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by Giacomo Calzolari, Andrea Ichino, Francesco Manaresi and Viki Nellas

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WHEN THE BABY CRIES AT NIGHT. INELASTIC BUYERS IN NON-COMPETITIVE MARKETS.

by Giacomo Calzolari*, Andrea Ichino*, Francesco Manaresi**, and Viki Nellas*

Abstract

We study an inflow of buyers who are less elastic because they lack both time and information. Theory predicts that sellers increase prices to expand surplus appropriation, even if marginal costs are non-increasing, but this effect weakens as market competition intensifies. Data from Italian pharmacies confirm these predictions. Monthly fluctuations in the number of newborns at the city level generate exogenous changes in the number of less elastic buyers (the parents) who consume hygiene products demanded by more experienced and elastic consumers as well. We estimate that the number of newborns has a positive effect on equilibrium prices even with non-increasing marginal costs. We exploit legislation that fixes the number of pharmacies that should serve a city as a function of the existing population. Using a Regression Discontinuity Design, we find that an increase in competition has a significant and negative effect on the capacity of sellers to extract surplus from less elastic buyers.

JEL Classification: D43, D83, L13.

Keywords: demand elasticity, consumer's information, price competition, pharmacies, regression discontinuity.

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1 Introduction¹

In some periods of their life consumers may enter markets that they know less well and/or face a higher opportunity cost of their time. Both these changes, for example, characterize what happens when they become parents of newborns. In such cases consumers often cannot acquire immediately all the useful information about the best prices in the new market they just entered and about the relevant products needed by their babies. They may also have less time to profit from the best deals even if they had all the information necessary to identify them. As a consequence, these consumers are less price sensitive than standard and more experienced ones. Similar kinds of buyers' heterogeneity, in terms of price elasticity, are likely to be a common feature of most markets, but their consequences on firms' actual pricing strategies are relatively unexplored.

In this paper we investigate empirically how firms react to the composition of the population of their consumers, when they perceive that the proportion of less elastic buyers changes. Specifically, we provide a novel and clean identification strategy to study what happens to prices when exogenous waves of hurried, less informed, and thus less elastic buyers enter a market. We then estimate how the *composition effect* on prices generated by an increase in the share of these buyers is affected by an exogenous modification in the degree of competition faced by firms.

Our analysis rests on the assumption that immediately after delivery, parents suddenly enter as buyers in the market of the goods that are necessary to raise their babies, but do not know well (yet) their children's needs and are relatively less informed about prices than other consumers of those products, including parents of older babies. They are also more likely to be under pressure (... when the kid cries!), thus facing a high opportunity cost of time to search and being less able to profit from the best offers available in the market.

For each of the 8,092 Italian municipalities (henceforth, cities), we have data on the number of newborn babies at the monthly frequency between January 2005 and December 2010. We have also identified a set of hygiene products demanded by parents of small babies as well as by other consumers and we are able to access monthly data on prices charged for these goods by a large number of pharmacies in these cities, together with the corresponding quantities. Thanks to these unique sets of data, under relatively mild identification assumptions², we are able to estimate the elasticity of the equilibrium price

¹We thank the software house that provided the data on pharmacies used in this study. We also thank ANPI (in particular, Massimo Brunetti) for the data on "Parafarmacie" and ISTAT (in particular Saverio Gazzelloni and Angela Silvestrini) for the demographic data. We received insightful comments from Marco Alderighi, Joshua Angrist, Chiara Fumagalli, Paul Heidhues, Peter Kuhn, Saul Lach, Jose Moraga-Gonzalez, Claudio Piga, Andrea Pozzi, Fernando Vega-Redondo, Giulio Zanella and seminar participants at the Bank of Italy, BCLE, Bologna, EUI, MACCI Conference 2012 Mannheim, St. Gallen, Stockholm School of Economics, UPF and Warwick to whom our gratitude goes.

²Controlling for city and time fixed effects, the variation in newborns at the monthly frequency is arguably

with respect to a shock in the monthly number of newborns. Consistently with the theoretical predictions, we find that an increase in the number of newborns (i.e. the relatively inelastic consumers of our products) significantly raises the average price at the city level. There are other possible interpretations for this result (most notably increasing marginal costs) but we are able to show that none of these alternative interpretations is consistent with the other available pieces of evidence.

The insights of the theoretical model that guides our analysis invite us to further explore empirically whether the elasticity of the equilibrium price with respect to newborns, that we estimate in the first part of the paper, decreases when competition among sellers increases. To do this, we need exogenous sources of variation in the number of sellers. We find these sources by concentrating the analysis on cities whose maximum population during the last 45 years has been in a neighborhood of the 7500 units threshold. Indeed, the Italian law prescribes, similarly to many other countries, that cities with a population lower than this threshold should have only one pharmacy, while an additional pharmacy should be opened in cities above the threshold. With respect to current population, there is substantial non-compliance with this rule, partly because of geographic reasons³, but more importantly because during the post-war period, when population grew above the threshold, pharmacies were opened but later they were not closed if population declined under the threshold. Precisely for this reason, *the maximum population size* reached historically by cities generates a fuzzy assignment mechanism for the current number of pharmacies. We exploit this assignment mechanism within a Regression Discontinuity design to study how the number of sellers influences the effect of an increase in the share of less elastic consumers.

Using this identification strategy we show, as expected, that cities immediately above the threshold (in terms of maximum historical population) have, on average, a larger number of pharmacies than cities immediately below it. More interestingly, we show that where the number of competing pharmacies is larger for this exogenous reason, the elasticity of equilibrium prices to newborns is significantly smaller. We interpret this finding as evidence that in less competitive environments sellers can exploit to their advantage increases of demand originating from less elastic consumers, as theory predicts. Competition, however, limits severely this sellers' ability to exploit market power.

Although there has been a recent surge of empirical investigations of consumers' heterogeneity, these studies typically do not address directly the composition effect on prices which emerges when, for some reasons, the relative proportion of different types of consumers changes. An important exception is Lach (2007) who studies the effect of an unexpected large inflow of immigrants to Israel during 1990. He shows that a one-percentage-point in-

random.

³The presence of remote areas or valleys within the city boundaries is the most common motivation for being allowed to have more pharmacies than what the Law would prescribe.

crease in the ratio of immigrants to natives in a city decreases prices of commodity goods by 0.5 percentage points. He explains this finding with immigrants having lower search costs and higher price elasticity than the native population. We consider instead an increase in less price-elastic and higher-search costs consumers (the parents of newborns), showing that this increase has a positive effect on prices. Moreover, Lach (2007) does not study how *competition among sellers* modifies the effect of an inflow of buyers characterized by a different price elasticity. We improve on this relevant question with respect to Lach (2007) by showing, in a Regression Discontinuity design, that greater competition reduces the capacity of sellers to extract surplus from less elastic buyers.

Search related effects of consumers' heterogeneity is also exploited in Aguiar and Hurst (2007). Using scanner data, they have shown that older individuals, facing a lower opportunity cost of time, shop more frequently looking for temporary discounts. They thus end up paying lower prices than younger consumers for exactly the same products. Interestingly for our analysis, Aguiar and Hurst (2007) are able to calculate the implicit opportunity cost of time, showing that it is hump shaped with respect to age, with a peak in the early thirties, precisely when most of them are engaged in parental cares. This empirical observation is consistent with our findings but, differently from their paper, we do not take shops' pricing strategies as given. We verify if and how shops endogenously modify prices when they observe a change in the composition of customers.

Addressing the role of frequency of purchase and consumers' information, Sørensen (2000) finds that the price dispersion and the price-cost margin for a prescription drug negatively relate with its specific frequency of dosage. Higher frequency of dosage allows consumers to become more informed on the prices available in the market for these drugs and pharmacies respond reducing price-cost margins and price variation on these products. We differentiate from this paper by studying differences in consumers not in products and by addressing the important role of competition as well.

The advent of Internet has been seen as one leading factor that has reduced search costs, increased the fraction of more informed consumers, and ultimately induced a reduction of prices. This has been documented, for example, by Brown and Goolsbee (2002) illustrating the effect of Internet comparison-shopping sites on the prices of life insurance in the 1990s. In the mutual funds industry, Hortacsu and Syverson (2004) document an upward shift of the estimated search costs distribution for heterogeneous investors that occurred between 1996 and 2000 and suggest, with indirect evidence, that this observation may be the result of entry of novice investors.⁴

Similarly to these papers, we are interested in measuring the *composition effects* in markets with consumers characterized by different levels of elasticities, possibly induced by

⁴However, they say on p. 441: “We emphasize that our model’s implication of such a composition shift is only suggestive—we would need investor-level data to test it definitively”.

different available information sets and higher time pressure. However, and differently from these papers, we address this analysis with a *direct measure* of an *exogenous* change in the composition of consumers, offered by the possibility to count explicitly the number of inexperienced newborns' parents entering the market for childcare products. We further qualify this composition effect by interacting it with an exogenous source of variation in the market structure, i.e. the number of pharmacies available to parents as implied by the law.

Our paper also relates to the literature on price discrimination, because in our environment pharmacists may charge higher prices to less elastic buyers, i.e. parents of newborns, or sell at a discount to more experienced and elastic consumers. If a pharmacist charges those different prices, an increase of the number of newborns, in a city and in a given month, determines an increase of the average price observed in that city and month. Graddy (1995) studies price discrimination in the NY Fulton fish market, showing that Asian buyers pay more than white buyers for similar products. Building on a simple model of (third-degree) price discrimination, she identifies and estimates conduct parameters of sellers which indicate their capacity to extract more or less surplus from consumers as a function of different price elasticities of Asian and non-Asian buyers. In our environment, we cannot identify the individual characteristics of each single buyer and thus we cannot test explicitly for the presence of price discrimination. We nevertheless discuss how our estimated parameters could be interpreted in the light of Graddy's (1995) model. Price discrimination makes perfect sense when applied to the two populations in the Fulton fish market, also because they probably do not communicate much one to the other. It seems instead less likely in our environment, taking into account pharmacists' reputational concerns, particularly in the small villages on which the most relevant part of our analysis is based. Consistent with this last remark, in Section 6, we show that our evidence on the direct effect of competition on price levels contradicts some of the theoretical implications of the model in Graddy (1995), thereby confirming that price discrimination may not be the main underlying mechanism of our results.

Our paper is also related to the vast literature on entry, initiated by Bresnahan and Reiss (1991) who showed that the pro-competitive effect of new entrants falls rapidly in many markets after 3-5 more firms have entered. Consistent with these results, we also find that in small cities a change from one to two pharmacies reduces to nil the pharmacists' ability to exercise market power.

The rest of the paper is organized as follows. Section 2 provides the theoretical background that guides our empirical exercise. Section 3 describes the data and illustrates the identification strategy. Section 4 presents and discusses the effect of newborns on the equilibrium price. Section 5 shows instead how competition affects the elasticity estimated in the previous Section. Section 6 is dedicated to a discussion of the effect of competition on *price*

levels, which is not the main focus of this paper but nevertheless deserves to be considered. Finally, Section 7 concludes.

2 Theoretical insights

Consider a market with S shops (pharmacies), each one selling a possibly differentiated product to a total of N_t consumers at any period t . Buyers are divided in two groups, the N_t^I “inelastic consumers” with an individual demand q_i^I for shop i and associated price elasticity η_i^I , and the N_t^E “elastic consumers” who instead have an individual demand q_i^E with price elasticity η_i^E . The two groups differ because the individual demand elasticity for the product sold at any shop i is lower for types I than for types E , for any given set of prices of all shops: $\eta_i^E < \eta_i^I < 0$.

Different elasticities may emerge for several reasons. Our empirical analysis will consider products that are used for various purposes among which, in particular, childcare and that are sold at pharmacies and supermarkets. Parents of newborns are buyers of these products and we believe it is conceivable that they have the following characteristics. Relative to other consumers, they:

- (i) have a higher (opportunity) cost of searching for better deals;
- (ii) have less experience on their actual needs.

As a result, they are relatively inelastic. Indeed, being pressed, parents of newborns search less for the best-price deals.⁵ Even when they know the best-price sellers, they may find it too costly to travel and reach those shops. Parents of newborns are also inexperienced, especially if they are at their first baby and just after delivery. At least initially, they may lack the information about the least price shops. Moreover, they may perceive purchases of childcare products at pharmacies as non-perfectly substitutable with those obtained in supermarkets, because of the value they attach to pharmacists’ advice and information. For any of their characteristics (i) and (ii), these consumers will then be our inelastic type I buyers. All the others consumers, possibly comprising also parents after some months of experience, will be instead our elastic type E buyers. The number of elastic and inelastic consumers at any t is assumed to be IID.⁶

⁵In principle, consumers may use the Internet to learn the expected price. However, even the acquisition of information from the Internet is far from being costless. Moreover, in the Italian context, very few pharmacies have a website.

⁶In general, the number of consumers of type E at date t may also depend on inflows of types I in previous periods because some parents may be able, after a while, to better organize their purchases and become childcare experts. In this case, they exit the group of types I consumers and enter into the group of type E . Although for simplicity here we do not explicitly model this transition, we will consider this possibility in our empirical analysis.

For the time being, we assume that any shop i has a constant (and time invariant) marginal cost c_i and will consider other possibilities in the sequel.

2.1 Pricing strategies and demand composition

We begin by considering the possibility that shops exploit the presence of the two groups of consumers and price discriminate. We will then consider other pricing strategies showing that they all lead to the same empirical predictions concerning the effect of an inflow of inelastic consumers in a market and how this effect changes depending on the number of sellers.

