulated products are in the same range as reported by other studies [Bonnet and Bouamra-Mechemache (2016), France: 15-42%; Chimdi and Murova (2011), US: 14.1-28.1%; Chimdi et al. (2005), US: 26%; Lopez and Lopez (2009), US: 11-53%; Canan and Cotterill (2006), US: 19.4-65.7%], the estimated price-cost margins in the regulated branch of the milk market are lower.

Table 6 about here

In Table 6 we use the estimation results to assess the role played by the price-ceiling regulation with respect to the considerable price difference observed between regulated and unregulated products (Table 3). To each of the 7 most popular unregulated milk products, we pair a regulated product which is the closest neighbor in the characteristics domain. Then, we subtract from the unregulated-product's price (column **a** in Table 6) the estimated marginal costs associated with the characteristics that differentiate this unregulated product from its regulated counterpart; this yields a price of a product which is equivalent in its characteristics to the regulated one, but does not incorporate the regulation effect (column **c**). The difference between the latter and the market price of the regulated good (column **b**) measures the regulation's effectiveness in terms of price reduction (column **d**). In column **e** we compute percentage decreases in the prices of the unregulated products would they have been regulated. On average, the equivalent regulated goods are 12% cheaper. Noteworthy is the most recently unregulated UHT 3%-fat Tnuva 1-liter Carton product. By the table calculation, deregulation increased its price by 2%, which is a bit smaller than the diff-in-diff estimate of about 5% (Table 2).

The above calculation of the effectiveness of the price-ceiling policy neither accounts for demand and substitution responses, nor evaluates welfare implications. To this end, we employ the estimated parameters  $\hat{\beta}$ ,  $\hat{\alpha}$ ,  $\hat{\sigma}$ ,  $\hat{\gamma}$  and  $\hat{\lambda}$  to develop a simulation model of a representative market. We use the observed prices and quantities to derive a calibrated baseline scenario, to which we compare simulation results obtained under various exogenous changes, where the model searches for sets of  $K$  product prices and quantities that solve simultaneously the demand and equilibrium-price equations. We compare the baseline scenario to the following ones:

- (a) Competitive equilibrium: the prices of all products are equated to their respective marginal costs, hence markups vanish.

- (b) Perfect collusion: all firms collude with respect to all products.
- (c) Laissez-faire oligopoly: none of the products is regulated ( $\Omega^n = \Omega$ ).
- (d) Regulated industry: the prices of all products are subjected to ceilings;  $\Omega^r = \Omega$  and  $\lambda = -0.94$ .
- (e) Benevolent government:  $\Omega^n$  and  $\Omega^r$  are unchanged, and  $a = \infty$  (i.e.,  $\lambda = -1$ ).
- (f) Complete regulatory capture:  $\Omega^n$  and  $\Omega^r$  are unchanged, and  $a = \lambda = 0$ .
- (g) Collusion in the laissez-faire segment:  $\Omega^n$  and  $\Omega^r$  are unchanged,  $\lambda = -0.94$ , and prices are represented by Eq. (12).

Table 7 about here

Table 7 reports the results; we consider first the simulated price changes. Of particular interest is the impact of the abolishment of the maximum-price regulation under the Nash-Bertrand oligopoly (Scenario c). Compared to the baseline, we predict 27% increase in the prices of regulated products; this coincides with the estimates by Ofek (2012), who found the prices of dairy products that have been released from the price-ceiling regulation during 2006–2007 to be 18%–35% above their simulated levels under the regulation. Our computed markups on the regulated products increase from the abovementioned 1.94-8.28% range to 15.92-33.32%, which is in agreement with free milk markets throughout the world. Noteworthy is also the regulation-spillover effect: in Scenario (c), parallel to the 27% upward shift of the prices of products that are subject to the ceiling policy in the baseline, the prices of the unregulated products also hike, but by only 2%. This resembles our finding based on the difference-in-difference analysis with respect to the UHT 1%-fat Tnuva 1-liter Carton product (Table 2). Nevertheless, the magnitude of the direct effect on prices is much larger, and therefore its impact dominates in terms of market-share changes: in Scenario (c), while prices of all products lift, the price-difference

between the two segments shrinks (the regulated/unregulated price ratio approaches 1), and therefore so is the gap between their market shares, where the consumption of the originally regulated (unregulated) products declines (increases).

Under a whole-market regulation (Scenario d), prices in both segments reduce, as expected. Apparently, the trends of consumption changes are similar to those obtained in Scenario (c), which we explain by the increase in the price ratio under both scenarios compared to the baseline. Noteworthy, the 13% reduction in the prices of the unregulated products under Scenario (d) is almost similar to the weighted average reduction of 12% reported in Table 6.

A negative efficiency aspect of the prevailing partial price-ceiling policy is the reduction in the regulated/unregulated price ratio compared to the marginal-costs ratio (Scenario a). Apparently, a whole-industry regulation (Scenario d) yields a price ratio similar to the optimum, whereas the laissez-faire scenarios (b and c) overlift the price ratio.

