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How Do Incumbents Respond to Bottom-of-the-Pyramid Firm Entry?

Ajay Bhaskarabhatla
Erasmus School of Economics
Applied Economics
bhaskarabhatla@ese.eur.nl

Chirantan Chatterjee
Indian Institute of Management
Strategy
chirantan.chatterjee@iimb.ernet.in

Abstract

Serving markets at the bottom of the pyramid (BOP), composed of consumers with low purchasing power, has been offered as a strategic business opportunity, although considerable disagreement exists about the size of the low-end market and the sustainability of the BOP strategy. Beyond serving low-end consumers, do BOP firms affect market prices and the strategic choices of incumbent firms? We examine the impact of a BOP firm?s potential and actual entry on incumbent pricing behavior, particularly that of high-end firms. We find that the threat of a BOP firm?s entry, as well as its actual, entry lowers high-end prices and raises low-end prices in the market. We document similar changes in package sizes revealing a potential mechanism. A BOP firm?s entry lowers the package size offered by high-end firms, limits their ability to effectively price-discriminate, and leads to lower high-end prices and an overall increase in the volume of sales. The anticipation of a BOP firm?s entry increases low-end prices prior to actual entry, as low-end incumbents adjust their package-size strategy. We relate these results to recent theoretical models of mixed markets featuring high-end and low-end firm entry and reflect on what makes the BOP strategy sustainable.

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Abstract

Scholars argue that serving markets at the bottom of the pyramid (BOP), composed of consumers with low purchasing power, has been offered as a strategic business opportunity. Beyond serving low-end consumers, do BOP firms affect market prices and the strategic choices of incumbent firms? We examine the impact of a BOP firm's potential and actual entry on incumbent pricing behavior, particularly that of high-end firms. We find that the threat of a BOP firm's entry, as well as its actual entry lowers high-end prices and raises low-end prices in the market. We document similar changes in package sizes revealing a potential mechanism through which this impact on prices is manifested. A BOP firm's entry lowers the package size offered by high-end firms, limits their ability to effectively price-discriminate, and leads to lower high-end prices and an overall increase in the volume of sales. The anticipation of a BOP firm's entry increases low-end prices prior to actual entry, as low-end incumbents adjust their package-size strategy. We relate these results to recent theoretical models of mixed markets featuring high-end and low-end firm entry and reflect on what makes the BOP strategy sustainable.

1 Introduction

Some strategy scholars argue that much fortune exists at the bottom of the economic pyramid (BOP) among billions of consumers around the world with relatively low purchasing power. Among them, C.K. Prahalad exhorted multinational firms to exploit these markets, citing anecdotal evidence from India (Prahalad 2004; Prahalad and Hammond 2002). Others have expressed a less sanguine assessment of BOP firm strategy, arguing that the size of the low-end market is too small for firms to exploit profitably and sustainably (Karnani 2007). Yet others have offered caution and highlighted the importance of exploiting scale economies and local conditions in establishing a sustainable BOP firm strategy (Rangan et al. 2011; Karamchandani et al. 2011; Govindarajan and Trimble 2012). Case-studies of both successes and failures of BOP strategy have been documented across several developing countries and industries. The conventional treatment of BOP firms is largely nonstrategic and examines the low-end market in isolation of the rest of the market. Such a treatment also assumes low-end firms to be too small to affect competitive behavior of other firms in the market, particularly those at the high-end.

Only recently have scholars begun to model competition among low-end and high-end firms in mixed markets and to study the implications of their entry for the evolution of prices in the market and profits for high-end and low-end firms (e.g., Amaldoss and Shin 2011; Ishibashi and Matsushima 2009; and de Figueiredo and Silverman 2007). Competitive effects of entry by large firms in the presence of non-strategic fringe firms—each of which has a negligible impact on market outcomes—

have also been recently investigated theoretically in the industrial organization and international trade literatures (e.g., Shimomura and Thisse 2012). Product design choices of low-end and high-end firms at entry have also been modeled recently (e.g., Davis et al. 2004). The implications of such models, particularly those featuring low-end firms, have not been weighed against the data. We exploit a unique setting in which a BOP firm coexists with high-end multinationals and other large domestic firms, and we estimate the impact of BOP firm entry on the pricing behavior and product design choices of incumbents in the market.

We choose the Indian context as it has served as the testbed for several BOP experiments (see Prahalad 2004). We focus on India's pharmaceutical industry, in which substantial price dispersion exists even within narrowly defined markets composed of homogeneous, bioequivalent goods.[1] Our preliminary analyses reveal an alarming trend of rapidly growing price dispersion in the Indian pharmaceutical markets in recent years, which we illustrate in Figure 1. The maximum nominal price of a composite drug in our data—computed as an average of the maximum prices across several drug markets—increased 5.56 times during 1999-2011. The minimum price of the composite drug increased 1.64 times. These patterns, plotted using wholesaler data, underestimate the actual extent of price dispersion in the retail market. The rapid growth in price dispersion in our data is not explained by the changing composition of markets over time or inflation as both affect the average maximum and minimum prices of the composite drug alike.[2] The growth in drug prices and price dispersion are, however, consistent with prior descriptive evidence from the pharmaceutical markets in India and the doubling of annual healthcare expenditure per capita in India from 62 to 132 (constant 2005 USD) during 1999-2010 (Selvaraj 2012).

Our preliminary analyses also reveal that multinational corporations (MNCs) and large domestic firms charge higher prices persistently over time. We plot in Figure 2 the fraction of time MNCs and domestic firms spend in a market in various quartiles of the price distribution. Figure 2 shows that MNCs spend on average twice as much time in the top quartile of the price distribution as do domestic firms. Such concerns have led entrepreneurial local firms to adopt BOP strategy,

[1] Price dispersion measures the difference between the maximum and minimum prices offered by sellers in a product market and it may be induced by several factors such as search costs, vertical differentiation, and competition. Price dispersion refers to between-firm variation in prices and it is different from price discrimination, which may explain within-firm variation in prices.

[2] According to World Bank figures, the GINI index for India increased from 30.82 in 1994 to 33.38 in 2005, not much different from the historical high of 35.09 in 1978; the out-of-pocket health expenditures declined from 91 to 86 percent during 1999-2010; and the percentage of GDP on healthcare expenditure decreased from 4.35 to 4.05 during 1999-2010. These modest changes in macroeconomic indicators fail to explain the several-fold increase in price dispersion in India's pharmaceutical markets, as reflected in figure 1.

providing us the ideal context to explore the impact of BOP firm entry on incumbent prices, particularly at the high-end.

Insert Figures 1 and 2

In this paper, we investigate the evolution of market-level prices as a function of BOP firm entry. We define a BOP firm as one with a stated mission to compete for the low-end market. We identify a pure-play BOP firm in the Indian pharmaceutical industry that competes exclusively for the low-end market. The BOP firm charges an average price that is 36 percent less than that of the average firm in the market. We find that the top percentiles of the market-level price distribution (such as the maximum and the 90th) are lower after BOP firm entry than before, but the minimum price is higher. The anticipation of BOP firm entry also leads to an increase in the minimum price and a decrease in the maximum price in the market months before BOP firm's actual entry. BOP firm entry is also associated with a decline in price dispersion and market expansion.

We then investigate potential mechanisms for explaining incumbent responses. We find that relative to other firms in the market, the BOP firm offers smaller package sizes (or dosage strengths in tour context), raises the minimum price at the low end, and increases the volume of sales. We examine how incumbents respond to a BOP firm's entry and choice of dosage strength, a key product design feature in the drug markets. We find that, compared to the average level, the maximum dosage strength in the market is 12-percent lower after BOP firm entry than before, but the minimum dosage strength is nine-percent higher. In addition, both the anticipated and the actual entry of the BOP firm lower dosage strength dispersion in the market by 27.5 percent of the average level. The changes in dosage-strength choices of high-end and low-end incumbents in response to BOP firm entry point to the mechanism underlying corresponding market-level price changes in response to BOP firm entry.

Overall, our results indicate powerful competitive effects of BOP firm entry, as it lowers price dispersion, acts as a credible threat to high-end firms lowering their ability to price-discriminate using different dosage strengths, and expands unit sales volume. We further empirically demonstrate, for the first time, that the bottom-of-the-pyramid firm strategy can raise minimum prices and can be profitable for BOP firms. Our focal BOP firm has gained eleven ranks in a span of four years to become one of the top ten pharmaceutical firms in India in 2009 despite continuing to compete exclusively for low-end customers. Our results also highlight that the BOP strategy can be successful if the scale of operation is large enough, which our focal firm achieved by expanding into vast untapped rural markets in India and marketing to general physicians rather than specialists.

Our results have important managerial and policy implications. From a firm-strategy perspective, our results highlight the role of dosage-strength (or broadly and interchangeably, package-size or product design) choices in competing at the low end of the market. When low-end firms' choice of package sizes aggregates demand away from high-end firms, BOP firm strategy can

achieve a scale of operation that is sustainable. At a broader level, our results reflect the disruptive role BOP firms play in emerging markets and how incumbents adjust to such industry dynamics.

