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Special Issue: The Profit Impact of Pricing and Revenue Management

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Special Issue Papers

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Call for Papers

Journal of Revenue and Pricing Management

Advances and Best Practices in Value-based Pricing

Guest Editor: Dr. Stephan Liozu (Chatham University)

NOTES FOR CONTRIBUTORS

Submission of Papers

In 2016, a special issue on "Advances and Best Practices in Value-based Pricing" will be guest edited by Dr. Stephan Liozu, Assistant Professor of Management & Strategy at Chatham University and Founder of Value Innoruption Advisors. We invite the scientific and practicing community to submit abstracts by 1st July 2015 in order to be considered for publication.

Pricing is a subject which has received significant academic attention. Despite a recent increased in publications (Anderson & Wynstra, 2010; A. Hinterhuber & Liozu, 2012), value-based pricing remains a methodology that is misunderstood and under-researched. In fact, a paper published in 2012 reports that the conceptualization of value-based pricing is still not clear in the field of practice (Liozu, Hinterhuber, Boland, & Perelli, 2012). Scholars and consultants agree that value-based pricing is a very progressive pricing orientation (Andreas Hinterhuber, 2008b). Others have demonstrated that it can positively impact firm performance (Liozu & Hinterhuber, 2013). Yet less than 20% of firms adopt value-based pricing in practice.

This special issue dedicated to the latest advances and best practices in value-based pricing aims at putting this unique pricing orientation or practice under the spotlight so that it can better understood, adopted, and assimilated in organizations. We welcome academic papers (qualitative, quantitative, mixed methods), practitioner's papers, case studies, and other relevant contribution to produce a ground breaking special issue dedicated to advances in value-based pricing. Because we focus on advances and developments, we will select papers based on the robustness of the survey methods, the contribution to the special issue mission, and the novelty and innovativeness of the findings.

Recommended topic areas to consider for inclusion in this special issue include, but are not limited to, the following:

1. The organizational challenges in getting value-based pricing adopted and assimilated in firms. Organizational and behavioral challenges have been reported in the past (Andreas Hinterhuber, 2008a). Why are leaders in organizations not managing to get value-based pricing successfully deployed? What are new barriers they encounter in practices?
2. The impact and ROI of value-based pricing on form performance have not been clearly demonstrating. We welcome case studies on successful deployments that led to increase in sales, profits, pricing power, and innovation success.
3. Understading the concept and nature of differentiation is critical to extraction differentiation value. How do customers understanding differentiation? How does differentiation perceptions change between product and services? What are the gaps between intended versus perceived differentiation?
4. Economic value analysis and the monetization of competitive advantage: what are the process and tools that leaders in firms use to assess and measure economic value and to translate the measured value into the final price setting process?
5. Managing the segmentation process as part of value-based pricing. Often mentioned as a key barriers to the success of value-based pricing, segmentation analysis and programs are difficult to conceptualize, design, and execute. How does successful firms using value-based pricing conduct segmentation analysis? How do they version offering and pricing models by customer segments?
6. Industry-specific case studies: how do specific industries (e.g. the chemical industry, the airline industry) organize for value-based pricing? How do industry players react to value-based pricing offerings? What are key success stories in specific verticals or industry that others can benefit from?

7. Technological Innovation in value-based pricing have been introduced to market in order to accelerate the deployment of value-based pricing across entire organizations. Companies develop specific tools and technique to systematize the execution of value-based pricing strategies and tactics.
8. What key performance metrics can be linked to value-based pricing and how do you know if you are being successful in the deployment? What are the critical factors to track? How do you define the scope of value-based pricing projects?

Value-based pricing is a methodology defined by experts as a 4 to 6 step process. Steps typically include segmentation analysis, competitive analysis, identification of differentiation drivers, quantification of differentiation value, translating differentiation value into pricing, and communication of value. All submitted academic papers and empirical contributions need to be framed within the context of pricing theory and value-based pricing in general. We do not wish to publish narrow papers that are only focused on one activity within the value-based pricing methodology. Because this special issue is also aimed at a practitioner's audience, we wish to contextualize all papers within the wide value-based pricing practice.

Submission of abstract:

Abstracts should be submitted to sliozu@chatham.edu

The abstract should be clearly labeled in the title line of the email - Journal of Revenue & Pricing Management - Advances in Value-based Pricing

The abstract should be no more than 400 words

The Journal of Revenue & Pricing Management serves as a bridge between practice and theory in order to advance the field through dissemination and publication of leading articles for the benefit of industry and the wider community. A strong emphasis is placed on the utility value of research in which application is demonstrated. This must be demonstrated in the abstract.

An abstract is required that considers the following points
Title of the proposed paper (essential)
Contributing authors and contact details (essential)
Purpose of proposal (essential)
Main findings (if appropriate)
Research methodology (if appropriate)
Theoretical contribution (if appropriate)
Forms of paper (i.e., research, practitioner, thoughts)
Utility Value for practitioners or industry (essential)
Four key words
Details about the journal and author guidelines can be found at http://www.palgrave-journals.com/rpm/index.htm

Deadlines

Abstract Proposal: July 1st 2015
Paper submissions: December 31st, 2015
Feedback to authors March 30th, 2016
Final papers: July 30th, 2016
Publication: December 2016

Queries

Advice about the suitability of papers and other enquiries can be sent to:

Stephan M. Liozu, Ph.D.
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Editorial

Measuring the profit impact of pricing & revenue management

Journal of Revenue and Pricing Management (2015) **14,** 137–139. doi:10.1057/rpm.2015.13

Chief executives increasingly pay attention to pricing (Liozu and Hinterhuber, 2013); the idea that pricing capabilities are an important source of competitive advantage is finding support from both qualitative and quantitative studies (Dutta *et al*, 2002; Hallberg, 2008; Flatten *et al*, 2014; Liozu and Hinterhuber, 2014a, b). The key question is, does an improvement in pricing lead to an improvement in performance? This special issue attempts to provide an answer.

On one side, although many companies struggle to effectively measure the return from marketing activities, they report that measuring marketing ROI is increasingly important (Stewart, 2009). Measuring the return from activities in pricing is even more challenging: in 2013 the results of a survey of 313 pricing and revenue management professionals around the world reveal that the vast majority (70 per cent) see the formal measurement of the returns from pricing and revenue management activities as important (Liozu and Hinterhuber, 2014a, b, p. 198). However, a majority of respondents (53 per cent) report not having a formal internal process for this measurement. This survey reveals serious gaps in the skills and capabilities required to formally measure the impact of pricing and revenue management (Liozu and Hinterhuber, 2014a, b, p. 202). When asked about the difficulties in measuring the impact of pricing and revenue management, most pricing professionals report difficulty measuring the overall incremental pricing effect for pricing initiatives, citing definitions, measurement and data collection as main obstacles.

On the other side, some studies document a relationship between initiatives in pricing, initiatives in revenue management and firm performance. In particular, Skugge (2004) finds that the introduction of revenue management translates to an average increase of revenues of 3–7 per cent. Liozu and Hinterhuber (2013) find that value-based pricing is positively linked to firm performance but that competition-based pricing is negatively linked to firm performance. Studies specifically concerned with new product pricing report similar findings (Ingenbleek *et al*, 2003; Ingenbleek *et al*, 2010). In a study of retailers, Khan and Jain (2005) find that simple models of quantity-based price discrimination at the chain level – as opposed to more-complicated models of price discrimination at the store level – substantially increase retailer profits. While all these studies suggest that pricing initiatives do increase firm performance, our understanding of the relationship between pricing initiatives and firm performance is incomplete. We have only a limited understanding of antecedents (Queenan *et al*, 2011), research on moderator and mediator effects is largely absent, and, finally, research on the psychological and behavioral foundations of profitable pricing strategies is fairly recent (Hinterhuber, 2015; Liozu, 2015).

We need more studies. If pricing and revenue management are to become a managerial practice that can influence the strategic direction of firms, we need more-rigorous academic research that systematically links pricing and revenue management to profit performance. These needs motivate this special issue of the *Journal of Pricing and Revenue Management*. In providing an open platform to promote the subject of the profit impact of pricing and revenue management, we intend to raise pricing professionals' awareness and skills with respect to the need to measure the profit impact of their activities and programs. An exploration of the relationship between pricing, revenue management and firm performance is thus critically important for pricing practitioners, and it is equally important for research.

This special issue offers six papers that address the profit impact of pricing and revenue management. First, Stoppel and Roth study the consequences of usage-based pricing in industrial markets. They highlight the potentials of usage-based pricing and analyze the profit impact of such a pricing scheme compared with posted-pricing selling. Kellerman and Cleophas analyze the impact of revenue management on customer reference prices in the European long-distance railway industry. Qiu and Xu investigate how channel members collaboratively implement introductory pricing strategies to develop a market for an innovative product. They link these strategies to the concept of profit sharing with customers. Johansson, Keränen, Hinterhuber, Liozu and Andersson suggest that value assessment and pricing capabilities provide the foundation for value creation and value appropriation in business-to-business markets; they highlight opportunities for profiting from value created and delivered, and they outline important areas for future research. Next, Kunz and Crone propose an empirical analysis of the impact of practitioner business rules on the optimality of a static retail revenue management system. They provide an empirical analysis of the impact of commonly applied business rules of using (a) discrete price points, (b) maximum price moves, (c) corridor pricing, and (d) passive pricing on the size and quality of the problem's solution space and their monetary impact. Finally, Hinterhuber and Liozu discuss the relationships between pricing ROI, pricing capabilities and firm performance. They offer two contributions: they explore the concept of pricing ROI, and they document a positive link between pricing ROI and firm performance.

This special issue helps advance the topic of the profit impact of the pricing and revenue management disciplines. This issue is an important step, but clearly more work in this area is warranted: all papers in this special issue highlight the implications for practicing pricing and revenue managers and lay out opportunities to contribute to further research in this important domain. As co-editors of this special issue, we are dedicated to advancing the field of pricing and revenue management, and we strongly encourage researchers to demonstrate the profit impact of these disciplines. We hope that this call for more research will resonate in the practitioner and academic communities.

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Research Article

Consequences of usage-based pricing in industrial markets

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ABSTRACT In industrial sales providers often neglect the potential for revenues in the customer's usage processes after the actual transaction. However, innovative providers tend to shift revenues to the usage phase by setting prices according to actual service usage. In this article, we discuss the consequences of usage-based pricing in a twofold manner: First, we point out the potentials of usage-based pricing. Here, we show the additional value proposition when usage-based costs and risks are shifted from customers to providers as well as the opportunities and challenges of adopting that pricing scheme. Second, we analyze the profit impact of a usage-based pricing scheme in comparison with posted-price selling. The findings show that usage-based pricing can help discriminate customers by their usage intensity. With low usage-independent costs, usage-based pricing is more profitable than posted-price selling, even though providers must cover usage-based costs with that pricing scheme. With high usage-independent costs, providers should consider a minimum usage level or improve their advantage over customers in terms of usage-based costs.
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published online 24 April 2015

Keywords: usage-based pricing; pay-per-use; value-in-use; value-based pricing; solution pricing

INTRODUCTION

In classic industrial sales, revenues are generated during the transaction phase and therefore before the customer uses the offer. When determining prices, many providers assume that value is inherent in their offers, which contain transformed resources and attributes (Woodruff and Flint, 2006). Thus, most industrial providers employ cost- or competition-based approaches to set prices (Hinterhuber, 2008). By focusing on the selling price, these providers valuate their offers on the basis of internal costs and competitive prices and lose sight of individual customers and their specific requirements. In contrast, especially industrial customers assess the value of an offer according to its potential to enable beneficial activities (Farres, 2012). From the customer perspective, value is not inherent in the offer. Value is perceived while using the offer as value-in-use (Bowman and Ambrosini, 2000; Ng *et al*, 2012).

Innovative providers try to understand their customers' perceived value and orient their pricing accordingly. Research on value-based pricing has noted discrepancies between providers' and customers' valuations and derive benefits of pricing oriented on customers' perceived value (Flint *et al*, 1997; Anderson and Narus, 1998; Hinterhuber, 2004; Terho *et al*, 2012). However, decision making regarding different pricing schemes for value-based pricing has been neglected in the literature. In practice, several approaches exist for pricing schemes, which refer to the customer's value in different ways (Lay *et al*, 2009). Some providers align their pricing scheme with customers' value creation. For example, Rolls-Royce has applied the power-by-the-hour approach for more than 50 years. The operators of their engines create value by transporting people and cargo by aircraft. To generate beneficial activities for its customers, Rolls-Royce offers a comprehensive solution by installing, monitoring, repairing and maintaining the turbines and does everything necessary to enable customers to pursue their activities. Because customers create value when using the engines, Rolls-Royce aligns the pricing scheme with their usage by charging a price per flying hour.

Building on previous research in revenue and pricing management (Ng, 2010; Hinterhuber and Liozu, 2012), the purpose of this article is to discuss the consequences of a pricing scheme based on customers' usage as an alternative to the selling approach. First, we show that by choosing a usage-based pricing scheme, providers change their value proposition. Instead of selling products, services and components, providers apply usage as a new reference item. Here, they bear the responsibility for and the costs of the usability of the offer and related risks during the usage phase. In doing so, providers improve the value proposition. However, providers must overcome several challenges when adopting that pricing scheme, which can result in further opportunities. Second, we analyze the profit impacts of both pricing schemes with a model that includes the different ways of assessing an offer applied by customers and providers. We use the model to analyze the effects of the cost structure specific to industrial offers on the optimal decision regarding the pricing scheme. We show that providers with low usage-independent costs are better off by applying usage-based pricing, even though they must incur the usage-based costs with that pricing scheme. Conversely, when choosing usage-based pricing, providers with high usage-independent costs should consider a contractual minimum usage level or improve their advantage over the customer in terms of usage-based costs.

We organize this article as follows: we first review the relevant literature and present the characteristics of posted-price selling and usage-based pricing. We then discuss the potentials of usage-based pricing. Next, elaborating a parameterized model, we analyze the effects of the cost structure on the profit potentials of both pricing schemes. We conclude with implications for practice and suggestions for future research.

CHARACTERISTICS OF POSTED-PRICE AND USAGE-BASED PRICING SCHEMES IN THE INDUSTRIAL CONTEXT

Usage-based pricing schemes have been investigated intensively in the context of access services (Bala and Carr, 2010; Fjell, 2010), such as fitness studios, theme parks, software environments and telecommunication/energy networks. With these services, customers 'pay for the privilege to access a facility but do not acquire any right to, or 'use up', the facility itself' (Essegaier *et al*, 2002, p. 139). Popular pricing schemes that firms in access industries use include subscription programs (Choudhary, 2007; Zhang and Seidmann, 2010), bucket pricing (Baron *et al*, 2005; Schlereth and Skiera,

2012) and multi-part tariffs (Jensen, 2006; Lambrecht *et al*, 2007). Especially linear tariffs and multi-part tariffs capture customers' intensity-of-use. The customer pays a price based on the received service. Comparative analyses between usage-based pricing and posted-price selling have primarily been conducted in the context of software services (Fishburn and Odlyzko, 1999; Gurnani and Karlapalem, 2001; Postmus *et al*, 2009; Bala and Carr, 2010; Bala, 2012).

However, two issues specific to industrial offers have not been considered in pricing research on access services. First, industrial solutions include durable goods (for example, machines, equipment) as components of the service provided. These goods must be constructed, built and implemented for each customer. Therefore, the integration of several goods and services is a key feature of a solution (Sawhney, 2006). The costs for the components and their integration exist with every customer and must be considered in the pricing decision. In contrast, with access services the provider builds resources with high fixed costs that are shared among as many customers as possible, taking capacity constraints into account (Essegaier *et al*, 2002). The costs of providing the service to an additional customer are negligible as long as the provider has the capacity to serve additional customers. That is, each customer does not receive an additional core product but only access to a resource that already exists. Second, when deciding to purchase an offer, industrial customers consider their anticipated usage-based costs that accrue in the usage phase. However, in a usage-based pricing scheme these costs are born by the provider, which is responsible for the operation availability of the infrastructure (Bonnemeier *et al*, 2010). The shift of the usage-based costs from customer to provider must be taken into account in a comparative analysis of posted-price selling and usage-based pricing. This issue has not been considered in the context of access services, because the shift of responsibilities and usage-based costs are not crucial to these services.

Selling scheme

Providers using the selling scheme articulate the value of an offer as a proposition and attach a fixed price to it. This price refers to the number of products and services precisely defined in a contract. Hinterhuber (2004, p. 769) develops a framework for value analysis as 'a tool designed to comprehend and to quantify the sources of value of a given product for a group of potential customers'. Here, Hinterhuber adopts Nagle and Holden's (2002) view that a product's economic value is the price of the customers' best alternative plus the value of whatever differentiates the offering from the alternative. Using this approach and taking the perspective of a customer segment, providers must identify the cost of the next best alternative. Then, they must detect the factors differentiating the offer from the alternative and measure the value with appropriate scientific methods (Hinterhuber, 2008). Finally, the total economic value can be determined and communicated by adding the price of the next best alternative and the benefits of the differentiation. To manage these tasks, providers must improve their pricing capabilities and resources when implementing a value-based pricing approach (Dutta *et al*, 2003; Liozu *et al*, 2014), overcome a set of challenges (Hinterhuber, 2008; Gale and Swire, 2012) and adjust the organizational design (Liozu *et al*, 2014). Some concepts consider approaches that contribute to customers' value throughout the entire life cycle (for example, total cost or total profit of ownership) to quantify and communicate the value of an offer (Ulaga and Chacour, 2001; Snelgrove, 2012). Although these approaches consider customers' individual situation, they cannot take into account customers' requirements in their usage processes, because the pricing is adjusted to a single transaction in which the scope of service is precisely defined. Any further problems customers become aware of in their usage processes must be solved by themselves. This means the customers are responsible for the integration of further products and services during their usage processes. It can be advantageous to sign additional maintenance contracts to ensure provider support; nevertheless, these are additional services with separate prices and transactions, and the customers must bear the costs for these services.

Usage-based pricing scheme

For the usage-based pricing scheme, a different conceptualization of value is more suitable. Terho *et al* (2012) conceptualize a value-based selling approach and show that value-oriented sellers focus on an offer's value-in-use potential for customers' business and financial profits rather than on separate components and product functionalities. Thus, providers must stress their contribution to the customers' value creation. In emphasizing support of the customer's value creation, both actors interact in a set of relational processes (Tuli *et al*, 2007). Here, a large part of the value-creating activities of both partners occur in the usage phase after the actual transaction (Brady *et al*, 2005; Kujala *et al*, 2010; Töllner *et al*, 2011). It is in this phase that the provider shifts the revenues from separate transactions to the customer's usage processes.

As mentioned previously, aircraft fleets create value by transporting people and cargo. For these customers, Rolls-Royce offers a fleet solution to all turbine problems a fleet manager may face. The solution covers the provision, maintenance, repairs, monitoring and disposal of the optimal equipment for every aircraft. In effect, Rolls-Royce sells mobility as a service rather than turbines. When using Rolls-Royce's service, customers create value, and according to this, the provider quotes a price appropriate to each customers' value creation – namely a price per flying hour. Rolls-Royce and its customers do not anticipate the entire value-in-use potential to set prices when the contract is concluded but focus on one unit of the customer's value creation. Therefore, the price refers to the provider's contribution to the customer's value creation broken down to one unit of use (hour). By measuring the units of use, the partners can compute the actually perceived scope of service and express it in monetary terms. In this pricing scheme, the intensity-of-use of the offer is a customer-driven item. With this item, the customer alone determines the amount payable. Thus, the intensity-of-use over the entire usage phase is part of the customer's proposition to the provider (Ng *et al*, 2009).

POTENTIALS OF USAGE-BASED PRICING

With usage as a reference item, many pricing issues change, the most important one being that customers do not acquire property rights but only pay for the service received (Hypko *et al*, 2010). Because the reference item (usage) implies that the promised service is available and the infrastructure is ready for operation, customers do not bear the costs of repairs, spare parts management, maintenance or condition monitoring (Oliva and Kallenberg, 2003; Bonnemeier *et al*, 2010). If customers cannot use the solution, they do not need to pay. Thus, in addition to capital expenditures, the provider covers the usage-based costs for the operational availability of the infrastructure. Such coverage can result in a higher value proposition for the customer and greater opportunities for the provider's business. However, the adoption of a usage-based pricing approach also implies several challenges.

Potential value propositions

By taking over risks and responsibilities for the customer, the provider can demonstrate the contribution of the risk coverage as a benefit to the customer's business. By emphasizing the benefit, the provider communicates an improved value proposition. We suggest a total of six value proposition potentials of usage-based pricing.

First, the provider must finance the infrastructure, which shifts the *investment risk* and the *capital costs* from the customer to the provider (Hünerberg and Hüttmann, 2003). Second, the provider also bears the *availability risk* because it is responsible for the operational availability (Oliva and Kallenberg, 2003). Third, given the responsibility for the operational availability and because revenues are lost when the infrastructure is not in operation, the provider has the incentive to improve the quality, reliability and durability of the solution (*quality risk*) rather than designing the components with regard to future maintenance orders (Toffel, 2008). Fourth, the provider also takes on part of the customer's *market risk* (Decker and Paesler, 2004). For the customer, it is difficult to predict whether an innovative product will be successful in the market and whether the investment will achieve the required return on investment (Hypko *et al*, 2010). With low sales, the intensity-of-use as well as the customer's derived demand will decrease. In this case, the provider bears part of the economic consequences of not-fully-utilized capacities because the revenue is directly linked to the usage. Fifth, in case the customer's usage requirement exceeds the present capacity in the long run, it is in the provider's interest to adjust the capacity to the customer's requirement and gain higher revenues along with higher usage (Thiesse and Köhler, 2008). Thus, the provider takes on the customer's *capacity risk* and the costs involved. Sixth, to maximize revenues, the provider wants the customer to have efficient and effective processes. Thus, the provider is interested in obviating malfunctions in upstream processes that result in lower usage and bears part of the *process risk*.

Challenges of adopting usage-based pricing

Providing an increased value proposition involves several challenges and barriers for the provider. First, on an *economic* level, the provider must consider the financial risks because it cannot estimate the effects of costs and revenues on the conclusion of the contract. Revenues could be lower than expected because of lower usage by the customer or a premature end to the contract. The specific investment for this customer could turn out to be unprofitable afterward, especially when the specific offer is not transferable to other customers (Buse *et al*, 2001). Both a long-term commitment to an unprofitable customer and a bond of capital to that relationship prevent the provider from forming new opportunities with more attractive customers when capacity is limited. On the cost side, in addition to capital costs, usage-based costs can arise from too severe wear and tear or inappropriate handling of the infrastructure, which results in a risk factor regarding the customer's behavior (Toffel, 2008). In addition to the risks in costs and revenues, with usage-based pricing the provider takes on several customer risks in the value proposition. So, the risk assessment and calculation for a long-term planning horizon is a significant challenge the provider can only overcome by gaining experience.

Second, *technical* challenges arise from the high requirements for the configuration and integration of multiple services. New technical improvements during the usage phase must be integrated with existing components. So, the provider faces a technical fulfillment risk when signing the contract (Buse *et al*, 2001). One way to handle this is to cooperate with additional partners to cover areas of responsibility for which the provider is not sufficiently qualified (Sawhney, 2006).

Third, challenges arise in the *management* of usage-based pricing. Price management requires new approaches that center on the relationship rather than on transactions. Instead of setting prices for tangibles, with the new approach the provider must set prices and premiums for the integration and customization of several predictable and unpredictable services as well as for activities and risks related initially to the customer. To do so, the provider must build appropriate pricing capabilities (Dutta *et al*, 2003). For marketing and sales, the orientation on the customer's value-in-use determines an adequate detection of the customer's needs, requirements, willingness-to-pay and the overall relationship potential (Sawhney, 2006; Bonnemeier *et al*, 2010). However, a pricing scheme that accounts for the usage during the whole life cycle of a product causes the interaction of the partners and the integration of the provider's activities into the customer's processes (Wise and Baumgartner, 1999; Grönroos and Helle, 2010). For this purpose, the provider must improve resources and capabilities and restructure the organization to be more service oriented, reconfigurable and flexible to manage every demand and challenge of the customer (Galbraith, 2002; Oliva and Kallenberg, 2003; Davies *et al*, 2006).

Opportunities for the provider's business

Providers that can handle these economic, technical and managerial challenges and integrate their activities into customers' value-creating processes are in a good position to support the customers in various ways and to exploit revenue potentials in the usage phase. In saturated industrial markets in particular, it is difficult for providers to build up and secure competitive advantages only with technical innovations, which can be imitated quickly (Evanschitzky *et al*, 2011). With usage-based pricing, the provider can attract new customers and more firmly bond existing customers so that revenues can be secured in the long run (Brady *et al*, 2005). A strong interaction with the customer enables the provider to extend comparative advantages because it obtains profound information about the customer's processes. By improving those processes continuously in terms of efficiency and effectiveness, the provider enhances its expertise in the customer's business and thereby increases customer loyalty. In turn, the relationship becomes a bilateral monopoly (Hypko *et al*, 2010).

With more knowledge about the operation and design of the offer, the provider has more opportunities to realize cost-reducing aspects. In the usage-based pricing scheme, responsibilities are allocated more efficiently – that is, the provider ensures a sustainable maintenance and an efficient operation. It also aligns the offer's design with the customer's requirements, with a quality level of minimum repairs, rather than maximizing selling prices and the number of additional maintenance services (Hypko *et al*, 2010). With an efficient allocation of responsibilities, both partners can gain a mutually created 'shared value' based on their interaction (Bertini and Gourville, 2012). Such additional value can be shared between the contractual partners through an appropriate pricing mechanism.

Finally, by taking over a wide range of tasks and responsibilities, the provider must form relationships with other suppliers and build up supplier networks with additional resources and capabilities. The interaction of several partners enhances the innovation potential of the network. With a powerful network and advantageous value propositions, the provider can exploit new markets and customers.

PROFIT IMPACT OF POSTED-PRICE SELLING AND USAGE-BASED PRICING

In this section, we analyze and compare the profit impacts of a posted-price selling and a usage-based pricing scheme while considering factors specific to industrial markets. In our model, we refer to specific decision making and specify the various ways providers and customers assess an offer's value. That is, industrial customers focus on the offer's contribution to one unit of their value creation and the extent to which they can use the offer, while providers consider the costs of and effort in providing certain services. Furthermore, we incorporate the specific cost structure of industrial offers, which has been neglected in previous research on access services. In summary, we specify two types of costs: usage-independent costs (for example, costs for design, production, transportation and implementation), which are born by the provider and usage-based costs (for example, costs for repairs, spare parts management, maintenance and condition monitoring), which are born either by the customer in the selling scheme or by the provider in the usage-based pricing scheme. Finally, we consider the provider's potential of competence advantage over the customer, particularly in how the provider can solve usage-based tasks at lower costs (Davies *et al*, 2006; Ulaga and Reinartz, 2011).

After defining the general model and notation, we analyze the optimal decision regarding the pricing scheme for a profit-maximizing provider. For this purpose, we first ignore the costs and show how usage-based pricing can be applied to skim customer surplus by discriminating customers by their intensity-of-use. Then, we will show the impact of usage-based costs and usage-independent costs on the optimal decision. Finally, we highlight the effects of the provider's competence advantages over the customer with regard to usage-based costs.

Model definition

Customer's decision making

In our model, customers anticipate an expected value when evaluating an offer. The expected value is the anticipated extent of perceived value-in-use in the course of the entire usage phase, and it consists of two variables linked multiplicatively:

Value-per-use v is a monetarily expressed expected value a customer perceives with one unit of use. In our previous example, aircraft fleets create value by transporting people and cargo. Rolls-Royce contributes to that value creation by enabling mobility. This contribution is the value-per-use the aircraft fleets receive while using the turbines for 1 hour. In our basic model, we assume that v is constant during the entire usage phase.

Intensity-of-use x is the expected sum of the received units of use over the entire usage phase. We assume that intensity-of-use is linked to the customer's derived demand – that is, it is determined by the customer's clients' demand for its products. So, the individual intensity-of-use is inelastic to changes in price. This assumption receives support in previous research (Essegaier *et al*, 2002; Bala and Carr, 2010). Applied to our example, it means that the aircraft fleets will not limit their transport service even if Rolls-Royce raises prices.

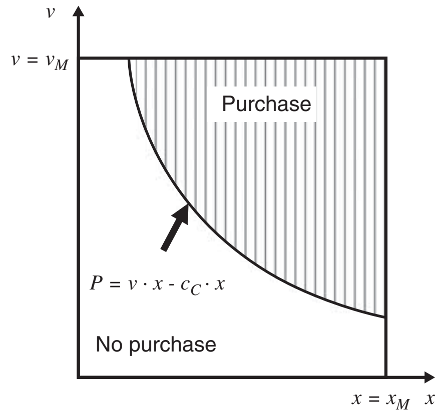

Figure 1: Demand structure: posted-price selling.

Customers differ in terms of these two variables and are described by a two-dimensional vector (v, x). All customers can exactly predict both their value-per-use v and their intensity-of-use x. The set of (v, x)-customers is uniformly distributed over the $[0, v_M]\times[0, x_M]$ square.

Furthermore, customers already consider their *usage-based costs* c_C during purchasing decisions. These costs arise in the usage phase and are calculated for every unit of use. The aggregated usage-based costs over the entire usage phase are $c_C \cdot x$. In our model, the usage-based costs c_C are equal for every customer and are known by both the customers and the provider in advance. To illustrate the demand for an offer, we display the set of potential (v, x)-customers on an area limited by $[0, v_M]\times[0, x_M]$ (see Figures 1 and 2).