We turn now to discuss policy welfare effects. The overall simulated welfare amounts at the baseline to 222 million \$/year, of which 91% is assigned to consumer surplus. Consumers and producers obtain, respectively, an average surplus of 0.95 and 0.09 \$/liter, constituting 70% and 7% of the fluid-milk average price, respectively. Scenarios (a) and (b) mark the range at which combinations of changes in policy and the industry structure can affect welfare in the Israeli fluid-milk market. The total impact spans 53.7 million \$/year (about 18% of the total sales value and 25% of the baseline welfare), ranging from +8.3 to -45.4 million \$/year when the baseline conditions change into perfect competition (Scenario a) and perfect collusion (Scenario b), respectively. Thus, comparing to the current equilibrium in Israel, the potential welfare loss due to collusion is more than five times larger than the potential welfare gain from perfect competition. The tendency of the observed situation toward the socially optimum is attributed to

the absence of collusion in the laissez-faire segment, and in a larger extent to the small distortion with respect to the prices of the regulated products, which constitute the majority in terms of sales value.

Scenarios (c) through (f) enable us to disentangle the factors affecting the 53.7 million \$/year welfare range. By scenarios (c) and (d) we study the welfare effect attributed to the set of price ceilings on the subset  $\Omega^r$  of regulated products at the baseline. Given the oligopolistic structure in the laissez-faire segment ( $\phi=0$ ) and the estimate  $\lambda=-0.94$ , the abolishment of the maximum-price regulation can reduce welfare by 25.8 million \$/year (Scenario c), about 12% of the welfare in the baseline; expanding the regulation to the whole industry's products (Scenario d) can increase welfare by only 6.7 million \$/year. That is, because most of the industry's sales are of regulated products, almost all of the regulation's potential benefits are already gained at its current shape. Noteworthy, while the substitution's welfare-effect plays a minor role in the regulation abolishment (0.4% out of the 12% welfare reduction under Scenario c), it accounts for most of the effect of a comprehensive regulation (1.75% out of the 3% welfare increase under Scenario d).<sup>15</sup>

The welfare difference between scenarios (a) and (c) captures the potential loss associated with the oligopolistic organization of the industry rather than being competitive ( $8.3+25.8=34.1$  million \$/year), of which the regulation prevents 25.8 million \$/year (76%). The welfare gap between scenarios (b) and (c) represents the potential loss in case that an oligopolistic industry (Scenario c) forms a cartel (Scenario b), amounting to 19.6 million \$/year; this is about one third of the overall collusive damage compared to the competitive solution.

In scenarios (e) and (f) we assess the impact of changes in the political power, represented by  $\lambda$ . The welfare difference between these scenarios is 40 million \$/year; of this gap, the welfare

loss associated with the estimated level of politicians' immorality (i.e., since  $\lambda = -0.94$  rather than  $\lambda = -1$ ) is only 1.3 million \$/year. Thus, the industry faces a large potential for regulatory-capture distortions. Indeed, Scenario (f) implies that, even under partial regulation, corrupted policymakers can harm society more than a laissez-faire oligopolistic industry (Scenario c); according to our calculations, this would occur if  $\lambda$  exceeds -0.27 (i.e.,  $a < 0.38$ ).

Another aspect of the regulation refers to the nutritious value of the consumed milk, particularly calcium which differs significantly between regulated and unregulated products. Table 7 reports the change in the annual amounts of calcium consumed through fluid-milk products under the various scenarios, separated into the entire population and the low-income ultra-Orthodox sector. Also here, we find no difference between the competitive- and fully-regulated-industry scenarios (a and d)—both are beneficial in terms of calcium consumption relative to the baseline. In comparison to scenarios (a and d), the laissez-faire ones (b and c) increase the per-liter average calcium content; however, the total calcium consumption declines; that is, the quantity effect of deregulation overwhelms the composition effect. The quantity impact on the ultra-Orthodox sector is more dramatic, amounting to almost 50% reduction in calcium consumption under Scenario (b).

Our last issue refers to the implications of collusion in the laissez-faire segment (Scenario g). As expected, the prices of non-regulated products are higher under collusion; however, at the same time, due to the substitution and the estimated parameter  $a$ , the simulated prices of regulated products are lower. Moreover, the producer surpluses associated with both segments are also lower, implying that, given the control regime and ethical norms of the regulatory agency in Israel, the dairies have no incentive to collude. Thus, due to the substitution effect, maximum prices in the partially regulated fluid-milk market not only tow down the prices of

unregulated products, but also discourage collusion in that segment. However, as already noted, this property may depend crucially on both the substitution level and the political influence.

