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The Impact of Maximum Markup Regulation on Prices

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The Impact of Maximum Markup Regulation on Prices[1]

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Abstract

We study the repeal of a regulation that imposed *maximum* wholesale and retail markups for all but five fresh fruits and vegetables. We compare the prices of products affected by regulation before and after the policy change and use the unregulated products as a control group. We find that abolishing regulation led to a significant *decrease* in both retail and wholesale prices. However, markup regulation affected wholesalers directly and retailers only indirectly. The results are consistent with markup ceilings providing a focal point for collusion among wholesalers.

JEL: L0, L1, L4, L5.

Keywords: markups, markup regulation, policy evaluation.

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1. Introduction

Government regulation of markups is common. State monopolists and ex-monopolists in a variety of markets worldwide, including the telecoms and utility sectors, have long been subject to maximum markup regulation. Markup regulation has also been used in oligopolistic markets, such as the market for pharmaceutical products and the gasoline market, in both high and low-income countries.[5] The imposition of minimum markups is also common and takes the form of sales-below-cost or minimum markup laws, or the general antitrust prohibition of predatory pricing in the US and Europe.

The typical government justification for imposing maximum markups is to protect 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. 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 weakly fall. The economic logic of the argument is clear (and also easy for politicians to communicate to voters), so much so that the predicted effect of maximum markup regulation has never been subject to systematic empirical testing.

In this paper, we take this seemingly uncontroversial prediction to the data and 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 Greek market for fresh fruits and vegetables. First implemented right after the Second World War, markup regulation was hastily

[5] For example, the Pennsylvania Liquor Control Board in the US is a state monopolist that implements a strict regulation system for wine and spirits with a uniform mandated markup. According to the World Health Organization (2011), around 60% of low and middle-income countries report regulating wholesale or retail maximum markups in the pharmaceutical industry. In high-income countries, maximum markups are also commonly imposed both for prescription and over-the-counter drugs. Maximum markups in the gasoline market are regulated in some Canadian provinces and have also been implemented in Luxemburg, Mexico, Greece and Spain.

canceled on June 2011 as part of a larger effort to establish product market reforms aimed at liberalizing the Greek economy, deeply affected by the global recession.

Regulation consisted of maximum wholesale and retail margins on (almost) all fruits and vegetables and was imposed on both locally produced and imported products. However, five fruit and vegetable products (apples, lemons, mandarins, oranges, and pears) were excluded from this regulation. To identify the impact of deregulation on prices, we compare prices of products affected by regulation before and after the policy change and use the 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 variability that allows us to estimate the causal impact of regulation.

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

The main challenge to the empirical study of markup regulation is that it is not typically possible to observe which firms are constrained and which are not, as observation of individual prices is not enough to infer markups. We overcome this obstacle by using a difference in difference methodology and studying the impact of a specific policy change on the conditional distribution of prices at the retail and wholesale level.

Surprisingly, we find that abolishing markup regulation led to 6 to 9 percent *lower* average retail prices. This result is robust to a number of alternative econometric specifications and different methods of selecting the control group. Retail prices of goods in the control group were not affected by the policy change. Wholesale prices also decreased as a consequence of deregulation by about the same amount. This result is also robust to a number of alternative specifications. Similarly, wholesale prices of products in the control group were not affected. Did regulation affect the behavior of wholesalers, retailers, or both? We find that, after accounting for wholesale prices, retail prices were not significantly affected by changes in regulation. This suggests that although regulation had a direct effect on wholesalers, it only indirectly affected retailers, who adjusted their prices to the lower wholesale prices.

How could deregulation lead to lower prices? While maximum markups limit the price charged by firms facing a binding constraint, they may also alter the pricing behavior of firms not subject to a binding constraint for two main reasons. The first is vertical relations. An upstream firm that is not directly affected by regulation may change its price in response to regulation in the retail sector. However, a maximum markup in the retail sector will generally lead to a lower intermediate price.[6] The second is horizontal relations. Maximum markups may provide a focal point for tacit collusion among unconstrained firms (either upstream or downstream). This may well lead to higher intermediate and retail prices.

Our results clearly cannot be explained by binding constraints alone, as deregulation led to *lower* prices. Nor can vertical relations explain the observed decrease in prices. Additional data shows that the wholesale market for fruit and vegetable products is more concentrated than the retail market and less affected by entry and exit. Firms (in terms of sale volume) are larger and more likely to be incorporated (Hellenic Competition Commission, 2011, henceforth HCC). This additional evidence is consistent with maximum markups providing a focal point for collusion among wholesalers. A number of factors facilitating collusion seem to be present in this market: product homogeneity (within varieties), limited entry, and frequent interaction and physical proximity of wholesalers.

Further evidence is also consistent with collusion. The supermarkets in our sample typically buy from wholesalers. In contrast, smaller retailers in street markets typically rely on wholesalers for imported goods, buying locally grown products from a fragmented market of local producers. We find that the average price

[6] We discuss this in detail in Section 4.

of goods sold in supermarkets was much more affected by deregulation. Moreover, in street markets, the retail price of goods bought from wholesalers fell as much as in supermarkets, while the retail price of local products was not significantly affected.