Pharmacists might identify the parents of newborns when they enter their shops. For example, mothers of newborns have probably shopped at the local pharmacy while pregnant before the birth date and newborns parents are likely to talk with their pharmacist about the recent change in their family life. In this case, third degree price discrimination may take place with prices p_i^E and p_i^I and the profit of shop i is

$$\pi_{it} = \left[(p_i^E - c_i) q_i^E \frac{N_t^E}{N_t} + (p_i^I - c_i) q_i^I \frac{N_t^I}{N_t} \right] N_t \quad (1)$$

The associated optimal prices p_i^{*E} and p_i^{*I} set by shop i are simply determined by independently maximizing the per-consumer profit for each one of the two types of consumers, i.e. finding the price p_i^{*j} that maximizes the profit $(p_i^j - c_i) q_i^j$ that shop i obtains with any consumer in the group j , with $j = \{I, E\}$, given the price charged by the competitors. Following Graddy (1995), Appendix 8.1 derives explicit expressions for these pricing rules, that conform to the standard price discrimination result according to which $p_i^{*E} \leq p_i^{*I}$. The *average price* observed by the econometrician at time t in shop i would then be:

$$p_{it} = \frac{p_i^{*E} N_t^E + p_i^{*I} N_t^I}{N_t} \quad (2)$$

It is easy to see that this average price is increasing in the fraction N_t^I/N_t of new and inelastic consumers. At the same time, a proportional increase in the number of consumers of the two types, thus keeping constant the ratio N_t^I/N_t , would leave the average price unaffected.⁷

Some shops, however, may be unable or may prefer not to price discriminate. For example, in our small Italian cities, to preserve their reputation of a “fair” treatment of customers, pharmacists may prefer not to be spotted charging different prices for the same products to different consumers. If a unique (linear) price p_{it} is charged, the profit of shop i becomes

$$\pi_{it} = (p_{it} - c_i) q_{it} N_t \quad (3)$$

⁷ See again Appendix 8.1 for a derivation of these results. With second degree price discrimination, i.e. when shops cannot identify groups, a similar result would hold. Indeed, with quantity discounts sellers would be similarly able to have consumers in the two groups paying different unitary prices.

where

$$q_{it} = q_i^E \frac{N_t^E}{N_t} + q_i^I \frac{N_t^I}{N_t}$$

is the demand expressed by a fictitious *average-consumer* in the population, for a price p_{it} , given the rivals' prices and the proportions of the two groups of consumers at time t . The firm then sets a price p_{it} which maximizes the average-consumer profit (3). Clearly, any change in the total number of consumers N_t that leaves unaffected the proportions of the two types of consumers N_t^E/N_t and N_t^I/N_t , would have again no effect on the optimal price since the demand of the average-consumer q_{it} would be unchanged and N_t is simply a multiplier in (3). On the other hand, any shock to N_t that also increases the fraction N_t^I/N_t of inelastic consumers induces an increase of the profit maximizing price p_{it} . This is formally shown in the Appendix 8.2, but the intuition is straightforward: when the proportion of inelastic consumers is larger, the average consumer is “more similar” to the inelastic one and the optimal price is then higher for this relatively less price-sensitive average consumer. In the limit, if the inelastic consumers make up for the entire population, then the optimal price simply becomes $p_{it} = p_i^{*I}$.

Since Varian (1980), it is well known that when price discrimination is impossible and shops' products are sufficiently substitutable, the presence of groups of consumers characterized by different price elasticities may induce firms to rely on mixed strategies so that a unique and deterministic price, as in our previous analysis of the average-consumer, fails to be an equilibrium. To see this, consider the extreme but simple case of unitary demand (i.e. $q_i^j \in \{0, 1\}$). Also assume, for simplicity, that consumers I are completely uninformed about the prices available in the market. Thus they simply randomize their choice about where to buy, so that the demand for shop i that originates from one of these consumers is $q_i^I = 1/S$ (which is the probability of being randomly chosen by the consumer) and the price elasticity η_i^I is zero. Consumers E instead are fully informed and each of them always buys at the shop with the lowest price since products are highly substitutable. Therefore, $q_i^E = \Pr(p_{it} < \min_{j \neq i} \{p_{jt}\})$, which is the probability that shop i charges the lowest price in the market, and the demand of these consumers is very elastic. For any price p_{it} , the profit function of shop i still writes as in (3), with these specific demands for the two types of consumers. In this environment, which we illustrate with more details in the Appendix 8.2, it is not optimal for any shop i to charge a unique price because shops confront themselves with two contrasting goals. On the one hand, they want to extract surplus from the price insensitive consumers and this surplus-appropriation effect calls for a higher price. On the other hand, they want to attract the informed consumers and this business-stealing effect calls instead for a lower price. It is only by means of mixed strategies that shops are able to balance these opposed goals, requiring to charge “sometimes” low prices but also high prices. The econometrician would then observe price variability across shops (and across

time) and an *average market price* p_t at time t . In this environment, an increase of N_t^I/N_t shifts the incentives towards the surplus-appropriation effect and thus induces a different equilibrium mixed strategy with high prices being employed with higher probability. More formally, an increase in the fraction of inelastic consumers induces a first order stochastic dominant transformation of the equilibrium price distribution, thus increasing the average price.⁸ When instead N_t changes, but the proportion of inelastic and elastic consumers remain unaffected, a simple inspection of the profit function (3) for any price p_{it} shows that the trade off between business-stealing and surplus-appropriation is unchanged so that the equilibrium (average) price observed by the econometrician is unaffected.

Summarizing, for the purposes of this study, we can claim that, independently of the specific pricing strategy, the following remark holds as for the observed average price p_t .

Remark 1 *Changes in the population of consumers may generate a scale and a composition effect:*

- (i) **Scale:** *Any change in the number of consumers N_t that preserves the same composition in the population among inelastic and elastic consumers (i.e. keeps constant N_t^I/N_t and N_t^E/N_t) leaves unaffected the average price p_t observed in the market.*
- (ii) **Composition:** *An increase in the proportion of inelastic consumers N_t^I/N_t induces an increase in the average price p_t in the market at date t .*

We will show in our empirical analysis that this remark matches the evidence that we observe. It is also important to note the following implication of this remark, which is relevant in our context: if I consumers (or at least some of them) effectively become E consumers after some time, i.e. at a future date $t' > t$, and nothing else changes, the wave of these consumers will induce a reduction of $N_{t'}^I/N_{t'}$, which in turn will determine a reduction of the average price $p_{t'}$. It is also worth noticing that if the population is homogeneous, for example there are only type E consumers, then clearly any change of N_t would leave prices unaffected.

We are also interested in studying how the composition effect derived above is affected by the presence of more sellers in the market, and in particular whether the expected price increase due to relatively more inelastic consumers is mitigated when the number of shops S is large. In all the environments illustrated above it is possible to derive the following:

⁸To avoid complications here we do not explicitly consider the possibility that uninformed consumers search for better deals. Although search protocols may differ being sequential or simultaneous, it has been shown that in any case an exogenous increase of the proportion of less informed consumers has a monotone and positive effect on the average price. See Baye, Morgan, and Scholten (2006) among others.

Remark 2 *The average price increase induced by the arrival of more inelastic consumers in the market (composition effect) is mitigated by competition, i.e. by a larger number of sellers S .*

We refer to Appendix 8 for a formal illustration of this remark with the three pricing strategies discussed above. As for the intuition, a larger number of sellers limits their willingness to increase surplus extraction from a larger number of newborns' parents because the risk of losing the more elastic among them in favor of competitors increases.

Finally, we postpone to Section 6 a discussion of the effect of the number of shops S on the price level. This topic has been extensively studied and we are less interested in it given that the focus of this paper is on the effect of changes in the composition of buyers in a market and on the interaction between these compositional changes and the number of sellers.

Before moving to the empirical analysis we need to consider and dismiss the possibility of a more conventional explanation for the effect of a demand shock on prices.

2.2 Non-constant marginal costs

If marginal costs are increasing in sold quantities, then a larger number of consumers N_t trivially implies an upward pressure on prices, independently of any composition of demand. The marginal costs of shops may be increasing (i) if the wholesale contracts with their suppliers are characterized by increasing wholesale prices (i.e. quantity premia), (ii) if there are capacity constraints so that shops risk of running out of stock, and (iii) if it is proportionally more costly to serve more consumers in the shop due to congestion and queuing (having people queuing in the shop may discourage future visits of more profitable consumers).

In the next Sections we will illustrate that none of these possibilities is present in the type of shops and for the type of products we are considering in our empirical analysis. Anticipating briefly our evidence, as for (i) we will show that wholesale contracts for pharmacists involve quantity discounts which should induce decreasing marginal costs, if anything. Concerning (ii), wholesalers promptly supply pharmacies more than once in a day and at no additional cost so that capacity constraints are very unlikely in our environment.⁹ Finally, as for (iii), we will show that the change in demand, generated by the increase of new inelastic consumers that we observe, is definitely too small to imply any significant congestion and queuing in pharmacies.

⁹Furthermore, in a model with informed (elastic) and uninformed (inelastic) consumers as in Varian (1980), Lester (2012) has shown that capacity constraints may actually deliver the opposite implication: an increase of the number of consumers N_t reduces the observed average price.

3 The data and the empirical strategy

We use information on a large sample of Italian pharmacies collected by “Pharma” (the name is fictitious for confidentiality reasons), a consultancy company for pharmacies and pharmaceutical firms. With the consent of its clients, we were given access to the details of every item sold by each pharmacy in the Pharma database for the period from January 2007 to December 2010. The dataset originates from each single sale receipt. During the period under study, Pharma collected data from 3,331 Italian pharmacies, corresponding to 18.6% of the universe of pharmacies in Italy. For 60% of them, we have complete information for the entire period; for 28.7% we have information starting from January 2009; and for the remaining 11.26% data is available only for the period January 2007-December 2008. The pharmacies in the Pharma database are located in almost all the Italian regions (with the exception of Basilicata), but their concentration is higher in the North since the company is located near Milan.¹⁰

Our goal is to use this dataset to test the theoretical predictions of Section 2, summarized in Remarks 1 and 2, concerning how, in a market, prices (and quantities) are affected by a demand shock deriving from a change in the fraction of new and inelastic consumers. We argue that a measure of this kind of shock for a subset of products sold by these pharmacies is represented by changes at the monthly frequency of the number of newborns in the neighborhood where a pharmacy is located.¹¹ Monthly data on newborns are obtained at the city level from the National Statistical Office (ISTAT). The left panel of Figure 1 plots the temporal evolution of the number of newborns in the cities where the pharmacies of the Pharma sample operate. There is a significant seasonality in newborns: the most relevant peaks are typically in the summer, while the lowest levels are more frequent in the winter. The right panel of the Figure plots the residuals of a regression of (log) newborns on city fixed effects. These residuals show a substantial within-city and over time variability in the number of newborns.

Ideally we would like to measure the monthly number of newborns in some neighborhood of each pharmacy, but we can only measure it at the level of a city. Therefore in the empirical analysis we aggregate all the pharmacies of the Pharma data set in each municipality and consider as a unit of observation the average price and the average quantity of these pharmacies in each city. Every city will thus be a market like the one described in Section

¹⁰Specifically 19% of these pharmacies are in the north east of Italy, 45% in the north west, 9% in the center, 16% in the south and 11% in the islands.

¹¹In principle, we would have liked to access data on the number of *first babies* born in each couple of a city. But the only available data are for *all newborns* in a city. We think that, for the reasons mentioned in the Introduction, parents may be less elastic than other customers even for babies born after the first child. In any case, this feature of our data should, if anything, lead us to underestimate the true size of the effects predicted by the theory.

2. Note that unfortunately we do not observe the quantity and the price of the pharmacies that, within each city, are not in the Pharma sample. This drawback of our dataset is in principle problematic, but we will report results restricted to cities in which we observe all the existing pharmacies (i.e. cities in which Pharma has a full market coverage), to show that all our tests of the theoretical predictions remain unaffected.

We select child hygiene products as the ones for which changes in newborns may be considered as a proxy of exogenous demand shocks originating from variations in the composition of elastic and inelastic consumers in the market. For this reason we focus on a set of 2925 hygiene products that are used for children immediately *after* birth and then extensively during the first years of their life. This set includes items (of different brands) like: bath foams and shampoos for babies; cleansers for babies; cold and barrier creams and oils for babies; baby wipes; talcum and other after-bath products for babies. Table 1 describes a sample of items in this basket: the upper panel shows the five products sold in largest quantity during the period 2007-2010, while the lower panel shows the ones that featured the highest unit price over the same period. For each item, we have the quantity sold by each pharmacy in each month and the price charged (in Euros).¹²

Parents of newborns are buyers of these products who, like type *I* consumers of the theoretical models described in Section 2, have a higher (opportunity) cost of search, because they are time-constrained, and are relatively inexperienced about the new market in which they just entered. If they were the only buyers of these products, theory suggests that an inflow of newborns would just produce a Scale Effect (see Remark 1) with no consequences on the price level. But there are other interested buyers of these products as well: for example, sportsmen are heavy users of ointments for child skin protection, while shampoos, bath foams, and barrier creams for children are used by adults as well. These buyers are the empirical counterpart of the type *E* consumers described in the theoretical models of the previous section. Moreover, with the passage of time, newborn parents themselves may become less time-constrained and more experienced, joining the stock of other buyers.

To show that both types of buyers indeed exist for these products and therefore that their market is suitable to test the predictions described in Remarks 1 and 2, we regress the total number of units sold in each city by the pharmacies under study, on the number of newborns and on time and city fixed effects.¹³ The stock of elastic buyers of child hygiene products *who*

¹²For items that have not been sold for an entire month, the price imputed is the price of the first subsequent transaction for the same item observed for the same pharmacy in a subsequent month. When the sold quantity is positive, instead, the monthly price is the weighted average of the (possibly) different prices actually charged over the month, with weights equal to the number of items sold at each price level.

¹³In the econometric analysis we will construct Laspeyres quantity and price indexes for the basket of goods in which we are interested, but for the purpose of assessing whether these goods are demanded by other customers beyond newborns, we can focus now on the actual total number of “boxes” sold in a month for each item.

have nothing to do with newborns is thus modeled as a specific characteristic of each city and month of the year, that can be captured, up to a random component, by city and time fixed effects. This regression allows us to decompose the variability of the number of sold boxes in the part attributable to newborns (plus time and city effects to be conservative) and the residual part that can be attributed to other customers. This decomposition indicates that 88% of the variability in the number of boxes sold from month to month is not generated by newborns' variation.¹⁴

For the econometric analysis we aggregate the products described above into a single basket and thus construct corresponding Laspeyres indexes of prices and quantities. Denoting with $h \in 1, \dots, H$ each product in a basket, and with p_{ith} , q_{ith} respectively the price and the quantity at pharmacy i at month t for product h , the price and quantity indexes (hereafter, price and quantity) for pharmacy i in month t are defined by:

$$p_{it} = \frac{\sum_h p_{ith} \bar{q}_h}{\sum_h \bar{p}_h \bar{q}_h} \quad (4)$$

$$q_{it} = \frac{\sum_h \bar{p}_h q_{ith}}{\sum_h \bar{p}_h \bar{q}_h} \quad (5)$$

where \bar{q}_h and \bar{p}_h are the quantity and the price for product h , respectively sold and charged on average by all pharmacies in all months. In other words, p_{it} is the weighted average price charged by pharmacy i in month t for the entire basket, where the weights are based on the quantities of each item sold on average in the entire market over all months. So this price index is independent of the quantities sold by pharmacy i and changes over time (and with respect to any pharmacy j) if and only if the price of at least one item changes in pharmacy i (or j). In particular, it is important to note that if a change in the composition of the population induces the pharmacists to sell relatively more expensive product h' instead of a less expensive one h (because, for example, parents of newborns are more exigent consumers and prefer a more expensive brand h'), this substitution would leave the price index p_{it} unaffected, as long as the pharmacists keep the prices of the two products unchanged. In this example, it is only when p_{iht} and $p_{ih't}$ change over time that we can observe a variation in the price index.

