the impact of markup regulation on prices

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The Impact of Maximum Markup Regulation on Prices[1]

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Abstract

Markup regulation is a common, yet understudied type of regulation. We analyze the repeal of *maximum* wholesale and retail markup regulation in an oligopolistic and vertically nonintegrated market. By comparing the prices of products affected by regulation before and after the policy change and using unregulated products as a control group, we find that abolishing regulation led to a significant *decrease* in both retail and wholesale prices. Our analysis provides indirect but consistent evidence that markup ceilings provided a focal point for collusion among wholesalers.

JEL: L0, L1, L4, L5

Keywords: Markup regulation, focal point, collusion, ex-post policy evaluation

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1. Introduction

State imposed markups are common across markets. According to the World Health Organization, around 60 percent of low- and middle-income countries regulate wholesale or retail maximum markups in the pharmaceutical industry.[5] In high-income countries, maximum markups are also commonly imposed for prescription and over-the-counter drugs.[6] Markup regulation has been used in the US market for alcoholic beverages and in the Canadian and European markets for gasoline.[7] In about 12 percent of the world gas market, prices are regulated using cost plus rules[8], which often prescribe regulated markups on production or import costs.[9] Extensive markup regulations have been used in the fruit and vegetable markets in Greece and are under review in Israel.[10] Yet despite this wide application, the effects of markup regulation have never been subject to systematic empirical testing.

Governments typically justify imposing maximum markups on the grounds of protecting consumers from the effects of excessive market power. In oligopolistic markets, the main argument in favor of maximum markups is to trim the right tail of the markup distribution, hence limiting the most extreme instances of exploitation of market power, in which the price far exceeds the marginal cost. This is expected to put downward pressure on retail prices, without affecting firms with smaller markups (e.g., a competitive fringe). If binding, markup ceilings will force some firms to reduce prices. If not binding, prices will not be affected. Hence, the average price is expected to fall.

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[5] See Ball (2011) and World Health Organization (2013).

[6] In nearly all EU member states, pharmacists' fees or margins on the sales of drugs are regulated (see Philipsen, 2013, for an overview and Schaumans and Verboven, 2008, for a study of entry in the Belgian market for pharmacies).

[7] Different types of markup regulation (often in conjunction with other types of regulation) have been used in the US market for alcoholic beverages (Seim and Waldfogel, 2013; Miravete, et al., 2014), in the Canadian and European gasoline markets (Sen et al. 2011; Suvankulov et al. 2012; Haucap and Müller 2012) and in the liberalized European telecom sector (Peitz, 2003). Finally, the American Defense Commissary Agency supplies groceries to military personnel and veterans at regulated prices, which are determined using a markup rule (Defense Commissary Agency, 2012).

[8] International Gas Union (2014).

[9] For example, gas prices in China at different stages of the production and transportation process are set by adding regulated margins to production costs. This generates significant local price differences (Corbeau et al., 2012).

[10] Consumers and producers seem to be advocating for the introduction of maximum wholesale markups in the market for fruits and vegetables. Regulations are under consideration in parliament (Israel Consumer Council, 2015).

Surprisingly, there is no evidence on the actual impact of markup regulation on prices. Moreover, existing studies on the impact of price regulation challenge this seemingly uncontroversial prediction.[11] Knittel and Stango (2003) show that mandatory price ceilings in the US credit card market had the unexpected effect of *increasing* average prices by providing a focal point for collusion to unconstrained firms (Schelling, 1960).[12] In principle, maximum markup regulation may also have this perverse effect. Still, the evidence on price regulation does not imply that markup regulation will have similar effects, and the impact of markup regulation on prices remains an open issue.[13]

In this paper, we estimate the impact of maximum markup regulation on retail and wholesale prices in an oligopolistic and vertically nonintegrated market. We take advantage of the repeal of maximum markup regulation in the market for fresh fruits and vegetables in Greece. First implemented right after the Second World War, markup regulation was hastily repealed in June 2011 with the objective of reducing unnecessary regulation in the Greek economy. Regulation consisted of maximum wholesale and retail markups on virtually all fruits and vegetables, whether imported or locally produced. Nonetheless, five products - apples, lemons, mandarins, oranges, and pears - were exempt from regulation.[14] To identify the impact of deregulation on prices, we compare prices of products affected by regulation before and after the policy change, using unregulated products as a control group. After accounting for product and store characteristics, time trends and yearly price cycles (typical of fruit and vegetable products), deregulation provides some plausibly exogenous variation that allows us to estimate the causal impact of regulation.

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[11] The literature on price regulation has mainly focused on other issues, such as rationing and the welfare effects of binding price regulation (Olsen, 1972; Smith and Phelps, 1978; Raymon, 1983; French and Lee, 1987; Deacon and Sonstelie, 1989; Deacon and Sonstelie, 1991; Suen, 1989; Davis and Kilian, 2011). There is no evidence on the actual impact of markup regulation on prices, product availability, or entry, while there is some recent evidence on the impact of price floors on prices and market structure (Carranza, Clark, and Houde, 2015).

[12] Albæk, Møllgaard, and Overgaard (1997) also show that price regulation may favor collusion. In their case, firms benefited from the increased transparency of price information rather than from the existence of a focal point. The fact that public information on pricing may facilitate collusive behavior among competitors was first highlighted in the General Electric – Westinghouse case in the 1960s and 70s. In that case, competitors would use a "price book" and essentially offer discounts off these publicly available prices, making it easy for market participants to understand each other's pricing strategy (Hay, 2000; Cabral, 2010).

[13] Section 2 compares markup and price regulation in greater detail.

[14] See Section 3 for details on the history of this regulation.

Our dataset consists of three types of data. First, it includes weekly store-level retail prices for each fruit and vegetable product category both from supermarkets and street markets in Athens, Greece. Our sample covers one and a half years before and after the policy change, from 4 January 2010 to 28 December 2012. Second, we use median monthly wholesale fruit and vegetable prices from the Athens Wholesale Central Market (henceforth, Central Market). Third, we collected weekly store-specific retail prices for 19 non-fruit and vegetable products sold in supermarkets in Athens during the same period.

Using a difference in difference methodology, we find that abolishing markup regulation led to a surprising 6 percent *drop* in average retail prices. This fall in the average price of fruits and vegetables corresponds to about a 1 percent reduction in the price of food for a typical Greek household. In aggregate, this decrease corresponds to savings of about €256 million per year. We find that deregulation had a direct effect on wholesalers and only indirectly affected retailers, who adjusted their prices in reaction to the lower wholesale prices. The retail and wholesale prices of goods in the control group were unaffected by the policy change. We also find that price dispersion increased (particularly at the bottom of the distribution) as a consequence of deregulation in the retail and wholesale market. These results are robust to a number of alternative econometric specifications and different methods of selecting the control group.

Given that *maximum* markup regulation is typically instituted to protect consumers, it is surprising to observe a decrease in prices after deregulation. In fact, the finding of lower mean prices after deregulation is not consistent with markup regulation having the sole effect of constraining firms with higher markups.[15] The sign and magnitude of our results point to large and unexpected effects of regulation that significantly impact consumers. In the second part of the paper, we investigate the hypothesis that maximum markups served as a focal point for collusion (Knittel and Stango, 2003), and explore alternative hypotheses based on incentives to reduce costs and vertical relations. The possibility of collusion seems real, as a number of factors facilitating collusion are present in the wholesale market. First, the market operates as a licensed

[15] See Section 2 and Appendix A for more details.

market, with a small and stable group of operators. Second, wholesalers operate in close physical proximity and trade homogeneous products (within varieties) on a daily basis, making it possible to monitor and share information (Hellenic Competition Commission, 2013; henceforth, HCC).

While we cannot offer direct evidence of explicit (and illegal) agreement among wholesalers, we provide six pieces of evidence consistent with collusion. First, deregulation increased price dispersion by causing a significant decrease in the left tail of the distribution of retail and wholesale prices. This is not in line with markup regulation having the sole effect of constraining firms with the largest markups, but is consistent with collusion.[16] Second, deregulation has a direct impact on wholesale prices and no direct effect on retail prices, which simply adjust to changes in wholesale prices.[17] Third, the effect of deregulation on retail prices appears to be driven by the effect on prices in supermarkets, which buy virtually all their produce from wholesalers. Fourth, at street markets, the effect of deregulation on prices is evident only in products purchased from wholesalers. Fifth, the effect of deregulation is larger for products with smaller regulated markups in the wholesale market, which is consistent with the theoretical prediction that higher focal points make collusion more difficult to sustain in equilibrium.[18] Sixth, we collect data on the profitability of wholesalers, and compare the profitability of those operating in the Central Market with those who do not, finding that the former experienced a significant drop in profitability after the reform, while the latter were not affected.

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[16] Section 2 and Appendix A develop this argument.

[17] Once we control for wholesale prices in pass-through regressions (described in Section 6), there is no effect of deregulation on retail prices.

[18] This hypothesis was developed by Knittel and Stango (2003) in the context of price ceilings, but extends to maximum markup regulation (as discussed in Section 2 and Appendix A).

This paper contributes to the literature on collusion by providing evidence that markup regulation may have this undesired consequence.[19] It also relates to empirical studies of markets with vertical relations.[20] From a policy perspective, this study contributes to the literature on the effects of regulation on efficiency and economic performance (see, for example, Djankov et al. 2002; Scarpetta and Tressel 2002; Blanchard, 2004; Katsoulacos et al. 2014), and informs the debate on recent investigations by the competition authorities (European Competition Network, 2012) into suspected vertical and horizontal agreements in the food market.[21]

The remainder of the paper is organized as follows. Section 2 discusses maximum markup regulation and its relation to price ceilings. The Greek market for fruits and vegetables is presented Section 3, while Section 4 introduces the data and the empirical strategy. Results on the impact of deregulation are discussed in Section 5, alongside several robustness checks. Section 6 analyses different potential explanations for these results. Finally, Section 7 concludes.

2. Markup Regulation, Price Ceilings, and the Distribution of Prices

Markup regulation constrains the distribution of markups and only indirectly affects the distribution of prices. This is an important difference between the two types of regulation. Still, price and markup

[19] In the literature on collusion, Porter and Zona (1993, 1999) study procurement auctions by comparing the bids of firms that were likely to be part of a collusive agreement and those who were not. Porter (1983), Ellison (1994), and Baldwin et al. (1997), instead, use a statistical model to identify collusive behavior from the data. Knittel and Stango (2003) build on this approach to distinguish the probability of collusion at the price ceiling from the probability of being constrained by the price ceiling. In our setting, it is not possible to observe which sellers are charging the maximum markups. Hence, our focus is entirely on policy evaluation. We do not aim at providing a general methodology for identifying collusion in the absence of an exogenous policy change.

[20] Research in this area has focused on the effects of vertical agreements (restraints) among firms that may facilitate collusion between upstream suppliers with the typical example being "most-favored nation" clauses (Cooper, 1986; Besanko and Lyon, 1993; Grether and Plot, 1984). In contrast, our aim is to measure the impact of government regulation (Lafontaine and Slade, 2008).

[21] A large literature relates to minimum markups, sales-below-cost laws, and predatory pricing (see Motta 2004 for a review and Biscourp, Boutin, and Vergè, 2013, for a recent policy evaluation). Although similar in their implementation (a constraint on markups), the economic rationale for these laws is different from that of maximum markup regulation studied in this paper.

distributions are related, and studying price distributions provides important insights into the effects of markup regulation. To illustrate the effects of markup regulation on the distribution of prices, consider a market in which firms with heterogeneous marginal costs c are selling differentiated products at prices p (for simplicity we omit firm specific subscripts). This could be the result of vertical and/or horizontal product differentiation. For example, different retailers (or wholesalers) that sell the same type of fruit may differ in the freshness of the product, which may be related to the price they pay to wholesalers (vertical differentiation). Additionally, the location of the store, packaging, advertising, and service quality may play a role in differentiating products across sellers (horizontal differentiation). The introduction of a maximum *markup* implies that the constrained price is

$$\tilde{p} = Min[p, (1 + a)c],$$

where a is the maximum markup. If the regulation is binding for some firms, then the expected price will fall after the introduction of this regulation, since $E(\tilde{p}) < E(p)$. Hence, the first prediction that we take to the data is that after deregulation we expect to see an increase in average prices.[22]

Moreover, markup regulation is expected to reduce price variability if regulation is more binding for firms with higher marginal costs (in other words, if there is a positive correlation between marginal costs, markups, and prices). This assumption is realistic in the market for fruits and vegetables, as higher marginal costs (for purchasing the product and providing the service) typically correspond to a higher quality product (e.g., taste and freshness of the product, quality of service), which makes it possible to charge higher markups (more rigid demand). The existence of a positive correlation between marginal cost and markups is also in line with the empirical evidence.[23] Moreover, it is consistent with the equilibrium outcomes of models of oligopoly pricing with vertical and horizontal product differentiation (see Appendix A for

[22] This prediction is not specific to markup regulation. The introduction of a price ceiling also implies a decrease in expected price, but this policy is different, as it truncates the distribution of prices and only indirectly affects the distribution of markups.
[23] For example, in the market for automobiles, Berry, Levinsohn, and Pakes (1995, Table VIII) show that markups rise almost monotonically with price.

details). Under this assumption, the second theoretical prediction is an increase in price variability after deregulation, driven mainly by a movement in the right tail of the price distribution.[24]

Markup regulation differs from price regulation in a number of other ways. First, markup regulation is used in markets (for example, fruits and vegetables) in which price regulation would be impossible to implement due to high seasonality and uncertainty in production costs (e.g., caused by weather conditions). In this case, even small administrative costs, for example related to determining and communicating the revised maximum prices, could make price regulation infeasible. Second, markup regulation limits the benefits from cost reductions, while price regulation provides strong incentives to increase efficiency.[25] Third, the enforcement of markup regulations is generally more difficult and costly, as firms may misreport or distort their cost structure in response to regulation.[26]

3. The Greek Market for Fruits and Vegetables

The market for fruits and vegetables in Greece consists of three tiers. At the production level, the market is very fragmented.[27] The next level, the wholesale market, is significantly more concentrated, with the Central Market operating as a closed market in which only licensed sellers can operate. Wholesalers mainly sell to retailers (with supermarkets as their largest customers), but also to street market sellers, grocery stores, and restaurants. Finally, at the retail level, consumers buy either from street markets (accounting for a 58 percent market share in year 2011 but steadily declining), supermarkets (a 32 percent market share but

[24] This result is derived in Appendix A, which illustrates the difference between markup regulation and price ceilings.
[25] From this point of view, markup regulation is a relatively low-powered regulation and resembles cost of service regulation (Viscusi et al., 2005). The principal-agent problems induced by regulation have been the focus of a large literature (Laffont and Tirole, 1993).
[26] Moreover, while both price ceilings and maximum markup regulations may provide focal points for collusion, they generate different conditions for the sustainability of collusion (Appendix A).
[27] The agricultural sector accounts for 3.1 percent of the Greek GDP and employs 9.2 percent of the total work force, which is twice the EU 27 average (4.7 percent). However, the average producer cultivates just 47,000 m^2 (11.6 ac) vs. the EU average of 126,000 m^2 (31.1 ac) Moreover, around 50 percent of the Greek producers own less than 20,000 m^2 (4.9 ac) plots.

steadily increasing), and - to a lesser extent - from grocery stores or other corner shops (10 percent). At street markets, approximately half of the vendors are also producers themselves (HCC, 2013).

The history of this system of regulation dates back to 1946. As it emerged from the Second World War and a later civil war, the Greek government sought to impose a series of market regulations on prices and markups for goods such as bread, meat, fruit and vegetables, and pharmaceutical products, which were considered to be essential and scarce.[28] It later created (law 3475/1955) the (state owned) Central Market, where the wholesale trade of raw agricultural products was required to take place. These policies had multiple objectives. In an economy plagued by scarcity of essential goods, they were designed to prevent wholesalers and retailers from making excessive profits. However, they also aimed at setting specific standards of food safety and hygiene, and facilitating the monitoring of prices and markups by the competent authorities.

Markup regulation initially covered all fruits and vegetables. By 1977, however, five products (apples, lemons, mandarins, oranges, and pears) had been exempted from the application of maximum markup regulations, as they were considered available in sufficiently large supply. No change in the list of excluded products has occurred since. Maximum markup regulation remained in place for all other fruits and vegetables until 2011, although the initial conditions of scarcity had long ceased to exist. The production, trade, and consumption of these products is now widespread throughout the country.

