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Abstract

B2B firms spend considerable sums of money on promotional activities to promote their products and to build brand equity. An increasing proportion of this spending is being devoted to direct to end-users (DTE) advertising in an effort to pull end-users towards their products as a complement to their push promotional activities. This is particularly true for US-based pharmaceutical firms following the deregulation of DTE advertising. This trend suggests the necessity to investigate how efficiently DTE advertising expenditure is being managed, and to ascertain whether the level of efficiency has any impact on profitability. This study examined the level of DTE advertising efficiency for a sample of US-based pharmaceutical firms and went on to investigate the impact of the efficiency level on firm profitability. The findings of the study demonstrate that DTE advertising efficiency does vary between firms and, furthermore, that the higher the level of efficiency, the better is firm profitability. These results are robust to alternative measures of firm profitability, specifically, return on assets (ROA), return on equity (ROE), gross profit margin (GPM) and net profit margin (NPM).

Key words: B2B**,** Resource-based view (RBV), Direct to end-user (DTE) advertising, Advertising efficiency, Profitability, Data envelopment analysis (DEA).

Introduction

Like their B2C counterparts, industrial firms are increasingly spending money on promotional activities to try to differentiate their products and brands and to increase sales (Jensen & Jepsen, 2007; Osinga, Leeflang, Srinivasan, & Wieringa, 2011). Their spending combines push and pull activities, with a noticeable trend in recent years to increase the proportion of spending on pull activities, in particular on advertising directly to end-users (Osinga, et al., 2011; Klara, et al., 2018). There is an emerging view that B2B firms which sell their products predominantly to trade customers such as wholesalers and retailers can still benefit indirectly by courting favour with end users who often influence the purchases of the intermediaries in the supply chain (Amaldoss & He, 2009; Osinga, et al., 2011; Huhmann & Limbu, 2016).

This trend is particularly evident in the pharmaceutical industry ever since the deregulation of direct to end-user (DTE) advertising by the US Food and Drugs Administration (FDA) in 1997. Since deregulation, pharmaceutical firms in the USA have been spending more of their marketing budgets on direct to end-users (DTE) advertising (Osinga, et al., 2011) even though their primary customers are physicians who prescribe medicines to the patients who are the end users. While pharmaceutical firms still spend considerably higher amounts on direct to physician (DTP) promotional activities, the growth rate of direct to end-user (DTE) advertising outstrips that of any other promotional activities due to the widely-held belief that it can be a source of competitive advantage in the marketplace (Amaldoss & He, 2009; Huhmann & Limbu, 2016; Klara, Kim, & Ross, 2018).

The resource-based view (RBV) of the firm provides a theoretical rationale for such an argument (Srivastava, Fahey, & Christensen, 2001; Joshi & Hanssens, 2010; Oh, Gulen, Kim, & Robinson, 2016; Klara, et al., 2018). RBV theory suggests that DTE advertising activities enable firms to create brand differentiation which can give them a competitive advantage that, in turn, should deliver superior financial performance (Joshi & Hanssens, 2009; Wang, Zhang, & Ouyang, 2009; Osinga, et al., 2011; Klara, et al., 2018).

Several studies have tried to test this proposition by exploring whether or not DTE advertising expenditure actually has any effect on overall firm performance (Graham Jr & Frankenberger, 2000; Conchar, et al., 2005; Ali Shah & Akbar, 2008; Hsu & Jang, 2008; Amaldoss & He, 2009; Peterson & Jeong, 2010;Osinga, et al., 2011;Vitorino, 2013; Lou, 2014; Edeling & Fischer, 2016; Klara, et al., 2018). In sum, these studies have produced mixed results; some found DTE advertising to have a positive effect on financial performance while others found a negative or non-significant effect (Erickson & Jacobson, 1992; Graham Jr & Frankenberger, 2000; Conchar, et al., 2005; Ali Shah & Akbar, 2008; Hsu & Jang, 2008; Amaldoss & He, 2009; Osinga, et al., 2011;Vitorino, 2013; Klara, et al., 2018). We are left with a rather open question therefore as to the relationship between DTE advertising and performance for B2B firms in general, and for pharmaceutical firms in particular.

What is striking about this body of literature is that all of the studies focused solely on the absolute amount of *advertising expenditure*, investigating whether the amount of money spent on DTE advertising affects firm financial performance. None of these studies considered how *efficiently* the advertising budget was managed to achieve the desired outcome. To the best of our knowledge, no study thus far has investigated whether or how *advertising efficiency* impacts firm performance as distinct from how the *absolute amount* of advertising expenditure impacts firm performance. The study reported in this paper fills this gap in the literature by addressing the question: what is the impact of DTE *advertising efficiency* on the profitability of pharmaceutical firms?

Drawing on the resource-based view (RBV) of the firm, we defined *advertising efficiency* as the extent to which a firm is able to minimize its advertising expenditure for a given level of performance output, or to maximize the output for a given level of advertising expenditure (Luo & Donthu, 2001; Pergelova, Prior, & Rialp, 2010; Cheong, De Gregorio, & Kim, 2014). It can be argued that firms with a higher level of DTE advertising efficiency will attain and sustain a competitive advantage in the marketplace through optimal utilization of advertising inputs to achieve an expected level of advertising output.

Developing this argument further, also consistent with the resource-based view (RBV), we argue that *advertising efficiency* stems from the combination of three co-specialized advertising assets, namely, *financial advertising assets, intellectual advertising assets and relational advertising assets* (Srivastava, et al., 2001; Lockett, Thompson, & Morgenstern, 2009; Cheong, et al., 2014). A firm's level of advertising efficiency is determined by the extent to which it possesses these three types of advertising assets.

To investigate the research question, this study adopted a two-stage approach. In the first stage, we measured the level of DTE advertising efficiency for a sample of US pharmaceutical firms using data envelopment analysis (DEA). In the second phase, using advanced econometric modelling, we explored whether or not the level of DTE advertising efficiency affects the profitability of the sample firms. The results showed that firms do vary in their DTE advertising efficiency and that this variation is correlated with varying levels of

profitability. In sum, firms with a higher level of DTE advertising efficiency also tend to be more profitable.

The paper is organized as follows. Section two below briefly describes the research context, explains the theoretical background of the study as well as developing the central hypothesis to be tested. Section three outlines the research methodology used and describes the data sources and measurement issues. Section four presents the results, and section five discusses the significance of the findings for theory as well as identifying some managerial implications.

Direct to End-user (DTE) advertising in the pharmaceutical industry

Traditionally, pharmaceutical firms used push rather than pull promotional activities to drive sales and build their brands, predominantly direct to physician (DTP) promotional activities (Amaldoss & He, 2009; Osinga, et al., 2011; Klara, et al., 2018). Direct to end-user (DTE) advertising was almost non-existent in the pharmaceutical industry before 1980 in the USA. A limited amount of DTE advertising began to appear in the 1980s and early 1990s, and pharmaceutical firms significantly increased their DTE advertising after the FDA relaxed its regulation of ethical drug advertising on television in August 1997 (Osinga, et al., 2011; Klara, et al., 2018).

In recent years, pharmaceutical firms have been using pull promotional activities more aggressively, and the DTE advertising budget has increased faster than budgets for push marketing activities which are directed towards physicians (Osinga, et al., 2011). For instance, in 1997 pharmaceutical firms in the USA spent $0.84 billion on DTE advertising but this grew to $5.6 billion by 2015 (Amaldoss & He, 2009; Klara, et al., 2018). The expenditure on DTE advertising seems to be showing an upward trend due to the belief that it increases patient demand, and thereby encourages prescribing and sales for the advertised drugs (Amaldoss & He, 2009; Klara, et al., 2018).

