Quant Mark Econ (2010) 8:429 460
DOI 10.1007/s11129-010-9089-5

Drivers of peak sales for pharmaceutical brands

Marc Fischer · Peter S. H. Leeflang · Peter C. Verhoef

Received: 20 January 2009 / Accepted: 28 July 2010 /
Published online: 13 August 2010

Abstract Peak sales are an important metric in the pharmaceutical industry. Specifically, managers are focused on the height-of-peak-sales and the time required achieving peak sales. We analyze how order of entry and quality affect the level of peak sales and the time-to-peak-sales of pharmaceutical brands. We develop a growth model that includes these two variables as well as control variables for own and competitive marketing activities. We find that early entrants achieve peak sales later, and they have higher peak-sales levels. High-quality brands achieve peak sales earlier, and their peak-sales levels are higher. In addition, quality has a moderating effect on the order of entry effect on time-to-peak-sales. Our results indicate that late entrants have longer expected time-to-peak-sales when they introduce a brand with high quality.

Keywords Peak-sales metrics · Brand growth · Econometric models · Market entry · Pharmaceutical marketing

JEL Classification C23 · C51 · L65 · M31

M. Fischer (✉)
Business and Economics,
University of Passau, Innstr. 27, 94032 Passau, Germany
e-mail: marc.fischer@uni-passau.de

P. S. H. Leeflang · P. C. Verhoef
Economics and Business, University of Groningen, P.O. BOX 800, 9700 AV Groningen, Netherlands

P. S. H. Leeflang
e-mail: P.S.H.Leeflang@rug.nl

P. C. Verhoef
e-mail: p.c.verhoef@rug.nl

P. S. H. Leeflang
LUISS Guido Carli, Rome, Italy

1 Introduction

New products play a very important role in the pharmaceutical industry (Leenders and Wierenga 2008; Stremersch and van Dyck 2009). Pharmaceutical firms constantly introduce new drugs, and for these new drugs, peak sales represent an important metric, frequently used by investors to assess pharmaceutical firms' value (Obeid and Vine 2005; Suresh et al. 2006).

Peak sales can be characterized along two dimensions: the *height of peak sales* and the *time to peak sales*. Both metrics are closely related to new product performance such as cumulative sales. Intuitively, a brand with a higher level of peak sales is likely to have higher average sales over its life cycle. As a result, cumulative sales are also higher. Similarly, a brand with longer time-to-peak-sales enjoys a longer period of growth that contributes to accumulate sales and achieve a higher level of peak sales. Consequently, cumulative sales are again higher.

There are, however, exceptions to these rules. For example, a high level of peak sales may be achieved very fast. Although, we cannot rule out such a case theoretically, we do not believe it occurs often in reality because of restrictions to growth. Note that the growth rate needs to double if the same level of peak sales is to be achieved in half of the time. Firms can handle faster growth only up to a certain level due to supply and resource restrictions. In Appendix A, we also demonstrate that faster growth implies a higher variance of sales and therefore higher cash-flow volatility which is not desirable (Srivastava et al. 1998). Hence, even if demand might allow for a shorter time-to-peak sales, there are limits to growth from the supply side. The broad sample of new drugs that forms the basis of our empirical study supports our view. Time-to-peak-sales enhances height-of-peak sales and both peak-sales metrics increase cumulative brand sales. Together the two metrics explain more than 96% of observed variance in cumulative brand sales.

Time-to-peak-sales and height-of-peak-sales provide two important yardsticks that are easy to evaluate and predict even before launch. Assume management wants to assess the sales potential of a new product two years prior to launch. Cumulative sales may be obtained from the life cycle curve. Predicting the lifetime and sales for all periods, however, requires much more information than predicting only two peak-sales metrics. It is much easier to reach a consensus estimate for time-to-peak-sales and height-of-peak-sales. For pharmaceuticals, as an example, management can triangle information on the population size, the incidence of a disease and the reachable market share for the new drug to obtain an estimate for the height-of-peak-sales. Management would certainly use information on competitive entries, order of entry, marketing investment, etc. to predict the peak-sales metrics. Our empirical analysis provides important insights into the relevance of these variables for peak sales. Importantly, the analysis also suggests that those variables do not provide explanatory power for cumulative sales beyond the two peak-sales metrics. Hence, peak-sales metrics cannot simply be substituted by other predictors.