In the *selling* scheme (Figure 1), all customers consider their individual consumer surplus CS. For a (v, x)-customer, purchasing is worthwhile if

$$CS_{Sell} = v \cdot x - c_C \cdot x - P \geqslant 0. \quad (1)$$

With a *posted-price* P, customers will decide to purchase when

$$P \leqslant v \cdot x - c_C \cdot x. \quad (2)$$

Figure 1 illustrates the posted-price P as an 'iso-utility' in the (v, x)-square. Customers on that line may have different values for v and x, but

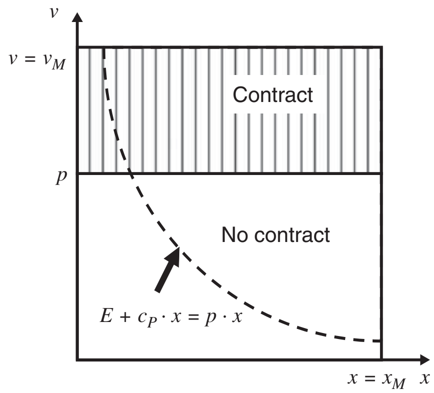

Figure 2: Demand structure: usage-based pricing.

they have the same total value ($v \cdot x - c_C \cdot x$). These customers are indifferent when it comes to purchasing because the expected value is as high as the price. Customers above the line (shaded area) expect a higher value and will purchase the offer.

Under *usage-based pricing* (Figure 2), the provider is responsible for the operational availability and, consequently, the usage-based costs. The customer only has to pay a *price-per-use p* for the received units of use.

For a (v, x)-customer, a usage-based offer is worthwhile if

$$CS_{ubp} = v \cdot x - p \cdot x \geqslant 0. \quad (3)$$

If the provider sets a price-per-use p, customers will accept the offer when

$$p \leqslant v. \quad (4)$$

Under usage-based pricing, customer decisions are not dependent on the expected intensity-of-use x as long as the customer's value-per-use v is higher than its price-per-use p. This condition results in a very different structure than that of selling, as Figure 2 illustrates.

Provider's decision making

To keep the model tractable, we consider a monopolistic provider without capacity constraints. When setting up each additional offer, the provider faces costs that arose before the customer's usage of the offer (for example, production costs, transportation costs, installation costs). We refer to these costs as *usage-independent costs E*. As fixed costs are not relevant for our analysis, we normalize them to zero.

In the *selling* scheme, the provider sets a posted-price P and does not incur any further costs after the transaction. Therefore, the provider realizes a *contribution margin CM* with every customer in the amount of

$$CM_{Sell}(P) = P - E. \quad (5)$$

The profit $\pi(P)$ results from the aggregation of the contribution margins CM over all (v, x)-customers buying the offer (shaded area of Figure 1), as well as the density function $f(v, x)$ from the distribution of (v, x)-customers:

$$\pi_{Sell}(P) = \int\int (P - E) \cdot f(v, x) dv\, dx. \quad (6)$$

In the *usage-based pricing* scheme, the provider sets a price-per-use p payable for every unit of use by the customer. Now, the provider is responsible for the operational availability and covers the *usage-based costs* $c_P \cdot x$. The level of usage-based costs differs between customer and provider because of differences in expertise and resources required to keep the infrastructure available ($c_P \neq c_C$).

With usage-based pricing, the provider's contribution margin CM (7) is different for every individual customer, whereas it is constant in selling (5). This is because CM depends on a customer's intensity-of-use x (that is, customers' value proposition):

$$CM_{ubp}(p) = p \cdot x - c_P \cdot x - E. \quad (7)$$

With selling used as the pricing scheme, the provider sets the posted-price P high enough to cover the usage-independent costs E. With usage-based pricing, the provider faces the problem of some customers having such a small intensity-of-use x that the revenues ($p \cdot x$) are not high enough to cover the costs ($c_P \cdot x + E$). The dashed line in Figure 2 illustrates the provider's costs. Customers below that line represent a negative contribution margin for the provider.

The provider has two options for addressing this problem. First, it can continue serving those customers and compensate for the loss with gains made from profitable customers (*no minimum-usage level*). Second, it can set a *minimum-usage level* $x_{\min}$ contractually with a corresponding fee ($p \cdot x_{\min}$). In this case, the provider sets the minimum usage level so high that the contribution margin is not negative.

$$CM_{ubp}(p,x) = p \cdot x_{\min} - c_P \cdot x_{\min} - E \geqslant 0. \quad (8)$$

From (8) follows

$$x_{\min} = \frac{E}{p - c_P}. \quad (9)$$

Now, we can derive the profit from

$$\pi_{ubp}(p) = \int_{p}^{v_M} \int_{x_{\min}}^{x_M} (p \cdot x - c_P \cdot x - E) \cdot f(v,x) dx\, dv. \quad (10)$$

Basic analysis with neglected costs

For a basic analysis, we ignore the influence of costs ($c_P = c_C = E = 0$) to generate model predictions about the mode of action of both pricing schemes. For the profit functions (6) and (10), we derive the integration limits from the shaded areas in Figures 1 and 2. By inserting $c_P = c_C = E = 0$ and the uniform density function $f(v, x) = 1/(v_M \cdot x_M)$, we can derive the profit functions.

$$\pi_{Sell}(P) = \int_{\frac{P}{v_M}}^{x_M} \int_{\frac{P}{x}}^{v_M} \frac{P}{v_M \cdot x_M} dv\, dx$$
$$= \frac{P}{v_M \cdot x_M} \left(v_M \cdot x_M - P + P \cdot ln\left(\frac{P}{v_M}\right) - P \cdot ln(x_M) \right), \quad (11)$$

$$\pi_{ubp}(p) = \int_{p}^{v_M} \int_{0}^{x_M} \frac{p \cdot x}{v_M \cdot x_M} dx\, dv$$
$$= \frac{1}{2} \cdot \frac{p}{v_M} \cdot x_M \cdot (v_M - p). \quad (12)$$

After determining the extrema, we find the optimal prices for both pricing schemes:

$$P_{Sell\,opt} \approx 0.28468 \cdot v_M \cdot x_M, \quad (13)$$

$$p_{ubp\,opt} = \frac{1}{2} \cdot v_M, \quad (14)$$

and the maximum profits using the optimal prices:

$$\pi_{Sell\,max}\left(P_{opt}\right) \approx 0.1018 \cdot v_M \cdot x_M, \quad (15)$$

$$\pi_{ubp\,max}\left(p_{opt}\right) = 0.125 \cdot v_M \cdot x_M. \quad (16)$$

The results show that a usage-based pricing scheme is a more profitable strategy when costs can be ignored. The intuition behind this is that the provider can perfectly discriminate customers by their intensity-of-use x. A forward-looking customer's willingness to pay falls within the parameters value-per-use v and intensity-of-use x. The provider can determine one of these parameters, namely x, even in the usage phase. When applying usage-based pricing, the provider can perfectly discriminate customers on the basis of that parameter. So, the individual contribution margin CM (7) enables the provider to skim the customers' surplus. In contrast, under the selling scheme, the provider sets the price before the usage phase. Without the information about customers' intensity-of-use, it must set one posted price for all customers and cannot differentiate between them.

The case of negligible costs occurs in markets of access services and information goods, as mentioned in the previous section. However, in the industrial context we also must consider that the provider implements a capital good in the customer's environment that, in turn, must be maintained in the usage phase.

Analysis of the influence of costs

With non-negligible costs, the model becomes more complex. A large number of parametric factors do not permit an analytical approach. Thus, we forgo the analytical solution here and apply a numerical computation. Furthermore, we assume that the provider's competence advantages in the integration of products and services during the usage phase are non-relevant. That is, the usage-based costs are equal regardless of whether the customer or the provider bears them ($c_P = c_C = c$).

Under *posted-price selling*, the provider faces only the usage-independent costs E and incurs no further costs after the transaction is completed. Instead, the customer takes the usage-based costs c into account. For this reason, these costs appear in the integral limits of the profit function.

$$\pi_{Sell}(P) = \int_{\frac{P}{v_M - c}}^{x_M} \int_{\frac{P}{x}+c}^{v_M} \frac{P-E}{v_M \cdot x_M} dv\, dx$$

$$= \frac{(P-E)\cdot\left(x_M\cdot(v_M-c)+P\cdot\ln\left(\frac{P}{v_M-c}\right)-P\cdot\ln x_M-P\right)}{v_M\cdot x_M} \quad (17)$$

$$\text{s.t. } 0 \leqslant \frac{P}{v_M - c} \leqslant x_M. \quad (18)$$

With *usage-based pricing*, the provider must bear the usage-based costs c. If the customer pays a price-per-use, the provider must consider unprofitable customers, which have such low intensity-of-use x that the provider cannot cover the costs. This is why we differentiate between (i) applying a contractual minimum usage level $x_{\min}$ and (ii) not applying it and serving every customer willing to pay the price-per-use p.

First, in case the provider does *not apply a minimum usage level*, the profit is

$$\pi_{ubp}(p) = \int_{p}^{v_M} \int_{0}^{x_M} \frac{p\cdot x - c\cdot x - E}{v_M\cdot x_M} dx\, dv$$

$$= \frac{1}{2}\frac{(v_M-p)\cdot(p\cdot x_M - c\cdot x_M - 2E)}{v_M}, \quad (19)$$

$$\text{s.t. } \quad c\cdot x_M + E \leqslant p\cdot x_M \leqslant v_M\cdot x_M. \quad (20)$$

The comparison of the maximum profits between selling and usage-based pricing shows that usage-based pricing rapidly loses the advantage. The shaded area in Figure 3 illustrates the constellations of E and c in which usage-based pricing is more profitable than selling. For numerical computations, we normalized the parameters v, x, E and $c \in [0, 1]$ with $v_M, x_M = 1$. This simple scaling process does not sacrifice generality. Because $E + c \leqslant 1$ follows from (20), the area above the diagonal is not defined. This restriction indicates that the costs should not be higher than the maximum expected value or higher than the maximum price a customer is willing to pay.

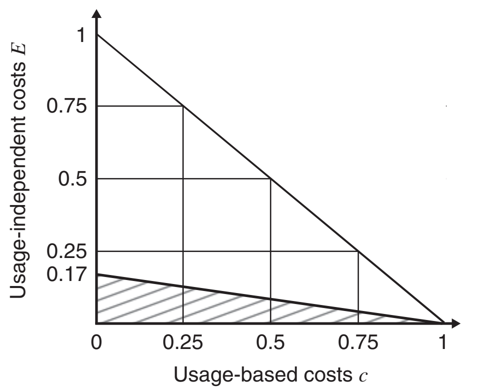

Figure 3: Advantage of usage-based pricing for E and c.

Figure 3 shows that usage-based pricing is more profitable only for relatively low levels of E. Therefore, only providers with relatively low usage-independent costs E will choose usage-based pricing over posted-price selling. In addition, we find that the critical value of E decreases with higher levels of usage-based costs c. We can also observe this phenomenon in practice for access service providers. Here, providers operate already existing resources (for example, telecommunication network, power supply network, gym equipment), and every individual customer causes high usage-based costs c (for example, connection charges, energy costs, service costs). A new customer, however, does not cause high usage-independent costs E. By signing the contract, the customer does not receive a costly product but only acquires access to a service or resources. In contrast, in industrial markets, providers are located in the upper area of the (E, c)-square (Figure 3) because high capital costs for machines and equipment accrue for every individual customer. Thus, usage-based pricing without a minimum usage level is unusual in industrial markets but common in access services.

Second, it is reasonable to set a *minimum usage level* $x_{\min}$ (9) to avoid unprofitable customers. Doing so results in a three-part-tariff with a fixed fee of $p \cdot x_{\min}$ for the right to use the offer, where $x_{\min}$ is the quantity threshold within which the usage is free of charge and p is the price-per-use for the usage units exceeding the threshold $x_{\min}$ (Chao, 2013). This is common use in practice: Carl Zeiss, the German manufacturer of optical systems, offers metrology aggregates with a usage-based pricing scheme according to hours of usage. The provider sets a minimum-usage threshold at 800 hours per year.

Applying a minimum-usage level, the profit under usage-based pricing is

$$\pi_{ubp}(p) = \int_{p}^{v_M} \int_{x_{\min}=\frac{E}{p-c}}^{x_M} \frac{p \cdot x - c \cdot x - E}{v_M \cdot x_M} dx\, da$$
$$= \frac{1}{2} \frac{(v_M - p) \cdot (p \cdot x_M - c \cdot x_M - E)^2}{v_M \cdot x_M (p - c)}. \quad (21)$$

When comparing the maximum profits of usage-based pricing (with minimum usage level $x_{\min}$) with those of selling, we find that usage-based pricing is more profitable for all constellations of E and c. However, the importance of usage-based pricing decreases with increasing costs E and c (Figure 4). With increasing costs, the seller must increase the prices; thus, the consumer surplus will decrease. The lower the consumer surplus, the lower is the impact of skimming. With $x_{\min}$, the provider serves only profitable customers and is able to skim their surplus by discriminating customers by their intensity-of-use.

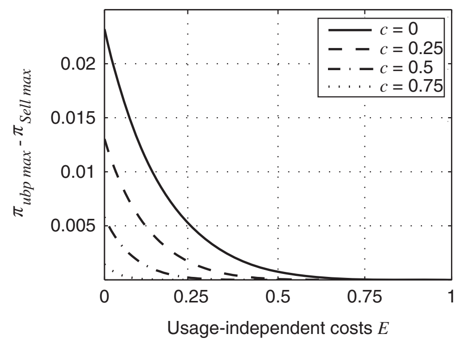

Figure 4: Advantage of usage-based pricing with minimum-usage level for E and c.

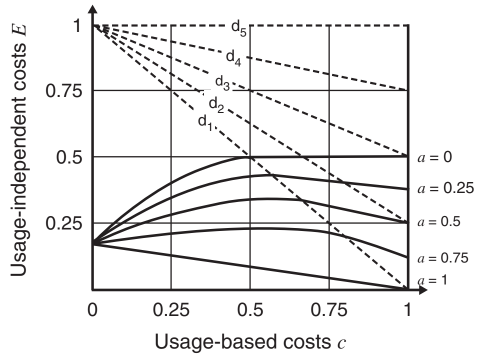

Figure 5: Advantage of usage-based pricing for E and c.

Analysis of the provider's competence advantages

In our model, we analyze the provider's competence advantages in a simplified way. We assume that the provider's usage-based costs c_P are lower than or equal to the customer's usage-based costs c_C ($c_P \leqslant c_C$). We denote the provider's competence advantage with the parameter $\alpha \in [0, 1]$. The lower α, the lower the provider's usage-based costs are than the customer's. Therefore, we denote the provider's usage-based costs as

$$c_P = \alpha \cdot c_C = \alpha \cdot c.$$

Because with a selling scheme the customer bears the usage-based costs, the provider's profit function (17) does not change. In contrast, the profit changes with the usage-based pricing scheme. We focus on usage-based pricing without a minimum usage level to analyze the potential effects on the area where usage-based pricing is the optimal scheme:

$$\pi_{ubp}(p) = \int_{p}^{v_M} \int_{0}^{x_M} \frac{p \cdot x - \alpha \cdot c \cdot x - E}{v_M \cdot x_M} dx\, dv$$
$$= \frac{1}{2} \frac{(v_M - p) \cdot (p \cdot x_M - \alpha \cdot c \cdot x_M - 2E)}{v_M}. \quad (22)$$

After determining the optimal prices and maximum profits numerically, we compare the profitability of both schemes in the (E, c)-square, analogous to Figure 3. In Figure 5, the areas below the solid lines for different values of α mark the constellations of E and c in which usage-based pricing is more profitable than selling.

Considering the provider's higher competence in supporting the customer's processes, we can show for $\alpha < 1$ that the threshold of E does not decrease with higher usage-based costs c but rather increases up to a certain point. The higher the competence advantage (the lower α), the stronger is this effect (see solid lines for $\alpha = 1$, 0.75, 0.5, 0.25, 0). In an extreme case in which the provider can handle the support without usage-based cost ($\alpha = 0$), the threshold increases up to half the definition domain $E = 0.5$. At this point, the provider barely covers the costs of the (uniformly distributed) low intensity-of-use customers with the profits of the high intensity-of-use customers.

In the selling scheme, the provider is not able to sell offers in the area above the diagonal in Figure 5 because the customer's usage-based costs and the posted-price P (which must be higher than or equal to E to remain profitable) are higher than the maximum expected value ($c_C \cdot x_M + P(\geqslant E) \leqslant v_M \cdot x_M$). In choosing usage-based pricing, the provider bears the costs ($\alpha \cdot c_C \cdot x_M + E$), which are lower than the sum of costs in the selling scheme when $\alpha < 1$. Thus, the area (in the lower-left-hand corner) restricted by ($\alpha \cdot c_C \cdot x_M + E \leqslant v_m \cdot x_M$) becomes larger with lower $\alpha < 1$ (see dashed lines d_1, d_2, d_3, d_4, d_5 for $\alpha = 1$, 0.75, 0.5, 0.25, 0 in Figure 5). This means that with the usage-based pricing scheme, responsibilities are allocated more efficiently. As a consequence, the partners are able to create higher shared value or the provider can enter new markets by offering solutions with higher usage-independent costs. In a classic selling scheme, these offers are not attractive to the customers. However, without a minimum usage level, only offers below the solid lines are profitable for the provider. Offers between the solid and corresponding dashed line are only profitable when the provider sets a minimum usage level contractually.

CONCLUSION

In this article, we discuss two pricing schemes applicable to value-based pricing of industrial offers. The article demonstrates that providers and customers assess offers in different ways because they have different understandings of value. The literature on value-based pricing indicates that it can be beneficial to analyze and quantify value from customers' point of view. Thus, we present two pricing schemes that can be aligned with the customer's perceived value. However, the approaches use different conceptualizations of value to quantify and allocate the value with a price. In a selling scheme, the price and the scope of service are fixed before usage, whereas with a usage-based pricing scheme, revenues are generated in the usage phase by measuring the actual intensity-of-use. Because extant literature is scarce in deriving implications for pricing schemes with regard to value-based pricing in the industrial context, we analyzed the consequences of posted-price selling and usage-based pricing as applicable schemes for industrial providers.

Managerial implications

For practitioners, this article presents two aspects regarding the consequences of usage-based pricing. First, providers can improve the value proposition with usage-based pricing. By offering usage of an infrastructure, providers commit themselves to ensuring operational availability and to interacting with customers during the usage phase. In doing so, providers bear several risks (that is, investment risk, availability risk, quality risk, market risk, capacity risk and process risk), thus improving their relationship with customers. As such, providers can charge premium prices and may increase profits if they have the required capabilities and competences to solve customers' problems efficiently, while facing additional challenges and costs (Storbacka, 2011). Second, with a usage-based approach providers can capture customers' intensity-of-use more precisely than with a posted price. With intensity-of-use, every customer has an individual revenue potential, depending on usage. This gives providers an opportunity to skim customers' surplus by using the appropriate pricing scheme. However, when applying usage-based-pricing in industrial markets, providers must also consider high usage-independent costs for the included equipment and the usage-based costs resulting from the shift of responsibilities in the usage phase. Providers face some customers with a low intensity-of-use, which results in negative contribution margins. Without a minimum usage level, only providers with relatively low usage-independent costs (for example, access service providers) gain higher profits with usage-based pricing. Conversely, providers of industrial services, which incur high usage-independent costs, should either exclude unprofitable customers with a contractual minimum usage level or consider selling as the optimal pricing scheme. A third opportunity is to improve their technical expertise and reduce usage-based costs for the operation as well as the operation availability of the provided equipment. With a provider bearing usage-based costs at a lower level than customers, both partners create an additional shared value through a more efficient allocation of responsibilities.

Limitations and directions for future research

The goal of this article was to encourage pricing research on new innovative pricing schemes in industrial markets. Our analysis contributes to previous research on selling versus usage-based pricing and extends it to the industrial context. For this purpose, we modeled the customer's and the provider's decision making in conformity with their understanding of value; the customer anticipates the value-in-use potential when assessing an offer, while the provider considers the costs of providing a service. Elaborating the model, we also considered the specific cost structure in industrial markets. Naturally, our results are limited by our assumptions, one of which is the absence of buyer uncertainty and risk aversion. Customers with high uncertainty about their intensity-of-use and capacity utilization are especially uncertain about the profitability of their investment. With usage-based pricing, the provider can reduce these uncertainties and realize further revenue potential with premiums for risk-averse customers. However, we do not consider any additional value customers receive by transferring risks to the provider. In addition, we made assumptions that future research should modify to analyze the effects of additional factors. An extension of our model should consider situations in which several providers compete in a market, customers are uncertain about their anticipated intensity-of-use and expected value or providers have capacity constraints when supporting a high number of customers.

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Research Article

Revenue management and the railway conundrum – The consequences of reference prices in passenger railway transport practice

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ABSTRACT While railway transport appears well suited to revenue management (RM), establishing it in practice appears difficult. To explain this, we investigate the long-term consequences of repeated transactions and reference pricing. We consider the implications of reference pricing based on an agent-based simulation of passenger railway RM. The model is empirically calibrated using data provided by a European long-distance railway operator. On the long term, reducing fares to induce additional demand can foil revenue gains when customers learn and communicate reference prices. Accordingly, knowing customers' tendency to build reference prices becomes crucial.

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MOTIVATION AND THEORETICAL BACKGROUND

Recently, Yeoman (2013) described the problem that consumers get used to discounts, stating that 'the majority of consumers will never pay full price again'. Here, we investigate the effects of reference price learning on railway revenue management (RM) practice. More precisely, we analyse the balance between demand stimulation and price adaption.

Referring to the seminal work of Helson (1964), Popescu and Wu (2007) provide a concise definition of the reference price concept: '[C]ustomers respond to the current price of a product by comparing it to an internal standard that is formed based on past price exposures'. Recently, Nasiry and Popescu (2011) considered reference pricing from the perspective of dynamic pricing. Von Massow and Hassini (2013) proposed to fine-tune RM to consumers' price perception.

Popescu and Wu (2007) and Nasiry and Popescu (2011) combine behavioural pricing and RM by 'providing very general nonlinear reference-dependent demand models that capture dynamics in the reference effect as the reference price shifts' (Popescu and Wu, 2007). In their outlook, Popescu and Wu propose further research on consumers' price memory and the 'Lucas critique' (Lucas, 1976): Econometric simulations rarely implement the endogenous change of model parameters.

By implementing an agent-based simulation that accounts for endogenous changes of model parameters, we pick up this idea. The contributions above searched optimal RM strategies in the face of reference-dependent demand. The question of why RM has not been applied to greater success in this area continues to astonish researchers (Sato and Sawaki, 2012). Our research aims to analyse the effect of reference pricing on passenger railway transport and to formulate managerial implications with regard to this field.

To this end, we implement reference pricing and behavioural pricing theory in an agent-based simulation model. We parameterize the model using empirical data and expertise collected from a major European railway. We seek to contribute to behavioural RM explicitly modelling supply-side competition and interaction both between suppliers and consumers and among consumers.

Throughout this article, we rely on the theoretical foundation of RM described in Talluri and van Ryzin (2005) and on insights of behavioural pricing research (Kahneman and Tversky, 1979; Thaler, 1985).

Reference price formation, social interaction and Prospect Theory

On the basis of the concept of reference prices, Kahneman and Tversky (1979) find evidence for behaviour that stands in contrast to neoclassical assumptions on utility; they present an alternative utility concept with *Prospect Theory*. Thaler (1985) develops these insights to a theory on *mental accounting*: Individuals follow their very own coding in calculating their respective utility values.

Adaptive expectations, or the interactive construction of preferences, have been an important issue in economic research. Identifying adaptive expectations as one of the drivers of economic stability, Arthur (1994) demonstrates the interdependence between individual and collective behaviour in his El Farol Bar example. The decision of going to a bar is a classical example for which there is no deductive solution because 'any commonalty of expectations gets broken up: if all believe *few* will go, *all* will go' (Arthur, 1994, p. 409). This article concentrates on a very simple form of adaptive expectations: consumers learn from and communicate experiences to establish reference prices.

Finally, Talluri and van Ryzin also expect 'behavio[u]ral theories of demand to influence RM practice more directly in the years ahead' (p. 665). Yet, RM literature incorporating behavioural pricing remains limited. Our contribution tests the implications of mental accounting in the application area of RM. Rather than analytically designing optimal strategies in the sense of Popescu and Wu (2007) and Nasiry and Popescu (2011), we aim to demonstrate the effect of reference pricing on the success of current practices in the special case of the railway transport industry. On the basis of our contribution, we outline a research agenda for further studies on RM in this industry. We argue that mental accounting and reference pricing can help to understand the railway conundrum, namely, why an application field that appears so well suited has yet seen few successful implementations of RM.

Agent-based simulation as a tool for RM strategy development

Following the marketing mix application mentioned by Rand and Rust (2011) and the line of argument in Cleophas (2012), agent-based simulations are specifically useful in pricing: If real-world data is too ambiguous or if empirical experiments would be too financially risky, research can only be undertaken with the help of simulations. Agent-based models are specifically suitable for behavioural price theory as they can model learning and communicating customers. Ihrig and Troitzsch (2013) point out that if a simulation model is underpinned by a theory, researchers 'also have to make sure that the model is a fair representation of the theoretical constructs'. Our agent-based model strongly relies on the theoretical background of reference pricing as described above.

However, a simulation model is only useful if it correctly represents relevant aspects of the empirical problem. Gilbert and Troitzsch (2005) recommend to closely integrate stakeholders into the process of building and validating a simulation model. Therefore, when designing the model presented here, we relied on domain knowledge and data provided by a major European railway company. To achieve a credible model, Gilbert (2008) advises researchers to conduct sensitivity analysis. In the results section of this article, we aim to follow this advice.

SIMULATION MODEL

We consider a long-distance passenger railway line with consumers building price experience through transactions. Our model is designed to investigate the explanatory power of different parameter settings for RM success.

It pitches the railway operator against individual car transport alternatives. The operator sells standard fares and offers reduced to increase capacity utilization. Seat allocation controls apply exclusively to reduced fares; consumers can always choose the more expensive standard fare. Customers can choose to buy a railcard in advance, leading to a 50 per cent reduction of the standard fare. This model component allowed for an effect of reference prices even when no reduced fares were offered. For the experiments presented here, budget control was very loose. Almost all consumer agents with a mobility demand could fulfil it from a budgetary point of view. Given empirical evidence, we calibrated demand so that 20 per cent of consumers choose the standard fare regardless of alternative models.

Following the empirical example, the model combines static pricing and primitive capacity-based RM. It comprises the independent, dependent and control variables listed in Table 1.

Table 1: Key variables of the revenue simulation model

Independent variables	• Fuel price • Standard fare • Railcard price and admittance • Price and quota of reduced fare
Control variables	• Degree of mental accounting • Car borrowing probability • Price-learning parameter
Dependent variables	• Revenue of the train operating company • Occupancy of trains

Supply and demand: Utility and social interaction

Our model assumes that transport demand is fixed, and that demand for a specific means of transport depends on the prices of all other means of transport. For example, increasing fuel prices will push demand from car transit to public transport and vice versa. At every tick, a fixed number of individuals display a mobility demand within the next 10 days. After 100 ticks, operator agents have collected enough experience about train utilization to implement the following load-factor-based RM: The least occupied 50 per cent of trains are assigned reduced fares for a 20 per cent share of seat capacity. While we are aware that this does not correspond to state-of-the-art capacity-based

RM, this general rule corresponds to the empirical discount allocation practice observed in the industry example. Note that these rules are not frequently adapted in practice: The firm aims to observe the effects of offering discounts over the complete booking horizon and has to comply with pricing restrictions for future bookings. Furthermore, this allocation rule lacks an explicit forecast: Demand is estimated only by offering reduced fares only on the least occupied trains. The rule implicitly assumes that these trains suffer from low demand, which can be increased through special offers. As our results demonstrate, the latter assumption does not necessarily hold.

This article relies on the price-learning rule described in Mazumdar *et al* (2005). Let α the learning parameter with $0 <= \alpha <= 1$. Then, the reference price p_{ref} is defined as

$$p_{ref} = p_{ref(t-1)}(1-\alpha) + p_n\alpha \tag{1}$$

We interpret Thaler (1985) in the way that consumers mentally distinguish a standard fare and a discounted one. They treat gains and losses separately for each fare category. We introduce a control parameter for manipulating the influence of reduced fares to the overall reference price. This 'degree of mental accounting' ranges from 0 (that is, consumers only construct a single joint reference price) to 1 (that is, price experience with reduced fares does not affect the reference price).

For the utility of price calculation, let *U(p)* be the utility in function of the price and *L* be the individual loss aversion factor. Let *c* be an indicator of sensitivity with $c = 2\ln((1)/(r-1))$, where *r* represents the extent of sensitivity of consumers to losses compared with gains; the value of *r* is subject to calibration and was specified to 0.7. *r* is a sensitivity parameter 0.5<r<1. The higher the *r*, the faster the sensitivity decreases to the function of perceived 'gains' of price.

Let norm be a parameter that aligns the utility values to $U(p_{ref} - \text{norm} = 1)$. We followed this suggestion for generating a standardised representation of utility values according to Prospect Theory. However, norm can be set to any other value except 0.

For $p \leqslant p_{\text{ref}}$

$$U_{rail,car}(p) := \frac{1 - e^{-c\left(\frac{p_{ref} - p}{norm}\right)}}{1 - e^{-c}} \tag{2}$$

For $p > p_{\text{ref}}$

$$U_{rail,car}(p) := -L \cdot \left(\frac{1 - e^{-c\left(\frac{p - p_{ref}}{norm}\right)}}{1 - e^{-c}} \right) \tag{3}$$

As speed is a major modal competitive factor, there is an additional utility bonus for faster trains. Speed utility is derived from the utility of price calculated before, together with the ratio of the speed of car transit to the public transport utility.

$$t = \frac{t_{car}}{t_{rail}} \tag{4}$$

If $t > 1$, the selected train is faster than car transport:

$$U_{car} := \begin{cases} \frac{U_{car}}{t}, | U_{car} > 0 \\ U_{car} - \left(|U_{car}| - \frac{|U_{car}|}{t} \right), | U_{car} < 0 \\ U_{car} - (1-t), | U_{car} = 0 \end{cases} \tag{5}$$

If $t < 1$, the selected train is slower than car transport:

$$U_{car} := \begin{cases} U_{car} + U_{car}(1-t), | U_{car} > 0 \\ U_{car} - \left(|U_{car}| - \frac{|U_{car}|}{t} \right), | U_{car} < 0 \\ U_{car} + (1-t), | U_{car} = 0 \end{cases} \tag{6}$$

The difference between the nominal prices for car and rail transport is accounted for as follows:

$$U_{rail} := \begin{cases} U_{rail} - \left(\frac{p_{rail}}{p_{car}} - 1 \right), | p_{rail} > p_{car} | \\ U_{rail} + \left(\frac{p_{car}}{p_{rail}} - 1 \right), | p_{rail} < p_{car} \end{cases} \tag{7}$$

In addition, we used empirical socio-demographic data to implement fixed bonus and malus additions to the calculated utility of price. For instance, car-loving individuals have a low propensity to use public transport, while usage increases if there is an urban public transport stop near the home.