To farther assess the collusion incentives we simulate oligopoly and cartel in the laissez-faire segment under various levels of  $\lambda$  and of the intra-category substitution parameter  $\sigma$ . Fig. 1 presents simulation results under the estimated substitution level of  $\sigma = 0.52$  as well as  $\sigma = 0.70$ , displaying the responses of the equilibrium prices and total producer surplus to changes in  $\lambda$  given the two laissez-faire market structures. Consider first the case of  $\sigma = 0.52$ . A more corruptive government (higher  $\lambda$ ) leads to higher unregulated and regulated prices (Figs. 1a and 1c, respectively). Naturally, collusion in the laissez-faire segment increases the unregulated prices (Fig. 1a), but the response of equilibrium price ceilings to the collusion is non-monotonic: the government reduces the maximum prices if  $\lambda$  is below -0.67 (Fig. 1c). In terms of the overall industry's producer surplus, the threshold level of  $\lambda$  beyond which collusion is beneficial from the industry's perspective is -0.79 (Fig. 1e).

Figure 1 about here

Consider now the substitution level of  $\sigma = 0.70$ . Compared to  $\sigma = 0.52$ , the unregulated prices increase more sharply when the industry establishes a cartel in the unregulated segment (Fig. 1b); this is because firms' benefits ensued by sharing consumer surpluses of substitutive products increase with the level of substitution. On the other hand, larger substitution increases the government's influence on unregulated prices through the regulated ones. Therefore, the pressure on the government to increase price ceilings intensifies. Consequently, the level of  $\lambda$  beyond which price ceilings increase in response to collusion reduces to -0.94 (Fig. 1d). In terms of producer surpluses, the threshold level of  $\lambda$  is -0.98 (Fig. 1f).

Thus, the incentive to collude with respect to unregulated products increases with both the political influence and substitution. Fig. 2 depicts the combined impact of  $\lambda$  and  $\sigma$  on the industry's best strategy. Point A marks the estimated combination, supporting our statistical collusion rejection.

Figure 2 about here

### **Concluding Remarks**

Empirical industrial organization methods based on structural econometric models of random-utility discrete-choice equilibrium with product differentiation in multi-product-firms industries were extensively used for studying processed-food markets worldwide (e.g., Nevo 2001, Villas-Boas 2007, Chidmi and Lopez 2007, Giacomo 2008, Cohen 2013, Richards et al. 2013, and Bonnet and Bouamra-Mechemache 2016). We contribute to this literature strand by developing a model that integrates an empirical IO method with a political-economy model to assess the effectiveness of a horizontally separating partial price-ceiling regulation. Our results for the case of the Israeli fluid-milk market indicate that governmental intervention using partial price-ceiling regulation is welfare enhancing compared to a laissez-faire oligopoly. Furthermore, the policy discourages collusion in the unregulated segment.

Our framework can be extended along a range of theoretical and empirical avenues; we mention here two challenging ones. First, the determination of maximum prices occurs in our static model given an exogenously predetermined set of regulated products. However, firms' political struggle for higher price ceilings may be affected by a long-run objective to release products from the regulation. Treating endogenously the list of regulated products would require developing a structural dynamic framework based on equilibrium conditions in a repeated multi-stage game, as well as a panel dataset spanning a much longer period.



Second, the oligopolistic structure of the fluid-milk industry in our model stems from the production of differentiated goods. However, food processing firms may act in oligopolistic environments also due to the presence of economies of scale and scope. Moreover, cross subsidization and economies of scope may motivate diversification of regulated firms into non-regulated markets (see Braeutigam and Panzar 1989, Sappington 2003 and Calzolari and Scarpa 2016). An extension of our structural model would be to differentiate between the cost and demand causalities of oligopolistic markets. In the case of fluid milk, this would require referring to the production costs of other dairy products, which in turn necessitate the employment of expenditure-based market-share models that account for different quantity units across products (Björnerstedt and Verboven 2016).

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**Table 1: Market shares of processors and retailers in the Israeli fluid-milk industry**

<b>Processor</b>	<b>Processing Level<sup>a</sup></b>		<b>Retailer</b>	<b>Retail Marketing Level<sup>b</sup></b>	
	<b>2005</b>	<b>2011</b>		<b>2005</b>	<b>2011</b>
Tnuva	83%	80%	Shufersal and Mega	37%	34%
Tara	8%	13%	“The Third Chain”	18%	24%
Strauss	8%	6.7%	Groceries	22%	20%
Ramat HaGolán Dairies	1%	0.3%	Minimarkets	23%	22%

- a. The Herfindahl–Hirschman Index (HHI) for the processing level is 7,018 and 6,614 for 2005 and 2011, respectively (the data resolution on retailers is insufficient for computation of the HHI index).
- b. The sources of the market share data are StoreNext (a commercial Israeli company for data collection) and Czamanski Ben Shahar and Co. (an Israeli economic consulting firm).

