The Unexpected Consequences of Asymmetric Competition. An Application to the Pharmaceutical Industry*

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Abstract

This paper shows that an asymmetric competition shock that leads to a steep price drop in one market segment may benefit substitute products. Consumers move away from the cheaper product triggering a *reverse competition effect*. This result is driven by non-price competition: asymmetric shocks decrease *some* firms' investment in promotion, which cripples their ability to lure consumers. We identify the conditions under which the lower priced product loses volume sales.

To assess the empirical relevance of these findings, we study the effects of generic entry into the pharmaceutical industry. We exploit a large product-level dataset for the US covering the period 1994Q1 to 2003Q4 and find strong empirical support for the model's theoretical predictions. Our estimates rationalize the observation that a molecule that loses patent protection (the originator drug plus its generic competitors) often experiences a drop in the quantity market share –despite being sold at a fraction of the original price.

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1 Introduction

To attract customers, firms selling imperfect substitutes do not only cut prices. They also invest in non-price instruments, such as advertising and brand management. In the presence of product differentiation and *asymmetric* competition shocks, the entry of a firm or the launch of a new product will not squeeze the profit margins of all incumbents in the same manner. Some experience intense margin compression, whereas others remain comparatively shielded.

Our model shows that, if we overlook non-price competition, asymmetric and symmetric shocks always have similar effects: demand shifts towards the cheaper market segment (call it A). Instead, when we take account of the non-price dimension, asymmetric competition shocks may give rise to what we call a *reverse competition effect*.

The reason is that intense competition also cripples firm A's capacity to invest in non-price instruments. This produces an opposite shift in demand, beneficial to the more expensive product segment (call it B). Hence, when non-price instruments are an important determinant of market outcomes, and when one segment (but not the other) moves from imperfect to perfect competition, allocative efficiency can be *reduced*. This holds whether demand eventually moves towards A or towards B. Further, even when non-price instruments do not directly enter consumers' utility, their surplus may be reduced by competition. This only happens when the demand shifts strongly towards B.

This is more than a theoretical construct: using a data trove tracking prices, promotion, and quantities sold, we show that competition by generics in the trillion-dollar pharmaceutical market often fails to put effective pressure on the drugs that remain protected by a patent. Despite price drops as high as 45% for the drug experiencing generic entry, it is often the market share of *competing molecules* that increases. The *volume* market share of the molecule that is now cheaper —the originator drug *plus its chemically equivalent generic version*— drops, on average, by 31% in the pharmacy channel and by 26% for drugs sold in hospitals. As we detail below, both our theoretical and empirical findings show that, quite counter-intuitively, this phenomenon is more pronounced when molecules are close substitutes and when market size is large.

To analyze these effects formally, we propose a stylized model in which two firms, A and B, each produce a differentiated product. Consider, first, the situation in which they compete only in price. Following standard intuition, the more substitutable the goods, the lower initial prices will be. Then, firm A is confronted with the entry of a new competitor that sells a direct substitute for its product. Absent capacity constraints, this competition shock drives the price of A down to marginal cost and forces B to also react with a lower price. In this situation, "competition works as expected".

What happens when the two firms also rely on non-price instruments such as advertising to attract consumers? In this setting, the asymmetric competition shock experienced by A also induces it to cut down investment in the non-price instrument. Whenever the non-price shock dominates the price shock, B sees its residual demand expand.

Under which conditions does this *reverse competition effect* materialize? Quite surprisingly, the problem is more acute when A's and B's products are *closer substitutes*. The reason is that the more substitutable the two goods are, the more aggressively A and B compete prior to the entry of the third firm (before *generic entry* in the case of the pharmaceutical industry). This translates into initially lower prices and higher "promotion" (the non-price instrument that we can measure in our data). In that situation, generic entry has a comparatively small impact on prices; the reduction in promotion dominates. *High* levels of differentiation have the opposite effect: prices are initially high and promotion low. Then, generic entry affects primarily prices: both A's and B's prices drop.

The model also informs us on the expected effects of demand elasticity: we find that a lower price elasticity of demand increases the likelihood that B benefits from the stiffer competition faced by A. The same goes for market size: the reverse competition effect is more likely to hold in large markets because B maintains a high level of promotion.