In terms of policy, India has historically used price controls to lower price dispersion for basic medicines such as anti-infectives. An alternative mechanism of limiting reimbursements through reference pricing has been successfully employed in countries such as Germany, the Netherlands, and New Zealand to curb rising prices in markets for antidiabetic, anti-coagulant, and cardiovascular drugs, the product markets we study in this paper. In the Philippines, a BOP experiment to offer generic medicines through a dedicated chain of pharmacy stores has seen rapid expansion in recent years, from 68 franchises in 1997 to 1000 in 2010 and a decline in price dispersion (Kayalar 2011). In contrast, our results based on select Indian pharmaceutical markets reflect the role of BOP firms in limiting price dispersion not merely through competition in distribution, but also in the production of pharmaceuticals.

This paper contributes to several strands in the literature. We contribute to the growing literature on price dispersion by highlighting the role of firm heterogeneity (e.g., Cornia et al. 2012). We contribute to the literature on entry strategies in pharmaceutical markets by documenting the differential use of pricing strategies, such as offering several dosage strength choices by low-end and high-end firms (see, also, Ellison and Ellison 2011). We contribute to the business strategy literature by studying bottom-of-the-pyramid firm strategies in a rich empirical setting and documenting strategic responses by incumbent firms (Prahalad 2004). Our study also relates to the emerging literature on the dynamics of disruptive innovation in emerging markets (Govindarajan and Ramamurti 2011).

Section 2 provides a brief overview of the pharmaceutical industry in India. In Section 3, we review related literature and develop hypotheses. We describe our estimation strategy in Section 4. Section 5 presents data and our results, and we conclude in Section 6.

2 Description of the Industry Context and the Rise of Mankind Pharma

2.1 The Role of High-End Pharmaceutical Firms

The Indian pharmaceutical industry is characterized by two essential policy instruments that have attracted much scholarly attention recently. They relate to the patent system and the price-control regime. First, the Indian Patents Act of 1970 recognized process patents and granted a considerably shorter patent life of five to seven years instead of the 20 years that is standard in many Western economies. The lack of product-patent protection in Indian patent law limited the role of MNCs and promoted free entry of indigenous generic firms to ‘reverse engineer’ patented drugs and manufacture them at lower costs. This institutional environment has created non-patent-based first-mover advantages, as prior work has documented (Bhaskarabhatla and Chatterjee 2012).

Second, the Indian government introduced price controls with the objective of lowering the prices of medicines in India, which were among the highest in the world (Kapczynski 2009). These policies provided an additional incentive for domestic firms to develop low-cost manufacturing capabilities (Chatterjee 2011). The changes in the policy environment in the 1970s are generally associated with the decline in market share of MNCs—from over 70 percent in 1970 to 30 percent in the mid-1990s—and a corresponding decline in drug prices.

However, the two policies—patent regime and price controls—have undergone substantial changes in the opposite direction in recent times. The extent of price controls and other regulations has steadily declined from 347 drugs in 1979 to 76 in 1995, thus facilitating MNC entry. In our focal therapeutic areas, for example, the number of markets in which MNCs entered increased from 45 (46 percent of the existing 4-digit Anatomical Therapeutic Chemical (ATC) classification markets) in 1999 to 139 (67.5 percent) in 2011. India also signed the World Trade Organization (WTO)-mandated Trade-Related Aspects of Intellectual Property Rights (TRIPS) in 1995, and, in 2005, implemented a stronger patent regime recognizing product patents. This move has provided additional incentives for MNCs to enter the Indian pharmaceutical markets (Chatterjee 2011).

After patent reforms in 2005, MNCs acquired some leading domestic firms in India: Abbott Laboratories acquired Piramal Healthcare Solutions; Daiichi Sankyo bought a stake in Ranbaxy Laboratories and Sanofi-Aventis in Shantha Biotechnics. A change in policy in 2000 to allow 100-percent FDI in the pharmaceutical industry further promoted MNC entry, as the value of FDI increased from $0.32 million in 1991 to a high of $188 million in 2004. These changes have generated apprehension, particularly in light of the anecdotal evidence of growing price dispersion and cost of health care more generally.[3] One minister recently expressed these concerns:[4]

> The apprehension amongst policy makers is that if five or 10 foreign companies take over production bases in India through the 100 per cent FDI route, it would give rise to monopolies, which would be able to dictate prices of common drugs, which the poor in this country would not be able to afford.

[3] For example, the Anti-Diabetic drug Amaryl (1mg, 10 tablets) with Glimepride as the active pharmaceutical ingredient is offered at an average price of 10.8 normalized units by the three lowest-priced brands and at 59.3 by the three highest-priced brands, as measured by IMS Health for India in 2009 (Selvaraj 2012). Similarly, the cholesterol-lowering drug Storvas (10mg, 10 tablets), containing Atorvastatin, is priced by the three highest-priced brands at 103, compared to an average of 22 by the three lowest-priced brands. When purchased by a state agency through a tender process, the prices of these drugs at the same dosage are much lower, 0.75 and 2.09, respectively, for Amaryl and Storvas.

[4] Stated remarks by the Union Minister of Chemicals and Fertilisers at India Pharma Summit 2011 organized jointly by FICCI, Department of Pharmaceuticals, Government of India, and the WHO Country Office, dated November 29, 2011.

These concerns led India's government to contemplate the reintroduction of price controls for a list of 348 essential drugs; of limits on FDI in the pharmaceutical sector; and of additional oversight of foreign acquisition of domestic pharmaceutical firms for anticompetitive effects (Wall Street Journal 2012). The use of compulsory licenses is also associated with a policy to control drug-price inflation in India (Sampat et al. 2012).

2.2 Bottom-of-the-Pyramid Entry by Mankind Pharma as a Response to Rising Prices

Rising drug prices and the general neglect of rural markets by established firms in India have attracted entry from entrepreneurial firms with a BOP entry strategy. Such firms are likened to mission-oriented organizations founded and staffed by motivated agents maximizing the volume of sales rather than profits. Mankind Pharma, the leading pure-play bottom-of-the-pyramid firm in India, was founded in 1995 by a former medical representative (also known as a detailer) after years of prior intra-industry experience. In its early years, the firm outsourced its manufacturing but in the late-1990s, when our dataset begins, established its own manufacturing facilities. It now operates 13 manufacturing facilities and claims to manufacture 95 percent of its drugs (Kakkar 2011). The firm's strategy has involved manufacturing and marketing drugs to general physicians (as opposed to specialists) and pharmacists in rural India's small towns and villages, whom MNCs and large domestic firms had neglected. According to IMS Health, a U.S. based firm that collects proprietary industry data, Mankind was present in every village in India that had 1,000 or more inhabitants in 2009, which contributed to 58 percent of the company's revenues (Bisserbe 2009).

According to a recent IMS survey, the firm—characterized by low overhead costs and austere corporate offices—leads the industry in terms of the number of prescriptions per doctor per month. Consistent with its mission to provide affordable medicine, Mankind placed limits on executive compensation. Mankind's founder notes that, "there is no creamy layer; we do not have highly paid vice-presidents or presidents" (Bisserbe 2009). The transformation from a niche, low-end generics producer for rural India with seed capital of $100,000 and sales of $760,000 in 1995 to an industry giant with $330 million in sales in 2011 was, according to its founder, made possible by its pricing strategy (Kakkar 2011):

> Selling at low prices and drastically reducing prices catalyzed our ascent[,] . . . we believed in high volumes more than profits.

For example, Mankind introduced a bioequivalent substitute for Zenflox, a drug sold by India's leading generics producer Ranbaxy at Rs. 26, for only Rs. 6. Similarly, Mankind introduced a substitute for GlaxoSmithKline's best-selling antibiotic at half the price. The founder further notes that the "pharma companies did not pass on the decrease in bulk drug prices to patients; I did."

We interviewed senior executives at large Indian pharmaceutical firms about the rise of Mankind Pharma, which has grown at an annual compounded growth rate of 35 percent in recent years. A senior director of business development at a leading firm noted that Mankind's success is driven by "a mission around execution excellence with a focus on volumes." The CEO of another major firm noted that Mankind's success is built around a focus on "general practitioner doctors around rural India" unlike his firm, which has a "focus on specialist doctors" located in semi-urban or urban India. He further commented that, as far as his firm was concerned, it might be difficult to switch and adopt Mankind's strategy: "We have built our business based on coverage of specialists, and all our organizational elements—customer selection, products, sales force systems, and manufacturing systems—are aligned to that."

Mankind attracted private equity investment in 2007 of $24 million from ChrysCapital—a Delhi-based firm that specializes in Indian investments. Its managing director further elaborated Mankind's pricing strategy (Bisserbe 2009):

> Mankind never went by the rule book. Normally companies rely on key opinion leaders (read: doctors) in metros. But Mankind started in rural and semi-rural markets: What differentiates Mankind from the other small companies are two things: an aggressive pricing strategy that has forced rivals to cut prices; and a huge sales force and distribution network that ensures its drugs are 'always available.'

These insights are consistent with Mankind's bottom-of-the-pyramid focus. Our empirical analyses will further reveal that Mankind has offered drugs at considerably lower prices relative to its competition during the period 1999-2011. Consequently, we use the case of Mankind Pharma to study the impact of a BOP firm's entry on incumbent prices in a given market. While there may be other bottom-of-the-pyramid firms in the Indian pharmaceutical industry, we argue that our focus on Mankind Pharma alone does not adversely affect our empirical analyses. Classifying some legitimate BOP firms as incumbents leads to an underestimation of the effect of BOP entry we set out to measure empirically.