When offered a transport both by rail and by car, consumer agents choose to maximize the nominal value of utility. When utility values are equal, car is preferred for flexibility.

$$\begin{aligned} U_{rail} > U_{car} &\rightarrow \text{use rail} \\ U_{rail} \leqslant U_{car} &\rightarrow \text{use car} \end{aligned} \tag{8}$$

Finally, consumers are randomly linked in a static structure. Every defined number of ticks, a randomly selected subgroup communicates the most recent transaction over one of the outgoing links. Thus, there is a diffusion of reference prices by means of communication. If the last transaction was a railcard fare and the link does not own a railcard, the communication is ignored.

Consumer agents can borrow and lend cars. This feature is controlled through a probability representing the car owner's affinity to borrow her or his car. On the basis of domain expert advice, we assume a 30 per cent probability of cars to be shared or borrowed.

Demand calibration

We enriched the simulation model using expert knowledge and market research data. Empirically set parameters included train frequency, schedule and all nominal prices. Consumers' socio-demographic properties were based on recent market research data available through the industry case.

A key element of calibration was to determine the overall demand for transportation across all means of transport that would produce a revenue level similar to empirical observations. No single railway operator has information on the full potential travel demand. Each can only observe their own revenue and conduct market research. Hence, calibration was performed through increasing the number of total demand per tick while observing the revenue per tick and occupancy output parameters until the *status quo* revenue level was reached.

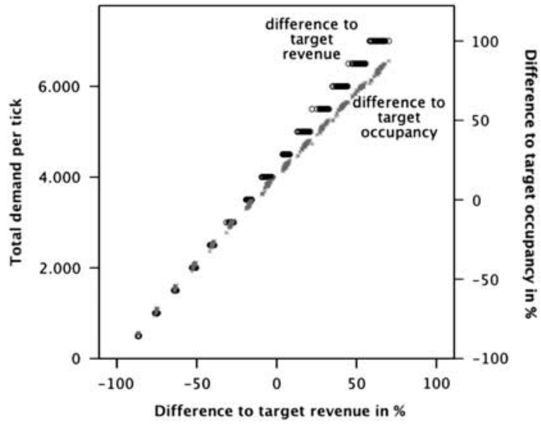

Figure 1: Finding the appropriate overall demand for representing revenue and occupancy of the target line.

Figure 1 illustrates the calibration output. To reflect both revenue and occupancy in a single graph, the total number of individuals with a mobility demand for any means of transport is represented on the *y*-axis to the left. The right-hand *y*-axis indicates the difference to the empirically observed occupancy that this demand level incurs. On the axis of abscissae, the difference from the empirical revenue target is linked to the respective total demand quantity. The further experiments employ the level of demand that came closest to the target revenue and occupancy.

In sum, we calibrated demand to produce the revenue level and occupancy of trains, which is known for a specific set of price parameters. Please note that no nominal revenue figures can be displayed for confidentiality reasons – this includes the share of railcard owners.

EXPERIMENTAL RESULTS

The experimental study presented here aims to show how endogenous changes in reference prices and price perception can affect revenue. It explores the circumstances, under which the demand inducing effects of RM may be weaker than the longer-term behavioural adaptation effects. Specifically, it considers potential tipping points, individuals communicating their price memory and the duration of such memory. All experiments apply the simplistic form of capacity-oriented RM found in railway practice to different manifestations of reference price formation.

Each experiment included 50 simulation runs for every parameter combination, defined as a scenario. The limited number of runs sufficed as the model includes only little stochastic noise. It was calibrated to data observed on business days 1 given overall stable demand. The model's time horizon corresponds to the scheduled train service offered per day, in which a selected train is associated with a unique number, for example, EX123 running daily at 19:00. Thus, one tick in the simulation model represents 1 day. Preliminary analysis led us to set a time limit of 500 ticks, corresponding to approximately one and a half years. The calculated means per tick for every scenario were submitted to a statistical effect analysis (cf. Lorscheid *et al*, 2012). Effect analysis refers to the extent, by which a parameter explains revenue variance. The parameters of the base scenario are described in Table 2.

Experiment 1: Demand potential and mental accounting

The first experiment manipulated the probability of car borrowing among consumer agents. It illustrates the demand potential that can be gained from car transport, as well as the degree of mental accounting between standard fares and reduced fares. The price-learning parameter was set to 0.1. The offer of reduced fares in an approximation of capacity-based RM was varied binomially. Consumer's tendency to borrow a car was tested over 10, 50 and 90 per cent. In addition, the degree of mental accounting between standard fares and reduced fares was set to 0, 50 and 100 per cent. Altogether, the experiment comprised 18 scenarios with 900 runs overall. Table 3 lists all parameterizations in the experiment. Results, including significance tests and the coverage of the variance for the three sets of parameters, are given by Table 4

As Table 4 illustrates, the degree of mental accounting did not have significant effects even in extreme settings. Introducing RM had positive overall effects in the presence of strong car transport competition. Given relatively low additional demand potential, which corresponds, in our case, to an availability of cars for non-car owners of less than 50 per cent, RM was not advantageous. The relevant tipping point was a car borrowing probability of less than 40 per cent, meaning that besides car holders, an additional 40 per cent such as family members will frequently have the opportunity to use cars. These results are illustrated by Figure 2.

This experiment shows the dependence of RM success on the available demand potential.

Table 2: Parameterization of the base scenario

Parameter	*Base setting*
Train operators on the line	1
Fuel price	1.40
Railcard	true
RM (load-factor based availability of reduced fares)	false
Memory (length of each individual's price memory list in no. of items)	10
Car_borrowing (chance for borrowing or sharing a car from/with one of the interlinked consumers)	30%
Mental_accounting (individual degree of separating standard fares and reduced fares)	0%
Exchange (frequency of communication with one of the interlinked consumer agents)	14
Forgetting (probability to forget the last transaction of the memory list)	0%
Price learning (price-learning parameter)	0.1

Table 3: Manipulations of the first experiment

Parameter	*Specification tested*
RM (load-factor based availability of reduced fares)	true/false
Car_borrowing (chance for borrowing or sharing a car)	10/50/90%
Mental_accounting (standard vs. reduced fares)	0/50/100%

Table 4: Significance and effect size analysis of experiment 1

Tests of between-subjects effects						
Dependent variable:	*Revenue*					
Source	*Type III sum of squares*	*DF*	*Mean square*	*F*	*Significance*	*Partial ε squared*
Corrected Model	203 464 575 209.281[a]	3	67 821 525 069.760	36 594.574	0.0000	0.992
Intercept	859 158 274 379.600	1	859 158 274 379.600	463 577.475	0.0000	0.998
RM	151 093 264.000	1	151 093 264.000	81.526	0.000	0.083
Car_borrowing	203 312 236 608.240	1	203 312 236 608.240	109 701.525	0.0000	0.992
Mental_accounting	1 245 337.042	1	1 245 337.042	0.672	0.413	0.001
Error	1 660 576 399.247	896	1 853 321.874	—	—	—
Total	2 651 386 104 256.000	900	—	—	—	—
Corrected Total	205 125 151 608.529	899	—	—	—	—

[a]$R^2 = 0.992$ (Adjusted $R^2 = 0.992$).

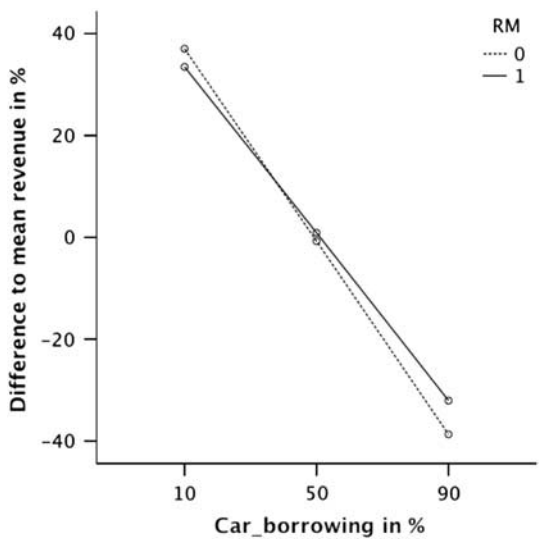

Figure 2: Effects of introducing RM in different extents of potential demand.

When demand potential is low, offering reduced fares even on the least occupied trains only leads to cannibalization without inducing further bookings. When it is high, additional bookings can be achieved.

Note that the RM rule implemented in our simulation study did not include an explicit forecast of demand potential. A forecast gauging the degree of car borrowing, which represents demand potential in our example, could support the dynamic offer of reduced fares. A corresponding rule would look as follows: While more than 50 per cent of non-car owners are not yet customers, offer reduced fares. Of course, such a dynamic implementation would require a forecast of demand potential that depends either on up-to-date market research or on intelligent comparative data analysis of historical sales data. As our results clearly show, it could improve revenues by up to 5 per cent depending on the actual demand potential at hand. Please compare Kellermann (2014) for more extensive results on the dependence of RM success and demand potential.

Experiment 2: Social exchange and scope of memory

The second experiment focused on the effects of social exchanges between consumers and the extent of their memory. This means, besides comparing the situation with and without RM, varying the length of each individual's price memory in number of remembered transactions as well as the frequency of inter-consumer communication. While social interaction was set to occur every 14 ticks in the general setting, we modulated the parameter from none to interactions every 5, 10 or 20 ticks. Moreover, we introduced alternative lengths of the price experience list kept by every consumer agent.

For this experiment, 50 runs over 40 scenarios implementing the parameter variations given in Table 5 resulted in 2000 simulation runs total. The results are described in Table 6.

The duration of consumer memory as modelled through the length of the price experience list had a considerable effect: It explains nearly 13 per cent of the variance, the frequency of exchange accounted for nearly 8 per cent. An astonishing result was the lack of strong effects from a longer memory list. Nevertheless, given the price-learning parameter α of 0.1 underlying this experiment, there is also no tendency of a long memory to decrease revenue earned for the firm. There seems to be a slightly similar direction of the effects of the exchange frequency: no exchange at all leads to a significantly inferior level of revenue, while a very occasional social exchange rate is enough to keep the higher revenue level. This is due to the idea that consumer communication is not limited to low reference prices, but also includes higher prices. Consumers with no previous price experience receive a price expectation they can compare with the observed price.

As the car borrowing probability parameter is set to 30 per cent in this experiment, the

Table 5: Manipulations in the second experiment

Parameter	*Variation*
RM (load-factor based availability of reduced fares)	true/false
Memory (individuals' price memory list in no. of items)	0/2/4/6/8
Exchange (frequency of communication)	0/5/10/20

Table 6: Significance and effect size analysis of experiment 2

Tests of between-subjects effects						
Dependent variable:	*Revenue*					
Source	*Type III sum of squares*	*DF*	*Mean square*	*F*	*Significance*	*Partial ε squared*
Corrected Model	3 567 969 242.701[a]	3	1 189 323 080.900	502 093	0.000	0.430
Intercept	1 337 059 813 448.760	1	1 337 059 813 448.760	564 462 261	0.000	0.996
RM	2 485 653 953.725	1	2 485 653 953.725	1 049 361	0.000	0.345
Memory	697 754 490.489	1	697 754 490.489	294 569	0.0ss00	0.129
Exchange	384560798.488	1	384 560 798.488	162 349	0.000	0.075
Error	4 727 989 051.258	1996	2 368 731.990	—	—	—
Total	7 286 053 692 009.000	2000	—	—	—	—
Corrected Total	8 295 958 293.960	1999	—	—	—	—

[a] $R^2 = 0.430$ (Adjusted $R^2 = 0.429$).

demand potential of load-factor based reduced fares was low. Therefore, in this experiment, enabling RM leads to inferior revenue.

Experiment 3: Randomised forgetting of price experiences and learning factor modulation

The final experiment investigated the effects of varying the learning parameter and of a randomised forgetting of price experiences as shown in Table 7. Randomised forgetting the last transaction was enabled given a price experience of at least 10 transactions. Revenue was evaluated for six settings of the price-learning parameter. The results from 1800 simulation runs are summarized in Table 7.

For the experiment, we again assumed a 30 per cent probability for consumer agents lending out their cars. In this situation, the findings of the first experiment lead us to expect a decrease in revenue when offering reduced fares. Agents' random forgetting the last transaction did not lead to a significant increase or decrease of revenue for the firm (Table 8).

Different price-learning factors accounted for nearly 3 per cent of the variance. We found that a price-learning factor of 0.4 marks a slight revenue improvement followed by a more severe revenue decrease in case reduced fares are offered. Confidence interval analysis supports that these results are statistically significant. As Figure 3 illustrates, the more customers are likely to learn reduced fares into their reference price, the more revenue decreases.

CONCLUSION AND MANAGERIAL IMPLICATIONS

In this article, we used an agent-based simulation to test the effects of specific assumptions on consumer behaviour and reference pricing in railway transport. We performed three simulation experiments to analyse the effects of introducing reduced fares given different demand scenarios.

Table 7: Manipulations in the third experiment

Parameter	*Specification tested*
RM (load-factor based availability of reduced fares)	true/false
Forgetting (probability to forget the last transaction on the memory list)	0/0.2/0.5
Price learning (price-learning parameter α)	0.1/0.2/0.4/0.6/0.8/0.9

Table 8: Significance and effect size analysis of experiment 3

Tests of between-subjects effects						
Dependent variable:	*Revenue*					
Source	*Type III Sum of squares*	*DF*	*Mean square*	*F*	*Significance*	*Partial ε squared*
Corrected Model	441.865[a]	3	147.288	79.275	0.000	0.117
Intercept	205.398	1	205.398	110.551	0.000	0.058
Forgetting	0.300	1	0.300	0.162	0.688	0.000
RM	349.272	1	349.272	187.989	0.000	0.095
Price learning	92.292	1	92.292	49.674	0.000	0.027
Error	3,336.865	1796	1.858	—	—	—
Total	3,778.730	1800	—	—	—	—
Corrected Total	3,778.730	1799	—	—	—	—

[a] $R^2 = 0.117$ (Adjusted $R^2 = 0.115$).

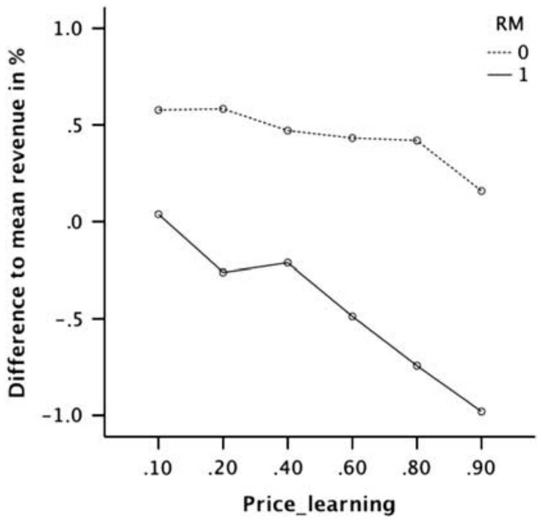

Figure 3: Effects of RM at different extents of price learning.

From the results, we conclude that systematically offering reduced fares can prove beneficial in the domain when extended potential demand is given. However, our model parameterization included only a simplified version of RM, where 20 per cent of seats are offered at reduced fares in the least occupied 50 per cent of trains. These rules as well as the model's calibration were based on an empirical case study. The failure to increase revenues given low demand potential therefore speaks eloquently for more sophisticated approaches, estimating and forecasting demand potential in addition to current load-factors. Because of reference pricing and a lack of additional demand potential, reducing the percentage of reduced fares offered would lead to less severe revenue losses. The success of targeting reduced fares to a percentage of least occupied trains also depends on the demand at hand: When customers are flexible with regard to travel times, cannibalization exceeds demand induction. Otherwise, the offer will succeed only if a sufficiently large demand segment can be induced. *Transport managers accordingly can expect the introduction of reduced fares to increase revenue only if they have a precise indication of potential demand. They have to be aware that they cannot in fact influence demand potential, but have to find and follow it using market research and data analysis.*

To evaluate the influence of reference prices in terms of mental accounting and price communication, we included the concept of a 'railcard' in the model. This concept was also observed in the empirical case: On the basis of the empirical data, a share of customers uses this railcard, which allows them to buy tickets at a 50 per cent discount at any time.

Our experiments showed significant effects when consumers' price experience becomes their reference. However, no revenue effects were observable when such memory included more than two prices. When consumers communicate their price experience, this significantly increased revenue regardless of the frequency of such exchanges. Furthermore, we find that a weighted influence of reduced fares as represented by a degree of mental accounting has no significant effects on revenue. The higher the degree of price learning is, the more dangerous are reduced offers. However, customers' tendency to observe, learn and communicate is not easily influenced – at most, the firm can remove details about price development and the comparative pricing from its own website, thereby decreasing transparency. *Instead, we recommend increasing the focus of market research on different degrees of price learning observable in different markets. When learning is high, transport managers should primarily communicate standard prices, so that reduced fares do not fully replace customers' reference expectations. This means understating the effects of the railcard in spite of their intuitive benefits of demand induction.*

In theoretical terms, our results replicate the contributions of Popescu and Wu (2007) and Nasiry and Popescu (2011) in illustrating that behavioural pricing is highly relevant with regard to RM. We propose to use this point of view to jointly consider the idea of reference pricing and strategic behaviour as described for instance in Jerath *et al* (2010). Strategic consumers form expectations not just about the price of a product at one point of time, but attempt to predict the development of prices over time. They delay their buying decision for the expected minimum price to be offered – this expectation is nothing but the result of time-dependent reference pricing. Future research on the consideration of behavioural pricing could aim at applying opaque and last-minute selling in the context of both time-independent and time-dependent reference prices.

In the matter of deviations of individuals' memory from a fully objective storage of price experience, we encourage further investigation on phenomena related to the nature of price memory. For instance, we understand possible amplification effects of extreme price experiences as worth experimenting with. Beyond peak-end anchoring (Nasiry and Popescu, 2011), all forms of non-probabilistic alterations of single elements of the price memory or the reference price itself could be explored.

Finally, we suggest further investigating the characteristics of the railway market from a RM perspective. This means applying the ideas of reference pricing and mental accounting to critically assess the idea of railcards as a way of permanently discounting prices in return for a one-time fee: This fee introduces an entry-barrier, while advertised railcard-adjusted prices can lower customers' reference prices. Our results show that there is a need for more dynamic capacity allocation methods in this area. However, this requires first a comparative consideration of the legal regulations limiting the flexibility of railway pricing in Europe. To both fit with these regulations, and combine insights from sales analysis, and market research on reference pricing calls for new forecasting and optimization approaches.

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Original Article

Introductory pricing, market development and profit sharing

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ABSTRACT This article investigates how channel members collaboratively implement introductory pricing strategy to develop a market for an innovative product. The overall market demand of the innovative product depends on the initial sales to pioneer consumers. When the potential market size is large, the manufacturer sets a high wholesale price and shares no profit with the retailer. The retailer is motivated by the large market potential, and therefore, is willing to develop the market by charging pioneers a low retail price. The retailer subsequently benefits from market development by increasing its price selling to the rest of the market. When the potential market size is moderate, the manufacturer lowers the wholesale price and shares a positive profit with the retailer. Hence, the manufacturer provides incentives for the retailer to charge a low retail price to develop the market, rather than a high retail price to capitalize on pioneer consumers only. Further, this article shows that, when the retailer is myopic, the manufacturer has to yield more profits in order to development the market to the retailer than in the case when the retailer is forward-looking.
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Keywords: channel interaction; market development; introductory pricing

INTRODUCTION

The success of many new products critically depends on the initial sales to pioneer consumers (Arndt, 1967; Bass, 1969; Mahajan *et al*, 1984). On the product market, those consumers facilitate the diffusion of new products by serving as a source of information for potential consumers. They can influence potential consumers directly via word-of-mouth (WOM) such as consumer reviews (for example, Dellarocas, 2003; Chevalier and Mayzlin, 2006) and social network (for example,Katona *et al*, 2011), or indirectly by helping potential consumers observe the purchase volumes (for example, Koo and Fishbach, 2010; Jing, 2011). On the financial market, initial sales have become a key metric for business analysts to predict whether a new product is a flop or not (for example, *ZDNet.com* 2011; *Wall Street Journal* 2012). For example, the recent disclosure of 6 million unsold Surface RT tablet by Microsoft confirmed an earlier suspicion that the product did not take off, and contributed to an 11 per cent fall of Microsoft's stock price in one day (Reuters, 2013). To conclude, in order to develop a market for a new product, it is important to quickly build a large base of pioneer consumers (for example, Glaeser *et al*, 2003; Joshi *et al*, 2009).

Nevertheless, market development requires a sacrifice of short-term profits, which is implemented through introductory pricing at the retail end. For instance, when launching its Kindle Fire tablet, Amazon priced it below cost to quickly build a large consumer base and took a huge loss (*isuppli.com* 2011). Kindle Fire then outsold all other Android tablets in a year to become the biggest challenger to Apple's iPad (ComScore, 2012), making the tablet competition a 'two-horse race' (*Forbes* 2012). While Amazon can smoothly develop a market for Kindle Fire via its integrated channel structure, many manufacturers have to rely on their channel partners to launch new products. When the tradeoff of short-term and long-term profits is entangled with channel-based profit-sharing, the manufacturer's and retailer's interests are not aligned. The retailer is concerned with the costs of market development it has to undertake, as well as the fraction of long-term profits from market development it can share. The manufacturer's concern, on the other hand, is how to motivate the retailer to explore the market potential of followers. When these issues are not dealt properly, a poor diffusion can ensue for a new product that otherwise can succeed. In the example of Surface RT, many tech analysts who had believed that Surface RT had the potential cited the high retail price as one major reason of its failure (for example, *PCMagazine* 2013).

This article intends to examine the issue of market development from the perspective of channel interactions on introductory pricing. It considers a stylized two-period framework where the manufacturer, who has a new product to launch, coordinates with a retailer to sell to pioneer consumers in Period 1 in order to build a base for developing a followers' market in Period 2. We specifically model the linkage between the sales to pioneers in Period 1 and the followers' valuation for the new product and, hence, their demand in Period 2. We focus on one demand factor – the market potential of followers – and one supply factor – the marginal production cost, and examine how the two factors jointly affect equilibrium pricing in market development.

We find that, when the retailer is forward-looking, and market potential is large, the manufacturer sets a very high wholesale price to engage the retailer to develop the market, and takes all the profits; the retailer receives zero profit. In comparison, when the market potential is moderate, the two channel members share the profits. That is, a large market potential hurts the retailer. When the retailer is myopic (that is, focusing on only its short-term profit), the manufacturer cannot implement market development when the marginal production cost is large. When the marginal production cost is small, the manufacturer has to yield more profits from market development to the retailer, making the myopic retailer better-off than when it is forward-looking.

We then study two different means by which the manufacturer can motivate the myopic retailer to develop the market. The manufacturer can set a zero wholesale price to let the retailer to pass along a discount to pioneer consumers. Alternatively, the manufacturer can provide a slotting allowance with a suggested retail price. In the latter case, the manufacturer sets a very high wholesale price to prevent the retailer from pursuing short-term profit. Finally, we discuss how the retailer can commit to myopia by implementing different compensation schemes.

In the next section, we review the related literature. After that, we describe the model setting. In the two subsequent sections, we, respectively, analyze the market equilibrium when the retailer is forward-looking and when it is myopic. We conclude the paper in the last section.

RELATED LITERATURE

The literature has discussed the critical role played by channels in new product diffusion (for example, Link, 1987; Rangan *et al*, 1992; Luo *et al*, 2007). Owing to the double marginalization problem, channel members' interests are not perfectly aligned. Literature suggests that manufacturers need to provide sufficient incentive, such as a slotting allowance to retailers, to improve the efficiency of channel coordination (for example, Lariviere and Padmanabhan, 1997; Rao and Mahi, 2003). More recently, Chiang (2012) finds that channel members are better-off in the long run when they ignore the impact of current prices on future demand, and focus on short-term profits. This article sheds light on how channel members coordinate to obtain long-term benefits, and finds that retailer myopia only benefits the retailer but not the manufacturer.

One important aspect studied in previous literature on channel interaction and new product diffusion is inventory constraint. Ho *et al* (2002) study the optimal sales plan for a given capacity level, and find that delaying product launch in order to build initial inventory may be optimal. Kumar and Swaminathan (2003) characterize optimal sales plans under backlogging and lost sales scenarios for both fixed and time-varying capacity. Shen *et al* (2011) develop a numerical example to show that the immediate fulfillment policy may be suboptimal in some new product diffusion settings. This article, in comparison, studies the 'demand constraint' caused by insufficient information among potential consumers. It thus contributes to the research on channel interaction and new product diffusion from the perspective of OM and marketing interface.

MODEL SETTING AND PRELIMINARY ANALYSIS

A manufacturer is launching a new product and selling through a retailer to a market. The manufacturer incurs a constant per-unit production cost, c. The retailer incurs no fixed cost upfront to sell the new product. This setting differs from that in Lariviere and Padmanabhan (1997), and allows us to focus on pricing decisions and study the pure motivation role of slotting allowance.

Consumer types and valuations

The market is composed of two types of consumers. The first type is eager to try this product, and thus has high financial liquidity and high tolerance for risks and failures. More importantly, these consumers are keen to provide information and recommendation sought by potential consumers about the new product (Glaeser *et al*, 2003). They are equivalent to the innovators and the early adopters defined by Rogers (1962). We hence label them *pioneers*.

Each pioneer consumer has a valuation, v_{pioneer}, measured by the willingness to pay for one unit of the new product. When paying p_1 for the product, pioneers' net utility is $v_{\text{pioneer}} - p_1$. For mathematical tractability, we assume that v_{pioneer} follows a uniform distribution on $(0, v]$, where v is positive constant. We normalize pioneers' population to one, and it is easy to write the demand function in Period 1: $d_1 = 1 - p_1/v$.

The other type of consumer, whose population is k times that of pioneers, usually experiences uncertainty around the product's value, or has a high level of scepticism and, hence, is subject to the influence of pioneers. Owing to the high psychological costs of buying a new product, we assume that those consumers will not consider purchasing the new product even if the financial outlay is small. Those consumers are equivalent to the late adopters termed by Rogers (1962) or of the imitators defined by Bass (1969). We label them *followers*.

Followers' valuation is positively linked with pioneers' realized demand. Such linkage is pervasive in many market situations. For example, in a situation where followers are uncertain about product quality, they become more informed upon a wider spread of (positive) WOM from pioneers, and hence have a high valuation (for example, Bearden *et al*, 1989; Chevalier and Mayzlin, 2006). In a situation where followers interpret a large volume of pioneers' demand *per se* as a sign of high quality, they then herd to purchase (for example, Moretti, 2011). In some other situations where the consumption of the product bears a positive network effect, followers perceive the product to be more valuable upon observing a large number of pioneer users (for example, Yikuan Lee and O'Connor, 2003). Followers can directly enjoy the interconnected consumption with other users (for example, He *et al*, 2012), or indirectly benefit from a large user network that facilitates consumption support and product maintenance (for example, Muenchen, 2013).

The linkage between followers' valuation and the realized pioneers' demand is pivotal to market development. We hence model the linkage in a simple linear relationship for the ease of exposition: $v_{\text{follower}} = d_1 v_{\text{pioneer}}$ for tractability.[1] Thus, followers' demand function becomes $d_2 = k(1-p_2/d_1 v)$, which is characterized by two factors: an *exogenous* factor, k, measuring the market potential, and an *endogenous* factor, d_1, influencing individual followers' valuation.

Given the lag between the purchase timing of the two consumer segments, we label the duration when pioneers purchase the product as Period 1, and that when followers make their purchase as Period 2. The corresponding variables are indexed by a subscript '1' or '2'. We set the time discount factor to one to alleviate mathematical complexity.

Integrated firm's profits

We first consider the benchmark case where the manufacturer vertically integrates the channel. The manufacturer trades off the two periods' profits. When the followers' market possesses a great potential (that is, k is large), the integrated firm will first price the product low enough (even below cost) to attract many pioneers, and reap on the high demand from followers later. In essence, such pricing can be regarded as low-ball pricing where the whole market acts as a single consumer who is enticed to 'repeat purchase' (made by followers) after some initial trial purchase (made by pioneers). Otherwise, the manufacturer will focus on selling to pioneers only.

Specifically, when the market potential is large (that is, $k \geqslant 4v^2/c^2$), and the marginal cost is low (that is, $0 < c < ((13)^{1/2}-3)v/2$), it is optimal for the integrated firm to set $p_1 = 0$ to develop the market. By doing so, it receives the total profit equal to $k(v-c)^2/4v-c$. In other situations, the integrated firm will give up market development and focus on selling to pioneers; it receives a profit equal to $(v-c)^2/4v$.

Channel members' profits

We assume that the manufacturer acts as the leader of the Stackelberg game in price setting as it enjoys some monopolistic power in launching a new product, which is unique on the market. Therefore, we do not model any specific bargaining activities between the two firms.

When the manufacturer relies on the retailer to develop the market, the diffusion of the new product to followers is critically affected by the retail price in Period 1. If the channel intends to sell to both segments sequentially, a price scheme (w_1, w_2, p_1, p_2) is to be determined over two periods. Accordingly, the total two-period profits are $\Pi_{12} = (p_1-w_1)d_1+(p_2-w_2)d_2$ for the retailer, and $\pi_{12} = (w_1-c)d_1+(w_2-c)d_2$ for the manufacturer subject to $d_2 \geqslant 0$.

By backward deduction, we first derive the optimal retail and wholesale prices in Period 2, and substitute them into the two profit functions:

$$\Pi_{12} = \frac{(p_1-w_1)(v-p_1)}{v} + \frac{[(v-p_1-c)]^2 k}{16(v-p_1)}, \quad \text{for } 0 < p_1 < v-c \tag{1}$$

$$\pi_{12} = \frac{(w_1-c)(v-p_1)}{v} + \frac{[(v-p_1-c)]^2 k}{8(v-p_1)}, \quad \text{for } 0 < p_1 < v-c \tag{2}$$

Back to Period 1, the manufacturer chooses w_1 to maximize π_{12}; given w_1 the retailer chooses p_1 to maximize Π_{12}.

