Bargaining Power and Quantity Discounts to Retailers: Evidence from India's Pharmaceutical Industry*

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Abstract

Suppliers offer quantity discounts to retailers, which are normally hidden from consumers. We develop a theory linking supplier bargaining power with quantity discounts, following the institutional setting of the Indian pharmaceutical industry, where retailers are organized as a trade organization that coordinates a national uniform wholesale price for each product. Under these conditions, our theory predicts that a supplier offers greater quantity discounts in markets in which it has relatively less bargaining power to compensate for the relatively higher national wholesale price paid by retailers in such markets. We test this and other predictions of the theory using detailed, product-level data in which we observe significant geographic dispersion in quantity discounts. We find evidence consistent with the theory. We further examine the implications of quantity discounts for consumer prices and the stability of retail trade organization. Overall, our analyses indicate that lesser supplier bargaining power and greater countervailing power of retailers do not necessarily lead to lower consumer prices.

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1 Introduction

Suppliers, large and small, rely on retailers to reach consumers in many industries. While suppliers possess market power, retailers possess countervailing buyer power, defined as the ability of buyers/retailers with bargaining strength to extract wholesale price concessions from suppliers (Galbraith, 1952). Retailers with more buyer power can act as gatekeepers and obtain larger price discounts by promising greater sales to suppliers and by threatening to exclude suppliers that do not provide price concessions by withholding demand (e.g., Dobson and Waterson, 2007; Inderst and Mazzarotto, 2008; Wu, 2009). Such price concessions are particularly large and often remain confidential in the pharmaceutical industry. Taking advantage of the discrepancy between gross sales reported in the IMS Health database and net sales reported to the US Securities and Exchange Commission, Herper (2012) suggests that pharmaceutical firms in the US provided nearly 40 billion dollars annually as rebates to institutional payers such as insurance agencies, health management organizations, and government health agencies.[1] Dafny et al. (2017) and Ellison and Snyder (2010) also document the growth in such price concessions in the pharmaceutical industry in the US.

In high-income countries, the buyer power of third party organizations that pool consumer risk and demand, such as health insurance and care providers and large drugstores, is seen as an important means to containing the market power of pharmaceutical firms and the overall cost of healthcare, implying that price concessions provided by suppliers are to some extent passed on to consumers (e.g., Graf, 2014; Morgan et al., 2017).[2] Nevertheless, since price concessions pharmaceutical firms provide to large buyers are often kept hidden from other large buyers and consumers, these practices have created policy challenges, such as inflated "list prices" for the coverage of uninsured and underinsured in high-income countries (Morgan et al., 2013b). Since high-income countries use drug prices abroad to set reference prices at home, the use of confidential price concessions reduces information on prices paid by others, making it difficult to set reference prices

[1] Using IMS Health data, Herper (2012) reports rebates for 10 medicines: Lipitor (35%), Plavix (3%), Nexium (61%), Abilify (24%), Adavair (13%), Seroquel (27%), Singulair (23%), Crestor (30%), Cymbalta (14%), and Humira (2%). Mattingly et al. (2018) use data on price discounts voluntarily reported by three pharmaceutical manufacturers with the Veterans Administration in the US and find that the discounted price as a percentage of the wholesale acquisition cost ranged from 9 to 74%.

[2] A significant body of work on price bargaining between insurance companies and hospitals in the US indicates that the difference in reimbursement between traditional and managed care insurance in the US arises due to the differences in prices paid for particular services rather than differences in the quantity or quality of care (e.g., Cutler et al., 2000).

and exacerbating regional inequities (Morgan et al., 2013a). Furthermore, recent studies raise concerns about the anticompetitive use of such price concessions extracted by retailers with significant buyer power (Doyle and Inderst, 2007; Carlton and Israel, 2011; Grant, 2017).[3] However, despite the prevalence of confidential price discounts negotiated by institutional payers and policymakers, their overall impact on affordability and access to medicines remains underexplored (see, for exceptions, Dobson and Waterson, 2007; Dafny et al., 2017).

In low- and middle-income countries, where institutional payers are largely absent, insurance coverage is negligibly low, and consumers pay out of pocket for healthcare (Van Doorslaer et al., 2006; Leive and Xu, 2008), the countervailing buyer power often rests entirely with the retailers and, by contrast, individual consumers have negligible buyer power *vis à vis* pharmaceutical firms. Therefore, the impact of such confidential price discounts on consumer prices and retailer sales in low- and middle-income countries is more likely to be significant given the relatively large share of uninsured and underinsured consumers in these countries (Shahrawat and Rao, 2012). Yet, we are not aware of any previous studies that examine the antecedents and consequences of pharmaceutical firms providing such discounts to retailers in low- and middle-income countries.

In this paper, we examine the Indian pharmaceutical industry, a context that features a retail trade association of pharmacies with significant buyer power. We develop a theory to explain how the relative bargaining strength of the retailers in a geographic market influences the level of quantity discounts they receive when suppliers negotiate a uniform wholesale price with the retailer association. The theoretical model features a Nash bargaining game in which suppliers and regional retailers negotiate over the wholesale price of a product variety. Given the wholesale price, retailers then set the retail price to maximize their profits. We distinguish between coordinated bargaining when an association coordinates bargaining between a supplier and regional retailers, and decentralized bargaining when regional retailers negotiate independently. As coordinated bargaining yields an unstable outcome, suppliers use quantity discounts to compensate for the regional retailers with greater bargaining power that would have obtained a lower wholesale price in the decentralized bargaining. A key implication of the theory is that quantity discounts are given more likely in regions with stronger retailer bargaining power. Furthermore, retail prices remain constant across regions despite differences in bargaining power, indicating

[3]Grant (2017) reports on the lawsuit filed by Pfizer claiming that Johnson & Johnson has used a system of rebates and discounts anticompetitively, limiting the sale of Pfizer's cheaper substitute.

that quantity discounts do not lower consumers prices. Retailers benefit from stronger bargaining power and associated quantity discounts through increased retailer profit. This stabilizes the trade union, with suppliers enjoying the resale price maintenance.

We test the predictions of our model using data on quantity discounts compiled by the retail pharmacies' trade association in India from March 2007 to June 2013. We first document the scope and extent of this activity in the Indian pharmaceutical industry. In our data, we find a steady increase in the share of medicines for which suppliers provided quantity discounts as well as in the share of quantity given as discounts, reaching 10 percent in June 2013. Descriptive statistics further indicate that quantity discounts are a significant phenomenon because larger pharmaceutical firms are more likely to provide such discounts than smaller firms, and they particularly do so in larger medicine markets. Quantity discounts account for INR 31.6 billion (USD 600 million) annually in our data, corresponding to five percent of the overall sales, reflecting the importance of the practice in the industry.

The model shows that higher bargaining power of the retailers decreases supplier concentration in the regional medicine market. Therefore, we proxy for bargaining power with supplier concentration and test the predictions of our theoretical model. We find that higher supplier concentration in a regional medicine market decreases quantity discounts received by retailers. For the same product variety, a one standard deviation higher supplier concentration in a region is associated with a 1 percent decrease in the probability of quantity discounts and a 0.9 percent decrease in the share of quantity discounts provided by suppliers to retailers. In line with our model's predictions, we also show that this association is stronger for medicines with lower elasticity of substitution, more expensive varieties or varieties of multiproduct suppliers. Our results are robust to alternative specifications of the model and proxy for bargaining power. In line with the theoretical prediction, retail prices, that is, the prices consumers pay, do not decrease in response to an increase in quantity discounts received by the retailers, indicating that the benefits of quantity discounts are not passed on to the consumers via lower prices. These additional results are consistent with the theoretical model.

Our study makes several contributions. First, we contribute to the literature on buyer power by studying a case where suppliers compete, and retailers are effectively a monopsony. Using wholesale prices for antibiotics sold to US drugstores, Ellison and Snyder (2010) show that the extent of price discounts larger drugstores receive from pharmaceutical firms depends on the presence of competition among suppliers, indicating that buyer

power does not always guarantee price discounts. Furthermore, they find that the extent of price discounts is greater for hospitals compared to drugstores because hospitals purchase in larger quantities and therefore can induce greater competition among suppliers. We are the first to study quantity discounts for an entire industry and show that lower supplier bargaining power in a region also leads to more quantity discounts in our context but not lower retail prices.

Second, we contribute to the literature of uniform pricing in heterogeneous geographic markets by studying the case of coordinated bargaining on prices in the Indian pharmaceutical industry. Uniform pricing is observed in many industries, across and within firms, and has relevant implications on consumer welfare (DellaVigna and Gentzkow, 2019; Antonecchia and Bhaskarabhatla, 2023). However, no study has focused on the vertical relationship between supplier and retailer. We show that the bargaining power of the regional retailers that cannot be exerted on prices spills over into nonprice outcomes, such as quantity discounts. This mechanism contributes to offset the profit gap for the regional retailers created by the uniform pricing, without lowering the price for the consumers. Nonetheless, quantity discounts under uniform pricing help preserve resale price maintenance and the stability of the trade association.

Third, we contribute to the literature on market power in the pharmaceutical industry (Lakdawalla, 2018; Scott Morton and Kyle, 2011) by examining the case of India and the role of the retail trade association. The trade association is made up of 850,000 pharmacies whose entry is regulated and ownership is distributed among small mom-and-pop businesses. As individual pharmacies in India do not directly negotiate any quantity discounts with pharmaceutical firms, our study points to the role of the buyer power exercised by the trade association in maintaining higher consumer prices and the need for closer scrutiny of the association's vertical practices (Genesove and Mullin, 2001, 2007; Levenstein and Suslow, 2006; CCI, 2013).

The rest of the paper is organized as follows. Section 2 contains institutional background and Section 3 contains the model and its testable predictions. We present data and descriptive statistics in Section 4 and test the predictions of the model in Section 5. Section 6 concludes.

2 Institutional Background

The theoretical modeling of the bargaining between the pharmaceutical industry and retailers closely matches the empirical context of the Indian pharmaceutical industry, featuring a nationwide retailer association, the All India Organization of Chemists and Druggists (hereafter AIOCD), with significant countervailing power for several reasons. First, the AIOCD forms the *exclusive* distribution channel through which pharmaceutical firms reach consumers. Previous efforts of pharmaceutical firms to circumvent the AIOCD and reach consumers directly either through online pharmacies, physicians, or direct sales to hospitals led the AIOCD to undertake coordinated and nationwide sales boycotts.[4] As a result of these boycotts pharmaceutical firms abide by the restrictive vertical trade practices exercised by the AIOCD (Bhaskarabhatla et al., 2016). Therefore, the AIOCD acts as a gatekeeper in local markets by regulating the entry of pharmaceutical products.