3 Literature Review and Hypotheses

Prior theoretical models show that high-end name-brand producers increase prices after low-cost generics enter the market. Such models conceive of a segmented market composed of price-sensitive consumers and price-insensitive, brand-loyal consumers. When a generic alternative enters the market, price-sensitive consumers switch from a branded drug to a generic, making the residual demand curve for the branded firms swivel inward (become steeper and more inelastic), which allows the branded firms to optimally respond by increasing prices (Frank and Salkever 1992; Bhattacharya

and Vogt, 2003).[5] Frank and Salkever (1997) find supporting empirical evidence that branded prices increased in the U.S. markets with generic entry. Studies have also shown that branded firms in the U.S. charge premium prices even after generic entry, while letting their market shares erode over time (Grabowski and Vernon 1992). However, increasingly innovators are introducing low-end versions of their products after patent expiry in India besides high-end versions. Both branded-generic firms and innovators are multiproduct firms that compete with unbranded-generic firms in low-end product markets composed of price-sensitive consumers. In addition, an overwhelming majority of the consumers pay for drugs and other healthcare expenses out-of-pocket, rather than through institutional reimbursement mechanisms, and are more likely to be price-sensitive. Furthermore, the low-end market, which, as we shall see, has implications for high-end and low-end firms' pricing strategies, is significantly larger in developing countries such as India than in the U.S., a fact that high-end firms cannot afford to ignore in developing countries.

Building on the segmented demand structure, Ishibashi and Matsushima (2009) model competition among high-end and low-end firms. They show that multiple high-end firms present in a market may earn more profits in the presence of low-end firms than otherwise, as the presence of a low-end firm acts as a credible threat and stops high-end firms from overproducing in an attempt to sell to low-end consumers. There are several caveats to their results. First, they make the strong assumption that for high-end consumers, high-end and low-end products are not substitutable, regardless of the relative price differential. Consequently, in their model, the presence of low-end firms is never harmful to high-end firms, as growth in the low-end market never leads to high-end consumers switching to the low-end product. Despite this assumption, the low-end market size alone determines the region within which the presence of low-end firms is beneficial to the high-end firm.[6] Second, they assume that low-end consumers are indifferent between low-end and high-end products, although consumers are likely to have a higher valuation for a higher-quality product. Third, their results hold when there are multiple high-end firms in the market, but not when there is just one high-end firm in the market. Fourth, they do not model the role of package size, despite considerable anecdotal evidence of its role in competing for the low-end market.

[5] For the broader literature, see, also, Grabowski and Vernon 1992; Frank and Salkever 1997; Masson and Steiner 1985; Hurwitz and Caves 1988; Caves, Whinston and Hurwitz 1991; Griliches and Cockburn 1994; and Perloff et al. 2006.

[6] Ishibashi and Matsushima (2009) assume that the demand for a low-end market L with product l is given by $D^L(p^l) = b(1 - p^l/a)$ if $p^l \in [0, a]$ and $D^L(p^l) = 0$ if $p^l \in (a, \infty)$. They show that if the low-end market is sufficiently large in terms of both willingness to pay for l (measured by a) and the low-end market size (measured by b), then high-end firms are better off. The region of higher profits for high-end firms is determined by a and b.

Standard models of strategic entry deterrence, in contrast, suggest that incumbent firms may lower prices to limit potential competition. Several theoretical models argue that preemptive action by incumbent firms in the form of lowering prices to deter entry is not irrational (e.g., Dixit 1979; Spence 1981; Milgrom and Roberts 1982; Fudenberg and Tirole 1988). Davis et al. (2004) model the impact of potential and actual entry on incumbent pricing and product design incentives in a market with low-end and high-end consumers. While their results show that low-end firm entry leads a single-product incumbent monopolist to raise prices, the results vary for a multiproduct monopolist and depend on the relative valuation of the low-end and high-end products by low-end consumers. However, even in the case of a single-product monopolist, potential entry always benefits the consumer.

Goolsbee and Syverson (2008) provide empirical evidence to suggest that discrete shifts in the threat of entry by Southwest Airlines—measured by Southwest's mere presence, without operational flights on one or both ends of a city-pair route—lower rivals' prices even before Southwest actually begins flight operations. These results reveal a strong competitive effect of Southwest's threat of entry on incumbent pricing behavior, although the reduction in incumbent prices becomes more aggressive only after actual entry. Empirical studies set in the Swedish pharmaceutical industry also show that increases in potential and actual competition lead to lower incumbent prices (e.g., Bergman and Rudholm 2003).

Furthermore, the pricing strategy of a BOP firm is expected to be a more credible threat for the incumbents than that of an average low-cost entrant because BOP firm's founding mission is to offer relatively lower prices persistently over time. Consequently, we expect prices at the high end to decline after BOP firm entry.

Hypothesis 1. Potential and actual BOP firm entry lowers prices at the top quartiles of the cross-sectional market-level price distribution.

Advocates of the BOP firm strategy have argued that much profit exists at the bottom of the pyramid, in the purchasing power of the aspiring poor, and that MNCs have failed to recognize this potential and develop strategies to exploit these market opportunities in countries such as India (Prahalad 2004). Karnani (2007) has, however, argued that the size of the market at the bottom of the pyramid is not as large for an MNC to exploit as was previously suggested.

Amaldoss and Shin (2011) examine the impact of the size of the low-end market on the efficacy of the BOP strategy. They develop a theoretical model of competition for the low-end market and derive profits for high-end and low-end firms. Unlike Ishibashi and Matshushima (2009), they model both low-end and high-end consumers as valuing higher-quality products more, and they also introduce heterogeneity in individual consumer valuations. As low-valuation consumers increase in a market, on average, a consumer's willingness to pay decreases. Yet, they find that an increase in the low-end market size can soften price competition and raise profits for the low-end firm provided the size of the low-end market is below a threshold. Intuitively, an increase in the size of the low-end

market (which implies the switching of marginal consumers, with relatively higher valuation for higher quality, away from the high-end market segment towards the low-end market segment) leads to greater differentiation and it can raise the low-end firm's ability to extract greater surplus from its expanding low-end consumer base. Consequently, we develop the following hypothesis.

Hypothesis 2. BOP firm entry raises prices at the bottom quartiles of the cross-sectional market-level price distribution.

Amaldoss and Shin (2011) test the implications of their model using experimental data, noting the difficulty in finding an appropriate field setting. Our context allows us to test the implications, as we observe entry by a BOP firm in the presence of high-end firms such as MNCs. The BOP firm we identify rapidly expanded the low-end market size by employing the largest number (more than 7,000) of marketing personnel by any pharmaceutical firm in India.

Our Hypotheses 1 and 2 imply that BOP firm entry lowers prices at the top quartiles of the price distribution and increases prices at the bottom quartiles. Consequently, BOP firm entry is expected to lower the extent of price dispersion—or the difference between the maximum and minimum prices—in the market after its entry.

Hypothesis 3. BOP firm entry lowers price dispersion in the market.

In drug markets, high-end and low-end firms differ not only in their pricing strategies, but also in their choice of package sizes. Previous research suggests that BOP firm strategy involves the strategic use of smaller package sizes (Prahalad 2004). In a market where the product is homogeneous and high-end firms offer a range of package sizes of the product, entry by low-end firms with a smaller package size can pose a competitive threat to high-end firms in the smaller-package-size submarkets.

Desai et al. (2008) model package-size choices between high-end and low-end firms competing in an emerging market. They conceive of a segmented demand composed of cash-constrained consumers and unconstrained consumers and show that low-end products in the presence of cash-constrained consumers sell for higher prices in emerging markets than in developed markets. Koenigsberg et al. (2010) derive theoretical results suggesting that smaller package sizes allow firms to charge a higher unit price and sell more unit volume, particularly for products with a low usable life, consumption rate, and packaging cost. BOP firms are, by definition, expected to offer relatively lower package sizes in a market since cash-constrained BOP consumers cannot afford larger package sizes (Prahalad 2004).

While an increase in the number of package sizes corresponds to product proliferation, a change in the sizes of individual packages in response to potential entry can be referred to as product specification or product location strategy. In models of product location choice, greater product differentiation is shown to soften price competition (see, for the broader literature, Tirole 1988; Shaked and Sutton 1982). For example, using a variation of the Hotelling model, Bonanno (1987) shows that product location strategy may be superior to product proliferation strategy under certain

conditions. Intuitively, in the Hotelling model with quadratic transportation costs, a protected monopolist unthreatened by the prospect of entry locates two stores on a continuum of $[0, 1]$ at $\frac{1}{4}$ and $\frac{3}{4}$. Under the threat of entry, Bonanno (1987) shows, the threatened monopolist alters her store location choices such that entry is deterred provided there is a positive fixed cost of entry. In the model, an entrant prefers to locate a store at one of the extremes to avoid the prospect of competing with both stores by locating at $\frac{1}{2}$ and earning a relatively lower profit. However, the incumbent can move her two stores towards the extremes before entry occurs such that the potential entrant's prospective profit becomes negative irrespective of the entrant's location choice. Similarly, Constantatos and Perrakis (1998) show when relocation is the least-expensive entry deterring strategy, the threat of entry causes a multiproduct monopoly to upgrade its intermediate qualities forcing a potential entrant to choose a relatively high quality, leaving low-end consumers unserved. Davis et al. (2004) also predict greater product differentiation and a softening of price competition due to post-entry product design incentives in the case of a single-product monopolist facing competition from an entrant.