Products exempted from markup regulation are not the output of any specific region or any identifiable set of producers and they are statistically indistinguishable from unregulated products in terms of mean cultivation area, production quantity, and yield.[29] Until 2011, the law provided for product-specific maximum markups ranging between 8 and 12 percent for the wholesale market, 20 and 35 percent for supermarkets, and 17 and 32 percent for street markets and grocery stores (see Table A1 in the Appendix

[28] These rules and regulations were first codified with the Market Decree 136/1946.
[29] See Table A2 in the Appendix, which uses annual data at the product level from EUROSTAT for 2011. Differences remain insignificant if we use other years before 2011 or the average values for the 2006-2011 period.

for details).[30] Following the 1977 reform of markup regulations, steps were gradually taken towards liberalizing the market for fruit and vegetables. By the 1990s, only maximum markups were still in place. In 1998, the Central Market was re-established as a state-owned limited company.[31]

The repeal of the maximum markup regulation was the outcome of mounting international pressure to liberalize the Greek economy in an attempt to limit red tape and government intervention in various markets.[32] In 2010, the European Commission also opened a case against Greece for restrictions on the wholesale trade in the Central Market.[33] The policy change was highly visible and prominently featured in national newspapers. Reactions were mixed and somewhat contradictory, with some expecting no change in prices to take place and others forecasting price increases. The process leading to deregulation was quick. The policy was implemented on 23 June 2011, about three weeks after the government first announced it.[34]

4. Data, Identification and Empirical Methodology

We matched three different data sources for our analysis. First, we obtained weekly store-level retail prices for fruits and vegetables in Athens.[35] Supermarkets were required to report their posted prices weekly to the Ministry for Development and Competitiveness. Street market vendors were sampled by employees of the same Ministry, and the mean prices in each market were then calculated for the same fruit and

[30] By law, maximum markups are calculated as the sum of the purchase price and transportation cost, before adding VAT.
[31] Due to significant growth of the produce market, the Central Market could no longer shelter all of the wholesalers. Although it continued to serve as the main wholesale market, some wholesalers began to operate on other premises.
[32] However, this was not formally part of any agreement between Greece and its creditors (IMF, ECB, EU).
[33] The Commission (case 2010/4090) argued that entry was difficult in the Central Market, whereas incumbents enjoyed a privileged position and protection against new competitors. Markup regulation was believed to be overly restrictive as it fundamentally interfered with firms' pricing decisions. The Commission argued that this could encourage collusion between wholesalers, with potentially adverse effects for consumers. The case was dropped following changes in legislation made by the Greek government.
[34] Ministerial decision A2-1045 (Gazette B' 1502/22-6-2011).
[35] We focus on Athens, as it is by far the biggest market in Greece, is well-documented in our supermarket sample, and provides reliable information on wholesale prices.

vegetable varieties as for supermarkets.[36] We obtained store-level data for 36 products, further subdivided into 72 varieties, from 20 supermarkets and 24 street markets in Athens from 4 January 2010 to 28 December 2012.[37]

Second, using a survey administered by the Greek Ministry for Development and Competitiveness, we gathered information on the retail prices of 19 grocery products other than fruits and vegetables sold in the same supermarkets (all product categories and varieties are reported in Table A3 in the Appendix). None of these products was affected by the markup regulation.

Third, we also obtained monthly wholesale median, minimum, and maximum prices of the same products from the administration of the Central Market during the same period. Wholesale transaction prices were collected biweekly by the market administration by surveying wholesalers.[38] The wholesale data covers all 36 products and 59 of the 72 product varieties in the sample of retail prices.[39]

Figure 1A plots the time series of the weekly average log price of fruit and vegetable products. The dashed black line shows products affected by markup regulation; the dashed grey line shows the five products not affected by regulation. The average price of products not affected by regulation (the solid grey line) slightly increased in the period following the policy change (the vertical red line). Instead, the average price of products affected by regulation (the solid black line) shows a large drop, suggesting a significant reduction in the price of these goods. Figure 1B plots the corresponding figures for wholesale prices,

[36] Posted prices of fruits and vegetables typically correspond to transaction prices. In supermarkets, the only possible difference between the two could come from coupons (which are hardly ever used for fresh produce) or loyalty programs (which typically reward customers by giving a discount on the whole basket of goods bought). At street markets, posted prices may differ from transaction prices if individual discounts are given to loyal customers based on personal knowledge.

[37] Our sample does not cover grocery stores or other small independent retailers (corner or convenience stores).

[38] The market administration was not involved in monitoring compliance with markup regulation. Monitoring was based on random checks carried out by the Ministry of Development.

[39] Wholesalers do not specialize but carry most fruits and vegetables. The vast majority of wholesale transactions are spot contracts. Wholesalers may price discriminate among their customers by providing discounts to customers on the basis of the quantity bought, type of payment, distance from the market, and customer loyalty (HCC, 2013). Based on conversations we had with wholesalers, the administration of the Central Market and buyers from supermarkets, we could find no evidence of any change in the type of contracts or the importance of price discrimination as a consequence of deregulation.

indicating that the wholesale price of products affected by regulation dropped considerably after deregulation, while the average price of products not affected by regulation slightly increased, as in the retail market.

Figures 2A and 2B report the distribution of retail and wholesale prices before and after deregulation for the products covered by regulation. Both figures show a substantial change in the distribution after the reform, with a drop in the mean and an increase in the standard deviation, mainly due to a shift in the left tail of the distribution. In the next sections, we build on these descriptive results and provide a more systematic analysis of the magnitude and significance of the possible impact of deregulation on the distribution of prices.

4.1 Identification and Empirical Methodology

Identification of the impact of the policy change is obtained within a difference in difference framework.[40] Denote by P_{ijt} the retail price of product variety *i*, in store *j*, in week *t*. The basic empirical specification is of the form:

$$\ln(P_{ijt}) = b_0 + b_1 Post_t + b_2 Treat_i + b_3 Post_t \times Treat_i + X_{ijt} d + e_{ijt} \tag{1}$$

where $Post_t$ is an indicator variable equal to one after deregulation, $Treat_i$ is an indicator variable for products affected by the regulation (treatment group), $Post_t$ x $Treat_i$ denotes their interaction; X_{ijt} is a matrix of control variables and e_{ijt} is a random shock with $E(e_{ijt}|Post_t, Treat_i, X_{ijt}) = 0$. b_3 is the crucial parameter capturing the impact of the policy change.

The key identifying assumption is that price trends would be the same (conditional on covariates X_{ijt}) in the treatment and control groups in the absence of treatment. This assumption becomes increasingly

[40] Early applications of this approach are found in Ashenfelter and Card (1985), Card (1992), and Card and Krueger (1994, 2000); more recent applications in industrial economics include, for example, Ashenfelter et al. (2013).

credible as we progressively add appropriate controls in X_{ijt}. First, we control for changes in the VAT rates.[41] Second, we include in X_{ijt} eleven month indicator variables, 53 store indicator variables, and 109 product variety-specific indicator variables. We then add the interaction of month and product fixed effects, capturing the yearly price cycle of each product (we assume that varieties of the same product follow the same cycle). Finally, we include a quadratic trend (measured in months).[42] This captures the overall changes in the average price of fruit and vegetable products during the sample period (due, for example, to the economic recession). The analysis of wholesale prices from the Central Market uses the same empirical specification, with the caveat that only median wholesale prices at a monthly (rather than weekly) frequency are available for each product variety.

5. Empirical Results on the Effect of Deregulation on Prices

Table 1 reports a simple before-after comparison of the retail price of products covered by regulation (treatment group). The average price decreases by 7.7 percent after deregulation (column 1). This difference is not much affected when controlling for month (column 2), store, and product variety-specific fixed effects (column 3). It is also robust to controls for product-specific yearly cycles (column 4). Additionally controlling for a linear and a quadratic trend (column 5) leads to slightly smaller estimated difference in prices (5.6 percent). Hence, looking only at the affected products, and in line with the evidence presented in Figure 1A, there is a negative and significant effect of deregulation on retail prices.

In Table 2, the simple difference in difference estimator, with no additional controls, shows that the average price of the treatment group significantly fell by 10 percent (column 1). In contrast, prices for the control group were not significantly affected. In columns 2 and 3, the negative impact of deregulation

[41] During our sample period, there were three changes in VAT rates that potentially affected both regulated and unregulated products: from 9% to 10% on 15/3/2010, from 10% to 11% on 1/7/2010 and from 11% to 13% on 1/1/2011.

[42] We also estimate the model using flexible period-specific indicator variables (153 week-specific indicator variables) instead of a time trend, as in Jin and Leslie (2003). None of our results changes in any fundamental way.

survives the inclusion of month, store, and variety-specific fixed effects. After controlling for product-specific yearly cycles (column 4) and quadratic trend (column 5), the estimated causal impact of deregulation is -6.4 percent.[43]

The economic magnitude of the results is significant. A 6 percent decrease in the average price of fruit and vegetables corresponds to a 1 percent decrease in the price of food for a typical Greek household and a 0.16 percent decrease in the consumer price index. This, in turn, corresponds to a decrease of €23 in expenditure per capita per year, amounting to €256 million per year in aggregate expenditure at the country level.

Table 3 reports the results when analyzing the wholesale data alone. A simple before-after comparison of the wholesale prices of regulated products indicates that prices fell by 9.9 percent after deregulation (column 1). Without additional control variables, the difference in difference estimate of the impact of the policy change is higher in column 2. Including month- and variety-specific fixed effects, product-specific yearly cycles, and the quadratic trend leads to a smaller but statistically significant estimated impact of deregulation of -9.5 percent.[44]

5.1. Selection of the Control Group and Placebo Test

The difference in difference approach assumes that the change in policy does not affect the control group (no spillover effects). However, given that both our control and treatment groups consist of fresh fruits and vegetables, the policy change could potentially have an indirect impact on the demand for, and hence the prices of, some products in the control group. This could happen if some cross price elasticities between products in the two groups were sufficiently high (positive or negative).

[43] The results are not affected if we add product-store fixed effects.
[44] Standard errors are larger than in Table 2 but the estimated coefficients are not significantly different from the corresponding estimates in Table 2.

In the absence of a formal randomization into treatment status, the choice of the control group entails a tradeoff. Similar products are more likely to meet the equal trends assumption, but they are also more likely to be related (substitutes or complements). If this is the case, our estimator will not capture the impact of the policy, but only the differential impact of the policy on the two groups. Note that both Figure 1, where the average prices of the control group are very similar before and after the policy change, and the insignificant $Post_t$ coefficient in Table 2 seem to refute this idea.

Nevertheless, we investigate this possible bias by using a different control group, comprised of 19 non-fruit and vegetable packaged goods such as rice, spaghetti, flour, and milk (the full list is reported in Table A3, column 3). These products are stocked in all supermarkets in our sample and are very unlikely to be strong substitutes or complements of the fruit and vegetables in our treatment group. Table 4 presents the results using the same additional control variables as in Table 2. The impact of deregulation ranges between 9 and 12 percent. In the specification with the richest set of controls (column 5), the impact of deregulation is about 8.8 percent, slightly larger than in Table 2, but within conventional confidence intervals of our previous estimates. As before, there is no systematic impact of deregulation on the price of the products in the control group. Hence, the choice of the control group seems not to significantly affect our results.

Since most of the products in the original control group are fruits, in Table 5, column 1, we also separately estimate the impact of the policy change for fruits and vegetables. The estimated impact of the policy is very similar in magnitude and not statistically different for the two groups. We also test the robustness of the common trend assumption in (1) using the period before the change in regulation to estimate the impact of a placebo treatment. In Table 5, column 2, we drop the period after 22 April 2011, which is two months before the actual policy change, to avoid any possible anticipation effects (which will be discussed in Section 5.3). We then choose the midpoint of the remaining period (22 September 2010) as the date of a fictitious reform. The results show that the fictitious policy has no impact on the treatment or the control group.[45]

5.2. The Impact on the Distribution of Prices

We now document how deregulation affected the entire price distribution. Figure 2A plots the distribution of the logarithm of retail prices for products in the treatment group for one year before and after deregulation. After deregulation, the distribution shifts to the left and becomes more dispersed. In particular, the mean and the median decrease, together with the 1st and 5th percentiles, whereas the 95th and 99th percentiles slightly increase.[46] In Table 6, we use quantile regressions to measure the impact of markup regulation on the distribution of retail price residuals. Deregulation clearly affected the left more than the right tail of the distribution. Figure 2B shows a similar pattern for wholesale prices as well and Table 7 provides quantile regressions on the distribution of wholesale price residuals. A very similar picture emerges, whereby the negative effect of deregulation is mostly felt on the left side of the distribution (with the effect being strongest for the first percentile and diminishing as we move to higher percentiles) rather than the right tail. On the right tail, instead, the effect is either not significant (95th percentile) or even positive (99th percentile).

As a robustness exercise for the wholesale market, we also studied changes in wholesale price variability using information on monthly minimum and maximum wholesale prices for each product. With this information, we compute the monthly relative wholesale price range for each product, $(max_{it} - min_{it})/min_{it}$. Table 8 reports the results of difference in difference regressions on price range. Wholesale price variability significantly increases as a result of the reform. The causes of this increase are analyzed in Tables 9 and 10, which report the results of difference in difference regressions on the minimum and maximum prices. In line with the results in Table 3 and Figure 2B, minimum prices significantly decrease,

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[45] There is no change in the list of available products or varieties before or after deregulation in the retail or wholesale dataset. Deregulation did not seem to have any effect on product availability or product variety.

[46] A similar pattern emerges from the distribution of residuals from a regression of retail prices on product, store, product-month interactions, and a quadratic time trend.

while maximum prices are largely unaffected by the reform; hence, the increase in price variability can be attributed to a shift of the left tail of the wholesale price distribution.

5.3. Product-Specific and Dynamic Effects

The estimated impact of the reform in Tables 2 and 3 is the average effect across products in the treatment group. However, we can exploit the richness of the data and estimate the impact of the reform separately for each product, while keeping the same control group. Table 11, column 1 reports the product-specific coefficients of the interaction of $Post_t$ x $Treat_i$ in equation (1) with product-specific indicator variables.[47] While there is significant variability across products, the negative effect of deregulation is not specific to one or a small set of products: 86 percent of products show a negative coefficient and 76 percent of them are significant at the 10 percent confidence level. Similar results emerge from the analysis of product-specific effects on wholesale prices in column 2. Overall, this table shows that the negative impact of deregulation was not driven by a small number of products, but from generalized changes in prices.

Finally, we estimate a dynamic model interacting $Treat_{\mathrm{i}}$ with indicator variables for 10 two-week periods before and after the policy change,

$$\ln(P_{ijt}) = b_0 + b_1 Post_t + b_2 Treat_i + b_{3,T-10}[Treat_i \text{ x } D^{T-10}] + b_{3,T-9}[Treat_i \text{ x } D^{T-9}] + \cdots + b_{3,T+9}[Treat_i \text{ x } D^{T+9}] + b_{3,T+10}[Treat_i \text{ x } D^{T+10}] + X_{ijt}d + e_{ijt} \quad (2)$$

where $D^{T-i} = 1$ in the i^{th} period before deregulation.[48] The last period (T+10) includes all the observations 20 or more weeks after the policy change.[49]

[47] One product (watermelon) is dropped because of data constraints.
[48] The results are robust with respect to the choice of the window around the policy change.
[49] The omitted indicator variable covers the period 20 or more weeks before deregulation. See Autor (2003) or Laporte and Windmeijer (2005) for a discussion of this approach.

Figure A1 in the Appendix plots the regression coefficients together with their 95% confidence interval.[50] Deregulation has no effect on prices until four weeks before its actual implementation.[51] There seems to be some anticipation effect about four weeks before the policy change, as indicated by the drop in the estimated coefficient in T-2. This coincides with the government's announcement of the impending change in regulation. Point estimates are negative and stable from that point on, and their magnitude is in line with our previous estimates of the impact of deregulation (Figure A1 also reports the estimated treatment effect from Table 2, column 4). A similar picture emerges for the wholesale market as well (Figure A2), although estimated coefficients (Table A5) are imprecisely estimated due to the fact that it is difficult to disentangle the monthly lead and lag variables around the reform date from the yearly cycle for each product (Figure A2 also reports the estimated treatment effect from Table 3, column 6).

6. Interpretation of the Estimated Impact of Deregulation: Markup Regulation and Collusion

Our results on the negative impact of deregulation on mean retail and wholesale prices are not consistent with the view that the sole effect of regulation is constraining firms with high markups. While some firms might have been constrained by the markup regulation, another effect must have played a major role. The main candidate explanation is that regulation facilitated collusive behavior. The economic intuition underlying this idea is that (unconstrained) firms used the maximum markups as focal points for coordination, leading to increases in average prices. Repeal of the law might have destroyed these focal points and led to significant price decreases.

Appendix A describes how collusion on focal markups may occur using the repeated game framework of Knittel and Stango (2003). Collusion on prices can be sustained in equilibrium by the threat of future punishments, triggered by deviations from the collusive pricing strategy (Green and Porter, 1984; Rotemberg and Saloner, 1986; Abreu et al., 1990; Haltiwanger and Harrington, 1991). Collusion on focal

[50] Estimated coefficients are reported in Table A4 of the Appendix.
[51] The null hypothesis that all coefficients for periods before deregulation are equal to zero is not rejected at conventional levels (p-value = 0.939).

markups makes it necessary for firms to infer their competitors' markups from available data on costs and prices. It is difficult to measure with precision exactly what wholesalers knew about their competitors' costs and prices. However, there are three main reasons to believe that monitoring was possible. First, the identity of (large) customers supplied by each wholesaler could easily be observed because of the physical arrangement of the Central Market. Second, wholesale transactions were far from confidential, although they were subject to negotiation between wholesalers and (large) buyers.[52] Finally, information on retail prices in supermarkets was widely available to competitors.

In this section, we empirically test six different implications of the collusion hypothesis. While none of these tests can provide conclusive proof on their own, collectively they make a strong case for deregulation leading to the breakdown of a collusive equilibrium in the Central Market. Our results also show how lower wholesale prices were then reflected in retail prices, leading to a substantial decline in prices in supermarkets and street markets.

6.1. Collusion and Price Dispersion

The first piece of evidence supporting the collusion hypothesis relates to the fact that deregulation affected the left more than the right tail of the price distribution. Both the descriptive evidence from Figures 2A and 2B and the quantile regressions in Tables 6 and 7 strongly indicate that deregulation mainly negatively affected the left tail of the price distribution both for retail and wholesale firms. This is inconsistent with maximum markup regulation having the sole effect of constraining firms with high markups, as deregulation in this case would have caused a significant move in the right tail of the price distribution. To the extent that prices and markups are positively correlated (see Appendix A), the strong movement in the left tail of the price distribution is consistent with a breakdown of collusion.[53]

[52] Wholesalers reported transaction prices to the market authorities and, given the physical proximity of wholesalers, this information could easily be shared with other wholesalers.
[53] Our results also contribute to the literature studying the impact of competition on price dispersion (see, for example, Borenstein and Rose, 1991, Gerardi and Shapiro, 2009, and Allen, Clark and Houde, 2014).