Second, the AIOCD has operated as an "open price" trade association imposing minimum thresholds for trade margins that lead suppliers to set uniform wholesale and retail prices and guaranteed retailer margins (CCI, 2013).[5] The AIOCD also punishes pharmaceutical firms that violate those margins with product sales boycotts by cutting off their product supplies (Bhaskarabhatla et al., 2016).

Third, the AIOCD has threatened to integrate backward in the past by introducing private labels, further strengthening its bargaining position.[6] Reflecting the significant bargaining power of the AIOCD, the pharmaceutical industry trade associations for domestic and foreign suppliers reached an agreement in 1982 that guarantees a minimum of

[4]Since at least 1980, no pharmaceutical firm in India would be allowed to launch a new drug without obtaining a "no objection certificate" from the AIOCD (Bhaskarabhatla, 2020; Singh, 1981, 1984). Firms that offered lower than acceptable retailer margins were boycotted (Singh, 1984): "The Sandoz boycott, typical of the "disciplinary" action being taken by Shah and Umedchand, began when Wander Pharmaceuticals, an associate company - both are owned by the multinational Sandoz - sacked three wholesalers who were unwilling to accept reduced margins on some drugs." Such restrictive trade practices were not limited to the pharmaceutical industry but extended to several other industries in India (Rao and Sastry, 1989)

[5]Open price trade associations, such as the Sugar Institute, operational during 1928-1936 in the US, required members to sell upon open prices and publicly announced terms, abolished price discrimination, and prohibited rebates to customers such that large customers like Coca Cola and Kroger paid the same price as a small customer (Genesove and Mullin, 2001, 2007). The open price regime in India is facilitated by India's maximum resale price maintenance laws that mandate the printing of the maximum resale price (MRP) on medicine packaging (Bhaskarabhatla, 2020). Maximum resale price maintenance denotes a supplier contract that specifies a retail price ceiling. Under this arrangement, a retailer cannot sell a particular product for more than a prespecified amount (Shaffer, 1991).

[6]India's AIOCD Ltd offers private label generics (Pharmaletter, 2010).

30 percent margin for unregulated medicines and 24 percent margin for price-controlled medicines (Bhaskarabhatla et al., 2016).

Consistent with the open price regime imposed by the AIOCD on the pharmaceutical firms in India, our data reveal little variation in prices. Specifically, product prices remain constant across regions, indicating that product prices are uniform in our setting. Therefore, whether the concentration of countervailing buyer power in the retail trade association is beneficial to consumers is an important question for both policymakers and competition authorities in general, but particularly so in countries such as India (Dobson and Waterson, 1997). The pharmaceutical firms bear transportation costs, which is consistent with our theoretical model, and provide quantity discounts directly to the retailers. These discounts are measured by the AIOCD's own subsidiary, responsible for compiling data on the pharmaceutical industry, and measured at the retailer level along with prices and quantities on a monthly basis.

In the empirical section, we use data obtained from a subsidiary unit of the AIOCD, which competes with other data providers such as IMS Health, to test the prediction of our theoretical model.

3 Theory

Our theory is broadly related to models of bargaining between suppliers and retailers taking into account the specific context of the pharmaceutical industry in India. Consistent with our institutional setting and empirical framework, suppliers produce one variety of a medicine that is sold to retailers in different regions. Both coordinated and decentralized bargaining models are examined where (i) decentralized bargaining involves bargaining between regional retailer pharmacies and suppliers over the wholesale price of a variety of a medicine, and (ii) coordinated bargaining refers to bargaining which takes place at the national level. With decentralized bargaining, the wholesale and retail prices are region-specific while coordinated bargaining results in a nationwide wholesale and retail price. As the bargaining powers of retail pharmacies and the pharmaceutical industry appear to be region-specific, optimal retail and wholesale prices differ across regions with decentralized bargaining. Coordinated bargaining subsequently yields unstable outcomes, as regions with high retail bargaining power will opt out and start bargaining on their

own.[7] To avoid such a scenario, suppliers will try to compensate retail pharmacies in regions with high retail bargaining power. Here is where the specific focus and contribution of this paper come in: this compensation is done through quantity discounts of the pharmaceutical suppliers to retailers.

The theoretical part is structured as follows. In Section 3.1 we model how suppliers and retailers set the wholesale and the retail price of each product variety with decentralized bargaining. In Section 3.2 we examine the same setup but with coordinated bargaining. Section 3.3 introduces quantity discounts as a means to compensate powerful retailers which are worse off with coordinated bargaining. In Section 3.4 we develop additional implications of the model and discuss possible extensions in Section 3.5.

3.1 Decentralized bargaining over wholesale price

Demand. A monopolistically competitive manufacturer produces one variety i of a medicine and sells it to a number of regional retailers. Retailers, located in the region j and selling the variety, bargain with the manufacturer on a regional wholesale price (w_{ij}) and set a regional retail price (p_{ij}). Regional consumers maximize their utility subject to a budget constraint and with a constant elasticity of substitution between the differentiated varieties of the medicine. Demand for a variety i of a medicine in region j can be written as:

$$q_{ij}(p_{ij}) = A_j p_{ij}^{-\sigma} \tag{1}$$

where σ stands for the country-wide elasticity of substitution across varieties within the medicine. In this equation, the constant can be written as $A_j = Y_j P_j^{\sigma-1}$, where P_j equals the regional price index of the medicine and Y_j is the exogenously determined total amount spent in the medicine market Dixit and Stiglitz (1977).[8]

Suppliers and regional retailers. The regional retailer bargains with each supplier

[7] Coordinated bargaining is different from centralized bargaining in the sense that the payoff with centralized bargaining is at the national level and regions would not matter. A union would maximize the national payoff with respect to a decision variable, e.g., wages. With coordinated bargaining, an association maximizes the sum of the regional Nash bargaining payoffs with respect to the same decision variable; see (Holden, 1988) for further discussion of central and local bargaining.

[8] The regional price index can be written as $P_j = \left(\sum_{i=1}^{N_j} p_{ij}^{1-\sigma}\right)^{\frac{1}{1-\sigma}}$. The number of firms/varieties in a region (N_j) is assumed to be large enough so that the firms take the price index as given. The exogeneity assumption of Y_j is appropriate for the pharmaceutical industry where demand for a medicine is due to the therapeutic need of the medicine and not to the number of firms serving the market.

over the wholesale price (w_{ij}) and maximizes profit with respect to the retail price, knowing w_{ij}. Therefore, the optimal outcome for the wholesale price and the retail price can be seen as the solution to a two-stage game where in the first stage the supplier and the regional retailer bargain over the regional wholesale price, and in the second stage the retailers set the regional retail prices. For variety i of the medicine in region j the retailer bears a variable cost corresponding to the wholesale price (w_{ij}), while the supplier bears a region-variety-specific fixed cost (F_{ij}) and a marginal cost of production (c), which is the same across all varieties and regions.[9] Similar to the model of Montagna (1995), only those suppliers for whom the operating profit is higher than the fixed cost will be active in the market.[10]

As the game is sequential, where there is first bargaining over the wholesale price and then retailers set the retail price, it is solved by backward induction. The regional retailer sets the regional price conditional on the regional wholesale price bargained with the supplier. Retailer's regional profit can be written as

$$\pi_{ij}^{R} = p_{ij} q_{ij}\left(p_{ij}\right) - w_{ij} q_{ij}\left(p_{ij}\right) \tag{2}$$

Maximizing the regional profit of the retailer with respect to its price gives:

$$p_{ij}^{*} = \frac{\sigma}{\sigma - 1} w_{ij} \tag{3}$$

Demand at the optimal price is equal to $q_{ij}^{*} = A_j \left(\frac{\sigma w_{ij}}{\sigma - 1}\right)^{-\sigma}$ and the maximized retailer's profit is equal to $\pi_{ij}^{R*} = \frac{A_j}{\sigma - 1} \left(\frac{\sigma}{\sigma - 1}\right)^{-\sigma} \left(w_{ij}\right)^{1-\sigma}$.

Bargaining. In the first stage of the game, the regional retailer and the supplier negotiate over the regional wholesale price for variety i. In the Nash bargaining game, regional retailers make profit π_{ij}^{R*} and the supplier makes profit $\pi_{ij}^{M*} = \left(w_{ij} - c\right) A_j \left(\frac{\sigma w_{ij}}{\sigma - 1}\right)^{-\sigma} - F_{ij}$. The Nash bargaining outcome for w_{ij} would be the outcome of:

$$\max_{w_{ij}} \left(\pi_{ij}^{R*}\right)^{\beta_{ij}} \left(\pi_{ij}^{M*} - \overline{\pi}_{0}^{M}\right)^{1-\beta_{ij}} \tag{4}$$

[9] The fixed cost (F_{ij}) varies across regions and determines the profitability, entry and survival of the variety in the region. This can be exemplified as a transport cost, see DellaVigna and Gentzkow (2019) or Antonecchia and Bhaskarabhatla (2023).

[10] Our model introduces heterogeneity in the variable costs of the retailer, but, unlike in the model by Melitz (2003) who introduced random productivity differences across firms as random differences in variable costs, the model endogenizes differences in variable costs by accounting for differences in firm bargaining power. Our model is similar in nature to Eckel and Egger (2009) who examined firms producing differentiated goods and negotiating with unions over the wage cost.

where β_{ij} denotes the bargaining power of the retailers in variety i in region j and $1 - \beta_{ij}$ equals the bargaining power of the supplier in variety i in region j. Note that the threatpoint, or the disagreement profit, for the supplier is equal to $\overline{\pi}_0^M = -F_{ij}$ as the fixed cost is already sunk when the firm starts the negotiations.

Equilibrium. Maximizing the Equation (4) leads to

$$\max_{w_{ij}} (w_{ij})^{\beta_{ij}-\sigma} (w_{ij} - c)^{1-\beta_{ij}} \tag{5}$$

whose first order condition gives

$$w_{ij}^* = \frac{\sigma - \beta_{ij}}{\sigma - 1} c \tag{6}$$

showing that wholesale prices are a decreasing function of the elasticity of substitution. The regional retail price can now be written as $p_{ij}^* = \frac{\sigma}{\sigma-1}\frac{\sigma-\beta_{ij}}{\sigma-1}c$, which is also a decreasing function of the elasticity of substitution. If the regional retailers have all the bargaining power ($\beta_{ij} = 1$) then they will pay the supplier only the marginal cost. If the supplier has all the bargaining power in the region ($\beta_{ij} = 0$) then the supplier will charge the monopoly price.