The central difference between our context and these models of product positioning is that these models assume that a potential entrant may enter at any location. However, a BOP firm is expected to enter at the low-end of the product spectrum; for example, in the range $[0, \frac{1}{2}]$ rather than $[0, 1]$. It is unclear whether the incumbent would upgrade intermediate qualities à la Bonanno (1987) and leave the low-end market unserved à la Constantatos and Perrakis (1998) even if (a) the potential entrant is a BOP firm committed to entering at the low-end; (b) the size of the low-end market is sufficiently large and fast-growing that leaving it unserved is unprofitable for the incumbent; and (c) the relative size of the low-end market is endogenous to BOP firm entry.

We conceive of an adjustment in package sizes offered by the incumbents in response to a BOP firm entry and speculate a relative decline in larger package size offerings in the market due to BOP firm entry. Consequently, we develop the following hypothesis.

Hypothesis 4: BOP firm entry lowers the size of larger package sizes in the market.

4 Estimation Strategy

We closely follow the prior literature in developing our estimation strategy, as described below. Our estimation strategy at the market level exploits within variation, over time, in firm-entry type in ATC 4-digit markets. We control for several observables and time and market-specific time fixed-effects.

4.1 Estimating Market-level Price, Quantity, and Dosage Strength

First, we estimate the impact of BOP entry on various quartiles of the market-level price distribution using the following specification for market j in month t:

$$\log\left(PRICE_{jt}^{Percentile}\right) = \alpha\, N_{jt} + \beta\, BOP\ in\ Market_{jt} + \gamma\, MNC\ in\ MARKET_{jt} + \sum_{j=1}^{206} \theta_j MARKET_j + \sum_{t=1}^{156} \kappa_t MONTH_t + \sum_{m=1}^{13} \delta_m YEAR_m + \sum_{j=1}^{206} \sum_{m=1}^{13} \sigma_{j,m} MARKET_j * YEAR_m + u_{jt} \quad (1)$$

where $\log\left(PRICE_{jt}^{Percentile}\right)$ is the log of the market-level price, which we measure at various points on the price distribution in market j in month t, but report results for the maximum, median, and minimum price, as they provide essential insights. The method of estimation is GLS with market fixed-effects. The explanatory variable N_{jt} is the number of firms in market j in month t; $BOP\ in\ Market$ is a persistent dummy indicating the continued presence of a low-end BOP firm, and $MNC\ in\ MARKET_{jt}$ is a dummy variable set to one when an MNC is present in a drug market and zero otherwise. Market, month, year, and market-specific year fixed-effects are included as before, and standard errors are clustered at the market level. Naturally, month and year fixed-effects are perfectly collinear and some month dummies are dropped during estimation. This comprehensive set of variables controls for factors specific to the industry over time, even if they differ in their effect on firms in individual markets over time. For instance, the seasonality in prices is explained by the month dummies, the economy-wide changes in the regulatory environment by the year dummies, and input price inflation specific to a market by the interacted market-year dummies. In some analyses, we include explanatory variables identifying time periods before the BOP firm enters to examine the impact of the threat of entry (see Table 1 for a list of variables and their descriptions). Our estimates will be consistent even if error terms are correlated with time-invariant, market-specific unobservables because we employ market fixed-effects.

A positive coefficient estimate for α, β, or γ reflects a higher price. The coefficient estimate of β allows for testing Hypotheses 1 and 2. For instance, $\beta > 0$ in regressions with top quartiles of the price as the dependent variable indicate that the entry of a BOP firm is associated with an increase in the high-end price in the market.

We then estimate the impact of BOP firm entry on market-level price dispersion using equation (1), but with two dependent variables measuring price dispersion for market j in month t: log P_{90}- log P_{10} and log P_{Max}- log P_{Min}. The explanatory variables are as described earlier, and the specification includes the full set of time and market fixed-effects. In this specification, $\alpha > 0$ implies larger price dispersion in markets with a greater number of firms, and $\beta < 0$ implies that in markets with the BOP firm, there is lower price dispersion, consistent with Hypothesis 3.

Similarly, we further extend market-level analyses with alternative dependent variables measuring log quantity sales and dosage strength to deepen our analyses and test Hypothesis 4. We measure package size by dosage strength in the Indian pharmaceutical industry. This is because retailers can sell in sizes smaller than those indicated by IMS package sizes such as a strip of tablets by breaking open packages. In contrast, retailers cannot change the dosage strength of a drug they sell.

4.2 Estimating Firm-level Prices and Dosage Strengths

Next, we turn to firm-level analyses to examine BOP firm pricing and package size strategies. We estimate the impact of BOP- and MNC-status on firm-level pricing behavior using the following specification for firm i in market j in month t:

$$\log(PRICE_{ijt}) = \alpha N_{ijt} + \beta BOP_i + \gamma MNC_i + \phi \boldsymbol{X} + \sum_{j=1}^{206} \theta_j MARKET_j + \sum_{t=1}^{156} \kappa_t MONTH_t + \sum_{m=1}^{13} \delta_m YEAR_m + \sum_{j=1}^{206} \sum_{m=1}^{13} \sigma_{j,m} MARKET_j * YEAR_m + u_{ijt} \quad (2)$$

where the dependent variable is the log of price, the vector of explanatory variables $\boldsymbol{X}$ contains firm- and market-specific variables, and u_{ijt} captures the error term. The key independent variable, BOP_i, is set to one if firm i is Mankind Pharma. We control for firm characteristics such as firm age, and firm scope (see Table 2 for a description of all variables). We also control for market characteristics such as the number of firms in the market and molecule age. The method of estimation is random effects GLS, as our key explanatory variable, BOP, is time-invariant and will drop out of the fixed-effects estimation.

Note that the BOP firm is not randomly assigned to markets as its pricing strategies are endogenous to entry decisions. Our objective here is to show the persistent nature of differences across low-end and high-end firms in our markets and, in particular, the pricing strategy of the BOP firm. A positive coefficient estimate for α, β, or γ reflects a higher price. For instance, $\beta \ll 0$ indicates that BOP firms charge a considerably lower price in the market relative to other firms ceteris paribus, which would be consistent with our operationalization of the BOP measure.

We extend our firm-level analyses by examining the impact of firm type on an alternative dependent variable, the dosage strength of the drug.

5 Data and Results

5.1 Data

We obtain our data from IMS Health—a U.S.-based firm that collects proprietary data on total units and sales (excluding those to hospitals and long-term care facilities) covering 3,500 wholesalers and some 55,000 retailers across India from 1999 to 2011. Our dataset is comprised of

oral anti-diabetic drugs (at the ATC 3-digit level A10B), anti-coagulants (at the ATC 3-digit level B01A) and 20 ATC 3-digit markets for cardiovascular drugs (between C01 to C10 at the ATC 2-digit level). Within these broader categories, there are 36 ATC 4-digit markets in A10B, 25 in B01A, and 145 in C01-C10. Representative ATC 4-digit markets in our study include: oral anti-diabetic A10B1 Glibenclamide; anticoagulant B01A2 Ticlopidine; and betablocker C01E1 Atenolol. In our data, the BOP firm entered 53 of the 206 ATC 4-digit markets. The BOP firm and MNCs coexisted in 48 such markets, and MNCs entered 139 of the 206 markets.

There are two main reasons for our choice of these drugs. First, they represent a substantial portion (more than 15 percent) of sales in the Indian pharmaceutical industry and are two of the fastest-growing markets, with an annual growth rate of 15 to 17 percent, compared to the industry average of seven percent. In these markets, the BOP firm is more likely to co-exist with high-end firms and entry-deterrence strategies using prices are also more likely to be implemented in such fast-growing markets, where longer-term success requires a significant market share from early on (Cabral 2000). Second, these drugs are typically prescribed rather than administered in hospitals, alleviating potential concerns with the data collection procedure employed by IMS Health in India.

Consumers in the healthcare sector in India pay for drugs overwhelmingly out-of-pocket rather than through intermediaries such as an insurance agency. As a result, our price data, at an aggregate level, reflect cash transactions between the seller and the consumer. In other words, we observe actual prices charged to the wholesaler as opposed to advertised prices some studies of price dispersion employ, which may not reflect actual transactions at those prices. Our prices are averaged across stores in India at the seller-level, purging spatial price dispersion generated by price discrimination through discounts, rebates, bundling, or store heterogeneity. In other words, our data underestimate the actual degree of price dispersion in pharmaceutical markets in India.[7]

The data are disaggregated at the level of individual dosage for each drug that a firm produces each month. We cannot use data on prices reported by IMS directly, as firms offer different dosages.[8] We calculate the average price of a drug per gram across dosage strengths in a month for a firm in a market using the formula below:

[7] In addition, our interviews revealed that low-end firms offer larger percentage discounts to the retailers than high-end firms, which implies that BOP prices are even lower at the retail level than our wholesaler data suggest.