Similarly, the quantity index q_{it} is the weighted average quantity sold by pharmacy i in month t for the entire basket, where the weights are based on the prices of each item charged on average in the entire market over all months. So also this quantity index is independent of the prices charged by pharmacy i and changes over time (and with respect to any pharmacy j) if and only if the quantity of at least one item changes in pharmacy i (or j).

As explained above, since newborns are measured at the city level, the price and quantity indexes p_{it} and q_{it} , constructed for each basket of products observed at time t in pharmacy

¹⁴For the quantity index described below, the correspondent percentage is 85%.

i , have to be averaged over the pharmacies in each city c , thus finally obtaining a price p_{ct} and a quantity q_{ct} observed in city c at time t .

The temporal evolutions of the two indexes (averaged over cities) for the basket of hygiene products in the pharmacies of the Pharma dataset, are plotted in the left panels of Figure 2. Quantities are characterized by seasonality (with the most relevant peaks during the summer) and by a weak downward trend. Conversely, prices are characterized by a more robust upward trend.¹⁵ Our empirical strategy exploits within city and across time variability of both these variables. The right panels plot the residuals of a regression of (log) quantity and (log) price on city fixed effects. These residuals show that both the quantity and the price change substantially over time at the intra-pharmacy level. Although the intra-pharmacy variability of the quantity index is larger, there is substantial variability also in the price index.

We are also interested in the effects of changes in the degree of competition between sellers for the market under study. To study these effects we need an exogenous source of variation in the number of pharmacies. Here, we will exploit the rules that regulate the Italian pharmacy market. In Italy, entry in and exit from this market are regulated by the Law 475/1968. This Law establishes (as in many other countries) the so-called “demographic criterion” to define the number of pharmacies authorized to operate in each city. Specifically, the law generates a set of population thresholds at which the number of existing pharmacies that should operate in a city changes discontinuously. Leaving the details to Section 5, for our purposes this law generates a Regression Discontinuity design that allows for the possibility to estimate the causal effect of a change in the number of competing pharmacies at each threshold.

Descriptive statistics for the variables used in the econometric analyses are displayed in Table 2.

4 Effects of changes in the proportion of inelastic consumers in a market

We exploit the data described in the previous Section to estimate, with different empirical models, the parameters of the following linear regression, which allows us to test the predictions of the theory:

$$p_{ct} = \alpha + \beta S_c + \delta N_{ct}^I + \Lambda(N_{ct-\tau}^I) + \phi_c + \mu_t + \varepsilon_{ct} \quad (6)$$

¹⁵However, note that, over the same period, the Italian Consumer Price Index has increased more than the price index of the hygiene products considered in this study. The weakly decreasing trend in quantities and in real prices of our basket of products may be the result of the ongoing deep recession, with more wealth-constrained consumers purchasing products in less expensive supermarkets.

where $c \in \{1, \dots, C\}$ denotes cities and $t \in \{1, \dots, T\}$ denotes months. p_{ct} is the (log) price index charged by the S_c pharmacies in city c at time t . N_{ct}^I is the (log) number of newborns in city c at time t . $\Lambda(N_{ct-\tau}^I)$ is a (first order) polynomial in the lags of the number of newborns. ϕ_c and μ_t are city and month fixed-effects which capture relevant characteristics of city markets, like the distance between pharmacies, or of calendar months, like seasonal effects.

Our identifying assumption requires that the city and time fixed effects capture, up to a random component, the (log) number of elastic consumers N_{ct}^E , for the part of this number that is independent of newborn parents. But the stock of elastic consumers may change also because parents, with the passage of time from delivery, become increasingly more elastic and may ultimately join the stock itself. This is captured by the polynomial in the lags of the number of newborns. Therefore, by measuring the effect of N_{ct}^I controlling for $\Lambda(N_{ct-\tau}^I)$, ϕ_c and μ_t we are effectively measuring the composition effect described in Remark 1 allowing for the possibility that, after some time, the parents of newborns exit the group of inelastic consumers. Finally, ε_{ct} is an error term, which is allowed to display heteroskedasticity and serial correlation at the city level. This, however, is not a threat for our identification strategy, since it does not affect the randomness of the number of newborns N_{ct}^I and of its lags.

The Appendix 8.1 shows how the parameters β and δ in equation (6) can be interpreted in terms the conduct parameters and elasticities of Graddy (1995) model, if price discrimination could be assumed to prevail in this market.

4.1 The elasticity of price to the proportion of inelastic consumer

We first exploit within-city variation of newborns for the estimation of the following standard fixed-effect model:

$$p_{ct} = \alpha + \delta N_{ct}^I + \Lambda(N_{ct-\tau}^I) + h_c + \mu_t + \varepsilon_{ct} \quad (7)$$

where, given equation (6), $h_c = \beta S_c + \phi_c$. Note that if our identifying assumptions are valid, N_{ct}^I is randomly assigned conditioning on city and time fixed effects. Thus, the parameter δ , that captures the *composition effect* derived in Part (ii) of Remark 1 in Section 2.1, can be interpreted as a causal parameter and its OLS estimate is consistent. Similarly, the coefficients of the polynomial in the lags of the number of newborns, $\Lambda(N_{ct-\tau}^I)$, measure the extent to which the *composition effect* fades away with time, while newborns' parents exit the group of inelastic consumers becoming less time-constrained and possibly more experienced buyers. It is worth noting that since the child hygiene products in our main basket are purchased by other customers as well and we have no measures of how many they are, we will not be able to test Part (i) of Remark 1 (Scale effect), according to which a change in the *size* of the population should have no effect on prices. In one of our robustness

checks, we will, nevertheless, be able to find supporting evidence for the scale effect as well, by restricting the analysis to the night and Sunday environment in which all buyers are presumably homogeneously more inelastic.

Table 3 reports estimates of equation (7). Let's first assume that marginal costs are constant or decreasing. Under this assumption, if parents of newborns are less elastic than other consumers we expect a positive estimate for δ . If instead, newborns' parents are as elastic as other consumers, the effect on price should be nil (or negative in case of decreasing marginal costs). Thus, a positive parameter δ should signal the presence of less elastic consumers and measure the associated *composition effect* discussed in our theoretical analysis (see Part (ii) of Remark 1).

The first row of Table 3 reports estimates of δ that are positive and highly significant. In the first column the entire sample is considered, while in the second column the estimate is based on the restricted sample of cities in which Pharma has full coverage. Since the estimates in the first column may be confounded by the fact that we do not observe the pharmacies not covered by the Pharma dataset, it is reassuring to see that results are essentially unchanged (actually, if anything larger) in the second column.

To help the interpretation of their size, we have standardized coefficients and standard errors by the standard deviation of the correspondent variable. The estimate in the first row and first column, for example, indicates that a one standard deviation increase in newborns causes an increase of 6.4% of a standard deviation of the equilibrium price. This indicates that when pharmacists note a (standard) increase in the number of newborns in a given month, the average price at which they sell in that month increases substantially and, as explained in Section 2, this effect realizes independently of the pharmacists' ability to price discriminate and to play pure or mixed strategies.¹⁶

The remaining rows of Table 3 report estimates for the first 11 monthly lags of the number of newborns. The regression actually includes all the 23 lags for which we have information in our dataset (see Section 3)¹⁷, but only the first 10 lags (except the second one) are statistically different from zero. The 11th (reported in the last row of the Table) and all the remaining ones (not reported to save on space) are statistically insignificant. The estimated coefficients do not decline monotonically, as one would have expected if they captured only the learning process of parents, but it should be noted that the differences

¹⁶In the presence of price discrimination, the effect that we estimate does not have to originate from the fact that pharmacists charge a higher list price to the parents of newborns. It may in fact be that they offer discounts with respect to the list price to more experienced and thus less loyal consumers. Also in this second case an increase in the fraction of newborn parents would generate an increase in the average price observed by the econometrician.

¹⁷Note that the inclusion of these lags does not imply a loss of observations, because the data on newborns extend in the past for 23 months before the moment in which we start to observe the data on pharmacies in the Pharma dataset.

between them are not statistically significant. Indeed they may also capture serial correlation in monthly birth rates.¹⁸ In any case, although we do not know exactly if, how and when parents of newborns exit the pool of the less elastic consumers, these estimates indicate that they remain relatively less elastic than experienced buyers for almost one year after delivery.

4.2 Evidence on marginal costs, placebo tests and robustness checks

Before concluding that the estimates of δ in Table 3 are positive because the parents of newborns are relatively inelastic consumers, it is necessary to dismiss the possibility that this finding is driven instead by the alternative potential interpretations discussed in Section 2.2. A positive estimate of δ could be the consequence of increasing marginal costs even if all customers were equally and fully informed. In this section we first present three pieces of evidence that exclude this possibility and, later on, we will provide corroborating evidence based on “placebo tests” and robustness checks.

First, it may be marginally more costly for a pharmacy to sell larger quantities if wholesalers charged higher prices for larger orders, in which case an increase in newborns may obviously translate into higher prices for consumers. The evidence, however, points in the opposite direction. From “InfoSystem” (fictitious name for confidentiality reasons), a software house specialized in managing information systems for pharmacies in Italy, we obtained the pricing schedule adopted by a large Italian wholesaler serving all pharmacies in the Center-North part of Italy during the period 2010-2011. This wholesaler sells 727 child hygiene products (24.8% of our basket) to pharmacies. For none of them the wholesale unitary price schedule, as a function of quantity, is increasing. Figure 3 shows the unitary price charged by the wholesaler for different quantities of the four main categories of child hygiene products (bath foam and shampoo, after bath products, barrier creams, wipes). What emerges is a clear decreasing pattern with quantity discounts supporting the theoretical assumption of non-increasing marginal costs. If anything, the presence of these quantity discounts should have reduced the composition effect that we document in Table 3.

Second, by contractual arrangements pharmacies can receive supplies from wholesalers more than once a day (at no additional costs) and, depending on their actual needs, with a simple phone call they can request additional refurbishment in a couple of hours. Hence, there is no effective shortage of inventories that might be binding for more than few hours.

Finally, we can also exclude that problems of congestion and queuing, caused by the increase of newborns, indirectly raise pharmacies’ marginal costs. If the increase of newborns has the potential to generate a queue of hurried parents in the pharmacy and if expected revenues from them are lower than the ones that can be expected from other consumers

¹⁸As suggested by the so called “Carnival effect”, if, in the absence of migration, most women in a city have a baby in a given month, the number of newborns must be lower in the immediately following months.

(of any product), the pharmacist may react by increasing prices on child hygiene products in order to reduce the undesired queue of newborns' parent. This possibility is extremely unlikely in our environment because child hygiene products represent on average a tiny percentage of the monthly transactions of a pharmacy: evidence from till receipts issued by the pharmacies in our sample show that those containing at least one child hygiene product are on average less than 2.2% of all monthly till receipts (i.e. around 130 over a total monthly average of 5,800). A 100% increase in monthly sales of child hygiene products would thus yield an increase of around 2.2% of total demand, which would not be enough to generate substantial queuing in the pharmacy.

We have performed a number of “placebo tests” as well to support our interpretation of the estimates of δ in Table 3. We do not report figures and tables for these results to save on space but they are available from the authors.

First, an increase in newborns should of course be irrelevant for the demand of products that are not consumed by newborn themselves. To verify that this is the case, we focus on a set of 308 personal hygiene products that are used by adult women (i.e. special washing products, sanitizing wipes and hygiene deodorants) and 2050 different types of deodorants. When we use these two different baskets of items typically demanded by adults for themselves, we see no effect on the observed price in conjunction with an increase of newborns.

In a similar vein, we have considered diapers for 4 months onward babies and performed the analysis of regression (7) considering only this particular type of product. We have verified that, as expected, the coefficients of N_{ct} and the first two lags, are not significantly different from zero, in this case because almost none of the parents of these newborns purchases diapers for older ages. Further lags are instead positive and significant, because of the composition effect predicted by the theory.

As an additional placebo test, we have estimated equation (7) including leads in the number of newborns instead of lags, and, as it should be, we find that future inflows of newborns parents in the market have no effect on the current price level.

Several robustness checks have also been useful to convince us about the validity of our results and interpretations. First, restricting the analysis to diapers for zero-to-three months old babies, which are bought only by newborn parents, we have been able to measure more precisely the *fraction* of inelastic consumers, without having to rely on lags, city and time fixed effects to control for the unknown number of elastic buyers. Consider the market of these small diapers in which, without much loss of generality, it is reasonable to assume that the weight of newborns can evolve in two ways: *normal*, in which case babies move to larger diapers after the third month from birth, or *low* in which case they continue to need small diapers for three more month after the third one from birth. In each cohort, the fraction

with low weight is α .¹⁹ Therefore, in any month t , the population of buyers of small diapers is composed by all the parents with babies less-than-three months old, which we denote with N_τ , and by the parents of low weight babies in the older relevant cohorts, which we denote as $\alpha N_{\tau-1}$.

Consumers of small diapers are not all equally elastic. More specifically, we further assume that in each cohort a fraction β^{nor} of normal weight babies has parents who are (relatively) inelastic, while the same happens for a fraction β^{low} of the low weight babies. Since low weight babies include premature babies who might be more in need of medical care and pharmaceutical products, their parents will need to visit pharmacies more often and will probably buy diapers from the pharmacist even if they may be cheaper elsewhere. We therefore assume that in this group the fraction of inelastic parents is larger, so that $\beta^{low} > \beta^{nor}$. To simplify notation and without loss of generality we normalize $\beta^{nor} = 0$ and redefine $\beta = \beta^{low} > 0$.