It is therefore not surprising that peak-sales metrics are widely adopted in practice, especially within the pharmaceutical industry. For example, Salix

Pharmaceuticals reportedly has tumbled because its IBD franchise will "only achieve peak sales of $ 99 million, lower than its previous estimate of $ 135 million because of the Dec. 28 approval of three generic balsalazide (Colazal) formulations by the Food and Drug Administration" (Trading Markets.Com 2007). The importance of peak-sales metrics prompts business intelligence agencies such as IMS or Datamonitor to predict the peak sales of newly introduced drugs (e.g., Datamonitor 2007). Not only are the metrics important in practice (Obeid and Vine 2005), but scholars also acknowledge their relevance. For example, Bauer and Fischer (2000) and Schmid and Smith (2002) demonstrate that time-to- and height-of-peak-sales differ across brands introduced into different drug categories and countries due to factors such as order of entry.

In the marketing literature, there has been extensive attention to the role of order of entry and quality with regard to (new product) performance (Gielens and Dekimpe 2001; Kalyanaram and Urban 1992; Kalyanaraman and Wittink 1994; Robinson and Fornell 1985; Shankar et al. 1998). An important debate addresses the question whether first movers really have a competitive advantage as is often attributed to them (Golder and Tellis 1993; Kornelis et al. 2008; Zhang and Narasimhan 2000). Quite in contrast, recently Tellis and Johnson (2007) argue that delivering superior quality is considered as the most important driver of new product success. Hence, we assess the role of order of entry and quality for the market performance of a new drug in terms of peak sales.

The main objective of this study is to determine the drivers of height-of peak-sales and time-to-peak-sales in the pharmaceutical industry. Through this study we contribute to the literature on new products and brand life cycles (Hauser et al. 2006), as this is the first study to investigate drivers of time-to- and height-of-peak-sales. We show that some drivers differentially impact height-of-peak-sales and time-to-peak-sales. For example, marketing expenditures increase the level of peak sales, while they decrease the time-to-peak-sales. We aim to contribute to the literature on drivers of new product performance with a further investigation on the relative roles of order of entry, quality, and marketing efforts (see Tellis and Johnson 2007). Importantly, our results suggest that quality has by far the strongest positive effect on height-of-peak-sales, while it reduces the time-to-peak-sales. Finally, by executing this study in the pharmaceutical industry we also contribute to existing knowledge on pharmaceutical marketing (e.g. Kremer et al. 2008; Stremersch and van Dyck 2009).

The article is organized as follows: In the next section, we review the literature on drug life cycles and provide explanations why peak sales is a quite common phenomenon in the evolution of drug sales. Subsequently, we discuss potential drivers of time-to- and height-of-peak-sales and how they might affect the two metrics. We develop a model to measure the effects, then describe data from the pharmaceutical industry and discuss estimation issues. We follow up with a discussion of the empirical results. We continue with a cross-sectional analysis of new product performance to substantiate the relevance of the suggested metrics. In the final section, we conclude with research implications, limitations, and suggestions for further research.

2 Drug life cycles and peak sales

2.1 Life cycle research

Studying the length and the shape of brand life cycles has a long history, including studies by Bauer and Fischer (2000), Brockhoff (1967), and Polli and Cook (1969). Research on specific metrics at the brand level in the development of the brand life cycle is scarce. Height-of-peak-sales and time-to-peak-sales have not been studied so far. Remarkably, studying the diffusion of article citations in *Econometrica* and the *Journal of Econometrics*, Fok and Franses (2007) model the time-to-peak citations and peak-citations of an article. Hence, though studied in a different context, there is academic attention for peak metrics in the econometric diffusion literature. We believe it is important to study such metrics in a new product context as well, as we will show that both these metrics are highly relevant for practice *and* they both are the most important determinants of cumulative brand sales.

Research at the product level has, however, investigated other specific metrics, as overviewed in Table 1. Several studies consider time-to-takeoff and subsequent growth of consumer durables (i.e., VCRs, televisions), as well as their drivers (Agarwal and Bayus 2002; Neelameghan and Chintagunta 2004; Golder and Tellis 1997; Stremersch and Tellis 2004; Tellis et al. 2003). Bayus (1998) specifically analyzes product lifetime as an important metric. Although these studies provide insights into which factors (i.e., economic, cultural) influence time-to-takeoff at the product level by country, they do not clarify the drivers at the brand level.

2.2 Brand life cycles in drugs

The development of demand for a new drug derives from both adoptions and repeats. For many drugs, the evolution of sales shows a peak. In Fig. 1, we depict the sales development of different brands in the French calcium channel blockers market. On the X-axis, we display the launch years of new drugs, and on the Y-axis, we provide annual sales for three entrants in this market. The figure clearly shows the occurrence of sales peaks. For example, the second entrant reaches its peak in 1988 with a sales level of approximately 200 million daily dosages.