Clearly, the pharmaceutical industry is a particular one. Yet, it is also an ideal testing ground to assess these predictions. First, we can precisely disentangle asymmetric shocks, caused by the loss of exclusivity (LoE), from the entry of new competing products. Such a clear dichotomy between the launch of new products and the loss of market power for a single product is difficult to observe in other markets. Second, non-price competition is particularly important: for large players, promotion represents 15% to 20% of total sales, about the same

as R&D.[1] Third, agency issues between patients, physicians, and insurances likely increase the sensitivity of demand to non-price instrument relative to prices, which magnifies the effects we are after. Fourth, we find that elasticities differ between hospitals and pharmacies. This allows us to test whether a lower price elasticity of demand indeed benefits B. Fifth, the market is economically relevant: worldwide sales totaled nearly a trillion US dollars in 2013, while the US market stood at 374 billion dollars in 2014.[2] Last, but not least, given the long time span between patent filling and Loss of Exclusivity (LoE), actual market size and the degree of substitutability of competing products cannot be predicted ahead of actual launch. This produces substantial exogenous variation across episodes of generic entry that we exploit in our regressions.

We start with a sample that covers all prescription sales in the U.S. between 1994Q1 and 2003Q4 (40 quarters). From that dataset, we extract all the therapeutic classes ("ATC3 markets") for which data on prices, quantities, and promotional efforts are available. We then crossed these data with that of the FDA to identify episodes of generic entry (see Section 4). This leaves us with 95 episodes of generic entry scattered over 53 different ATC3 markets.

The size of this sample allows us to exploit the (heterogeneous but always large and asymmetric) shocks to competition associated with LoE to identify the coefficients of the demand function. As shown in Section 5.1, the price-to-promotion elasticity ratio is lower in the pharmacy channel than in the hospital channel. We use this difference to test–and confirm–our theoretical predictions relating these elasticities to the evolution of market shares.

After controlling for other possible sources of heterogeneity, we find that, on average, generic entry alone causes a 12% *increase* in market share for molecules that remain on patent. The effect is smaller in the hospital channel: the higher price elasticity reduces the magnitude of this effect by about 3 percentage points. We also propose a novel measure

[1] In the *Oxford Handbook of the Biopharmaceutical Industry*, Harrington (2012) estimates the R&D to be at 17.9% of total net sales for the period 2001-2005, and Kenkel and Mathios (2012) report that the advertising-to-sales ratio was 18% in 2005 in the U.S. As points of comparison, they highlight that, in 2010, advertising stood at 4.5% of total net sales for General Motors (a car producer), 9.5% for Anheuser Busch (a beer producer) and 10.8% for Kellogg (breakfast cereals). The figures are typically smaller for most other R&D-intensive industries. For instance, in 2013, Apple spent 3% of its total net sales on R&D and 0.4% on advertising (Apple 2013: 10-K SEC submission). See also Manchanda *et al.* (2005)

[2] Source: http://www.statista.com/statistics/263102/pharmaceutical-market-worldwide-revenue-since-2001/ and http://www.statista.com/statistics/238689/us-total-expenditure-on-medicine/

of product differentiation for the pharmaceutical industry based on the number of modes of action within a therapeutic class. We argue that the existence of different modes of action to treat a particular condition is indicative of more differentiation. We find that differentiation knocks another 4 percentage points off the market share gain of the competitors. Finally, the market share gain is further reduced by 7 percentage points in "small" markets. Each of these observations is in line with the theoretical predictions sketched out above.

Related literature. Our paper is at the intersection of several literature strands, including industrial organization, advertising, and health economics. With regard to our empirical application, the existing literature on competitive interactions in the pharmaceutical industry has produced a complex, and sometimes contradictory, picture. One group of papers analyzes inter-brand competition when drugs are still patent-protected (see, for instance, Brekke and Kuhn (2006) for a theoretical model and Dave and Safer (2012) for empirics). de Frutos, Ornaghi and Siotis (2013) analyze inter-brand competition when the proportion of brand-loyal consumers is endogenously determined by promotional effort.

Another strand focuses on intra-molecular competition following loss of exclusivity — *i.e.*, when a generic bio-equivalent drug can legally come to market (*e.g.* Scott Morton (2000)).[3] It was in that context that the "generic entry paradox" has been unearthed (the paradox being that the price of the originator drug often goes up following the launch of a competing chemically equivalent generic). This empirical finding has been thoroughly documented (see *a.o.* Caves *et al.* (1991); Regan (2008); Vandoros and Kanavos (2013)).

The few papers that attempted to simultaneously analyze pre- and post-LoE competition have produced a mixed picture. For instance, Stern (1996) provides evidence of intense inter-molecular competition, whereas Ellison *et al.* (1997) reports strong intra-molecular rivalry between the originator and the generic version of the drug, as well as weak (or insignificant) inter-molecular competition.

A related literature focuses on the relative importance of the persuasive and informative roles of promotional effort (Ching and Ishihara (2012)) and on whether detailing and direct-

[3]See Grabowski and Kyle (2007) for a description of generic entry in the US in the period 1995-2005 and Berndt and Dubois (2016) for a comparison of generic penetration across OECD countries for the period 2004-2010.

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