In some situations, followers have a low valuation, and hence, the market development does not generate meaningful demand from them that the channel is willing to fulfill. Forecasting this outcome, the channel sells only to pioneers and optimizes its profit in Period 1. In this case, the retailer's profit is $\Pi_1 = (p_1 - w_1)(1 - p_1/v)$, and the manufacturer's profit is $\pi_1 = (w_1 - c)(1 - p_1/v)$. The two firms, respectively, charge the following optimal prices in Period 1: $w_1 = w^\star \equiv (v+c)/2$, and $p_1 = p^\star \equiv (3v+c)/4$, and receive the optimal profits $\pi^\star{}_1 \equiv (v-c)^2/8v$ and $\Pi^\star{}_1 \equiv (v-c)^2/16v$.

ANALYSIS OF MARKET DEVELOPMENT

In this section, we present the equilibrium pricing strategies of the two channel members. We begin with the retailer's decision of p_1 when facing w_1. The first-order and the second-order derivatives of Π_{12} given in equation (1) *w.r.t.* p1 are

$$\frac{d\Pi_{12}}{dp_1} = \frac{v + w_1 - 2p_1}{v} + \frac{k}{16}\left(\frac{c^2}{(v - p_1)^2} - 1\right),$$

$$\frac{d^2\Pi_{12}}{dp_1^2} = -2 / v + \frac{c^2 k}{8(v - p_1)^3}.$$

Depending on the sign of $d^2\Pi_{12}/dp_1^2$, Π_{12} can be concave, convex or concave-convex over $p_1 \in [0, v-c]$. To determine the curvature, we solve for the *inflection* point of Π_{12} by setting $d^2\Pi_{12}/dp_1^2 = 0$. Denote the inflection point as $\tilde{p}$, which is given by

$$\tilde{p} \equiv v - \frac{\sqrt[3]{4kvc^2}}{4}. \qquad (3)$$

It is easy to verify that $d^3\Pi_{12}/dp_1^3 > 0$. Hence, $d^2\Pi_{12}/dp_1^2$ is monotonically increasing in p_1. Depending on $\tilde{p}$, we characterize the concavity of Π_{12} into three cases:

	Concavity of Π_{12}	*Values of $\tilde{p}$*	*Parametric space*
Case 1	Convex	$\tilde{p} < 0; d^2\Pi_{12}/dp_1^2 > 0$ for $p_1 \in [0, v-c]$	$k > 16v^2/c^2$
Case 2	Concave-convex	$0 \leqslant \tilde{p} \leqslant v-c$; $d^2\Pi_{12}/dp_1^2 < 0$ for $p_1 \in [0, \tilde{p}]$; $d^2\Pi_{12}/dp_1^2 > 0$ for b$\in[\tilde{p}$, v$-c]$	$16c/v \leqslant k \leqslant 16v^2/c^2$
Case 3	Concave	$\tilde{p} > v-c$; $d^2\Pi_{12}/dp_1^2 < 0$ for $p_1 \in [0, v-c]$	$0 < k <$ 16c/v

To focus on non-trivial cases that highlight the theme of market development, in the following analysis we restrain our analysis to Case 1 where k is sufficiently large, that is,

$$k > k_a \equiv \frac{16v^2}{c^2}. \qquad (4)$$

Analyses of Cases 2 and 3 are available upon request from the author.

Optimal retail and wholesale prices in Period 1

In Case 1, Π_{12} is convex in p_1 over the range of $[0, v-c]$. To maximize Π_{12} by selling to two segments, the retailer has to choose one of the two ends of the price range $[0, v-c]$.

Lemma 1. *When the retailer charges a higher retail price such that $p_1 \geqslant v-c$, it is never an optimal retail price in Period 1 for the manufacturer who wants to develop the market.*

The rationale behind Lemma 1 is that when p_1 is set too high, such that $p_1 \geqslant v-c$, the sales to pioneers are too low to generate sufficiently high valuation from followers. Thus, there is no meaningful demand from followers that the channel is willing to fulfill.

Alternatively, the retailer can give up sales in Period 2 and focuses on that in Period 1 by charging $p_1=(v+w_1)/2$, given the wholesale price w_1. Combing the result of Lemma 1, the retailer now has only two choices for p_1: 0 or $(v+w_1)/2$.

The equilibrium of the Stackelberg pricing game proceeds as the retailer compares $\Pi_{12}\ |_{p_1=0}$ with $\Pi_1\ |_{p_1=(v+w_1)/2}$ to decide which price to charge. Anticipating the comparison outcome, the manufacturer decides on w_1 to lead the retailer to charge p_1 that gives the manufacturer higher profits. To break the tie, we assume that the retailer opts to set $p_1=0$ when it is indifferent.

When charging $p_1=0$, the retailer's total profits become

$$\Pi_{12}\ |_{p_1=0}\ =\frac{(v-c)^2k}{16v}-w_1. \tag{5}$$

The manufacturer's total profits become

$$\pi_{12}\ |_{p_1=0}\ =w_1+\frac{(v-c)^2k}{8v}-c. \tag{6}$$

To maximize its total profit, the manufacturer charges a wholesale price, extracting all the profits from retailers, that is, $\Pi_{12}\ |_{p_1=0}\ =0$:

$$\hat{w}\ \equiv\ \frac{(v-c)^2k}{16v}. \tag{7}$$

The manufacturer receives

$$\pi_{12}=\frac{3(v-c)^2k}{16v}-c. \tag{8}$$

Such a profit is lower than what the integrated firm receives (owing to the double marginalization in Period 2), but is the highest profit the manufacturer can get from market development. The retailer earns zero total profits: it incurs a loss in the sales to pioneers, and receives a positive profit from followers just to break even. The channel fully develops the market by maximizing the sales to pioneers.

If the retailer can make a positive profit by charging $p_1=(v+\hat{w})/2$, that is, $\Pi_1\ |_{p_1=(v+\hat{w})/2}\ >\Pi_{12}\ |_{p_1=0}\ =0$, it will do so rather than charging $p_1=0$. This condition introduces a second constraint imposed on k for market development. Lemma 2 summarizes the result.

Lemma 2: *Given the wholesale price* $\mathrm{w}_1=\hat{w}$, *denote* $k_{\mathrm{b}}\equiv16\mathrm{v}^2/(\mathrm{v}-\mathrm{c})^2$,

(a) *When* $k>k_b$, *the retailer optimizes its profit by charging* $p_1=0$ *to sell to both segments.*
(b) *When* $k\leqslant k_b$, *the retailer optimizes its profit by charging* $p_1=(v+\hat{w})/2$ *to sell to pioneers only.*

According to Lemma 2, when the market potential is large, that is, $k>k_b$, the manufacturer discourages the retailer to sell to pioneers by setting a very high wholesale price. The larger the market potential, the higher the wholesale price is. The retailer is forced to get on board of market development to offer the zero introductory price to pioneers, and thus, it shoulders all the cost of market development, yet breaks even from subsequent sales to followers. In comparison, when $k\leqslant k_b$, the wholesale price drops and the retailer sees the opportunity of making positive profits by focusing on pioneers only.

An incentive compatibility constraint is needed to motivate the retailer. Specifically, the manufacturer determines a new wholesale price, denoted as $w^{\star\star}$, at which the retailer is indifferent between charging $p_1=(v+w^{\star\star})/2$ and 0:

$$w^{\star\star}=\left\{w_1\ \mid\ \Pi_1\ |_{p_1=\frac{(1+w_1)}{2}}\ =\Pi_{12}\ |_{p_1=0}\right\}, \tag{9}$$

where $\Pi_1\ |_{p_1=(1+w_1)/2}\ =(v-w_1)^2/4$, and $\Pi_{12}\ |_{p_1=0}$is given in equation (5).

We solve for $w^{\star\star}$, which is given by

$$w^{\star\star}=\frac{(v-c)\sqrt{k}}{(2-v)}. \tag{10}$$

By setting the wholesale price at $w^{\star\star}$ in Period 1, the manufacturer can entice the retailer to set a low retail price. The results are summarized in the following Lemma.

Lemma 3: *When* $k_a<k\leqslant k_b$,

(a) *The retailer optimizes its profit by charging* $p_1=0$ *if the wholesale price* $w_1=w^{\star\star}$.

Table 1: Market equilibrium under a forward-looking retailer

Parametric space	*Targeted segment*	*Optimal prices*	*Optimal profits*
Region 1: $k \geqslant \max\{k_a, k_b\}$	Pioneers and followers	$p_1 = 0$ $w_1 = \hat{w}$	$\Pi_{12} = 0$ $\pi_{12} = 3(v-c)^2k/16v-c$
Region 2: $\max\{k_a, k_c\} \leqslant k \leqslant k_b$	Pioneers and followers	$p_1 = 0$ $w_1 = w^{\star\star}$	$\Pi_{12} = (v-c)^2k/16v-w^{\star\star}$ $\pi_{12} = w^{\star\star}+(v-c)^2k/8v-c$
Region 3: $k_a < k < k_c$	Pioneers	$p_1 = p^{\star}$ $w_1 = w^{\star}$	$\Pi_{12} = (v-c)^2/16v$ $\pi_{12} = (v-c)^2/8v$

$\hat{w} \equiv (v-c)^2k/16v$, $w^{\star} \equiv (v+c)/2$, $w^{\star\star} \equiv (v-c)\sqrt{k/2}-v$.

(b) *The retailer's total profit increases as k decreases.*

Lemma 3 suggests that, when the market potential is moderate, the manufacturer has to yield some of its profits to the retailer by lowering its wholesale price in Period 1. The retailer is indeed better-off in this case. The lower the market potential, the higher the retailer's profit is.

Manufacturer's decision on market development

We now consider the manufacturer's decision on market development. The manufacturer will pursue market development only if it brings in a higher profit than merely selling to pioneers. This condition leads to the following profit comparison:

$$\pi_{12} \mid_{p_1=0} = w^{\star\star} - c + \frac{(v-c)^2 k}{8v} < \pi_1^{\star}. \qquad (11)$$

where, $\pi^{\star}_1 \equiv (v-c)^2/8v$, is given in the previous section.

The comparison leads to the third threshold on k, as summarized in Lemma 4.

Lemma 4: *Define*

$$k_c \equiv \left(\frac{\sqrt{13v^2+6vc+c^2}-2v}{v-c}\right)^2.$$

(a) *when $k<k_c$, the manufacturer optimizes its profit by charging $w^{\star}$ in Period 1, selling only to pioneers.*

(b) *The threshold value k_c increases as the cost c increases, that is, $\partial k_c/\partial c > 0$.*

Lemma 4 suggests that a larger potential market size of followers is needed for market development when the manufacturer faces a higher production cost. The high cost lowers the channel's margin in the followers' segment, as well as the profit, making the effort of market development not worthwhile. Hence, the manufacturer needs a large volume of sales in Period 2 to compensate for the cost of market development.

On the basis of Lemmas 2–4, the following proposition presents the main finding on the market equilibrium for this section.

Proposition 1: *The market equilibrium under different scenarios is presented in* Table 1.

As a graphic summary, Figure 1 illustrates the different parametric regions where the channel members operate. Note that both the demand and supply factors critically influence the equilibrium outcome of market development. A higher production cost in general hinders market development, whereas a large market potential favors market development.

Discussion

The above analysis shows that, in order to develop the market, the channel has to incur certain costs, reflected as the introductory pricing to pioneer consumers in Period 1. When the manufacturer leads the

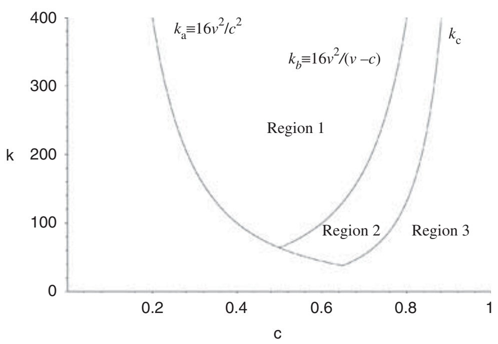

Figure 1: The operational region of market potential and product costs for market development.

channel, most of the cost is undertaken by the retailer.

Interestingly, the retailer is strictly worse off when the channel faces a potentially bigger market. When the market potential is $k \geqslant \max\{k_a, k_b\}$, the retailer makes zero profit; when k is small, it earns a positive profit. The rationale is that, in the manufacturer-led channel, the manufacturer sets a high wholesale price when market potential is large. The retailer cannot pass such high wholesale price on to pioneers by charging $p_1 = (v+w_1)/2$.The retailer is then forced to 'cooperate' with the manufacturer to develop the market by charging $p_1 = 0$. The retailer makes up the lost revenue in Period 1 by the sales to followers in Period 2. When market potential is moderate, the optimal wholesale price is set moderate, which allows the retailer to earn some positive profit by selling to pioneers. To motivate the retailer to develop market, the manufacturer has to further lower the wholesale price to offer some extra margin for the retailer.

MYOPIC RETAILER

In this extension, we consider a scenario in which the retailer is myopic (that is, it maximizes its profit in each period separately). In equilibrium, the retailer always sets $p_t = (v+w_t)/2$ and receives the profit equal to $(v-w_t)^2/4v$ in Period $t = \{1, 2\}$. The manufacturer still acts strategically.

We first consider a special case when the marginal cost c is high.

Lemma 5: *When $c \geqslant v/2$, the manufacturer optimizes its profit by charging $w_1 = (v+c)/2$ to sell to pioneers only.*

Lemma 5 implies that, when the retailer is myopic, the sales to pioneers cannot generate valuation high enough from followers for the channel to make a positive profit. As a result, the manufacturer will give up market development no matter how large the potential is, and focus on pioneers only. The following analysis focuses on the case of $c < v/2$.

Market development through a low-ball wholesale price

The manufacturer can still influence d_2 via its choice of w_1 in Period 1. Hence, its total profits in two periods are also a function of w_1:

$$\pi_{12} = \frac{(w_1 - c)(v - w_1)}{2v} + \frac{1}{16}(v - w_1 - 2c)\left[1 - \frac{2c}{(v - w_1)}\right]k, \quad \text{for } 0 < w_1 < v - 2c. \tag{12}$$

Similar to (2) in the section 'Channel members' profits', when the manufacturer sets w_1 so high that $w_1 > v-2c$, there will be no meaningful demand from followers in Period 2. Hence, w_1 is bounded for the sake of market development.

We take the first- and the second-order derivatives of π_{12} *w.r.t.* w_1:

$$\frac{\partial \pi_{12}}{\partial w_1} = \frac{v + c - 2w_1}{2v} + \frac{k}{16}\left[\frac{4c^2 - (v - w_1)^2}{(v - w_1)^2}\right];$$

$$\frac{\partial^2 \pi_{12}}{\partial w_1^2} = \frac{kc^2}{2(v - w_1)^3} - \frac{1}{v}.$$

As we require $k > k_a \equiv 16v^2/c^2$, it is easy to verify that $\partial^2 \pi_{12}/\partial w_1^2 > 0$, and π_{12} is convex in w_1. The manufacturer can maximize its profit either by choosing one of the two ends of the

Table 2: Market equilibrium when the retailer is myopic

Parametric space	*Targeted segments*	*Optimal prices*	*Optimal profits*
$k \geqslant k_d$ and $c \leqslant v/2$	Pioneers and followers	$w_1 = 0$	$\Pi_{12} = v/4 + (v-2c)^2/32$
	—	$p_1 = v/2$	$\pi_{12} = (1-2c)^2 k/16v - c/2$
	—	$w_2 = v/4 + c/2$	—
	—	$p_2 = 3v/8 + c/4$	—
$k_a < k < k_d$ or $c > v/2$	Pioneers	$p_1 = p^\star$	$\Pi_{12} = (v-c)^2/16v$
	—	$w_1 = w^\star$	$\pi_{12} = (v-c)^2/8v$

price range $[0, v-2c]$, or by charging $w_1 = (v+c)/2$.

We examine the signs of $\partial\pi_{12}/\partial w_1$ at the two ends of $[0, v-2c]$ to determine the optimal wholesale price. Specifically,

$$\frac{\partial \pi_{12}}{\partial w_1}\Big|_{w_1=0} = \frac{v+c}{2v} + \frac{k}{16}\left[\frac{4c^2 - v^2}{v^2}\right];$$

$$\frac{\partial \pi_{12}}{\partial w_1}\Big|_{w_1=v-2c} = \frac{5c-v}{2v}.$$

It follows that if $0 < c < v/5$, $\partial\pi_{12}/\partial w_1 \,|_{w_1=v-2c} \leqslant 0$. In other words, the manufacturer maximizes its profit when charging the lowest wholesale price, which is zero. On substitution, the manufacturer receives a total profit equal to

$$\pi_{12}\,|_{w_1=0} = \frac{k}{16v}(v-2c)^2 - \frac{c}{2}.$$

Alternatively, if $v/5 \leqslant c \leqslant v/2$, $\partial\pi_{12}/\partial w_1 \,|_{w_1=v-2c} > 0$. There are two local maximums at 0 and $(v+c)/2$ for the manufacturer to choose from. When charging $w_1 = (v+c)/2$, the channel sells only to pioneers, and the manufacturer receives $\pi^\star{}_1 \equiv (v-c)^2/8v$. The comparison between $\pi^\star{}_1$ and $\pi_{12}\,|_{w_1=0}$ yields the following result.

Lemma 6: Define

$$k_d = \frac{2(v+c)^2}{(v-2c)^2}, \tag{13}$$

(a) *When $k_a < k < k_d$, the manufacturer optimizes its profit by charging $w_1 = (v+c)/2$ to sell to pioneers.*

(b) *When $k \geqslant k_d$, the manufacturer optimizes its profit by charging $w_1 = 0$.*

Lemma 6 suggests that retailer's myopia could cause some inefficiency in market development. When the market potential is relatively large, that is, $k_a < k < k_d$, the manufacturer gives up market development even if. In this case, the retail price in Period 1 does not equal to zero as the retailer maximizes its profit in Period 1.

Proposition 2: *The market equilibrium when the retailer is myopic is presented in* Table 2.

Proposition 2 shows that, under a large market potential, the retailer is better-off when it is myopic than when it is forward-looking. The rationale is that, when the retailer is no longer concerned with large future sales to followers, it will not charge a zero retail price to pioneers. As a result, the manufacturer has to undertake all the cost of market development by offering a zero wholesale price to the retailer, in the hope that the retailer will pass on some savings to pioneers. The manufacturer receives fewer profits owing to the retailer's myopia. This result differs from Chiang (2012) in that all channel members are better-off in the long run when they focus on short-term profits.

Market development and slotting allowance

We now consider an alternative approach where the manufacturer offers slotting allowance to motivate the myopic retailer to develop the market. In the mean time, the manufacturer proposes a non-binding suggested retail price in Period 1, p_1^{MSRP}. The manufacturer also decides w_1, such that the myopic retailer will charge p_1^{MSRP}.

The retailer's profit in Period 1, upon receiving the slotting allowance L from the manufacturer, is

$$\Pi_1 = \left(p_1^{MSRP} - w_1\right)\left(\frac{1 - p_1^{MSRP}}{v}\right) + L.$$

The manufacturer's profit in Period 1 is

$$\pi_1 = (w_1 - c)\left(\frac{1 - p_1^{MSRP}}{v}\right) - L.$$

In order to motivate the retailer to charge p_1^{MSRP}, the manufacturer has to make sure that the retailer is indifferent to charge $p_1^{MSRP}$and $p_1 = (v+w_1)/2$ without taking the allowance. That is,

$$\left(p_1^{MSRP} - w_1\right)\left(\frac{1 - p_1^{MSRP}}{v}\right) + L = \frac{(v - w_1)^2}{4v}.$$

It thus follows that the minimum slotting allowance needed is

$$L = \frac{(v + w_1)^2 - 4p_1^{MSRP}\left(v + w_1 - p_1^{MSRP}\right)}{4v}. \quad (14)$$

The two firms then sequentially choose the retail price and wholesale price in Period 2 to maximize their period-two profit, respectively.

In equilibrium, the manufacturer's period-two profit becomes

$$\pi_2 = \frac{\left(v - p_1^{MSRP} - c\right)^2 k}{8\left(v - p_1^{MSRP}\right)}.$$

On substitution, the manufacturer's total profits become

$$\pi_{12} = (w_1 - c)\left(\frac{1 - p_1^{MSRP}}{v}\right) - \frac{(v + w_1)^2 - 4p_1^{MSRP}\left(v + w_1 - p_1^{MSRP}\right)}{4v} + \frac{\left(v - p_1^{MSRP} - c\right)^2 k}{8\left(v - p_1^{MSRP}\right)} \quad (15)$$

That is, the manufacturer shall decide on $p_1^{MSRP}$and w_1 to maximize π_{12}. The following proposition presents the optimal p_1^{MSRP}, $w_{1,}$ as well as L in Period 1.

Proposition 3. *In Period 1, the optimal wholesale price is v; the optimal manufacturer suggested retail price is zero; and the optimal slotting allowance $L^\star = v$. The manufacturer receives the total profit equal to $(v-c)^2k/8v-c$.*

Proposition 3 suggests that through the slotting allowance, the manufacturer manages to have the myopic retailer charge a zero price to pioneers. The usage of slotting allowance results in a high wholesale price, which is in sharp contrast to the case where the manufacturer sets a zero wholesale price to motivate the retailer. The rationale is that, as the manufacturer cannot bundle the retail price with the slotting allowance (otherwise it will be regarded as price fixing, which is illegal in many countries), it has to set the wholesale price high enough to prevent the retailer from deviating p_1^{MSRP}.

Endogenizing myopia

We have shown that the retailer benefits from its myopia under a large market potential. A related question is how the retailer can implement myopia as a strategic decision variable. As studies in sales force management suggest, retailers can implement different compensation schemes among their sales staff to influence their focus on short-term and long-term objectives (for example, Misra and Nair, 2011). In this way, retailers can make the myopia credible and observable to manufacturers. In addition, as the adjustment of compensation scheme is infrequent, retailers are able to be committed to myopia.

Now suppose that the retailer has the choice to implement a non-irreversible compensation scheme that can fully direct its sales team's attention to short-term profits; the question is, when should the retailer become myopic? Clearly, when the market potential is large ($k > \max\ \{k_a, k_b, k_c\}$) and the marginal production cost is low ($c < v/2$), the retailer is strictly better-off implementing such a compensation scheme. However, when the cost is high ($c > v/2$) and the market potential is not too large, the manufacturer gives up market development if the retailer is myopic. As we show in the previous section, the retailer can benefit from market development rather than focusing on pioneers. Therefore, it is beneficial for the retailer to stay forward-looking.

MANAGERIAL IMPLICATIONS

In this article, we study how the channel can capitalize on the linkage between the sales to pioneers and followers' demand. We show that in order to fully develop the market, it is desirable to implement introductory pricing and sell to as many pioneers as possible. Yet, the cost of market development is undertaken mostly by the retailer. When the market potential is large, the retailer is worse-off than when the market potential is moderate. Further, we show that when the market potential is large, the retailer receives a greater profit when it is myopic than when it is forward-looking. Finally, when the retailer can switch to myopia by implementing compensation schemes, we discuss the conditions when it should do so.

This article offers several managerial implications to channel members. For manufacturers, they sometimes can charge a high wholesale price to entice an introductory retail price when market potential is sufficiently large. Yet, under some situations, manufacturers have to provide sufficient incentive to retailers to develop the market. In particular, when facing a myopic retailer, manufacturers sometimes have to charge a zero wholesale price.

For retailers, they can implement different compensation schemes for their sales associates to commit to short-term versus long-term objectives. This activity offers some flexibility to retailers in channel coordination and, hence, increases their profitability. When the information is asymmetric, retailers can benefit by being conservative in reporting market potential to manufacturers.

As this article pursues a concise illustration of the main ideas, there are several issues not captured in this article, which we hope can be addressed in future research. This article considers the deterministic demand from followers in Period 2. Thus, there is no risk associated with the efforts of market development. Future research is needed to consider a stochastic followers' demand. In addition, this article considers the channel as manufacturer-led, based on the premise that the manufacturer enjoys bigger bargaining power in channel coordination owing to its monopolistic right of selling the new product. In many situations retailers may be in the dominant position even if distributing new products. We would expect some different findings for a different setting.

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NOTE

1 We acknowledge that such linkage can be non-linear, demonstrating a diminishing return. For example, when there is ceiling on consumers' valuation, the linkage is non-linear. Yet, employing the linear linkage makes the analysis tractable, and does not qualitatively change the essence of findings.

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Practice Article

Value assessment and pricing capabilities—how to profit from value

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ABSTRACT Value is a key concept for researchers and practitioners in the fields of strategy, marketing, and pricing. In the strategy literature, value is closely related to competitive advantage and profit, in the marketing literature value is the cornerstone of the marketing management process, in the pricing literature value represents the customer's willingness to pay. The aim of this article is to bridge the gap between marketing, pricing and strategy research through a compilation of five short essays that focus on value assessment and pricing capabilities. This article argues that value assessment and pricing capabilities provide the foundation for value creation and value appropriation in business-to-business markets, highlights their implications for profiting from value created and delivered, and outlines important areas for future research.

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Keywords: value assessment; capabilities; pricing; strategy; profit

INTRODUCTION

Value is a key concept for researchers and practitioners in the fields of strategy, marketing, and pricing. In the strategy literature, a firm's competitive advantage stems from its ability to create value for its customers, and value is defined largely as the difference between a customer's perceived utility from a given product and the firm's cost of producing it (Porter, 1985; Bowman and Ambrosini, 2000; Mizik and Jacobson, 2003; Peteraf and Barney, 2003; Besanko *et al*, 2010) In the marketing literature, value is considered as the cornerstone of the marketing management process, and usually defined as the customer's subjective perception of the benefits and costs involved in an exchange (Ulaga & Eggert, 2006; Anderson *et al*, 2008; Grönroos, 2011). And in the pricing literature, value is considered as the key lever to increasing profitability, and usually defined as the customer's willingness to pay (Nagle and Holden, 2002; Liozu *et al*, 2012; Hinterhuber, 2013). What is common to each of these literature streams is that to benefit (or profit) from value, firms need to be able to leverage their value assessment and pricing capabilities, and quantify and communicate the potential and delivered value to their customers (Anderson *et al*, 2006).

By value assessment, we refer to activities related to understanding, documenting, and communicating value created for and with customers (Payne and Frow, 2005; Anderson *et al*, 2006), and by pricing, we refer to activities related to setting and getting prices that enable firms to appropriate a profitable portion of the value created (Dutta *et al*, 2003; Hinterhuber, 2004; Wagner *et al*, 2010, see also Ingenbleek and van der Lans, 2013). Prior research has considered value assessment and pricing activities in business-to-business (B2B) markets mainly as a responsibility of, marketing, and pricing units, who work in close interaction with customers (for an overview of various types of value assessment and pricing methods see for instance Anderson *et al*, 1993; Lipovetsky *et al*, 2011). This view, however, underemphasizes value assessment and pricing capabilities that leverage resources from several organizational functions, and are exercised in a strategically concerted fashion throughout the whole organization. Capabilities play a key role in several research streams, and the aim of this article is to bridge the gap between customer value-oriented marketing, pricing and strategy research by pointing to a few important areas of value assessment and pricing capabilities that are central to profiting from value delivered.

Capabilities can be seen as special, firm specific, types of resources (Makadok, 2001) in the form of a collection of routinized activities (Winter, 2003) or as the skills being exercised through organizational processes (Day, 1994). Hence, we view value assessment and pricing capabilities as routinized activities or processes that ensure repeatability and reliability in the firm's assessment of the value it creates and appropriates.[1]

Prior research on capabilities has to a large extent focused on the role in value creation or cost reduction in order to gain a competitive advantage (Peteraf and Barney, 2003). However, several scholars (for example, Pitelis, 2009; Pitelis and Teece, 2009; Ellegaard *et al*, 2014) have emphasized the importance of capabilities required to appropriate value and the interaction between value creation and value appropriation capabilities of the firm. Among the studies of capabilities that focus on appropriation we find work related to pricing capabilities (Dutta *et al*, 2003), although they do not deal explicitly and exclusively with value assessment or value-based pricing techniques.

Successful value assessment aims to make the created and delivered value visible to customers (Payne and Frow, 2005), which in turn facilitates value appropriation through value based pricing (Hinterhuber, 2008a). Hence value assessment and pricing capabilities are closely related, and viewing them as firm capabilities emphasizes a holistic perspective where value creation and value appropriation cut across a multitude of functions of the firm. This is in line with the recent calls in marketing literature to connect business processes that cut across traditional organizational silos, especially related to value creation and value appropriation (Bolton, 2006; Ellegaard *et al*, 2014).

Background

This article provides five different perspectives on the role of value assessment and pricing capabilities through a compilation of five short essays that are based on some of the key presentations from a workshop on the topic of Value Assessment Capabilities organized by the Institute of Economic Research, Lund University, Sweden in May, 2014. The first two essays have a strategy perspective, and they address value assessment capability as an integrative process, and illustrate how it might be deployed in practice. The next two essays have a pricing perspective, and they address the behavioral barriers to implementing value-based pricing and establishing socio-technical pricing capabilities. Through these two essays we provide a link between value assessment capabilities and their implementation, and the way that they relate to pricing and pricing capabilities. Finally, the last essay outlines the need for future research on value quantification, with a particular focus on B2B markets. Overall, the purpose of these five essays is to provide a synoptic view of important areas related to value assessment and pricing capabilities in B2B markets, and highlight their implications for profiting from value created and delivered.

LAYING THE FOUNDATION FOR FUTURE VALUE CAPTURE – VALUE ASSESSMENT AS AN INTEGRATIVE CAPABILITY, MAGNUS JOHANSSON

Performing value assessment often ends up being the responsibility of the pricing function of the firm. The reason for this is that when a new product finally reaches the point where price has to be set the question of value has to be addressed. So pricing will have to make sure that it has a reasonable value estimate to base its price setting on. The exception is of course when the firm does not care at all about market value when pricing its products or services, but instead relies on cost-plus or competition-based pricing.