**Table 2 – Difference-in-difference analyses<sup>a</sup>**

		Observations		Price (\$/liter)	
	Product	Baseline	Follow-up	Baseline	Follow-up
Control	Regular 3%-fat Tnuva 1-liter Carton	3,772	3,864	1.423	1.385
Treatment	UHT 3%-fat Tnuva 1-liter Carton	2,706	2,772	1.506	1.547
Diff (Treatment - Control) <sup>a</sup>				0.083	0.161
Diff-in-Diff <sup>a</sup>				0.078	
R <sup>2</sup>				0.27	
Control	Enriched 1%-fat Tnuva 1-liter Carton	3,321	3,402	2.060	2.020
Treatment	UHT 1%-fat Tnuva 1-liter Carton	1,845	1,890	1.846	1.856
Diff (T-C) <sup>a</sup>				-0.213	-0.164
Diff-in-Diff <sup>a</sup>				0.049	
R <sup>2</sup>				0.79	

a. Fixed effects for regions, quarters in years, type of store and sector are included. All differences are significant at 1%.

**Table 3: Summary statistics**

<b>Variables and Characteristics</b>	<b>Mean</b>	<b>Weighted mean (in sale volumes)</b>	<b>Std. Dev.</b>	<b>Median</b>
<u>Market share</u>				
Out of all products ( $s_{kt}$ )	0.029	0.122	0.074	0.006
Within category ( $s_{kgt}$ )	0.189	0.425	0.257	0.074
Regulated products ( $s_{lt}$ )	0.044	0.135	0.092	0.013
Unregulated products ( $s_{jt}$ )	0.005	0.021	0.009	0.002
Ultra-Orthodox sector	0.061	0.405	0.146	0.006
Non-ultra-Orthodox sector	0.021	0.086	0.037	0.006
<u>Price (\$/liter, including 16% VAT)</u>				
All products	1.88	1.58	0.54	1.73
Regulated products	1.56	1.48	0.30	1.57
Unregulated products	2.38	2.28	0.45	2.31
Ultra-Orthodox sector	1.69	1.33	0.41	1.64
Non-ultra-Orthodox sector	1.93	1.61	0.56	1.77
<u>Characteristics</u>				
Fat (%)	2.20	2.71	0.98	3
UHT milk (dummy)	0.27	0.02	0.45	0
Regular milk (dummy)	0.53	0.88	0.50	1
Enriched milk (dummy)	0.20	0.10	0.40	0
Milk in carton (dummy)	0.67	0.44	0.47	1
Milk in 2-liters plastic jug (dummy)	0.09	0.11	0.29	0
Milk in bag (dummy)	0.24	0.45	0.42	0
Tnuva processor (dummy)	0.70	0.84	0.46	1
Tara processor (dummy)	0.15	0.10	0.35	0
Strauss processor (dummy)	0.08	0.06	0.26	0
Ramat Hagolan processor (dummy)	0.07	0.01	0.26	0
High kosher level (dummy)	0.59	0.41	0.49	1
Content (liter)	1.02	1.11	0.37	1
<u>Additional explanatory variables</u>				
Regulated product (dummy)	0.60	0.88	0.49	1
Target price (\$/liter)	0.67	0.67	0.04	0.66
Ultra-Orthodox sector (dummy)	0.19	0.11	0.40	0
Non ultra-Orthodox sector (dummy)	0.81	0.89	0.40	1
Shufersal and Mega – heavy-discount supermarkets (dummy)	0.22	0.22	0.42	0
Shufersal and Mega – supermarkets (dummy)	0.18	0.15	0.38	0
“The Third Chain” - large supermarkets (dummy)	0.18	0.20	0.39	0
Minimarkets (dummy)	0.24	0.22	0.42	0
Groceries (dummy)	0.18	0.21	0.38	0
South (dummy)	0.12	0.14	0.33	0
South center (dummy)	0.15	0.14	0.35	0
Jerusalem (dummy)	0.17	0.12	0.38	0
Tel Aviv (dummy)	0.15	0.22	0.36	0
North center (dummy)	0.15	0.16	0.36	0
Haifa (dummy)	0.12	0.11	0.33	0
North without Haifa (dummy)	0.14	0.11	0.34	0
Energy index (100 = November 2011)	78.26	78.25	11.57	76.66
Labor index (100 = November 2011)	97.28	97.27	1.26	97.03
Euro rate (\$/Euro)	1.59	1.59	0.17	1.60

a. All monetary values are in terms of November 2011 US dollars.