Theoretical Background

Drawing on the resource-based view (RBV) of the firm (Barney, 1991), this section explains the potential sources of DTE advertising efficiency and how this efficiency can be a source of competitive advantage that might affect firm profitability. Firstly, we provide an overview of the RBV of the firm. Secondly, we develop the argument concerning how the DTE advertising efficiency of a pharmaceutical firm can be a source of competitive advantage leading, in turn, to higher profitability.

Resource-based view (RBV) of the firm

The resource-based view (RBV) sees firms as bundles of resources that are deployed in unique combinations to create value (Peteraf, 1993; Barney, 1991; Barney, 2014). According to RBV theory, firms in a given industry differ from each other in terms of their resource-bases (Peteraf, 1993). In other words, firms are *heterogeneous* due to possessing diverse kinds of resource-bundles (Peteraf, 1993; Srivastava, et al., 2001). RBV theory postulates that firms try to utilise their resource-base to create a unique competitive advantage in the marketplace that should translate into a superior financial return (Barney, 1991). In sum, resource heterogeneity among firms impacts the level and nature of competition, and firms

with superior resources gain an edge over competing firms (Peteraf, 1993; Barney, Wright, & Ketchen, 2001).

Resources "include all assets, capabilities, organizational processes, attributes, information, knowledge, etc. controlled by a firm" (Barney, 1991, p101). These resources may be both tangible e.g. plant, and intangible e.g. brand equity and/or management efficiency (Russo & Fouts, 1997; Srivastava, et al., 2001). A firm's resources become useful when it nurtures and deploys them to take advantage of opportunities that exist in the external environment (Russo & Fouts, 1997; Acquaah, 2003). That is, having a resource is not enough, firms must also have the requisite organizational competence to take advantage of it (Russo & Fouts, 1997; Srivastava, et al., 2001).

Furthermore, while a firm might have access to a diverse range of resources, all resources are not equally useful in creating a competitive advantage (Barney, 1991). Resources can only be used to create and sustain competitive advantage if they are *valuable, rare, inimitable and non-substitutable (VRIN)* (Barney, 1991; Srivastava, et al., 2001. A resource is *valuable* if it assists a firm to implement its strategies effectively (Wade & Hulland, 2004). A resource cannot contribute to competitive advantage if it has little or no value (Srivastava, et al., 2001). Resources also need to be *rare,* i.e. available only to a limited set of firms. A *valuable* resource cannot create lasting competitive advantage if it is not *rare* (Wade & Hulland, 2004).

A resource must also be unique so as not to be easily *imitated* by other competing firms. If competing firms can *imitate* a resource, the firm that possesses that resource will not be able to defend the competitive advantage attained through that resource (Wade & Hulland, 2004). Finally, a resource also has to be *non-substitutable* which means that there are very few, if any, strategically equivalent resources that are, themselves, rare and inimitable (Wade & Hulland, 2004; Srivastava, et al., 2001).

Refining these criteria further, proponents of RBV divide them into two performance categories (Wade & Hulland, 2004): resources which allow firms to *attain* competitive advantage in the marketplace and others which enable them to *sustain* that competitive advantage (Wade & Hulland, 2004). These two categories of resource attributes are considered as *ex ante limits to competition* and *ex post limits to competition* respectively (Peteraf, 1993*;* Wade & Hulland, 2004). *Valuable and rare* attributes of a resource help firms to achieve competitive advantage, while *inimitable and non-substitutable* attributes help firms to sustain their competitive advantage (Peteraf, 1993; Barney, et al., 2001; Wade & Hulland, 2004).

Drawing propositions from RBV, it can be argued that firms must be able to combine (and recombine) their various co-specialized assets so as to achieve and sustain a competitive advantage in the marketplace, thereby leading to superior firm performance (Barney, et al., 2001; Srivastava, et al., 2001; Vorhies & Morgan, 2003; Onyemah & Anderson, 2009). We have adapted this argument for the topic of *DTE advertising efficiency* in the pharmaceutical industry, as described in the next sections.

Direct to end-users (DTE) Advertising as a source of competitive advantage

RBV theorists view advertising as one of the most significant sources of competitive advantage (Srivastava, et al., 2001; Srinivasan, Pauwels, Silva-Risso, & Hanssens, 2009;

Joshi & Hanssens, 2009; Peterson & Jeong, 2010; Sethuraman, Tellis, & Briesch, 2011; Osinga, et al., 2011; Lou, 2014). B2B scholars also acknowledge the significance of advertising, including advertising to end-users (DTE) as well as to intermediate customers, in creating a competitive advantage in the marketplace (Gilliland & Johnston, 1997; Jensen & Jepsen, 2007; Osinga, et al., 2011; Baack, Wilson, van Dessel, & Patti, 2016; Klara, et al., 2018).

This is likely to pertain in pharmaceuticals as in other B2B markets; advertising may assist pharmaceutical firms to build competitive advantage in a number of ways (Lichtenthal, Yadav, & Donthu, 2006; (Srinivasan, et al., 2009; Amaldoss & He, 2009; Joshi & Hanssens, 2010; Osinga, et al., 2011; Leonidou, Leonidou, Hadjimarcou, & Lytovchenko, 2014; Baack, et al., 2016; Klara, et al., 2018). DTE advertising can assist pharmaceutical firms to differentiate their brands from those of their competitors enabling them to insulate themselves from competitive pressure (Herzenstein, Misra, & Posavac, 2004; Srinivasan, et al., 2009; A. M. Joshi & Hanssens, 2009; Amaldoss & He, 2009; Stremersch, Landsman, & Venkataraman, 2013; Osinga, et al., 2011; Edeling & Fischer, 2016).

DTE advertising has been shown to have a positive effect on customers' awareness, attitudes and loyalty (Wilkes, Bell, & Kravitz, 2000; Herzenstein, et al., 2004; Jensen & Jepsen, 2007; Amaldoss & He, 2009; Parnes et al., 2009; Nikki Lee-Wingate & Xie, 2010; Wang, 2012; Stremersch, et al., 2013; Edeling & Fischer, 2016; Siddiqi & Shah, 2017). Research has also shown that DTE advertising increases the probability that the advertised brand will be included in the end-users' consideration set and patients tend to request their physicians to prescribe the advertised pharmaceutical brand (Yoo, Donthu, & Lee, 2000; Amaldoss & He, 2009; Parnes, et al., 2009; Stremersch, et al., 2013).

DTE advertising has been shown to positively affect customer loyalty because it strengthens brand associations and reinforces positive attitudes towards the advertised pharmaceutical brand (Herzenstein, et al., 2004; Amaldoss & He, 2009). These advertising effects should positively influence brand equity leading to a competitive advantage in the marketplace (Herzenstein, et al., 2004; Joshi & Hanssens, 2010; Luo & de Jong, 2012; Baack, et al., 2016). This is why pharmaceutical firms keep spending on advertising patent-expired brands even though they usually spend more during the patent-period (Amaldoss & He, 2009; Mukherjee, Limbu, & Wanasika, 2013; Huhmann & Limbu, 2016).