Our findings resonate with the results of Knittel and Stango (2003), who show that mandatory price ceilings in the credit card market had the perverse effect of increasing average prices. Their evidence strongly suggests that price ceilings were used as a focal point for collusion. However, their results do not necessarily imply the existence of a similar effect of markup regulation, which does not impose the same price on all the constrained firms. In markets with cyclical prices (e.g., fruits and vegetables), collusion on markups may be easier to achieve (and more difficult for authorities to detect) than collusion on prices. While collusive prices would require frequent periodic adjustments, markups can be kept relatively stable even if production costs vary greatly over the yearly cycle. On the other hand, collusion on markups requires having some information about competitors' marginal costs, and this could be more or less difficult to obtain, depending on the characteristics of the market (we will come back to this issue in Section 4).

Our findings are also related to those of Albæk, Møllgaard, and Overgaard (1997), who show that government regulation may have the perverse effect of favoring collusion. In their case, firms benefited from the availability of price information rather than from the existence of a focal point. In the market for pharmaceutical products, the evidence on the effects of maximum markups is mixed (World Health Organization 2011). Very few studies exist in other markets (Sen et al. 2011 and Suvankulov et al. 2012 study maximum markup regulation in the gasoline market).[7] Our work is also related to empirical studies of markets with vertical interactions. However, most of the research in this area has focused primarily on the effects of vertical agreements (restraints) among firms, rather than on government regulation of prices and markups (Lafontaine and Slade 2008).

[7] Schaumans and Verboven (2008) focus on the effects of entry regulation in the Belgian market for pharmacies, where markups are also regulated. Seim and Waldfogel (2013), Miravete, Seim and Thurk (2012) study the objectives and pricing strategies of the Pennsylvania Liquor Control Board, a monopolist in the wholesale and retail of wine and spirits operating under markup regulation.

From a policy perspective, our work is also related to a large literature indicating that heavy regulation is generally associated with greater inefficiency and poor economic outcomes (see, for example, Scarpetta and Tressel 2002; Blanchard 2004; Katsoulacos, Genakos and Houpis 2014). Finally, our work is also related to recent sectorial investigations by the European competition authorities (European Competition Network, 2012) into suspected vertical and horizontal agreements harming competition in the food market.[8]

The structure of the paper is as follows. Section 2 provides a short description of the fruits and vegetables market in Greece and the changes in markup regulation. Section 3 describes the data. Section 4 illustrates our empirical methodology and the assumptions required to exploit the variability induced by the policy change. Section 5 discusses our empirical results and Section 6 concludes.

2. Maximum markup regulation and the Greek market for fruits and vegetables

The market for fruits and vegetables in Greece consists of three vertical layers. At the production level, the market is very fragmented.[9] The wholesale market is significantly more concentrated, with the Athens Central Wholesale market operating as a closed market in which only licensed sellers can operate. Wholesalers mainly sell to retailers (supermarkets being their largest customers), but also to street market sellers, grocery stores, and restaurants. Finally, at the retail level, consumers buy either from street markets (58 percent market share but steadily declining), supermarkets (32 percent market share and steadily increasing), and to a lesser extent from groceries or other corner shops (10 percent). In street markets, approximately half of the sellers are also producers.

[8] 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.

[9] The agricultural sector accounts for 3.1 percent of the Greek GDP and employs 9.2 percent of the total work force, which is double the EU 27 average (4.7 percent). However, the average producer cultivates just 47,000 m^2 vs. the EU average of 126,000 m^2. Moreover, around 50 percent of the Greek producers own less than 20,000 m^2 plots.

The introduction of maximum markups for fruits and vegetables was part of a broad set of regulations originally introduced in 1946.[10] In our sample period, markups range between 8 and 12 percent for the wholesale market, between 20 and 35 percent for supermarkets, and between 17 and 32 percent for street markets and groceries.[11] The markup regulation does not apply to five fruit and vegetable products (apples, lemons, mandarins, oranges, and pears) nor to any other food or drink product. The last product to be excluded from the markup regulation on fruits and vegetables was apples in 1977, and no other change has been made to the list of excluded products since. We could find no explanation for these specific exemptions in the available documentation or in our conversations with the Ministry officials.

Repeal of the maximum markup regulation was the outcome of mounting international pressure to liberalize the Greek economy, in an attempt to limit the effects of the recession. The policy change was highly visible and prominently featured in national newspapers, and the process leading to deregulation was speedy. The policy was implemented on 23 June 2011[12], about three weeks after the government first announced it. Although some anticipation effects are possible, they are likely to be limited to this period.[13]

3. Data

We matched three different data sources for our analysis. First, we obtained weekly store-level retail prices for fruits and vegetables in Athens[14]. The data was collected through a regular survey run by the Greek Ministry for Development and Competitiveness. Both supermarkets and street markets were sampled

[10] The so-called "market code" covered various aspects of retail and wholesale trade in Greece, including regulation of licensing, opening hours and pricing.
[11] By law, maximum markups are computed over the sum of the buying price and the transportation cost, before adding VAT. Maximum markups changed several times after 1946, but not in our sample period.
[12] Ministerial decision A2-1045 (Gazette B' 1502/22-6-2011).
[13] The only other policy that potentially affected both the regulated and unregulated products during that period were three increases in VAT: from 9% to 10% on 15/3/2010, to 11% on 1/7/2010 and to 13% in 1/1/2011.
[14] We focus on Athens as it is by far the biggest market in Greece and is well-documented in our supermarket sample, and also because we could collect reliable wholesale information on it.

on a weekly basis.[15] 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.[16]

Second, through a survey administered by the Greek Ministry for Development and Competitiveness, we also collected information on the retail prices of 19 grocery products, other than fruits and vegetables, sold in supermarkets. None of these products was affected by the markup regulation. Third, we also obtained monthly wholesale median prices of the same fruit and vegetable varieties from the administration of Athens Central Wholesale Market during the same period. The wholesale data covers all 36 products and 59 of the 72 product varieties in the sample of retail prices.