[8] Suppose that the firm produces two different dosage forms for the drug: one is a 500mg tablet sold individually and the other is a 350mg pack of the same tablet containing two strips, with each strip containing ten tablets. We calculate the price per milligram of each dosage form and then average them across dosage forms each month. We normalize the price to a gram for all drugs rather than to their prescribed daily dosage levels, as we do not estimate impact on health outcomes.

$$Price_{ijt} = \frac{10^3}{n} * \sum_{n} \frac{Price_{nijt}}{Strength(in\ mg) * N\ of\ Capsules\ in\ Strip * N\ of\ Strips\ in\ Pack}$$

where, $Price_{nijt}$ is the price listed in the IMS data and $Price_{ijt}$ is the per-gram price of a drug sold by a firm i in market j in month t and n represents the dosage form.[9] Consequently, we further purge within-firm price dispersion in prices induced by multiple dosages. The data contain 206 ATC-4 markets and 261 firms over 156 months. Descriptive statistics are shown in Table 2.

5.2 Market-level Prices

We estimate equation (1) to test Hypotheses 1 and 2, and the results are shown in Table 3. The coefficient estimate of $BOP\ in\ Market$ is negative and significant in specification (1), reflecting 8.6 $(= \exp(-0.090))$ percent lower maximum price after BOP entry, consistent with Hypothesis 1. We build on Goolsbee and Syverson (2008) who estimate incumbent responses to an industry outsider's actions and argue that our BOP firm operates in a market segment distant from the high-end segment exclusively. Since BOP firms persistently operate at the lower end of the price distribution, the choice of prices by high-end firms is not endogenous to BOP firm decision-making and thus our results reflect a clear and robust change in the behavior of high-end firms in response to BOP firm entry.

The coefficient estimate of $BOP\ in\ Market$ in specification (3) is positive and significant, reflecting a 15.4-percent higher minimum price after BOP entry, consistent with Hypothesis 2. The BOP firm's choice of (low-end) price and decision to enter are interrelated. We will later examine the role of package-size choices as a potential mechanism through which the BOP firm increases low-end prices.

The coefficient estimate of $MNC\ in\ Market$ is positive in specifications (1) and (2) and negative in (3) but not significant. In nearly a third of the market-month observations that have experienced MNC entry, more than one MNC has entered, and 21 percent have two MNCs. We include $MNC\ in\ Market > 1$ to isolate the effect of additional MNC entry. We find that additional MNC entry in the market does not change the maximum and minimum prices but raises the median price in the market by 6.8 percent, as shown in specification (2).

We include two other explanatory variables in the model to identify changes to incumbent behavior in the market in response to potential entry by BOP and MNC firms in the quarter prior to actual entry. The coefficient estimates of $Quarter\ Before\ MNC\ Entry$ are not significant in specifications (1) and (2), reflecting no significant change in incumbent behavior in response to high-end firm entry. However, the coefficient estimate of $Quarter\ Before\ BOP\ Entry$ is positive and

[9] We drop a small percentage (less than one) of observations that belong to vials, injections, and syrups due to difficulty in converting volume information to strength information.

significant at the 0.1 level in model (2), reflecting that incumbents at the low end increase their prices at the bottom of the price distribution in anticipation of BOP firm entry. The coefficient estimate of $N\ of\ Firms$ is positive and significant in specification (1) and negative and significant in (3), reflecting that the presence of more firms in a market is associated with higher maximum and lower minimum prices.

Goolsbee and Syverson (2008) exploit discrete shifts in the threat of entry by Southwest Airlines to estimate incumbent price responses. In our setting, according to the Drugs and Cosmetics Act of 1940 (and Rules of 1945) of India, the manufacture of new drugs requires prior approval from the national and provincial regulatory authorities. The approval process involves manufacturing on a pilot scale (at least 100,000 tablets or capsules), establishing the stability of drug substances and formulations over a period of six to twelve months to determine shelf-life, and providing additional production process, packaging, and manufacturing location details.

While, in principle, it is possible to exploit the timing of such applications by a BOP firm in our estimation strategy to measure discrete shifts in the threat of entry, we have been unable to secure such information, as it is spread across several national and state regulatory offices in India. Nonetheless, we expand specification (1) of Table 3 to include several months prior to entry, which reveals insights into the timing of incumbents' response to potential entry. The estimates of the regression, shown in specification (1) of Table 4, indicate that five and six months prior to BOP firm entry, the decline in the maximum price in the market is statistically significant—8.7 and 7.5 percent, respectively. One month prior to BOP firm entry, there is a further decline in maximum price by an additional 10.5 percent. The coefficient estimate is negative but imprecise for eight months prior to BOP entry and turns positive for nine months prior to entry, reflecting that incumbents likely learn about potential entry six to eight months prior to actual entry and adjust their pricing strategy. In contrast, the increase in incumbent prices at the low end occurs one month prior to BOP firm entry, as reflected by coefficient estimates in specification (2). These effects are separate from the additional decrease in maximum and increase in minimum price due to actual BOP entry. Overall, these results indicate a strong competitive effect of BOP firm entry in our markets.

Figure 3 illustrates how maximum price, p_{max}, and minimum price, p_{min}, in a market shift due to BOP firm entry. Prices before the threat of BOP firm entry are indexed by before, under the threat of BOP firm entry but before BOP firm sales are indexed by threat, and after BOP firm entry are indexed by after. Potential and actual BOP firm entry lower price dispersion, or the difference between p_{max} and p_{min} by raising the minimum price and lowering the maximum price in the market.

5.3 Price Dispersion and Quantities

We then estimate the effect of BOP firm entry on price dispersion using a variation of equation (1). The results are shown in specifications (4) and (5) in Table 3. The coefficient estimate of

$BOP\ in\ Market$ is negative, which reflects a lowering of price dispersion and is significant in specifications (4) and (5), consistent with Hypothesis 3. The size of the effect is large: BOP presence reduces log P_{Max}-log P_{Min} by 25.8 percent and log P_{90}-log P_{10} by 12.3 percent. The threat of BOP entry further reduces log P_{Max}-log P_{Min} by 13.5 percent in the quarter prior to BOP entry. In contrast, the coefficient estimate of $MNC\ in\ Market$ is positive and significant in both specifications, reflecting that, controlling for other factors, MNC entry increases price dispersion relative to before entry. The size of the effect is again large: The presence of MNC increases log P_{Max}-log P_{Min} by 17.3 percent and log P_{90}-log P_{10} by 21.6 percent above the average level for the market. The coefficient estimates in specifications (4) and (5) reflect that additional MNC entry does not have a significant impact on price dispersion in the market.

Price dispersion may be induced by several factors: spatially, by drugstore heterogeneity and drug characteristics such as the frequency of use and the associated search costs (Sorensen 2000; Brown and Goolsbee 2002; Bayliss and Perloff 2002); temporally, by constantly changing store-specific prices due to randomized sales activities (Lach 2002; Varian 1980); and by the intensity of competition (Baye et al. 2004; Syverson 2007). Our results show that the nature of the entrant can affect market-level price dispersion significantly and that a low-end BOP firm can lower price dispersion in a market substantially.

We then estimate the impact of BOP firm entry on the log of market-level monthly aggregate quantity of sales normalized by the package size. The results of the estimation are shown in specification (6) of Table 3. The coefficient estimate of $BOP\ in\ Market$ is positive, reflecting an increase in the quantity of sales after BOP firm entry but the effect is not statistically significant. The threat of BOP entry, however, is associated with 15.8-percent increase in the quantity of sales in the quarter prior to BOP firm entry.

5.4 Firm-level Prices and Mankind's Pricing Strategy

We then estimate equation (2) and present results in Table 5. The coefficient estimate of BOP is negative and significant, reflecting that the BOP firm charged 36.6-percent $(\exp(-0.457) = 0.634)$ lower prices compared to an average firm in the market. Consistent with our operationalization of the BOP measure, the firm has, during 1999-2011, persistently charged substantially lower prices relative to others in the same market-month. In contrast, the coefficient estimate of MNC is positive and significant, reflecting that MNCs charge 14.3 percent $(= \exp(0.134))$ higher prices. Excluded in our regression is the group of domestic firms in India. Note that the BOP measure is a Mankind-Pharma-specific effect that is time-invariant. Consequently, our estimates are robust even if Mankind-specific time-invariant unobservables are correlated with error terms. Other explanatory variables have relatively small coefficient estimates.

5.5 Impact of BOP Firm Entry on Market-Level Dosage Strength Choices

We next investigate a potential mechanism by which powerful competitive effects of BOP firm entry are obtained. We estimate the impact of BOP firm entry on the range of dosage strengths offered in a market, using a specification similar to equation (1). We estimate the difference between the market-level maximum and minimum dosage strengths in a month in a market, as well as the difference between 90^{th}- and 10^{th}-percentile dosage strengths. The results of these regressions are shown in specifications (1) and (2) of Table 6. The coefficient estimate of $BOP\ in\ Market$ in specification (1) is negative and significant, reflecting that BOP firm entry lowers the range of dosage strengths by 10.135, which is nearly 18 percent of the average level (53.98) offered in the market. The coefficient estimate of $Quarter\ Before\ BOP\ Entry$ is also negative and significant at the 0.1 level, reflecting that in anticipation of BOP firm entry, there is an additional decline of 8.7 percent in the range of dosage strengths offered in the market relative to the average level. The results in specification (2) are largely similar, except that the coefficient estimate of $Quarter\ Before\ BOP\ Entry$ is not significant. The coefficient estimate of $MNC\ in\ Market$ is positive and significant in specifications (1) and (2), reflecting a 31-percent increase in dosage strength dispersion. These results provide a clear insight into the mechanism by which incumbents in the pharmaceutical industry adjust their behavior in response to potential and actual BOP firm entry.