6.2. Pass-through Regressions

If collusion is driving the results in Tables 1-4, we can expect to see a larger impact of the policy in markets where collusion is easier to maintain. As discussed in Section 3, the Central Market has many of the characteristics identified in the literature as favorable to collusion (Harrington, 2008; Buccirossi, 2008).[54] First, entry into the Central Market is difficult and highly regulated, while entry is easy in the retail market. Second, the wholesale market is much more concentrated than the retail or the production market. Third, wholesalers are located in close physical proximity of each other, while retailers tend to be more heterogeneous and dispersed. Finally, products (within varieties) are relatively homogenous in the wholesale market, while at the retail level there is more differentiation due to location, availability, and complementary services offered to customers. Hence, there are reasons to expect collusion to be easier to maintain in the wholesale market.

We investigate the impact of the policy change on retail prices using pass-through regressions, which allow us to disentangle the direct impact of the policy on the distribution of retail prices from the indirect impact through the effect on the wholesale price distribution. We merged the retail with the wholesale price data, excluding the varieties not included in the wholesale data set. Table 5, column 3, reports the results from our benchmark specification when controlling for store, variety-specific fixed effects, product-specific yearly cycles and quadratic trend on this slightly modified dataset. Not surprisingly, the impact of the policy (-5.5 percent) is very much like that found in Table 2, column 5 (-6.4 percent). In Table 5, column 4, we also control for wholesale prices,[55] and the effect of the policy change becomes statistically insignificant. Deregulation affected retail prices indirectly through wholesale prices, but there is no evidence of a *direct* effect of deregulation on retail prices. Hence, pass-through regressions clearly point towards collusion in the wholesale market as the cause of the overall fall in prices after the reform.

[54] Standard arguments can be used to show that collusion is more likely in less competitive markets when focal points are determined by markup regulation (See Appendix A).
[55] The coefficient of the wholesale price in this regression is expected to be positive, since increases in wholesale price lead to increases in marginal cost for the retailers.

Deregulation, in principle, could also have affected the pass-through behaviour of retailers. We explore this possibility in detail in Table A6 of the Appendix. Column 1 reproduces the baseline pass-through regression (Table 5, column 4) to facilitate comparison. Columns 2-4 report pass-through coefficients estimated separately for 2010, 2011, and 2012. Pass-through coefficients are not significantly different across years and they are very close to the estimated pass-through coefficient in column 1. Finally, in column 5 we also add an interaction between the wholesale price and the post indicator. Results from column 5 indicate that the interaction effect is both small and statistically insignificant. Overall, the evidence is consistent with no change in retailers' pass-through behaviour.

6.3. The Heterogeneous Impact of the Reform in Supermarkets and Street Markets

The fact that the effect of the reform on prices originated in the wholesale market is also supported by the differential effect of deregulation in supermarkets and street markets. As discussed in Section 3, supermarkets typically buy all their grocery products from the wholesale market (HCC, 2013). Street vendors, on the other hand, have access to a variety of small producers, or are producers themselves. Hence, collusion at the wholesale level is more likely to have a higher impact on prices in supermarkets than at street markets. In Table 5, column 5, we find that the policy change indeed had a large and significant impact (-10 percent) on supermarkets, whereas street markets were relatively unaffected.

6.4. The Impact of the Reform on Specific Products at Street Markets

To further confirm the key role played by the wholesale market, we analyze the differential impact of the policy change on specific products sold at street markets. In fact, even street vendors have to rely on wholesalers for their supply of some specific products. Based on information drawn from the HCC report (2013), street vendors almost never buy lettuce from wholesalers, but rely on them heavily for peaches. Hence, we can test whether the policy had a different impact on the price of these two products at street markets.[56]

[56] We cannot extend this approach to more products, as the report provides information on very few products.

Table 12, column 1, reports the results of our benchmark specification using the same control group as before, but this time including only lettuce (classified as "low") and peaches ("high") in the treatment group. The impact of the policy is very similar, although standard errors are larger, due to the smaller sample. Column 2 confirms our previous findings on the differential effect in supermarkets and at street markets. Column 3 shows that at street markets, deregulation had no significant impact on the price of lettuce ($\text{Low}_i \times \text{Street market}_j$) but had a negative impact on the price of peaches ($\text{High}_i \times \text{Street market}_j$). By contrast, in supermarkets, both lettuces and peaches were affected by the policy. Hence, the decrease in prices is only evident when the wholesale market plays an important role.

6.5. Collusion and the Level of Regulated Markups

We further investigate the collusion hypothesis by testing the prediction that collusion is more difficult to maintain as the gains from deviating from collusive behavior increase. Knittel and Stango (2003) show that cheating becomes more attractive when the focal point generated by a price ceiling is higher, since profits from cheating rise faster than profits from cooperation. Appendix A shows that this result extends to focal points induced by markup regulation.[57]

To test this theoretical prediction, we categorize products into two groups. The "low" maximum markup group includes products with maximum markups at 8 and 10 percent. The "high" maximum markup group includes products with a 12 percent maximum markup (see Table A1). In Table 13, column 1, we report the estimated impact of deregulation on the wholesale price obtained interacting $Post_t$ x $Treat_i$ with an indicator variable for each group.[58] We find that the effect of deregulation was strong and significant for products with low maximum markups, while we do not observe any impact for products with high

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[57] The results should be interpreted with caution, since we estimate the differential impact of deregulation on average prices, not directly on the probability of collusion (see Appendix A3 for a more detailed discussion).

[58] One may argue that the government may endogenously choose the level of markups on the basis of some product characteristic (unobserved to the econometrician) that may affect the impact of deregulation on the distribution of prices. While possible, we think that this is not very realistic in our application. We could not find evidence of any sophistication in the choice of markups. The history of this legislation indicates that changes in regulation were very infrequent. Moreover, the only documented purpose of this legislation was to protect consumers from high and exploitative prices and there is no mention of any effort to adjust markups in response to changes in other variables, such as the distribution of costs.

maximum markups. This is consistent with the idea that collusion was mainly taking place for low markup products.

In column 2, we perform a similar exercise using the prices in supermarkets, splitting products into two categories based on their maximum markups in the *retail* market.[59] We find no significant difference in the impact of the policy change between the two groups. Interestingly though, when we classify products according to the level of the maximum markup in the *wholesale* market (column 3), we find that *retail* prices significantly fell for products with low maximum markups and did not significantly change for products with high maximum markups. In other words, only differences in maximum markups at the wholesale level generate differences across products in the impact of the policy change. These results are consistent with previous evidence suggesting that collusion was taking place in the wholesale market and not in the retail market.

6.6. Profitability

As a last test of the collusion hypothesis, we examined the impact of the reform on the profitability of wholesalers operating within and outside the Central Market. A breakdown of collusion among wholesalers in the Central Market implies a drop in their profitability, but it does not necessarily affect wholesalers operating outside the market. To investigate this hypothesis, we collected balance sheet data on EBITDA (earnings before interest, taxes, depreciation and amortization), a commonly used proxy for profitability, for firms in the Central Market, creating an unbalanced panel of 45 firms (out of approximately 60 firms) between 2007 and 2014.[60] In addition, we collected the same information for an unbalanced panel of 115 firms operating in the wholesale market for fruits and vegetables in Greece, but not operating in the Central

[59] Maximum markups are correlated across markets. The correlation coefficient between the maximum markups for wholesalers and supermarkets is 0.33 (whereas between those for supermarkets and street markets it is 0.99).

[60] Our sources are company-specific annual reports (accessed through Naftemportiki's website). The main reason for the limited coverage of the sample is that only limited liability companies are required to publish their accounts. The panel is unbalanced because not all years are available for all the companies in the data set.

Market.[61] These firms are exposed to the same sectoral and economic-wide forces as the ones inside the Central Market and, of course, were subject to the same markup regulation. However, as they are located outside the Central Market, they are not affected by the conditions favoring collusion there.

Table A7 reports summary statistics for firms inside and outside the Central Market. Firms outside the Central Market are also active in the import and export of fruits and vegetables. Consequently, they are on average bigger, with a small number of firms being much bigger than the typical wholesalers in the Central Market. On average, they are also more profitable. Figure 3 plots the average EBITDA before and after the change in regulation (the reform occurred in June 2011, so 2011 is excluded) for the two groups of firms. The profitability of firms in the Central Market fell sharply after 2011, while profits for firms outside the market were barely affected by the change in regulation.

Table 14, column 1, describes the results of a regression of profitability on an indicator variable for the period after the reform using data for firms operating in the Central Market. In column 2, we include in the sample firms operating outside the Central Market. In column 3, we add year fixed effects and an indicator equal to one for firms operating in the Central Market. The coefficient on the interaction term (*Central Market* × *Post*) is negative and significant. Finally, in column 4, we add a full set of firm specific fixed effects, and the coefficient on the interaction term increases in absolute value (although the standard error also increases).

Given the unbalanced data, one potential concern is entry and exit of firms before and after deregulation. To check for the importance of this effect, we exclude firms present in the sample only before or after the reform. The coefficient of the interaction effect in column 5 is not much affected. A second potential concern is that the sample of firms outside the Central Market includes some particularly large outliers (see Table A7). In Column 6, we exclude from the sample firms with revenues above 20 million euros in 2008. The coefficient on the interaction term is again negative and statistically significant. The estimated

[61] The source of this data is ICAP (http://www.icap.gr/Default.aspx?id=9921&nt=19&lang=2), which is a private international company that publishes annual sectoral reports on this market based on firms' accounting data.

coefficient of *Central Market* is no longer significant, suggesting that these large firms were responsible for the higher profitability of firms outside the Central Market. Adding a full set of firm fixed effects in column 7 results in an estimated coefficient similar to that in column 4. Taken together, these results indicate that firms in the Central Market experienced a large and significant drop in profits, unlike firms in the same sector that were not active in it.[62]

6.7. Alternative Hypotheses and Interpretations of the Results

In this section we explore various alternative plausible explanations for the negative impact of deregulation on both retail and wholesale prices.

Markup Regulation and Cost Inflation

A binding markup regulation limits the benefits from cost reductions, as investments that reduce marginal cost result in a reduction in the maximum price that a firm can charge. For example, a retailer may not benefit from exerting effort in trying to buy at the lowest price, or in minimizing transportation costs, since lower costs are reflected in a lower maximum price. Hence, in principle, firms may distort their cost structure in response to regulation.

Leaving aside the possibility of collusion, the introduction of a binding markup regulation has, in theory, two effects. First, it directly reduces prices for a given marginal cost. Second, it may lead to inefficiencies and higher marginal costs, resulting in higher prices. However, the incentives to inflate costs only partially offset the direct impact of regulation.[63] Hence, markup regulation is expected to lead to lower prices. Yet this clearly contradicts the empirical evidence.

[62] While these results are in line with our previous results, they should be interpreted with caution, as the two groups of firms are somewhat different, and a causal interpretation relies on the common trend assumption being satisfied for the two groups.

[63] Consider the introduction of a binding maximum markup regulation. Regulation makes profit proportional to revenues, but a price that maximizes revenues is strictly lower than the profit maximizing price (for any positive

Moreover, the cost inflation hypothesis implies that constrained firms drive the higher average prices during the regulation period. If there is a positive correlation between the level of prices and markups (see Appendix A), then the impact of regulation will be concentrated in the right tail of the price distribution. However, Figure 2 and the results on the quantile regressions suggest that the impact of the policy is larger in the left tail of the price distribution, where unconstrained firms are more likely to operate.

Markup Regulation and Vertical Relations

The introduction of a binding markup regulation at the retail level can affect incentives for an upstream wholesaler. However, theoretical arguments suggest that the wholesaler will never charge a higher wholesale price in response to the introduction of markup regulation downstream.[64] This implies that the higher prices observed in the fruit and vegetable market before the reform are unlikely to be caused by vertical relations along the supply chain.[65]

Weak or Imperfect Law Enforcement

The specific nature of the regulation we are studying required extensive monitoring by the regulator. How could weak or imperfect law enforcement affect the interpretation of the results? Evidence from the HCC (2013) report suggests that the law was enforced by auditing the accounts of retailers and wholesalers (although enforcement in supermarkets was stronger than at street markets). In any case, our analysis does not rest on any assumption about the quality of enforcement. Lack of enforcement would imply that regulation was less effective (or perhaps even completely ineffective) at constraining prices. If that were the case, we would expect to find no impact of deregulation, whereas we find a significant effect. However,

marginal costs). Hence, even if the firm can manipulate its marginal cost, the second effect of markup regulation will never fully offset the first. This argument is described in detail in Appendix B.

[64] In the classic vertical relations game (Spengler 1950; Tirole 1988), the introduction of a maximum markup regulation downstream cannot lead to higher wholesale prices upstream. Appendix B illustrates this result in greater detail.

[65] Also this second alternative explanation is based on the idea that constrained retailers drive the increase in average price during the regulation period. Hence, one would again expect a larger impact of deregulation in the right tail of the distribution of prices, which is not observed in the data.

even if it was not binding or only poorly enforced, regulation might have provided a focal point for collusion.

7. Concluding Remarks

In this paper, we present the first systematic evidence of the impact of maximum markup regulation on prices. Our results show that repeal of regulation led to significant price decreases, corresponding to an estimated €256 million yearly consumer savings at the national level. We also provide indirect but consistent evidence that the most likely explanation for this phenomenon was collusion at the wholesale level. The existing data do not allow us to investigate the exact mechanism possibly used to sustain collusion, nor to assess whether explicit or tacit collusion is more likely to have taken place (although this distinction is clearly important for competition policy). Overall, the results of our ex-post policy evaluation highlight the unexpected consequences of a common yet little studied type of regulation. While maximum markup regulation may well serve its intended purpose in some markets, our results show that this cannot be taken for granted.

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Appendix A: Markup regulation and collusion on focal markups

1. The impact of price and markup regulation on average price (without collusion)

Consider a market with heterogeneous firms with different marginal costs and different prices denoted by the random variables c and p respectively.[66]. The introduction of a binding maximum **price** implies that the expected price and the variance of prices decrease. The introduction of maximum **markup** regulation implies that the constrained price is

$$\tilde{p} = Min[p, (1+a)c],$$

where a is the maximum markup. If the regulation is binding for some firms, then the expected price will also fall, $E(\tilde{p}) < E(p)$.

2. The impact of price and markup regulation on price variability (without collusion).

The introduction of a binding **price** regulation implies that the variance of prices decreases. The introduction of a binding maximum **markup** regulation implies that the conditional variance $V(\tilde{p}|c)$ is smaller after regulation, $V(\tilde{p}|c) < V(p|c)$, which implies that $E[V(\tilde{p}|c)] < E[V(p|c)]$. Using the law of total variance

$$V(p) = E[V(p|c)] + V\big[E\big(p|c\big)\big],$$

we obtain $V(\tilde{p}) < V(p)$ if $V[E(\tilde{p}|c)] < V[E(p|c)]$. Markup regulation reduces the variance of prices if the variance of the expected price is lower when markup regulation is in place.

A sufficient condition for $V[E(\tilde{p}|c)] < V[E(p|c)]$ is that markup regulation is more binding for firms with higher marginal cost, that is, for any $c_1 < c_2$,

[66] This can be interpreted as the equilibrium outcome of an oligopoly pricing game. Two examples of such models are described below.

$$E\left(\frac{p-c}{c}\middle|c=c_1\right)-E\left(\frac{\tilde{p}-c}{c}\middle|c=c_1\right)<E\left(\frac{p-c}{c}\middle|c=c_2\right)-E\left(\frac{\tilde{p}-c}{c}\middle|c=c_2\right). \quad \text{(A1)}$$

This assumption is realistic in the market for fruits and vegetables, as higher marginal costs typically correspond to a higher quality product (e.g., freshness of the product or quality of the service), which makes it possible to charge higher markups (more rigid demand). This generates a positive correlation between prices, markups, and marginal costs.

This assumption implies that

$$0<E(p|c_1)-E(\tilde{p}|c_1)<E(p|c_2)-E(\tilde{p}|c_2),$$

and

$$E(\tilde{p}|c_2)-E(\tilde{p}|c_1)<E(p|c_2)-E(p|c_1),$$

hence

$$V[E(\tilde{p}|c)]<V[E(p|c)].$$

Markup regulation decreases the variance of prices by shifting the right tail of the price distribution, which is more strongly affected by the constraint imposed by regulation. A positive correlation between marginal costs and markups (assumption A1) is consistent with different models of firm behavior and can be rewritten in terms of the primitives of such models. We describe two such models (with vertical and horizontal differentiation) in the next section.