Table 1 shows that the mean prices (and standard deviations) of regulated and unregulated fruits and vegetables are similar. The other packaged products (not fruits and vegetables) in our sample tend to be more expensive on average. The variability in prices is also higher due to more heterogeneity across products (see Table A1 in the Appendix).[17]

Figure 1 describes the time series of the weekly average log price of fruit and vegetable products in the treatment (black solid line) and control group (grey dotted line) in the sample period. The figure shows that fruit and vegetable prices follow a yearly cycle, which is typical of any agricultural product.[18] More importantly, the average price of products in the control group (the straight grey line) are very similar in the one year preceding and following the policy change (the vertical red line). On the other hand, there seems to be a large drop in the average price of products in the treatment group (the straight black line),

[15] Street markets were sampled by employees of the Ministry for Development and Competitiveness and median prices in each market were then computed and recorded in the data set for the same fruit and vegetable varieties as for supermarkets.

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

[17] The comparison of the average retail and wholesale price in Table 1 does not provide reliable information on average markups for several reasons. First, we do not observe individual prices paid by retailers to wholesalers, but only the median price. Second, median wholesale prices are computed with monthly (not weekly) frequency. Third, the data set on wholesale prices does not include all the varieties we observe in the data set on retail prices. Finally, there is no reliable information on transportation costs. In this paper, we do not attempt to directly estimate the level of markups, but focus instead on the change in prices following deregulation.

[18] The figure also suggests that the cycles of the two groups of products may be quite different (we will come back to this issue in the next section).

suggesting a possible negative impact of the policy change on the price of these goods. The next two sections will develop this intuition, precisely measure the differential impact of the policy on the two groups, and discuss its significance.

4. Identification and Empirical Methodology

Identification of the impact of the policy change is obtained within a difference in difference framework. 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:

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

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, and e_{itj} is a random shock with $E(e_{itj}|Post_t, Treat_i, X_{ijt}) = 0$. X_{ijt} is a matrix of control variables; 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 credible as we progressively add appropriate controls in X_{ijt}. First, we control for changes in the VAT rates. Second, we include in X_{ijt} month, store, and 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). 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 Athens Central Wholesale 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

Table 2 reports a simple before-after comparison of the retail price of products covered by regulation. Average price seems to decrease by 7.7 percent after deregulation (column 1). This difference is not much affected when controlling for month (column 2), store, and variety-specific fixed effects (column 3). It is also robust to controls for product-specific yearly cycles (column 4). Additionally controlling for a quadratic trend (column 5) leads to slightly smaller estimated difference in prices of 5.6 percent.

Table 3 reports our main results. 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). On the contrary, prices for the control group were not significantly affected. In columns 2 and 3, the negative impact of deregulation 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.

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 of 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 (about 0.12 percent of GDP).

Table 4 reports the results when analyzing only the wholesale data. 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.[19]

Selection of the control group and placebo test

The difference in difference approach assumes that the policy change 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, 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).

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 3 seem to refute this idea.

Nevertheless, we investigate this possible bias by using a different control group, comprising of 19 non-fruit and vegetable packaged goods such as rice, spaghetti, flour, and milk (the full list is reported in the third column of Table A1). 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 5 presents the results using the same additional control variables as in Table 3. 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 3 but within conventional confidence intervals of our previous estimates. As before, there is no systematic impact of deregulation on the price of

[19] Standard errors are larger than in Table 3 but the estimated coefficients are not significantly different from the corresponding estimates in Table 3.

the products in the control group. Overall, the choice of the control group does not seem to significantly affect our results.

Since most of the products in the original control group are fruits, in Table 6, 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 6, column 2 we drop the period following 22 April 2011, which is two months before the actual policy change, to avoid any possible anticipation effects (which will be discussed in Section 5.2). 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.

5.1 Interpretation of the estimated impact of deregulation

Our results are not consistent with the view that the only effect of regulation is that of constraining firms with high markups, hence leading to a decrease in average prices. Unexpectedly, we find that average prices decreased with deregulation. Although some firms might have been constrained by the markup regulation, some other effect must have played a major role.

The first candidate explanation is strategic interaction due to vertical relations. Unconstrained firms upstream may indeed respond to a binding constraint downstream, but they have no incentive to increase their price in response to maximum markup regulation (see the Appendix for more details). Hence, we would expect to observe an increase - not a decrease - in prices following deregulation.

The second 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. The repeal of the law might have destroyed these focal points and led to significant price decreases.