In view of the considerable evidence that DTE advertising acts as a source of competitive advantage by way of influencing customer awareness and loyalty, studies in various industry-settings have examined whether or not DTE advertising has a follow-on impact on firm financial performance (Ali Shah & Akbar, 2008; Joshi & Hanssens, 2010; Osinga, et al., 2011; Spotts, G. Weinberger, & F. Weinberger, 2014). The findings of these studies are mixed (Conchar, et al., 2005; Ali Shah & Akbar, 2008). Some found a positive effect on firm performance while others did not find any significant effect (Ali Shah & Akbar, 2008; Joshi & Hanssens, 2010; Srinivasan, et al., 2009; Spotts, et al., 2014). Studies in the pharmaceutical industry have also reported extremely mixed findings with some finding advertising to have a positive impact, while others found a negative or non-significant impact (Narayanan, Desiraju, & Chintagunta, 2004; Kremer, Bijmolt, Leeflang, & Wieringa, 2008; Donohue, Cevasco, & Rosenthal, 2007; Amaldoss & He, 2009; Bala & Bhardwaj, 2010; Osinga, et al., 2011; Mukherjee, et al., 2013).

Regardless of the industry context, what is notable about the earlier studies is that they considered solely the *absolute amount* of advertising expenditure, investigating whether firms that spend more on DTE advertising achieve superior financial performance. This body of research did not cast any light on *advertising efficiency,* that is, how *efficiently* firms were using their DTE advertising budget. It can be surmised that the mixed findings owe something to the fact that these studies considered only the *absolute amount* of advertising expenditure to the exclusion of the level of efficiency in managing the DTE advertising budget.

We propose that how *efficiently* the advertisement expenditure is managed should be investigated rather than considering only the *absolute* amount of advertising expenditure. This argument is developed further in the next section.

Advertising efficiency and profitability

Advertising efficiency is conceptualized as the extent to which a firm is able to minimize advertising inputs such as production costs and media space, while maximizing the outputs such as customer awareness, liking and purchases, which convert ultimately into sales revenue (Luo & Donthu, 2001; Pergelova, et al., 2010; Cheong, et al., 2014). To put it simply, *advertising efficiency* is the ratio of advertising inputs to outputs (Luo & Donthu, 2001; Pergelova, et al., 2010). Firms with a higher level of advertising efficiency use less advertising inputs and attain equal or more advertising outputs compared to firms with a lower level of advertising efficiency (Cheong, et al., 2014). Following this reasoning, it can be argued further that superior DTE advertising efficiency may be a source of competitive advantage that should positively affect profitability (Srivastava, et al., 2001; Luo & Donthu, 2001; Lockett, et al., 2009).

Developing the concept of *advertising efficiency* further, it can be said that it is composed of three types of co-specialized advertising assets, namely, *financial advertising assets, intellectual advertising assets and relational advertising assets* (Srivastava, et al., 2001; Lockett, et al., 2009; Cheong, et al., 2014). Co-specialised assets are those assets which must be used in conjunction with others to reap maximum benefit (Lockett, et al., 2009). That is, a single co-specialized asset in insolation is far less useful than a number of co-specialized assets combined together (Lockett, et al., 2009; Onyemah & Anderson, 2009). In essence, a firm's level of *advertising efficiency* is determined by the extent to which it possesses these three types of advertising assets as well as how effectively these co-specialised assets are combined (and re-combined), and managed over time (Ketchen Jr, Thomas, & Snow, 1993; Lockett, et al., 2009; Onyemah & Anderson, 2009).

The *financial advertising assets* of a firm are conceptualized as the dollar amount that a firm spends on its advertising program over a given period of time. According to the RBV, this kind of advertising asset is *valuable* because it enables firms to implement their advertising strategy (Lockett, et al., 2009). *Financial advertising assets* may not be *rare*, however, as many other firms might have access to this asset (Lockett, et al., 2009). Furthermore, this kind of advertising asset may be easily *imitated* by other firms by matching the spending of their competitors. So, while *financial advertising assets* may assist firms in creating a competitive advantage, they may not be able to sustain this competitive advantage due to lack of *non-rarity* and *non-inimitability* attributes (Lockett, et al., 2009).

The second type of co-specialized advertising asset that firms possess is *intellectual advertising assets* which are defined as a firm's breadth and depth of knowledge and expertise about the various constituents of its advertising program such as the products/services, end-users, trade customers, competitors, and so forth (Srivastava, et al., 2001). Firms with a higher level of *intellectual advertising assets* are able to conceptualise and design their advertising programs more effectively, so as to better resonate with their markets. *Intellectual advertising assets* are entrenched assets and are, therefore, embedded in individuals and processes within the firm (Srivastava, et al., 2001). These assets are v*aluable* and *rare* because they enable firms to conceptualise and implement advertising programs effectively, and they are distributed heterogeneously among competing firms in a given industry (Lockett, et al., 2009).

Unlike *financial advertising assets, intellectual advertising assets* may not be easily *imitated* by other firms (Lockett, et al., 2009). Also, these assets are *non-substitutable* and may not be easily replaced by other assets. In sum, *intellectual advertising assets* may assist firms to create a unique competitive advantage but also to sustain this competitive advantage in the long run due to *inimitability and non-substitutability* attributes (Lockett, et al., 2009). These intangible assets are likely to have a more profound, if elusive, effect on firm's sales performance.

The third type of asset is *relational advertising assets* which are defined as the firm's ability to develop and cultivate relationships with various external stakeholders who directly and indirectly impact the advertising program, such as the advertising agency, creative agency, and media-buying agency (Srivastava, et al., 2001). This kind of advertising asset, when combined with other co-specialized assets, might also be a source of competitive advantage. Firms that possess better *relational advertising assets* are able to carry out advertising programs more effectively with the help of their relevant stakeholders. *Relational advertising assets* are *valuable* as they help firms to strategize and implement their advertising programs effectively.

This asset is also *rare*, i.e. distributed heterogeneously among competing firms in a given industry (Lockett, et al., 2009). Furthermore, *relational advertising assets* may not be easily copied by other firms as it usually takes a long time to develop strong relationships with external agencies (Lockett, et al., 2009). This asset is *non-substitutable* as it may not be easily replaced by other assets. Consequently, *relational advertising assets* may assist firms, not only to create competitive advantage, but also to sustain this competitive advantage. (Lockett, et al., 2009).

It is argued that firms which possess these three types of co-specialized advertising assets ought to have a higher level of *advertising efficiency* compared to firms that lack these co-specialized asserts (Srivastava, et al., 2001; Cheong, et al., 2014). However, mere possession of these co-specialised assets does not guarantee attainment of the *maximum* possible level of *advertising efficiency*. The firm must be able to combine and recombine these co-specialized assets so as to achieve the *maximum* possible level of DTE *advertising efficiency* (Srivastava, et al., 2001*;* Cheong, et al., 2014). A higher level of DTE advertising efficiency resulting from the combination of these co-specialized assets will assist the firm to attain a competitive advantage, and this should be evidenced in both a *cost advantage* and a *revenue advantage* (Srivastava, et al., 2001; Vorhies & Morgan, 2003; Peterson & Jeong, 2010; Cheong, et al., 2014). The cost advantage will have a positive impact on the *advertising inputs* while the revenue advantage will positively affect the *advertising outputs* (Cheong, et al., 2014).