2.1. Duopoly competition with vertical differentiation

A standard model of oligopoly pricing with vertical differentiation is consistent with a positive correlation between marginal costs and markups. Consider a continuum of consumers with preferences $U=\vartheta s-p$, where $\vartheta \sim uniform[\underline{\vartheta}\geq 0, \underline{\vartheta}+1\equiv\overline{\vartheta}]$ and $\overline{\vartheta}\geq 2\underline{\vartheta}$. There are two firms i =1, 2 producing goods of quality s_1 and s_2 with marginal costs c_1 and c_2 respectively, with $c_1<c_2$ and $s_1<s_2$. The two firms compete in

prices. After deriving the demand functions and their best reply functions, we can solve for the equilibrium prices,

$$p_1^* = \frac{1}{3}(c_2 + 2c_1) + \frac{\Delta s}{3}(\overline{\vartheta} - 2\underline{\vartheta})$$

$$p_2^* = \frac{1}{3}(c_1 + 2c_2) + \frac{\Delta s}{3}(2\overline{\vartheta} - \underline{\vartheta})$$

where parameters must be such that $p_1^* \leq \underline{\vartheta} s_1$ for the market to be covered. Given the equilibrium prices, markups satisfy

$$\frac{p_1^* - c_1}{c_1} < \frac{p_2^* - c_2}{c_2}$$

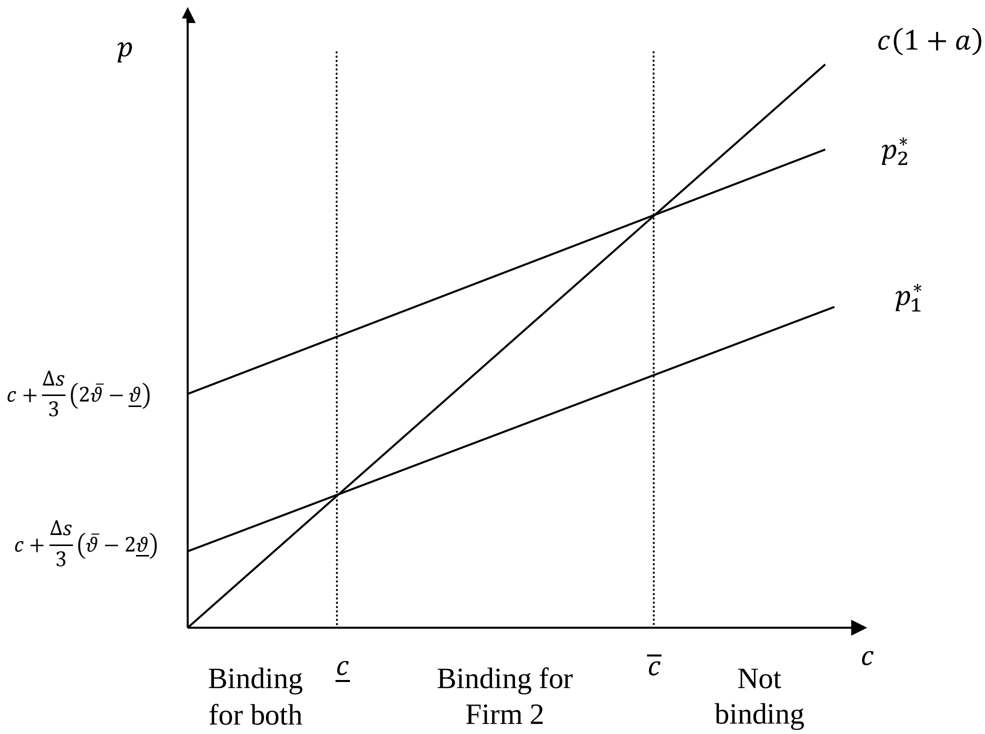
if and only if

$$\frac{1}{3}(c_2 - c_1)(c_2 + c_1) < \frac{\Delta s}{3}\left[(2\overline{\vartheta} - \underline{\vartheta})c_1 - (\overline{\vartheta} - 2\underline{\vartheta})c_2\right] \qquad \text{(A2)}$$

This condition implies that markups and marginal costs are positively correlated if differences in marginal costs is sufficiently small relative to differences in consumers' taste.

For example, this condition is satisfied in the limit as $c_1 \rightarrow c$ and $c_2 \rightarrow c$. Figure A1 describes the equilibrium outcomes p_1^* and p_2^* in this special case as c varies. When the marginal cost is smaller than $\underline{c}$, a maximum markup regulation a is binding for both firms. When the marginal cost is between $\underline{c}$ and $\overline{c}$, then regulation is binding for firm 2 (the firm with higher marginal cost), but not for firm 1. Finally, when the marginal cost is larger than $\overline{c}$, the regulation is not binding.

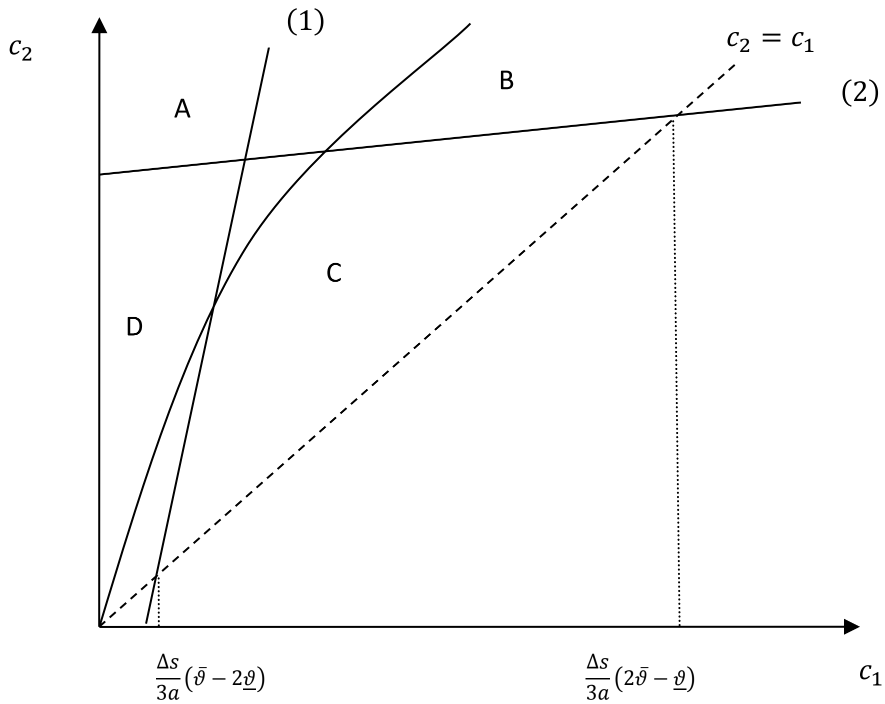
Figure A1: Equilibrium with vertical differentiation and homogeneous costs.



In general, condition A2 holds for marginal costs that are sufficiently close. Graphically, this condition corresponds to the area between the upward sloping concave curve in Figure A2 and the 45 degree line. In this area, markups are higher in equilibrium for the firm with higher marginal cost.

The impact of the maximum markup regulation depends on the marginal costs of the two firms. In Figure A2, the two continuous upward sloping lines, (1) and (2), define the combinations of c_1 and c_2 in which markup regulation is binding for firm 1 only (area A), $p_1^* > c_1(1+a)$, for firm 2 only (area C), $p_2^* > c_2(1+a)$, for both firms (area D), or is not binding at all (area B). If condition A2 holds, regulation is either non-binding (a is relatively high), binding for firm 2 (intermediate case), or binding for both firms (a is relatively low).

Figure A2: Equilibrium with vertical differentiation and heterogeneous costs.



2.2. Duopoly competition with horizontal differentiation

A duopoly pricing model à la Salop is also consistent with a positive correlation between marginal costs and markups. Consider a unit mass of consumers uniformly distributed on the unit circle. Firms $i = 1,2$ are located at 0 and ½ and the marginal costs are $c_1 < c_2$. Consumers pay the transportation costs t_1 and t_2 for buying from firm 1 and 2 respectively. The equilibrium prices are

$$p_1^* = \frac{1}{3}\left(\frac{1}{2}t_1 + c_2 + t_2 + 2c_1\right)$$

$$p_2^* = \frac{1}{3}\left(t_1 + 2c_2 + \frac{1}{2}t_2 + c_1\right)$$

and markups satisfy

$$\frac{p_1^* - c_1}{c_1} < \frac{p_2^* - c_2}{c_2}$$

if and only if

$$\frac{t_2}{c_2} + \frac{2(c_2 - c_1)(t_1 + t_2 + c_1 + c_2)}{c_1 c_2} < \frac{t_1}{c_1} \qquad (A3)$$

If $c_1 \to c$ and $c_2 \to c$, then this condition simplifies to $t_2 < t_1$. This situation is described in Figure A3. For $c < \underline{\underline{c}}$, the maximum markup regulation is binding for both firms. For $\underline{\underline{c}} < c < \overline{\overline{c}}$, regulation is binding only for firm 2, while for $c > \overline{\overline{c}}$, regulation is not binding. Hence, the equilibrium features a positive correlation between marginal costs and markups if the transportation cost for buying from the inefficient firm is sufficiently low.[67] The intuition is similar to the case of vertical differentiation: products need to be sufficiently differentiated for a positive correlation between markups and marginal costs to occur in equilibrium.

When marginal costs differ, a positive correlation between markups and marginal costs occurs in the area between the upward sloping concave line in Figure A4 and the 45 degree line. While different in their set up, the two models provide exactly the same intuition. A positive correlation between marginal costs and markups emerges in equilibrium if differences in costs are sufficiently small (or differences in transportation costs sufficiently large).[68]

The impact of a maximum markup regulation a depends on the marginal costs of the two firms. In Figure A4, the two continuous upward sloping lines, (1) and (2), define the combinations of c_1 and c_2 in which markup regulation is binding for firm 1 only (area A), $p_1^* > c_1(1 + a)$, for firm 2 only (area C), $p_2^* > c_2(1 + a)$, for both firms (area D), or is not binding at all (area B). If condition A3 holds, regulation is

[67] When transportation costs are identical (or lower for the efficient firm), the efficient firm must have a higher markup.
[68] In a pricing game with n firms with heterogeneous costs and product differentiation, the equilibrium will generally depend on the joint distribution of marginal costs and transportation costs.

either non-binding (a is relatively high), binding for firm 2 (intermediate case), or binding for both firms (a is relatively low).

Figure A3: Equilibrium with horizontal differentiation and homogeneous costs.

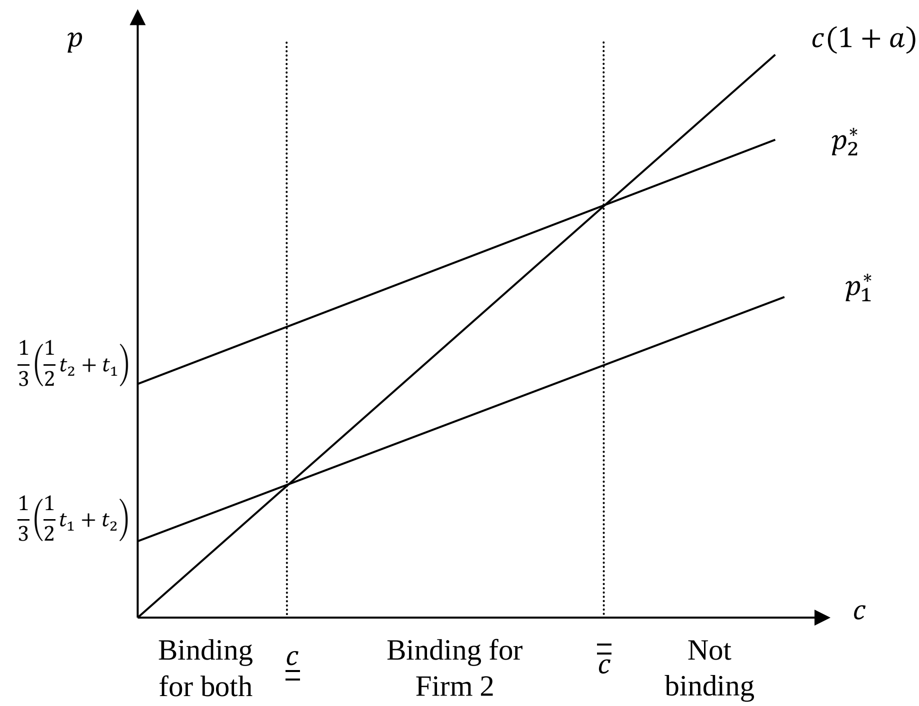
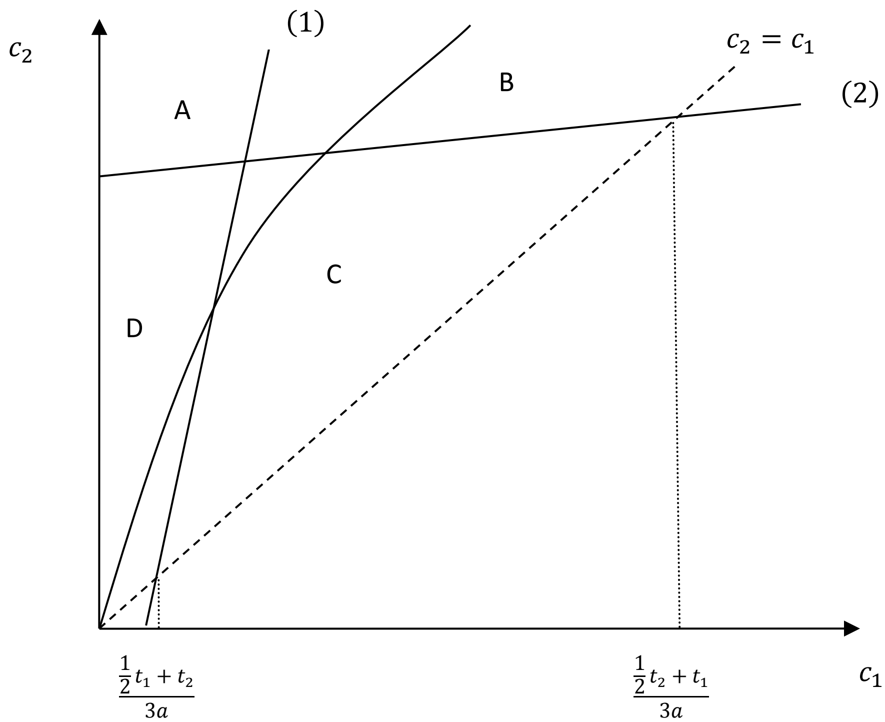


Figure A4: Equilibrium with horizontal differentiation and heterogeneous costs.



2. Collusion and markup regulation

In this section, we show that

1) a maximum markup can be used as a focal point for collusion,

2) collusion on a focal markup is not the same as collusion on a focal price.

We closely follow the discussion of the sustainability of tacit collusion in Knittel and Stango (2003), from which we also borrow the notation. Consider an infinitely repeated game between two firms $i = 1,2$ with marginal cost c_i. The per period profit function of firm 1, when prices are $p_{1,}$ and p_2, is denoted by $\Pi_1(p_{1,}p_2)$. Profits can also be represented as

$$\Pi_1(p_{1,}p_2) = p_1 D_1(p_{1,}p_2)$$

where D_1 is the demand function of firm 1. We assume that

1) the two goods are substitutes

$$\frac{dD_1(p_{1,}p_2)}{dp_2} > 0$$

2) prices are strategic complements

$$\frac{dp_1^*}{dp_2} > 0$$

3) the own price elasticity of demand is greater in absolute value than the cross price elasticity of demand

$$\frac{dD_1(p_{1,}p_2)}{dp_2} < -\frac{dD_1(p_{1,}p_2)}{dp_1}.$$

Define

$$p_1^*(p_2) = \arg max_{p_{1,}}\ \Pi_1(p_{1,}p_2)$$

as firm 1's short run best reply to firm 2's price. For simplicity, assume that the noncooperative equilibrium implies per period profits equal to

$$\Pi_1(NC_1, NC_2)$$

where $NC_1 = p_1^*(NC_2)$ and $NC_2 = p_2^*(NC_1)$, and that defection by one firm is followed by permanent reversion to the noncooperative price. Collusion on prices $(p_{1,}p_2)$ is possible in equilibrium if the profit from cheating is smaller than the profit from collusion,

$$\Pi_1(p_1^*(p_2), p_2) + \frac{\delta}{1-\delta}\Pi_1(NC_1, NC_2) < \frac{1}{1-\delta}\Pi_1(p_{1,}p_2).$$

The multiplicity of equilibria that can be sustained in equilibrium in this setting (Folk Theorems) suggests that, in practice, collusion may take place on focal points. For example, **a price ceiling** C may be a focal point for collusion on $p_1 = p_2 = C$ if

$$\Pi_1(p_1^*(C), C) + \frac{\delta}{1-\delta}\Pi_1(NC_1, NC_2) < \frac{1}{1-\delta}\Pi_1(C, C). \quad (1)$$

A **markup ceiling** a **can be used as a focal for collusion** on $p_1 = (1+a)c_1$ and $p_2 = (1+a)c_2$ if

$$\Pi_1\big(p_1^*\big((1+a)c_2\big), (1+a)c_2\big) + \frac{\delta}{1-\delta}\Pi_1(NC_1, NC_2) < \frac{1}{1-\delta}\Pi_1\big((1+a)c_1, (1+a)c_2\big).$$

While the logic behind collusion in the two cases is the same, in practice **collusion on a focal price is identical to collusion on a focal markup only if marginal costs are the same**. Consider a markup ceiling a such that $C = (1+a)c_2$ and assume that $c_1 < c_2$, then,

$$\Pi_1(p_1^*(C), C) + \frac{\delta}{1-\delta}\Pi_1(NC_1, NC_2) < \frac{1}{1-\delta}\Pi_1\big((1+a)c_1, C\big). \quad (2)$$

Since the left hand sides of (1) and (2) are identical, collusion on the focal markup a is easier to maintain than collusion on the focal price C for the efficient firm if $\Pi_1\big((1+a)c_1, C\big) > \Pi_1(C, C)$. This will always occur as long as there is some incentive to unilaterally cheat from a collusive equilibrium by undercutting the opponent $\left(\frac{d\Pi_1}{dp_1} < 0\right)$. Hence, when the marginal costs are different, regulation providing a focal price level need not produce the same results as regulation providing a focal markup. If maximum markup regulation provides a focal point for collusion, then some unconstrained firms increase their prices to match the focal markup. This reduces the variance of prices by changing the left tail of the price distribution (see previous section).