Assuming the elasticity of substitution between varieties of the same medicine is greater than one ($\sigma > 1$), these results show that varieties with higher retail bargaining power in the region have lower wholesale and retail prices, lower producer markup ($\frac{w_i}{c}$), unaltered retail markup ($\frac{p_i}{w_i}$), lower supplier profits and higher retail profits. These results are valid both within variety across regions—variety i has a lower wholesale price in the regions where it has higher retail bargaining power than in the regions where it has lower bargaining power—and within a region across varieties—variety i has lower a wholesale price than variety h if in the same region variety i has higher retail bargaining power than variety h.

Competition. One variety is supplied in a region only if it generates profits for the supplier. Variety i is supplied in region j only if the bargaining power β_{ij} is such that the wholesale price w_{ij} is high enough to cover the fixed costs of the supplier F_{ij}. This requires β_{ij} to be lower than a $\overline{\beta}_{ij}$ threshold above which variety i has negative supplier profits in region j and would not be supplied. The higher this threshold the higher the probability that $\beta_{ij} < \overline{\beta}_{ij}$. The number of varieties supplied in region j (N_j) is given by

the number of varieties with $\beta_{ij} < \overline{\beta}_{ij}$.

$$N_j = \sum_i 1[\pi_{ij}^M(\beta_{ij}) > 0] = \sum_i 1[\beta_{ij} < \overline{\beta}_{ij}] \tag{7}$$

Therefore, the regions with higher average $\overline{\beta}_{ij}$ and, consequently, higher average β_{ij}, are also those served by more varieties and with lower supplier concentration.[11] To formalize this result, consider β_{ij} as a function of three components: i) β_i = average retail bargaining power of the variety across all regions; ii) β_j = average retail bargaining power of the region across all varieties; iii) b_{ij} = variety-region specific additive component with expected value zero. In formula:

$$\beta_{ij} = f(\beta_i, \beta_j) + b_{ij} \tag{8}$$

where β_i can be interpreted as the appeal of the variety in the country. Since β_i does not vary across regions and b_{ij} is expected to be null, the expected number of varieties supplied in a region is a function of the average bargaining power of the regional retailers:

$$E[N_j] = \phi(\beta_j) \tag{9}$$

which entails that supplier concentration is an inverse function of β_j.[12]

3.2 Coordinated bargaining over wholesale price

Demand. Whereas the previous subsection examined bargaining at the regional level, we now consider the case of coordinated bargaining where a nationwide retail trade association coordinates bargaining efforts for a nationwide wholesale price (w_i) and sets a uniform country-level retail price (p_i). Demand for variety i of a medicine in region j remains as in Equation (1) with the only difference that the retail price is the same in all

[11] As an example, suppose that the fixed cost is the same for all the varieties within the region, $F_{ij} = F_i$. In such a case $\overline{\beta}_{ij}$ would be the same for all the varieties within the region, $\overline{\beta}_{ij} = \overline{\beta}_j$. All the varieties with a β_{ij} lower than the threshold will be supplied in the region. The higher this threshold, the higher the average β_{ij} of the region, the more the varieties that will be available in the region, the lower the concentration.

[12] Our analysis considers the steady state. Montagna (1995) explains how in a setting like ours firms incumbents stay in the market as long as it is profitable and potential entrants all face the same ex-ante uncertainty about their level of bargaining power and fixed cost. Uncertainty disappears once firms pay an entry cost and values for their bargaining power and fixed cost are drawn from a random distribution.

regions.[13]

Suppliers and retailer association. Also supplier cost conditions (c and F_{ij}) are the same as in the decentralized case. The difference is that the retail trade association maximizes the aggregated profit with respect to the uniform retail price, after having bargained over a nationwide w_i. Therefore, the optimal outcome for the wholesale price and the retail price can be seen again as the solution to a two-stage game where in the first stage the supplier and the retail association bargain over the manufacturer price, and in the second stage, the retail association sets the price.

With a uniform wholesale and retail price, the retailer's regional profit can be written as $\pi_{ij}^R = p_i q_{ij}(p_i) - w_i q_{ij}(p_i)$. The trade association maximizes total national retail profit with respect to its price:

$$\max_{p_i} \sum_j \pi_{ij}^R \tag{10}$$

The optimal uniform retail price for variety i is:

$$p_i^* = \frac{\sigma}{\sigma - 1} w_i \tag{11}$$

Regional demand at the optimal uniform price is equal to $q_{ij}^* = A_j \left(\frac{\sigma w_i}{\sigma - 1}\right)^{-\sigma}$ and the maximized retailer's profit is equal to $\pi_{ij}^{R*} = \frac{A_j}{\sigma - 1} \left(\frac{\sigma}{\sigma - 1}\right)^{-\sigma} (w_i)^{1-\sigma}$.

Bargaining. In the first stage of the game, the retail trade association and the supplier negotiate the wholesale price. In the Nash bargaining game, both the suppliers and the retail association consider the sum of all their regional profits over variety i. The regional retailers have profit π_{ij}^{R*} and the supplier has profit ${\pi^M}_{ij}^* = (w_i - c) A_j \left(\frac{\sigma w_i}{\sigma - 1}\right)^{-\sigma} - F_{ij}$. The Nash bargaining outcome for w_i would be the outcome of

$$\max_{w_i} \sum_j \left(\pi_{ij}^{R*}\right)^{\beta_{ij}} \left({\pi^M}_{ij}^* - \overline{\pi}_0^M\right)^{1-\beta_{ij}} \tag{12}$$

where we assume variation in β_{ij} across regions. Note again that the threat point, or disagreement profit, for the supplier is equal to $\overline{\pi}_0^M = -F_{ij}$ since the fixed cost is already sunk when the suppliers starts the negotiations.

[13] Despite the country-wide uniform (wholesale and retail) price, the regional price index of the medicine (P_j) varies across regions because of the different varieties sold in each region.

Equilibrium. Maximizing Equation (12) corresponds to:

$$\max_{w_i} \sum_j Aj \left(w_i\right)^{\beta_{ij}-\sigma} \left(w_i - c\right)^{1-\beta_{ij}} \tag{13}$$

which, comparing the equation with equation (5), means maximizing a weighted average of the regional Nash bargaining payoffs. The maximization function can be approximated by

$$\max_{w_i} \sum_j \left(w_i\right)^{\beta_i^A-\sigma} \left(w_i - c\right)^{1-\beta_i^A} \tag{14}$$

where β_i^A, with $\min_j \beta_{ij} < \beta_i^A < \max_j \beta_{ij}$, denotes the bargaining power of the retailer association in variety i across all regions and $1 - \beta_i^A$ equals the bargaining power of the supplier in variety i across all regions.[14] The first order condition for maximization gives

$$w_i^* = \frac{\sigma - \beta_i^A}{\sigma - 1} c \tag{15}$$

The equation shows again that wholesale prices are a decreasing function of the elasticity of substitution. Note that equation (15) corresponds to equation (6) if $\beta_{ij} = \beta_i^A$. The retail price can now be written as:

$$p_i^* = \frac{\sigma}{\sigma - 1} \frac{\sigma - \beta_i^A}{\sigma - 1} c \tag{16}$$

which is again a decreasing function of the elasticity of substitution. If regional retailers have heterogeneous bargaining power over variety i, whatever the functional form of β_i^A, the uniform wholesale price of the variety would be different from the optimal wholesale price of the variety if decentralized bargaining was in place. In fact, retailers a region with a retail bargaining power higher than that of the association ($\beta_{ij} > \beta_i^A$) would be forced to pay a higher price than their regional optimal wholesale price ($w_{ij} < w_i$) and set a higher than optimal retail price ($p_{ij} < p_i$). This would reduce regional retailers' profits and make coordinated bargaining unstable as the regions with the highest bargaining power would be better off with decentralized bargaining.

As in the decentralized bargaining case, assuming that the elasticity of substitution is greater than one ($\sigma > 1$), varieties in which the trade association has a higher bargaining

[14] β_i^A can be interpreted as the bargaining power of the national retail association in a centralized Nash bargaining game. The functional form of β_i^A can be general: $\beta_i^A = f(\beta_i) + b_i^A$, where β_i is the average retail bargaining power of the variety across all regions - or the variety appeal, like in Equation (8) - and b_i^A a variety-specific additive component.

power have lower wholesale and retail prices, a lower supplier markup ($\frac{w_i}{c}$), an unchanged retail markup ($\frac{p_i}{w_i}$), a lower supplier profits and higher retail profits. These results are valid only across varieties within region as one variety has uniform price across regions.

Competition. Likewise the decentralized bargaining case, one variety is supplied in a region only if it generates profits for the supplier. The difference is that here the bargaining power that determines the wholesale price is uniform across all regions (β_i^A) but the threshold above which variety i has negative supplier profits in region j varies across regions ($\overline{\beta}_{ij}$) as it depends on the regional-specific fixed costs (F_{ij}). The number of varieties supplied in region j (N_j) is given by the number of varieties with $\beta_i^A < \overline{\beta}_{ij}$.

$$N_j = \sum_i 1[\pi_{ij}^M(\beta_i^A) > 0] = \sum_i 1[\beta_i^A < \overline{\beta}_{ij}] \tag{17}$$

This result does not alter the result in Equation (9) for which the higher the average bargaining power of the region, the more the varieties supplied. The only difference is that, in the coordinated bargaining scenario, the average bargaining power of the region is that of the trade association and no longer that of the regional retailers. The average bargaining power of the varieties changes across regions because every region has a different set of varieties supplied.

3.3 Quantity discounts

As coordinated bargaining yields an unstable outcome, suppliers may compensate the regional retailers with greater bargaining power. In this section, we will consider a quantity discount, which has the significant advantage of maintaining uniform pricing, for such an implicit monetary transfer. When the supplier gives a quantity discount of $100x_{ij}\%$ to the regional retailer j for variety i, the retailer can sell a fraction x_{ij} of the quantity sold without paying w_i.