We further explore the impact on dosage strength of BOP firm entry in specifications (3) and (4) of Table 6. The maximum dosage strength offered in a market is 7.5-percent lower after BOP firm entry relative to the average level, as reflected by the negative and significant coefficient estimate of $BOP\ in\ Market$ in specification (3), consistent with Hypothesis 4. As the level of maximum dosage strength in the market is not endogenous to BOP firms' decision-making process, our results point to the strategic response of high-end incumbents to BOP firm entry. The coefficient estimate of $Quarter\ Before\ BOP\ Entry$ is also negative and significant, reflecting an additional 4.7-percent decline in the maximum dosage strength in the market. In contrast, the coefficient estimate of the minimum dosage strength at the market level is positive and significant, reflecting that BOP firm entry increases the dosage strength at the bottom of the pyramid by 8.9 percent.

5.6 Firm-Level Analyses of Dosage Strength Decisions

We further investigate the mechanism at the firm level. We estimate equation (2) with an alternative dependent variable measuring the average dosage strength of the drug in a given month for a given firm in a market. The results of the random-effects GLS regression are shown in Table 7. The results reflect that the BOP firm offers lower dosage strength compared to other firms in the market. The coefficient estimate of BOP is 5.9 milligrams, which represents a ten-percent decline relative to the average dosage size of 57 milligrams in our data. Since the BOP measure is associated with a single firm, namely Mankind, the coefficient estimate of BOP represents a firm fixed-effect. The

coefficient estimate of MNC is not statistically significant, reflecting that MNCs do not differ from other domestic firms in terms of their dosage strength choices.

5.7 Discussion

Our study is based on incumbent responses to one successful pure-play BOP firm, Mankind Pharma. Subsequent research can expand the set of low-end firms to examine incumbent responses, although, as Amaldoss and Shin (2011) note, it is challenging to identify cases of BOP firms as definitive as that of Mankind. Nonetheless, since our focus here is on incumbent responses, if there are other important BOP firms we have neglected, their inclusion with incumbents would only lead to an attenuation of the BOP effect we have set out to measure. Yet we obtain robust incumbent responses in terms of prices, quantities, and dosage strengths.

We do not have data on the relative size of the low-end market, which may explain the extent of incumbent responses across our molecule markets. We do not control for a firm's promotional abilities and drug quality due to data limitations. IMS India indicated to us that it has not systematically archived firm-level promotional information over the years in these pharmaceutical markets. Anecdotal evidence suggests that domestic firms, and Mankind in particular, have a better promotional capability than MNC firms in India. Mankind employs more sales representatives (7000—78 percent of its total workforce) compared to other leading domestic firms (e.g., Cipla, 6,000; Ranbaxy, 4,500; and Cadilla, 4,400).

It can be argued that even though the drugs are bioequivalent, consumers may perceive quality differences between BOP and branded drugs between domestic firms and MNCs, perhaps driven by complementarities between patented and non-patented drug brands offered by the MNCs.[10] One can also envision that MNCs, with their superior marketing capability to influence specialist physicians' prescriptions, can charge higher prices while maintaining their market shares. The data to differentiate the efficacy of different drugs in the same market are difficult to gather, as are the data on physician prescriptions. Thus, addressing related concerns remains beyond the scope of this study.

6 Conclusion

We investigate the impact of potential and actual BOP firm entry on incumbent drug prices in the Indian pharmaceutical industry. Our results show that BOP firm entry lowers the degree of price dispersion and limits the ability of high-end firms to charge higher prices through price discrimination. Our results also point to the role of BOP firm entry in changing incumbents' package-size choices. BOP firm entry is also associated with market expansion leading to the long-term

[10] There may be differences between drugs produced by MNCs and domestic firms in terms of their efficacy. MNC drugs may contain technologies such as time-release, extended-release, etc. However, we do not know the extent of such differences and the relevance to our data.

success of the BOP firm strategy. As Rangan et al. (2011) note, recognition of the heterogeneity in the consumer base at the low end of the market and designing a product to target that segment appear central to the success of the BOP firm strategy.

Our case study of the Indian pharmaceutical industry has wider implications for other emerging economies that face similar concerns about healthcare inflation caused by rising drug prices. More broadly, in the global context, the Indian pharmaceutical industry has an important role to play in providing cheaper generic alternatives to consumers. By some industry estimates, Indian generics firms alone, supply 35 percent of the U.S. demand for generics. India also has the largest number of U.S. FDA-approved manufacturing plants outside of the U.S. and has steadily improved its manufacturing practices. Maintaining the health of the Indian generic-drug industry is, therefore, important for advanced nations as they make policy trade-offs between access and innovation in healthcare markets. In particular our results have implications for the availability of new drugs around the world given regulatory changes in both developed and developing countries (Berndt et al. 2011).

Our results suggest that facilitating the entrepreneurial activity of BOP firms can curb price dispersion. In contrast, India's drug-price controls, which are formulated by incorporating prices of branded drugs in markets, may fail to substantially reduce price dispersion but delay the launch of new drugs in India (see, also, Kyle 2007). Several countries have now implemented generic price substitution and reference price mechanisms that limit price dispersion by limiting reimbursement rates and physician budgets (e.g., Danzon and Ketcham 2003). Our results suggest that empowering the consumer to price-shop, along with recent BOP experiments in some developing countries to set up dedicated retail stores for generics, can lead to improvements in access to affordable drugs. Recent administrative and legal changes in India, which mandate physicians to prescribe a generic alternative, can also improve access to drugs by increasing the relative size of the low-end market. To the extent that the perceived quality of drugs underlies price dispersion, efforts to certify the quality of generics drugs can also lead to lower prices.

We have related our empirical results to several existing models featuring competition among high-end and low-end firms. Our work adds to the literature on mixed markets and provides scholars the opportunity to build richer theoretical models of competition at the low end of the market, featuring mission-oriented bottom-of-the-pyramid firms. Our work also adds to the nascent literature on the disruptive role of bottom-of-the-pyramid strategies of entrepreneurial startups and established firms in emerging markets.

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Figures and Tables

Figure 1: Growing price dispersion in India over time

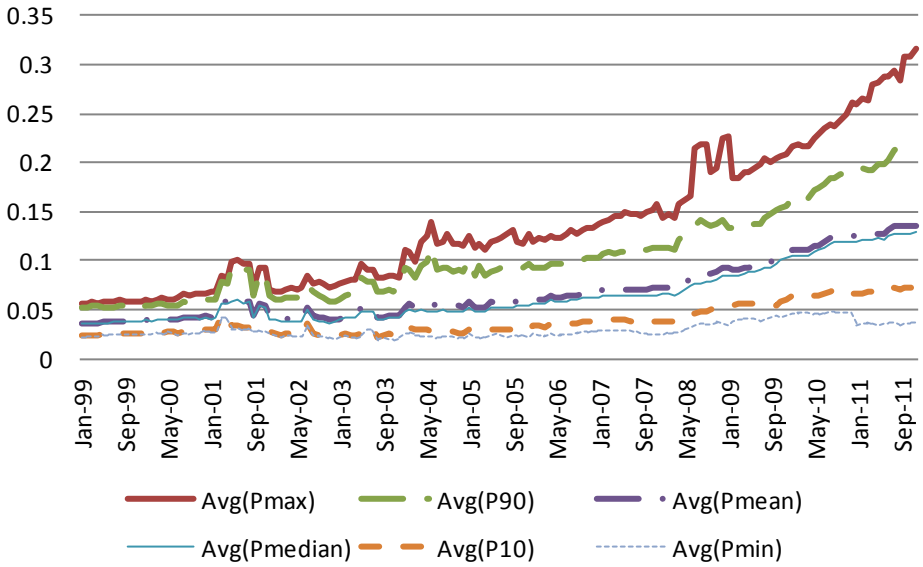


FIGURE 1 NOTES: Figure shows the time path of the maximum, 90th percentile, mean, median, 10th percentile, and minimum monthly nominal price of a strength-adjusted representative drug of one gram in our sample of oral anti-diabetes, anti-coagulant and cardiovascular drugs. For example, the average of P_{max} is obtained by averaging maximum prices across all markets present in a given month in our sample.