3. Collusion on markups becomes more difficult as the focal markup increases

We now investigate the sustainability of collusion as the focal markup increases. Following Knittel and Stango (2003), we first focus on the case in which the collusive prices are equal to the prices in the noncooperative equilibrium (so sustaining collusion is trivially easy), $C_1 = NC_1 = (1+a)c_1$ and $C_2 = NC_2 = (1+a)c_2$. Differentiating the profit from cheating with respect to the focal markup we obtain

$$\frac{d\Pi_1(p_1^*(NC_2), NC_2)}{da} = \frac{d\Pi_1(p_1^*(NC_2), NC_2)}{dp_1}\frac{dp_1}{dp_2}c_2 + \frac{d\Pi_1(p_1^*(NC_2), NC_2)}{dp_2}c_2$$

where the first term is equal to zero because of reoptimization by firm 1. Differentiating the per period profit from collusion

$$\frac{d\Pi_1(NC_1, NC_2)}{da} = \frac{d\Pi_1(NC_1, NC_2)}{dp_1}c_1 + \frac{d\Pi_1(NC_1, NC_2)}{dp_2}c_2$$

where the first term is negative, as cheating (by reducing the price) increases the per period profit of firm 1. This implies that

$$\frac{d\Pi_1(p_1^*(NC_2), NC_2)}{da} > \frac{d\Pi_1(NC_1, NC_2)}{da},$$

so changes in profits from cheating rise faster than profits from collusion in $C_1 = NC_1 = (1+a)c_1$ and $C_2 = NC_2 = (1+a)c_2$. To show that this holds also away from the noncooperative equilibrium, we compute the second derivatives of the profit functions (assuming that the second derivatives of demand are zero as in Knittel and Stango, 2003),

$$\frac{d^2\Pi_1(p_1^*(C_2), C_2)}{da^2} = \frac{dp_1^*}{dp_2}\frac{dD_1(C_{1,}C_2)}{dp_2}c_2$$

$$\frac{d^2\Pi_1(C_1, C_2)}{da^2} = 2\left(c_1^2\frac{dD_1(p_{1,}p_2)}{dp_1} + c_1c_2\frac{dD_1(p_{1,}p_2)}{dp_2}\right)$$

The first is always positive and the second is negative when $c_1 > c_2$. Hence, for the less efficient firm, the profits from cheating rise faster than the profits from collusion. Since a unilateral deviation is enough to break the collusive equilibrium, increasing the focal markup makes collusion more difficult to sustain in equilibrium.

In this model, when the maximum markup is sufficiently high, collusion cannot occur in equilibrium, as profits from cheating rise faster than the profits from collusion as a grows. Given two markets with *sufficiently different* maximum markups, there will be no effect of deregulation in the market with high markup and a negative effect on prices in the market with low maximum markup. If markups are not sufficiently different, then collusion at the maximum markup either occurs in both markets or none. In the first case, deregulation is expected to lead to lower prices in both markets. In the second, deregulation is expected to have no effect on prices.

4. Collusion on maximum markups becomes more difficult as competition increases

The result that collusion becomes more difficult in more competitive markets is based on the (realistic) assumption that the per period profits from collusion decrease as the number of firms increase, hence making the punishment less effective. This result is not directly linked to the type of focal point that is used to select one of the many possible equilibria. In a market with n firms, collusion on markups becomes more difficult as the number of firms increases if

$$\frac{\mathrm{d}\Pi_i(C_i, C_{-i}, n)}{dn} < 0$$

and

$$\frac{\mathrm{d}\Pi_i(p_i^*(C_{-i}), C_{-i}, n)}{dn} \geq 0.$$

Appendix B: Cost inflation and vertical relations

1. Markup Regulation and Cost Inflation

Consider the standard monopoly pricing problem, denoting as c>0 the marginal cost and D(p) the demand function, with $D' < 0$, $D'' \leq 0$. The monopoly price is obtained with the inverse elastic rule, $\frac{p^m - c}{p^m} = 1/\varepsilon$, where $\varepsilon = -\frac{D' p^m}{D}$. At the optimum, the absolute value of the elasticity of demand ε is larger than 1. The monopoly profits are decreasing in the marginal cost, hence the firm benefits from increases in efficiency.

Consider now the introduction of a binding markup regulation, where a is the maximum markup, so that the regulated price is $c(1+a)$. In this case, the benefits from increases in efficiency are less clear-cut, since the profit function is $\Pi = c(1+a)D\big(c(1+a)\big) - cD\big(c(1+a)\big)$, which can be rewritten as $\Pi = acD\big(c(1+a)\big)$. Increasing c increases the regulated price and the absolute profit margin for each unit, while also decreasing demand. Hence, the monopolist may in principle benefit from optimally choosing c. However, the first order condition with respect to c implies that $c^*(1+a) = -\frac{D\left(c^*(1+a)\right)}{D'\left(c^*(1+a)\right)}$. This implies that, at the optimum, the elasticity of demand ε is equal to 1. Hence, the price of a regulated monopolist cannot be higher than the standard monopoly price.

2. Markup Regulation and Vertical Relations

Consider the standard vertical relations model (Spengler, 1950; Tirole, 1988) in which an upstream wholesaler sells to a downstream retailer (stage 1), who then sells to final consumers (stage 2). For simplicity, the demand function is linear, $D(p) = 1 - \beta p$, where p denotes the retail price. The marginal cost of production is denoted by c and the wholesale price by p_w. The retailer maximizes $(p - p_w)D(p)$ at a price $p^*(p_w)$ that solves $p^*(p_w) = p_w - \frac{D(p)}{D'(p)}$. The wholesaler maximizes $(p_w - c)D\big(p^*(p_w)\big)$ at a wholesale price p_w^* that solves

$$p_w^* = c - \frac{D(p)}{D'(p)\frac{dp^*}{dp_w}}.$$

Substituting, the equilibrium retail price is given by

$$p^* = c - \frac{D(p)}{D'(p)}\left(1 + \frac{1}{\frac{dp^*}{dp_w}}\right), \text{ where } \frac{dp^*}{dp_w} = \frac{1}{2 - \frac{D(p)D''(p)}{[D'(p)]^2}}.$$

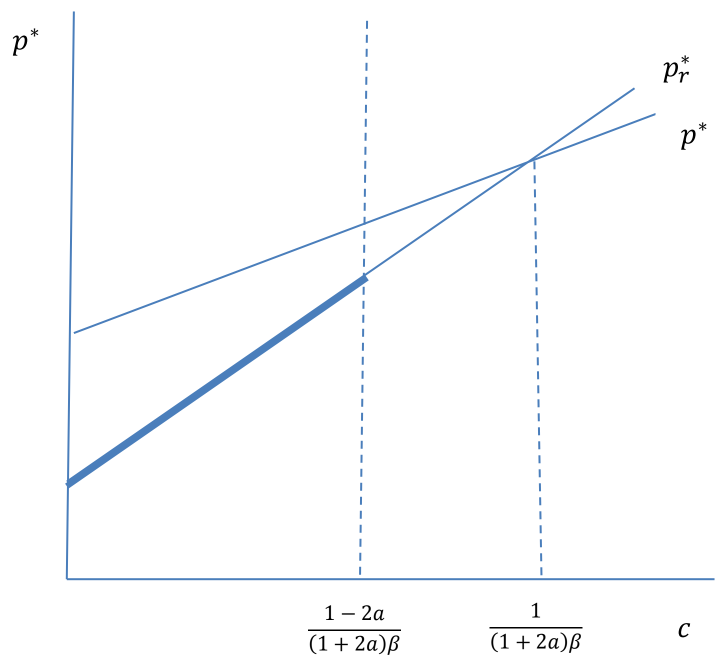
Using the linearity of the demand function, we can obtain simple expressions for the equilibrium prices, $p^* = \frac{c}{4} + \frac{3}{4\beta}$ and $p_w^* = \frac{c}{2} + \frac{1}{2\beta}$.

After the introduction of a binding markup regulation, the retail price is constrained by the regulation. The wholesaler maximizes $(p_w - c)D\big(p_w(1+a)\big)$ at a wholesale price $p_{w,r}^*$ that solves

$$p_{w,r}^* = c - \frac{D\big(p_{w,r}^*(1+a)\big)}{D'\big(p_{w,r}^*(1+a)\big)(1+a)}.$$

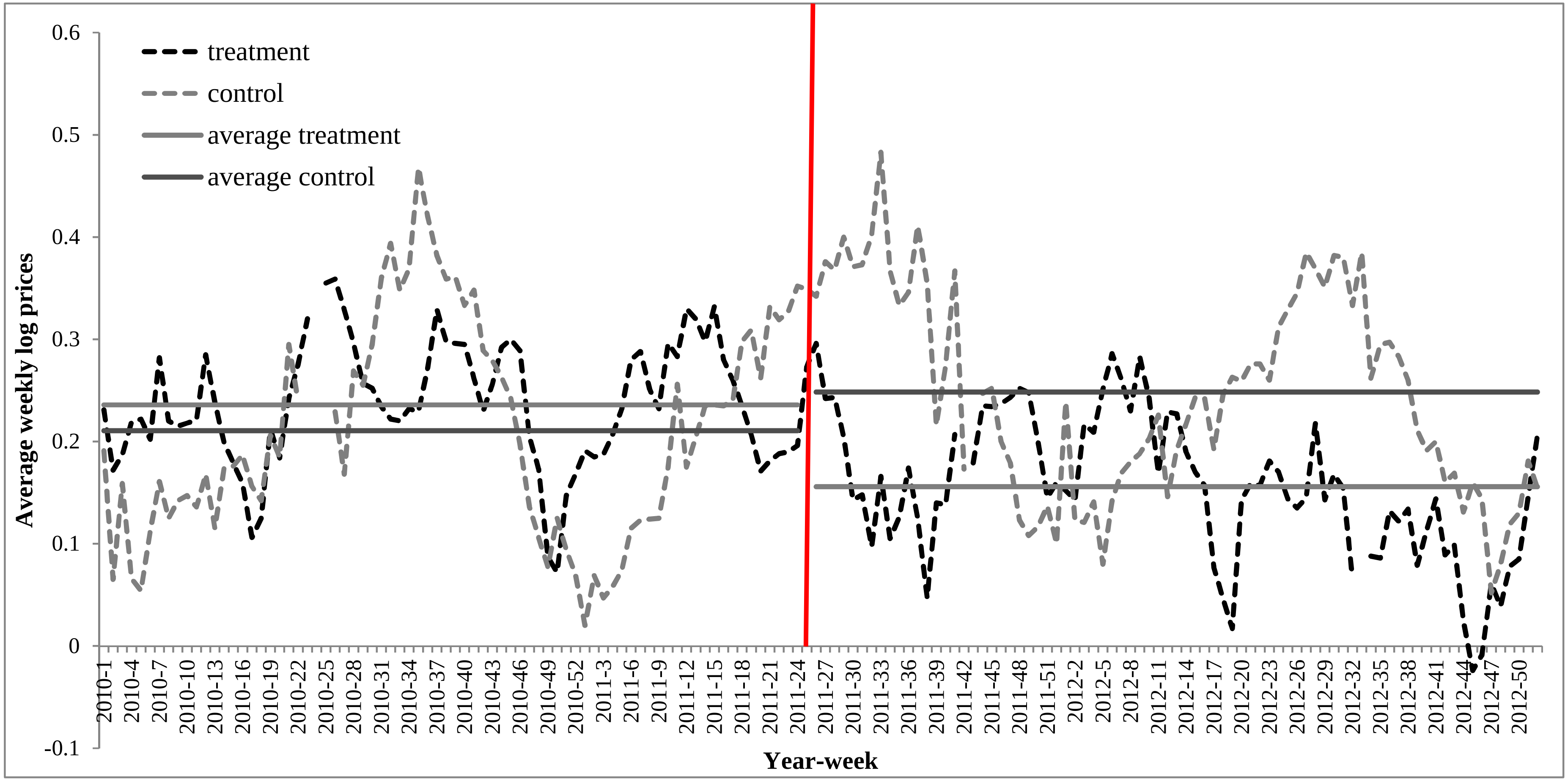
The retail price is then $p^* = p_{w,r}^*(1+a)$. Since demand is linear, we can solve for $p_r^* = \frac{c(1+a)}{2} + \frac{1}{2\beta}$ and $p_{w,r}^* = \frac{c}{2} + \frac{1}{2\beta(1+a)}$. In equilibrium, the wholesale price with regulation $p_{w,r}^*$ is lower than the wholesale price without regulation p_w^* for any c. Figure B1 describes the retail prices p_r^* and p^* with and without regulation; p_r^* is smaller than p^* if $c < \frac{1}{(1+2a)\beta}$. However, this condition is always met when the markup regulation is binding, since $p^* - (1+a)p_w^* > 0$ implies that $c < \frac{1-2a}{(1+2a)\beta}$. Hence, in equilibrium, the retail price is also lower after the implementation of a binding markup regulation.

Figure B1: The equilibrium retail price with and without markup regulation.



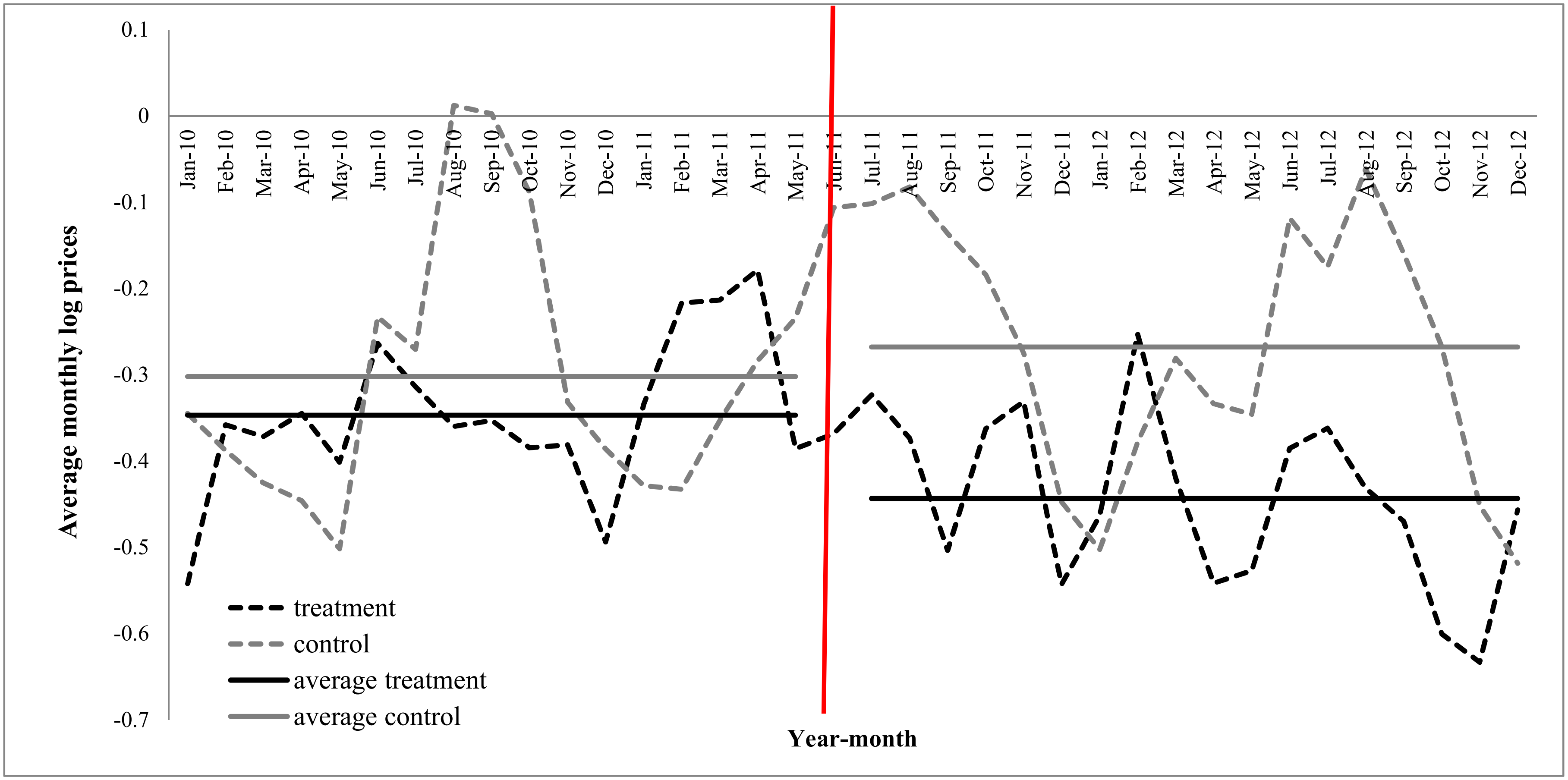
Appendix C: Additional Tables and Figures

FIGURE 1A: AVERAGE RETAIL PRICES OF REGULATED (TREATMENT) AND UNREGULATED (CONTROL) PRODUCTS



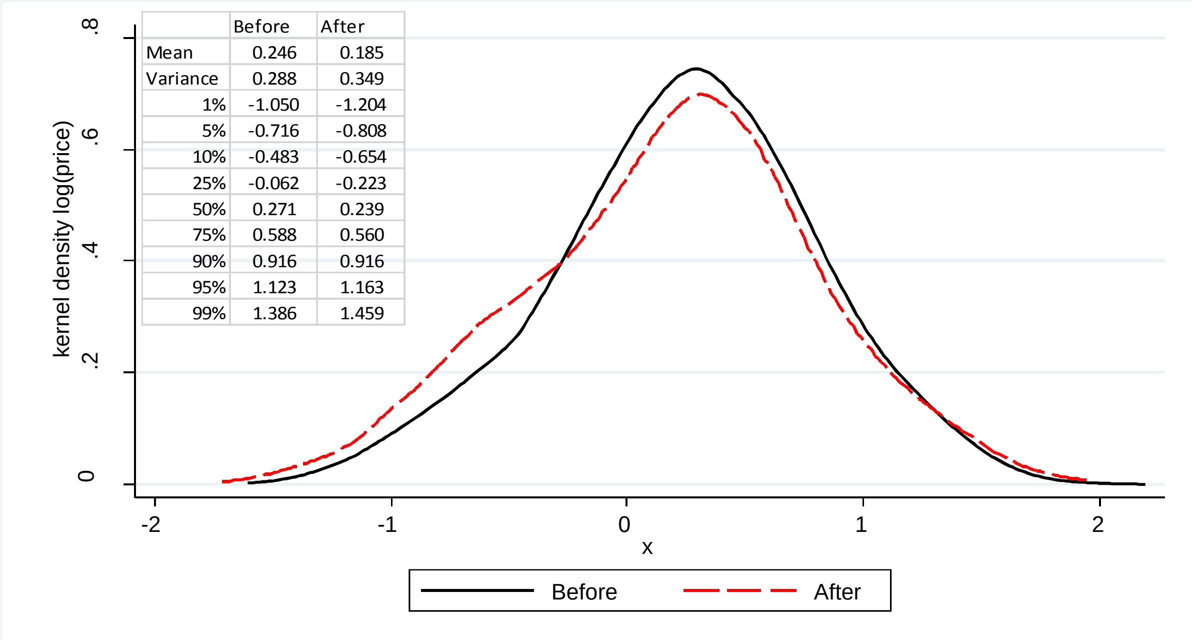
Notes: The figure reports the weekly average of the logarithm of fruits and vegetables products' prices affected by the markup regulation (treatment group, black dashed line) and not affected by regulation (control group, gray dashed line) and their averages (black solid line for the treatment group and grey solid line for the control group) before and after deregulation.
Source: Authors’ calculations based on data from the Greek Ministry of Development.