The quantity discount can compensate for the missing profits of the regional retailers with higher bargaining power than that of the retail association. To fully restore the differences in regional bargaining power of those retailers, discounts should be the amount of quantity not paid by the regional retailers that yield the same profits as in the decentralized bargaining scenario:

$$p_{ij}(w_{ij})q_{ij}(p_{ij}) - w_{ij}q_{ij}(p_{ij}) = p_i(w_i)q_{ij}(p_i) - w_iq_{ij}(p_i)(1 - x_{ij})$$

Solving for x_{ij} gives:

$$x_{ij}^{*} = \frac{1}{\sigma - 1}\left[\left(\frac{\sigma - \beta_{ij}}{\sigma - \beta_i^A}\right)^{1-\sigma} - 1\right] \tag{18}$$

In Figure 1, the y-axis reports the quantity discounts that should be given at different levels of β_{ij} (x-axis) when $\beta_i^A = 0.4$ (Panel A) and $\beta_i^A = 0.6$ (Panel B) for an elasticity of substitution of 4, 6 and 8.

The equation yields three hypotheses, which we will test in our empirical analysis.

Hypothesis 1: *A variety offers more quantity discounts in regions with a higher retailer bargaining power.*

Hypothesis 1 relates to the differences in bargaining power across regions and the uniform coordinated bargaining power of each variety. The equation shows that the smaller the bargaining power gap between the regional retailer and the trade association, the smaller the extent of quantity discounts given as compensation. Obviously, discounts are given only when $\beta_{ij} > \beta_i^A$. As an example, consider the case in which the bargaining power of the retail association is equal to 0.4 and the elasticity of substitution is equal to 4 (Figure 1, Panel A, solid line). If the bargaining power of the regional retailer is also 0.4 the discounts will be zero because the wholesale price has been set optimally for the regional retailers. If the bargaining power of the regional retailer is higher than 0.4, say 1 (that is, the bargaining power rests entirely with the retailers), then a 24 percent quantity discount should be given to the regional retailers to compensate for the higher wholesale price paid.

Hypothesis 2: *The difference in bargaining power between regional retailers and the trade association induces more quantity discounts in medicines with lower elasticity of substitution.*

Hypothesis 2 is based on the result that quantity discounts are a decreasing function of the elasticity of substitution. This originates from the result that wholesale and retail prices are a decreasing function of this elasticity (Equation (15) and (16)). It is assumed that all varieties of the same medicine have the same elasticity of substitution and within and across regions. Therefore, regional retailers with significant bargaining power would obtain a relatively higher return when the elasticity of substitution is lower, and hence would need a higher compensation for giving up this higher regional bargaining power. It follows that medicines with a higher elasticity of substitution have a lower retail price at

the national level and, given the bargaining power of the regional retailers and the trade association, have less discounts. This effect is exemplified in both panels of Figure 1. For any given bargaining power gap between regional retailers and the trade association, the higher the elasticity of substitution, the lower the discounts.

Hypothesis 3: *The difference in bargaining power between regional retailers and the trade association induces more quantity discounts for varieties with higher bargaining power of the trade association.*[15]

The intuition behind Hypothesis 3 is similar to the one underpinning Hypothesis 2 but instead of operating across medicines it operates across varieties within the medicine-region. Varieties in which the retail association has significant bargaining power would have relatively lower wholesale price, and hence higher revenues and profits than their competing varieties. A marginal difference in non-exerted bargaining power implies a bigger profit loss for the regional retailer when the coordinated bargaining power is higher. Consequently, the compensation in terms of discounts required by the regional retailers will also be higher. So, given the bargaining power gap between regional retailers and the retail association, varieties with a higher bargaining power of the trade association have relatively higher discounts. This effect is exemplified in Figure 1. For the same bargaining power gap between regional retailers and the trade association, discounts are higher in Panel B - where the coordinated bargaining power is 0.6 - than in Panel A - where the coordinated bargaining power is 0.4.

3.4 Other implications of the model

3.4.1 Quantity discounts versus price discounts

A natural question that arises is whether suppliers in our model can offer equivalent price discounts instead of quantity discounts. Quantity discounts offer unique and significant advantages over price discounts. To establish this insight, we need to quantify the excess profits that retailers in regions with strong bargaining power receive through quantity discounts. The unit value of the quantity discount is equal to the discount per unit

[15]This hypothesis might not be intuitive when looking at Equation (18), as a a higher β_i^A might stem form a higher appeal for the variety β_i that in turns generates a higher β_{ij}. To observe the effect of an increase in β_i^A, given the difference in bargaining power between regional retailers and the trade association, it is convenient to rewrite $\beta_{ij} = \beta_i^A + B_{ij}$, where B_{ij} is the difference in bargaining power between regional retailers and the trade association. Then, for a given $B_{ij} > 0$, an increase in β_i^A affects discounts positively.

quantity, as derived in Equation (18) multiplied with the wholesale price, as derived in Equation (15), and is equal to $\frac{1}{\sigma-1}\left[\left(\frac{\sigma-\beta_{ij}}{\sigma-\beta_i^A}\right)^{1-\sigma}-1\right]\frac{\sigma-\beta_i^A}{\sigma-1}c$. The total value of the discount is the unit value multiplied by the demand $q_{ij}^* = A_j\left(\frac{\sigma}{\sigma-1}\frac{\sigma-\beta_i^A}{\sigma-1}c\right)^{-\sigma}$. The expression for the value of the quantity discount shows that it is increasing in the relative regional bargaining power, the regional demand, while decreasing in the production cost and the elasticity of substitution. Therefore, the monetary compensation takes into account the (excess) regional bargaining power, the level of regional demand, the production cost, and the elasticity of substitution, which is related to the market power of the variety. Whereas increased elasticity of substitution reduces the price and increases demand, it also reduces the unit value of the quantity discount in a way that the total value of the quantity discount is decreasing in the elasticity of substitution. Therefore, quantity discounts offer several advantages over price discounts. First, a significant advantage of such a quantity discount is that it can take into account cost, demand, and bargaining conditions without an explicit financial transfer. Second, quantity discounts maintain uniform wholesale and retail prices. By contrast, price discounts would entail lower input prices for the retailers which would be passed on to consumers as retailers increase market share and maximize profit. Furthermore, as a consequence, price discounts would become observable to everyone and would give room for undesirable renegotiation and trade between regions to exploit these price differences.

3.4.2 Quantity discounts and consumer prices

The model yields additional insights that merit discussion. We begin with a summary of the winners and losers in the model. The coordinated bargaining with quantity discounts benefits all retailers regardless of their bargaining power, as the retailers across all regions are represented by a single union. Specifically, retailers with a relatively weak bargaining power benefit in this scenario, as they pay a relatively lower wholesale price negotiated in a coordinated way. The retailers with a relatively strong bargaining power maintain their profitability as they benefit from the additional quantity discounts they receive even when the wholesale price remains at the same coordinated level. On the contrary, coordinated bargaining lowers the profits of suppliers, as they transfer surplus to retailers with significant bargaining power. Surprisingly, consumers in our model are unaffected by these transfers, as they still pay a uniform price which is higher (lower) in regions with relatively strong (weak) retailer bargaining power as compared to the case of decentralized

bargaining. In other words, the use of quantity discounts by suppliers enriches retailers with relatively strong bargaining power, but the benefits of quantity discounts are *not* passed on to consumers through lower consumer prices.

3.4.3 The incentives and costs of giving quantity discount

The previous discussion makes it clear that retailers have an incentive to bargain in a coordinated way over wholesale and retail prices. Furthermore, suppliers also have an incentive to offer quantity discounts and prevent decentralized bargaining. This is because, under decentralized bargaining, regional retailers would exploit their regional bargaining power resulting in different wholesale and retail prices. Therefore, in this case, there will also be trade between regions to exploit these price differences. Furthermore, there will be a high organizational cost when firms need to negotiate with many different parties instead of a coordinating organization. On top of that, different prices would require different packaging and labeling, resulting in a higher operating cost for the suppliers. Therefore, in line with DellaVigna and Gentzkow (2019) there is a strong incentive for suppliers to employ uniform pricing. Finally, suppliers prefer coordinated bargaining because under this regime, a strong retail trade association such as the AIOCD guarantees resale price maintenance for suppliers through its retaliatory and exclusionary vertical practices.

While we have derived the costs of providing quantity discounts, which is proportionate to the market, the benefits of providing these discounts to prevent a break-up in the negotiations, as discussed in the previous paragraph, will be proportional to these costs. When there is a fixed cost associated with giving quantity discounts, discounts will not be provided when the value of the demand is below a threshold. In this case, the market is not very profitable as demand is relatively low. Therefore, there will be a positive relationship between regional sales and the strategy of providing quantity discounts.

3.4.4 Discounts help retail trade association stability

An important implication of our model concerns the role of quantity discounts in stabilizing the trade association. Regional retailers for whom $\beta_{ij} < \beta_i^A$ enjoy lower wholesale prices with coordinated bargaining. Regional retailers for whom $\beta_{ij} > \beta_i^A$ can obtain compensation for the higher wholesale price with centralized bargaining through quantity discounts. This allows for a trade association to form across regions with different strengths

in terms of their individual bargaining power to organize as a single organization at the national level and operate under uniform pricing regime. The trade association would also proliferate more variety as firms would not sell in regions with strong bargaining power when there is decentralized bargaining. With coordinated bargaining, this region may sell the variety when it is compensated for the non-exerted bargaining power. If the region with strongest bargaining power does not sell the variety under coordinated bargaining, it may be the case that a variety does not offer any discounts, which is consistent with the evidence that not all varieties give discounts.

3.5 Model extension to multiproduct suppliers

In the pharmaceutical industry suppliers might produce more product varieties across different medicines. We extend the model to study if discounts change when a supplier is a multiproduct firm. These suppliers bargain with the trade association on the wholesale price of multiple product varieties and might have a higher bargaining power compared to suppliers bargaining for one variety.

Suppose the regional retailer bargaining power of variety i of supplier s to be composed similarly as from Equation (8) but with an additional supplier-level component β_s:

$$\beta_{isj} = f(\beta_i, \beta_s, \beta_j) + b_{isj} \tag{19}$$

Also the bargaining power of the trade association will incorporate a supplier-level component β_s:

$$\beta^A_{is} = f(\beta_i, \beta_s) + b^A_{is} \tag{20}$$

We assume that multiproduct suppliers have higher bargaining power than single-product ones. Therefore we assume that the component β_s is higher for single-product suppliers than for multiproduct suppliers.