Since pricing often comes in late in the process of product development, when the value assessment is finally done it might be too late. The product may already have a cost base that exceeds the value that it can command in the market. As Nagle and Hogan (2006) state, the value creation process should start with customers and the customer value that needs to be created, after that price, cost and product definitions can be addressed. And it is in the interest of the pricing function to push the value assessment capability further back in the organization so that it gets to price products with the right value offering and cost level. Value assessment is not a pricing problem but is a problem that the whole organization must address.

Value assessment activities that truly put customers and value first have to handle a number of challenges. For instance, needs and value perception may vary on the individual level of the customer, which increases the complexity of value assessment (Corsaro and Snehota, 2010). This is common for B2B-settings and services where customization provides customer unique value. Another challenge of value assessment stems from innovative industries where the pace of change makes future value estimation difficult. To estimate the exchange value of a product the firm needs to assess not just future customer preferences but also how fast competitors will fulfill the new demands of customers (c.f., Möller and Törrönen, 2003). In general, innovation introduces risk into an industry, and if innovation involves technology as well as market changes, the higher the risk level is (Assink, 2006).

Example: Stream of product generations with innovation

To illustrate the challenges of value assessment on innovative markets consider a market where new products or new product generations are constantly introduced. Each new product or product generation involves a competitive race where new features are brought to the market and where timing is essential.

Since value creation should start with customers and value, the firm needs to estimate future value perception of a new product concept and whether competitors will make it to the market before or after the firm manages to do so. Since many products can have long development cycles, estimates may concern customer value perception and competitor offering estimates several years ahead. A key issue is to try to estimate what will be a differentiating value of the firm's product and what will end up as a commodity value at launch because of competition, that is, what parts of the use value will constitute differentiation versus commodity value (Smith and Nagle, 2005) at launch.

Firms need to decompose their products and their competitor's products into value drivers and then analyze what technologies provide innovation value for these value drivers. For future products the focus should be on the key technologies that provide the prime innovation value. To achieve this, value assessment needs to be integrated with technology forecasting to provide estimates of the timing, value and content of future product and product generations.

On markets where new technologies are introduced at a constant rate such analysis can be supported by considering the pace of the industry and its players (Eisenhardt and Brown, 1998). Within the limits of incremental innovation, firms are constrained in introducing new technologies in their products because of the risks that these incur. Therefore, they are often introduced at a regular pace (see Figure A1) that also provides opportunities for competitor analysis, especially when trying to forecast value, content and timing of new product releases. Historical analysis of technologies and price relations can add to this picture by providing estimates of value erosion. Keeping track of the industry pace in relation to value can also help provide early warnings of disruptive behavior of competitors (Christensen, 2003; Assink, 2006).

The integrative role of value assessment capability

Value assessment therefore requires integration with technology forecasting, competitor and customer intelligence as well as with R&D, product & portfolio management and marketing. Value assessment should therefore be viewed as an integrative capability (Yeoh and Roth, 1999) in the form of an integrative and iterative set of routinized activities.

The process of value assessment integrates internal functions, capabilities and resources as well as external data. Since it also has to deal with value assessment of future offerings it is iterative (see Figure A2) in refining its value estimate toward product launch. It is a central process to the firm because of the strategic importance of the value concept (Porter, 1985; Brandenburger and Stuart, 1996) and of the concept of competitive advantage as defined from the perspective of value creation (Peteraf and Barney, 2003). Value assessment is central for value creation, value capture and decision making of the firm.

Implication for pricing and its profit impact

Although one of the two common definitions of competitive advantage relies solely on value creation, the ability of the firm to assess value will influence not just value capture activities but also support value creation activities making them more effective. Assessing value, which is essential if applying a value based pricing approach, is far from cost free. It requires resources being put to use in value assessment activities. To ensure reliability and efficiency value assessment capability as an organizational process, in the form of a set of routinized activities, must be collective, that is, coordinating and integrating individual resources (Felin *et al*, 2012), repetitive (Helfat and Peteraf, 2003) and supported by the appropriate organizational structures (Felin *et al*, 2012). Of particular importance is that the activities can be supported by appropriate structures through various stages of the product development and lifecycle stages and the various functions that are involved. An efficient value assessment capability should be one of the first priorities of the firm as it helps identify one of the key parameters of competitive advantage of the firm, the value level provided to the market. Thus, it provides the framework for value creation and value capture activities of the firm, and essentially lays the foundation for the organizations ability to capture profit. In particular, firms with a well-developed value assessment capability can help improve communication of value to customers and strengthen the bargaining position of the firm and thus the opportunity to capture more value through pricing.

STRATEGY AND ORGANIZATION – HOW TO DEPLOY VALUE ASSESSMENT CAPABILITY, JOONA KERÄNEN

The central role of capabilities in creating value and achieving superior performance has long been recognized in the marketing and management literature (for example, Helfat and Peteraf, 2003). Organizational capabilities are often regarded as 'complex bundles of skills and accumulated knowledge, exercised through organizational processes' (Day, 1994, p. 38), or 'a firm's capacity to deploy resources for a desired end result' (Helfat and Lieberman 2002, p. 725). From this perspective, understanding the processes and resources that are needed to deploy a firm's value assessment capability is key to delivering and capturing value.

Owing to that value assessment is often regarded as a sales or pricing activity, prior research has focused on exploring the related processes, resources, and activities in these domains (Dutta *et al*, 2003; Töytäri *et al*, 2011). However, as modern B2B markets have become more complex, several studies have illustrated difficulties encountered by sales and pricing organizations when trying to appropriate and capture value from customer engagements (for example, Hinterhuber, 2008a; Ellegaard *et al*, 2014; Ulaga and Loveland, 2014). In reality, delivering, evaluating, and capturing value has increasingly become a cross-functional and firm-wide effort that goes beyond the sales or pricing unit's responsibilities (Sheth and Sharma, 2008).

For example, emerging research findings indicate that best practice firms in B2B markets tend to employ customer value assessment strategies that utilize several organizational functions (Keränen and Jalkala, 2014). Instead of an activity that is only delegated to sales or pricing, these firms see value assessment as an organization-wide process that leverages resources, skills, and knowledge from all of the firm's customer facing organizational units including sales, delivery, service and marketing. In essence, best practice firms have understood that successful value creation and value capture requires strategic alignment of resources (Mizik and Jacobson, 2003), and, consequently, established organizational structures and routines that facilitate value assessment throughout the whole life cycle of customer engagement.

Examples from best practice firms

Leading firms in the enterprise software industry, Oracle and SAP, leverage their industry knowledge and consulting skills by establishing designated organizational units and value specialist teams that focus on evaluating and quantifying business benefits that customers receive from their products and services. These value specialist teams have two important functions: first, they work in close collaboration with sales, production, and R&D, combining customer insight with engineering to maximize value delivered to customers. Second, and perhaps even more importantly, they help marketing and pricing to demonstrate the actual worth and monetary value that customers will realize from the firm's products and services. This improves the chances that products and services are created to fulfill valuable customer needs, and that customers are willing to accept pricing logics that are based on value delivered to customers.

However, securing commitment to value assessment and coordinating resources from several organizational units requires strong support from senior management. For example, SKF, a global industrial bearings supplier has placed value management on their top agenda. To implement this strategy, SKF has appointed global value managers, whose mission is to develop value quantification tools and value propositions that will make potential cost savings and other benefits visible to prospective customers and other stakeholders, and ensure that the activities of the whole organization are aligned with these goals.

Strategic initiative

By recognizing the strategic and long-term nature of value assessment, best practice firms have avoided the typical pitfall with which most firms in B2B markets tend to struggle: short-sighted management that treats value assessment as a tactical activity, left to individual sales reps to conduct at their own. This approach underutilizes skills and knowledge about prior deliveries that have accumulated within the organization, and usually results in arbitrarily set pricing strategies with very little, if any, concrete evidence on potential value that the customer is expected to gain.

An 'ideal' value assessment process should, at least, evaluate how a supplier can add value to its customers' business, measure customers' current performance and, ultimately, ensure that promised value added is realized in the long term (Keränen and Jalkala, 2014). This takes time, commitment, and coordinated activities aimed at understanding how customers actually benefit from the supplier's products and services in their own value-generating processes. Specifically, to evaluate how customers actually utilize the supplier's value proposition, firms need to look beyond sales and pricing, and leverage organizational units who have a better visibility to customers' everyday operations. The value from the supplier's offering is often realized long after implementation (Tuli *et al*, 2007), and field technicians and service people represent key resources that are needed to delve deep into customers' world of product usage and value creation in B2B markets (Ulaga and Reinartz, 2011).

Implication for pricing and its profit impact

Successful firms know how to deliberately allocate organizational resources such as processes, routines, and people, to evaluate, document and demonstrate the value and business benefits their offerings deliver to customers. By providing credible value evidence on the potential benefits of their offerings, suppliers can reduce customer´s uncertainty to purchase higher-priced offerings (Anderson and Wynstra, 2010), and barriers to accept value-based pricing strategies (Hinterhuber, 2008a). The first step toward a more efficient deployment of value assessment capability is often the realization that, instead of merely sales or pricing activity, it is strategic initiative that involves several organizational functions. This allows management to take a closer look at their resource portfolio, and choose the optimal strategies and organizational structures that are needed to ensure that suppliers actually profit from the value delivered.

BEHAVIORAL BARRIERS TO VALUE BASED PRICING, LINN ANDERSSON

Despite the strong impact pricing has on profitability (Dutta *et al*, 2003) and the advantages of value-based pricing (Anderson and Narus, 1998; Hinterhuber, 2008a; Hinterhuber and Bertini, 2011), surprisingly few B2B firms succeed in developing a pricing capability that enables them to match prices with the products' customer value (Hinterhuber, 2004; Lancioni, 2005;

Hinterhuber, 2008a). One reason to why few managers decides to invest resources in implementing ambitious value-based pricing strategies is the belief that prices are automatically determined by external factors, such as customers and competitors, and therefore consider price setting as a response to changes in customer and competitive situation (Dolan and Simon, 1996; Nagle and Holden, 2002). A second reason is difficulties in communicating the product's customer value to the customer (Hinterhuber and Bertini, 2011). Another major challenge for managers when managing the firm's pricing processes is the pricing authority delegation decision, for example, deciding who should have the authority to grant discounts.

A common practice within B2B firms is to delegate the pricing authority to the individual sales representative (Richards *et al*, 2005). Sales representatives are likely to accumulate in-depth customer specific information throughout the many customer interactions. Therefore, sales representatives are often in a better position *vis-à-vis* management to set and negotiate prices with individual customers (Joseph, 2001; Mishra and Prasad, 2005; Homburg *et al*, 2012). Since communicating the sales representative's tacit knowledge that they gain from continuous customer interactions to others in the organization is difficult (Szulanski, 1996) and often costly, the company often has to rely on each individual sales representative, especially if the pricing strategy is to match the product's often idiosyncratic value to individual customers. Consequently, the individual sales representative plays a key role in the firm's ability to maximize gross-profit margin (Anderson *et al*, 2007; Blocker *et al* 2012; Haas *et al*, 2012). Given the information asymmetry, managers might decide not to interfere in the sales representative's decision making in customer negotiations and instead choose output control in form of monetary incentives (Hinterhuber, 2004; Nagle and Hogan, 2006; Hinterhuber, 2008a).

A sales representative that is measured and rewarded on gross profit margin might be more willing to walk an extra mile. Yet the fact that managers often finds it difficult to implement value-based pricing (Hinterhuber, 2004; Lancioni, 2005; Hinterhuber, 2008a), despite the wide spread practice of rewarding the sales force based on profit contribution, combined with the flora of pricing techniques that have been known to most industries for quite some years (see Dolan and Simon, 1996; Monroe, 2005; Marn *et al*, 2004) indicates that relying on monetary incentives and training in pricing techniques is not sufficient in order to implement value-based pricing. Hence, our theoretical understanding of value-based pricing implementation is not complete.

A longitudinal, case study of a three-year value-based pricing implementation project in a global, manufacturing B2B firm, based on 59 semi-structured interviews with respondents ranging from higher level management to sales representatives (see Andersson, 2013 for detailed case study description), showed that the key success factor to achieve value-based prices was to address the following behavioral obstacles; (i) the influences of hedonic intrinsic motives on individual behavior (Lindenberg, 2001), causing sales representatives to prioritize friendly, pleasant customer relations at the expense of profit maximization, (ii) individuals tendency to behave in a myopic manner (Cyert and March, 1963; Levinthal and March, 1993), causing price setters to use discounts as a means to quickly close a deal even when it has a negative influence over profit margin contribution, and (iii) individuals' uncertainty-avoidance in decision processes and tendency to stick to already established procedures (Cyert and March, 1963), causing price setters to turn to historical prices instead of trying to negotiate higher-profit margins.

Hedonic intrinsic motivation explains why individuals in some situations prioritize the type of behavior that simply makes them feel better here and now over behavior that result in a future reward (Lindenberg, 2001). Hedonic intrinsic motivation is distinguished from both normative intrinsic motivation, referring to incentives that make individuals behave according to what they believe that norms stipulate to be appropriate, and extrinsic motivation, which generally concerns more unpleasant actions that individuals undertake in order to achieve a reward (Lindenberg, 2001). The case study findings showed that close customer relationships often develop into something that resembled friendship between the sales representatives and the customers' representatives, which in turn sometimes resulted in the sales representative granting discounts as a sympathetic gesture, and deliberately avoided price discussions. Owing to hedonic intrinsic motives, the sales representatives were inclined to prioritize a nice, pleasant, friendly meeting with the customer over value-based prices and higher-profit margins, also in situations when the sales representatives were rewarded based on gross profit margin contribution. Hence, instead of capturing the customer value in customized value-adding arrangements based on in-depth customer understanding accumulated during years of close relationships, the sales representatives were instead often inclined to grant discounts as a gesture of friendship.

Like individuals in general, salespeople prioritize short-term gains before long-sightedness, simply because that is the human nature (Cyert and March, 1963; Levinthal and March, 1993). The case study showed that influence from myopic behavior caused sales representatives to sometimes grant discounts in order to close a deal as quickly as possible even if that meant accepting a lower gross profit margin

Lastly, the sales representatives in the study tended to favor historical prices instead of revised prices, also in situation when historical prices were clearly unprofitable because of increased cost of production. One reason for this is the human nature of seeking to avoid uncertainty in decision process (Cyert and March, 1963). A key challenge with value-based pricing is that the pricing decision process often involves uncertainty concerning the idiosyncratic product value to individual customers, which causes sales representatives to rely on historical prices because of uncertainty avoidance.

Implication for pricing and its profit impact

When management at the case firm identified mentioned three behavioral barriers to value-based pricing, they decided to restrict the individual sales representative's influence over prices and discounts. This compromised the sales representatives' autonomy to influence prices to individual customers, but it resulted in higher profit margins. Management concluded that although the individual sales representatives often had an information advantage *vis-à-vis* management regarding individual customers, they were not in a better position to match price with the products' often idiosyncratic value to individual customers. Even though the sales representatives might be in a better position to assess the products' value to individual customers, the strong impact from behavioral barriers for profit margin maximization motivated the decision to restrict the individual sales representatives' pricing authority.

Although some publications addressing challenges with implementing new pricing strategies might recognize difficulties with changing 'the mindset for pricing' among salespeople (for example, Lancioni, 2005), they seldom elaborate on this observation. The case study identified three behavioral obstacles that need to be addressed in order to implement value-based pricing.

PRICING CAPABILITIES FROM A SOCIO-TECHNICAL PERSPECTIVE, STEPHAN LIOZU

Pricing is an organization discipline that can be adopted and internalized only through the design and implementation of an intentional transformational strategic roadmap aimed at generating and developing organizational capital in pricing.

For a successful transformation in pricing, managers in charge must think like social-technical designers and must pay equal attention to technical and humans resources and capabilities in pricing as shown in Figure A3. The technical resources and capabilities relate to infrastructure, information systems, pricing analytics, tools & models and advanced pricing methods (Hallberg, 2008). Social or organizational capabilities relate to organizational change capacity, organizational confidence, championing behaviors and organizational design of pricing organization (Liozu and Hinterhuber, 2012). This strategic roadmap becomes a journey toward pricing excellence that leads to superior relative firm performance (Liozu, 2014).

Research questions

A careful review of the analysis in the area of pricing capabilities from a socio-technical perspective uncovers significant research gaps. The first gap relates to the social, human, and organizational dimensions of firms that can positively impact the pricing transformation towards pricing excellence but also positively impact firm performance. Second, pricing is traditionally considered by many practitioners as a function mostly characterized by its technical and analytical dimensions. It is therefore equally critical to identify the organizational capabilities that can increase the technological adoption of pricing resources and ensure a successful organizational transformation. Finally, to the best of our knowledge, a comprehensive quantitative scale to measure pricing capabilities as a construct does not exist (Liozu and Hinterhuber, 2014).

These three gaps represent the basis for the research questions addressed in this research stream and presented in Figure A4.

Overview of research design

The overall research design was informed by a problem of practice, by our strong practitioner experience, as well as by various research methodologies studied over the past years. The lack of attention to and interest in the field of pricing, and particularly pricing capabilities, guided the overall research agenda. The overall design for addressing the research questions embraces a mixed methods approach (Creswell, 2009) and is aligned with the declared research gaps and the related research questions shown in Figure A4. Three distinct empirical studies were designed and executed sequentially from 2010 through 2012 (one qualitative inquiry and two quantities surveys).

Development of an integrated model

We propose a model for the adoption and internalization of pricing over time. This model depicts the interconnection between technical pricing capabilities and organizational capabilities at every stage of the pricing transformation. On the basis of our research findings and practical experience in conducting such a pricing transformation, in the next section, we discuss five stages of transformation toward pricing excellence.

Stages of Transformation – There are five distinct stages of transformation (see Figure A5). During each stage, technical pricing resources are deployed and necessary pricing activities are implemented. Stage 1 is a stage of realization and exploration during which a firm's managers understand the nature of their problems and engage in search (Cyert and March, 1963) and mindful scanning behaviors (Fiol and O'Connor, 2003) to explore potential solutions.

From Stage 1 on, and assuming they have found potential solutions, firms proceed to stage 2 to build a knowledge foundation in pricing to prepare the future. At this stage, technical pricing activities might include conducting training on basic technical concepts. This stage is critical for initial cultural appropriation of future pricing resources (Geels, 2004). Stage 3 is the phase of experimentation during which pilot projects are conducted. Firms stay in experimentation mode until success is demonstrated across several pilot projects. Stage 4 is a step of increased adoption once technical pricing capabilities prove successful in delivering the intended outcome. Finally, Stage 5 is an acceleration of the transformation process with the deployment of pricing resources at the enterprise level. At this stage of the transformation, pricing has become embedded in the fabric or DNA of the firm (Forbis and Mehta, 1981). The journey through the stages is different for each firm. Firms will adopt various pricing resources at different stages, and each stage may be longer or shorter depending on the organization's capacity to change and learn. There is no copy-and-paste template for this process. Each firm will have to design a specific roadmap in order to undertake this journey and reach the desired level of performance.

Constant interaction between technical and social dimensions

As technical pricing resources are deployed in the organization, constant interactions occur between the technical and social dimensions of change. Organizational change is a learning process that requires the development of a learning community inside the firm (Pasmore, 1995) and among users of technology. Because deployed pricing resources become increasingly technical and complex at each stage the intensity of learning must remain high level at each stage. Two organizational capabilities associated with pricing – organizational confidence and organizational change capacity – will also grow in intensity from stage to stage, as depicted in Figure A6. The increase in intensity is correlated with the increase in organizational scope of the programs as well as the increased level of complexity. The third organizational capability, related to championing behaviors, remains constant throughout the journey to provide sustained support and drive to the overall implementation (Liozu *et al*, 2014). All three organizational capabilities were positively and significantly linked to relative firm performance composed of sales growth, profit, and pricing power.

Dynamic learning environment

A critical element of this capability assimilation model is the feedback loop between the various stages indicating a need to experiment with pricing concepts and resources. Experimentation may lead to increased success and therefore increased adoption (Thomke, 2003). But it may also lead to failures and a need to modify the roadmap for this difficult transformation. Pilot studies and projects happening in Stage 3 of the transformation are therefore critical to ensure that pricing technologies are deployed successfully and supported by the appropriate capabilities and to show a significant impact to the bottom line. Feedback loops are important to ensuring that the pace of change is controlled and that firms move from stage to stage when ready. Pacing changes and ensuring high levels of absorptive capacity (Cohen and Levinthal, 1990) are part of the required behavioral repertoire leaders must adopt to promote knowledge assimilation and cultural appropriation (Geels, 2004).

Implication for pricing and its profit impact

By developing conceptions of technical and social pricing capabilities, we hope that pricing practitioners might realize the complex nature of technical and social pricing capabilities. This realization then may lead to a desire to further explore both dimensions of these capabilities and request additional training focused on social and organizational elements of change. Our quantitative studies revealed a very significant and positive relationship between pricing capabilities and relative firm performance. We hope that pricing leaders in charge of pricing resources, programs, and activities will find these results useful with respect to designing and organizing pricing roles and responsibilities, and to reinforcing their firm's pricing sophistication by adopting modern pricing methods and organizational design. Showing the link between pricing capabilities and relative firm performance can help to build more credibility for the pricing discipline and to make the case for greater future investments.

VALUE QUANTIFICATION AND FIRM PERFORMANCE IN INDUSTRIAL MARKETS – AN AGENDA FOR INQUIRY, ANDREAS HINTERHUBER

Pricing is certainly a key function in business: 'Of all the tools available to marketers, none is more powerful than price' (Han *et al*, 2001, p. 435). In industrial marketing, pricing has one further, distinctive twist: industrial marketing managers must quantify the benefits delivered to customers in order to document that the quantified value delivered to customers is larger than the price or, with competition, that the quantified incremental value over the customer's best available alternative is larger than the price premium. To be clear: Industrial marketing managers must quantify both value and price.

This is not the case in consumer products: consumers translate perceived value into utility and will purchase only if this self-calculated utility is larger than the purchase price (Miller *et al*, 2011).

Value in B2B markets 'is the worth in monetary terms of the economic, technical, service, and social benefits a customer firm receives in exchange for the price it pays for a market offering' (Anderson *et al*, 2008, p. 6). According to this view, value is equal to the sum of the benefits customers receive as a result of the purchase. This conceptualization, quite frequently used in the marketing literature (Forbis and Mehta, 1981; Nagle and Holden, 2002; Hinterhuber, 2004; Liozu *et al*, 2012) as well as in the strategic management domain (Priem, 2007) has the advantage that value is quantified independently of price: changes in, for example, prices, discount levels or payment terms do not change the amount of customer value as defined here. Industrial purchasing managers will thus buy from those suppliers offering the largest absolute difference between value and price (Anderson *et al*, 2006).

Value quantification is thus a core and distinctive element of industrial marketing. The value proposition (Lanning and Michaels, 1988) or alternatively, the value word equation (Anderson *et al*, 2006) are instruments designed to translate customer value into quantified, monetary benefits: Anderson *et al* (2006, p. 96): 'a value word equation expresses …. how to assess the differences in functionality or performance between a supplier's offering and the next best alternative and how to convert those differences into dollars.'

Numerous studies suggest that very few sellers have the capabilities to quantify the value proposition for their customers (Anderson *et al*, 2007; Hinterhuber, 2008a). Practicing managers concur: Snelgrove (2013), Chief Value Officer of SKF states: 'Best in class companies have taken the time, effort, and focus to quantify the value of their products and services. If you can't, purchasing will have no choice but to ask for a lower price.'.

Intuition would suggest that the ability to quantify and document value to customers positively influences performance in industrial markets; so far, however, we do not have empirical data to substantiate this intuition. Value quantification is thus a substantial problem of practice as well as an area where further academic research is warranted.

Quantifying value in B2B markets – challenges

Value is not an inherent property of goods and services, but a property that customers ascribe to them. This poses three challenges: the multidimensionality, the subjectivity and the discoverability of value.

First, value in industrial markets is multidimensional (Hinterhuber, 2008b; Terho *et al*, 2012): suppliers create value for their customers by providing tangible, quantified financial benefits (that is, revenue increase, cost reduction, working capital reduction and risk reduction) as well as by providing qualitative, intangible benefits (for example reputation, experience, relationship benefits, status and ease of doing business). Customer value quantification thus inevitably requires quantifying both financial benefits as well as non-financial, qualitative benefits into one monetary measure of total customer value created; the relative importance of financial versus non-financial benefits will vary across offerings and customers. Aggregating financial and qualitative benefits into one monetary measure of total value created is a non-trivial challenge: many of the available approaches to quantify customer willingness to pay (for example, conjoint analysis, BDM) require sample sizes that are larger than the ones typically available in industrial markets. As a consequence, the literature suggests to retort to expert estimates to estimate customer willingness to pay (for example, Nagle and Holden, 2002; Anderson *et al*, 2007), but so far we do not have a single rigorous study comparing the performance of these approaches with real purchase data or with the value actually delivered to industrial customers.

Second, value is subjective, that is, customer-specific (for example, Grönroos, 2011). Value is always relative to one, and only one customer. With the exception of customized products or services it may, however, not be technically feasible to quantify customer value on an individual basis – a customer segmentation and aggregation is thus required: Broadly defined, customers in industrial markets can be segmented by how they perceive value from suppliers (DeVincentis and Rackham, 1998):

- Price buyers: these buyers invest minimum resources in the relationship with suppliers. The relationship with suppliers is transactional and the primary interface is the purchasing department. The time horizon is short, cooperation is minimal and price is the predominant purchase factor.
- Total cost of ownership buyers: Total cost of ownership (TCO) is the 'sum of purchase price plus all expenses incurred during the productive lifecycle of a product minus its salvage or resale price' (Anderson *et al*, 2008). TCO is exclusively concerned with the cost side of customer value and thus neglects the value of customer-specific benefits (Anderson *et al*, 2008; Piscopo *et al*, 2008). TCO buyers expect to collaborate with suppliers to identify opportunities for joint cost reductions. The relationship with suppliers is consultative and the primary interface is operations (for example, manufacturing). Price is not the main purchase factor if a higher price allows for reducing the overall cost of ownership.
- Total value of ownership buyers. Companies such as SKF have found ways to document to customers the total value created – beyond TCO. This requires that elements such as the quality of the relationship, a track record of superior performance and other soft factors are quantified into a monetary value that reflects the sum of customer benefits created, financial as well as intangible (Snelgrove, 2012). Total value of ownership buyers enter into strategic partnerships with suppliers, exchange know-how and competencies and aim to jointly create more value – as opposed to jointly reducing the total costs of ownership. The relationship with buyers is enterprise wide and the main interface is frequently general management.

The following figure illustrates the impact of differences between customers on subjective perceptions of value (DeVincentis and Rackham, 1998). Figure A7.

Quantifying customer value where differences between customer segments are significant or where segment membership is difficult to establish is thus likely fraught with difficulties. Furthermore, an open research question is: what are factors that explain why different customers assign a different economic value to substantially similar purchase offerings in industrial markets?

Third, value discoverability. Research in consumer markets points out that customer willingness to pay is ultimately unobservable (Voelckner, 2006). Unobservability may not be the main issue in industrial markets – substantial research (for example, Plank and Ferrin, 2002; Terho *et al*, 2012; Keränen and Jalkala, 2014) as well as individual practitioners (Snelgrove, 2012) point out that industrial suppliers go great lengths to quantify and document value to customers.

The main issue in industrial markets rests on the weak, quite possible negative, incentives customers have to fully reveal the total value created by their suppliers which, *de facto*, is value co-created together with their suppliers (Grönroos and Voima, 2013): Recent qualitative research suggests that customers are very reluctant to fully reveal the total economic benefits that products or solutions create within their organization (Rosenback, 2013). One reason is the fear that the documentation of the full economic value created could motivate suppliers to ask for a commensurate price increase. In other words, suppliers do have incentives to document that the total value exceeds the purchase price or, with competition, that the incremental difference in value between alternative suppliers exceeds the price premium. In the organization of their customers the total value created may exceed this amount by a very substantial amount, and customers will be very reluctant to reveal this to their suppliers; customers will, of course, reveal all those instances where the value actually realized falls short of the value promised. So far, academic research has not yet found convincing answers on how to motivate customers to reveal the full economic value co-created with their suppliers without triggering requests for price increases by their suppliers. Value in B2B markets may be observable by customers, but it may be difficult to discover by suppliers.

A tentative research agenda

In light of the above it seems worthwhile to conduct systematic research to answer the following questions:

- What are value creation capabilities? Quantitative surveys are required to operationalize the construct.
- Value quantification and firm performance: in view of the importance of value quantification in industrial marketing practice it is surprising that we do not know if value quantification leads to superior firm performance. Of particular further interest are contingency and moderation effects.
- The multidimensionality of value: we need approaches that measure the value of qualitative customer benefits (for example, reputation, brand, ease of doing business, relationship quality) as well as the value of quantitative, financial benefits with small sample sizes.
- The subjectivity of value: we need further research that explores why and how different customer segments assign different economic value to substantially similar purchase offerings.
- The discoverability of value: we need further research that explores how suppliers motivate customers to disclose the total economic value created.
- The micro-foundations of pricing: are characteristics at the individual level (for example, psychological traits) an explanation for organizational outcomes in value quantification and pricing capabilities?

This list of research questions should provide a stimulus for further research although it certainly is not exhaustive.

CONCLUDING DISCUSSION

Value assessment and pricing capabilities play a central role when firms want to profit from the value they create and deliver to their customers. We argue that firms should recognize the resources (that is, processes, structures, and people) and collective efforts needed to make value assessment and pricing efficient and reliable, that is, capabilities of the firm.

In this article we have shown how value assessment and value-based pricing capabilities are closely related, and the organizational obstacles associated with deploying and implementing these capabilities at the firm's operational level. We have also argued how these capabilities stretch beyond the sales and pricing domain, and should be viewed as organizational capabilities that provide the foundation for value creation and value appropriation activities in B2B markets. Managers should recognize the firm-wide nature of these capabilities and how they leverage resources from several functions of the firm. By doing so, the firm can establish a foundation that can help to guide value creation and appropriation activities and ensure that firms actually profit from value delivered.