Given the above assumptions, the fraction of inelastic consumers of small diapers is

$$\frac{\beta \alpha N_\tau + \beta \alpha N_{\tau-1}}{N_\tau + \alpha N_{\tau-1}} \quad (8)$$

which, for this specific market, corresponds to the fraction N_t^I/N_t of the general model illustrated in Section 2. Testable predictions, based on the results of the general model applied to the context of small diapers, can be derived from the analysis of how this fraction of inelastic buyers changes when N_τ and $N_{\tau-1}$ are exogenously shocked by the monthly inflows of newborns. It is easy to check that the effect of $N_{\tau-1}$ on the fraction of inelastic buyers is larger than the effect of N_τ , so that the following difference between derivatives, allowing for a slight abuse of notation, is positive:

$$\frac{\partial(N_t^I/N_t)}{\partial N_{\tau-1}} - \frac{\partial(N_t^I/N_t)}{\partial N_\tau} = \frac{\alpha(1-\alpha)\beta}{(N_\tau + \alpha N_{\tau-1})^2}(N_\tau + N_{\tau-1}) \geq 0. \quad (9)$$

The intuition for this result is that the fraction of parents of older babies who still purchase small diapers is composed by relatively more inelastic buyers than with “regular” consumers. Now, recalling from the general model of Section 2 that

$$\frac{\partial p_t}{\partial \frac{N_t^I}{N_t}} \geq 0, \quad (10)$$

we can evaluate the difference between the effects of $N_{\tau-1}$ and N_τ on the average price p_t of small diapers observed in month t , obtaining that:

$$\frac{\partial p_t}{\partial N_{\tau-1}} - \frac{\partial p_t}{\partial N_\tau} \geq 0. \quad (11)$$

¹⁹The most recent estimate of premature and underweight babies in Italy is 11% of newborns which is non negligible and it is most probably an underestimate of our α .

This prediction is verified in the data, as shown by the estimates of the following modified version of equation (7), for the restricted market of small diapers:

$$p_{ct} = \underset{[0.002]}{0.0028}N_{\tau} + \underset{[0.002]}{0.0044}N_{\tau-1} - \underset{[0.0008]}{0.0008}N_{\tau} \times N_{\tau-1} + \phi_c + \mu_t + \varepsilon_{ct} \quad (12)$$

where p_{ct} is now the average price of zero-to-three months diapers, observed in city c at time t . Based on these estimates we test the null hypothesis that $\frac{\partial p_{ct}}{\partial N_{\tau-1}} - \frac{\partial p_{ct}}{\partial N_{\tau}} = 0$ versus the one sided alternative that $\frac{\partial p_{ct}}{\partial N_{\tau-1}} - \frac{\partial p_{ct}}{\partial N_{\tau}} > 0$ and the null is rejected with a p-value of 0.002.²⁰ The analysis for this specific product further confirms the composition effect which here refers to a change in heterogeneity *within* the population of parents of newborns.

As a second robustness check, we exploited the fact that pharmacies are also available at night and on Sunday (in Italy according to a predetermined plan of regulated opening hours and rotation among pharmacies over the month) for any product they may sell during regular opening hours. Since we expect that at night/Sunday time only very pressed customers may want to buy child hygiene products, the population of these customers should be very homogeneous and price inelastic. Indeed, consistently with this expectation, the average night/Sunday price for the basket of hygiene products that we consider is 2.3% higher than the working-day regular price, although this may be also due to the increased market power of the fewer pharmacies open at night. Moreover, this night/Sunday environment with relatively homogeneous consumers allows us to test the Scale effect in Remark (i), because an increase in demand originating from newborn parents should leave unaffected the composition of night/Sunday buyers, who are presumably all inelastic. We have, therefore, repeated our previous analysis estimating equation (7) on the restricted dataset originating from purchases that occurred during the night (i.e. between 7:30 p.m. and 8:30 a.m.) or on Sundays. Indeed, we find no effect of N_{ct}^I (and lags) on night/Sunday prices. Although we must acknowledge that estimates are imprecise in this case since we can identify the hour and week-day of the transaction only in a limited set of pharmacies (860 pharmacies, belonging to 585 cities) and only for year 2010, this finding is consistent with our theoretical predictions.²¹

As a final set of robustness checks, we augmented equation (7) in various ways to capture non-linearities and some specific forms of confounding factors. First, we have allowed for different effects of the number of newborns in cities with low or high newborns' number variability over time, finding a larger composition effects in cities where variability is higher.²² It is reasonable to expect such result if pharmacists follow pure or mixed pricing strategies,

²⁰The correspondent p-value for the two sided test is 0.004.

²¹Anticipating the analysis of the next Section, we also notice that the increased market power at night should have strengthened the composition effect (Remark 2). On the contrary, homogeneity of night buyers and the associated scale effect instead explain the negligible effect of newborns on night price that we observe.

²²Cities were classified as having high variability if their (log) variance of the number of newborns was larger than the median log variance.

because in these cases only when the variability of newborns is large price adjustments are likely to be worthwhile for the seller. In the case of price discrimination, instead, the average price increase would be the result of a change in the proportion of the two types of customers even if sellers do not change prices. In this case, the above finding would be due to the fact that higher variability is associated with larger compositional changes.

Then, we have considered the possibility of *city specific time varying events* (e.g., the closure or opening of a new firm in a small city), that we have been trying to capture with city specific linear time trends. When all cities are considered, estimates of the composition effect are still positive but insignificant. They maintain instead their sign, size and statistical significance when we restrict the analysis to the cities in which we have full coverage of pharmacies in the Pharma dataset. The lack of significance in the first case is arguably due to the fact that our model can deliver more precise estimates where we observe all relevant prices in a city.

Given the above discussion of alternative explanations, placebo tests and robustness checks, we can conclude with sufficient confidence that the positive effect of the number of newborns on prices, estimated in Table 3, is evidence of parents of newborns being different with respect to standard consumers. In particular, since they face a higher opportunity cost of searching for better deals and/or are less informed and experienced, they are overall relatively less elastic than other consumers of child hygiene products. Pharmacies are therefore capable to exploit the limited ability of newborn parents to substitute with cheaper suppliers. We can now explore whether this capacity to extract surplus from less elastic consumers changes according to different levels of competition faced by pharmacies in this market.

Before doing so a word should be said concerning quantities. As explained in Section 2 we expect that an increase in the number of newborns raises the quantity sold by pharmacies. This result, however, is less interesting from the viewpoint of this paper because it does not contain specific information concerning the capacity of firms to extract surplus from inelastic consumers, which is our main focus. It is nevertheless reassuring to see that this expectation is confirmed by our evidence. We do not report results in tables to save on space, but our evidence indicates that a standard deviation increase in (log) newborns causes an increase of almost 6% of a standard deviation of the (log) quantity. Also in the case of quantities results are confirmed when the analysis is restricted to cities in which Pharma has full coverage of the existing pharmacies.

5 Can competition limit the capacity of pharmacies to extract surplus from inelastic consumers?

As previously discussed, entry and exit in the pharmacy market is regulated in Italy by law 475/1968 which establishes how many pharmacies should operate in a city as a function of the existing population. Below 7500 inhabitants there should be only one pharmacy. From 7500 to 12500 there should be two pharmacies. Above this threshold a new pharmacy should be added every 4000 inhabitants. Compliance with this theoretical rule is however imperfect for at least two reasons. First, cities that are composed by differentiated and land locked geographical areas with difficult transport connections (e.g. because of mountain ridges or rivers), are allowed to have more pharmacies than what would be implied by the demographic rule. Second, the evidence suggests that it is easier to open a pharmacy than to close one, probably because of the difficulty of “deciding” who should exit the market when pharmacies are too many (the law being silent on this issue). In some rare occasions market forces induce the bankruptcy of the weakest pharmacy in a city in which demand is no longer sufficient to sustain positive profits for all the existing ones. But otherwise, the evidence suggests that, given the rents that a pharmacy probably grants to its owners in a highly regulated market like the Italian one, new sellers enter immediately whenever possible, but very few later exit if and when the city population declines.

This historical asymmetry in the likelihood that pharmacies are opened or closed generates, nevertheless, an exogenous source of variation in the current number of pharmacies based not on the current population but on the population peak reached since 1971.²³ Consider the threshold of 7,500 inhabitants at which the number of existing pharmacies should theoretically increase from 1 to 2, according to the law. The left panel of Figure 4 shows local polynomial smoothing (LPS) regression estimates of the number of pharmacies as a function of the current city population, together with the 95% confidence intervals.²⁴ No discontinuity in the number of competitors can be appreciated. The right panel of the same Figure shows instead analogous LPS regression estimates of the number of pharmacies against the maximum level reached by the city population since 1971. Here the discontinuity is large and statistically significant.

As it can be seen, there are cities in which the population never went above 7500 units since 1971 and nevertheless have more than one pharmacy for the already mentioned historical or geographic reasons. Similarly, on the right of the threshold, the average number of pharmacies is larger than two, more than what the law would prescribe. But even in the

²³The 1971 Census is the first reliable population measure at the city level after the date of enactment of Law 475/1968.

²⁴For municipalities in which pharmacies are observed in our dataset since January 2007, current population is measured at December 31, 2006; for municipalities in which pharmacies are observed since January 2009, current population is measured at December 31, 2008.

presence of this generalized “upward non-compliance”, a significant discontinuity of approximately half a pharmacy emerges at the threshold.

Table 4 reports estimates of the equation

$$S_c = \omega + \varphi K_c + g(|Pop_c - \kappa|) + \zeta_c \quad (13)$$

where c denotes a city, S_c is the number of pharmacies in a city; Pop_c is the maximum historical population in a city; $K_c = 1(Pop_c \geq \kappa)$ is a dummy taking value 1 for cities on the right hand side of the k -threshold. The parameter φ in this equation measures the discontinuity at the threshold. Independently of the specification of the polynomial $g(\cdot)$, the first panel of Table 4 confirms the visual impression of Figure 4, suggesting an even larger discontinuity at the threshold (we report local linear and polynomial regressions for different population windows around the threshold, from $\pm 1,500$ to $\pm 4,000$ inhabitants). The same happens in Panel B of the same Table in which the analysis is restricted to the cities with a 100% Pharma coverage and in Panel C where observable controls are included in the specification to improve efficiency.²⁵

At higher thresholds, involving larger cities with more pharmacies, even the compliance with the rule based on the population peak is more blurred, so that we are forced to use only the first threshold of 7500 units for our analysis. This however is enough to test in a clean way the theoretical predictions concerning the effects of competition in this market (Remark 2).²⁶

Having shown that the number of pharmacies effectively changes discontinuously at this threshold, we now have to provide evidence supporting the identifying assumption for a Regression Discontinuity (RD) design, requiring that nothing else relevant changes discontinuously at the same threshold. Figure 5 shows the LPS regressions of four observable “pre-treatment” factors on the maximum historical population since 1971: the average monthly number of newborns, a dummy taking value 1 if the city is in a urban area, a dummy taking value 1 if the city is in Northern Italy and per capita disposable income (measured in 2008) at the city level. For none of these variables a quantitatively or statistically significant discontinuity should be observed at the threshold and this is precisely the evidence emerging from the figure.²⁷ Nonetheless, in some empirical specifications we include these variables as regressors to increase efficiency.

²⁵ The included controls are: the average monthly number of newborns, a dummy taking value 1 if the city is in a urban area, a dummy taking value 1 if the city is in Northern Italy, and per capita disposable income at the city level.

²⁶ It would instead not be enough for a complete policy design since we only have insights concerning changes from approximately 1 to approximately 2 pharmacies in relatively small cities.

²⁷ We have also tested the existence of a discontinuity at the threshold for these variables using local linear and polynomial regressions for different windows around the threshold (as suggested by Imbens and Lemieux (2008)). Results uniformly fail to identify any significant discontinuity. Additional covariates for which the unconfoundedness hypothesis has been tested include the population growth rate since 1971, per capita consumption, per capita expenditure on pharmaceuticals, the number of convenience-stores allowed

A crucial assumption for the validity of a fuzzy RD approach is that the assignment rule has a monotone effect on the treatment variable (see Imbens and Lemieux (2008)). We provide evidence in favor of monotonicity with the test developed by Angrist, Graddy, and Imbens (2000). Figure 6 plots the cumulative distribution function of the number of pharmacies (our treatment variable) for the two groups defined by our instrumental variable (i.e., those below and above the 7500 inhabitants threshold). The plot shows that the CDF above the threshold stochastically dominates the one below the threshold, as it must happen if monotonicity holds.²⁸

Since the conditions for a RD design are satisfied we can now describe what we learn from estimates based on it, concerning the effect of competition on the ability of firms to extract surplus from inelastic consumers. To this end, we test whether the *composition effect* on prices of an increase in the number of inelastic consumers is different at different levels of competition between pharmacies, everything else being equal.²⁹ In other words, we are now interested in the interaction between N_{ct}^I and S_c . The theoretical analysis in fact suggests that when competition is tougher, an inflow of type I consumers should have a less positive effect on prices than when competition is weaker (Remark 2). To gather evidence on this prediction we proceed in three steps.

1. We regress the price and the number of newborns at t on newborns' lags, city and time fixed effects to partial out these variables. That is, we estimate the following model for the set of dependent variables $H_{ct} = \{N_{ct}^I, p_{ct}\}$:

$$H_{ct} = \Lambda(N_{ct-\tau}^I) + \phi_c + \mu_t + \eta_{ct}, \quad (14)$$

and we retrieve the residuals for each dependent variable that we denote as: \tilde{H}_{ct} .

2. *Separately for each city*, we regress the residual price on the residual newborns' number obtained from step 1. That is, we run a total of C regressions like:

$$\tilde{p}_{ct} = \alpha_c + \delta_c \tilde{N}_{ct}^I + \tilde{\varepsilon}_{ct} \quad (15)$$

Each regression yields a city specific estimate $\hat{\delta}_c$ of the elasticity of the price p_{ct} to the contemporaneous number of newborns.

to sell drugs ('parafarmacie'), and the number of grocery stores, all at the city level. The expected values of all these variables do not show any significant discontinuity at the threshold. Results are available upon request.

²⁸We tested also for manipulation of the running variable around the threshold using the McCrary (2008) density test. Our running variable (the maximum population reached by the city between 1971 and 2008) should not be manipulable by stakeholders, and indeed the test confirms it (p-value = 0.31).