FIGURE 1B: AVERAGE WHOLESALE PRICES OF REGULATED (TREATMENT) AND UNREGULATED PRODUCTS (CONTROL)



Notes: The figure reports the monthly average of the logarithm of fruits and vegetables products' prices affected by the markup regulation (treatment group, black dashed line) and not affected by regulation (control group, gray dashed line) and their averages (black solid line for the treatment group and grey solid line for the control group) before and after deregulation.
Source: Authors' calculations based on data from the Central Market.

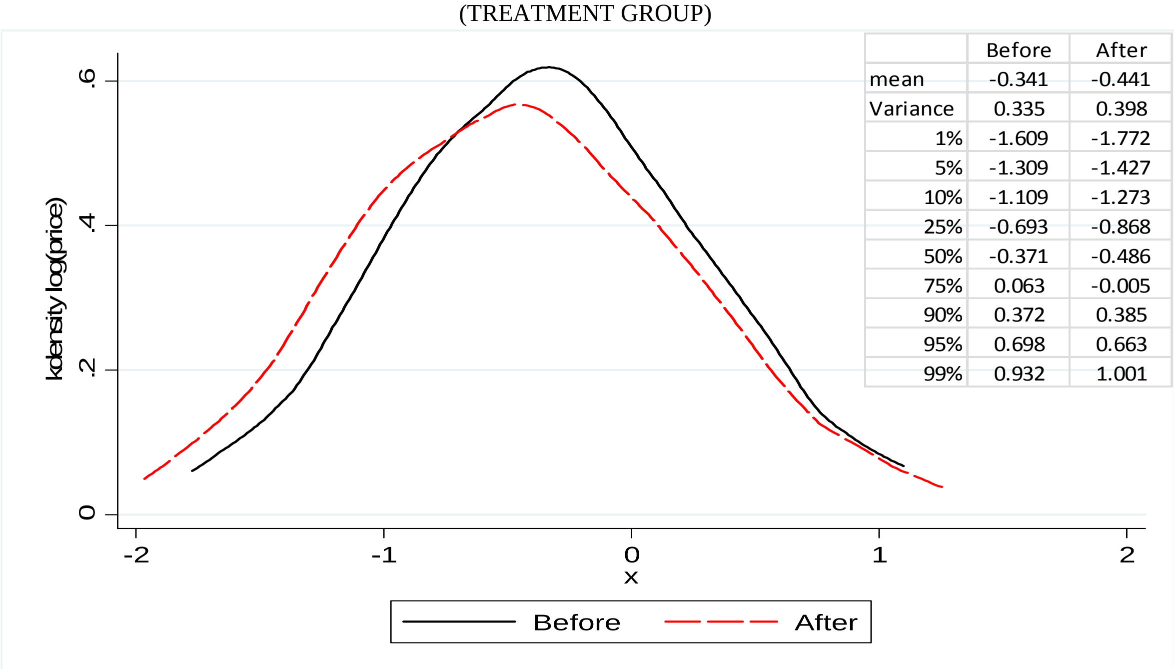
FIGURE 2A: THE DISTRIBUTION OF RETAIL PRICES BEFORE AND AFTER DEREGULATION (TREATMENT GROUP)



	Before	After
Mean	0.246	0.185
Variance	0.288	0.349
1%	-1.050	-1.204
5%	-0.716	-0.808
10%	-0.483	-0.654
25%	-0.062	-0.223
50%	0.271	0.239
75%	0.588	0.560
90%	0.916	0.916
95%	1.123	1.163
99%	1.386	1.459

Notes: The figure plots the distribution of log prices of fruits and vegetable products in the treatment group one year before ("Before") and one year after ("After") the policy change. Sample statistics are reported in the top left corner.
Source: Authors' calculations based on data from the Greek Ministry of Development.

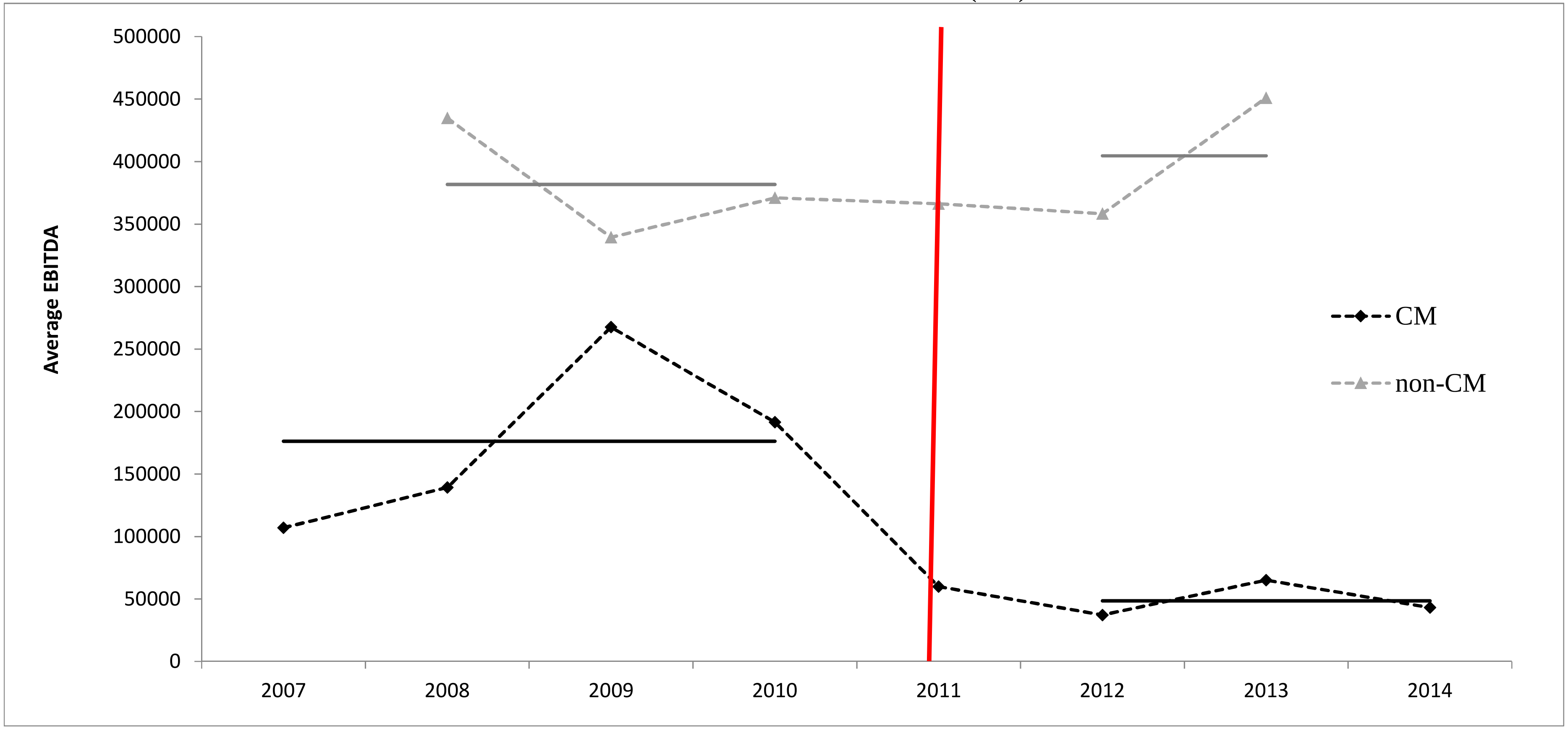
FIGURE 2B: THE DISTRIBUTION OF WHOLESALE PRICES BEFORE AND AFTER DEREGULATION (TREATMENT GROUP)



	Before	After
mean	-0.341	-0.441
Variance	0.335	0.398
1%	-1.609	-1.772
5%	-1.309	-1.427
10%	-1.109	-1.273
25%	-0.693	-0.868
50%	-0.371	-0.486
75%	0.063	-0.005
90%	0.372	0.385
95%	0.698	0.663
99%	0.932	1.001

Notes: The figure plots the distribution of log prices of fruits and vegetable products in the treatment group one year before ("Before") and one year after ("After") the policy change. Sample statistics are reported in the top right corner.
Source: Authors' calculations based on data from the Central Market.

FIGURE 3: EVOLUTION OF PROFITABILITY FOR FIRMS INSIDE (TREATMENT) AND OUTSIDE (CONTROL) THE ATHENS CENTRAL WHOLESALE MARKET (CM)



Notes: The figure reports the evolution of profitability (EBITDA) of firms inside (black dashed line) and outside (grey dashed line) the Central Market before and after deregulation. The solid lines report the average profitability of firms inside (black solid line) and outside (grey solid line) the Central Market before and after the deregulation.
Source: Authors' calculations based on data from ICAP and publically available annual accounts of firms in the fruits and vegetables wholesale market.

TABLE 1 - THE IMPACT OF DEREGULATION ON RETAIL PRICES (TREATMENT ONLY)

	(1)	(2)	(3)	(4)	(5)
Estimation method	OLS	FE	FE	FE	FE
Dependent variable	ln(Retail Price)$_{ijt}$	ln(Retail Price)$_{ijt}$	ln(Retail Price)$_{ijt}$	ln(Retail Price)$_{ijt}$	ln(Retail Price)$_{ijt}$
Post$_t$	-0.077***	-0.061**	-0.067***	-0.075***	-0.056**
dummy=1 after 22 June 2011	(0.026)	(0.027)	(0.024)	(0.024)	(0.025)
Observations	44,606	44,606	44,606	44,606	44,606
Adjusted R^2	0.005	0.008	0.808	0.867	0.868
Clusters	56	56	56	56	56
Month FE		yes	yes		
Store FE			yes	yes	yes
Product variety FE			yes	yes	yes
Month × Product FE				yes	yes
Year-month trend and square					yes

Notes: The dependent variable is the logarithm of the retail price of product variety *i*, in store *j*, and week *t*. All regressions include binary indicators for the changes in VAT rates. Standard errors clustered at the product variety level are reported in parenthesis below coefficients: *significant at 10%; **significant at 5%; ***significant at 1%.
Source: Authors' calculations based on data from the Greek Ministry of Development.
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TABLE 2 - THE IMPACT OF DEREGULATION ON RETAIL PRICES (CONTROL AND TREATMENT)

	(1)	(2)	(3)	(4)	(5)
Estimation method	OLS	OLS	FE	FE	FE
Dependent variable	ln(Retail Price)$_{ijt}$	ln(Retail Price)$_{ijt}$	ln(Retail Price)$_{ijt}$	ln(Retail Price)$_{ijt}$	ln(Retail Price)$_{ijt}$
Treat$_i$ × Post$_t$	-0.101**	-0.100**	-0.096***	-0.064***	-0.064***
	(0.045)	(0.044)	(0.026)	(0.022)	(0.023)
Post$_t$	0.024	0.033	0.015	-0.015	0.005
dummy=1 after 22 June 2011	(0.036)	(0.035)	(0.025)	(0.020)	(0.021)
Treat$_i$	0.028	0.025			
	(0.117)	(0.117)			
Observations	56,523	56,523	56,523	56,523	56,523
Adjusted R^2	0.005	0.009	0.789	0.858	0.859
Clusters	72	72	72	72	72
Month FE		yes	yes		
Store FE			yes	yes	yes
Product variety FE			yes	yes	yes
Month × Product FE				yes	yes
Year-month trend and square					yes

Notes: The dependent variable is the logarithm of the retail price of product variety *i*, in store *j*, and week *t*. All regressions include binary indicators for the changes in VAT rates. Standard errors clustered at the product variety level are reported in parenthesis below coefficients: *significant at 10%; **significant at 5%; ***significant at 1%.
Source: Authors' calculations based on data from the Greek Ministry of Development.
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TABLE 3 - THE IMPACT OF DEREGULATION ON WHOLESALE PRICES

	(1)	(2)	(3)	(4)	(5)	(6)
Estimation method	OLS	OLS	OLS	FE	FE	FE
Dependent variable	ln(Wholesale Price)$_{it}$	ln(Wholesale Price)$_{it}$	ln(Wholesale Price)$_{it}$	ln(Wholesale Price)$_{it}$	ln(Wholesale Price)$_{it}$	ln(Wholesale Price)$_{it}$
Sample	Treatment only	Control & Treatment	Control & Treatment	Control & Treatment	Control & Treatment	Control & Treatment
$Treat_i \times Post_t$		-0.156**	-0.156**	-0.244***	-0.093**	-0.095**
		(0.072)	(0.072)	(0.049)	(0.040)	(0.041)
$Post_t$	-0.099**	0.056	-0.022	0.052	-0.074*	-0.077
dummy=1 after 22 June 2011	(0.041)	(0.059)	(0.063)	(0.052)	(0.043)	(0.055)
$Treat_i$		-0.021	-0.026			
		(0.148)	(0.149)			
Observations	880	1,115	1,115	1,115	1,115	1,115
Adjusted R^2	0.007	0.012	0.028	0.787	0.910	0.911
Clusters	45	59	59	59	59	59
Month FE			yes	yes		
Product FE				yes	yes	yes
Month × Product FE					yes	yes
Year-month trend and square						yes

Notes: The dependent variable is the logarithm of the wholesale price of product variety *i* in month *t*. All regressions include binary indicators for the changes in VAT rates. Standard errors clustered at the product variety level are reported in parenthesis below coefficients: *significant at 10%; **significant at 5%; ***significant at 1%.
Source: Authors' calculations based on data from the Central Market.

TABLE 4 - THE IMPACT OF DEREGULATION ON RETAIL PRICES (ALTERNATIVE CONTROL GROUP)

	(1)	(2)	(3)	(4)	(5)
Estimation method	OLS	OLS	FE	FE	FE
Dependent variable	ln(Retail Price)$_{ijt}$	ln(Retail Price)$_{ijt}$	ln(Retail Price)$_{ijt}$	ln(Retail Price)$_{ijt}$	ln(Retail Price)$_{ijt}$
$Treat_i \times Post_t$	-0.089***	-0.089**	-0.120***	-0.087***	-0.088***
	(0.037)	(0.038)	(0.020)	(0.017)	(0.017)
$Post_t$	0.012	0.010	0.041**	0.016	0.026
dummy=1 after 22 June 2011	(0.026)	(0.033)	(0.018)	(0.016)	(0.018)
$Treat_i$	-0.546**	-0.548**			
	(0.254)	(0.255)			
Observations	65,753	65,753	65,753	65,753	65,753
Adjusted R^2	0.118	0.119	0.931	0.954	0.954
Clusters	75	75	75	75	75
Month FE		yes	yes		
Store FE			yes	yes	yes
Product variety FE			yes	yes	yes
Month × Product FE				yes	yes
Year-month trend and square					yes

Notes: The dependent variable is the logarithm of the retail price of product variety *i*, in store *j*, and week *t*. The control group comprises of products sold in supermarkets and shown in column 3 of Table A3. All regressions include binary indicators for the changes in VAT rates. Standard errors clustered at the product variety level are reported in parenthesis below coefficients: *significant at 10%; **significant at 5%; ***significant at 1%.
Source: Authors' calculations based on data from the Greek Ministry of Development.