The equilibrium outcomes in both decentralized and centralized cases are the same functions as the ones in Section 3.1 and 3.2 but with β_{isj} instead of β_{ij} and β^A_{is} instead of β^A_i. The discount compensation solution takes the formula:

$$x^*_{ij} = \frac{1}{\sigma - 1}\left[\left(\frac{\sigma - \beta_{isj}}{\sigma - \beta^A_{is}}\right)^{1-\sigma} - 1\right] \tag{21}$$

Considering the assumption above (β_s is lower for multiproduct firms), we have that β_{is}^A is lower for multiproduct firms. Following the same intuition as for Hypothesis 3 in Section 3.3, we derive that for a given difference in bargaining power between regional retailers and the trade association, a lower bargaining power of the association would reduce discounts. Like as Hypothesis 3, we can formulate a hypothesis for multiproduct suppliers that operates across varieties within the medicine-region: *the difference in bargaining power between regional retailers and the trade association induces less quantity discounts for varieties belonging to the supplier serving more varieties.* This hypothesis is valid for suppliers that offer more varieties both within the same medicine market and in different medicines.

4 Data and descriptive evidence

4.1 Data

We use data obtained from India's retail pharmacy trade association, the AIOCD, for the period March 2007 through June 2013. The AIOCD data represent the census of pharmaceutical firms in India and span the whole country, divided into 23 regional medicine markets. The data contain monthly wholesale and retail prices and quantities of drugs sold in each of the regional markets in India and their monthly quantity discounts for 76 months. The data are compiled by the AIOCD's own subsidiary through sales audits of the retailers. For each of the 85,384 varieties identified by a unique stock keeping unit (SKU), we observe a detailed description of the medicine, including the active ingredient (e.g., paracetamol, atorvastatin), delivery form (e.g., injection, tablet), dosage strength (e.g., 10 mg, 100 ml) and package size (number of tablets, syringes, etc.). The data contain nearly 35.4 million variety-region-month observations, spanning 681 firms, 23 regions, and 18,079 medicine formulations, defined as the combination of active ingredients, dosage form, and drug strength (Table 1). We use the terms medicines, medicine formulations, and products interchangeably. Within each medicine market, varieties differ by brand or pack size.

4.2 Descriptive statistics on quantity discounts

We define confidential quantity discounts as the quantity of units given by the manufacturer to the retailer free of charge, as reported in the AIOCD data.[16] We measure such quantity discounts: (i) at the extensive margin as the share of variety-region-month observations giving quantity discounts (*Share of products discounted*); and (ii) at the intensive margin as the ratio between the units given as quantity discounts and those purchased at wholesale prices by retailers, considering only the observations giving quantity discounts (*Discounted-to-undiscounted ratio*). In our sample, 9.2 percent of the variety-region-month observations offer quantity discounts and, among them, the discounted-to-undiscounted ratio is 15.8 percent (that is, for every six units sold, one is given for free). A variety does not offer discounts uniformly in all regions and there is considerable cross-sectional heterogeneity in the discounting practices within a variety. On average, 19.7 percent of the varieties offer quantity discounts monthly. Table 2 shows that quantity discounts are region specific even when we aggregate products at the formulation or firm level. Discounts are given in 30.7 percent of the medicine formulations, but when considering formulations across regions, only 14.7 percent of them have varieties giving quantity discounts. At an aggregate level, almost two-thirds of the firms provide quantity discounts at the country level (that is, in at least one of the regions) and 38.6 percent do so when considered at the firm-region level.

The descriptive statistics presented in Table 2 indicate that quantity discounts are an important phenomenon in the Indian pharmaceutical industry. However, the practice of offering quantity discounts varies largely across regions. In Figure 2, we observe significant regional variation in both measures of quantity discounts. Quantity discounts are more commonly given by larger firms and for their best-selling medicines. Panels A and B of Figure 3 show that the firms and medicine formulations that offer discounts are on average 29 and 32 percent larger, respectively, than those not offering discounts.

We exploit the geographic disaggregation of the data and observe the same variety offering discounts in one geographic market and not in another. The model predicts that this depends on the bargaining power of the regional retailers. Following Galbraith (1952) and Ellison and Snyder (2010), we assume the bargaining power of retailers to have a negative relationship with supplier concentration and expect to observe a negative relationship

[16] Our data are aggregated at the variety-region-month level and not at the pharmacy level. Therefore, we cannot assess how individual pharmacy characteristics such as buyer size influence quantity discounts.

between discounts and supplier concentration. We plot the Herfindahl-Hirschman Index (HHI) at the region level and the share of firms giving quantity discounts in Figure 4. Consistent with our expectation, the figure shows that increasing levels of concentration are correlated with lower shares of firms giving quantity discounts as well as a lower share of quantity discounts relative to the undiscounted units sold. In Table A.1, in Appendix, we show that the same negative correlation is observed at the formulation, active ingredient-dosage form, and active ingredient levels.

Although one product variety can give a different share of discounts across regions, its price is the same across all regions. Wholesale and retail price vary largely across varieties but are uniform within variety across regions.[17]

5 Results

5.1 Testing the predictions of the model

We test the hypotheses derived from the model solution for discounts in Equation (18).

5.1.1 Hypothesis 1: How retail bargaining power affects discounts

Hypothesis 1 states that one variety offers more quantity discounts in regions with a higher retailer bargaining power. It follows Equation (18), in which a larger bargaining power gap between regional retailer and trade association generates more discounts. Since the bargaining power of the trade association for one variety is invariant across regions (β_i^A), a variety would give more discounts in the regions whose retailers have more bargaining power (β_{ij}).

Regional bargaining power is not a variable that can be observed. To address this issue, we refer to the findings in Ellison and Snyder (2010) who show that supplier competition is a prerequisite for the retailers to have bargaining power. We proxy regional bargaining power with a supplier concentration index of the regional medicine market. High supplier concentration signals low average regional bargaining power of the retailers. An additional recommendation to use supplier concentration to proxy for regional bargaining power comes from the model. From Equation (8) we can assume that β_i^A is a component of

[17] Table A.2, in Appendix, reports the moments of the distributions of HHI and prices.

β_{ij} and the difference between the two is a function of the average bargaining power of the varieties served in the region (β_j).[18] From Equation (9) and (17) we derive that the regional bargaining power of the medicine influences positively the number of varieties and, therefore, negatively the supplier concentration. In other words, the more concentrated is the formulation geographic market, the less retail bargaining power one variety has. Higher HHI (lower regional retail bargaining power), controlling for variety-time FE and region-time FE, is expected to correlate with lower discounts. To test Hypothesis 1, we estimate the following equation:

$$D_{ijt} = \alpha HHI_{gjt} + \gamma y_{gjt} + \theta_{it} + \delta_{jt} + \epsilon_{ijt}, \tag{22}$$

where D_{ijt} is either (i) a dummy taking value 1 when variety i in region j and month t gives quantity discounts; or (ii) the share of quantity discounts relative to the undiscounted units sold by variety i in region j and month t.[19] Our main explanatory variables are HHI_{gjt}, the HHI index at the formulation (g)-region(j)-month (t) level. The higher the regional HHI, the lower the bargaining power of the regional retailers, and the lower the quantity discounts they receive. We control for the regional sales (in logs) of the medicine formulation (y_{gjt}) and a set of fixed effects. Variety-month FE (θ_{it}) captures changes in the variety discount policy across regions or consumer preference for the variety or changes in the bargaining power of the association or changes in competition within a formulation at the national level (entry of national competitors). With the inclusion of variety-month FE we exploit the heterogeneity in discounts given by a variety across regions and relate it to the differences in regional supplier concentration of the formulation. We also control for region-month FE (δ_{jt}), capturing changes in regional policy (liberalization, taxes) and aggregate consumer tastes. According to Hypothesis 1 the parameter α is expected to be negative.

In Table 3, we report the estimated coefficients of Equation (22).[20] A variety is less likely to give quantity discounts in regions where the HHI index of the formulation is higher (Column 1-4). Similarly, on the intensive margin, a variety gives a lower share of discounts

[18] It is not necessary that β_i^A is the average retailer bargaining power of the variety across across all the regions. If it is larger or smaller only the distribution of the error term would change.

[19] The estimates in which the dependent variable is the discounted-to-undiscounted ratio are conducted on the sample of variety-region observations that have positive quantity discounts over the sample period.

[20] Despite both discount measures are limited dependent variables, linear models are recommended to avoid the incidental parameter problem, likely to occur when estimating many fixed effects using non-linear models on a large number of observations.

in regions where the HHI index of the formulation is higher (Column 5-8). The estimated coefficients remain negative and stable when introducing the explanatory variables one-by-one. Regional sales - exogenous variables in the model - are also positively correlated with the extent of quantity discounts given by a variety (Column 3 and 7). This rules out an alternative mechanism that predicts discounts to be given strategically to increase sales in markets with a lower aggregate demand. By including variety-region FE we control for variety-specific demand factors within the region and can capture the relationship between the changes in discounts and HHI over time for the same variety-region. This dynamic relationship is predicted to be negative as well. Columns 4 and 8 report in fact a negative relationship between HHI and discounts. The coefficients of our preferred specification, as from Equation (22), should be interpreted as follows: a 1 percent point increase in HHI in the formulation-region decreases the probability of a variety to be discounted in the region by 0.34 percent (Column 3) and the share of discounted units by 0.28 percent (Column 7). Alternatively, a variety supplied in a formulation-region with one standard deviation higher HHI has almost 1 percent lower probability of giving discounts and, when it gives discounts, they are 0.9 percent lower.[21]

5.1.2 Hypothesis 2: The effect of retail bargaining power depends on the elasticity of substitution

According to model prediction 2, the lower the elasticity of substitution in the formulation, the larger the effect of non-exerted bargaining power of regional retailers on discounts. Therefore, we test if higher concentration decreases discounts to a lesser extent when varieties in a formulation are more substitutable. In the model, the elasticity of substitution is the same for all varieties in the same formulation and is given by objective characteristics (exogenous in the model) that drive the consumer preferences. One can make a distinction using the state of matter of the drugs. The literature shows that solid drugs (tablets) are more substitutable than liquid (syrups), which are in turn more substitutable than injections.

[21]The intention of this empirical study is not to identify the causal relationship between HHI and discounts, as in the model they both depend on the bargaining power of the variety. The OLS estimates in Table 3 might suffer from a simultaneity bias lead by the mechanism for which discounts are given to stimulate product demand. Since the products that receive more discounts are those with larger demand and prices (see Table A.3 in Appendix), higher discounts would increase HHI and this simultaneity bias is positive. The coefficients estimated in Table 3 can be considered upper bounds of the causal effect.