²⁹As already stated, the products in our basket are also available in other shops such as supermarkets. Since we concentrate on similar cities to the left and to the right of the population threshold, the RD approach allow us to practically eliminate any possible difference related to the presence of these alternative shops.

3. We then use the RD design, to test whether these city-specific elasticities differ on the two sides of the population threshold $\kappa = 7500$, keeping in mind that on the left of this threshold the number of pharmacies is significantly lower than on the right. Therefore we estimate the following equation restricting the analysis to cities in a neighborhood of the threshold:

$$\hat{\delta}_c = \omega + \gamma K_c + g(|Pop_c - \kappa|) + \eta_c \quad (16)$$

where $K_c = 1(Pop \geq \kappa)$ is a dummy equal to 1 on the right of the threshold.

A negative estimate for γ in the RD regression (16) would confirm the prediction of the theoretical Section 2.1 (Remark 2), according to which an increase in the number of competitors should reduce the *composition effect*, i.e. the capacity of pharmacies to extract surplus from less elastic consumers and therefore that it should reduce the positive effect of newborns on prices.

Figure 7 plots the LPS regression estimates of the elasticity of price with respect to the number of newborns on the two sides of the threshold. In line with the theoretical model we see that the elasticity of price to newborns declines down to zero when competition increases, suggesting that pharmacies facing higher competition are less able to extract surplus from inelastic consumers.

Table 5 reports estimates of the coefficient γ in equation (16), confirming the visual impression of Figure 7.³⁰ In the first four columns we find a significant effect of the number of competitors on the elasticity of price with respect to newborns, independently of the specification of the polynomial in the distance from the threshold and of the window around the threshold. Indeed, this elasticity is always significantly lower on the right of the threshold than on the left. This finding is consistent with the prediction of the theoretical analysis according to which an increase in the number of competitors reduces the *composition effect*.

Column 5 of Table 5 shows that these results are robust with respect to the failure of observing all the pharmacies in a city. Estimates are in fact qualitatively and quantitatively similar when we restrict the analysis to cities with a 100% Pharma coverage.³¹ Column 6 of Table 5 reports, instead, results obtained controlling for the already mentioned observables (see footnote 25) to increase efficiency. As expected, point estimates remain substantially unchanged.

Finally, our setting allow us to use also the Instrumental Variables method for the purpose of measuring the effect of competition on the pharmacies' ability to extract surplus from

³⁰In Table 5 inference is based on heteroscedasticity-robust standard errors. Alternatively, standard errors have been bootstrapped: results, available upon request, show unaffected statistical significance.

³¹Note, however, that focusing on this subsample reduces the number of observations, so that we have to enlarge the window up to 4,000 inhabitants and rely on lower order polynomials to obtain precise estimates.

uninformed consumers. We estimate the equation

$$\hat{\delta}_c = \chi + \psi s_c + g(|Pop_c - \kappa|) + \nu_c \quad (17)$$

using the threshold dummy $K_c = 1(Pop_c \geq \kappa)$ as an instrument for the number of competitors faced by a pharmacy, which is given by $s_c = S_c - 1$. Therefore, the measure of competition used in this regression is the number S_c of pharmacies in the market minus 1. In this way, *near the threshold* where $Pop_c \approx \kappa$, the constant captures what happens when in a city there is only one pharmacy. Table 6 reports estimates of the effect ψ of the real number of competitors (*Treatment Effect*) on the elasticity of price to newborns, as opposed to estimates of the effect of their theoretical number (*Intention to Treat Effect*), which were reported in Table 5. Here, controls have been added to increase efficiency. The four columns use different windows around the threshold up to $\pm 4,000$ inhabitants and report the F-statistics of the excluded instrument. This set of estimates shows that, near the threshold, when there is just one pharmacy in the market (i.e. a pharmacy with $s_c = 0$ competitors), the elasticity of equilibrium price to the number of newborn is positive and significant.³² The presence of an additional competitor annihilates this elasticity.

6 Competition and prices

The effect of the number of available shops on market prices is a well investigated issue both in the theoretical and in the empirical literature. Although this is not the main focus of our paper, since we are more interested in the composition effect and in how it is affected by competition, our Regression Discontinuity design is well suited to directly address also the relation between competition and price levels. In addition, this analysis may shed some light on the different pricing strategies illustrated in Section 2 that may be associated with the composition effect. In fact, for most of the theoretical models of competition, a larger S reduces (average) price levels, although there are some important exceptions. In particular, to our knowledge there are two classes of models that may deliver an opposite result.

First, in search-related models with differently informed consumers (such as our I and E buyers) and shops playing mixed strategies, a larger S may induce higher expected prices (see Janssen and Moraga-Gonzalez (2004), among others).³³ The intuitive reason for this unexpected result is that when there are more shops around, both the business-stealing and the surplus-appropriation effects weaken because, given any price, the individual demands of

³²The value of the constant has been measured at the mean value of the covariates included, that are a dummy equal to 1 in Northern Italy, the municipal area, and the number of ‘parafarmacie’ (i.e. special convenience-stores allowed to sell drugs).

³³Although to the left of our population threshold there is on average one pharmacy, still one cannot see this pharmacist as a monopolist because we know that our childcare products are also available in other shops such as supermarkets. Hence, this pharmacist may still want to play a mixed pricing strategy.

any shop i , q_i^I and q_i^E , reduce (see the discussion in Section 2). However, the probability to sell to consumer I reduces less than that of selling to consumer E so that the shops' trade-off between business stealing and surplus appropriation is rebalanced towards the latter, which in turns calls for higher prices.³⁴

Second, Chen and Riordan (2008) have shown that when products are horizontally differentiated, on the one hand a larger S induces shops to reduce prices as usual, but on the other hand it makes consumers less elastic, thereby generating the possibility of higher overall prices. The reason for reduced elasticity hinges on shops being intrinsically differentiated competitors, for example through location. When there are more shops, each consumer has a closer shop to buy from, which is, *ceteris paribus*, a better alternative than any other shop. Hence, larger price differences are needed to induce a consumer to move to another competing shop and the intensity of competition is reduced, thus possibly leading to higher prices.

Using the same RD design described in Section 5, we find that competition does not have a direct negative effect on price levels in our environment.³⁵ Below the historical population threshold of 7500 inhabitants, where cities are characterized by a lower number of pharmacies, we observe a lower price level than above the threshold, where the number of pharmacies is larger. The effect is statistically insignificant but the hypothesis of a negative effect of S on prices can be rejected at standard significance levels. This evidence illustrates that at least one of the two theoretical explanation illustrated above should play a significant role in our environment. In both cases, indeed, there are countervailing factors that may reduce and even annihilate the pro-competitive effect of more pharmacies, contrary to other more standard models of competition that would nevertheless be consistent with our previous empirical results, summarized in Remarks 1 and 2.

One may be then induced to further explore the causal effects of competition on prices by studying higher moments of the price distribution, such as for example the variance. Indeed, there exists a vast theoretical and empirical literature that investigates the role of competition on measures of price dispersion (e.g. variance, sample price range, or interquartile range, see for example Baye, Morgan, and Scholten (2006) and Chandra and Tapatta (2011)). It has been shown, both in theory and empirically, that when consumers' search and lack of information are important, we should expect a positive relation between S and measures of price dispersion. We have performed this empirical investigation in our environment exploiting the RD design and found a negative and significant relation instead (results available from the authors). Again, since this is not the aim of our investigation, we do

³⁴On top of this Janssen and Moraga-Gonzalez (2004) show that consumers may also have lower incentives to search for better deals when the number of shops is larger, thus remaining relatively less informed and corroborating shops' incentives to higher prices.

³⁵Results are available from the authors.

not push this result to discriminate among different theoretical models. We rather use it as a possible warning about the interpretations of common empirical findings on competition and price dispersion for the following reasons. Since the shocks of newborns are identical on average on the two sides of the threshold and since the composition effect is stronger on the left of it, this explains why one should find, as we do, higher price variability in cities with less pharmacies than in cities with more pharmacies. We think this unveils a new and important link between price variability and competition that has not been identified so far.

7 Conclusions

In this paper we provide new evidence on the role of consumers' heterogeneity in terms of elasticity for the retail sector and on its interplay with competition among sellers. Theory predicts that an inflow of less experienced consumers with higher search costs should have a positive effect on the average price charged by sellers. This composition effect (generated by sellers being able to extract larger rents from inelastic consumers through higher prices) should also decline as the number of competitors increases.

We gather data for a large sample of Italian pharmacies and estimate the effect of a positive shock in the number of newborns (at the monthly frequency and controlling for city and time fixed effects) on the average price at the city level, for a basket of child hygiene products. We argue that parents of newborns indeed face higher search costs because they are more hurried and are also less experienced than other consumers of the same set of products. Thus, an increase of newborns is a source of exogenous variation in the number of relatively inelastic consumers. Consistently with theoretical predictions, an increase in newborns has a positive effect on the average observed price. We provide evidence allowing us to exclude that this positive effect might be driven by increasing marginal costs and/or by congestion at the pharmacy level. We also present a series of robustness checks and placebo tests that confirm our analysis and interpretations.

To study the effect of competition on the elasticity of price to the fraction of inelastic consumers, we exploit a legislative feature of the Italian pharmacy market that is common to many countries and is based on a demographic criterion. In Italy the law imposes that municipalities under 7,500 inhabitants should have a single pharmacy, while those right above this threshold should have two. Despite the presence of partial non-compliance with this law, we are able to exploit it within a Regression Discontinuity Design and show that the elasticity of prices to the number of newborns declines to zero in cities where the number of pharmacies is higher. These results confirm the theoretical prediction that competition reduces the capacity of firms to extract surplus from less elastic buyers.

8 Appendix

In this Appendix we illustrate in greater detail how the theoretical analysis presented in Section 2 allows us to derive Remarks 1 and 2, when firms price discriminate or when they do not price discriminate but rely either on pure or mixed strategies.

8.1 Price discrimination

Following Graddy (1995), if sellers can price discriminate the profit is as in equation (1) and the optimal pricing conditions for the two types of buyers can be written as:

$$p_i^{*E} (1 + M_i^E) = c_i \quad (18)$$

$$p_i^{*I} (1 + M_i^I) = c_i \quad (19)$$

where M_i^j is the mark-up applied by shop i to consumers of type j , with $j = E, I$. The mark-up $M_i^j = \Theta_i \tilde{\eta}_i^j$ is decomposed into a conduct parameter $\Theta_i \geq 0$, assumed to be the same for the two types of consumers, and an inverse measure of elasticity $\tilde{\eta}_i^j$, so that $\tilde{\eta}_i^E \geq \tilde{\eta}_i^I$. Graddy (1995) applies this framework to her study of the differences in the demand of Asian and White customers in the NY Fulton fish market. She assumes the same conduct parameters for her two groups of customers given that the “same dealers participate in each market and each group is serviced in the same physical location and in the same manner.” Inasmuch as the pharmacies in our study can price discriminate, this assumption makes sense also in our context. Note that the conduct parameter Θ_i can be seen as an (inverse) measure of competitiveness: it values zero in perfect competition and one in monopoly. In other words, if S is the number of sellers, $\Theta_i = \theta_i(S)$ with $\frac{\partial \Theta_i}{\partial S} < 0$.³⁶

Substituting these pricing rules in equation (2), that gives the average price observed by the econometrician for seller i at time t , we obtain:

$$p_{it} = \frac{p_i^{*E} N_t^E + p_i^{*I} N_t^I}{N_t} = \tilde{\beta} + \tilde{\delta} \frac{N_t^I}{N_t} \quad (20)$$

where

$$\tilde{\beta} = \frac{c_i}{1 + \Theta_i \tilde{\eta}_i^E} \quad (21)$$

and

$$\tilde{\delta} = (\tilde{\eta}_i^E - \tilde{\eta}_i^I) \frac{\Theta_i c_i}{(1 + \Theta_i \tilde{\eta}_i^I)(1 + \Theta_i \tilde{\eta}_i^E)} \quad (22)$$

These expressions have several interesting implications that can be easily checked with simple algebra.

First, a proportional increase in the two groups of consumers that leaves unchanged the composition (i.e. the ratio N_t^I/N_t), does not affect the average price, i.e.

$$\frac{\partial p_{it}}{\partial N_t} \Big|_{\frac{N_t^I}{N_t} = \xi} = 0 \quad (23)$$

with ξ constant, as reported in part (i) of Remark 1.

³⁶With the above decomposition of the mark-up, the parameter relating to the elasticity $\tilde{\eta}_i^j$ does not depend on S .

Second, as long as $\Theta_i > 0$ (i.e. competition is imperfect) the average price is increasing in the fraction N_t^I/N_t of inelastic consumers, since

$$\frac{\partial p_{it}}{\partial \frac{N_t^I}{N_t}} = \tilde{\delta} \geq 0 \quad (24)$$

as in part (ii) of Remark 1.

Third, the average price increase induced by more newborns is augmented by a larger value of the conduct parameter Θ_i . Since Θ_i is a decreasing function of the number of sellers, we have that the average price increase induced by more inelastic consumers is larger the less competitive is the market, i.e.

$$\frac{\partial^2 p_{it}}{\partial N_t^I \partial S} = \frac{\partial \tilde{\delta}}{\partial S} \leq 0 \quad (25)$$

as in Remark 2.

Finally, if changes in N_t and its components are independent of S , an increase in the number of competitors S decreases the average price observed in the market, because

$$\frac{\partial p_{it}}{\partial S} = \frac{\partial \tilde{\beta}}{\partial S} + \frac{\partial \tilde{\delta}}{\partial S} \frac{N_t^I}{N_t} \leq 0 \quad (26)$$

given that Θ_i is decreasing in S and $\eta^j \leq 0$.

Note that the parameters of equation (6) that we will estimate in our empirical analysis can be related to the parameters $\tilde{\beta}$ and $\tilde{\delta}$ in equation (20) above. Therefore, they may be interpreted in terms of Graddy (1995) pricing rules and conduct parameters, if third degree discrimination could be assumed to prevail in the markets faced by the pharmacies considered in this study. Specifically, it is easy to see that:

$$\delta = \frac{\partial p_{it}}{\partial \frac{N_t^I}{N_t}} = \tilde{\delta} = (\tilde{\eta}_i^E - \tilde{\eta}_i^I) \frac{\Theta_i c_i}{(1 + \Theta_i \tilde{\eta}_i^I)(1 + \Theta_i \tilde{\eta}_i^E)} \quad (27)$$

which captures the Composition effect in Part (i) of Remark 1, for which we provide evidence with the estimation of equation (7) and with the results reported in Table 3. Moreover, it follows immediately that

$$\frac{\partial^2 p_{it}}{\partial \frac{N_t^I}{N_t} \partial S} = \frac{\partial \tilde{\delta}}{\partial S} = \frac{\partial \delta}{\partial S} \quad (28)$$

which captures the Competition effect of Remark 2, for which the evidence is offered by the Regression Discontinuity Design of Section 5, in particular by Figure 7, and Tables 5 and 6.