**Table 4: Estimation results**

Variable <sup>a</sup>	Demand <sup>b</sup>		Price <sup>b</sup>
	Coefficient	Marginal Effect (market share, %) <sup>c</sup>	Coefficient
Price ( $-\alpha$ )	-1.796	-1.71	-1.796
Substitutability ( $\sigma$ )	0.525		0.525
Fat (%)	0.208	0.74	0.018
UHT milk	-2.117	-4.95	0.076
Enriched milk	0.819	22.94	0.434
Milk in bag	-0.273	-0.57	-0.218
Milk in 2-liters plastic jug	-0.836	-2.86	0.109
High kosher level	-0.138	-0.70	0.046
Strauss processor	-0.057	-0.39	0.019
Tara processor	-0.398	-2.00	-0.047
Ramat HaGolan processor	-0.303	-1.65	0.024
Regulated products ( $\lambda$ )			-0.253
Target price			1.097
Energy index			0.001
Labor index			0.012
Euro rate			0.000
Constant	-9.785		0.361
	<b>Own price elasticity<sup>d</sup></b>		<b>Markup<sup>d</sup></b>
Regulated products	-3.88		0.07 \$/liter (5.3%)
Unregulated products	-8.09		0.32 \$/liter (16.5%)
All products	-4.37		0.1 \$/liter (6.6%)
No. of observations	97,276		97,276
Generalized $R^2$	0.72		0.83

a. Both the demand and price equations include dummy variables for store type, region and time (quarterly), and the demand also for ultra-Orthodox sector.

b. All coefficients except the euro-rate coefficient are significant at the 1% level. All marginal effects, elasticities and markups are significant at the 1% level, as calculated by the Delta Method.

c. For a continuous product characteristic  $x_{kt}^u$ , the marginal effect is  $\frac{\partial s_{kt}}{\partial x_{kt}^u} = \frac{\beta^u s_{kt}}{1 - \sigma} (1 - \Psi_{gt} q_{kt})$  where  $\beta^u$  is

characteristic- $n$ 's coefficient; if  $x_{kt}^u$  is a dummy characteristic, we report the difference

$$s_{kt}|_{x_{kt}^u=1} - s_{kt}|_{x_{kt}^u=0} = s_{kt}|_{x_{kt}^u=0} \left( \exp\left(\frac{\beta^u}{1 - \sigma}\right) - 1 \right).$$

d. Average, weighted by sales; percentages are out of market prices.

**Table 5 – Robustness of structural variables to IV specifications for the price in the demand equation.<sup>a</sup>**

	Baseline	Model 1	Model 2	Model 3
Cost variables	Yes	No	Yes	Yes
Regulated products fixed effects	Yes	Yes	No	Yes
Regulated-products' average price	Yes	Yes	Yes	No
$\lambda$	-0.942 [-0.954,-0.931]	-0.952 [-0.964,-0.941]	-0.962 [-0.977,-0.948]	-0.971 [-0.983,-0.960]
$\alpha$	0.482 [0.468,0.496]	0.478 [0.463,0.492]	0.642 [0.620,0.664]	0.480 [0.465,0.496]
$\sigma$	0.525 [0.509,0.542]	0.541 [0.524,0.558]	0.324 [0.298,0.350]	0.549 [0.531,0.568]

a. Values in square brackets indicate 95% confidence intervals.

**Table 6 – Regulation efficiency in terms of price reduction**

<u>Unregulated Product</u>		<u>Regulated Counterpart</u>		<u>Equivalent<sup>a</sup></u>	<u>Regulation Effectiveness</u>	
Characteristics	Price (\$/liter) <b>a</b>	Characteristics	Price (\$/liter) <b>b</b>	Price (\$/liter) <b>c</b>	(\$/liter) <sup>b</sup> <b>d=c-b</b>	(%) <b>e=100×d/a</b>
Enriched 3%-fat Tnuva 1-liter Carton	2.29	Regular 3%-fat Tnuva 1-liter Carton	1.44	1.86	0.42	18
Enriched 1%-fat Tnuva 1-liter Carton	1.98	Regular 1%-fat Tnuva 1-liter Carton	1.37	1.54	0.18	9
Enriched 3%-fat Yotveta 1-liter Carton	1.97	Regular 3%-fat Yotveta 1-liter Carton	1.28	1.54	0.26	13
Enriched 3%-fat Tnuva 1-liter Carton	2.29	Regular 3%-fat Tnuva 1-liter Bag	1.15	1.64	0.49	22
Enriched 1%-fat Tnuva 1-liter Carton	1.98	Regular 1%-fat Tnuva 1-liter Bag	1.10	1.32	0.22	11
UHT 3%-fat Tnuva 1-liter Carton	1.54	Regular 3%-fat Tnuva 1-liter Carton	1.44	1.47	0.03	2
UHT 1%-fat Tnuva 1-liter Carton	1.76	Regular 1%-fat Tnuva 1-liter Carton	1.37	1.68	0.31	18
Weighted average <sup>c</sup>	1.97		1.27	1.51	0.24	12