The *cost advantage* and *revenue advantage* might occur in several ways which will assist firms to achieve better DTE advertising efficiency (McAlister, Srinivasan, & Kim, 2007; Peterson & Jeong, 2010; Osinga, et al., 2011). Firms that possess more *financial advertising assets* might spend more on advertising enhancing customers' depth and breadth of knowledge and awareness about their products and services, leading to more advertising outputs i.e. better sales revenue (Peterson & Jeong, 2010; Osinga, et al., 2011). Firms with more *financial advertising assets* may not necessarily always be able to achieve a cost advantage (Peterson & Jeong, 2010). Nonetheless, if managed properly, firms ought to be able to attain some cost advantage as well from their *financial advertising assets.* For instance, getting a discount for bulk media buying, thereby reducing the *advertising inputs*, will positively affect the DTE advertising efficiency. In sum, *financial advertising asset* should result in both a *cost advantage* i.e. less advertising inputs, and a *revenue advantage* i.e. more advertising output, thereby having a positive impact on the overall DTE advertising efficiency. It can be surmised, however, that the *revenue advantage* of financial advertising assets will outweigh the *cost advantage*.

Firms with better *intellectual advertising assets* are believed to have profound knowledge and insights about various constituents of their advertising programs and are, therefore, expected to be able to produce more persuasive and effective advertisements (Srivastava, et al., 2001; Lockett, et al., 2009). Such effective advertisements should strengthen brand associations as well as heighten customer loyalty which should affect *advertising output* positively i.e. more sales revenue (McAlister, et al., 2007; Peterson & Jeong, 2010). Furthermore, firms that are able to produce relatively more effective advertisements will need to use less advertising inputs which will have a positive effect on the overall advertising efficiency. In sum, firms with better *intellectual advertising assets* will benefit from both a revenue advantage i.e. more advertising output, and a cost advantage i.e. less advertising inputs.

Finally, *relational advertising assets* will assist firms to have both revenue and cost advantages (Srivastava, et al., 2001). Relational capital in the form of strong relationships with various connections such as advertising, creative and media-buying agencies should assist firms to gain better business terms such as better credit terms, discounts etc. which might help them to attain a cost advantage i.e. less advertising inputs (Srivastava, et al., 2001). Furthermore, better relationships with supporting agencies might assist firms to produce more effective advertisements that might in turn have a positive impact on advertising output i.e. better sales revenue (Srivastava, et al., 2001; McAlister, et al., 2007; Peterson & Jeong, 2010). If deployed properly in conjunction with other co-specialized advertising assets, namely, financial and intellectual advertising assets, relational advertising assets should assist firms to achieve relatively more advertising output i.e. sales revenue, for relatively less advertising inputs.

All in all, the extent to which a firm will be able to achieve the *maximum* possible level of advertising efficiency will hinge upon its application and combination of these three types co-specialized advertising assets (Lockett, et al., 2009; Srivastava, et al., 2001). Firms that are in possession of these three types of advertising assets and which are able to deploy them effectively will be able to minimize the utilization of inputs and maximize the outputs, thereby having a positive impact on advertising efficiency.

In view of the foregoing, it can be argued that firms with a high level of DTE *advertising efficiency* should be in position to reduce their advertising inputs while at the same time

managing to generate high levels of advertising output, leading ultimately to a higher level of profitability. Based on the foregoing discussion, we therefore propose the following central hypothesis:

H: The higher a firm's direct to end-user (DTE) advertising efficiency, the higher will be its profitability.

Methodology

Design of the study

This study was conducted in two stages; the first stage used data envelopment analysis (DEA) to measure the level of DTE advertising efficiency. The second stage used econometric analysis to investigate the impact of advertising efficiency on firm profitability. The following sections describe the data sources and the sampling procedure used as well as the details of the DEA analysis.

Data sources and Sampling frame

The sample for this study was drawn from a single B2B industry, namely, pharmaceuticals, and from a single country, namely, the USA. This research context was chosen for a few reasons. Firstly, due to the deregulation of direct to end-user (DTE) advertising by the FDA, US pharmaceutical firms are increasingly using DTE advertising as pull activities alongside their push promotional activities. Furthermore, the yearly budget for DTE advertising is growing at a much faster rate compared to other forms of promotional initiatives. The choice of a single industry was made to satisfy a requirement of data envelopment analysis which assumes homogeneity among the firms under investigation.

The study focused on US-based pharmaceutical firms because only the USA and New Zealand allow DTE advertising for prescription drugs. The sampling frame for this study was the top USA advertisers published by *Advertising Age*. *Advertising Age* data have been used extensively by earlier studies (e.g. Luo & Donthu, 2001; Cheong, et al., 2014). Advertising expenditure data were collected for the large US-based pharmaceutical companies which appeared among A*dvertising Age's* leading national advertisers. This fits well with data envelopment analysis which measures the relative efficiency of a focal firm in comparison to other firms in the sample. Furthermore, these firms are large suggesting that they are equally likely to enjoy economies of scale in their operations compared to smaller firms (Wei & Varela 2003).

Data were collected in two stages. In the first stage, advertising expenditure data were collected from the *Advertising Age's* datacentre. Subsequently, firm profitability data and data for control variables were collected from Compustat. Data for each firm were collected from 2001 to 2016. However, due to non-availability of data for some firms for some years, the final sample size of the study was 174 firm-year observations.

Data Envelopment Analysis (DEA)

The simplest but not necessarily the most effective method to measure advertising efficiency is through ratio analysis. However, ratio analysis can only incorporate one input and one output which is a fundamental limitation. Hence, some earlier studies on advertising

efficiency used data envelopment analysis (DEA) to measure efficiency as it can incorporate multiple inputs and outputs simultaneously (Luo & Donthu, 2001; Stolyarova & Rialp, 2014; Cheong, et al., 2014; Walraven, Koning, Bijmolt, & Los, 2016).

DEA has proven to be a useful methodology to measure relative efficiency by comparing the efficiency score of one firm with those of other firms (Seiford, 1996; Emrouznejad, Parker, & Tavares, 2008; Stolyarova & Rialp, 2014). DEA measures a firm's relative efficiency score by determining either the minimum inputs needed to produce a set of outputs, or by determining the maximum possible output that can be produced from a given set of inputs. It also identifies the best practice frontier or data envelope (Wang, Ho, & Oh, 2010; Walraven, et al., 2016).

DEA produces a single efficiency value known as the relative efficiency score. Firms with a score of 1 are considered to be efficient given the required inputs and outputs produced. Firms with a score of less than 1 are less efficient compared to the most efficient firms.

When data on firms are available over time, i.e. cross-sectional time-series data, the advertising efficiency score may be measured for each time period, making it possible to compare the efficiency of firms over multiple time periods (Webb, 2003; Asmild, Paradi, Aggarwall, & Schaffnit, 2004). In such cases, each time period for each firm is treated as if it were a distinct firm. This DEA technique is known as window analysis (Fadzlan, 2007; Kao & Liu, 2014) and this is what was used by this current study since it was based on panel data. The window width for the current study was set at 1.

Two of the most widely-used DEA models are the CCR and BCC models. The CCR model assumes Constant Returns to Scale (CRS) and the BCC model assumes Variable Returns to Scale (VRS) (Charnes, Cooper, & Rhodes, 1978; Banker, Charnes, & Cooper, 1984). The CRS model assumes that an increase in the input(s) will lead to a proportionate increase in the output(s), while a VRS model assumes that an increase in input(s) will result in either an increase or decrease in output(s) (Norman & Stoker, 1991; Harris, Ozgen, & Ozcan, 2000). Following earlier studies (e.g. Cheong, et al. 2014), the current study used the VRS model because an increase in advertising inputs such as TV or radio advertising may or may not result in a proportional increase in advertising output measured as sales revenue.