If collusion is driving the results in Tables 2-6, we will expect to see a larger impact of the policy in markets in which collusion is easier to maintain. As discussed earlier, the wholesale market for fruit and vegetable products is more concentrated than the retail market, and less affected by entry and exit. Firms (in terms of sale volume) are also larger and more likely to be incorporated (HCC 2011). Moreover, wholesalers are physically closer to each other and interact daily. Finally, products (within varieties) are homogenous in the wholesale market, while at the retail level there is differentiation due to location, availability, and complementary services offered to customers. Hence, collusion is expected to be more likely in the wholesale market.

We test this hypothesis in three ways. First, we investigate the impact of the policy change on retail prices holding wholesale prices constant. We merged the retail with the wholesale price data, excluding the varieties not included in the wholesale data set. Table 6, column 3 reports the results from our benchmark specification 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 similar to what we found in Table 3, column 5 (-6.4 percent). In Table 6, column 4 we additionally control for wholesale prices 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.[20]

Second, we estimate the differential effect of the change in regulation in supermarkets and street markets. This is because supermarkets typically buy all of their grocery products from wholesalers (HCC 2011). 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 likely to impact prices in supermarkets more than in street markets. In Table 6, column 5 we find that indeed the policy change had a large and significant impact (-10 percent) on supermarkets, whereas street markets were unaffected.

[20] 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.

Our third approach focuses on the differential impact of the policy on specific products sold at street markets, since even street vendors have to rely on wholesalers for their supply of some specific varieties. According to the HCC (2011) report, street vendors never buy lettuce from wholesalers, while they rely on them heavily for peaches. Hence, we test if the policy had a different impact on the price of these two products in street markets.

Table 7, column 1 reports the results of our benchmark specification using the same control group as before but 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 street markets. Column 3 shows that in street markets, deregulation had no significant impact on the price of lettuce ($Low_i \times$ Street $market_j$) but had a negative impact on the price of peaches ($High_i \times$ Street $market_j$). By contrast, in supermarkets, both lettuces and peaches were affected by the policy. These new results are consistent with markup regulation affecting wholesale prices first, and only indirectly affecting retail prices.

The interpretation of the results based on collusion requires that wholesalers could monitor the strategies of their competitors. It is difficult to evaluate what wholesalers knew about their competitors' costs and prices, although monitoring seems to have been possible for three main reasons. First, the identity of (large) customers supplied by each wholesaler could easily be observed because of the physical arrangement of the Athens Central Wholesale Market. Second, wholesale transactions were far from secret, although they were subject to negotiation between wholesalers and (large) buyers.[21] Finally, information on retail prices in supermarkets was widely available to competitors.

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 report (2011) suggests that enforcement was good for supermarkets. We do not have direct evidence

[21] In fact, wholesale prices had to be reported to the market authorities, although we have no evidence on the extent to which this information would then become available to wholesalers.

on the quality of enforcement in street and wholesale markets. In any case, our analysis does not rest on the assumption that enforcement was perfect. Lack of enforcement would imply that regulation was less effective (or perhaps even completely ineffective) in constraining prices. In the absence of other effects (through vertical or horizontal relations) we would then expect no impact of deregulation, while instead we do find a significant effect. However, even if not binding or poorly enforced, regulation might have provided a focal point for collusion.

5.2 Additional results

Markup regulation is expected to constrain firms with the largest markups, but it may also induce collusion among unconstrained firms. This implies a more concentrated markup distribution, but does not necessarily imply a more concentrated price distribution, as marginal costs (purchase price plus transportation costs) may vary significantly across firms.[22]

Since we do not observe firm-specific wholesale prices, we cannot estimate individual markups and their correlation with marginal costs. Hence, we cannot use evidence on price variability to infer the existence of collusion. However, it is interesting to use quantile regressions to document the impact of markup regulation on the price distribution. Moreover, quantile regressions are less affected by outliers and provide a good robustness check of our previous results. Figure 2 suggests that the entire distribution shifted after deregulation (not only the mean), possibly leading to a more concentrated price distribution. In fact, Table 8 shows that deregulation negatively affected prices at the 25th, 50th, and 75th percentiles of the price distribution. The impact is larger at the 25th and 50th percentile than at the 75th, although the differences are not statistically significant.

[22] However, if marginal costs are (weakly) positively correlated with markups, markup regulation will lead to less price dispersion. This is related to the growing empirical literature on the impact of collusion and cartels on price variability (see for example Abrantes-Metz, Froeb, Geweke, and Taylor 2006, Botolova, Connor and Miller 2008).

Finally, we estimate a dynamic model interacting $Treat_i$ with indicator variables for 10 two-week periods before and after the policy change,

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

where $D^{T-i} = 1$ in the i^{th} period before deregulation. The last period (T+10) includes all the observations 20 or more weeks after the policy change.[23]

Figure A1 in the Appendix plots the regression coefficients together with their 95% confidence interval.[24] Deregulation has no effect on prices until four weeks before the actual implementation. 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. 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 3, column 4).[25]

6 Concluding remarks

In this paper, we present the first systematic evidence of the impact of the repeal of maximum markup regulation on retail and wholesale prices. Our results show that the repeal led to significant price reductions, corresponding to an estimated €256 million decrease in consumer expenditure. We also provide evidence that the most likely explanation for this phenomenon was collusion at the wholesale level. First, the negative impact of deregulation on retail prices seems to be entirely driven by changes at the wholesale level. Second, prices in supermarkets - which mainly buy from wholesalers - experienced the most significant changes.