TABLE 5 - THE IMPACT OF DEREGULATION ON RETAIL PRICES (ROBUSTNESS)

	(1)	(2)	(3)	(4)	(5)
Estimation method	FE	FE	FE	FE	FE
Dependent variable	ln(Retail Price)$_{ijt}$	ln(Retail Price)$_{ijt}$	ln(Retail Price)$_{ijt}$	ln(Retail Price)$_{ijt}$	ln(Retail Price)$_{ijt}$
Sample	Control & Treatment	Placebo	Merged Retail & Wholesale data	Merged Retail & Wholesale data	Merged Retail & Wholesale data
$Treat_i \times Post_t$		0.027	-0.055**	-0.020	
		(0.024)	(0.027)	(0.013)	
$Treat_i \times Post_t \times Fruit_j$	-0.070*				
	(0.036)				
$Treat_i \times Post_t \times Vegetable_j$	-0.063***				
	(0.023)				
$Treat_i \times Post_t \times$ Street $market_j$					-0.027
					(0.026)
$Treat_i \times Post_t \times$ Super $market_j$					-0.102***
					(0.038)
ln(Wholesale Price)$_{it}$				0.526***	
				(0.024)	
$Post_t$	0.004	-0.014	-0.010	0.027*	-0.016
dummy=1 after 22 June 2011	(0.021)	(0.024)	(0.024)	(0.014)	(0.024)
Observations	56,523	23,091	43,159	43,159	43,159
Adjusted R^2	0.858	0.805	0.866	0.887	0.867
Clusters	72	71	59	59	59
Store FE	yes	yes	yes	yes	yes
Product variety FE	yes	yes	yes	yes	yes
Month × Product FE	yes	yes	yes	yes	yes
Year-month trend and square	yes	yes	yes	yes	yes

Notes: The dependent variable is the logarithm of the retail price of product variety *i*, in store *j*, and week *t*. In column 2, the sample includes only observations before 22 April 2011. In columns 3-5, the sample includes only products for which data on wholesale prices is available. All regressions include binary indicators for the changes in VAT rates. Standard errors clustered at the product variety level are reported in parenthesis below coefficients: *significant at 10%; **significant at 5%; ***significant at 1%.
Source: Authors' calculations based on data from the Greek Ministry of Development and the Central Market.

TABLE 6 - THE IMPACT OF DEREGULATION ON RETAIL PRICES (QUANTILE REGRESSIONS)

Dependent variable	(1) residuals 1th percentile	(2) residuals 5th percentile	(3) residuals 25th percentile	(4) residuals 50th percentile	(5) residuals 75th percentile	(6) residuals 95th percentile	(7) residuals 99th percentile
$Treat_i \times Post_t$	-0.087*	-0.067*	-0.052**	-0.063***	-0.066***	-0.038*	-0.032
	(0.044)	(0.037)	(0.020)	(0.018)	(0.019)	(0.023)	(0.053)
Observations	56,523	56,523	56,523	56,523	56,523	56,523	56,523
Clusters	72	72	72	72	72	72	72

Notes: The dependent variable is the residuals of a regression of the logarithm of the retail price of product variety *i*, in store *j*, and week *t* on store, product variety, month × product fixed effects and a linear and quadratic trend measured in months including binary indicators for the changes in VAT rates. Standard errors clustered at the product variety level are reported in parenthesis below coefficients: *significant at 10%; **significant at 5%; ***significant at 1%.
Source: Authors' calculations based on data from the Greek Ministry of Development.

TABLE 7 - THE IMPACT OF DEREGULATION ON WHOLESALE PRICES (QUANTILE REGRESSIONS)

Dependent variable	(1) residuals 1th percentile	(2) residuals 5th percentile	(3) residuals 25th percentile	(4) residuals 50th percentile	(5) residuals 75th percentile	(6) residuals 95th percentile	(7) residuals 99th percentile
$Treat_i \times Post_t$	-0.443***	-0.294***	-0.172***	-0.151***	-0.150***	-0.041	0.300***
	(0.085)	(0.108)	(0.052)	(0.045)	(0.044)	(0.057)	(0.094)
Observations	1,115	1,115	1,115	1,115	1,115	1,115	1,115
Clusters	59	59	59	59	59	59	59

Notes: The dependent variable is the residuals of a regression of the logarithm of the wholesale price of product variety *i*, in month *t* on product variety and month fixed effects and a linear and quadratic trend measured in months including binary indicators for the changes in VAT rates. Standard errors clustered at the product variety level are reported in parenthesis below coefficients: *significant at 10%; **significant at 5%; ***significant at 1%.
Source: Authors' calculations based on data from the Central Market.

TABLE 8 - THE IMPACT OF DEREGULATION ON THE WHOLESALE PRICE RANGE

	(1)	(2)	(3)	(4)	(5)	(6)
Estimation method	OLS	OLS	OLS	FE	FE	FE
Dependent variable	Wholesale Price Range$_{it}$	Wholesale Price Range$_{it}$	Wholesale Price Range$_{it}$	Wholesale Price Range$_{it}$	Wholesale Price Range$_{it}$	Wholesale Price Range$_{it}$
Sample	Treatment only	Control & Treatment	Control & Treatment	Control & Treatment	Control & Treatment	Control & Treatment
Treat$_i$ × Post$_t$		0.629***	0.639***	0.553***	0.344	0.349
		(0.189)	(0.200)	(0.198)	(0.212)	(0.215)
Post$_t$	0.511***	-0.118	-0.391**	-0.308*	-0.164	-0.118
dummy=1 after 22 June 2011	(0.116)	(0.149)	(0.187)	(0.173)	(0.172)	(0.214)
Treat$_i$		-0.197	-0.207			
		(0.187)	(0.190)			
Observations	880	1,115	1,115	1,115	1,115	1,115
Adjusted R^2	0.039	0.039	0.066	0.344	0.541	0.542
Clusters	45	59	59	59	59	59
Month FE			yes	yes		
Product FE				yes	yes	yes
Month × Product FE					yes	yes
Year-month trend and square						yes

Notes: The dependent variable is the wholesale price range divided by the minimum price, $(max_{it} - min_{it})/min_{it}$ for product variety i in month t. All regressions include binary indicators for the changes in VAT rates. Standard errors clustered at the product variety level are reported in parenthesis below coefficients: *significant at 10%; **significant at 5%; ***significant at 1%.
Source: Authors' calculations based on data from the Central Market.

TABLE 9 - THE IMPACT OF DEREGULATION ON WHOLESALE MINIMUM PRICES

	(1)	(2)	(3)	(4)	(5)	(6)
Estimation method	OLS	OLS	OLS	FE	FE	FE
Dependent variable	ln(Wholesale Price)$_{it}$	ln(Wholesale Price)$_{it}$	ln(Wholesale Price)$_{it}$	ln(Wholesale Price)$_{it}$	ln(Wholesale Price)$_{it}$	ln(Wholesale Price)$_{it}$
Sample	Treatment only	Control & Treatment	Control & Treatment	Control & Treatment	Control & Treatment	Control & Treatment
Treat$_i$ × Post$_t$		-0.292***	-0.289***	-0.344***	-0.133	-0.135
		(0.104)	(0.103)	(0.096)	(0.087)	(0.087)
Post$_t$	-0.230***	0.062	0.073	0.115	-0.048	-0.030
dummy=1 after 22 June 2011	(0.057)	(0.087)	(0.088)	(0.087)	(0.074)	(0.078)
Treat$_i$		0.066	0.059			
		(0.140)	(0.141)			
Observations	880	1,115	1,115	1,115	1,115	1,115
Adjusted R^2	0.033	0.033	0.050	0.650	0.816	0.816
Clusters	45	59	59	59	59	59
Month FE			yes	yes		
Product FE				yes	yes	yes
Month × Product FE					yes	yes
Year-month trend and square						yes

Notes: The dependent variable is the logarithm of the minimum wholesale price of product variety i in month t. All regressions include binary indicators for the changes in VAT rates. Standard errors clustered at the product variety level are reported in parenthesis below coefficients: *significant at 10%; **significant at 5%; ***significant at 1%.
Source: Authors' calculations based on data from the Central Market.

TABLE 10 - THE IMPACT OF DEREGULATION ON WHOLESALE MAXIMUM PRICES

	(1)	(2)	(3)	(4)	(5)	(6)
Estimation method	OLS	OLS	OLS	FE	FE	FE
Dependent variable	ln(Wholesale Price)$_{it}$	ln(Wholesale Price)$_{it}$	ln(Wholesale Price)$_{it}$	ln(Wholesale Price)$_{it}$	ln(Wholesale Price)$_{it}$	ln(Wholesale Price)$_{it}$
Sample	Treatment only	Control & Treatment	Control & Treatment	Control & Treatment	Control & Treatment	Control & Treatment
Treat$_i$ × Post$_t$		-0.077	-0.071	-0.165***	-0.041	-0.043
		(0.065)	(0.065)	(0.049)	(0.051)	(0.052)
Post$_t$	-0.070	0.007	-0.073	0.005	-0.100*	-0.076
dummy=1 after 22 June 2011	(0.042)	(0.049)	(0.062)	(0.057)	(0.058)	(0.059)
Treat$_i$		-0.041	-0.051			
		(0.150)	(0.152)			
Observations	880	1,115	1,115	1,115	1,115	1,115
Adjusted R^2	0.003	0.006	0.021	0.810	0.912	0.913
Clusters	45	59	59	59	59	59
Month FE			yes	yes		
Product FE				yes	yes	yes
Month × Product FE					yes	yes
Year-month trend and square						yes

Notes: The dependent variable is the logarithm of the maximum wholesale price of product variety i in month t. All regressions include binary indicators for the changes in VAT rates. Standard errors clustered at the product variety level are reported in parenthesis below coefficients: *significant at 10%; **significant at 5%; ***significant at 1%.
Source: Authors' calculations based on data from the Central Market.

TABLE 11 - THE IMPACT OF DEREGULATION ON RETAIL AND WHOLESALE PRICES BY PRODUCT

	(1)	(2)
Estimation method	FE	FE
Dependent variable	ln(Retail Price)$_{ijt}$	ln(Wholesale Price)$_{it}$
Apricot	-0.271***	-0.123
	(0.023)	(0.101)
Artichoke	-0.028	-0.238***
	(0.017)	(0.037)
Banana	-0.010	0.024
	(0.020)	(0.032)
Beans	-0.058*	-0.093
	(0.031)	(0.102)
Beetroot	-0.023	-0.092**
	(0.019)	(0.037)
Broccoli	-0.121***	-0.090***
	(0.019)	(0.027)
Cabbage	-0.180***	-0.397***
	(0.019)	(0.026)
Carrot	-0.110***	-0.107***
	(0.020)	(0.034)
Cauliflower	-0.157***	-0.196***
	(0.020)	(0.028)
Cherry	-0.011	-0.007
	(0.021)	(0.101)
Cucumber	0.041	-0.014
	(0.027)	(0.031)
Eggplant	-0.037*	-0.052
	(0.020)	(0.043)
Fresh onion	0.012	0.036
	(0.019)	(0.029)
Grapes	0.014	-0.039
	(0.030)	(0.100)
Greens	-0.080***	-0.192**
	(0.019)	(0.081)
Kiwi	-0.029	-0.165***
	(0.074)	(0.030)
Leek	-0.033*	-0.008
	(0.019)	(0.041)
Lettuce	-0.093***	-0.240***
	(0.020)	(0.032)
Mellon	-0.167***	-0.115
	(0.055)	(0.084)
Nectarine	-0.191***	-0.150*
	(0.026)	(0.083)
Okra	-0.057*	0.172
	(0.029)	(0.104)
Onion	-0.179***	-0.148***
	(0.020)	(0.035)
Peach	-0.172***	-0.109
	(0.025)	(0.090)
Peas	-0.151***	-0.594***
	(0.021)	(0.078)
Pepper	-0.104***	-0.123***
	(0.027)	(0.039)
Potato	-0.129***	-0.407***
	(0.024)	(0.119)
Spinach	-0.027	0.013
	(0.019)	(0.023)
Strawberry	0.023	-0.055
	(0.019)	(0.037)
Tomato	-0.060***	-0.298***
	(0.020)	(0.056)
Zucchini	-0.070***	-0.119***
	(0.020)	(0.031)
Store FE	yes	
Product variety FE	yes	yes
Month × Product FE	yes	yes
Year-month trend and square	yes	yes

Notes: The dependent variable in column 1 is the logarithm of the retail price of product variety *i*, in store *j*, and week *t*. The dependent variable in column 2 is the logarithm of the wholesale price of product variety *i* in month *t*. All regressions include binary indicators for the changes in VAT rates. Standard errors clustered at the product variety level are reported in parenthesis below coefficients: *significant at 10%; **significant at 5%; ***significant at 1%.
Source: Authors' calculations based on data from the Greek Ministry of Development and the Central Market.

TABLE 12 - THE IMPACT OF DEREGULATION ON RETAIL PRICES (SELECTED PRODUCTS)

	(1)	(2)	(3)
Estimation method	FE	FE	FE
Dependent variable	ln(Retail Price)$_{ijt}$	ln(Retail Price)$_{ijt}$	ln(Retail Price)$_{ijt}$
$Treat_i \times Post_t$	-0.113***		
	(0.030)		
$Treat_i \times Post_t \times$ Street $market_j$		-0.032	
		(0.042)	
$Treat_i \times Post_t \times$ Super $market_j$		-0.245***	
		(0.032)	
$Treat_i \times Post_t \times Low_i \times$ Super $market_j$			-0.250***
			(0.031)
$Treat_i \times Post_t \times High_i \times$ Super $market_j$			-0.238***
			(0.036)
$Treat_i \times Post_t \times Low_i \times$ Street $market_j$			0.006
			(0.018)
$Treat_i \times Post_t \times High_i \times$ Street $market_j$			-0.136***
			(0.021)
$Post_t$	-0.013	-0.017	-0.003
dummy=1 after 22 June 2011	(0.033)	(0.034)	(0.038)
Observations	14,075	14,075	14,075
Adjusted R^2	0.876	0.879	0.880
Clusters	19	19	19
Store FE	yes	yes	yes
Product variety FE	yes	yes	yes
Month FE	yes	yes	yes
Year-month trend and square	yes	yes	yes

Notes: The dependent variable is the logarithm of the retail price of product variety *i*, in store *j*, and week *t*. The sample includes all the products assigned to the control group (see Table A1) but only lettuces ("Low") and peaches ("High") in the tretment group. All regressions include binary indicators for the changes in VAT rates. Standard errors clustered at the product variety level are reported in parenthesis below coefficients: *significant at 10%; **significant at 5%; ***significant at 1%.
Source: Authors' calculations based on data from the Greek Ministry of Development.

TABLE 13 - THE IMPACT OF THE LEVEL OF REGULATED MARKUPS

	(1)	(2)	(3)
Estimation method	FE	FE	FE
Dependent variable	ln(Wholesale Price)$_{it}$	ln(Retail Price)$_{ijt}$	ln(Retail Price)$_{ijt}$
Treat$_i$ × Post$_t$ × Low markup regulation$_j$	-0.147***		-0.086**
Wholesale markup regulation ≤ 10%	(0.047)		(0.036)
Treat$_i$ × Post$_t$ × High markup regulation$_j$	-0.063		-0.044
Wholesale markup regulation > 10%	(0.043)		(0.028)
Treat$_i$ × Post$_t$ × Low markup regulation$_j$		-0.066*	
Retail markup regulation ≤ 30%		(0.034)	
Treat$_i$ × Post$_t$ × High markup regulation$_j$		-0.055*	
Retail markup regulation > 30%		(0.028)	
Observations	1,115	17,895	17,895
Adjusted R^2	0.899	0.897	0.897
Clusters	59	72	72
Store FE	yes	yes	yes
Product variety FE	yes	yes	yes
Month × Product FE	yes	yes	yes
Year-month trend and square	yes	yes	yes

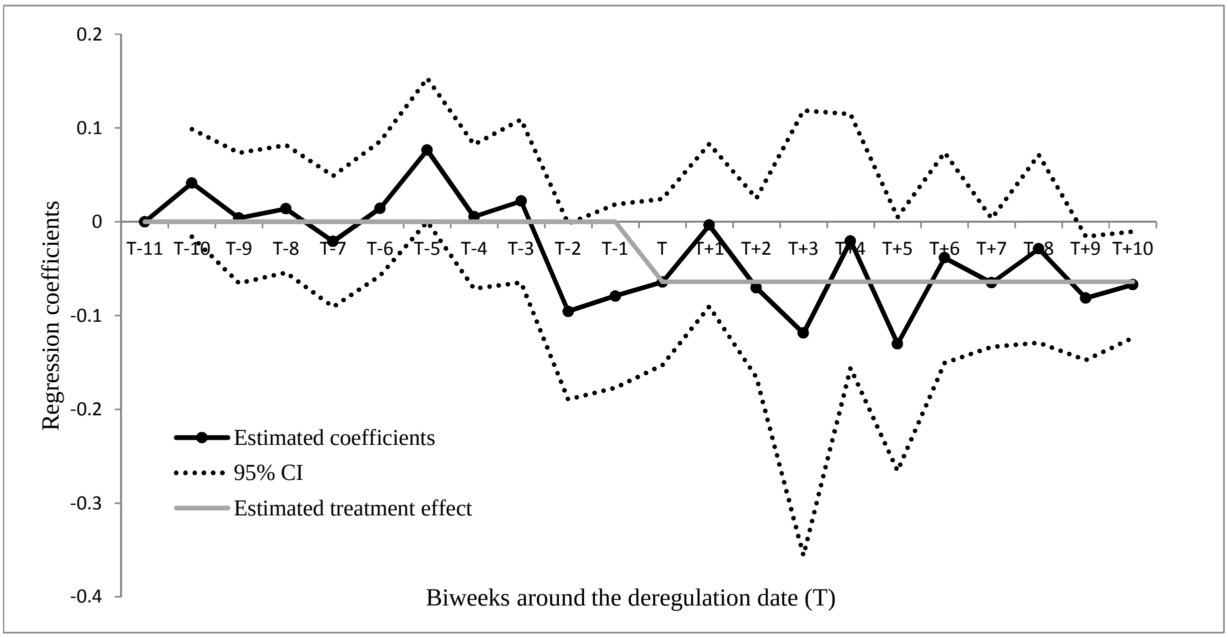
Notes: The dependent variable is the logarithm of the wholesale (column 1) and retail (columns 2 and 3) price of product variety *i* and week (retail) or month (wholesale) *t*. All regressions include binary indicators for the changes in VAT rates. Standard errors clustered at the product variety level are reported in parenthesis below coefficients: *significant at 10%; **significant at 5%; ***significant at 1%.