DEA models can be input-oriented or output-oriented. An input-oriented DEA model aims to minimize the use of inputs while maintaining the same level of outputs, while an output-oriented model aims to maximize the level of outputs given the current level of inputs. Put differently, an output orientation assumes that firms have direct control over the outputs and an input orientation assumes little control over the outputs (Harris, et al., 2000; Ahn & Min, 2014; Walraven, et al., 2016). It stands to reason that the firms in this study would have more control over their advertising expenditure compared to their sales revenue. In keeping with similar studies, (e.g. Cheong, et al. 2014), this study utilized an input-oriented DEA model.

Operationalization of Input and Output Variables for DEA window analysis

The input and output variables to measure direct to end-user (DTE) advertising efficiency were chosen from the advertising literature (Luo & Donthu, 2001; Färe, Grosskopf, Seldon, & Tremblay, 2004; Büschken, 2007; Cheong, et al., 2014; Cheong & Kim, 2014; Stolyarova & Rialp, 2014). Six input variables were used which were measured in terms of spending on individual media, namely, TV, radio, outdoor, magazines, newspapers, and online

advertisements. One output variable was used which was sales revenue. These variables and how they were measured are summarised in **Table 1.**

Table 1: Input and output variables used to measure DTE advertising efficiency

Input variables	***Description***	***Operationalization***
	TV advertising	Yearly dollar amount spent on TV
	Radio advertising	Yearly dollar amount spent on radio
	Magazine advertising	Yearly dollar amount spent on local and national magazines
	Newspaper advertising	Yearly dollar amount spent on newspapers
	Outdoor advertising	Yearly dollar amount spent on outdoor advertising
	Online advertising	Yearly dollar amount spent on internet
Output variable	Sales performance	Yearly sales revenue

Table 2 below shows the descriptive statistics for the input and output variables used in the DEA analysis to measure DTE advertising efficiency.

Table 2: Descriptive statistics for input and output variables *(in USD million)*

Variables	***Mean***	***SD***
TV advertising	77865.45	206662.5
Radio advertising	914.9885	3098.352
Magazine advertising	23550.55	73484.07
Newspaper advertising	3182.914	10804.39
Outdoor advertising	99.9546	402.6082
Internet advertising	3086.15	10434.52
Sales performance	34496.65	15264.56

One of the assumptions of DEA is that the input and output variables should be correlated. **Table 3** below shows the correlation matrix of the input and output variables.

Table 3: Correlation between input and output variables

Variables in DEA analysis	
	Sales revenue
TV advertisement	0.2500*
Radio advertisement	0.1230
Magazine advertisement	0.2378*
Newspaper advertisement	0.3053*
Outdoor advertisement	0.2258*
Internet advertisement	0.1611*

Correlation significant at the 5% level*

Relationship between DTE advertising efficiency and profitability

Having calibrated the DTE advertising efficiency of the sample firms utilizing DEA window analysis, econometric analysis was used to examine the impact of DTE advertising efficiency on firm profitability. Two measures of firm profitability were used, namely, return on assets (ROA) and return on equity (ROE), both of which have been widely used by earlier studies. Return on assets was measured as net income divided by total assets, and return on equity (ROE) was measured as net income divided by stockholder equity.

As firm performance is affected by other activities beyond DTE advertising efficiency, a set of control variables was introduced, drawn from the firm performance literature. The size of the firm is one variable that has been shown to influence firm performance (Horváthová, 2012). Therefore, we controlled for the effect of firm size. We also controlled for the firm's debt leverage which has been shown to influence financial performance (Horváthová, 2012). Earlier studies have demonstrated that highly leveraged firms generally have a lower level of performance because highly leveraged firms tend to be less efficient (Opler & Titman, 1994; Tallman & Li, 1996). Spending on R&D has also been found to have an impact on firm performance (McAlister, et al., 2007; Rubera & Kirca, 2012). We therefore controlled for firms' R&D intensity.

Earlier studies (e.g. Berman, Wicks, Kotha, & Jones, 1999) have also demonstrated that selling intensity can affect firm performance; hence, this was controlled for in the current study. Moreover, since a firm's performance might be affected by the firm's expenditure on other promotional activities such as on push marketing initiatives, we controlled for the overall advertising expenditure through advertising intensity.

Finally, we created a dummy variable that distinguished between firms that spend more on advertising than the average of the sample firms, since there are some firms with a much higher expenditure than others. This regressor controlled for the impact that the overall expenditure of these companies may have on the results.

Table 4: Data sources and operationalization of variables.

Types of variables	***Variable***	***Operationalization***	***Data Source***
Dependent variable	Profitability	1. ROA (Net income divided by total assets) 2. ROE (Net income divided by stockholders' equity)	Compustat
Independent variable	DTE Advertising efficiency	Measured using DEA (6 inputs and 1 output variable)	Advertising age and Compustat
Control Variables	Firm Size	Natural log of total Assets	Compustat
	Leverage	Total long-term debt/ total assets	Compustat
	R&D intensity	R&D expenditure/ sales	Compustat

	Selling intensity	Selling, general and administrative expenses/ total assets	Compustat
	Advertising Intensity	Advertising expenditure/sales	Compustat
	High Vs Low Adspender	Dummy variable that take value 1 if the firm spends more on advertising than the average and 0 otherwise.	Compustat

Model specification

To estimate the relationship between DTE advertising efficiency and ROA, and DTE advertising efficiency and ROE, this study relied on the following specifications:

$$ROA_{it} = \beta + \alpha_0 ROA_{it-1} + \alpha_1 DTE\ Advertising\ Efficiency_{it-1} + \alpha_2 Firm\ Size_{it} + \alpha_3 Leverage_{it} + \alpha_4 R\&D\ Intensity_{it} + \alpha_5 Selling\ Intensity_{it} + \alpha_6 Advertising\ Intensity_{it} + \alpha_7 High\ Vs\ Low\ Adspender_{it} + \eta_i + \varepsilon_{it}$$

$$ROE_{it} = \beta + \alpha_0 ROE_{it-1} + \alpha_1 DTE\ Advertising\ Efficiency_{it-1} + \alpha_2 Firm\ Size_{it} + \alpha_3 Leverage_{it} + \alpha_4 R\&D\ Intensity_{it} + \alpha_5 Selling\ Intensity_{it} + \alpha_6 Advertising\ Intensity_{it} + \alpha_7 High\ Vs\ Low\ Adspender_{it} + \eta_i + \varepsilon_{it}$$

Where i and t represent firm and year, respectively; $\eta_i$is the possible firm-specific component of the error term and ε_{it} is the error term. In keeping with similar studies, we lagged the DTE advertising efficiency variable by one year.

Endogeneity and model estimation method

Endogeneity is likely to be present in research settings like ours because it is very often present in studies examining cause and effect relationships (Jean, Deng, Kim, & Yuan, 2016; Zaefarian, Kadile, Henneberg, & Leischnig, 2017; Ullah, Akhtar, & Zaefarian, 2018). Endogeneity may occur for reasons such as omitted variables, measurement errors and reverse causality (Zaefarian, et al., 2017; Ullah, et al., 2018). Research exploring cause-effect relationships must therefore address the endogeneity issue; failing to account for it may generate biased and inaccurate results and conclusions (Zaefarian, et al., 2017; Ullah, et al., 2018). We therefore followed a few steps for detection of possible endogenous regressors in our models as well as to eliminate endogeneity bias.