Figure 2: Persistence of Pricing Strategies by Firm Type

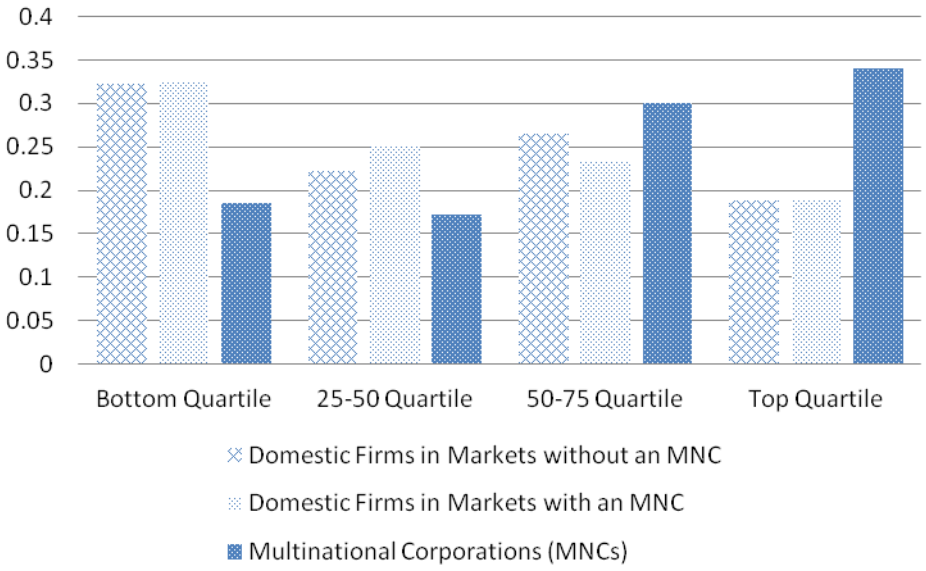
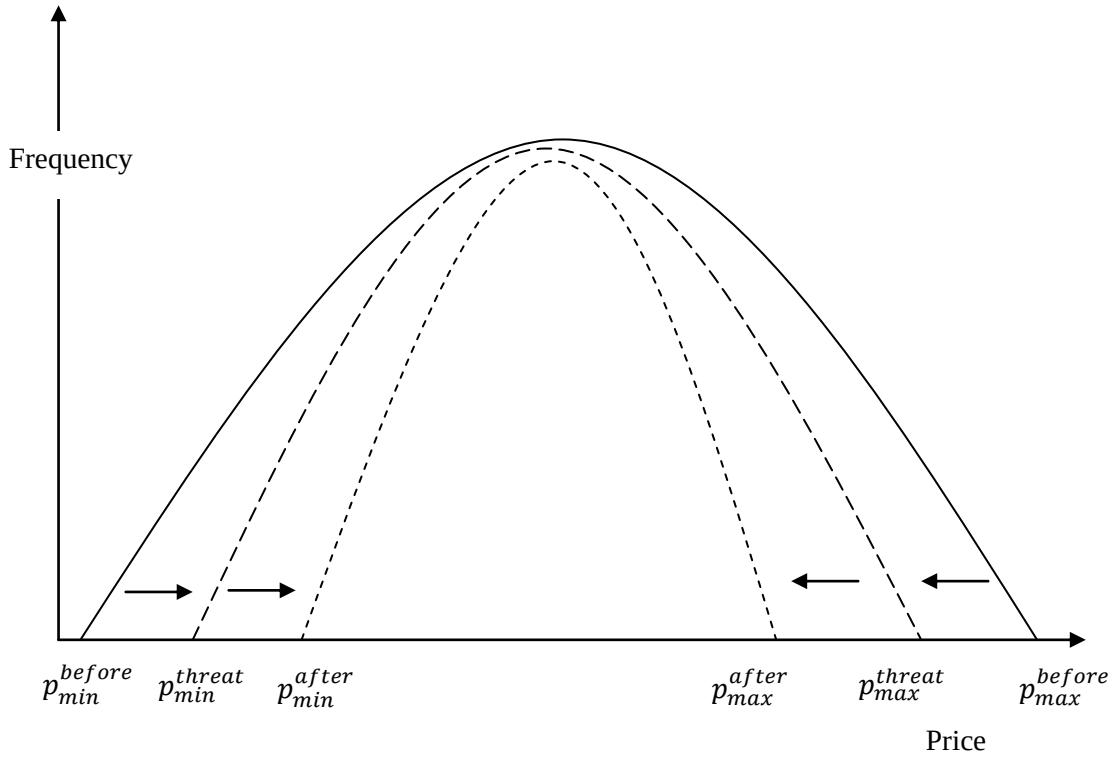


FIGURE 2 NOTES: Figure shows the fraction of months spent by a firm in a market, averaged across three categories of firms. According to the figure, an MNC spends nearly twice as much time in the top quartile of the price distribution as a domestic firm.

Figure 3: Stylized Illustration of the Impact of BOP Entry on Market-Level Prices



Notes—The figure illustrates how maximum and minimum prices—p_{max} and p_{min}—in a market shift due to BOP firm entry. The x-axis plots prices offered in a market and the y-axis plots the number of sellers at each price-level. Prices before the threat of BOP firm entry are indexed by before, under the threat of BOP firm entry but before BOP firm sales are indexed by threat, and after BOP firm entry are indexed by after. Potential and actual BOP firm entry lower price dispersion, or the difference between p_{max} and p_{min} in the market by raising the minimum price and lowering the maximum price in the market.

Table 1: Description of Variables

Variable	Description
Price	Price of a drug per gram averaged across dosage strengths in a month for a firm in a market.
$P_{Max,}$ $P_{90,}$ $P_{Median,}$ $P_{10,}$ $P_{Min.}$	Maximum, 90th, Median, 10th percentile, and minimum price—in market j in month t.
BOP	Dummy=1 if the firm is Mankind Pharma, our stylized BOP firm.
BOP in Market	Dummy=1 if BOP firm is present in the market in a month
Quarter Before BOP Entry	Dummy=1 for the quarter before entry of BOP firm in a market.
MNC	Dummy=1 if a firm is a Multinational Company as defined by IMS
MNC in Market	Dummy=1 if MNC is present in the market in a month
MNC in Market > 1	Dummy=1 if more than one MNC is present in the market in a month
Quarter Before MNC Entry	Dummy=1 for the quarter before entry of MNC in a market.
Firm Age in Market	The variable measures the age of a firm in an ATC 4-digit market in a given month.
N of Firms in Market	The variable measures the number of firms in an ATC 4-digit market in a given month
N of Markets (Firm Scope)	The variable measures the number of other ATC 4-digit markets a firm is present in a given month.
Molecule Age	This variable measures the age of the market in number of months from the month of its launch in India. For the preexisting markets at the start of our dataset, age of the market is measured from January 1999.
Dosage Strength (DS)	Dosage strength of the drug in a market in a month offered by a firm
Log of Quantity Adjusted	Log of aggregate drug unit sales in thousands in an ATC-4 molecule market in a month divided by total package size (which is the number of strips in the package times the number of tablets in the strip times dosage strength)

Table 2. Descriptive Statistics

Variable	N	Mean	Std. Dev.	Min	Max
log (Price)	218343	-4.01	1.82	-14.30	2.30
BOP	218343	0.01	0.11	0	1
MNC	218343	0.08	0.28	0	1
Firm Age in Market	218343	47.82	36.41	1	156
N of Firms in Market	218343	24.60	17.55	1	65
Firm Scope	218343	28.82	21.59	1	84
Molecule Age	218343	76.62	40.37	1	156
$\log P_{90} - \log P_{10}$	23027	1.21	1.48	0	8.67
$\log P_{75} - \log P_{25}$	23027	0.75	1.11	0	7.76
$\log P_{Max}$	23027	-3.21	1.80	-9.28	2.30
$\log P_{90}$	23027	-3.35	1.79	-9.28	2.30
$\log P_{Mean}$	23027	-3.94	1.70	-9.28	2.30
$\log P_{Median}$	23027	-3.94	1.77	-9.28	2.30
$\log P_{10}$	23027	-4.56	1.88	-14.30	2.30
$\log P_{Min}$	23027	-4.73	1.92	-14.30	2.30
N of Firms in Market	23027	9.48	11.97	1	65
MNC in Market	23027	0.47	0.50	0	1
Dosage Strength (DS_{Min})	23027	36.79	73.41	.1	600
Dosage Strength (DS_{Max})	23027	90.78	144.67	.1	1000
DS_{Max}-DS_{Min}	23027	53.98	120.75	0	999.75
DS_{90}-DS_{10}	23027	42.93	98.17	0	999.75
$\log(Q_{Adjusted})$	23027	-0.74	2.95	-15.43	6.81
BOP in Market	23027	0.12	0.32	0	1
Quarter Before MNC Entry	23027	0.01	0.10	0	1
Quarter Before BOP Entry	23027	0.01	0.08	0	1

Table 3: Estimates of the effect of BOP Entry on market-level prices, price dispersion, and quantities