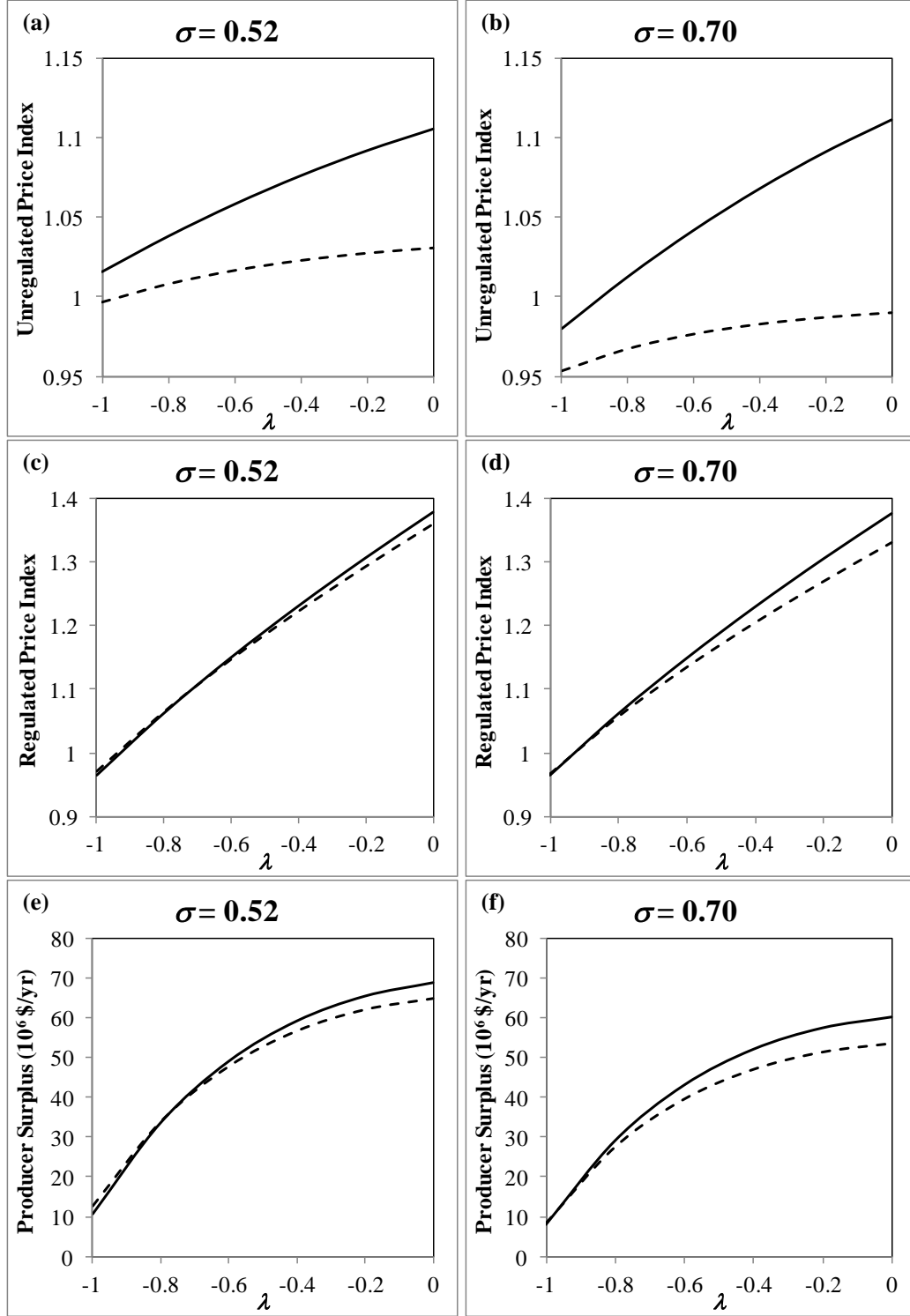
- The price of the unregulated-product's equivalent equals the unregulated-product's market price (column **a**) minus the estimated marginal production costs of the characteristics that differentiate that product from its regulated counterpart.
- The differences in **d=c-b** are all statistically significant at 5%.
- The averages are weighted by the market shares (in sale volumes) of the unregulated products.