FUTURE RESEARCH

While this article provides a synoptic view of important areas related to value assessment and pricing capabilities in B2B markets, future research could take a more in-depth approach, and investigate how these capabilities, or their deployment and the related challenges, varies across different business contexts. Another interesting research area would be to outline the differences and interdependencies between value assessment and pricing capabilities. Since value creation is the core element of profitable exchange, firms need more understanding on the capabilities that allow them to successfully appropriate a profitable portion of the value delivered. From this perspective, future research would benefit greatly from integrating the fields of marketing, pricing, and strategy, within which advances so far have been partly done in parallel. An increased cross-fertilization of these areas would most likely help us moving forward toward a better understanding of how firms can profit from the value they create and deliver to their customers and broader stakeholder networks.

NOTE

1 By value creation, we refer to the total value that is created in a collaborative exchange between a supplier and a customer, and by value appropriation, we refer to the net value that a supplier (or a customer) can successfully claim (see for example, Wagner *et al*, 2010). While the service-logic of marketing (for example, Grönroos, 2011) advocates a different conceptualization, where *value creation* refers to customers' activities, and *value generation* to suppliers' activities in creating value-in-use, we use the term 'value creation' to refer to the collaborative activities between suppliers and customers.

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APPENDIX

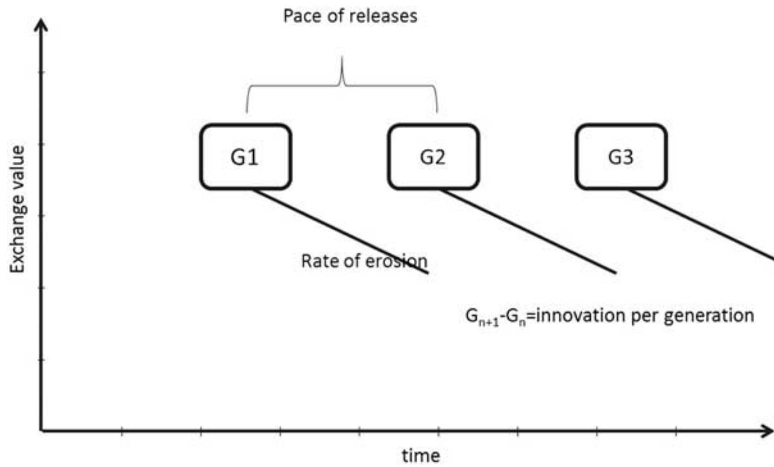

Figure A1: Pace of product generation releases, value level and erosion.

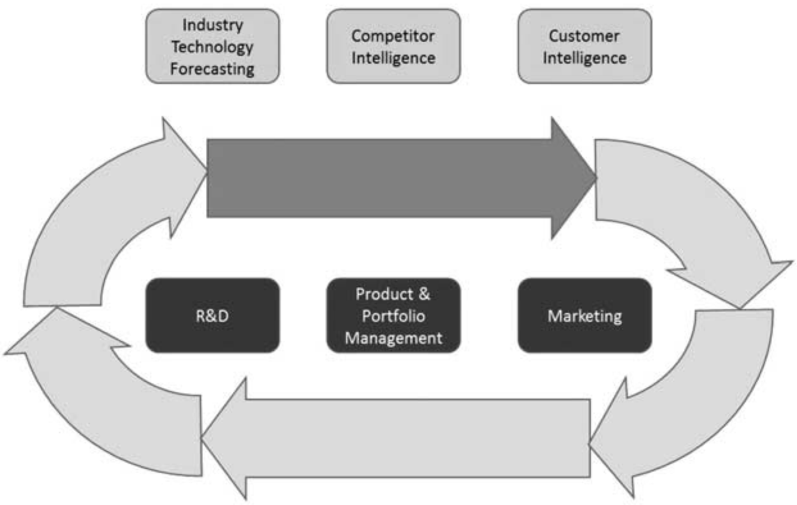

Figure A2: Value assessment capability – iterative and integrative, example functions.

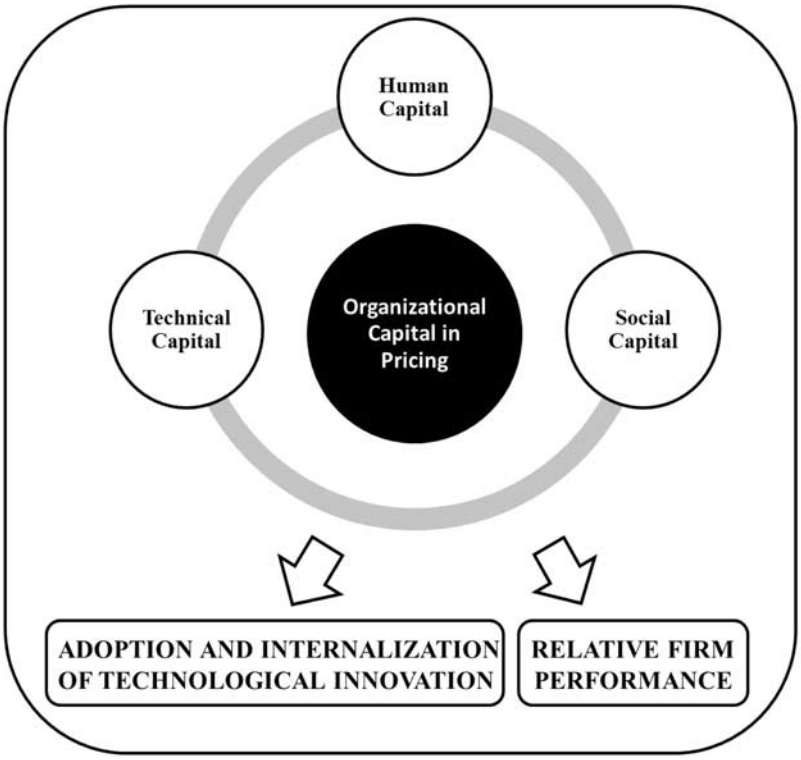

Figure A3: Overall theoretical hypothesis.

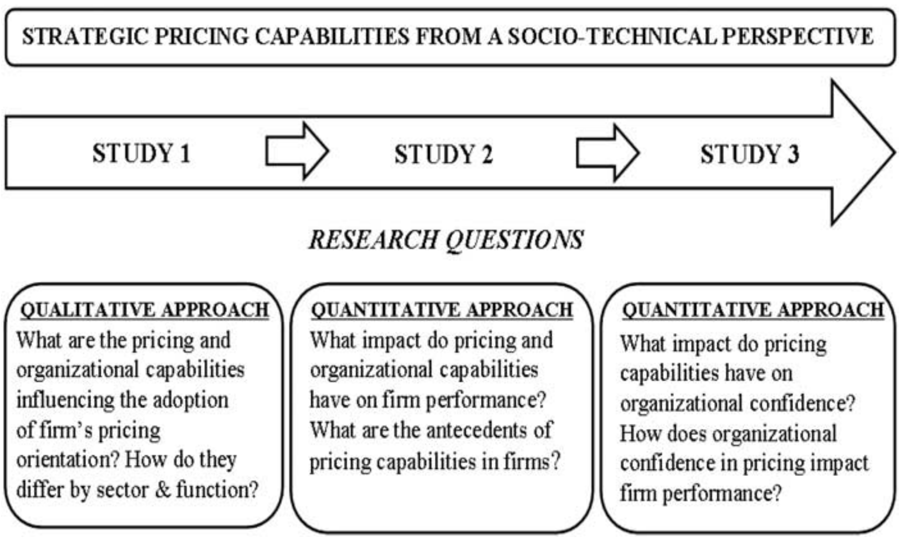

Figure A4: Overall research design.

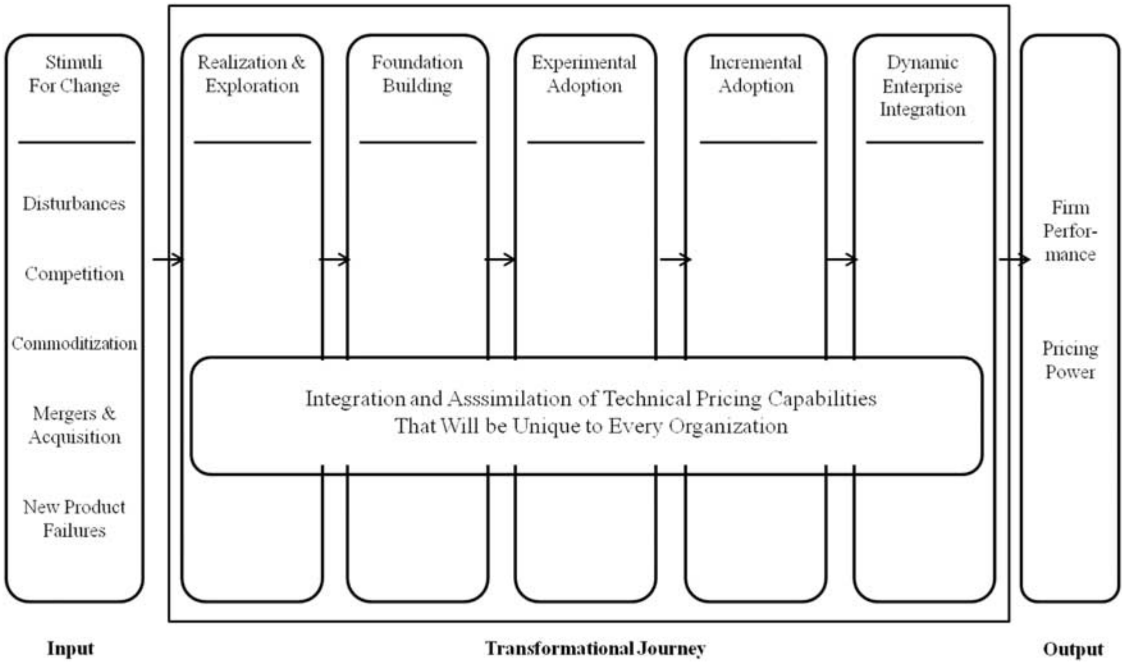

Figure A5: Stages of the transformation process.

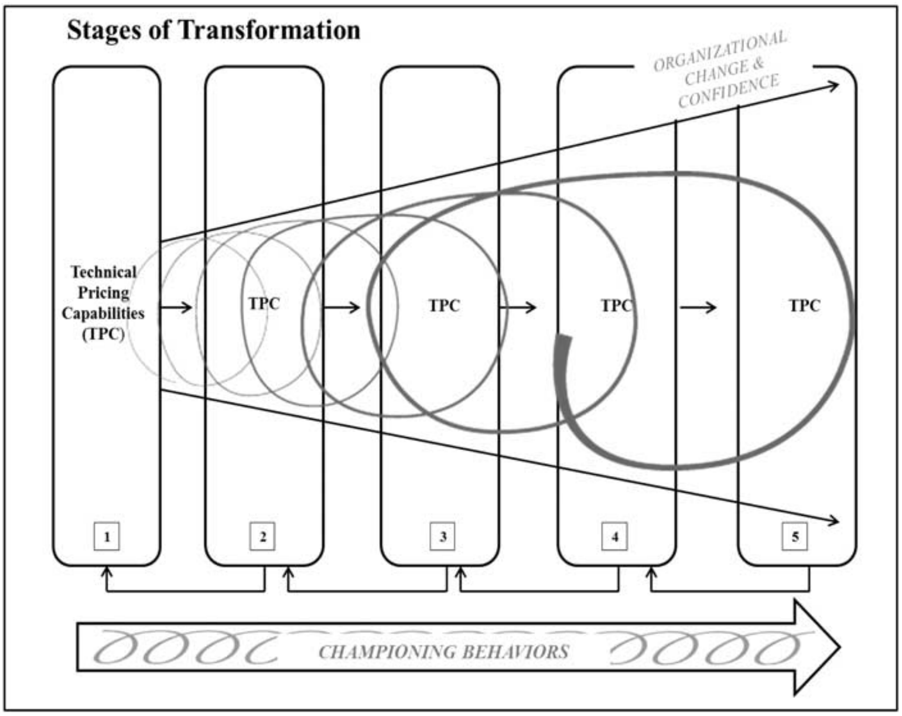

Figure A6: Toward a model of pricing as a socio-technological innovation.

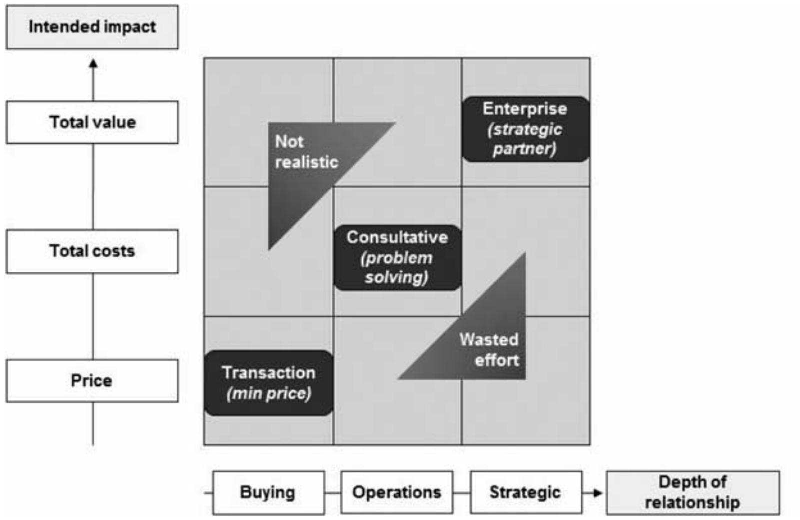

Figure A7: A classification of industrial customers by value perceptions (DeVincentis and Rackham, 1998).

Research Article

The impact of practitioner business rules on the optimality of a static retail revenue management system

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ABSTRACT Retailers engaging in revenue management rarely implement theoretically optimal prices from an optimisation system directly. Rather, they adjust these with business rules – simple empirical guidelines derived from best practices – such as using discrete price points ending in '9'. Similarly, competing objectives of maximizing sales or store visits are regularly considered, which may contrast the profit optimal solution. Although these rules obviously constrain the solution space for the price optimization, little is known about their consequences on overall profits. This study provides an empirical analysis on the impact of commonly used business rules of using (i) discrete price points, (ii) maximum price moves, (iii) corridor pricing and (iv) passive pricing on the size and the quality of the problem's solution space and their monetary impact. As expected, we find that each additional business rule further constrains the solution space, offering fewer valid price vectors. However, while the combinations of multiple rules substantially reduce the solution space and yields suboptimal solutions that deviate up to 20 per cent from the profit maximum, the application of only individual rules will still provide some optimal solutions. At the same time, business rules enable the estimation of larger assortment subcategories, which allow results more representative for retail practices. This suggests that price vectors which reflect business rules allow not only an increased adherence to business reality, but may lead to little or no deviation from the optimal solution for larger assortments than in unconstrained optimization systems.
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Keywords: retail revenue management; price optimisation; business rules; retail strategy

INTRODUCTION

The adoption of Revenue Management (RM) in retail exhibits different levels of progress: while research on the 'classical' RM problem of dynamic price optimization for markdown management is established, as well as promotional pricing, the task of static price optimization to determine optimal undiscounted base prices has received less attention (Kunz and Crone, 2014). The emphasis in static retail pricing research has been on finding optimal price vectors with complex demand and optimization models, but the challenges of demand model estimation, and the computational burden of optimization has often limited the analysis to small sub-categories and hence restricted practical relevance of the findings.

Further, retail pricing research has largely ignored prevalent industry practices of balancing multiple objectives, and applying discretionary pricing rules. The latter are often referred to as business rules and exist in various forms and usually impose numerous restrictions on viable price solutions, such as considering only discrete price points ending in '9', or limiting price moves to a minimum-maximum range. Hawtin, 2003 documents how common and important such rules are in retail pricing practice and provides a practical account of the role and the impact of business rules on the financial performance of a commercial retail RM system. Similarly, Natter *et al* (2006), Natter *et al* (2007), and Natter *et al* (2009) – in the following 'Natter and colleagues' – confirm the importance and effectiveness of business rules from an implementation project for an Austrian DIY retailer. While it is intuitively clear that such business rules will restrict the solution space by excluding viable price vectors, their study revealed that by applying such business rules, a full enumeration of the problem became feasible. Given the vast assortments of their industry-sized problem, this was an unexpected finding and a direct benefit derived from the use of business rules. However, Natter and colleagues used a simplified regression based approach, instead of modelling cross price effects with the more rigorous class of choice models conventionally applied in academic studies.

In contrast, the impact of business rules on the solution space has not yet been assessed for a system that relies on the prevalent class of choice based demand models. If the findings from Natter and colleagues could be generalised across demand models, a full enumeration might be feasible for larger problem instances, that is, larger retail subcategories or indeed full categories. This could make research insights more representative regarding problem size, and at the same time more relevant to retail practice because of the adherence of the solution to business rules. As these rules are ubiquitous in practice, the significance of these findings could be substantial.

Similarly, in practice retailers often consolidate multiple objectives across the assortment by combining profit maximization of one subcategory with the maximization of revenue or unit sales (often used as a metric for footfall) for another. More often, a true multi objective solution that simultaneously balances several of these objectives is targeted while price vectors which are optimal given a single objective are often deemed undesirable in practice. However, most research studies attempt to determine optimal prices solely on profit maximization.

This article investigates the effect of business rules on the solution space of an exemplary static retail price optimization problem that is based on a choice style demand model. The article's contributions are twofold: First, we extend the work of Hawtin (2003) and consider four experimental business rules of using (i) discrete price points, (ii) maximum and minimum price moves, (iii) corridor pricing, and (iv) passive pricing at different levels of restrictiveness, and combinations thereof. Second, we analyze their monetary implications in constraining price vectors which maximize the different single objectives (i) profit, (ii) revenue, and (iii) unit sales, as well as a (iv) balanced multiple objective solution. Drawing on the study by Natter and colleagues, for each of these scenarios, we assess the size, quality, and properties of the solution space and determine under which of the business rules scenarios full enumeration is feasible. We further assess their effect on profitability, revenue, unit sales maximization or a composite combination of multiple objectives.

The article is organized as follows: The section 'Practical considerations in retail pricing' reviews the business rules typically used by retailers.

We then briefly describe a choice based price optimization system, and discuss the methodology that includes 14 business rule scenarios as well as the data used in the section 'Demand model, methodology, and data'. Next, the impact of these scenarios on the size (section 'Size of the solution space') and the quality (section 'Impact on the quality of the solution space') of the solution space is assessed, followed by an evaluation on the monetary results of the system (section 'Impact on the monetary results').

PRACTICAL CONSIDERATIONS IN RETAIL PRICING

Business rules

Pricing heuristics and business rules are ubiquitous in retail practice. These often constitute time-honoured pricing principles that can be traced back to earlier, often analytically unsupported, discretionary pricing practices of the industry (for example, Kopalle, 2010). Even though retailers sacrifice a large part of their pricing freedom with these rules, they are often deemed imperative to either ensure price, quality or size integrity and therefore customer satisfaction, to satisfy manufacturer and vendor relations, to preserve competitiveness and financial budgets, or to assure compliance with price strategy and commercial policy. In the following, we discuss four of the most popular categories of retail pricing business rules, which are regularly employed individually or in combination with each other.

(D) Discrete price points: The practice of relying on a set of discrete price points, such as prices ending in '5' or '9', is often referred to as 'rounding rules' (Hawtin, 2003) or 'odd pricing' (Baumgartner and Steiner, 2007) and has been enjoying a great deal of attention in marketing research. The motivation that drives this ubiquitous practice is based on behavioural insights that indicate that customers do not notice final digits (Anderson and Simester, 2003) as well as on an expected discontinuity in price response functions. Findings as to whether this practice is worthwhile are inconclusive. However, despite its ubiquity, studies on its effect remain inconclusive, ranging from large effects (for example, Anderson and Simester, 2003) to marginal or no effects, or showing benefits dependent on the item properties, category (Macé, 2012), or the customer (Baumgartner and Steiner, 2007).

(M) Maximum and minimum price move: Retailers frequently limit price changes to a minimum or maximum price move up or down, defined as a percentage or an absolute value. The maximum price move is often enforced to prevent an unpleasant surprise for customers by an extensive price change, often referred to as 'Sticker Shock'. The minimum price change is primarily motivated by the operational cost attached to changing a price in stores which can be significant (for example, Levy and Bergen, 1997), although this cost has been moderated by the recent advent of digital price tags. As the optimal price vector following optimization can suggest substantial price changes across many products, yet provide only a marginal additional profit, these solutions, even though optimal, might be excluded in practice.

(C) Corridor pricing: These more intricate rules are often applied to ensure size and quality integrity within a category. For one, retailers ensure that sizes of the same product are priced in relationship to each other, so that the unit price of a multipack is not below that of the single unit. Further, retailers like to safeguard the positioning of individual brands in the assortment so that the price of store brand, national brands, and premium brands keep a predefined 'distance' to each other and cannibalization is minimized.

(P) Passive pricing: Retailers often passively adopt established or externally set prices for certain items. Often this is done for a small subset of articles in the assortment, to assure that the price of these items stays within close proximity to the competition. Usually these are frequently bought 'signpost items' for which shoppers are expected to have extensive price knowledge and that are therefore considered to be indicative of the store price level (Anderson and Simester, 2003). Also, retailers often agree with manufacturers or

vendors to stay within a given price range or even adhere to fixed price points.

Although it is apparent that such constraints will reduce the number of viable price vectors and hence limit the solution space, it is unclear how much these constraints will affect the final result, for example, profit optimum. Furthermore it is unclear how combinations of these rules interact, and under which combination of constraints a complete enumeration might become feasible.

Multiple objectives

Another dimension that significantly shapes pricing practices of retailers is the existence of multiple, and competing goals underlying the pricing process as retailers often define sub-category or category specific pricing objectives. In a typical scenario, one sub-category will act as a footfall generator and is therefore priced to maximize unit sales in the category, while another is priced for profitability or as a revenue driver. Most of the time, the retailer will try to simultaneously balance and trade off a number of these objectives. Surprisingly the vast majority of the academic literature is primarily focused on profit optimality, yet purely profit optimal prices are usually not accepted in retail pricing practice as can be seen by most industry accounts (for example, Chintagunta, 2002; Natter *et al*, 2007; Subramanian and Sherali, 2009). The consideration of these competing objectives is therefore often identified as a promising, and important area for future research (for example, Levy *et al* 2004). As multi objectives significantly shape pricing practices of retailers, an assessment of the impact of business rules should be considerate of multiple objectives and combinations thereof, and not just profit.

DEMAND MODEL, METHODOLOGY, AND DATA

Demand model

A valid demand model is required to estimate demand given the unconstrained or constrained price vectors, and to further assess the quality of the price vectors based on their financial performance (that is, profit, revenue, unit sales or a combination). A comprehensive overview of demand models can be found in Huang *et al* (2013), and in regards to retail price optimization in Kunz and Crone (2014).

We consider a demand model in accordance with González-Benito *et al* (2010), and model demand as a two-step process: First, we determine market share π_i of product i as a function of all prices $\vec{p}$ where α_i is the product specific attraction parameter and β is the price sensitivity parameter. As described in function (1), the market share is determined in a choice model style configuration based on the attraction of the individual product $exp(\alpha_i+\beta p_i)$ in relation to the aggregated attraction of all products I that constitute the category.

$$\text{Market share:} \quad \pi_i = \frac{exp(\alpha_i + \beta p_i)}{\sum_{j=1}^{I} exp(\alpha_j + \beta p_j)} \qquad (1)$$

In a second step, we model category volume in terms of unit sales q as a simple linear regression with parameters γ and ζ, where category price level l is the only covariate. The latter is determined as the sum of product individual prices p_i weighted by market share π_i as described in (2).

$$\text{Unit sales:} \quad q = \gamma + \zeta l \qquad l = \sum_{i=1}^{I} \pi_i p_i \qquad (2)$$

Note that this model is distinct to the one used by Natter and colleagues, which incorporated asymmetric, item-specific profit lift effects based on market basket data into the profit function, instead of modelling cross price effects with one of the more rigorous choice models conventionally used in research.

Methodology

We seek to assess the impact of applying empirical business rules on finding optimal static retail prices, profit, revenue and unit sales. Extending the work of Natter and colleagues of fully enumerating such a problem, we assess the impact of these rules on the size of the solution space, the optimality and frequency of viable solutions, as well as potential trade-offs. For the purpose of this study, we will define a set of typical scenarios of the business rules described in section 'Business rules' and compare them with a full and unconstrained solution space, denoted by (Full). For 3 of the 4 condition classes (D, M, and P), we define both a less and a more restrictive condition; for condition class C we evaluate a single scenario:

- Unrestricted search space with all price points available
- Discrete price points
  - Prices ending in '5' or '9' only
  - Prices ending in '9' only
- Maximum and minimum price move
  - Price move minimum +/−1 per cent and maximum +/−15 per cent (or unchanged)
  - Price move minimum +/−3 per cent and maximum +/−10 per cent (or unchanged)
- Corridor pricing
  - Prices within price tier ($p_{tier_1} < 2.50$, $2.50 \leqslant p_{tier_2} \leqslant 3.00$, and $p_{tier_3} > 3.00$)
- Passive pricing
  - Top 20 per cent of products unchanged (highest market share)
  - Random 20 per cent of products unchanged

In addition, we consider combinations of the individual business rules that are most common in practice: (D1M1), (D1M1C1), (D1M1C1P1), (D2M2), (D2M2C1), (D2M2C1P2). In total, we consider 13 different sets of business rule conditions in addition to the unrestricted case (Full).

We first address the original motivation for this study and look into the size of the solution space and the possibility of fully enumerating the problem given the business rule conditions defined above. The idea of full enumeration can only be entertained under the premise that price is discrete. We therefore consider 0.01 monetary units the smallest available unit which constitutes a price point. An obvious limitation here is that the actual size of the solution space is dependent on the absolute price level. We continue by fully enumerating the problem for different sizes of sub-categories. This will allow us to comment on how the rules above impact the solution space. We then consider the effects of these conditions under four different objectives as formulated in function (3): we either consider unit sales q, revenue r, profit g where c_i represents product specific cost, or a weighted multi objective function m similar to the one used by Natter and colleagues.

$$f = \begin{cases} \sum_{i=1}^{I} (p_i - c_i) q \pi_i & = g \quad \text{(profit)} \\ \sum_{i=1}^{I} p_i q \pi_i & = r \quad \text{(revenue)} \\ \gamma + \zeta l & = q \quad \text{(unit sales)} \\ 0.7\, g + 0.2\, r + 0.1\, q & = m \quad \text{(multi objective)} \end{cases} \tag{3}$$

As we will see in the course of the study, we will evaluate scenarios that we cannot fully enumerate. In these cases, we numerically determine the optimal solution as a base for comparison by solving the non-linear programme described in (4) for each of the functions presented in (3).

$$\begin{aligned} \textit{Programme}: \quad & \max_{p_i} \quad f \\ & \text{s.t.} \quad p_i \geqslant c_i \quad \forall\ i \\ & \qquad l \geqslant -\gamma / \zeta \\ & \qquad l = \sum_{i=1}^{I} \tilde{\pi}_i p_i \end{aligned} \tag{4}$$

The first two constraints prevent pricing below cost, and non-negativity of the category model. The last line determines that for price level l, market share $\tilde{\pi}_i$ is a constant.

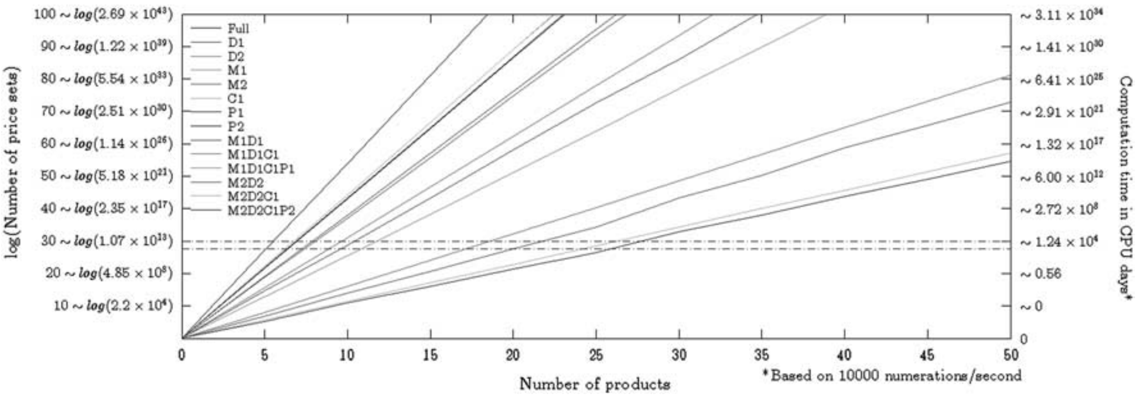

Figure 1: Number of price sets under various business rule scenarios.

This assures the structural integrity of the approach. It rests on the assumption that category unit sales are determined by the attractiveness of the category described by price level *l*. Here, the market share is the weight of the individual product in the customer's overall category price perception.

Data

For expositional purposes we focus on a single data scenario that provides an example of a generic retail category. Data and demand model parameters are determined within the bounds typically seen in our empirical work and yield results that are comparable to those encountered by Natter and colleagues and Hawtin (2003).

We allow the cost in our data to vary between 1.86 and 3.23, with revenues and profits resulting from the price vectors determined accordingly. To facilitate a full enumeration we impose two very liberal constraints on the data, and hence the search space: As a lower bound, we establish $p_i \geqslant c_i$. Even though the use of 'loss leaders' is common retail practice, pricing below cost is often unlawful. Given the properties of our model and the scope of our study, we can exclude this aspect without compromising the value of the results. For the upper bound, there is no such obvious option. We therefore arbitrarily chose $p_i < 2c_i$ which, if surpassed, would imply a margin of 100 per cent or more. Given the empirical reality of usually much smaller margins in grocery and fast-moving consumer goods retailing, and the questionable predictive quality of any demand model in the case of such vast price changes, this seems unlikely to exclude empirically relevant price vectors. We do note however, that this data condition may not hold in all retail formats (for example, fashion retail).

Table A1 in the Appendix provides an overview of the products, and the demand model parameters used, as well as of the model results that maximize the objectives considered.