[23] The omitted indicator variable covers the period 20 or more months before deregulation. See, Autor (2003) or Laporte and Windmeijer (2005) for a discussion of this approach.
[24] Estimated coefficients are reported in Table A2 of the Appendix.
[25] The coefficients are imprecisely estimated, as fruit and vegetable prices show considerable weekly variability in addition to their yearly cycle. The estimates of the dynamic impact of the reform on wholesale prices are also very noisy. Figure A2 and Table A3 in the Appendix describe the regression coefficients.

Third, in street markets, deregulation seems to have had more of an impact on the prices of products more likely to be bought from wholesalers.

Finally, we observe several features of the Athens Central Wholesale Market that make it more prone to collusion (centralized physical arrangement, barriers to entry, limited number of large competitors, daily interaction). However, with aggregate data alone, we cannot investigate the exact mechanism possibly used to sustain collusion, nor can we 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 understudied 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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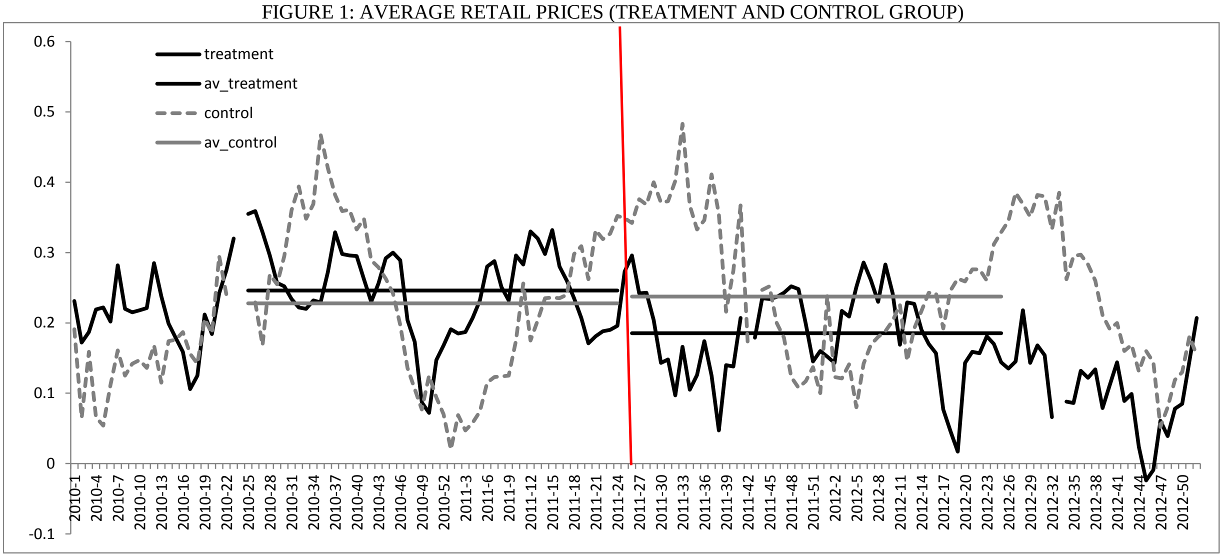
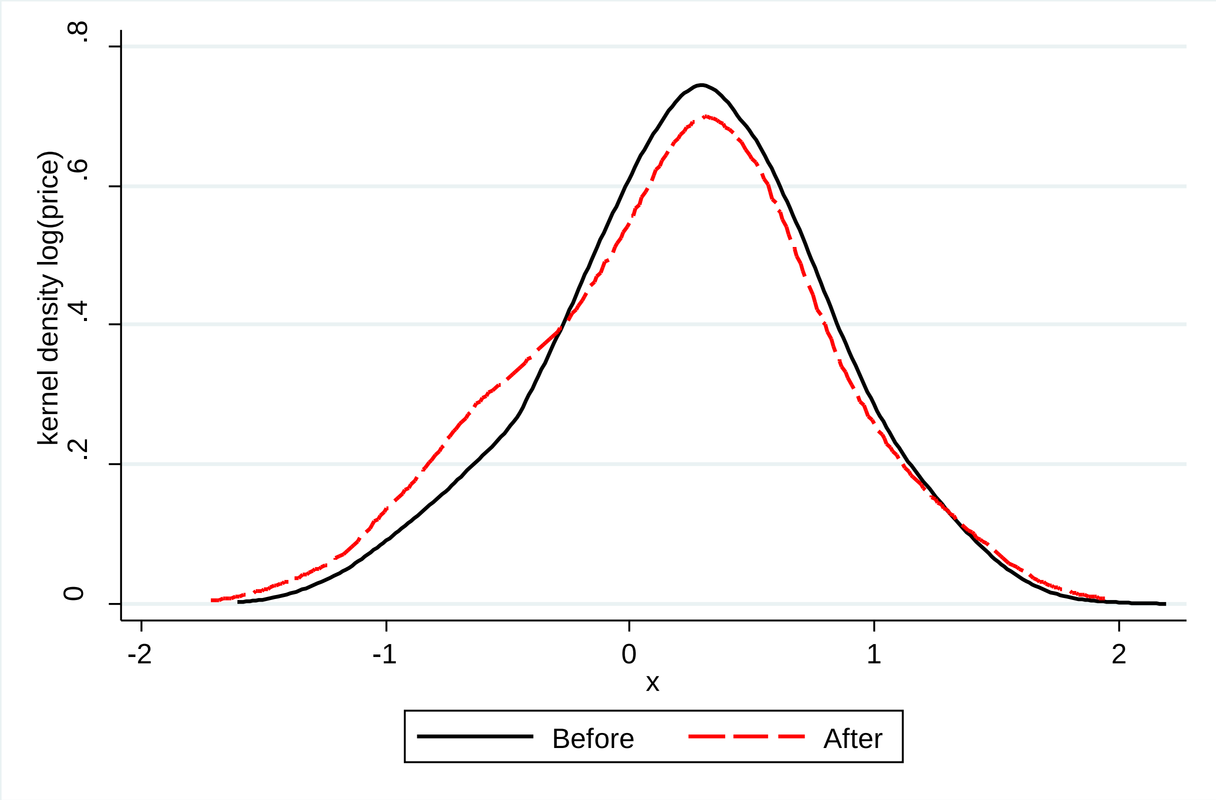
FIGURE 1: AVERAGE RETAIL PRICES (TREATMENT AND CONTROL GROUP)