The direct effect of the number of sellers on the price level, discussed in Section 6, is instead given by

$$\frac{\partial p_{it}}{\partial S} = \frac{\partial \tilde{\beta}}{\partial S} + \frac{\partial \tilde{\delta}}{\partial S} \frac{N_t^I}{N_t} = \frac{\partial \beta}{\partial S} + \frac{\partial \delta}{\partial S} \frac{N_t^I}{N_t} \quad (29)$$

Here is where our empirical evidence diverges from Graddy's (1995) model because we find an insignificant (or possibly positive) effect, while her price discrimination model would imply unambiguously a negative effect. This evidence suggests that (third degree) price discrimination may not be practiced by the pharmacies considered in this study. See Section 5 for more on this.

8.2 No price discrimination: pure and mixed strategies

First we formally derive the effect of a change in the proportion of inelastic consumers on the optimal price with no price discrimination and deterministic pricing. Following the notation used in the previous Appendix 8.1, the optimal pricing condition can be written as

$$p_{it}(1 + M_i) = c_i \quad (30)$$

where M_i is now the mark-up set by shop i for the average consumer, with $M_i = \Theta_i \tilde{\eta}_i$ and being

$$\tilde{\eta}_i = \frac{N_t^I}{N_t} \tilde{\eta}_i^I + \left(1 - \frac{N_t^I}{N_t}\right) \tilde{\eta}_i^E \quad (31)$$

the (inverse) measure of price elasticity of the average consumer. Differentiating the pricing condition we immediately obtain

$$\frac{\partial p_{it}}{\partial N_t} \Big|_{\frac{N_t^I}{N_t} = \xi} = 0 \quad (32)$$

for ξ constant,

$$\frac{\partial p_{it}}{\partial \frac{N_t^I}{N_t}} = p_{it} \Theta_i (\tilde{\eta}_i^E - \tilde{\eta}_i^I) \geq 0 \quad (33)$$

and

$$\frac{\partial^2 p_{it}}{\partial \frac{N_t^I}{N_t} \partial S} \leq 0 \quad (34)$$

because $\frac{\partial \Theta_i}{\partial S} < 0$. These results confirm Remarks 1 and 2.

Consider now the case in which shops sell perfectly substitutable products, demand is unitary $q_i^j \in \{0, 1\}$, consumers I are completely uninformed about prices (and cannot, for simplicity, search because they face very high opportunity costs for searching better price deals) and consumers E are instead fully informed. Proceeding as in Janssen and Moraga-Gonzalez (2004), let $G(p)$ be the probability that any shop i sets a price lower than p (we drop the shop index since we concentrate on symmetric equilibria). The profit of shop i associated with a price p_i is as in equation (3), where now the individual demand of the two types of consumers are

$$\begin{aligned} q_i^I &= \frac{1}{S} \\ q_i^E &= (1 - G(p_i))^{S-1} \end{aligned} \quad (35)$$

For a price p_i not higher than the consumers' willingness to pay v , any consumer buys. The uninformed and inelastic consumer I simply enters into a shop at random so that q_i^I is actually the probability that the consumer buys at shop i which is one out of the S competing shops. The informed and elastic consumer E instead buys from the least price shop so that, given the $S - 1$ competitors' mixed strategy $G(\cdot)$, q_i^E is the probability that $p_i \leq \min_{j \neq i} \{p_j\}$. Normalizing $c_i = 0$ to simplify expressions, the symmetric mixed strategy equilibrium is (for details see Janssen and Moraga-Gonzalez (2004))

$$G(p) = 1 - \left(\frac{v - p}{Sp} \frac{N_t^I}{N_t^E} \right)^{\frac{1}{S-1}} \quad \text{on } [p_0, v], \text{ with } p_0 \equiv v \frac{N_t^I}{N_t^I + S N_t^E} \quad (36)$$

and the expected price at time t is for any of the S shops is

$$E[p] = \left(\frac{N_t^I}{N_t^E} \right)^{\frac{1}{S-1}} \int_{p_0}^v \frac{v}{S(S-1)p} \left[\frac{v-p}{Sp} \right]^{\frac{2-S}{S-1}} dp \quad (37)$$

The average price p_t in the market at date t is thus $p_t = E[p]$. Point (i) of Remark 1 simply follows by observing that a change in N_t that leaves unaffected N_t^I/N_t and N_t^E/N_t also does not affect $\frac{N_t^I}{N_t^E}$ and thus

$$\frac{\partial p_t}{\partial N_t} \Big|_{\frac{N_t^I}{N_t} = \xi} = 0 \quad (38)$$

for ξ constant. If instead N_t^I/N_t increases, since $\frac{N_t^E}{N_t} = 1 - \frac{N_t^I}{N_t}$ must obviously decrease, then $\frac{N_t^I}{N_t^E}$ increases so that

$$\frac{\partial p_t}{\partial \frac{N_t^I}{N_t}} = \frac{N_t^I}{N_t^E(S-1)} p_t \geq 0 \quad (39)$$

as indicated in Point (ii) of Remark 1. Finally, from the previous expression, a larger S has a stronger effect on the first term than on p_t so that

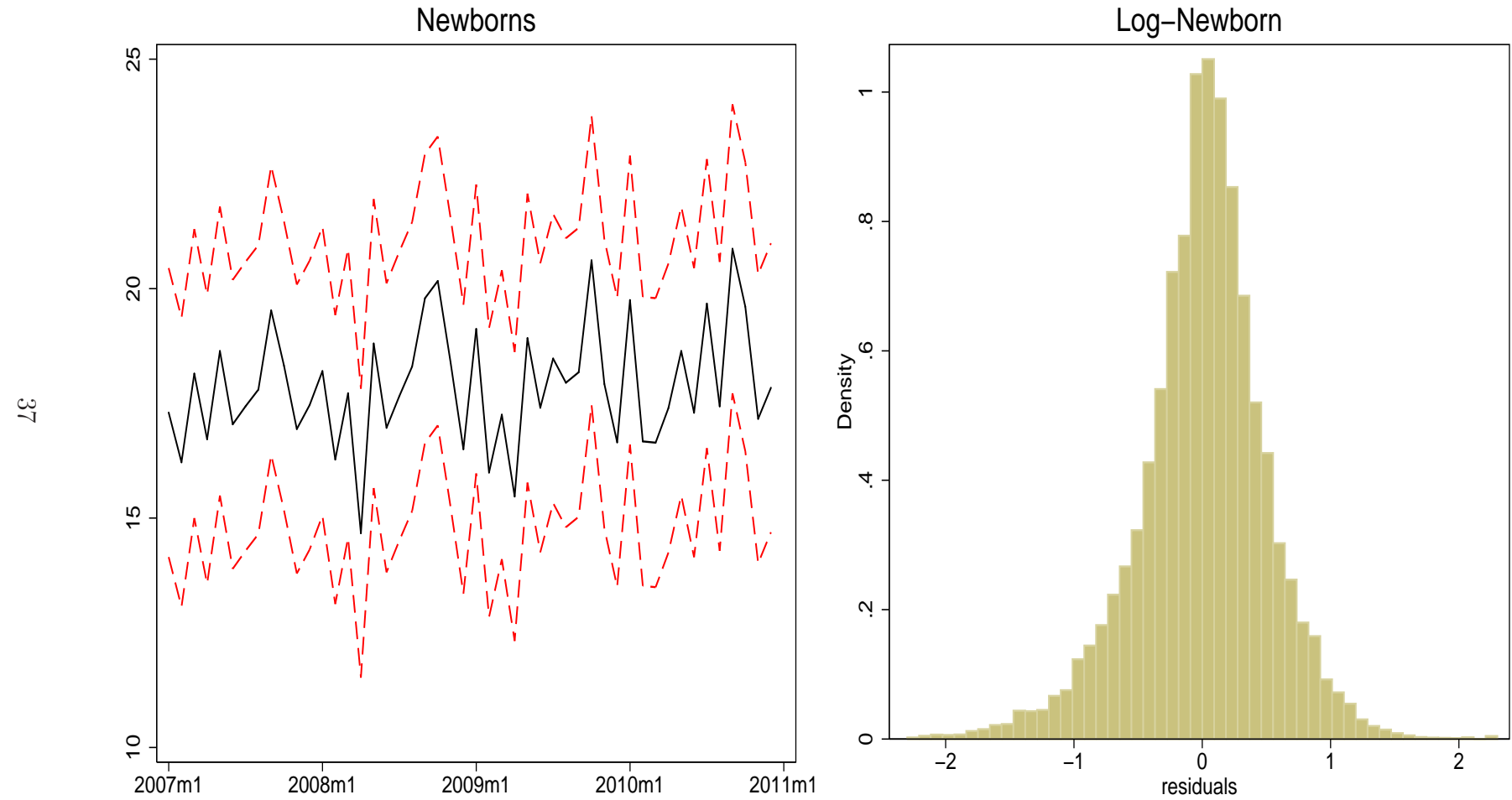
$$\frac{\partial^2 p_{it}^*}{\partial \frac{N_t^I}{N_t} \partial S} \leq 0 \quad (40)$$

as stated in Remark 2.

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Figure 1: Temporal evolution and within city variability of the number of newborns



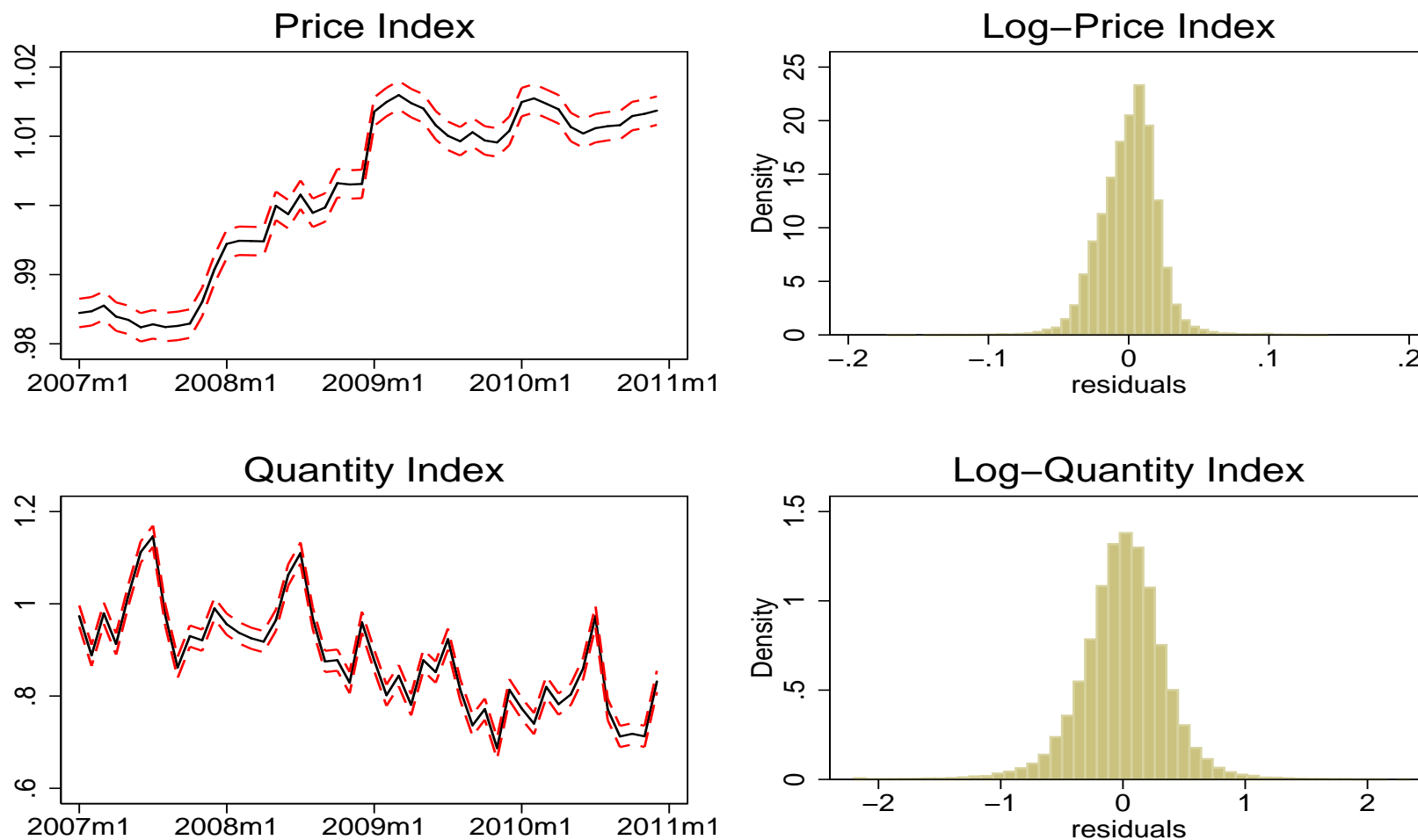
Notes: Temporal evolution of the average number of newborns per city (left panel), and histograms of the residuals of a regression of log-newborns on city fixed effects (right panel). Dashed lines delimit the 95% confidence interval.

Table 1: Top items in the basket of hygiene products

Name	Description	Price	Quantity
<i>Top-5 by Sold Quantity</i>			
Salviette Assorbello	Hygienic Towels	2.04	39.94
GP Baby Pasta all'Ossido di Zinco	Zinc-Oxyde Paste	4.91	23.3
Bluedermin Pasta BB 100ml	Diaper Change Ointment	5.83	17.21
Trudi Baby Care Salviettine	Hygienic Towels	2.07	16.53
GP Baby Detergente	Cleansing Cream	5.02	15.3
<i>Top-5 by Price</i>			
Soin de Fee 24-Hour Baby Cream 50ml	Barrier Cream	45	0.21
Vidermina 3 Soluzione 1000ml	Cleansing Cream	40.32	0.01
Buba Shampoo e Bagno	Shampoo and Bath Foam	37.61	0.04
Unilen Gel 15ml	Barrier Cream	36.06	0.11
Protezione Solare Bambini Vichy	Suntan Cream	30.9	0.02

Notes: Our calculations based on the Pharma database. Prices are in Euros.