To test Hypothesis 2 we estimate the following equation:

$$D_{ijt} = \alpha_1 HHI_{gjt} + \alpha_2 HHI_{gjt} \times Liq_g + \alpha_3 HHI_{gjt} \times Inj_g + \gamma y_{gjt} + \theta_{it} + \delta_{jt} + \epsilon_{ijt}, \qquad (23)$$

where Liq_g and Inj_g take value 1 when the drug formulation is liquid or injectable, respectively. Coefficient α_1 captures the effect of HHI when the drug formulation is solid. The coefficients α_2 and α_3 are also expected to be negative with $\alpha_3 < \alpha_2$.

Table 4 reports the results of the Hypothesis 2 test for both the extensive and intensive margin of discounts. HHI coefficient is negative in solid formulations (high substitutability) and larger in absolute terms in formulations with lower substitutability. This confirms the prediction stated in Hypothesis 2.

5.1.3 Hypothesis 3: The effect of retail bargaining power depends on the level of the association bargaining power

According to model prediction 3, the effect of non-exerted bargaining power of regional retailers on discounts is larger when the bargaining power of trade association is higher. We test this prediction considering that bargaining power of the trade association drives wholesale price. When the wholesale price of the variety is high the bargaining power of the association for that variety is low. Therefore, in regions with lower bargaining power of the retailers (higher HHI) we expect to observe less discounts for varieties with higher prices.

To test Hypothesis 3 we estimate the following equation:

$$D_{ijt} = \alpha_1 HHI_{gjt} + \alpha_2 HHI_{gjt} \times Hw_{ijt} + \alpha_3 Hw_{ijt} + \gamma y_{gjt} + \theta_{it} + \delta_{jt} + \epsilon_{ijt}, \qquad (24)$$

where Hw_{ijt} takes value 1 when variety i has a price above the median of the formulation in region j. Both α_1 and α_2 are expected to be negative.

Table 5 reports the results of the Hypothesis 3 test for both the extensive and intensive margin of discounts. Higher HHI is negatively associated with discounts for varieties with both lower and higher wholesale prices than the median. The significance of coefficient α_2 implies that in regions where HHI is higher, the discounts are lower for varieties with a higher wholesale price than the median (lower trade association bargaining power). This confirms the prediction stated in Hypothesis 3.

5.2 Robustness analysis

Robustness of H1 test. From Equation (17) we derive that the regional bargaining power of the medicine influences positively the number of varieties and, therefore, negatively the supplier concentration in the regional market. As an alternative to supplier HHI, the number of product varieties competing in the region-formulation would also proxy for the differences in regional bargaining power of retailers. In this case, however, a higher number of varieties implies stronger competition and we expect it to be positively correlated with the discounts. The results reported in Table A.4, in Appendix, confirm the model prediction.

Robustness of H2 test. In Equation (23) we use the state of matter of the drug to proxy for different elasticities of substitution across drugs. Another possibility is to distinguish between medications used to treat acute and chronic diseases using a classification developed by the AIOCD based on short-term versus long-term use and interact HHI with a dummy signalling drugs that treat an acute disease. Medicines for acute disease treatment are supposed to have a lower elasticity of substitution as they are used for immediate or emergency use. Medicines for chronic diseases are, instead, likely to be purchased in advance and the constant use of the drug generates incentives to search for cheaper alternative brands. This makes drug varieties for chronic diseases more substitutable with each other within the formulation. In Table A.5, in Appendix, columns 1 and 3, we report the results. A marginally higher concentration of suppliers reduces quantity discounts (both the probability and the amount) more for drugs treating acute diseases than for drugs treating chronic diseases. Another test of H2 can be conducted by distinguishing drugs that need a doctoral prescription to be purchased and those available over the counter. Medicines that require prescription are supposed to have lower elasticity of substitution as their consumption is mediated by the doctor that can recommend specific brands. Substitutability among over-the-counter medicines is, instead, more driven by consumer preferences. This makes over-the-counter drug varieties more substitutable with each other within the formulation. In Table A.5, in Appendix, columns 2 and 4, we report the results. A marginally higher concentration of suppliers reduces the amount of discounts more for prescription than for over-the-counter drugs. This is in line with the prediction of the model, where lower elasticity of substitution expands the effect of higher regional bargaining power of the retailers on discounts.[22]

[22]The elasticity of substitution σ in the model is assumed to be region invariant and not dependent on the number of competitors. It follows the other assumption that the number of competitors in all

Robustness of H3 test: multiproduct suppliers. As described in Section 3.5, the mechanism behind H3 is similar to the one upholding the hypothesis in the model extension for multiproduct suppliers. The latter hypothesis states that the difference in bargaining power between regional retailers and the trade association induces less quantity discounts for varieties belonging to suppliers that produce more varieties. We test this hypothesis considering two variables for multiproduct firms: (i) the number of varieties of the supplier in the formulation-region; (ii) the number of formulations of the supplier in the region. We distinguish the regions where the suppliers produce more varieties/formulations than the median supplier and indicate it with a dummy. Then we interact these variables with formulation-region HHI and report the results in Table A.7, in Appendix. The coefficients of the interacted variables are negative and significant, meaning that in regions where a supplier offers a higher number of varieties in the same formulation, a higher HHI is associated with lower discounts (Columns 1 and 3). Similarly, in regions where a supplier offers a higher number of formulations, a higher HHI is associated with lower discounts (Columns 2 and 4). This evidence supports the hypothesis of the model extension to multiproduct suppliers: producing more varieties increases supplier bargaining power which in turn decreases the effect of non-exerted regional retail bargaining power on discounts. It is worth noting that the main effect of the number of varieties and formulations have both positive and significant coefficients. This confirms what we have observed above in the descriptive statistics: large firms (which produce more varieties and more formulations) give more discounts. Discounts might be given conditional on the number of varieties the retailers carry: "The more brands the retailer stocks, the higher its discount" (Shaffer, 1991). To support this evidence there is also the cost mechanism that we point out in Section 3.4.3, according to which in regions with larger sales (i.e., where suppliers offer more varieties and formulations) suppliers give more discounts.

6 Conclusion

Pharmaceutical firms in many high-income countries offer price rebates to institutional payers such as health insurers, group buying organizations, and public healthcare systems

regions is large enough. Besides facilitating the aggregation of results across regions, these assumptions follow what we observe in the data, where the median number of suppliers in the region-formulation is 5. In Table A.6, in Appendix, we show that the relationship between HHI and discounts remains negative and significant also in region-formulations with a lower number of competitors than the median.

with buyer power. In low- and middle-income countries—where such institutional payers are largely absent and individual consumers do not have much bargaining power—the use of confidential quantity discounts by pharmaceutical firms is rarely examined. Using novel data on wholesale and retail prices of medicines and quantity discounts given to retailers and hidden from consumers in the Indian pharmaceutical industry between March 2007 and June 2013, we document how pharmaceutical firms offer more quantity discounts within a variety to retailers in regions with higher bargaining power and how it lowers supplier profits and increases retailer profits while keeping the consumer prices unchanged, and how the practice helps maintain the stability of the retailer union's restrictive vertical trade practices. We discuss the advantage that quantity discounts offer over price discounts. Specifically, quantity discounts maintain uniform pricing within a variety while taking into account cost, demand, and bargaining conditions without an explicit financial transfer from the supplier to the retailer. We also extend the model to show that quantity discounts are lower for multiproduct firms, as they can leverage their greater bargaining power. Overall, our results indicate that the use of confidential quantity discounts is likely bad for the consumers because they serves to stabilize price coordination through the trade association and consequently limit price competition among retailers.

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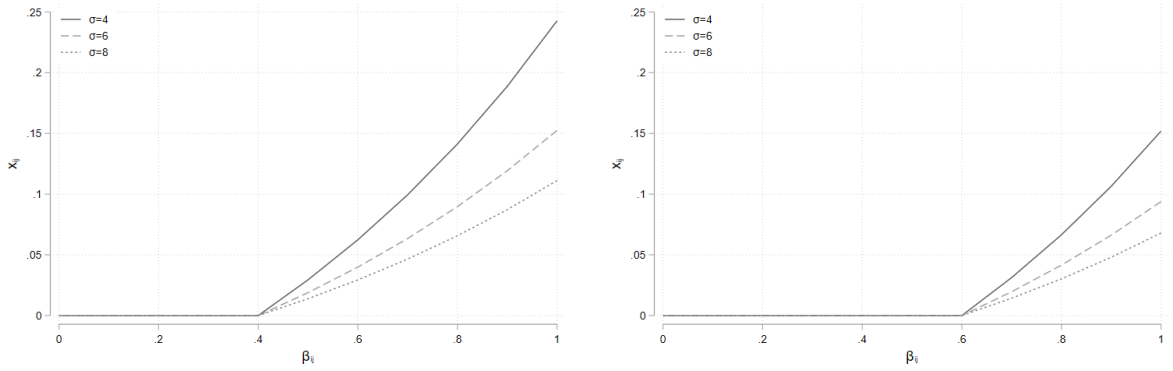
Figures

Figure 1: Discounts for different elasticities of substition (σ)

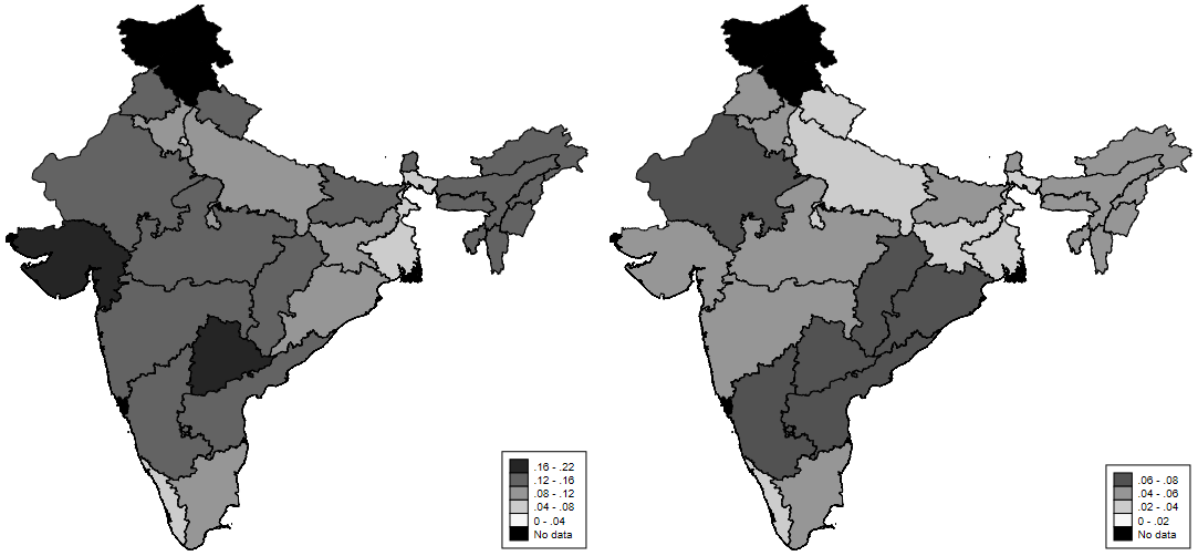
(A) if $\beta_i^A = 0.4$ (B) if $\beta_i^A = 0.6$