Notes: The figure reports the weekly average log prices of products in the treatment and control groups and their one-year average before and after deregulation.
Source: Authors' calculations based on data from the Greek Ministry of Development.

FIGURE 2: THE DISTRIBUTION OF RETAIL PRICES BEFORE AND AFTER DE-REGULATION (TREATMENT GROUP)



Notes: The figure reports information on the distribution of log prices of products in the treatment group. The period "before" the policy change includes observations from one year before to the date of deregulation. The period after includes observations for one year after deregulation.

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

TABLE 1 - AVERAGE PRICE AND PRICE VARIABILITY BY MARKET AND PRODUCT GROUP

	Type of product	Retail Market			Wholesale market
		Supermarkets	Street markets	Total	
Regulated products	Fruits and vegetables	1.349 (0.859)	1.455 (0.799)	1.421 (0.820)	0.805 (0.523)
Unregulated products	Fruits and vegetables	1.401 (0.494)	1.316 (0.505)	1.342 (0.503)	0.805 (0.278)
	Other packaged goods	4.458 (6.721)	-	4.458 (6.721)	-

Notes: The table reports the average prices and the standard deviations of prices for different groups of products. The list of products is provided in Table A1. Prices for the sample of "other packaged goods" are available only for supermarkets.
Source: Authors’ calculations based on data from the Greek Ministry of Development.

TABLE 2 - THE IMPACT OF DE-REGULATION 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 x 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 DE-REGULATION ON RETAIL PRICES (CONTROL AND TREATMENT)

	(1)	(2)	(3)	(4)	(5)
Estimation method	OLS	OLS	FE	FE	FE
Dependent variable	$\ln(\text{Retail Price})_{ijt}$	$\ln(\text{Retail Price})_{ijt}$	$\ln(\text{Retail Price})_{ijt}$	$\ln(\text{Retail Price})_{ijt}$	$\ln(\text{Retail Price})_{ijt}$
$Treat_i \times Post_t$	-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 x 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 inc lude 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 4 - THE IMPACT OF DE-REGULATION ON WHOLESALE PRICES

	(1)	(2)	(3)	(4)	(5)	(6)
Estimation method	OLS	OLS	OLS	FE	FE	FE
Dependent variable	$\ln(\text{Wholesale Price})_{it}$	$\ln(\text{Wholesale Price})_{it}$	$\ln(\text{Wholesale Price})_{it}$	$\ln(\text{Wholesale Price})_{it}$	$\ln(\text{Wholesale Price})_{it}$	$\ln(\text{Wholesale Price})_{it}$
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 x 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 Greek Ministry of Development.

TABLE 5 - THE IMPACT OF DE-REGULATION 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 x 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 products sold in supermarkets and classified as "other packaged goods" in Table A1. 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 6 - THE IMPACT OF DE-REGULATION 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	Retail & Wholesale	Retail & Wholesale	Retail & Wholesale
Treat$_i$ × Post$_t$		0.027	-0.055**	-0.020	
		(0.024)	(0.027)	(0.013)	
Treat$_i$ × Post$_t$ × Fruit$_j$	-0.070*				
	(0.036)				
Treat$_i$ × Post$_t$ × Vegetable$_j$	-0.063***				
	(0.023)				
Treat$_i$ × Post$_t$ × Street market$_j$					-0.027
					(0.026)
Treat$_i$ × Post$_t$ × 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 x 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 avavilable. 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 7 - THE IMPACT OF DE-REGULATION 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 8 - THE IMPACT OF DE-REGULATION ON RETAIL PRICES (QUANTILE REGRESSIONS)