Figure 2: Temporal evolution and within city variability of the quantity and price indexes



Notes: Temporal evolution of the average quantity and price indexes of hygiene products (left panels), and histograms of the residuals of a regression of the (log) quantity and (log) price indexes on city fixed effects (right panels). Dashed lines delimit the 95% confidence interval.

Table 2: Descriptive statistics of the variables used in the econometric analysis

	Mean	Standard deviation	Minimum	Maximum	Number of Observations
Price Index	1	0.03	0.8	1.15	63432
Quantity Index	1	0.52	0.003	7.2	63432
Sold boxes of hygiene products	72	68	0	992	63432
Number of newborns in t	19	79	0	4048	63432
Number of pharmacies per city	7	28	1	709	63432

Notes: Price and quantity information concerns 2925 hygiene products sold by the 3331 pharmacies in the Pharma dataset. Information on newborns refers to the 1565 cities in which the pharmacies of the Pharma dataset operate. One observation is a city in a month.

Table 3: Effect of the monthly number of newborns on the equilibrium price

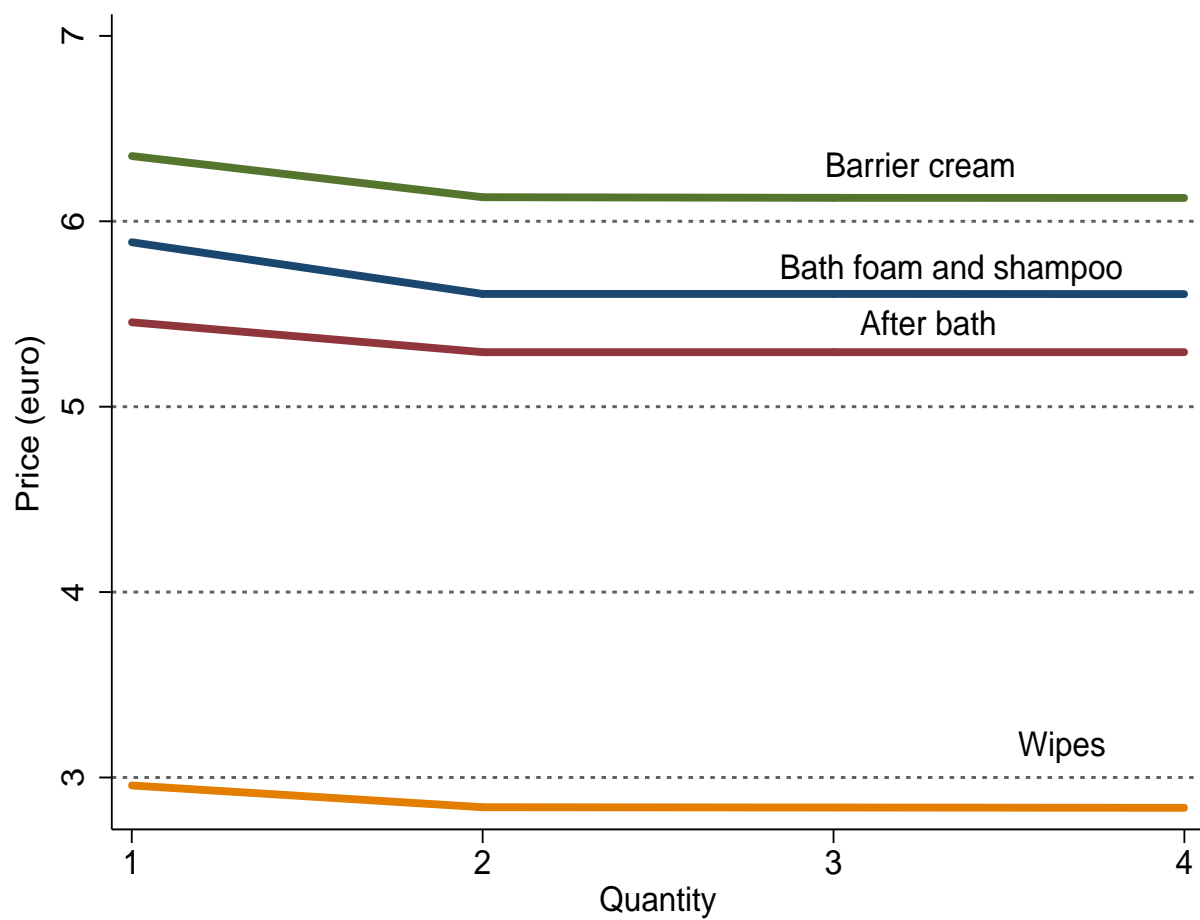
	All cities	100% Pharma Coverage
Log Newborns (t)	0.0158 (0.0053)***	0.0193 (0.0056)***
Log Newborns (t-1)	0.0138 (0.0053)***	0.0155 (0.0056)***
Log Newborns (t-2)	0.0084 (0.0053)	0.0094 (0.0056)
Log Newborns (t-3)	0.0129 (0.0056)**	0.0116 (0.006)*
Log Newborns (t-4)	0.0153 (0.0056)***	0.0122 (0.006)**
Log Newborns (t-5)	0.0213 (0.006)***	0.0162 (0.006)***
Log Newborns (t-6)	0.0245 (0.006)***	0.0182 (0.0063)***
Log Newborns (t-7)	0.0228 (0.0066)***	0.0170 (0.0066)**
Log Newborns (t-8)	0.0236 (0.0066)***	0.0163 (0.0063)**
Log Newborns (t-9)	0.0125 (0.0066)***	0.0100 (0.0063)
Log Newborns (t-10)	0.0068 (0.0066)**	0.0049 (0.0063)
Log Newborns (t-11)	0.0055 (0.0066)	0.0003 (0.0063)
Time effects	Yes	Yes
City effects	Yes	Yes
Number of observations	63432	25967
Number of cities	1565	699

Notes: OLS estimates of the regression

$$p_{ct} = \alpha + \delta N_{ct}^U + \Lambda(N_{ct-\tau}^I) + h_c + \mu_t + \varepsilon_{ct}$$

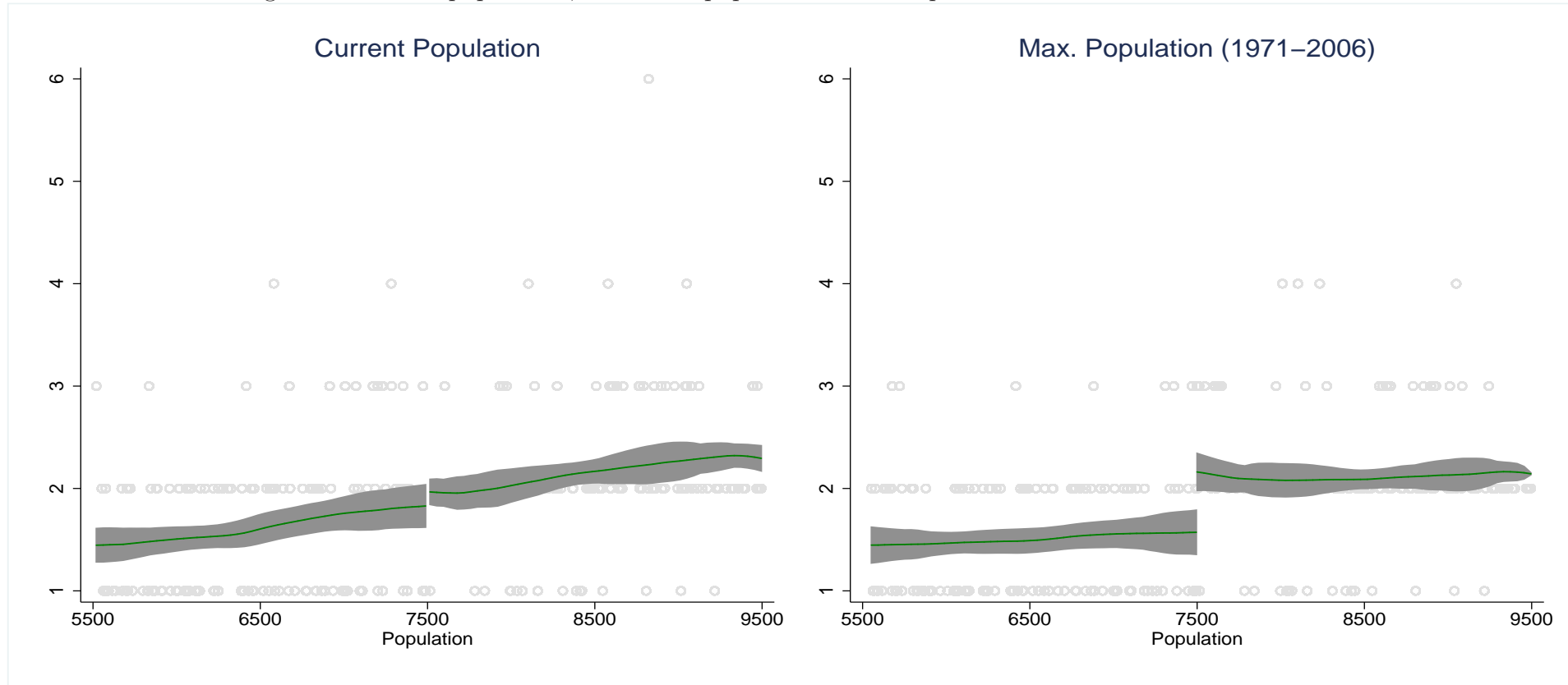
where all variables are in logs, c denotes a city, t a month, p_{ct} is the equilibrium (log) price and N_{ct}^U is the (log) number of newborns, $\Lambda(N_{ct-\tau}^I)$ is a polynomial in the lags of the number of newborns, h_c and μ_t are respectively city and time fixed effects. The specification includes 23 lags, although only the first 10 have a significant effect. The remaining insignificant lags are omitted to save on space. Robust standard error, clustered at the city level, in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Reported coefficients and standard errors have been standardized by the standard deviation of the correspondent variable. To evaluate the size of the estimates note that a standard deviation is ≈ 1.8 for the (log) number of newborns at different lags and to 0.03 for the (log) price.

Figure 3: Unitary wholesale price to pharmacists for child hygiene products.



Source: Authors' calculations on data from InfoSystem.

Figure 4: Current population, maximum population and competition at the threshold



Notes: Scatter plot and local polynomial smoothing regressions (bandwidth = 300) of the number of pharmacies with respect to current and maximum historical population. Current population is measured at 12-31-2006 for municipalities observed since January 2007, at 12-31-2008 for municipalities observed since January 2009.

Table 4: Competing pharmacies on the two sides of the maximum hystorical population threshold.

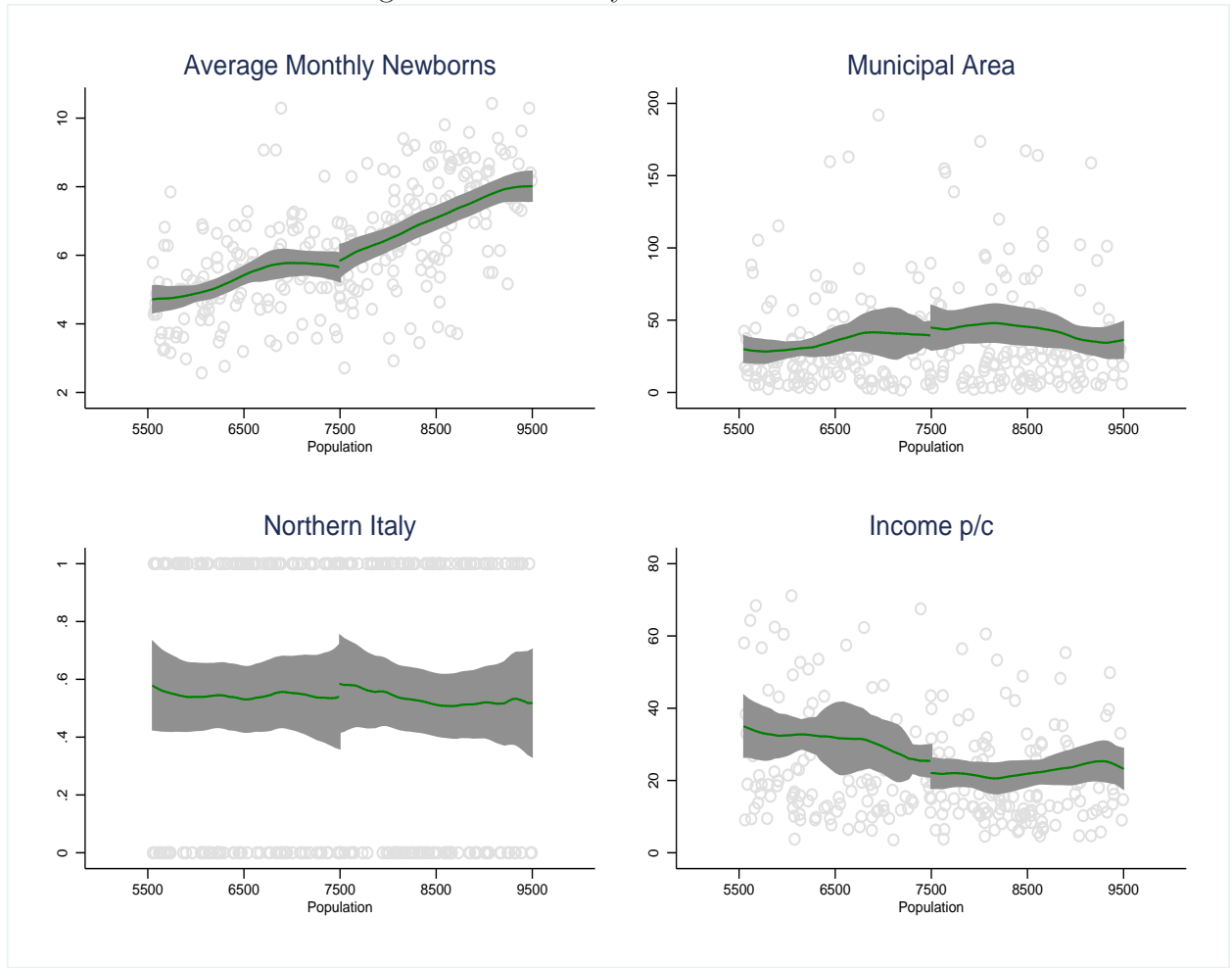
	Local linear $\pm 1,500$ inhabs.	Polynom. 2^{nd} $\pm 2,000$ inhabs.	Polynom. 3^{rd} $\pm 3,000$ inhabs.	Polynom. 4^{th} $\pm 4,000$ inhabs.
<i>Panel A: All cities</i>				
Right side of the threshold	0.518 (0.195)***	0.605 (0.247)**	0.774 (0.260)***	0.843 (0.281)***
Constant	0.619 (0.136)***	0.644 (0.184)***	0.584 (0.193)***	0.574 (0.206)***
No. of Obs.	209	269	417	569
<i>Panel B: 100% Pharma coverage</i>				
Right side of the threshold	0.484 (0.212)**	0.699 (0.244)***	0.807 (0.273)***	0.668 (0.264)**
Constant	0.090 (0.084)	0.067 (0.103)	0.047 (0.102)	0.051 (0.103)
No. of Obs.	85	110	185	282
<i>Panel C: Controls included</i>				
Right side of the threshold	0.450 (0.178)**	0.587 (0.224)**	0.754 (0.235)***	0.849 (0.253)***
Constant	1.795 (0.336)***	1.832 (0.330)***	1.765 (0.282)***	1.584 (0.278)***
No. of Obs.	209	269	417	569