The theories of adoption and imitation (Bass 1969) and informational cascades (Golder and Tellis 2004) explain why brand sales follows a life cycle. However, they are usually associated with the product level and first-time adoptions. Brand sales are, in addition, composed of repeat purchases, and they are subject to competition (Hahn et al. 1994).

Although some authors have questioned the transfer of the product life cycle concept to brands (Dhalla and Yuspeh 1976), brand life cycles have been reported quite frequently. The broadest evidence for brand life cycles is available for pharmaceuticals. Bauer and Fischer (2000), Corstjens et al. (2005), Cox (1967), Grabowski and Vernon (1990), Hahn et al. (1994), Lilien et al. (1981), Rao and Masataka (1988), and Simon (1979) all find strong evidence for the existence of a drug life cycle. In total, these researchers document the life cycles for more than 500 newly introduced drugs.

Table 1 Overview of prior studies investigating specific metrics over a brand's/product's life cycle

Study	Metrics	Data	Antecedents	Major findings
Golder and Tellis (1997)	Time-to-takeoff	Aggregated sales by category in the U.S.	Price, year of introduction, market penetration	- Average time-to-takeoff is six years. - At takeoff, price is 63% of introductory price, and penetration is 1.7%. - Time-to-takeoff decreases after World War II.
Bayus (1998)	Product lifetime	Aggregated sales at various product market levels in the U.S. PC industry	Product introduction year, firm entry year, technology substitution	- Product life cycles are not shrinking over time. - Observed acceleration in life cycles is a result of technology substitution.
Tellis et al. (2003)	Time-to-takeoff	Aggregated sales by category for different European countries	Economic and cultural variables	- Time-to-takeoff varies substantially across European countries. - Culture partially explains country differences. - Advantages for waterfall strategy for international product introduction.
Agarwal and Bayus (2002)	Time-to-takeoff	Aggregated sales by category in the U.S.	Price, new firm entry, commercialization year	- Takeoff in new firm entry leads to sales takeoff. - Firm entry dominates other drivers of time-to-takeoff.
Stremersch and Tellis (2004)	Rate of growth, duration of growth	Aggregated sales by category for different European countries	Economic and cultural variables	- Growth metrics vary substantially across European countries. - Economic factors primarily explain country differences.
Golder and Tellis (2004)	Time-to-takeoff, slowdown, duration of growth	Aggregated sales by category in the U.S.	Price, economic growth, type of product, market penetration	- Slowdown occurs when sales declines by about 15%. - Probability of slowdown is higher when economic growth is slower, price reductions are smaller, and penetration is higher. - Leisure-enhancing products tend to have higher growth rates and shorter growth stages.
This Study	Time-to-peak-sales, height-of-peak-sales	Brand sales of 45 pharmaceutical brands in France, Germany, Italy, and UK	Own marketing expenditures, competitive marketing expenditures, order-of-entry, quality, number of competitors	- Order of entry reduces time-to-peak-sales and height-of-peak-sales. - Quality reduces time-to-peak-sales and increases height-of peak sales. - A higher quality reduces the negative effect of order of entry on time-to-peak-sales.

DOCKET ALARM

Explore Litigation Insights

Docket Alarm provides insights to develop a more informed litigation strategy and the peace of mind of knowing you're on top of things.

Real-Time Litigation Alerts

Keep your litigation team up-to-date with **real-time alerts** and advanced team management tools built for the enterprise, all while greatly reducing PACER spend.

Our comprehensive service means we can handle Federal, State, and Administrative courts across the country.

Advanced Docket Research

With over 230 million records, Docket Alarm's cloud-native docket research platform finds what other services can't. Coverage includes Federal, State, plus PTAB, TTAB, ITC and NLRB decisions, all in one place.

Identify arguments that have been successful in the past with full text, pinpoint searching. Link to case law cited within any court document via Fastcase.

Analytics At Your Fingertips

Learn what happened the last time a particular judge, opposing counsel or company faced cases similar to yours.

Advanced out-of-the-box PTAB and TTAB analytics are always at your fingertips.

API

Docket Alarm offers a powerful API (application programming interface) to developers that want to integrate case filings into their apps.

LAW FIRMS
Build custom dashboards for your attorneys and clients with live data direct from the court.

Automate many repetitive legal tasks like conflict checks, document management, and marketing.

FINANCIAL INSTITUTIONS
Litigation and bankruptcy checks for companies and debtors.

E-DISCOVERY AND LEGAL VENDORS
Sync your system to PACER to automate legal marketing.