Notes: Quantity discounts offered by the suppliers for different values of β_{ij}, β_i and σ

Figure 2: Quantity discounts across regions

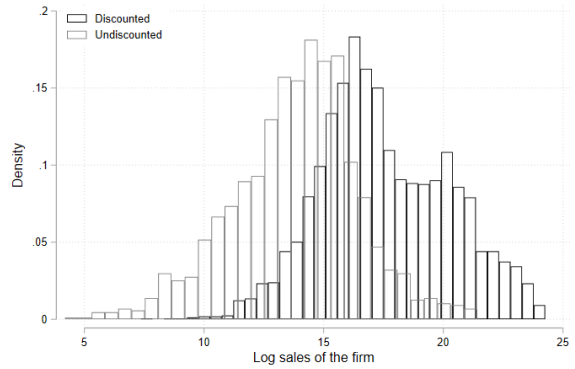
(A) Share of varieties discounted (B) Discounted-to-undiscounted ratio



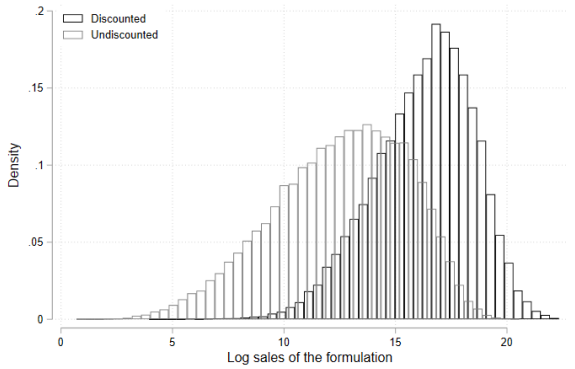
Notes: *Share of varieties discounted* is the share of varieties that give discounts. *Discounted-to-undiscounted ratio*, measured as the ratio between the units given as quantity discounts and those purchased at wholesale price by the retailers. Both variables are aggregated across formulation at the region-year level for year 2012. The area of Maharasthra is colored considering the simple average of the variable for the regions of Mumbai, Vidarbha and Marathwada. The area of West Bengal is colored considering the simple average of the variable for the regions of Kolkata and West Bengal Rest. This figure is based on AIOCD data of year 2012.

Figure 3: Firms and formulations that give quantity discounts by size

(A) Firm size



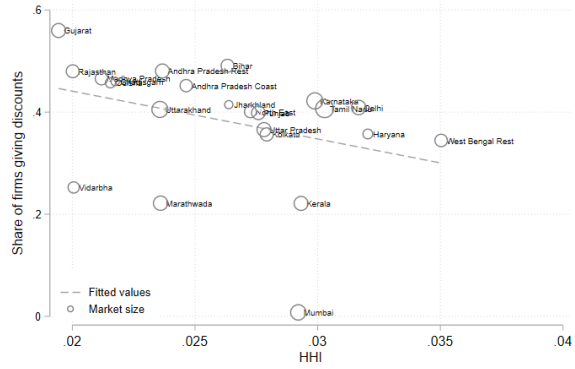
(B) Formulation size



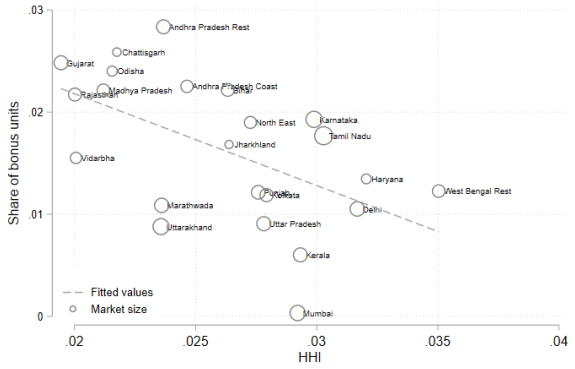
Notes: Panel (A): Size distribution of the firms giving quantity discounts (*Discounted*) and of the firms that do not (*Undiscounted*). Panel (B): Size distribution of the formulations giving quantity discounts (*Discounted*) and of the formulations that do not (*Undiscounted*). This figure is based on AIOCD data from April 2007 to June 2013.

Figure 4: Quantity discounts and HHI across regions

(A) Extensive margin



(B) Intensive margin



Notes: *Share of firms giving discounts* is the share of firms that give discounted varieties. *Discounted-to-undiscounted ratio* is measured as the ratio between the units given as quantity discounts and those purchased at wholesale price by the retailers. *HHI* is the Herfindahl-Hirschman Index. All variables are first aggregated at the region-month level and later averaged across the months. This figure is based on AIOCD data from April 2007 to June 2013.

Tables

Table 1: Variables and definitions

	Number	Definition
Regions	23	Andhra Pradesh Coastal, Andhra Pradesh Rest, Bihar, Chattisgarh, Delhi, Gujarat, Haryana, Jharkhand, Karnataka, Kerala, Kolkata, Madhya Pradesh, Marathwada, Mumbai, North East, Odisha, Punjab, Rajasthan, Tamil Nadu, Uttar Pradesh East, Uttarakhand & Uttar Pradesh West, Vidarbha, West Bengal Rest
Suppliers	681	Pharmaceutical manufacturers
Formulations	18,079	Active ingredient - Dosage form - Strength
Varieties	85,384	Stock Keeping Unit
Months	76	March 2007 - June 2013
Observations	35,347,564	Variety-region-month level

Notes: This table is based on AIOCD data from March 2007 to June 2013.

Table 2: Quantity discounts at various levels of analysis

Level	Observations	Extensive margin	Intensive margin
Variety-region-month	35,347,564	9.2	15.8
Variety-month	3,501,567	19.7	7.0
Formulation-region-month	12,128,758	14.7	9.5
Formulation-month	880,630	30.7	4.5
Firm-region-month	461,419	38.6	4.3
Firm-month	45,401	61.8	3.8

Notes: The *Extensive margin* is the share of Varieties that give discounts. The *Intensive margin* is measured as the ratio between the units given as quantity discounts and those purchased at wholesale price by the retailers. This table is based on AIOCD data from March 2007 to June 2013.

Table 3: Testing Hypothesis 1: Supplier concentration and quantity discounts

	Dummy discounted				Discounted-to-undiscounted ratio			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Formulation-region HHI	-0.060***	-0.033***	-0.034***	-0.016***	-0.033***	-0.024***	-0.028***	-0.012***
	(0.003)	(0.002)	(0.002)	(0.001)	(0.004)	(0.004)	(0.004)	(0.002)
Log sales			0.026***	0.010***			0.008***	-0.000
			(0.000)	(0.000)			(0.001)	(0.001)
Variety X Month FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region X Month FE	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Variety X Region FE	No	No	No	Yes	No	No	No	Yes
R-squared	0.511	0.531	0.538	0.732	0.532	0.540	0.541	0.677
Observations	34618025	34618025	34615228	34560576	8096394	8096394	8096185	8095904

Notes: OLS estimates, standard errors (in parentheses) clustered at the formulation level. The dependent variables are: *Dummy discounted* that takes value one when the variety gives quantity discounts and zero otherwise; *Discounted-to-undiscounted ratio* is measured as the ratio between the units of variety given as quantity discounts and those purchased at wholesale price by the retailers. *Formulation-region HHI* is the formulation-region-month Herfindahl-Hirschman Index. *Log sales* is the logarithm of the formulation-region-month sales. The estimates reported in Column 1-4 are conducted on the full sample of variety-region-month observations; the estimates reported in Column 5-8 are conducted on the sample of variety-region-month observations that give discounts at least once in the period considered. This table is based on AIOCD data from March 2007 to June 2013.

Table 4: Testing Hypothesis 2: The role of elasticity of substitution

	Dummy discounted	Discounted-to-undiscounted ratio
	(1)	(2)
Formulation-region HHI	-0.021***	-0.021***
	(0.003)	(0.007)
Formulation-region HHI × Liquid	-0.020***	0.011
	(0.006)	(0.007)
Formulation-region HHI × Injection	-0.059***	-0.051***
	(0.008)	(0.014)
Variety × Month FE	Yes	Yes
Region × Month FE	Yes	Yes
R-squared	0.541	0.525
Observations	28586728	6683393

Notes: OLS estimates, standard errors (in parentheses) clustered at the formulation level. The dependent variables are: *Dummy discounted* that takes value one when the Variety gives quantity discounts and zero otherwise; *Discounted-to-undiscounted ratio* is measured as the ratio between the units of Variety given as quantity discounts and those purchased at wholesale price by the retailers. *Formulation-region HHI* is the formulation-region-month Herfindahl-Hirschman Index. The estimates in both columns control for the formulation-region-month sales and the variety X month FEs control for the dummies *Liquid* and *Injection*. All estimates control for the logarithm of the formulation-region-month sales. The estimates reported in Column 1 are conducted on the full sample of Variety-region-month observations; the estimates reported in Column 2 are conducted on the sample of Variety-region-month observations that give discounts at least once in the period considered. This table is based on AIOCD data from March 2007 to June 2013.