Notes: OLS estimates of the regression:

$$S_c = \omega + \varphi K_c + g(|Pop_c - \kappa|) + \zeta_c$$

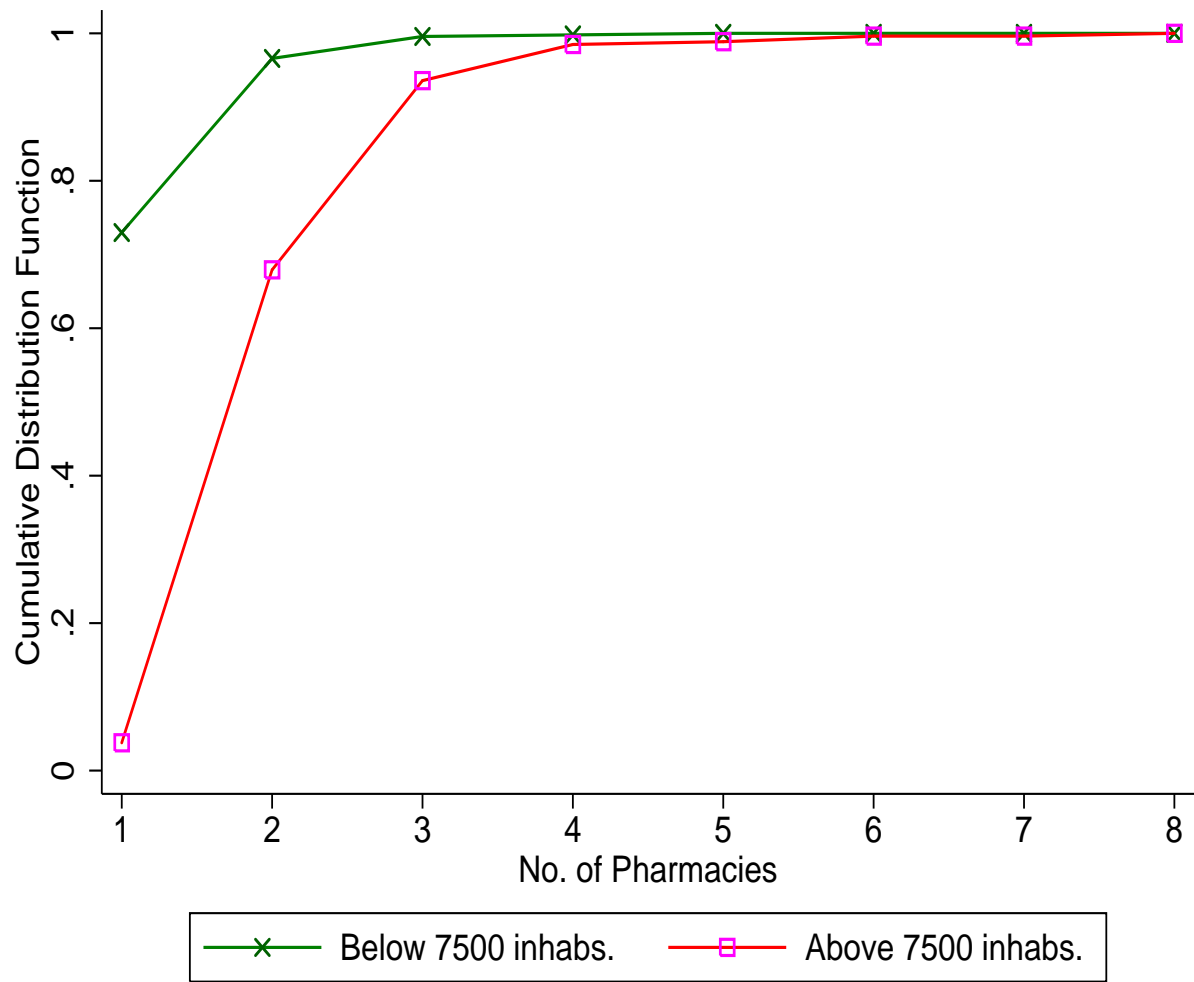
where c denotes a city, S_c is the number of pharmacies in a city; Pop_c is the maximum historical population in a city; $K_c = 1(Pop_c \geq \kappa)$ is a dummy taking value 1 for cities on the right side of the threshold. Robust standard errors, in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Panel B includes cities in which Pharma has a 100% coverage on pharmacies. Regressions in Panel C includes the average monthly number of newborns, a dummy taking value 1 if the city is in a urban area, a dummy taking value 1 if the city is in Northern Italy and per capita disposable income at the city level as controls.

Figure 5: Continuity tests for covariates



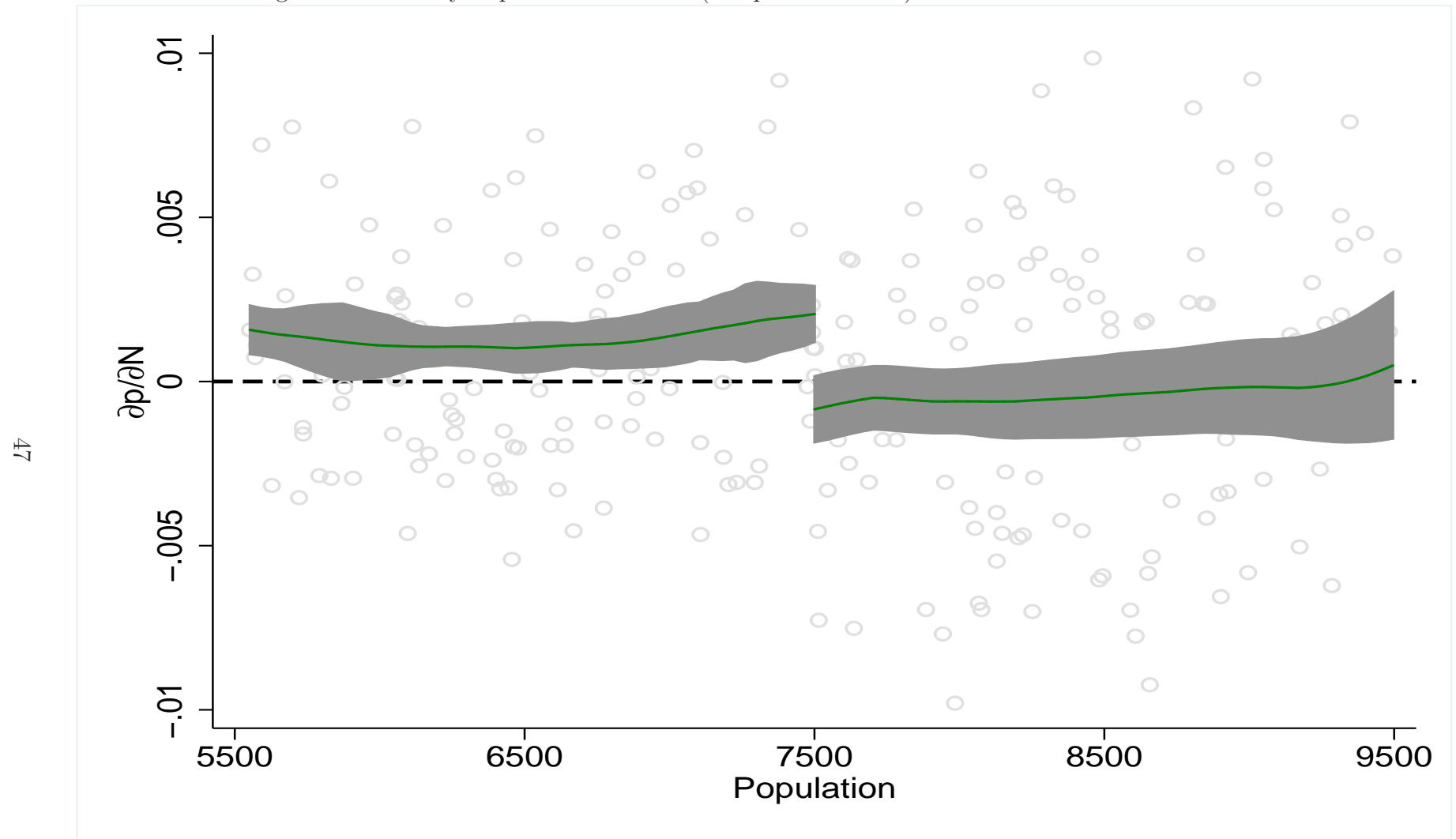
Notes: Scatter plot and local polynomial smoothing regressions (bandwidth = 300) of four observable “pre-treatment” city characteristics with respect to maximum historical population. The four characteristics are: the average monthly number of newborns, a dummy taking value 1 if the city is in a urban area, a dummy taking value 1 if the city is in Northern Italy and per capita disposable income in the city.

Figure 6: The monotonicity test



Notes: The figure reports the cumulative distribution functions of the number of pharmacies (treatment variable) for cities below and above the 7500 inhabitants threshold (the instrumental variable). Monotonicity requires that the CDF above the threshold is (weakly) greater than the CDF below (Angrist, Graddy, and Imbens, 2000).

Figure 7: Elasticity of price to newborns (composition effect) on the two sides of the threshold



Notes: Scatter plot and local polynomial smoothing regressions (bandwidth = 300) of the city specific elasticity of price $\hat{\delta}_c$ with respect to the monthly number of newborns.

Table 5: Elasticity of the price index with respect to the monthly number of newborns on the two sides of the threshold.

	Local Linear Reg. ± 1,500 inhabs. All Sample 1	Polynom. 2 nd ± 2,000 inhabs. All Sample 2	Polynom. 3 rd ± 3,000 inhabs. All Sample 3	Polynom. 4 th ± 4,000 inhabs. All Sample 4	Local Linear Reg. ± 4,000 inhabs. 100% NL Coverage 5	Polynom. 4 th ± 4,000 inhabs. All Sample 6
Higher competition	-0.003 (0.001)**	-0.004 (0.001)***	-0.003 (0.001)**	-0.004 (0.002)**	-0.003 (0.001)**	-0.004 (0.002)**
Constant	0.002 (0.001)***	0.003 (0.001)***	0.002 (0.001)**	0.002 (0.001)**	0.002 (0.001)***	0.003 (0.002)
Controls	N	N	N	N	N	Y
No. of Obs.	209	269	417	569	185	417

Notes: OLS estimates of the regression

$$\hat{\delta}_c = \omega + \gamma K_c + g(|Pop_c - \kappa|) + \eta_c$$

where c denotes a city; Pop_c is the maximum historical population in a city; $K_c = 1(Pop_c \geq \kappa)$ is a dummy taking value 1 for cities on the right side of the threshold. The dependent variable δ_c is obtained in two steps: first we regress p_{ct} and N_{ct} on lag newborns, city and time fixed effects and retrieve the residuals; then we regress the residuals of price on the residuals of newborns separately for each city, exploiting the within city time variability. Column 5 includes cities in which Pharma has a 100% coverage on pharmacies. Column 6 includes the average monthly number of newborns, a dummy taking value 1 if the city is in a municipal area, a dummy taking value 1 if the city is in Northern Italy, and per capita disposable income at the city level as controls. Robust standard errors are in parentheses with *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 6: IV estimates of the effect of a change in the number of competitors on the elasticities of price with respect to the number of newborns.

	Local Linear Reg. ± 1,500 inhabs. 1	Polynom. 2 nd ± 2,000 inhabs. 2	Polynom. 3 rd ± 3,000 inhabs. 3	Polynom. 4 th ± 4,000 inhabs. 4
Number of competitors	-0.005 (0.002)**	-0.007 (0.003)**	-0.005 (0.002)**	-0.004 (0.002)**
Const. (1 pharmacy, 0 competitors)	0.006 (0.002)***	0.004 (0.002)**	0.004 (0.002)**	0.003 (0.002)**
Controls	Y	Y	Y	Y
No. of Obs.	209	269	417	569
F-stat of excluded instrument	12.37	10.86	13.16	13.72

Notes: IV estimates of the regression

$$\hat{\delta}_c = \omega + \gamma s_c + g(|Pop_c - \kappa|) + \eta_c$$

where c denotes a city; s_c is the number of competitors (equal to the number S_c of pharmacies in a city minus 1) and is instrumented with $K_c = 1(Pop_c > \kappa)$; Pop_c is the maximum historical population in a city; $K_c = 1(Pop_c \geq \kappa)$ is a dummy taking value 1 for cities on the right side of the threshold. The dependent variable δ_c is obtained in two steps: first we regress p_{ct} and N_{ct} on lag newborns, city and time fixed effects and retrieve the residuals; then we regress the residuals of price on the residuals of newborns separately for each city, exploiting the within city time variability. All regressions include the following controls: a dummy taking value 1 if the city is in Northern Italy, municipal area, and number of ‘parafarmacie’. Robust standard errors are in parentheses with *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

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