**Table 7: Simulated policy and industry-structure changes**

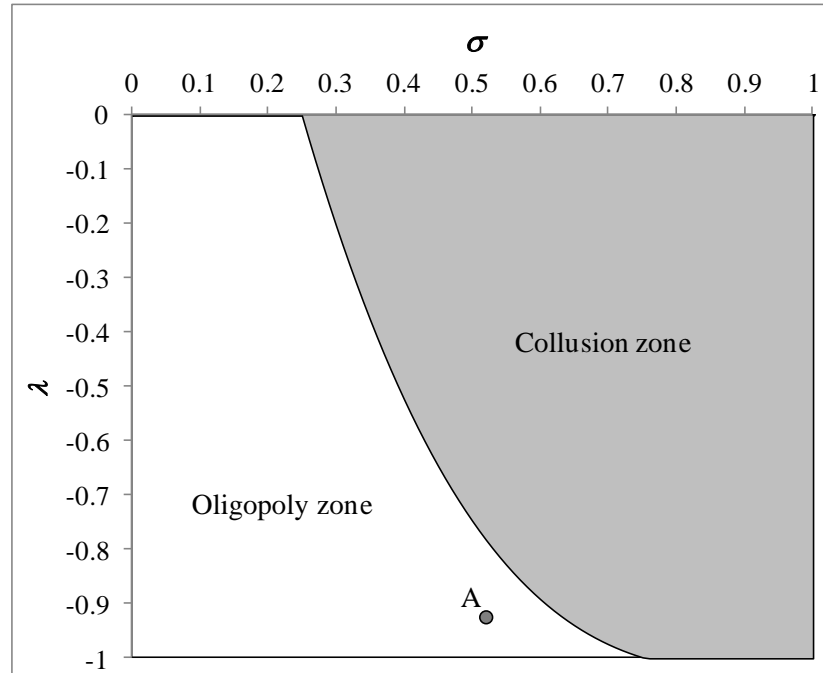
		Competitive	Collusion	Laissez-faire	Regulated	Benevolent	Fully-	Collusion
	Baseline	solution	(cartel)	oligopoly	industry	government	captured	in the
	values	(a)	(b)	(c)	(d)	(e)	(f)	laissez-faire
								segment
								(g)
<b>Price</b>	<b>\$/liter<sup>a</sup></b>				<b>Change (%)</b>			
Regulated products	1.28	-5	38	27	-2	-3	36	-1
Unregulated products	1.95	-15	11	2	-13	-0.5	3	2
All products	1.36	-7	33	22	-4	-2	30	-0.1
Ratio <sup>b</sup>	0.71	0.79	0.88	0.87	0.79	0.69	0.93	0.69
<b>Quantity</b>	<b>10<sup>6</sup> liter/year</b>							
Regulated products	185.6	-3	-48	-38	-6	4	-50	3
Unregulated products	26.6	99	25	54	92	-5	76	-14
All products	212.2	15	-35	-21	11	2	-27	-0.3
Ratio <sup>b</sup>	6.98	3.39	2.88	2.83	3.40	7.67	1.99	8.29
<b>Producer surplus</b>	<b>10<sup>6</sup> \$/year</b>							
Regulated products	12.1	-100	335	277	-43	-55	305	-9.4
Unregulated products	7.7	-100	113	73	-75	-7	107	-2.3
All products	19.7	-100	249	198	-55	-36	227	-6.6
<b>Consumer surplus</b>								
All products	202.0	14	-47	-32	9	4	-41	0.14
<b>Welfare</b>								
All products	221.7	4	-20	-12	3	1	-17	-0.5
					<b>Change (10<sup>6</sup> \$/year)</b>			
All products	221.7	8.3	-45.4	-25.8	6.7	1.3	-38.7	-1.0
<b>Calcium</b>	<b>ton/year</b>				<b>Change (%)</b>			
All sectors	23.0	16.5	-34.2	-19.5	12.7	2.4	-25.3	-0.6
Ultra Orthodox	2.4	5.6	-47.4	-32.9	0.9	4.7	-46.8	0.0
	<b>mg/liter</b>							
All sectors	108.2	6.4	8.3	8.6	6.3	-0.6	13.5	-0.9
Ultra Orthodox	100.4	0.4	0.8	0.7	0.5	-0.1	1.3	0.0

a. Average, weighted by sales; not including 16% VAT.

b. Regulated/unregulated.



**Figure 1: Variation of unregulated prices (a and b), price ceilings (c and d) and total producer surplus (e and f) under oligopoly and cartel in the laissez-fair segment in response to changes in the political parameter  $\lambda$  under two levels of the intra-category-substitution parameter  $\sigma$ .**



**Figure 2: Combined effects of the intra-category-substitution parameter  $\sigma$  and the political influence  $\lambda$  on the incentive to collude in the laissez-fair segment as measured by the industry's producer surpluses.**

## Notes

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- <sup>1</sup> Price ceilings have been applied to control utilities supplying electricity, natural gas and water (Viscusi et al. 2005, Davis and Kilian 2011), as well as housing (Autor et al. 2014), pharmaceuticals (Brekke et al. 2011) and processed and fresh food (Genakos et al. 2014, Azzam and Rettab 2013).
- <sup>2</sup> Montes (2013) employs an empirical industrial organization framework to study regulatory biased prices, however, without explicitly accounting for the strategic interaction between regulators and firms.
- <sup>3</sup> The IDB includes about 20 delegates from the milk production and processing sectors, governmental ministries and consumer organizations. Production quotas are generally set at the levels determined by the dairies, where shortages/surpluses are controlled using milk powder imports/exports (Chief Economist of the IDB, personal communication, April 2017).
- <sup>4</sup> The PIC is composed of 4 bureaucrats, nominated by the Minister of Finance and the Minister of Agriculture and Rural Development.
- <sup>5</sup> Arlozerov, M., April 14, 2015, on *TheMarker* [Hebrew], accessed Apr 2015, <http://www.themarker.com/news/1.2613096> ; Arlozerov, M., May 5, 2015, on *TheMarker* [Hebrew], accessed May 2015, <http://www.themarker.com/news/1.2628079> ; Arlozerov, M., January 14, 2014, on *TheMarker* [Hebrew], accessed Mar 2014, <http://www.themarker.com/news/1.2216457> ; Yefet, O., March 16, 2014, on *Calcalist* [Hebrew], accessed Mar 2014, <http://www.calcalist.co.il/marketing/articles/0,7340,L-3626640,00.html>; Zumer, N., April 5, 2005, on *Ynet* [Hebrew], accessed Mar 2013, <http://www.ynet.co.il/articles/0,7340,L-3068026,00.html>. Reich (2006) argued that the