D.V.=	(1) log (P_{Max})	(2) log (P_{Median})	(3) log (P_{min})	(4) log P_{Max}- log P_{Min}	(5) log P_{90}- log P_{10}	(6) log ($Q_{Adjusted}$)
BOP in Market	-0.090**	0.022	0.168**	-0.258**	-0.123+	0.027
	[0.0317]	[0.0471]	[0.0601]	[0.0693]	[0.0680]	[0.0638]
Quarter Before BOP Entry (No BOP Firm Sales)	-0.022	0.026	0.113+	-0.135*	-0.057	0.147*
	[0.0259]	[0.0620]	[0.0611]	[0.0639]	[0.0493]	[0.0734]
MNC in Market	0.05	0.013	-0.123	0.173+	0.216*	0.06
	[0.0768]	[0.0756]	[0.1002]	[0.1010]	[0.0933]	[0.1233]
MNC in Market > 1	0.03	0.066*	0.043	-0.013	-0.017	-0.052
	[0.0396]	[0.0315]	[0.0623]	[0.0757]	[0.0678]	[0.0660]
Quarter Before MNC Entry (No MNC Sales)	-0.028	0.000	0.027	-0.056	-0.097	-0.034
	[0.0396]	[0.0426]	[0.0619]	[0.0672]	[0.0600]	[0.0723]
N of Firms	0.039**	-0.008+	-0.052**	0.091**	0.042**	0.094**
	[0.0074]	[0.0046]	[0.0070]	[0.0107]	[0.0098]	[0.0104]
Constant	-4.098**	-4.124**	-4.182**	0.084	0.301**	-1.893**
	[0.0469]	[0.0298]	[0.0500]	[0.0665]	[0.0676]	[0.0975]
Observations	23,027	23,027	23,027	23,027	23,027	23,027
N of Markets	206	206	206	206	206	206
Market FE	YES	YES	YES	YES	YES	YES
Month FE	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES
Market*Year FE	YES	YES	YES	YES	YES	YES
N_of_Clusters	206	206	206	206	206	206
R2_Overall	0.115	0.0192	0.0532	0.55	0.479	0.208
R2_Between	0.0215	0.00228	0.000108	0.336	0.277	0.105
R2_Within	0.91	0.911	0.85	0.864	0.835	0.72
Market-Clustered S.E. in brackets; ** p<0.01, * p<0.05, + p<0.1						

TABLE 3 NOTES: The method of estimation is GLS with market fixed-effects. The dependent variable in specifications (1), (2), and (3) is log Price at three points on the price distribution. The dependent variables in specifications (4) and (5) are two measures of price dispersion: log P_{Max}- log P_{Min} is the difference between the log of the maximum and the log of the minimum prices in the market; and log P_{90}- log P_{10} is the difference between the log of the 90th percentile price and log of the 10th percentile price in a market. The dependent variable in specification (6) is log quantity sales in the market adjusted for dosage-strength differences. The sample consists of an unbalanced panel of 206 markets spanning 156 months. $N\ of\ Firms$ measures the number of firms in a market in a month; $MNC\ in\ Market$ indicates whether an MNC is present in the market in a month and $BOP\ in\ Market$ indicates BOP firm presence. $MNC\ in\ Market > 1$ indicates the presence of more than one MNC in the market in a given month. Market, month, year, and market-specific year fixed-effects are included to control for alternative explanations, and standard errors are clustered at the market level.

Table 4: Estimates of the threat of BOP Entry on high-end and low-end market prices

D.V.=	(1) log (P_{Max})	(2) log (P_{Min})
9 Months Before BOP Entry (No BOP Firm Sales)	0.013	-0.046
	[0.0408]	[0.1047]
8 Months Before BOP Entry (No BOP Firm Sales)	-0.047	-0.085
	[0.0355]	[0.1051]
7 Months Before BOP Entry (No BOP Firm Sales)	-0.076	0.018
	[0.0489]	[0.0808]
6 Months Before BOP Entry (No BOP Firm Sales)	-0.078+	-0.022
	[0.0409]	[0.0850]
5 Months Before BOP Entry (No BOP Firm Sales)	-0.091*	0.03
	[0.0406]	[0.0813]
4 Months Before BOP Entry (No BOP Firm Sales)	-0.04	0.04
	[0.0308]	[0.0896]
3 Months Before BOP Entry (No BOP Firm Sales)	-0.042	0.07
	[0.0315]	[0.0899]
2 Months Before BOP Entry (No BOP Firm Sales)	-0.034	0.045
	[0.0334]	[0.0886]
1 Month Before BOP Entry (No BOP Firm Sales)	-0.111+	0.170+
	[0.0621]	[0.0983]
BOP in Market	-0.144**	0.192**
	[0.0474]	[0.0709]
MNC in Market	0.047	-0.125
	[0.0763]	[0.1004]
MNC in Market > 1	0.031	0.036
	[0.0385]	[0.0600]
Quarter Before MNC Entry (No MNC Sales)	-0.03	0.023
	[0.0401]	[0.0628]
N of Firms	0.040**	-0.054**
	[0.0074]	[0.0074]
Constant	-4.105**	-4.179**
	[0.0452]	[0.0476]
Observations	23,027	23,027
N of Markets	206	206
Market FE	YES	YES
Month FE	YES	YES
Year FE	YES	YES
Market*Year FE	YES	YES
N_of_Clusters	206	206
R2_Overall	0.108	0.0682
R2_Between	0.0126	0.00153
R2_Within	0.902	0.809
Market-Clustered S.E. in brackets; ** p<0.01, * p<0.05, + p<0.1		

TABLE 4 NOTES: See notes for Table 3.

Table 5: Persistent Pricing Strategies of the BOP Firm

D.V.= log (Price)	1999-2011
BOP (Mankind Pharma Dummy)	-0.457**
	[0.0347]
MNC	0.134**
	[0.0158]
Firm Age in Market	0.001*
	[0.0007]
N of Firms in Market	-0.001+
	[0.0007]
N of Markets (Firm Scope)	0.004**
	[0.0013]
Molecule Age	0.000
	[0.0009]
Constant	-4.844**
	[0.0762]
Observations	218,343
N of Firm-Markets	3,488
Market FE	YES
Month FE	YES
Year FE	YES
Market*Year FE	YES
N_of_Clusters	261
R2_Overall	0.775
R2_Between	0.782
R2_Within	0.277
Firm-Clustered S.E. in brackets; ** p<0.01, * p<0.05, + p<0.1	

TABLE 5 NOTES: The method of estimation is random-effects GLS. The dependent variable is the log of the strength-adjusted price of one gram of drug in a market aggregated across dosage forms. Market, month, year, and market-specific year fixed-effects are included in regression specifications, and standard errors are clustered at the firm level.

Table 6. Dosage-Strength Choice as a Mechanism to Respond to BOP Firm Entry

D.V.=	(1) DS_{Max}-DS_{Min}	(2) DS_{90}-DS_{10}	(3) DS_{Max}	(4) DS_{Min}
BOP in Market	-10.135*	-8.743**	-6.847+	3.288**
	[4.3201]	[2.5571]	[4.0931]	[1.0428]
Quarter Before BOP Entry (No BOP Firm Sales)	-4.696+	-2.421	-4.280+	0.416
	[2.4584]	[1.5149]	[2.3411]	[0.5624]
MNC in Market	16.767+	17.107+	15.233	-1.534
	[10.0386]	[9.9360]	[9.3299]	[3.5575]
MNC in Market > 1	8.07	9.396	9.554	1.484+
	[8.7967]	[8.5791]	[8.6468]	[0.8223]
Quarter Before MNC Entry (No MNC Sales)	-8.935	-9.861	-7.933	1.002
	[8.9967]	[8.9759]	[8.8779]	[1.0814]
N of Firms	3.098**	1.610**	1.666**	-1.432**
	[0.6433]	[0.4520]	[0.3918]	[0.3750]
Constant	13.488*	15.671*	70.618**	57.130**
	[6.3885]	[6.1489]	[4.2336]	[4.9969]
Observations	23,027	23,027	23,027	23,027
R-squared	0.861	0.786	0.881	0.859
Market FE	YES	YES	YES	YES
Month FE	YES	YES	YES	YES
Market*Year FE	YES	YES	YES	YES
N_of_Clusters	206	206	206	206
R2_Overall	0.429	0.292	0.138	0.0087
R2_Between	0.181	0.105	0.0108	0.0088
R2_Within	0.861	0.786	0.881	0.859

Market-Clustered S.E. in brackets; ** p<0.01, * p<0.05, + p<0.1

TABLE 6 NOTES: The method of estimation is GLS with market fixed-effects. The dependent variable is dosage strength at two points of the market-level package size distribution. The sample spans 156 months during 1999-2011. $N\ of\ Firms$ measures the number of firms in a market in a month; $MNC\ in\ Market$ indicates whether an MNC is present in the market in a month; and $BOP\ in\ Market$ indicates BOP firm presence. $MNC\ in\ Market\ >\ 1$ indicates the presence of more than one MNC in the market in a given month. Market, month, year, and market-specific year fixed-effects are included to control for alternative explanations, and standard errors are clustered at the market level.

Table 7: Dosage Strength Choices of the BOP Firm

D.V.=	Dosage Strength
BOP (Mankind Pharma Dummy)	-5.894**
	[1.7919]
MNC	-0.67
	[2.1402]
Firm Age in Market	-0.163**
	[0.0453]
N of Firms in Market	0.03
	[0.0411]
N of Markets (Firm Scope)	0.09
	[0.1058]
Molecule Age	0.147**
	[0.0451]
Constant	-5.006**
	[3.7382]
Observations	218,343
Market FE	YES
Month FE	YES
Year FE	YES
Market*Year FE	YES
N_of_Clusters	261
N of Firm-Markets	3,488
R2_Overall	0.778
R2_Between	0.747
R2_Within	0.14
Firm-Clustered S.E. in brackets; ** p<0.01, * p<0.05, + p<0.1	

TABLE 7 NOTES: The method of estimation is maximum likelihood for GLS random-effects. The dependent variable is the average dosage strength in a market in a month, offered by a given firm. The key independent variable is BOP. Market, month, year, and market-specific year fixed-effects are included in all regression specifications. Standard errors are clustered at the firm level.