	(1)	(2)	(3)	(4)	(5)	(6)
Estimation method	FE	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)$_{ijt}$	ln(Retail Price)$_{ijt}$
	25th percentile	50th percentile	75th percentile	25th percentile	50th percentile	75th percentile
$Treat_i \times Post_t$	-0.165**	-0.120***	-0.095*	-0.091***	-0.098***	-0.074***
	(0.081)	(0.042)	(0.049)	(0.022)	(0.028)	(0.026)
$Post_t$	0.009	0.069	0.052	0.032	0.041	0.010
dummy=1 after 22 June 2011	(0.064)	(0.043)	(0.042)	(0.025)	(0.031)	(0.027)
Observations	56,523	56,523	56,523	56,523	56,523	56,523
Adjusted R^2	0.004	0.007	0.005	0.777	0.784	0.777
Clusters	72	72	72	72	72	72
Month FE	yes	yes	yes	yes	yes	yes
Product variety FE				yes	yes	yes
Store 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*. 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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Appendix

1. Vertical interactions and markup regulation

We describe here the impact of the introduction of maximum markup regulation in the simplest possible model of vertical interaction. Firm 1 is the upstream monopolist, selling to a downstream retailer (firm 2). Firm 1 has zero cost of production. Firm 2 buys each unit of the good from firm 1 at price c. There is no other cost of production (all prices are linear). Consumers' demand is $q = 1 - p$, where q is the quantity and p the retail price.

The retailer chooses the price p in order to maximize profits $\Pi_2 = (p - c)(1 - p)$. Hence, $p = \frac{1+c}{2}$ and $q = \frac{(1-c)}{2}$. The upstream manufacturer chooses c to maximize $\Pi_1 = \frac{c(1-c)}{2}$. Hence, in equilibrium $\left\{c^* = \frac{1}{2}, p^* = \frac{3}{4}, q^* = \frac{1}{4}\right\}$. Double marginalization implies that the price is higher than the monopoly price of the vertically integrated firm (1 and 2).

Markup regulation

Markup regulation in the retail market requires that $(p - c)/c < t$, where $t > 0$ is the maximum allowed markup. Replacing the expression for the optimal retail price, the retailer is not affected by the regulation if $c > \frac{1}{2t+1}$. In this case, regulation has no bite; otherwise, the constraint is binding and the retailer sets a price $p = c(1 + t)$.

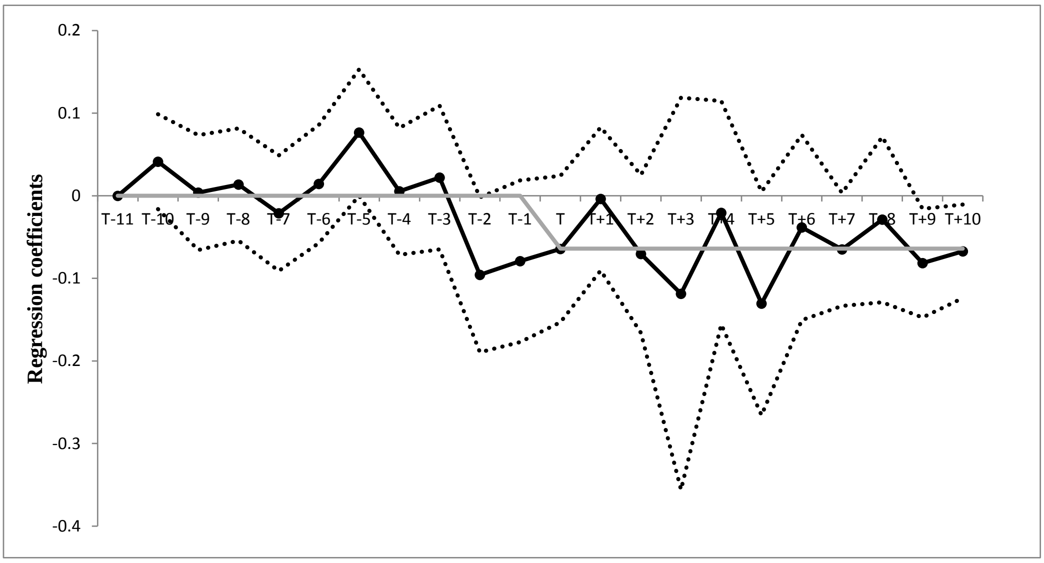
The upstream manufacturer chooses c to maximize

$$\Pi_1 = \begin{cases} \dfrac{c(1-c)}{2} \text{ if } c > \dfrac{1}{2t+1}, \\ c\big(1 - c(1+t)\big) \text{ otherwise.} \end{cases}$$

Two cases are possible in equilibrium. If $t > 1$, $\left\{c^* = \frac{1}{2}, p^* = \frac{3}{4}, q^* = \frac{1}{4}\right\}$, regulation is not binding and prices are not affected. If $t < 1$, $\left\{c^* = \frac{1}{2(1+t)}, p^* = \frac{1}{2}, q^* = \frac{1}{2}\right\}$, regulation is binding and *both* prices c and p fall with respect to the unregulated market. If sufficiently strict, a markup ceiling solves the double marginalization problem and leads to lower prices.