Table 5: Testing Hypothesis 3: The level of bargaining power of the trade association

	Dummy discounted	Discounted-to-undiscounted ratio
	(1)	(2)
Formulation-region HHI	-0.031***	-0.025***
	(0.002)	(0.003)
HHI X High wholesale price	-0.012***	-0.010***
	(0.002)	(0.003)
Variety X Month FE	Yes	Yes
Region X Month FE	Yes	Yes
R-squared	0.538	0.541
Observations	34615228	8096185

Notes: OLS estimates, standard errors (in parentheses) clustered at the formulation level. The dependent variables are: *Dummy discounted* that takes value one when the Variety gives quantity discounts and zero otherwise; *Discounted-to-undiscounted ratio* is measured as the ratio between the units of Variety given as quantity discounts and those purchased at wholesale price by the retailers. *Formulation-region HHI* is the formulation-region-month Herfindahl-Hirschman Index. The estimates in both columns control for the formulation-region-month sales and the dummy *High wholesale price*. The estimates reported in Column 1 are conducted on the full sample of Variety-region-month observations; the estimates reported in Column 2 are conducted on the sample of Variety-region-month observations that give discounts at least once in the period considered. This table is based on AIOCD data from March 2007 to June 2013.

A Additional figures and tables

Table A.1: Supplier concentration and quantity discounts for various definitions of product market

	Share of varieties discounted			Discounted-to-undiscounted ratio		
	(1)	(2)	(3)	(4)	(5)	(6)
Formulation HHI	-0.019***			-0.018***		
	(0.005)			(0.003)		
Active ingredient-Dosage form HHI		-0.013**			-0.017***	
		(0.006)			(0.003)	
Active ingredient HHI			-0.023***			-0.019***
			(0.007)			(0.004)
Region FE	Yes	Yes	Yes	Yes	Yes	Yes
Month FE	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.018	0.022	0.028	0.006	0.009	0.011
Observations	12128757	6507087	3189615	12127289	6505671	3189374

Notes: OLS estimates, standard errors (in parentheses) clustered at the formulation-region level. *Share of varieties discounted* is the share of varieties that give discounts within the market considered. *Discounted-to-undiscounted ratio* is the ratio between the units given as quantity discounts and those purchased at wholesale price by the retailers within the market considered. *HHI* is the market-region-month Herfindahl-Hirschman Index. The estimates are based on three samples with variety-region-month observation aggregated at the formulation-region-month level (Column 1 and 4), active ingredient-region-month level (Column 2 and 5), and active ingredient-dosage form-region-month level (Column 3 and 6). This table is based on AIOCD data from March 2007 to June 2013.

Table A.2: Distribution of prices and concentration

	Mean	Standard Deviation		
		Across regions Across formulations	Across regions Within formulation	
Formulation-region HHI	0.52	0.33	0.11	
		Across varieties	Across varieties	Within variety
Wholesale price	96.03	631.62	10.19	0.00
Retail price	121.85	791.73	12.79	0.00

Notes: Mean and standard deviation of the distributions of HHI, wholesale and retail prices. Price observations are at the variety-region-month level. HHI observations are at the formulation-region-month level. *Mean* is the mean across all formulations, regions and months. *Standard deviation* is the average of all standard deviations of the distributions specified. This table is based on AIOCD data from March 2007 to June 2013.

Table A.3: Quantity discounts, prices and demand

	Log wholesale price		Log retail price		Log undiscounted units	
	(1)	(2)	(3)	(4)	(5)	(6)
Dummy discounted	0.045***		0.027***		2.225***	
	(0.003)		(0.002)		(0.008)	
Discounted-to-undiscounted ratio		0.024***		0.017***		0.942***
		(0.006)		(0.006)		(0.096)
Region X Formulation X Month FE	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.816	0.859	0.821	0.860	0.358	0.386
Observations	28343967	6112106	28343947	6110667	28346907	6112284

Notes: OLS estimates, standard errors (in parentheses) clustered at the formulation level. *Log wholesale price* and *Log retail price* are measured as the logarithm of rupees per unit of variety. *Log undiscounted units* is measured as the logarithm of the units of variety purchased at wholesale price by the retailers. *Dummy discounted*, that takes value one when the variety gives quantity discounts and zero otherwise; *Discounted-to-undiscounted ratio*, that is the ratio between the units of variety given as quantity discounts and those purchased at wholesale price by the retailers. In Column 1, 3 and 5 estimates are conducted on the full sample of variety-region-month observations. In In Column 2, 4 and 6 estimates are conducted on the subsample of variety-region-month observations that give discounts at least once in the period considered. This table is based on AIOCD data from March 2007 to June 2013.

Table A.4: Robustness analysis H1: Number of competitors and quantity discounts

	Dummy discounted		Discounted-to-undiscounted ratio	
	(1)	(2)	(3)	(4)
Log number of varieties	0.031***	0.003***	0.013***	0.003**
	(0.002)	(0.001)	(0.002)	(0.001)
Variety X Month FE	Yes	Yes	Yes	Yes
Region X Month FE	Yes	Yes	Yes	Yes
Variety X Region FE		Yes		Yes
R-squared	0.532	0.732	0.540	0.677
Observations	34618025	34563379	8096394	8096113

Notes: OLS estimates, standard errors (in parentheses) clustered at the formulation level. The dependent variables are: *Dummy discounted* that takes value one when the variety gives quantity discounts and zero otherwise; *Discounted-to-undiscounted ratio* is measured as the ratio between the units of variety given as quantity discounts and those purchased at wholesale price by the retailers. *Log number of varieties* is the logarithm of the number of varieties in the formulation-region-month. The estimates in all columns control for the formulation-region-month sales. The estimates reported in Column 1-2 are conducted on the full sample of variety-region-month observations; the estimates reported in Column 3-4 are conducted on the sample of variety-region-month observations that give discounts at least once in the period considered. This table is based on AIOCD data from March 2007 to June 2013.

Table A.5: Robustness analysis H2: Acute Vs Chronic treatment medicines

	Dummy discounted		Discounted-to-undiscounted ratio	
	(1)	(2)	(3)	(4)
Formulation-region HHI	0.011***	-0.035***	-0.009***	-0.018***
	(0.002)	(0.003)	(0.003)	(0.002)
HHI X Acute treatment	-0.059***		-0.021***	
	(0.004)		(0.005)	
HHI X Prescription		0.003		-0.022***
		(0.004)		(0.008)
Variety X Month FE	Yes	Yes	Yes	Yes
Region X Month FE	Yes	Yes	Yes	Yes
R-squared	0.538	0.538	0.541	0.541
Observations	34615228	34615228	8096185	8096185

Notes: OLS estimates, standard errors (in parentheses) clustered at the formulation level. The dependent variables are: *Dummy discounted* that takes value one when the variety gives quantity discounts and zero otherwise; *Discounted-to-undiscounted ratio* is measured as the ratio between the units of variety given as quantity discounts and those purchased at wholesale price by the retailers. *Formulation-region HHI* is the formulation-region-month Herfindahl-Hirschman Index. *Acute treatment* is a dummy taking value 1 when the drug is used for treating acute diseases (as opposed to chronic). *Prescription* is a dummy taking value 1 when the drug needs a doctoral prescription to be purchased. The estimates in both columns control for the formulation-region-month sales. The estimates reported in Column 1 are conducted on the full sample of variety-region-month observations; the estimates reported in Column 2 are conducted on the sample of variety-region-month observations that give discounts at least once in the period considered. This table is based on AIOCD data from March 2007 to June 2013.

Table A.6: Robustness analysis: elasticity of substitution and number of suppliers

	Dummy discounted	Discounted-to-undiscounted ratio
	(1)	(2)
Formulation-region HHI	-0.027***	-0.025***
	(0.002)	(0.004)
Formulation-firm HHI X High N suppliers	-0.020***	-0.010***
	(0.003)	(0.003)
High N suppliers	0.015***	0.005***
	(0.002)	(0.001)
Variety X Month FE	Yes	Yes
Region X Month FE	Yes	Yes
R-squared	0.538	0.541
Observations	34615228	8096185

Notes: OLS estimates, standard errors (in parentheses) clustered at the formulation level. The dependent variables are: *Dummy discounted* that takes value one when the variety gives quantity discounts and zero otherwise; *Discounted-to-undiscounted ratio* is measured as the ratio between the units of variety given as quantity discounts and those purchased at wholesale price by the retailers. *Formulation-region HHI* is the formulation-region-month Herfindahl-Hirschman Index. *High N suppliers* is a dummy taking value 1 when in that region the number of suppliers is higher than the median of the formulation across regions. The estimates in both columns control for the formulation-region-month sales. The estimates reported in Column 1 are conducted on the full sample of variety-region-month observations; the estimates reported in Column 2 are conducted on the sample of variety-region-month observations that give discounts at least once in the period considered. This table is based on AIOCD data from March 2007 to June 2013.

Table A.7: Robustness analysis H3: Multiproduct suppliers

	Dummy discounted		Discounted-to-undiscounted ratio	
	(1)	(2)	(3)	(4)
Formulation-region HHI	-0.033***	-0.025***	-0.028***	-0.024***
	(0.002)	(0.002)	(0.004)	(0.004)
HHI X High N varieties within firm-region-formulation	-0.018***		-0.015***	
	(0.004)		(0.005)	
HHI X High N formulations within firm-region		-0.020***		-0.008***
		(0.002)		(0.002)
High N varieties within firm-region-formulation	0.011***		0.007***	
	(0.002)		(0.002)	
High N formulations within firm-region		0.026***		0.011***
		(0.001)		(0.001)
Variety X Month FE	Yes	Yes	Yes	Yes
Region X Month FE	Yes	Yes	Yes	Yes
R-squared	0.538	0.538	0.541	0.541
Observations	34615228	34615228	8096185	8096185

Notes: OLS estimates, standard errors (in parentheses) clustered at the formulation level. The dependent variables are: *Dummy discounted* that takes value one when the variety gives quantity discounts and zero otherwise; *Discounted-to-undiscounted ratio* is measured as the ratio between the units of variety given as quantity discounts and those purchased at wholesale price by the retailers. *Formulation-region HHI* is the formulation-region-month Herfindahl-Hirschman Index. *High N varieties within firm-region-formulation* is a dummy taking value 1 when in that region-formulation the supplier provides a number of varieties higher than its median across regions for the same formulation. *High N formulations within firm-region* is a dummy taking value 1 when in that region the supplier provides a number of formulations higher than its median across regions. The estimates in all columns control for the formulation-region-month sales. The estimates reported in Columns 1-2 are conducted on the full sample of variety-region-month observations; the estimates reported in Columns 3-4 are conducted on the sample of variety-region-month observations that give discounts at least once in the period considered. This table is based on AIOCD data from March 2007 to June 2013.