IMPACT ON THE PRICE OPTIMIZATION SYSTEM

Size of the solution space

As a first step, we want to illustrate the actual dimension of the problem by observing the numerical size of the solution space and how it is affected by the restrictions described in the section 'Methodology'.

Figure 1 shows the exponential growth of the solution space under the various restriction scenarios. As a function of the number of products (x-axis), the number of possible price vectors is depicted on a log scale (left y-axis) and the corresponding computing time needed for exhaustive enumeration is shown in CPU days (right y-axis). With each restriction imposed, the number of price sets and therefore the size of the solution space greatly reduces as noted in the diminishing slope of the lines. However, the effect of the combinatorial explosion even at small problem instances is evident. (D1) and (D2) are virtually identical since under both scenarios the number of products is reduced by 20 per cent. By applying all business rules simultaneously as it is done under (D1M1C1P1) and (D2M2C1P2) we limit the possible price points between 1 and 6 per item. Even under such a highly restrictive scenario, we have 4.61×10^{25} possible price vectors for an assortment of only 50 products.

The combinatorial explosion is reflected in the indicated computational time needed for full enumeration: Assuming a rate of 10 000 price set evaluations per second, a rate we were able to achieve easily even though our implementation was focused on analytical convenience rather than computational efficiency, the evaluation of 4.61×10^{25} price sets would require 146 trillion (1.46×10^{14}) CPU years. The horizontal corridor in Figure 1 indicates the region between 1–10 trillion price sets ($log(10^{12}) = 27.63$ to $log(10^{13}) = 29.93$) with a corresponding computational time between 1562 and 11532 CPU days. For the purpose of this study we will determine this as a reasonable threshold for what we consider still viable for full enumeration given current computing standards and the possibility of parallelization. On the basis of this we can enumerate (Full) up to five products as any larger scenario already leaves the corridor of computational feasibility, with the number of price vectors surpassing half a trillion combinations ($log(6.04\times10^{11}) = 27.13$). For the purpose of this study, we will gradually increase the level of dimensionality by focusing first on five products for which full enumeration for all scenarios is still possible, 10 products that can still be enumerated if more than one business rule is applied, and 20 products that can only be enumerated for the most restrictive cases (D1M1C1P1) and (D2M2C1P2).

Impact on the quality of the solution space

We illustrate the impact of the business rule scenarios on the size and the quality of the solution space by fully enumerating the problem for the five products case. Figure 2 shows the complete feasible set – that is, the number of available price vectors – for each of the 14 business rule scenarios discussed in section 'Methodology'. For each scenario, the distribution of the available price vectors in regards to (i)profit, (ii)revenue, (iii)unit sales, and (iv)multi objective as defined in (3) is illustrated. The height of the bars indicates the number of feasible price vectors on a logarithmic scale.

The graphs illustrate how the increasingly restrictive business rule scenarios shrink the size of the solution space from $\approx 5.2\times10^{11}$ feasible price vectors in the unrestricted scenario (Full) to 180 in the most restrictive scenario (D2M2C1P2). We note that the 'discrete price points' restrictions (D1) and (D2), eliminate price vectors across the entire result spectrum, reducing the number of less favourable solutions but still provide optimal solutions that achieve a maximum profit or revenue. However, the remaining rules greatly shift the result space of the feasible set and no longer include any revenue maximizing solutions. For the multi objective case, all scenarios include price vectors that yield results in close proximity to the maximum achievable under the unrestricted case (suboptimality of the most restricted case (D2M2C1P2) $\approx$ 0.8 per cent).

To illustrate the relationship between the shrinking solution space and the multiple objectives of the problem, we further increase the level of dimensionality for this observation to 10 products. For this case we can only fully enumerate the problem for the scenarios (D1M1C1), (D1M1C1P1), (D2M2), (D2M2C1), and (D2M2C1P2). For comparison, we determine an optimal solution for (Full) by numerically solving the programme stated in (4).

Figure 3 shows five surface plots each illustrating the trade off between revenue and

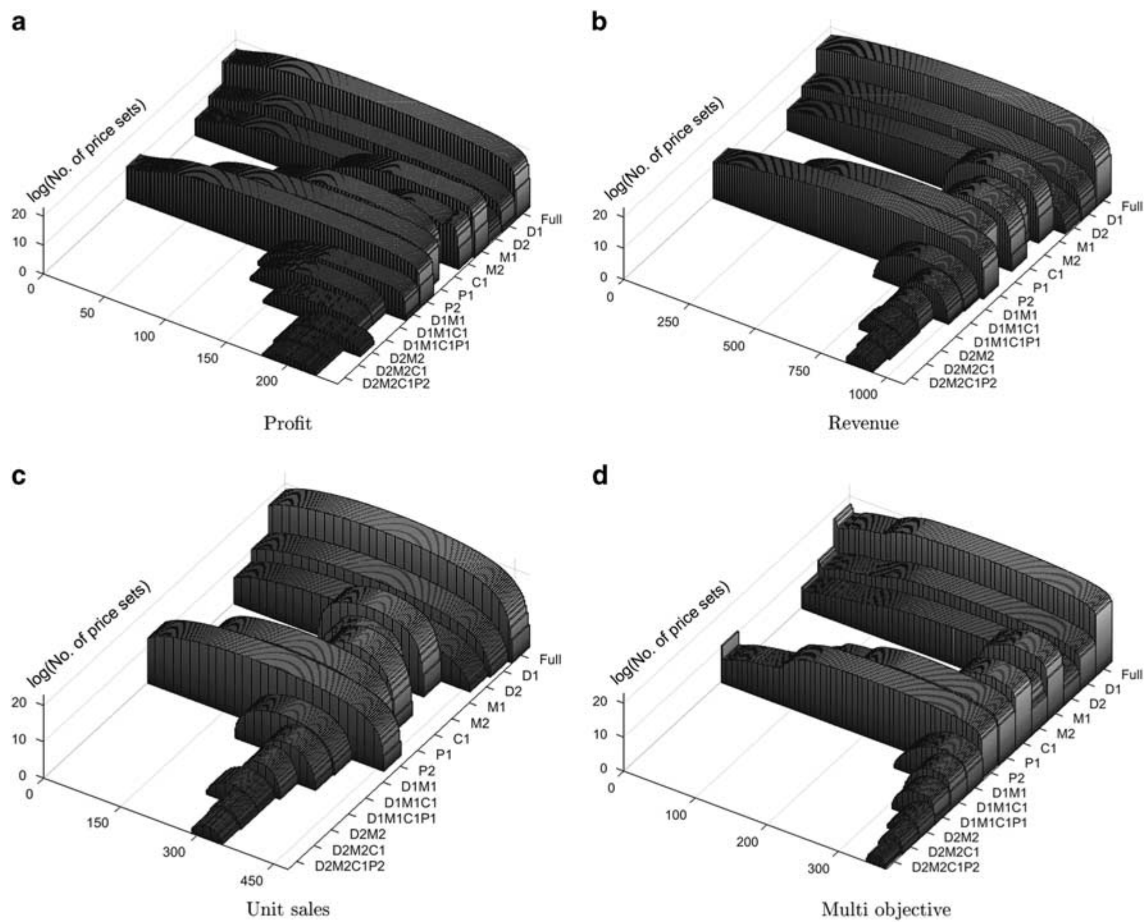

Figure 2: Impact of business rules on size and quality of solution space – 5 products.

profit for one of the business rule scenarios listed above. Once again the vertical axis shows the number of price vectors on a logarithmic scale. The vertical bars represent multi objective optimality (dark), as well as the results given the 'current' price vector (light). The ellipsoid shape of the graph illustrates how price vectors are distributed across all combinations of profit and revenue, with the largest group of price vectors yielding profit $g \approx 188$ and revenue $r \approx 915$ in the least restricted scenario (D1M1C1). The height of the shape decreases as the scenarios become increasingly restrictive and the size of the solution space reduces. Further, we can see how the gap to an accessible optimal multi objective solution (dark bar) extends.

Impact on the monetary results

We now take a closer look at the monetary impact of the above. Figure 4 also evaluates the 10 product case and illustrates the quality of the solutions available under the different business rule scenarios. Here, the number of price vectors is expressed as a percentage of total price vectors available given the restrictions of the scenario. We see that even though more solutions are eliminated by the more restrictive scenarios, the share of solutions in the solutions space that yield price vectors that are advantageous when considering multiple objectives is actually increasing. Only the least restrictive case (D2M2) includes three distinct price sets that come within 0.1 per cent of multiple objective optimality. The most restrictive scenario

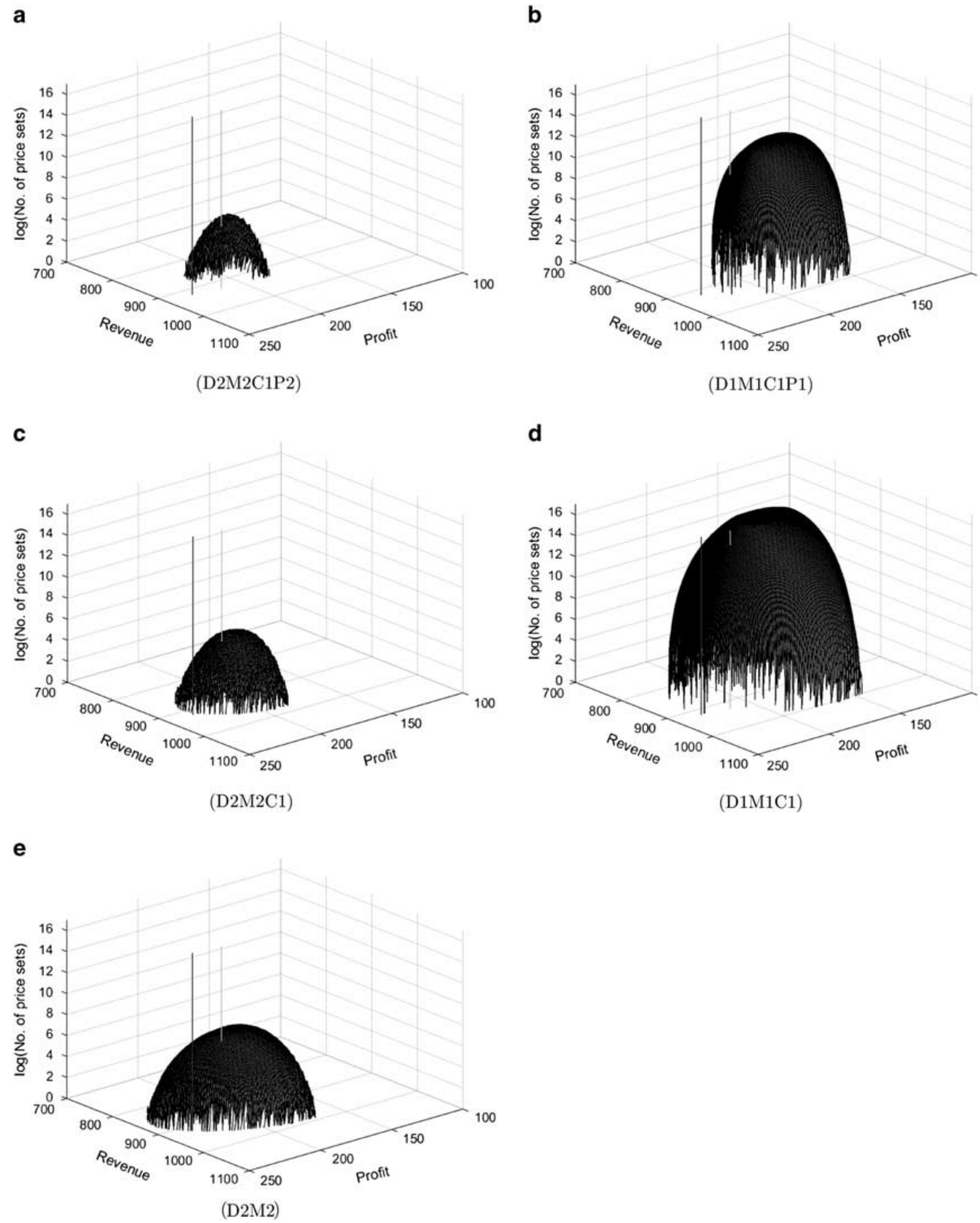

Figure 3: Number of price vectors – 10 products.

(D2M2C1P2) only comes within 2 per cent of optimality yet (D2M2C1P2) yields over 90 per cent (92.24 per cent) of price sets within 6 per cent of optimality.

For the last observation, we further increase the dimensionality of the problem to 20 products. Even though this is still far away from the dimensions of industry size problems, we can

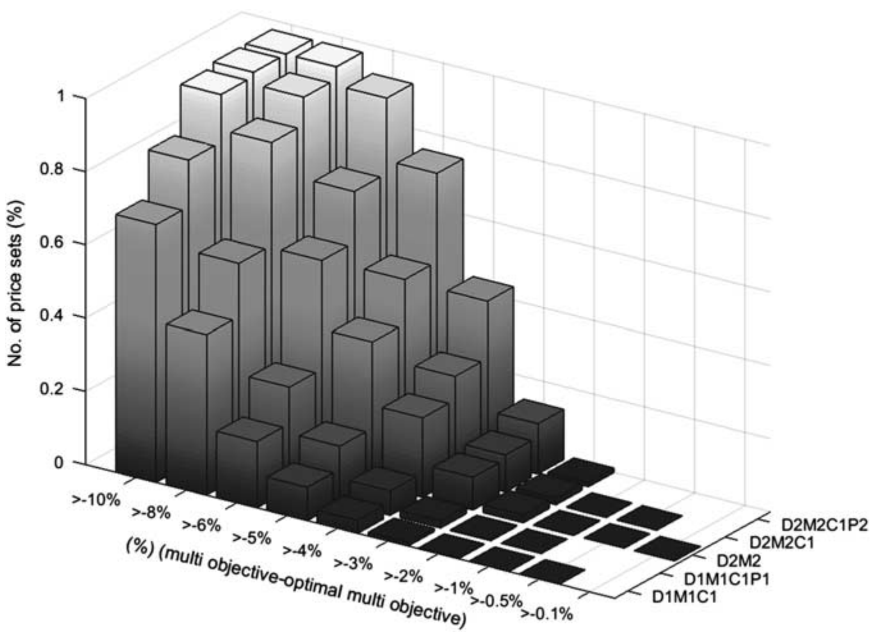

Figure 4: Share of solution space in terms of difference to profit optimality.

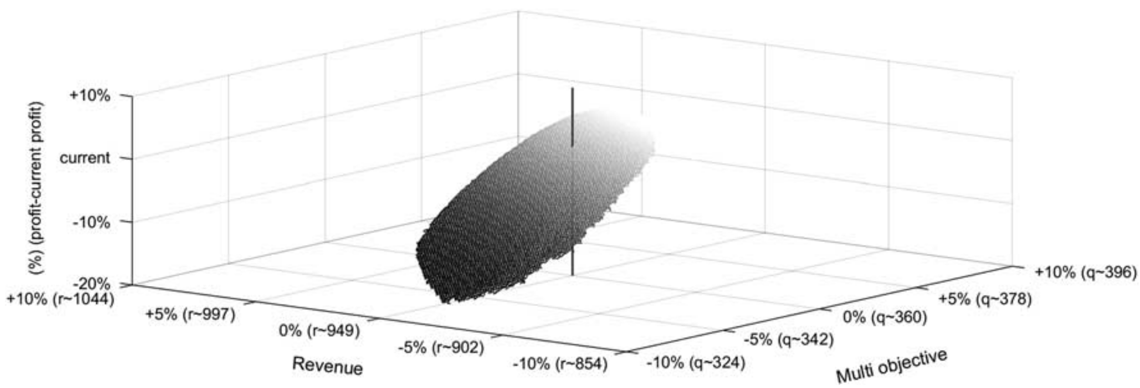

Figure 5: Trade off between profit, revenue and multi objective for scenario (D1M1C1P1) – 20 products.

only enumerate the most restrictive scenarios. For expositional purposes we focus on (D1M1C1P1). Figure 5 provides a high level view on the interaction between profit, revenue, and multi objective and an illustration of the range of the results available in this restricted solution space. The axes of the base show the percentage changes ranging from −10 per cent to +10 per cent of revenue and multi objective in comparison to the results of the initial price vector. The vertical axis shows the profit change of the best possible price vector given the revenue and multi objective change indicated on the base. The vertical bar indicates said 'current' situation – that is, the results of the initial price vector – without any (0 per cent) change in the two measures indicated on the base.

The graph shows the trade off between the 3 objectives with a positive relationship between profit and multi objective, and a negative relationship between revenue and profit. We see that the solution space that remains given the restrictions of (D2M2C1P2) offers limited potential for a profit increase (6.3 per cent) but vast potential for a decrease (−19.4 per cent). The most profitable result in the restricted solution space is therefore almost 24 per cent under the unrestricted profit optimal solution whereas the gap to the multi objective optimum is a mere 2.2 per cent.

CONCLUSION

This brief exploration of the solution space of an exemplary static price optimization system has illustrated the combinatorial challenges implied by even the smallest problem instances. A full enumeration as it was done by Natter and colleagues is only feasible if model formulations are used that exploit alternative ways to cope with cross-price effects. Such models are rarely discussed in the academic literature. As was expected, the imposed restrictions have strong effects not only on the size of the solution space but also on the quality of the solutions in the feasible set. In such high dimensional problems it is hard to evaluate the consequences: As some price vectors become unavailable, others might exist that yield identical results. We have visualized that this applies to our problem only to a certain extent. The monetary implications can only be discussed in a multi objective context. We have seen in our example that the potential gap between optimality for certain multi objective combinations can be significant. The obvious limitation of this study is that it evaluates a single data scenario. Even though we have taken great care to consider a realistic, rather than a convenient example, the results are intended to be descriptive rather than normative. However, as we have seen, some rules drastically limit the 'mobility' of the possible price vector. Even though this might not seem dramatic from a multi objective point of view, the consequences from a single objective perspective seem more severe. However, the results have demonstrated that the restrictions are capable of serving as a risk reduction mechanism: while they certainly eliminate the potential to achieve optimality, price vectors that are substantially suboptimal are reliably excluded. When implementing a price optimization system, the potential risk of 'getting it wrong' is often a main concern of retailers when moving from discretionary pricing to analytical decision making. Considering restrictions such as those explored in this study can help to overcome these concerns while still leaving large potential for improvements. Note that the (still disputed) benefit of discrete price points on demand was not reflected in the demand model, and is hence not considered in the estimated profit, revenue, unit sales or combined objective functions. Incorporating these in the system formulation might yield different results, which require further investigation.

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APPENDIX

Data parameters and model results

We determine initial price $p_i^{(0)}$ and cost c_i for 20 products i within empirical relevant bounds as summarized in section (a) of Table A1. All prices $\overrightarrow{p^{(0)}}$ end in '9' so that the initial price vector is valid under conditions (D1) and (D2). We assign price tiers as defined in condition (C1) so that 20 per cent of the products are priced in $p_{tier_1} < 2.50$, 40 per cent within $2.50 \leqslant p_{tier_2} \leqslant 3.00$, and 40 per cent in $p_{tier_3} > 3.00$. Cost is determined randomly so that the initial product specific gross margin h_i is between 16.7 per cent and 30.1 per cent. Section (b) of the table presents the model results for the 5, 10, and 20 product case. For each of the objectives stated in 3, the model results of the price vector that maximizes the respective objectives are presented: We show the percentage difference between current and optimal price (Δ per cent$(p^{opt} - p^{(0)})$), the difference between current and optimal gross margin ($\Delta(h^{opt} - h^{(0)})$) as well as the absolute and percentage change of the four objectives. Table section (c) presents the model parameters for the category and the market share model.

Table A1: Data parameters and model results

		Product (i)																				
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	$\bar{x}$
(a) Price and cost																						
	Price ($p^{(0)}_i$)	2.49	2.89	2.99	3.59	3.69	2.39	2.59	2.69	3.49	3.39	2.29	2.79	2.59	3.79	3.29	2.19	2.79	2.69	3.99	3.39	3.00
	Price tier	1	2	2	3	3	1	2	2	3	3	1	2	2	3	3	1	2	2	3	3	
	Cost (c_i)	2.00	2.18	2.20	2.45	2.57	2.04	2.04	2.12	2.33	2.35	1.96	2.40	2.02	2.33	2.42	1.88	2.17	2.32	3.23	2.89	2.30
	Gr. Margin (%)	19.7	24.6	26.4	31.8	30.4	14.6	21.2	21.2	33.2	30.7	14.4	14.0	22.0	38.5	26.4	14.2	22.2	13.8	19.0	14.7	22.7
(b) Optimal results																						
max		5 products																				
[g]	$\Delta\%(p^{opt}-p^{(0)})$	14.8	9.2	7.6	0.9	1.2																6.8
	$\Delta(h^{opt}-h^{(0)})$	10.4	6.4	5.2	0.6	0.9																4.7
	Model results:	$g^{max}=240.2$ (9.1%), $r=770.6$ (−12.0%), $q=240.1$(−20.1%), $m=346.2$ (−3.6%)																				
[r]	$\Delta\%(p^{opt}-p^{(0)})$	−19.7	−24.6	−26.4	−31.3	−30.4																−26.5
	$\Delta(h^{opt}-h^{(0)})$	−19.7	−24.6	−26.4	−31.1	−30.4																−26.4
	Model results:	$g=0.8$ (−99.6%), $r^{max}=1065.2$ (21.7%), $q=476.0$ (58.5%), $m=261.2$ (−27.3%)																				
[q]	$\Delta\%(p^{opt}-p^{(0)})$	−19.7	−24.6	−26.4	−31.8	−30.4																−26.6
	$\Delta(h^{opt}-h^{(0)})$	−19.7	−24.6	−26.4	−31.8	−30.4																−26.6
	Model results:	$g=0.0$ (−100.0%), $r=1065.2$ (21.7%), $q^{max}=476.2$ (58.5%), $m=260.7$ (−27.4%)																				
[m]	$\Delta\%(p^{opt}-p^{(0)})$	3.5	−1.2	−2.5	−8.4	−8.3																−3.4
	$\Delta(h^{opt}-h^{(0)})$	2.7	−0.9	−1.9	−6.2	−6.3																−2.5
	Model results:	$g=218.2$ (−0.9%), $r=910.0$ (3.9%), $q=312.4$ (4.0%), $m^{max}=366.0$ (1.9%)																				
		10 products																				
[g]	$\Delta\%(p^{opt}-p^{(0)})$	17.7	11.6	9.8	2.6	2.9	21.0	15.9	15.0	2.3	4.5											10.3
	$\Delta(h^{opt}-h^{(0)})$	12.1	7.8	6.6	1.7	1.9	14.8	10.8	10.3	1.5	3.0											7.1
	Model results:	$g^{max}=253.8$ (18.5%), $r=787.1$ (−15.1%), $q=246.8$ (−26.1%), $m=359.7$ (−2.4%)																				
[r]	$\Delta\%(p^{opt}-p^{(0)})$	−19.7	−24.2	−25.1	−30.7	−30.4	−14.6	−21.2	−21.2	−29.7	−28.8											−24.6
	$\Delta(h^{opt}-h^{(0)})$	−19.7	−24.1	−24.6	−30.3	−30.4	−14.6	−21.2	−21.2	−28.2	−28.0											−24.2
	Model results:	$g=11.3$ (−94.7%), $r^{max}=1069.6$ (15.4%), $q=484.3$ (45.0%), $m=270.2$ (−26.7%)																				
[q]	$\Delta\%(p^{opt}-p^{(0)})$	−19.7	−24.6	−26.4	−31.8	−30.4	−14.6	−21.2	−21.2	−33.2	−30.7											−25.4
	$\Delta(h^{opt}-h^{(0)})$	−19.7	−24.6	−26.4	−31.8	−30.4	−14.6	−21.2	−21.2	−33.2	−30.7											−25.4
	Model results:	$g=0.0$ (−100.0%), $r=1068.5$ (15.3%), $q^{max}=487.8$ (46.1%), $m=262.5$ (−28.8%)																				
[m]	$\Delta\%(p^{opt}-p^{(0)})$	6.4	1.2	−0.3	−6.8	−6.7	9.1	4.9	4.1	−6.8	−5.0											0.0
	$\Delta(h^{opt}-h^{(0)})$	4.8	0.9	−0.2	−5.0	−5.0	7.1	3.7	3.1	−4.9	−3.6											0.1
	Model results:	$g=232.6$ (8.6%), $r=920.9$ (−0.6%), $q=317.8$ (−4.8%), $m^{max}=378.8$ (2.7%)																				
		20 products																				
[g]	$\Delta\%(p^{opt}-p^{(0)})$	19.2	12.7	10.8	3.3	3.5	22.7	17.3	16.3	3.0	5.3	24.1	18.8	16.9	−2.6	8.5	25.6	14.8	19.8	8.5	13.9	13.1
	$\Delta(h^{opt}-h^{(0)})$	12.9	8.5	7.2	2.2	2.4	15.8	11.6	11.0	1.9	3.5	16.6	13.6	11.3	−1.7	5.8	17.5	10.0	14.3	6.4	10.4	9.1
	Model results:	$g^{max}=250.2$ (29.3%), $r=782.8$ (−17.5%), $q=245.0$ (−30.2%), $m=356.2$ (−1.2%)																				
[r]	$\Delta\%(p^{opt}-p^{(0)})$	−17.8	−21.7	−22.7	−29.0	−30.1	−14.6	−18.8	−19.8	−27.9	−26.9	−14.4	−14.0	−18.8	−31.2	−25.8	−14.2	−20.8	−13.8	−19.0	−14.7	−20.8
	$\Delta(h^{opt}-h^{(0)})$	−17.4	−21.0	−21.7	−27.9	−30.0	−14.6	−18.2	−19.4	−25.9	−25.5	−14.4	−14.0	−18.1	−27.9	−25.6	−14.2	−20.4	−13.8	−19.0	−14.7	−20.2
	Model results:	$g=28.2$ (−85.4%), $r^{max}=1065.8$ (12.3%), $q=472.9$ (34.7%), $m=280.2$ (−22.3%)																				
[q]	$\Delta\%(p^{opt}-p^{(0)})$	−19.7	−24.6	−26.4	−31.8	−30.4	−14.6	−21.2	−21.2	−33.2	−30.7	−14.4	−14.0	−22.0	−38.5	−26.4	−14.2	−22.2	−13.8	−19.0	−14.7	−22.7
	$\Delta(h^{opt}-h^{(0)})$	−19.7	−24.6	−26.4	−31.8	−30.4	−14.6	−21.2	−21.2	−33.2	−30.7	−14.4	−14.0	−22.0	−38.5	−26.4	−14.2	−22.2	−13.8	−19.0	−14.7	−22.7
	Model results:	$g=0.0$ (−100.0%), $r=1062.0$ (11.9%), $q^{max}=483.4$ (37.7%), $m=260.7$ (−27.7%)																				
[m]	$\Delta\%(p^{opt}-p^{(0)})$	7.9	2.3	0.8	−6.1	−6.1	10.7	6.3	5.4	−6.2	−4.2	11.9	7.2	6.0	−11.1	−1.5	13.2	4.1	8.2	−2.3	2.8	2.5
	$\Delta(h^{opt}-h^{(0)})$	5.9	1.7	0.6	−4.5	−4.5	8.3	4.7	4.1	−4.4	−3.0	9.1	5.8	4.4	−7.7	−1.1	10.0	3.1	6.5	−1.9	2.3	2.0
	Model results:	$g=228.6$ (18.1%), $r=919.4$ (−3.1%), $q=316.4$ (−9.9%), $m^{max}=375.5$ (4.2%)																				
(c) Model parameters																						
	α_i	0.00	0.90	1.20	0.50	0.80	0.20	1.00	0.95	0.80	0.95	0.10	1.10	1.00	1.10	0.70	0.25	1.10	1.05	0.60	0.70	0.75
		Product independent model parameters: $\gamma=1000$ $\zeta=-240$ $\beta=-1.8$																				

Research Article

Pricing ROI, pricing capabilities and firm performance

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ABSTRACT Pricing is not only an important activity but frequently also a very important expense for industrial companies. In this short article we examine whether an improvement in measuring the return from pricing (pricing return on investment (ROI)) leads to an improvement in pricing capabilities and firm profits. The answer to this question is not trivial: performance measurement is costly and could, at least in theory, reduce performance. We survey 166 marketing and pricing managers from business-to-business companies globally and find that the effectiveness of pricing ROI measurement is positively related to firm performance only if pricing capabilities are well developed. This article offers two contributions: it explores the concept of pricing ROI, and it documents a positive link between pricing ROI and firm performance. To the ongoing debate on antecedents of pricing capabilities this research thus adds a further, so-far unexplored, perspective.

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INTRODUCTION

Pricing is a key element of the marketing mix: ‘Of all the tools available to marketers, none is more powerful than price’ (Han *et al*, 2001, p. 435). Effective pricing has benefits, but pricing is also costly. Consider the following: business-to-business (B2B) companies are increasingly establishing a dedicated pricing function, which comes at an expense (Hinterhuber and Liozu, 2012). In many B2B companies, chief executive officers are personally championing the pricing function, dedicating substantial managerial attention, resources and time on the corporate agenda to pricing, which again has non-trivial costs (Liozu and Hinterhuber, 2013). Finally, price promotions are a very substantial expense and a key concern for manufacturers and retailers alike (Hilarides, 1999).

Obviously, a number of companies measure the returns from marketing and pricing activities.

Consider the following two contrasting examples. Take General Electric: a reporter asks Beth Comstock, Chief Marketing Officer, about the specific approach the company uses to relate multibillion marketing investments to financial outcomes. She answers flatly: 'I would say that we haven't figured it out yet' (Comstock, 2008, p. 1). Contrast this with Coca Cola: in a presentation at the Marketing Science Institute, Ram Krishnamurthy, Group Marketing Director, illustrates the company's approach to optimizing the return on investment (ROI) from pricing and marketing activities. The company uses marketing variance analysis and a hierarchical Bayesian approach to determine how many dollars to allocate to which brand in which territory at any given moment in time so as to generate a pre-defined level of incremental profits (Krishnamurthy, 2010). Model parameters adjust in real time, and marketing executives activate only those specific levers (for example, a price increase; a cut in media spend) that maximize the expected incremental contribution margin.