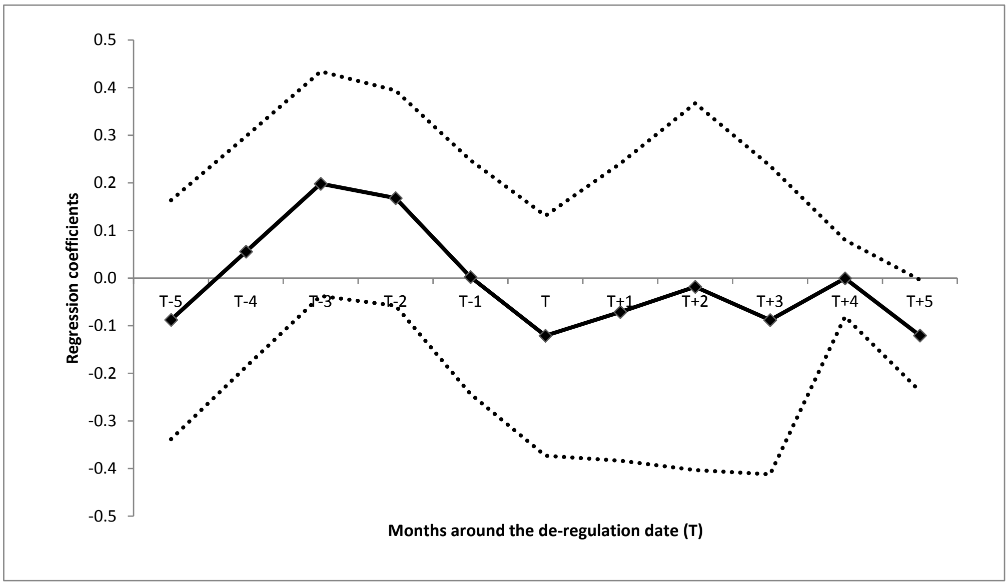
The sign of the impact of regulation on p is unchanged if a maximum markup is implemented only for the upstream monopolist, since the retail price is increasing in c. Moreover, this result also holds when regulation affects both the producer and the retailer. (The analysis is the same as in the case of downstream regulation, but with an additional constraint on the producer price.) In conclusion, markup regulation is expected to lead to lower prices.

FIGURE A1: DYNAMIC RETAIL PRICE RESPONSE TO DE-REGULATION



Notes: Figure A1 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 A2.

FIGURE A2: DYNAMIC WHOLESALE PRICE RESPONSE TO DE-REGULATION



Notes: Figure A2 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 A3.

TABLE A1- 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-imported)	**Brandy**
Banana	Apple (Starkin-imported)	METAXA 3* 700ml
Banana (imported)	**Lemon**	**Cereals**
Beans	Lemon (common)	KELLOGS SPECIAL K 500gr
Bean Barbouni	Lemon (imported)	**Condensed milk**
Bean Barbouni (imported)	**Mandarins**	nounou 410gr
Bean Tsaouli	Clementin mandarin	nounou light 170gr
Beetroot	Clementin mandarin (imported)	**Flour**
Broccoli	Mandarin (common)	Giotis flour 1kg
Broccoli (common)	**Orange**	**Pasteurised milk**
Broccoli (imported)	Valencia orange	Delta full fat 3.5% 1lt
Cabbage	Orange (navalines-merlin)	Nounou family full fat 1lt
Carrot	**Pear**	Olympos full fat 1lt
Cauliflower	Pear (imported)	Chocolate milk Milko
Cauliflower (common)	Pear Krystali	**Rice**
Cauliflower (imported)	Pear Krystali (imported)	Carolina 3A 500gr
Cherry		**Rum**
Cherry (petrokeraso)		Bacardi 1lt
Cherry (crisp)		**Spaghetti**
Cucumber		Misko 500gr
Eggplant		**Toast bread**
Tsakonian eggplant		Karamolegkos
Eggplant (common)		**Toast**
Eggplant (imported)		friggania papadopoulou 510gr
Fresh onion		**Whisky**
Grapes		jonnie walker red 1lt
Grape (common)		**Wine**
Sultana grapes (raisin)		Kourtaki retsina
Greens		
Italian chicory		
Kiwi		
Kiwi (common)		
Kiwi (imported)		
Leek		
Lettuce		
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.
Source: Authors' calculations based on data from the Greek Ministry of Development.

TABLE A2 - DYNAMIC IMPACT OF DE-REGULATION 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)
$Treat_i \times Post_{t0}$	-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 A3 - DYNAMIC IMPACT OF DE-REGULATION ON WHOLESALE PRICES

Estimation method	FE
Dependent variable	ln(Wholesale Price)$_{it}$
Treat$_i$ × Post$_{t-5}$	-0.088
	(0.125)
Treat$_i$ × Post$_{t-4}$	0.056
	(0.121)
Treat$_i$ × Post$_{t-3}$	0.198*
	(0.118)
Treat$_i$ × Post$_{t-2}$	0.168
	(0.113)
Treat$_i$ × Post$_{t-1}$	0.002
	(0.123)
Treat$_i$ × Post$_{t0}$	-0.121
	(0.126)
Treat$_i$ × Post$_{t+1}$	-0.071
	(0.156)
Treat$_i$ × Post$_{t+2}$	-0.018
	(0.192)
Treat$_i$ × Post$_{t+3}$	-0.088
	(0.162)
Treat$_i$ × Post$_{t+4}$	-0.000
	(0.040)
Treat$_i$ × 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 Greek Ministry of Development.