As a first step, a Durbin-Wu-Hausman (DWH) test which is a widely used test for endogeneity was carried out. If the test statistic is significant, then the variables being tested must be treated as endogenous. This test was carried out for each of the regressors used in both models of this study to detect the possible endogeneity of the variables. In the first model with "ROA" as the dependent variable, the results confirmed the presence of endogeneity in two variables: DTE Advertising Efficiency and Selling Intensity. (DTE Advertising Efficiency: $Chi^2_{Durbin-Wu-Hausman\ test} = 4.224,\ p - value = 0.0399$; Selling Intensity: $Chi^2_{Durbin-Wu-Hausman\ test} = 6.791, p - value = 0.0092$). In the second model wherein the dependent variable is "ROE", the results are similar

(DTE Advertising Efficiency: $Chi^2_{Durbin-Wu-Hausman\ test} = 7.458,\ p - value = 0.0063$; Selling Intensity: $Chi^2_{Durbin-Wu-Hausman\ test} = 7.676, p - value = 0.0056$). Consequently, the variables DTE advertising efficiency and selling intensity were treated as endogenous regressors in both models and all other variables were treated as exogenous variables.

Since some of the regressors in our models turned out to be endogenous, ordinary least square (OLS) estimation or static panel data models would produce unreliable results. As a second step, therefore, we adopted an instrumental variable approach to deal with the endogeneity in our models. Specifically, this study used the system generalized method of moments (GMM) estimation technique, a dynamic panel data method, to examine the relationship between DTE advertising efficiency and firm profitability. This estimator is designed for situations where the dependent variable is dynamic, that is, its present value depends on its past value, and the independent variables are not strictly exogenous (Arellano & Bover 1995; Blundell & Bond 1998). The instrumental variables for this study were obtained through the lags of the endogenous variables (Arellano & Bover 1995; Blundell & Bond 1998). In all cases, the second lags of our endogenous regressors were included in the estimation as instrumental variables.

Using the system GMM has several benefits. It includes firm fixed effects to account for unobservable firm level heterogeneity such as level of creativity (Duru, Iyengar, & Zampelli, 2016; Ullah, et al., 2018). It is a reliable technique for dynamic panel model estimation and is robust to panel-specific heteroscedasticity and serial correlation (Capezio, et al., 2011; Feng, Morgan, & Rego, 2015; Duru, et al., 2016; Ullah, et al., 2018). Moreover, it can account for sample gaps in unbalanced panels (Duru, et al., 2016) which is the case in the current study.

Moreover, the system GMM is better than other estimation methods because of its superior efficiency and performance when the dependent variable is persistent. In effect, the GMM estimator is specially designed for autoregressive models, as in the current study, where the current value of the dependent variable might be dependent on past values (Ullah, et al., 2018).

As a third step, we conducted tests to examine the validity of the instruments used in our study. To ensure that the instruments used in both of our models were valid, the moment conditions adequate, and not producing overidentification (Roodman, 2006), we conducted a Hansen J test and a Sargan test to examine the validity of the instruments. The results of these tests are reported in Table 8 which show that our instruments are valid.

Finally, the dynamic panel data estimation requires that the errors cannot be serially correlated. Therefore, we also conducted an Arellano–Bond second order autocorrelation test (AR (2)) to ensure that there was no second-order serial correlation among the residuals (Capezio, Shields, & O'Donnell, 2011; Ullah, et al., 2018). The result of these tests can also be seen in table 8 and demonstrates that there is no second order autocorrelation.

Descriptive Statistics and Correlation

Descriptive statistics are shown in **Table 5** and the correlation matrix for each of the models is shown in **Table 6** and **Table 7.** No outliers were detected in the data.

To examine multicollinearity among the explanatory variables, variance inflation factors (VIF) were calculated. The VIF ranged from 1.06 to 3.76 (see **Table 5**) which is substantially lower than the cut-off of 10 for multiple regression models (Hair, Anderson, Tatham and Black, 1998), indicating that multicollinearity is not an issue.

Table 5: Descriptive statistics

	Obs	Mean	SD	Min	Max	VIF
ROA	174	0.0943	0.0581	-0.0709	0.3409	
ROE	174	0.2721	0.2657	-0.3076	1646852	
GPM	174	0.7630	0.0918	0.3849	0.9051	
NPM	174	0.1593	0.0944	-0.2399	0.5619	
Advertising Efficiency	174	0.9535	0.1229	0.3544	1.0000	1.13
Firm size	174	10.9123	0.6112	9.4070	12.2688	2.61
Leverage	174	0.1696	0.1022	0.0015	0.5513	1.19
R&D Intensity	174	0.1617	0.0638	0.0515	0.5264	1.06
Selling Intensity	174	0.2709	0.0854	0.0853	0.4855	2.55
Advertising Intensity	174	0.0222	0.0256	0.0000	0.0892	3.62
High Vs Low Adspender	174	0.8333	0.3737	0.0000	1.0000	3.76

Table 6: Correlation matrix I

		1	2	3	4	5	6	7	8
1	ROA	1.00							
2	Advertising Efficiency	-0.25	1.00						
3	Firm Size	-0.21	0.09	1.00					
4	Leverage	-0.08	-0.01	-0.14	1.00				
5	R&D Intensity	-0.23	0.01	-0.16	0.07	1.00			
6	Selling Intensity	0.40	-0.24	-0.71	-0.08	0.00	1.00		
7	Advertising Intensity	0.16	-0.07	0.18	0.17	-0.05	-0.05	1.00	
8	High Vs Low Adspender	-0.32	0.84	0.18	0.02	0.00	0.04	-0.33	1.00

Table 7: Correlation matrix II

		1	2	3	4	5	6	7	8
1	ROE	1.00							
2	Advertising Efficiency	-0.18	1.00						
3	Firm Size	-0.16	0.09	1.00					
4	Leverage	0.54	-0.01	-0.14	1.00				
5	R&D Intensity	-0.14	0.01	-0.16	0.07	1.00			
6	Selling Intensity	0.17	-0.24	-0.71	-0.08	0.00	1.00		
7	Advertising Intensity	0.16	-0.07	0.18	0.17	-0.05	-0.05	1.00	
8	High Vs Low Adspender	-0.18	0.84	0.18	0.02	0.00	0.04	-0.33	1.00

Main findings

The findings of the System GMM estimation are shown in **Table 8** below. The first column reports the results of model 1 where ROA is the dependent variable; the second column reports the results of model 2 where the dependent variable is ROE. In both models, DTE *Advertising Efficiency* has been used as the main independent variable. The findings demonstrate that the coefficient estimate of DTE Advertising Efficiency is positive and significant at the 0.1% level in model 1 and at the 1% in model 2 ($\alpha_1 = 0.2305,\ p - value = 0.000; \alpha_1 = 0.7146,\ p - value = 0.008$). The results therefore support our

central hypothesis that the higher the DTE advertising efficiency, the greater is firm profitability as measured by ROA and ROE. The $Wald\ Chi^2$ statistic is presented as a complementary measure which confirms that at least one coefficient is statistically different from zero in both models.