TABLE 14 - THE IMPACT OF DEREGULATION ON PROFITABILITY

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Estimation method	OLS	OLS	OLS	FE	FE	FE	FE
Dependent variable	$EBITDA_{it}$	$EBITDA_{it}$	$EBITDA_{it}$	$EBITDA_{it}$	$EBITDA_{it}$	$EBITDA_{it}$	$EBITDA_{it}$
Sample	Central Market only	Central Market & Outside	Central Market & Outside	Central Market & Outside	Firms with obs before and after	Outliers excluded	Outliers excluded
Central $Market_i \times Post_t$		-298,030***	-138,664**	-211,505*	-246,305*	-175,473**	-219,861*
		(42,809)	(55,726)	(123,073)	(133,143)	(83,651)	(117,872)
$Post_t$	-113,278**						
dummy=1 after 2011	(55,923)						
Central $Market_i$			-195,530***			-93,417	
dummy=1 for ACM firms			(74,933)			(67,192)	
Observations	177	700	700	700	640	606	606
Adjusted R^2	0.022	0.021	0.033	0.014	0.017	0.050	0.026
Clusters	44	147	147	147	121	122	122
Year FE			yes	yes	yes	yes	yes
Firm FE				yes	yes		yes

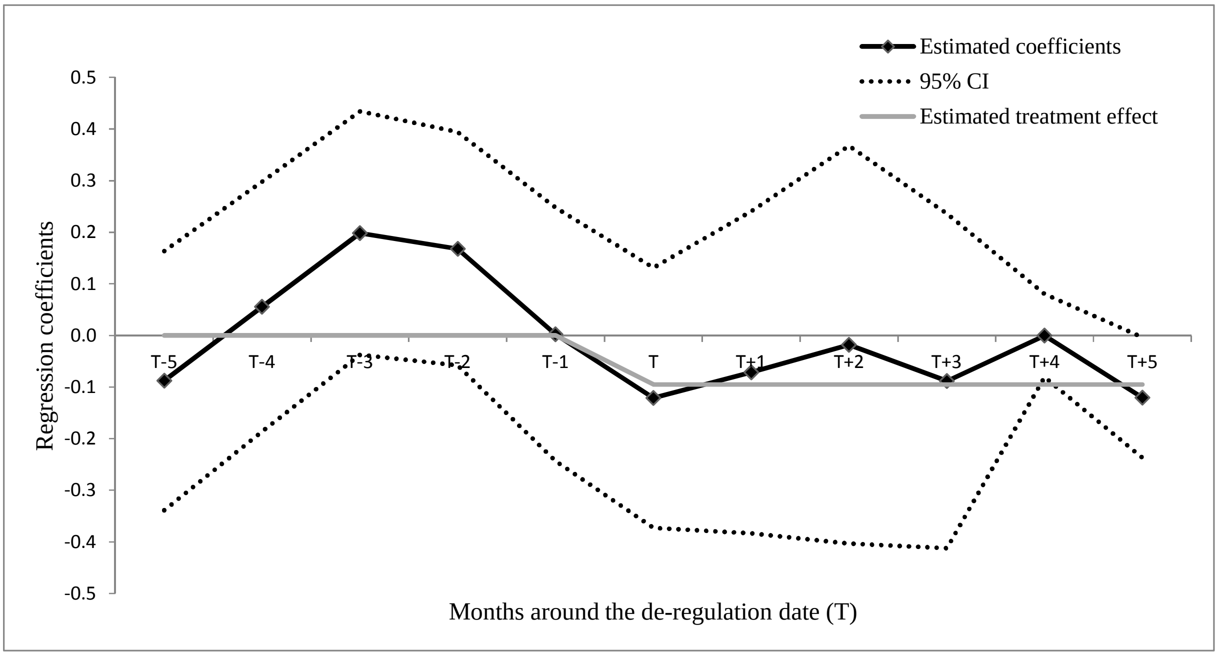
Notes: The dependent variable is the earning before interest, taxes, depreciation and amortisation of firm *i* in year *t*. Robust standard errors reported in parenthesis below coefficients: significant at 10%; **significant at 5%; ***significant at 1%.
Source: Authors' calculations based on published annual reports from fruits and vegetables wholesale firms inside and outside the Central Market.

FIGURE A1: DYNAMIC RETAIL PRICE RESPONSE TO DEREGULATION



Notes: The figure plots the regression coefficients from model (2), capturing the dynamic impact of deregulation on the logarithm of retail prices. Each period corresponds to two weeks. The period denoted by T includes the first two weeks following the policy change. The 95 percent confidence interval is based on standard errors clustered at the product variety level. Estimated coefficients are reported in Table A4 and the average treatment effect (solid grey line) comes from Table 2, column 4.

FIGURE A2: DYNAMIC WHOLESALE PRICE RESPONSE TO DEREGULATION



Notes: The figure plots the regression coefficients from model (2), capturing the dynamic impact of deregulation on the logarithm of wholesale prices. Each period corresponds to one month. The period denoted by T includes the first month following the policy change. The 95 percent confidence interval is based on standard errors clustered at the product variety level. Estimated coefficients are reported in Table A5 A4 and the average treatment effect (solid grey line) comes from Table 3, column 6.

TABLE A1- MAXIMUM WHOLESALE AND RETAIL MARKUPS

Product	Wholesale maximum markup	Retail maximum markup (supermarkets and grocery stores)	Retail maximum markup (street markets)
Potato	8%	25%	23%
Dry onions	10%	20%	17%
Artichoke, cucumber, tomatoes, strawberry	10%	25%	22%
Zucchini, cauliflower, beetroot, lettuce, spinach, cabbage, broccoli, greens, leek, peas, carrots, fresh onions, peppers, okra, eggplant	10%	30%	27%
Apricot	10%	35%	32%
Peach	10%	35%	30%
Grapes, beans	12%	28%	25%
Bananas	12%	30%	27%
Zucchini, cauliflower, beetroot, lettuce, spinach, cabbage, broccoli, greens, leek, peas, carrots, fresh onions, peppers, okra, eggplant	12%	35%	32%

Source: Ministerial decision A2-1045 (Gazette B' 1502/22-6-2011)

TABLE A2 - TEST OF MEANS FOR REGULATED AND UNREGULATED PRODUCTS

Estimation method	(1) Unregulated 2011	(2) Regulated 2011	(3) p-value Ha: diff != 0	(4) Unregulated 2006-2011	(5) Regulated 2006-2011	(6) p-value Ha: diff != 0
Cultivation area (1000 hectares)	9.680	9.042	0.938	11.536	9.725	0.845
	(4.407)	(3.050)		(11.536)	(3.437)	
Harvested production (1000 tonnes)	266.940	158.828	0.413	260.176	269.697	0.975
	(155.196)	(45.992)		(158.902)	(114.702)	
Yield (100 kg/hectares)	167.560	211.584	0.512	161.248	207.063	0.506
	(26.925)	(26.053)		(27.385)	(25.949)	

Notes: Standard errors are reported in parenthesis below means. Unregulated group includes: apples, pears, lemons, oranges and mandarins. Regulated group includes products affected by markup regulation: apricots, atrichokes, beans, beetroot, berries (exl strawberries), beans, cabbage, carrot, cauliflower, broccoli, celery, cherries, courgettes, cucumbers, eggplants, peas, figs, garlic, leeks, lettuces, melons, nectarines, onions, peaches, peas, plums, potatoes, peppers, spinach, strawberries, sweet lupins, tomatoes, table grapes, watermelons.
Source: EUROSTAT, Crops products - annual data [apro_cpp_crop] .

TABLE A3- PRODUCT CLASSIFICATION

Treatment Group	Control Group	Super Market Control Group
Apricot	**Apple**	**Beer**
Apricot (Diamantopoulou)*	Apple (Golden)*	Amstel can 6x330
Apricot (common)*	Apple (Golden-imported)	Kaiser can 6X330
Artichoke	Apple (Grand Smith)*	**Biscuits**
Artichoke (common)*	Apple (Grand Smith-imported)	Pti beur Papadopoulou 225gr
Artichoke (imported)	Apple (Starkin)*	**Brandy**
Banana	Apple (Starkin-imported)	Metaxa 3* 700ml
Beans	**Lemon**	**Cereals**
Bean Barbouni*	Lemon (common)*	Kellog's Special K 500gr
Bean Barbouni (imported)	Lemon (imported)	**Condensed milk**
Bean Tsaouli*	**Mandarins**	Nounou 410gr
Beetroot	Clementin mandarin*	Nounou light 170gr
Broccoli	Clementin mandarin (imported)	**Flour**
Broccoli (common)*	Mandarin (common)*	Giotis flour 1kg
Broccoli (imported)	**Orange**	**Pasteurised milk**
Cabbage	Valencia orange	Delta full fat 3.5% 1lt
Carrot	Orange (navalines-merlin)*	Nounou family full fat 1lt
Cauliflower	**Pear**	Olympos full fat 1lt
Cauliflower (common)*	Pear (imported)	Chocolate milk Milko
Cauliflower (imported)	Pear Krystali*	**Rice**
Cherry	Pear Krystali (imported)	Carolina 3A 500gr
Cherry (petrokeraso)*		**Rum**
Cherry (crisp)*		Bacardi 1lt
Cucumber		**Spaghetti**
Cucumber small*		Misko 500gr
Cucumber large*		**Toast bread**
Eggplant		Karamolegkos
Tsakonian eggplant*		**Toast**
Eggplant (common)*		Friggania papadopoulou 510gr
Eggplant (imported)		**Whisky**
Fresh onion		Jonnie Walker red 1lt
Grapes		**Wine**
Grape (common)*		Kourtaki retsina
Sultana grapes (raisin)*		
Greens		
Kiwi		
Kiwi (common)*		
Kiwi (imported)		
Leek		
Lettuce		
Lettuce (common)*		
Lettuce (brown)*		
Melon		
Melon (common)*		
Melon (Argitis)*		
Melon (Thrace)*		
Nectarine		
Okra		
Thick okra*		
Fine okra*		
Onion		
Onion (common)*		
Onion (imported)		
Peach		
Peas		
Pepper		
Pepper (longish)*		
Florinis peppers*		
Green pepper (large)*		
Green pepper (large-imported)		
Potato		
Potato (common)*		
French potato		
Potato (imported)		
Potato Cyprus		
Spinach		
Strawberry		
Tomato		
Tomato (common)*		
Tomato (imported)		
Watermelon		
Zucchini		
Zucchini*		
Zucchini (imported)		

Notes: The table reports information on the classification of all the products (and their varieties) used in the estimation. All products were also covered in the wholesale data. A star (*) indicates the product varieties matched in the wholesale data.

TABLE A4 - DYNAMIC IMPACT OF DEREGULATION ON RETAIL PRICES

Estimation method	FE
Dependent variable	ln(Retail Price)$_{ijt}$
$Treat_i \times Post_{t-10}$	0.041
	(0.029)
$Treat_i \times Post_{t-9}$	0.004
	(0.035)
$Treat_i \times Post_{t-8}$	0.014
	(0.034)
$Treat_i \times Post_{t-7}$	-0.021
	(0.035)
$Treat_i \times Post_{t-6}$	0.014
	(0.036)
$Treat_i \times Post_{t-5}$	0.076*
	(0.038)
$Treat_i \times Post_{t-4}$	0.005
	(0.039)
$Treat_i \times Post_{t-3}$	0.022
	(0.044)
$Treat_i \times Post_{t-2}$	-0.096**
	(0.047)
$Treat_i \times Post_{t-1}$	-0.079
	(0.049)
$Treat_i \times Post_{t}$	-0.064
	(0.044)
$Treat_i \times Post_{t+1}$	-0.004
	(0.043)
$Treat_i \times Post_{t+2}$	-0.070
	(0.048)
$Treat_i \times Post_{t+3}$	-0.119
	(0.119)
$Treat_i \times Post_{t+4}$	-0.021
	(0.068)
$Treat_i \times Post_{t+5}$	-0.130*
	(0.068)
$Treat_i \times Post_{t+6}$	-0.038
	(0.056)
$Treat_i \times Post_{t+7}$	-0.065*
	(0.034)
$Treat_i \times Post_{t+8}$	-0.029
	(0.050)
$Treat_i \times Post_{t+9}$	-0.082**
	(0.033)
$Treat_i \times Post_{t+10}$	-0.067**
	(0.028)
Observations	56,523
Adjusted R^2	0.861
Clusters	72
Store FE	yes
Product variety FE	yes
Month x Product FE	yes
Year-month trend and square	yes

Notes: The dependent variable is the logarithm of the retail price of product variety *i*, in store *j*, and week *t*. Each period corresponds to two weeks. The period denoted by T includes the first two weeks following the policy change. All regressions include binary indicators for the changes in VAT rates. Standard errors clustered at the product variety level are reported in parenthesis below coefficients: *significant at 10%; **significant at 5%; ***significant at 1%.

Source: Authors' calculations based on data from the Greek Ministry of Development.

TABLE A5 - DYNAMIC IMPACT OF DEREGULATION ON WHOLESALE PRICES

Estimation method	FE
Dependent variable	$\ln(\text{Wholesale Price})_{it}$
$Treat_i \times Post_{t-5}$	-0.088
	(0.125)
$Treat_i \times Post_{t-4}$	0.056
	(0.121)
$Treat_i \times Post_{t-3}$	0.198*
	(0.118)
$Treat_i \times Post_{t-2}$	0.168
	(0.113)
$Treat_i \times Post_{t-1}$	0.002
	(0.123)
$Treat_i \times Post_{t}$	-0.121
	(0.126)
$Treat_i \times Post_{t+1}$	-0.071
	(0.156)
$Treat_i \times Post_{t+2}$	-0.018
	(0.192)
$Treat_i \times Post_{t+3}$	-0.088
	(0.162)
$Treat_i \times Post_{t+4}$	-0.000
	(0.040)
$Treat_i \times Post_{t+5}$	-0.121**
	(0.058)
Observations	764
Adjusted R^2	0.936
Clusters	59
Product FE	yes
Month x Product FE	yes
Year-month trend and square	yes

Notes: The dependent variable is the logarithm of the wholesale price of product variety *i* in month *t*. Each period corresponds to one month. The period denoted by T includes the first month following the policy change. All regressions include binary indicators for the changes in VAT rates. Standard errors clustered at the product variety level are reported in parenthesis below coefficients: *significant at 10%; **significant at 5%; ***significant at 1%.
Source: Authors' calculations based on data from the Central Market.

TABLE A6 - THE IMPACT OF PASS-THROUGH ON RETAIL PRICES (ROBUSTNESS)

	(1)	(2)	(3)	(4)	(5)
Estimation method	FE	FE	FE	FE	FE
Dependent variable	ln(Retail Price)$_{ijt}$	ln(Retail Price)$_{ijt}$	ln(Retail Price)$_{ijt}$	ln(Retail Price)$_{ijt}$	ln(Retail Price)$_{ijt}$
Sample	Merged Retail & Wholesale data (all years)	Merged Retail & Wholesale data (2010)	Merged Retail & Wholesale data (2011)	Merged Retail & Wholesale data (2012)	Merged Retail & Wholesale data (all years)
Treat$_i$ × Post$_t$	-0.020				-0.021
	(0.013)				(0.014)
ln(Wholesale Price)$_{it}$	0.526***	0.499***	0.533***	0.550***	0.531***
	(0.024)	(0.043)	(0.052)	(0.058)	(0.027)
ln(Wholesale Price)$_{it}$ × Post$_t$					-0.007
					(0.015)
Post$_t$	0.027*				0.025*
dummy=1 after 22 June 2011	(0.014)				(0.014)
Observations	43,159	13,484	14,610	15,065	43,159
Adjusted R^2	0.887	0.895	0.901	0.886	0.886
Clusters	59	51	54	52	59
Store FE	yes	yes	yes	yes	yes
Product variety FE	yes	yes	yes	yes	yes
Month × Product FE	yes	yes	yes	yes	yes
Year-month trend and square	yes	yes	yes	yes	yes

Notes: The dependent variable is the logarithm of the retail price of product variety *i*, in store *j*, and week *t*. All regressions include binary indicators for the changes in VAT rates. Standard errors clustered at the product variety level are reported in parenthesis below coefficients: *significant at 10%; **significant at 5%; ***significant at 1%.
Source: Authors' calculations based on data from the Greek Ministry of Development and the Cetntral Market.
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TABLE A7 - SUMMARY STATISTICS ON WHOLESALE FIRMS' PROFITABILITY

	(1) mean	(2) sd	(3) p10	(4) p50	(5) p90	(6) min	(7) max	(8) N
Firms in the Athens Wholesale Central Market								
EBITDA	112,165	383,254	-16,409	41,100	307,486	-1,073,089	2,145,180	177
Revenues	5,197,008	5,450,899	713,475	3,009,797	14,100,000	241	25,100,000	177
Firms outside the Athens Wholesale Central Market								
EBITDA	383,243	726,912	-38,669	270,042	933,612	-3,710,436	7,355,227	523
Revenues	8,627,196	9,717,728	2,419,423	5,493,026	18,600,000	36,690	84,200,000	523

Source: Authors' calculations based on data from ICAP and publically available annual accounts of firms in the fruits and vegetables wholesale market