background for the extended agricultural exemption (in antitrust law) of marketers as well as farmers is due to the strong political power of Tnuva.

<sup>6</sup> Cohen, A., May 19, 2011, in *TheMarker* [Hebrew], accessed Mar 2013, <http://www.themarker.com/consumer/1.644240>; Kadosh, N., November 1, 2010, at *NRG* [Hebrew], accessed Mar 2013, <http://www.nrg.co.il/online/16/ART2/173/108.html>.

<sup>7</sup> We employ difference-in-difference analyses only to Tnuva's products because it is the only processor producing the most relevant potential substitutes.

<sup>8</sup> Giacomo (2008) provides farther justifications for the use of NL in analyzing the Italian yogurt market.

<sup>9</sup> The NL own- and cross-price elasticities are  $\eta_{kk} = \frac{-\alpha p_k}{1-\sigma} \left[ 1 - q_k \left( \frac{1-\sigma}{M} - \frac{\sigma}{Q_g} \right) \right] < 0$  and  $\eta_{kz} = \alpha p_z q_z \left[ \frac{\sigma}{(1-\sigma)Q_g} + \frac{1}{M} \right] > 0$  for  $k \neq z$  where  $k \& z \in g$ , and  $\eta_{kz'} = \alpha p_{z'} \frac{q_{z'}}{M} > 0$  where  $k \in g$  &  $z' \notin g$ , respectively.

<sup>10</sup>  $\partial \left( M \ln \left[ \sum_g D_g^{(1-\sigma)} \right] / \alpha \right) / \partial p_l^r = M \frac{(1-\sigma) D_g^{-\sigma} e^{\frac{\delta_l^r}{1-\sigma}} \frac{-\alpha}{1-\sigma}}{\alpha \sum_g D_g^{(1-\sigma)}} = -M \frac{e^{\frac{\delta_l^r}{1-\sigma}}}{D_g^\sigma \left( \sum_g D_g^{(1-\sigma)} \right)} = -M s_l^r \equiv -q_l^r.$

<sup>11</sup> Consider four extreme cases: (A)  $\Omega^r = \Omega$  &  $a = \infty$ ; therefore  $\mathbf{p}^{r*} = \mathbf{c}^r$  (all products are regulated and the policy makers are fully robust to political pressures; hence, the competitive solution appears); (B)  $\Omega^r = \Omega$  &  $a = 0$ ; hence  $\mathbf{p}^{r*} = \mathbf{c}^r + [\Delta^r]^{-1} \mathbf{q}^r(\mathbf{p})$  (all products are regulated and the government fully ignores social welfare; hence, the cartel solution emerges); (C)  $\Omega^n = \Omega$  &  $\Delta_{ij}^{*nm} = \begin{cases} 1 & \text{if } \exists f : \{i, j\} \subset \Omega_f \\ 0 & \text{otherwise} \end{cases}$ ; hence  $\mathbf{p}^{n*} = \mathbf{c}^n + [\Delta^{nm}]^{-1} \mathbf{q}^n(\mathbf{p})$  (there are no



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regulated products and no collusion, resulting in a pure oligopolistic equilibrium); (D)  $\Omega^n = \Omega$  &  $\Lambda^{nn} = \tilde{\Lambda}^{nn}$ ; then  $\mathbf{p}^{n*} = \mathbf{c}^n + [\tilde{\Lambda}^{nn}]^{-1} \mathbf{q}^n(\mathbf{p})$  (none of the products is regulated and there is perfect collusion in the industry, yielding the cartel solution).

<sup>12</sup> As in Cohen (2013), we assume a consumption of 200 ml of fluid milk per capita a day, the US daily recommended serving size (8 oz.).

<sup>13</sup> The target price may also be suspected endogenous, and is therefore instrumented in the price equation using the animal-feed-price index. In addition, replacing the target price by the animal-feed-price index as an IV for the price in the demand equation had neglectable impact on the estimation results.

<sup>14</sup> Chief Economist of the IDB, personal communication, January 2013.

<sup>15</sup> We evaluate the substitution effect on welfare by running scenarios (c) and (d) while fixing the prices of unregulated and regulated products, respectively.