With respect to control variables, our findings show that firms which have lower R&D Intensity and smaller in size, and an advertising expense above the average, ($\alpha_4 = -0.4315$, $p - value = 0.002; \alpha_2 = -0.0090$ $p - value = 0.002; \alpha_7 = 0.0152$ $p - value = 0.014$) also have a higher profitability as measured by return on assets (ROA). The analysis also demonstrates that those firms which have lower R&D Intensity and an advertising expense above the average ($\alpha_4 = -0.8640$, $p - value = 0.015; \alpha_7 = 0.0878$ $p - value = 0.022$) have a better profitability as measured by return on equity (ROE).

Table 8: Results of dynamic panel data regression analysis using system GMM

	Model 1: ROA	***Model 2***: ROE
ROA (t - 1)	0.4494***	
	(0.0938)	
ROE (t - 1)		0.5227**
		(0.1669)
DTE Advertising Efficiency (t - 1)	0.2305***	0.7146**
	(0.0656)	(0.2682)
Firm Size	-0.0090**	-0.0538
	(0.0029)	(0.0277)
Leverage	-0.0121	0.3112
	(0.0514)	(0.2519)
R&D Intensity	-0.4315**	-0.8640*
	(0.1372)	(0.3559)
Selling Intensity	-0.0156	0.0843
	(0.1399)	(0.1203)
Advertising Intensity	-0.3172	0.3151
	(0.2003)	(0.6374)
High Vs Low Adspender	0.0152*	0.0878*
	(0.0062)	(0.0382)
$Wald\ Chi^2$	117966.6***	15822.2***
Arellano-Bond test for AR(2)(p-value)	0.081	0.128
Sargan test (p-value)	0.585	0.115
Hansen test (p-value)	0.990	0.951

Standard errors in parentheses. *p<0.05; **p<0.01, ***p<0.001.

Additional analysis and robustness check

Further analysis was carried out to examine whether or not our results were robust to alternative measures of profitability. We used gross profit margin (GPM) and net profit margin (NPM) as alternative measures of profitability. Gross profit margin (GPM) was measured as gross profit divided by sales revenue and net profit margin (NPM) was measured as net income divided by sales revenue.

As was done in the main analysis, we conducted a Durbin-Wu-Hausman (DWH) test to detect the possible endogeneity of the variables. In the first model, where the dependent

variable was gross profit margin (GPM), the results confirmed the presence of endogeneity in two variables: Advertising Efficiency and R & D Intensity.
(DTE Advertising Efficiency: $Chi^2_{Durbin-Wu-Hausman\ test} = 4.398,\ p - value = 0.0360$; R&D Intensity: $Chi^2_{Durbin-Wu-Hausman\ test} = 6.066, p - value = 0.0138$), as the null hypothesis establishes the absence of endogeneity. In the second model, where the dependent variable was net profit margin (NPM), the results confirmed the presence of endogeneity only in DTE Advertising Efficiency (DTE Advertising Efficiency: $Chi^2_{Durbin-Wu-Hausman\ test} = 49.130,\ p - value = 0.0000$)

The results of the additional analysis are shown in the **Table 9** below. The first column reports the results of model 1 where GPM is the dependent variable, and the second column reports the results of model 2 where the dependent variable is NPM. The findings demonstrate that the coefficient estimate of DTE advertising efficiency is positive and significant at the 1% level in model 1 and at the 0.1% level in model 2 ($\alpha_1 = 0.0399,\ p - value = 0.001;\ \alpha_1 = 0.4547,\ p - value = 0.000$). The results show that the higher the DTE advertising efficiency the greater is firm profitability as measured by GPM and NPM.

In sum, the results of this additional analysis show that our results are not sensitive to alternative measures of profitability, and DTE advertising efficiency has a consistently positive effect on all measures of profitability.

Table 9: Results of dynamic panel data regression analysis using system GMM

	Model 1: GPM	***Model 2***: NPM
GPM (t - 1)	0.9598***	
	(0.0951)	
NPM (t - 1)		0.4198***
		(0.0910)
DTE Advertising Efficiency (t – 1)	0.0399**	0.4547***
	(0.0121)	(0.1124)
Firm Size	-0.0024	-0.0095
	(0.0070)	(0.0063)
Leverage	0.0073	-0.0725
	(0.0077)	(0.0778)
R&D Intensity	0.05910	-0.5142*
	(0.0598)	(0.2132)
Selling Intensity	0.0168	-0.5294*
	(0.0509)	(0.2147)
Advertising Intensity	-0.0265	-0.3084
	(0.0478)	(0.4602)
High Vs Low Adspender	0.0070	0.0016
	(0.0044)	(0.0087)
$\boldsymbol{Wald\ Chi^2}$	5290000***	1571.16***
Arellano-Bond test for AR(2)(p-value)	0.749	0.242
Sargan test (p-value)	0.999	0.704
Hansen test (p-value)	0.897	0.996

Standard errors in parentheses. *p<0.05; **p<0.01, ***p<0.001.

We carried out additional analysis to test for timing effects by including year (2012 to 2016) as the control variable. This time horizon is particularly relevant for the pharmaceutical industry because there was an unprecedented number of patent expirations during this time

period which could have impacted firm performance. The results, shown in Table 10, confirm the impact of DTE advertising efficiency on the four dependent variables considered: ROE, ROA, GPM, NPM, while controlling for the possible impact of patent expirations that occurred during the period 2012-2016.

Table 10: Results of dynamic panel data regression analysis using system GMM

	Model 1: ROA	***Model 2***: ROE	***Model 3***: GPM	***Model 4***: NPM
ROA (t - 1)	0.5241*			
	(0.2627)			
ROE (t - 1)		0.2856**		
		(0.0871)		
GPM (t - 1)			0.5929**	
			(0.1757)	
NPM (t - 1)				0.2586*
				(0.1140)
DTE Advertising Efficiency	0.4512**	0.5312*	0.3822*	1.0663*
	(0.1773)	(0.2390)	(0.1698)	(0.5131)
Firm Size	-0.0073	-0.0124	0.0057	-0.0372
	(0.0094)	(0.0158)	(0.0159)	(0.0366)
Leverage	0.0070	0.4446*	-0.0007	-0.2002
	(0.0627)	(0.1903)	(0.0427)	(0.1311)
R&D Intensity	-0.3405*	-0.6527	0.3690	-0.5508*
	(0.1507)	(0.3952)	(0.1978)	(0.2638)
Selling Intensity	0.5535	-0.0891	-0.2822	-0.3878
	(0.5341)	(0.2890)	(0.2148)	(0.4699)
Advertising Intensity	0.3633	0.8886	0.2566	0.9931*
	(0.9622)	(0.7288)	(0.1895)	(0.4943)
High Vs Low Adspender	-0.1306*	-0.2151*	-0.1206*	-0.3863*
	(0.0591)	(0.0900)	(0.0548)	(0.1847)
Dummy Year 2012	-0.0273	0.0123	-0.0057	0.0336
	(0.0220)	(0.0277)	(0.0098)	(0.0344)
Dummy Year 2013	-0.0189	0.0268	-0.0185	0.0903
	(0.0278)	(0.0324)	(0.0129)	(0.0543)
Dummy Year 2014	-0.0479	-0.0178	-0.0199	0.0737
	(0.0335)	(0.0354)	(0.0146)	(0.0752)
Dummy Year 2015	-0.0394	0.1050	-0.0128	0.2123
	(0.0447)	(0.1170)	(0.0189)	(0.1509)
Dummy Year 2016	-0.0492	0.0234	-0.0311	0.1106
	(0.0546)	(0.0481)	(0.0207)	(0.0795)
$\boldsymbol{Wald\ Chi^2}$	4436.74***	31210.53***	80600000***	17761.22***
Arellano-Bond test for AR(2) (p-value)	0.442	0.870	0.173	0.314
Sargan test (p-value)	0.532	0.087	0.886	0.356
Hansen test (p-value)	0.999	0.493	0.424	0.303

Standard errors in parentheses. *p<0.05; **p<0.01, ***p<0.001.

Conclusion

A considerable body of research has investigated the impact of advertising expenditure on firm financial performance, with mixed results. Typically, those studies have taken a narrow

view, examining only the direct effect of aggregate advertising expenditure on performance, without considering the level of *efficiency* in managing the advertising program. Advertising expenditure alone is a blunt instrument that could conceal a considerable amount of variation in the efficiency of advertising management.

In this paper we proposed a more nuanced model of the relationship between advertising and firm performance. We used the concept of direct to end-user (DTE) *advertising efficiency* to capture variation in the level of efficiency of advertising activities among competing firms. We developed a theoretical argument that *advertising efficiency* derives from three co-specialized assets, namely, *financial advertising assets, intellectual advertising assets and relational advertising assets*. A firm's DTE advertising efficiency is determined by the extent to which it possesses all three of these advertising assets as well as how effectively they are deployed.

This theoretical argument led to the general proposition that firms with a higher DTE *advertising efficiency* will use fewer advertising inputs i.e. money spent on advertising, while achieving higher performance output i.e. sales. Following this reasoning, we hypothesised that firms with a higher level of DTE *advertising efficiency* should be able to develop and sustain a competitive advantage relative to their competitors which, in turn, should lead to higher profitability.

This hypothesis was tested on a sample of major US pharmaceutical firms which spend a considerable portion of their advertising budgets on DTE advertising as a pull marketing strategy, alongside their longstanding push marketing activities focused on direct to physician (DTP) promotional initiatives. These firms were largely in the B2B sector, which contrasts with previous studies which have mainly studied B2C firms. This study attempted to fill this void in the B2B advertising literature where DTE advertising is becoming increasingly important as a pull marketing tool, particularly in the pharmaceutical industry.

The findings showed the coefficient estimate of DTE *advertising efficiency* to be positive and significant in two estimation models for ROA and ROE. These results supported our central hypothesis that DTE advertising efficiency is likely to be positively correlated with firm profitability. Our results demonstrated that firms with higher levels of DTE advertising efficiency enjoy significantly higher profitability as measured by ROA and ROE. These results were also found to be robust for alternative measures of profitability and they remained consistent in models estimated with gross profit margin (GPM) and net profit margin (NPM) as the dependent variables.

While the findings of this study are not directly comparable to previous studies due to the fact that this study examined DTE advertising *efficiency* whereas other similar studies considered only the *absolute* amount of adverting expenditure, the results of this study are consistent with earlier studies in demonstrating the positive effect of DTE advertising on financial performance. For example, Narayanan, et al. (2004) showed that DTE advertising expenditure by pharmaceutical firms yields more sales revenue. Amaldoss & He (2009) found that brand-specific DTE advertising by pharmaceutical firms positively affects firms' profit. In a similar vein, Kalyanaram (2009) showed that DTE advertising has a statistically significant and positive effect on firms' market share. Osinga, et al. (2011) reported that investment in DTE advertising by pharmaceutical firms leads to higher stock returns and lower systematic risk. In sum, our findings are consistent with those of the earlier studies and demonstrate the positive impact of DTE advertising on firm financial performance.

This present study makes three main contributions to the relevant literature. Firstly, from a theoretical perspective, this paper contributes to the RBV theoretical literature by demonstrating that DTE *advertising efficiency* is a valid concept that can be a source of sustained competitive advantage. It also developed the theoretical argument that DTE advertising efficiency can stem from three co-specialized assets, namely, *financial advertising assets, intellectual advertising assets and relational advertising assets.* There is considerable scope to operationalise this framework in additional ways as a foundation for further research.

Secondly, it builds upon previous research examining the link between advertising spending and profitability, by developing and testing a more refined model of DTE *advertising efficiency* that acknowledges variation in the level of efficiency of advertising programs. The significant and positive results demonstrate the incremental value of this refinement in the model and help to break the deadlock in the existing literature which is conflicting and inconclusive concerning the impact of advertising on firm performance.

Thirdly, from a methodological perspective, the current study showed that data envelopment analysis (DEA) can be a useful tool to capture DTE advertising efficiency and to investigate relative performance over time. Using panel data and advanced econometric modelling, this study revealed the potential to produce more insightful findings because panel data analysis considers both inter-firm differences and intra-firm dynamics. Additionally, panel data can capture the impact of unobservable variables such as the level of creativity which cross-sectional data cannot do (Hsiao, 2007).

Finally, this study added to the B2B advertising literature which has seen a relatively small amount of research on advertising topics, compared to the B2C sector. This study demonstrated that DTE advertising efficiency is a valid measure in B2B with a significant effect on profitability, even in the context of relatively small advertising budgets compared to B2C peers.

Managerial implications

The findings of this study also have significant managerial implications. Our findings demonstrate that B2B advertising managers should concern themselves with their level of DTE advertising efficiency as well as with their gross spending. That is to say, it is possible to maximize the impact of advertising on sales revenue while simultaneously reducing advertising spending. In sum, it is a realistic aspiration for advertising managers to try simultaneously to minimize the level of advertising expenditure while maximizing the advertising outcome i.e. sales, in pursuit of an optimum level of DTE advertising efficiency.

The findings of this study underline the importance of examining the DTE advertising efficiency of B2B firms to find out how well their overall advertising budget is being spent, and to try to understand whether they are underspending or overspending across various media. Such understanding will assist managers to refine their advertising budget allocation strategy to enhance overall advertising efficiency. By enhancing the overall DTE advertising efficiency, B2B firms will be able to reap the benefit in the form of better overall profitability.

Limitations and future direction

While this study produced some insightful results, as with all research it has some limitations. This study drew its research sample from the US-based pharmaceutical industry. The results may not be generalizable, therefore, to firms based in other countries and operating in other industries. Furthermore, this study focussed only on very large firms with correspondingly large advertising budgets. Consequently, the results may not be applicable to relatively smaller firms with smaller outlays on advertising. Future research should be conducted in other industries, among firms of different sizes, and with a larger sample size.

The current study examined the direct and immediate impact of DTE advertising efficiency on firm profitability. However, other firm-specific variables might mediate or moderate the relationship between DTE advertising efficiency and firm profitability. For example, a firm's overall size, or the size of its brand and product portfolio might moderate the relationship between these variables.

Additionally, various industry-specific variables such as competitive intensity, nature of competition etc. might moderate the link between DTE adverting efficiency and firm financial performance. It is suggested that future studies should adopt a contingency approach and incorporate firm-and industry-specific variables to investigate the link between these variables to generate further insights. For example, a firm's innovation capability might affect the relationship between DTE advertising efficiency and profitability Finally, future studies might consider exploring the relative impact of the three co-specialized advertising assets, namely, financial advertising assets, intellectual advertising assets and relational advertising assets on the firm performance.

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