These two companies, both highly admired and highly profitable, represent the two extreme points on a spectrum of effective marketing ROI measurements. Our key research question is: Does this difference make a difference? More formally: Does the difference in effectiveness of measuring the return from pricing lead to performance differences?

The answer to this question is not trivial. Measurement effectiveness could be associated with firm performance. Measurement itself, however, is costly; furthermore, intuition, which is quick, could, at least in principle, lead to better performance than analytical performance measurements.

We survey 166 marketing and pricing managers from B2B companies globally and find that the effectiveness of pricing ROI measurement is positively related to firm performance only when pricing capabilities are well developed. If pricing capabilities are weak, improvements in measurement effectiveness do not lead to superior performance. Our data thus suggest that firms need to develop their pricing capabilities first in order to improve firm performance via measurement systems that analyze the effectiveness of investments in pricing. Our data suggest that investments aimed at improving measurement effectiveness – investments in software, for example – are misguided and will not increase firm performance unless pricing capabilities are well developed in the first place.

The results of this study therefore seem to indicate that, for a quantitative discipline such as pricing, formal analysis leads to high performance under conditions of high pricing capabilities. Whether this is true also for other marketing disciplines – say, branding or product development – would make a fascinating study for future research.

This short article is organized as follows. We first summarize the relevant literature and then present our key hypotheses. Following that, we describe our survey instrument and the sample and subsequently discuss key findings and implications for industrial marketing theory and practice.

THEORETICAL BACKGROUND

Our simple model examines whether improvements in the perceived effectiveness of pricing ROI measurement contribute to pricing capabilities and firm performance. Figure 1 describes our hypothesized research model.

Table 1 defines the three constructs.

Defining and measuring pricing ROI

The focal construct in our research is the *effectiveness of pricing ROI measurement*. In this section we first define pricing ROI and then discuss current research in this area.

Traditional marketing metrics are imperfect: Seggie *et al* (2007) outline key ways that effective marketing metrics should evolve in order to be both academically rigorous and managerially relevant: (i) from non-financial to financial, (ii) from backward-looking to forward-looking, (iii) from short-term to

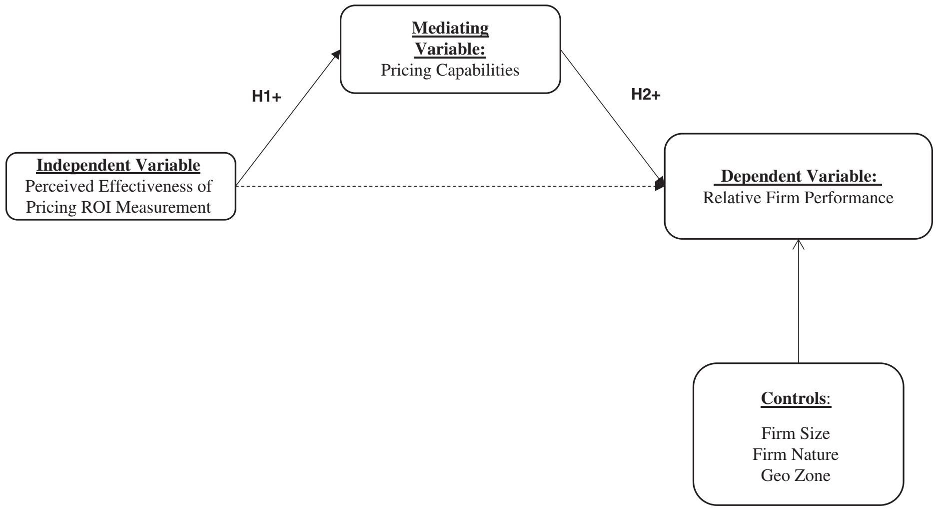

Figure 1: Hypothesized research model.

Table 1: Construct definitions

Name	*Construct definition*
Effectiveness of pricing ROI measurement	Perceived ability to appropriately quantify the ROI of the pricing function, of specific pricing activities (for example, price increases), of the pricing infrastructure (for example, IT systems) or of the overall organizational transformation related to pricing
Pricing capabilities	Set of skills referring, on the one hand, to the price-setting capability and, on the other hand, to the price-getting capability *vis-à-vis* customers
Firm performance	Subjective performance vs. key competitors, taken as average over two subsequent years

long-term, (4) from macro to micro data, (5) from independent metrics to causal chains, (6) from absolute to relative and (7) from subjective to objective. Marketing ROI meets these criteria better than other marketing performance metrics (Rust *et al*, 2004; Best, 2012).

Marketing ROI considers costs and benefits of marketing activities and is calculated as follows (Lenskold, 2003; Rust *et al*, 2004; Farris *et al*, 2010):

$$\text{Marketing ROI} = \frac{CM - I}{I}, \qquad (1)$$

where CM is the incremental contribution margin associated with specific marketing activities, and I is the investment in marketing activities. Like traditional ROI measurement, marketing ROI is the result of dividing incremental marketing returns by associated marketing investments.

Marketing scholars adapt this ROI calculations to sub-domains of marketing: concepts such as social media ROI (Kumar *et al*, 2013), advertising ROI (Danaher and Rust, 1996), new product ROI (Scheuble, 1969), ROI from customer relationship management (Streukens *et al*, 2011), promotional ROI (Wittink, 2002) and even training ROI (Phillips, 1997) are all now quite well established concepts.

Since we are interested in costs and returns from pricing activities, we adapt the formula and propose to define pricing ROI as follows:

$$\text{Pricing ROI} = \frac{CM - I}{I}. \qquad (2)$$

Investments in pricing can be broadly divided into four main groups: (i) investments in the organization of pricing (Homburg *et al*, 2012), such as investments to establish a chief pricing officer or a dedicated pricing function; (ii) investments to carry out specific pricing activities (Nagle and Holden, 2002), such as price promotions or price increases; (iii) investments in the pricing infrastructure, such as in IT systems related to pricing; and (iv) investments in the overall organizational transformation towards new pricing practices (Forbis and Mehta, 1981), such as CEO championing activities of pricing or value-based selling. All these activities have costs and are potentially subject to formal ROI calculations.

Pricing ROI is thus the incremental return from investments in the pricing organization, in pricing activities, in the pricing infrastructure, or in the overall organizational transformation related to pricing divided by the specific investment. The *effectiveness of pricing ROI measurement* is therefore the perceived ability to measure the return of the pricing function, pricing activities, the pricing infrastructure or the overall organizational transformation related to pricing. Figure 2 illustrates our core construct and lists pertinent literature.

Marketing has developed a plethora of measures: among these are market share, sales growth, customer satisfaction and price premium. Far less developed are attempts to measure the overall effectiveness of marketing activities. The CMO (Chief Marketing Officer) Council observes: 'Marketing – known more as art than science – has been the last of the corporate functions to formally develop and adopt processes and standards that can be tracked and measured quantitatively' (as cited in Stewart, 2009, p. 637).

Measuring the effectiveness of marketing and its components – we are interested, of course, in pricing – is therefore a significant challenge, certainly also for marketing practitioners. To gain an understanding of the current state of practice on the measurement of marketing ROI, we summarize the relevant industry studies.

Marketing ROI measurement: The state of the practice

The CMO survey

The CMO survey, hosted by Duke University, has polled chief marketing officers of the 1000 largest, US-based companies semiannually since 2008 on various marketing-related issues. The 2013 survey results show that 65 per cent of companies are unable to prove the impact of marketing spend on business (Moorman, 2013). Similarly, about 70 per cent of companies do not evaluate the quality of marketing analytics, even though these same companies forecast increasing their investments in marketing analytics by about 50 per cent in the coming years. Finally, in those companies where marketing analytics is actually deployed, it is used first to inform decisions on customer acquisition/retention, digital marketing, and, to a fairly large degree, promotion and pricing.

The Forrester survey

Forrester, a market research agency, reports the results of a survey of 111 marketing executives of large and medium-sized US-based companies. These executives report that 'agreeing on a definition of marketing ROI' is the number-two item on a list of items related to the difficulties of improving marketing ROI – the top item is 'acting quickly to improve results' (Nail, 2005, p. 6). Other items, in order, include 'improving reporting systems', 'data comprehensiveness' and 'changing established practices' (Nail, 2005, p. 6). This study also suggests that definitions of marketing ROI vary widely within companies; however, the most common conceptualization of marketing ROI is 'incremental sales from marketing'. Finally, this study

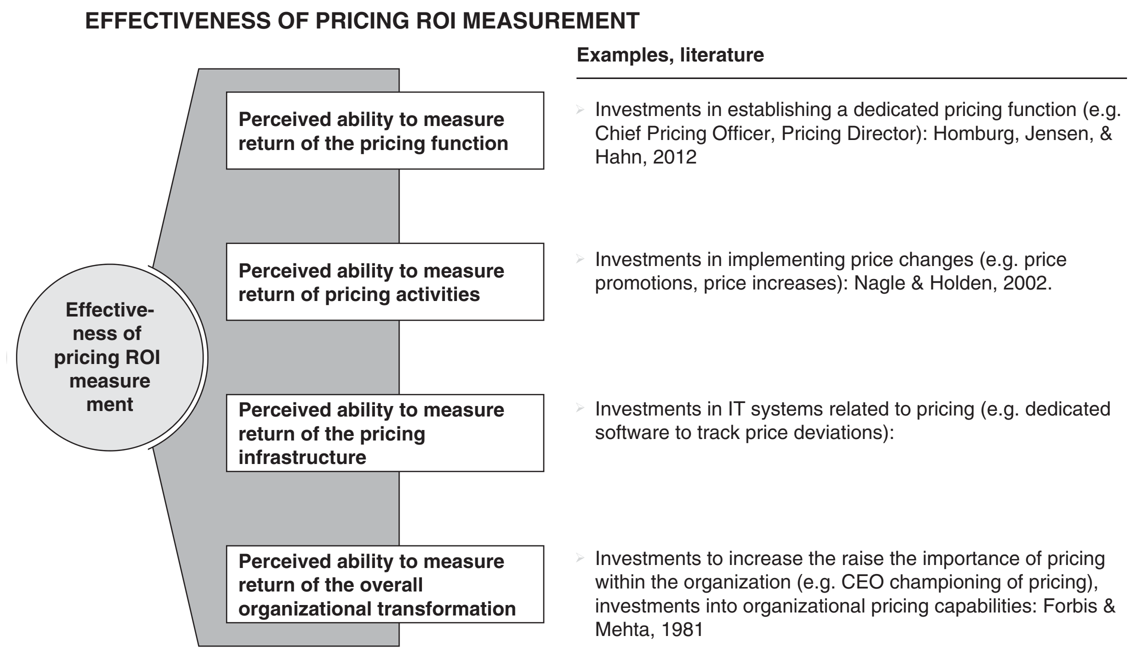

Figure 2: Effectiveness of pricing ROI measurement.

finds that the tools used today to measure marketing ROI are very simple (for example, response analysis) but that executives recognize that the use of marketing mix modeling will increase strongly in the future (Nail, 2005, p. 9).

The corporate executive board survey

On the basis of a survey of 27 marketing executives of mid-sized US companies, the results of this survey show, like previous surveys, a general dissatisfaction with the ability of respondents to measure marketing ROI (Corporate Executive Board, 2007). Interestingly, this study finds that pricing metrics are among the least used and also among the least effective of the available set of overall marketing metrics.

The McKinsey survey

In a poll of 587 senior executives McKinsey and Company (Doctorow *et al* 2009) finds that only about 14 per cent of companies employ quantitative, analytical marketing models.

In sum, in their diversity the findings of these surveys are remarkably consistent: (i) marketing ROI measurement and improvement are a priority for practicing executives, (ii) few companies measure marketing ROI effectively today and (iii) measuring the effectiveness of pricing activities in particular is especially difficult for practitioners.

Academic research on marketing ROI

The question of marketing efficiency has vexed researchers since the earliest days of marketing. In 1936, in the second issue of the newly launched *Journal of Marketing,* Cassels (1936, p. 129), professor at Harvard University, observes: 'The great central problem of marketing' ['marketing' during this period essentially refers to trade and distribution], 'the problem of carrying through efficiently... this final stage in the production process, has remained essentially the same since it was so intelligently discussed by Plato twenty-three hundred years ago'.

In the 1960s numerous authors propose the use of ROI analysis to guide marketing decisions. Dean (1966) suggests viewing advertising as an investment, not an expense. As such, it has to be capitalized on the balance sheet, and it should be optimized via ROI and discounted cash flow analysis. In this conceptual article Dean clearly recognizes the difficulties in forecasting expected returns from advertising. Scheuble (1969, p. 110) proposes a 'new point of departure' for analyzing the profitability of new product introductions: ROI and discounted cash flow analysis. This pioneering article is interesting: counterintuitively, it goes largely unnoticed – in over 40 years it is cited just three times. The article develops a practical framework allowing the modification of relevant elements of the marketing mix (volume, price, costs) to obtain a desired ROI from new product introductions. For researchers interested in pricing, too, this article is noteworthy: Scheuble (1969, p. 118) proposes, in full contrast to the then prevailing theory and practice, to take a 'marketing price' and to 'work back to get a cost figure' that meets the overall ROI goals. Interestingly, this article is probably one of the first to discuss target costing. It does not attract substantial attention. Probably also for this reason, researchers have struggled to make significant advances in measuring the impact of marketing.

In the following years, researchers repeatedly propose the application of financial measurements to marketing management (Kirpalani and Shapiro, 1973). Mossmann *et al* (1974) propose an early version of marketing ROI analysis. To evaluate the return on specific marketing activities, the authors suggest calculating the 'net segment margin' (p. 47), that is, the net income attributable to a specific customer or product segment, and dividing this margin by segment-specific assets to obtain the ROI. This proposal also goes largely unnoticed.

The concept of marketing ROI witnesses a dramatic surge in interest only several decades later, when Rust *et al* (2004) publish a seminal article highlighting the importance of marketing ROI as a tool to guide and improve marketing effectiveness. As a result, the number of publications on marketing metrics and marketing ROI rises substantially thereafter.

Current research has, however, one caveat. Conceptual articles outnumber empirical studies by a large degree. These papers lament, essentially, the difficult state of affairs of marketing. Stewart (2009, p. 638), for example, flatly states: 'Marketing in 2008 is where quality was 50 years ago'. Stewart implies that marketing researchers know much more about marketing costs than they do about marketing outcomes and that one reason for this ignorance is the lack of standards like those the quality movement, for example, has developed in recent decades (for example, ISO, Six Sigma).

In a survey in the high-technology sector, O'Sullivan and Abela (2007) find that companies with a high ability to measure marketing performance outperform their competitors, as reported by senior executives. Similarly, in a survey of 212 senior executives, Germann *et al* (2013) find that the deployment of marketing analytics is positively linked to firm performance. The authors find that top management team advocacy, an analytics culture, analytic skills and data/IT are key antecedents of effective marketing analytic deployment. Mintz and Currim (2013) similarly link marketing metric use to marketing mix performance and find a significant positive relationship. In sum: these empirical studies indicate that marketing performance measurement improves firm performance.

A number of mostly managerial studies, however, suggest precisely the opposite: Peters and Waterman (1982, p. 31), in their widely read book *In Search of Excellence*, warn against 'paralysis by analysis'. Excellent companies cultivate a bias for action, and avoid complex analytical models. Similarly, Perot (1988, p. 48), after selling his company Electronic Data Systems to General Motors (GM), suggests that an overreliance on analysis is detrimental to performance: 'I come from an environment where, if you see a snake, you kill it. At GM, if you see a snake, the first thing you do is go hire a consultant on snakes. Then you get a committee on snakes, and then you discuss it for a couple of years'. Speed of action, even though the outcome may be less than an elusive concept of perfection, is itself a source of competitive advantage (Stalk, 1988). This stream of literature suggests: analysis can slow down, if not delay, action and lead to low performance.

In principle, the very act of measuring performance could either decrease or increase firm performance. It is therefore by no means obvious that improved measurement leads to improved performance. In a recent Marketing Science Institute report, Pauwels *et al* (2008, p. 29), proposing a research agenda on marketing performance measurement, ask, 'Are dashboards worth it?' At the moment we have no conclusive answers.

There are, to the best of our knowledge, no empirical studies specifically linking pricing ROI measurement to firm performance. This research thus aims to explore the consequences of effective pricing ROI measurement on firm performance.

Research on pricing capabilities

Research in the domain of pricing capabilities has witnessed a surge of interest recently: current studies, qualitative as well as quantitative, suggest that pricing capabilities are a key driver of firm performance (Dutta *et al*, 2003; Liozu and Hinterhuber, 2014). Pricing capabilities are a focal construct of the present study: Table 2 summarizes the relevant literature in this context.

HYPOTHESES DEVELOPMENT

Effectiveness of pricing ROI measurement and firm performance

Our central construct is the effectiveness of pricing ROI measurement (see Table 1 and Figure 2 for a definition). The extant literature, as discussed, offers mixed evidence on the question of whether improvements in measurement lead to improvements in performance.

On the one hand, the marketing literature (Germann *et al*, 2013; Mintz and Currim, 2013) as well as research in strategy (Ouchi, 1979) and in total quality management (Juran, 1992) all suggest that measurement improves organizational performance: Measurement improves the quality and speed of organizational decision making, enables learning and feedback, and aligns diverse actors on a common set of standards. On the other hand, the qualitative studies cited earlier indicate that performance measurement requires adequate measurement systems, which come at a cost; in addition, performance measurement will require analysis and evaluation of both past and future actions, which is time consuming and could put the company at a disadvantage (Stalk, 1988). In sum: formal performance evaluation is costly. Intuitive decision making, by contrast, relies on a combination of past experience, pattern recognition and emotional perceptions and has one critical advantage: it is fast (Kahneman, 2011).

We suggest that a contingency model is able to reconcile these contrasting findings: whether an improvement in measurement abilities leads to superior performance or not depends on current capabilities. Formally:

Hypothesis 1 Pricing capabilities fully mediate the positive relationship between the effectiveness of pricing ROI measurement and firm performance, so that the positive relationship between effectiveness of pricing ROI measurement and firm performance is stronger under conditions of high pricing capabilities than under conditions of low pricing capabilities.

Our dependent variable is firm performance. In line with an extensive stream of research on pricing capabilities (Dutta *et al*, 2003; Hallberg, 2008; Andersson, 2013), we conjecture that higher pricing capabilities lead to higher firm performance.

Table 2: Research on pricing capabilities

Construct	*Definition*	*Authors and items*
Market-related capabilities – pricing	Pricing capabilities are part of seven distinct market-related capabilities: 1. Product development 2. Pricing 3. Channel management 4. Marketing communications 5. Selling 6. Market planning 7. Marketing implementation	Morgan *et al* (2009) • Using pricing skills and systems to respond quickly to market changes • Knowledge of competitors' pricing tactics • Doing an effective job at pricing products/services • Monitoring competitors' prices and price changes
Premium pricing capability	The premium price capability reflects the ability to command superior prices. Customers are willing to pay premium prices for product innovation. Products that offer new features or products that are first in the market can command premium prices	Koufteros *et al* (2002) • Capability of selling at price premium • Capability of selling at prices above average • Capability of selling at high prices that only a few firms can achieve
Pricing capabilities (qualitative research)	Pricing capabilities refer, on the one side, to the price-setting capability within a firm (identifying competitor prices, setting pricing strategy, translating from pricing strategy to price) and, on the other, to the price-setting capability *vis-à-vis* customers (convincing customers on the logic of price changes, negotiating price changes with major customers)	Dutta *et al* (2003) • Translating pricing strategy to price • Convincing customer on the price change logic • Negotiating price changes within major customers • Developing internal pricing management process • Capturing value through price
Pricing capabilities (quantitative research)	Pricing capabilities can be measured with a 10-item scale (PRICECAP) that includes items related to internal pricing processes and skills, items related to understanding competitors, and items related to understanding customer needs and customer willingness to pay Pricing capabilities are positively linked to firm performance	Liozu and Hinterhuber (2014) • Using pricing skills to respond quickly to market changes • Knowledge of competitor pricing tactics • Doing an effective job of pricing products/services • Quantifying customer willingness to pay • Measuring and quantifying differential economic value vs. competition • Measuring and quantifying price elasticity of products/services • Designing proprietary tools to support pricing decisions • Conducting value-in-use analysis or total cost of ownership analysis • Designing and conducting specific training programs • Developing a proprietary internal price-management process

Table 3: Total sample characteristics (166 respondents)

Firm nature		*HQ location*	
Manufacturing	49%	Americas	45%
Service	35%	EMEA	50%
Distribution/Retail	16%	APAC	5%
	100%		100%

Size of pricing teams		*Number of employees*	
Less than 5 people	34%	Less than 500	18%
6–10 people	17%	501 to 1000	20%
11–20 people	12%	1001 to 5000	8%
21–50 people	16%	More than 5000	55%
Over 51 people	20%		100%
	100%		

Hypothesis 2 The higher the pricing capabilities, the higher the firm performance when controlling for firm size, firm nature, and geographical location.

METHODS

Data collection and sampling

We use a random extraction of members of the Professional Pricing Society (PPS) as the sample frame for this study. PPS is the world's largest professional organization dedicated to pricing. Members are marketing, pricing and general managers involved in pricing at mostly large global companies from around the world. The president of the PPS endorses our study through personal support and encourages recipients to respond to the survey. PPS distributes the survey instrument electronically in June 2013 to 10 000 members randomly extracted from its membership of 18 000. The unit of analysis is the individual respondent. We assure respondents of anonymity and give them the option to enter a raffle to win a branded tablet as inducement for participation. We receive 308 fully or partially completed questionnaires. After removing records that are either incomplete or that exhibit insufficient variation in responses, we obtain 201 usable questionnaires. Since we are interested only in data from B2B companies, we extract 166 B2B self-declared respondents from the 201 usable questionnaires. This yields a response rate of 3 per cent. This response rate is certainly a concern; other large-scale surveys have response rates of between 5 and 20 per cent (Roth and Van Der Velda, 1991; Stock *et al*, 2000; Shah and Ward, 2003). One explanation for this comparatively low response rate is the nature of the survey: the state-of-practice surveys cited previously suggest that practicing managers today do not routinely perform marketing and pricing ROI calculations (Moorman, 2013). This may explain why a recent survey on the use of marketing metrics has a response rate of well below 1 per cent (Mintz and Currim, 2013). Our response rate reflects the exploratory nature of this research. The low response rate is clearly a limitation.

Table 3 summarizes the sample profile: respondents are mostly pricing managers from large, US-based companies.

Measure development and assessment

In our simple research model we use three constructs: perceived effectiveness of pricing ROI measurement, pricing capabilities and firm performance. For the latter two constructs the literature provides available scales; for the construct 'perceived effectiveness of pricing ROI measurement' we develop indigenous items following rigorous established item-development procedures and guidelines (Churchill, 1979). We define these constructs in Table 1 and provide the scales, items and applicable sources in the Appendix. In summary:

- Pricing capabilities: 10-item scale from Liozu and Hinterhuber (2014).
- Effectiveness of pricing ROI measurement: New 4-item scale.
- Firm performance: 3-item scale, adapted from O'Sullivan and Abela (2007).

Our survey items measure perceptions, as opposed to objective data. This may be of concern particularly for the construct firm performance, a subjective performance measure: we measure the perceived performance relative to competitors on three items – absolute price levels, pricing power and operating profitability – on a 7-point scale (anchored at 'much worse/lower' and 'much better/higher than competitors', respectively). To mitigate the effect of annual fluctuations in firm performance, we collect subjective performance data for 2 years (2011 and 2012) and take the average value as the indicator of firm performance. We note that the two annual performance values are highly correlated (0.85).

The use of subjective performance measures warrants clarification. First, North American and European respondents dominate the sample. A multidimensional measure based on perceived firm performance facilitates comparisons across different regions with different accounting standards. Second, our sample includes many small and medium-sized companies (38 per cent have fewer than 1000 employees). For these companies, researchers express reservations about the use of objective performance data, since these data may be biased as a result of managerial manipulation for corporate and personal tax reasons (Sapienza *et al*, 1988). Third, recent studies show that perceptual performance measures tend to be highly correlated (80 per cent) with objective performance indicators (Kumar *et al*, 2011). Subjective performance data are used widely in industrial marketing research (Merrilees *et al*, 2011; Park *et al*, 2012).

We pretest scale items with a panel of academics and pricing practitioners and then send a pilot-test survey to pricing and marketing professionals. We modify the survey iteratively to incorporate all relevant test results.

Firm-level control variables

We control for a number of likely determinants of performance by including demographic characteristics of the firm, such as firm type, geographical location and firm size (Amburgey and Rao, 1996).

Non-response bias

We follow the convention and estimate non-response bias by comparing early and late respondents on the study variables (Armstrong and Overton, 1977). One-way ANOVA tests, performed at the item level, indicate no significant differences in data derived from early versus late responders. Consequently, it appears that bias present from the time of response is due to chance.

Common method bias

We collect exogenous and endogenous variables at the same time using the same instrument – hence it is prudent to conduct a common method bias test. We use the common latent factor (CLF) method advocated by MacKenzie and Podsakoff (2012) when no theoretically driven marker variable is collected. Comparing the standardized regression weights before and after adding the CLF shows us to what extent the variables in our model share common variance. We find no significant difference for any variables. We therefore opt to remove the CLF for the remainder of the analyses, rather than using CLF-adjusted values. As further evidence of no method bias, we reassess the

Table 4: Construct reliability and validity results

Factors	*CR*	*AVE*	*MSV*	*ASV*	*Relative firm performance*	*Pricing capabilities*	*Perceived effectiveness of ROI calculation*
Relative firm performance	0.91	0.566	0.452	0.316	***0.752***	—	—
Pricing capabilities	0.933	0.541	0.452	0.388	0.672	***0.735***	—
Perceived effectiveness of ROI calculation	0.9	0.693	0.325	0.253	0.425	0.57	***0.832***

Bold italic number are square root of AVE.

validity and reliability of our measurement model with the CLF present. All criteria for discriminant and convergent validity, as well as reliability, are still met – despite the presence of the CLF. This suggests that common method variance has not biased our measures.

Measurement models

We conduct an exploratory factor analysis (EFA) on the sample dataset using principal axis factoring with Promax rotation. For all but one item, communalities exceed the minimal acceptable threshold of 0.50 (Hair *et al*, 2010). In addition, both the Kaiser–Meyer–Olkin (KMO) value and Bartlett's test of sphericity exceed the acceptable threshold levels, indicating the appropriateness of the data for factor analysis. The EFA yields three factors, consistent with our conceptual model as displayed in Figure 1. Each item significantly loads on its respective factor with a value greater than 0.40 and no cross-loadings of more than 0.20 (Igbaria *et al*, 1995; Hair *et al*, 2010). The total variance explained by these three factors is 55 per cent.

The final number of items represented by the four factors, after completion of the EFA analysis, is 24. In addition, the reliability of each of the final six factors is computed as shown in Table 4 and in most cases exceeds the minimum acceptable threshold of 0.70 (Nunnally, 1978). Table 4 provides the correlations between the factors. All of the average variance extracted (AVE) (Davey *et al*, 1998) values exceed the square of the correlation between the constructs, demonstrating discriminant validity.

We assess the psychometric properties of the four factors derived from the EFA using a confirmatory factor analysis (CFA) to validate the factor structure. The measurement model is constructed incorporating each construct and associated items. The model is further trimmed and appropriate covariance relationships added when theoretically justified (Byrne, 2009). The overall fit for the model is good: CMIN/DF = 1.587, CFI = 0.959, RMSEA = 0.040, PCLOSE = 0.999. The composite reliability (CR) for each construct is provided in Table 3. The CR values exceed the acceptable threshold level (>0.70), and the AVE values confirm the reliability of the indicators and demonstrate convergent validity. For discriminate validity we show that for all constructs the maximum shared variance (MSV) and average shared variance (ASV) are less than the AVE (Fornell and Larcker, 1981).

Invariance test

To establish that the model is not significantly affected by respondents' region, we conduct configural and metric invariance tests (Steenkamp and Baumgartner, 1998) on the measurement model. Using the two-group model for both analyses, we observe adequate fit for the unconstrained measurement models. After constraining the models to be equal, we find the χ^2 difference test to be

Table 5: Structural model results

Hyp	*Hypothesized relationship*	*Direct β without mediation*	*Direct β with mediation*	*Indirect β*	*Type of mediation*
Hypothesis 1	Pricing capabilities fully mediate the positive effect of ROI calculation on relative firm performance	0.421⋆⋆	0.06 (NS)	0.385⋆⋆⋆ ($P=0.006$)	Full
Hyp	*Hypothesized paths*	*Regression estimates*	*Critical ratio*	*Hypothesis supported*	
Hypothesis 2	The higher the pricing capabilities, the higher the relative firm performance	0.673⋆⋆⋆	7.696	Yes	
	R^2 Relative firm performance	0.47			
	R^2 pricing capabilities	0.33			

⋆⋆⋆$P<0.01$; ⋆⋆$P<0.05$; ⋆$P<0.1$.

non-significant, and we find none of the regression paths to be significant at the 95 per cent confidence level. Therefore our measurement model meets criteria for metric and configural invariance across regions.

RESULTS

We test our hypotheses using structural equation modeling (SEM). SEM is particularly appropriate because it allows estimation of multiple associations, simultaneously incorporates observed and latent constructs in these associations, and accounts for the biasing effects of random measurement error in the latent constructs (Medsker *et al*, 1994).

The results are shown in Table 5. All hypothesized relationships are significant. The fit indices for the final structural model indicate that this model reaches an acceptable goodness of fit (CMIN/DF = 1583; GFI = 0.907; CFI = 0.959; RMSEA = 0.040; PCLOSE = 0.999).

We first perform a mediation analysis using causal and intervening variable methodology (Baron and Kenny, 1986; MacKinnon *et al*, 2002) and techniques described by Mathieu and Taylor (2006). We analyze the paths connecting our independent variable to our dependent variable through our mediating variable to examine the direct, indirect and total effects. For the mediation hypothesis being tested, we run a model without the mediation paths (only direct effects). The result of our mediation analysis reveals the presence of full mediation, supporting Hypothesis 1. The direct effect of the effectiveness of ROI calculation on relative firm performance before adding pricing capabilities as a mediator is 0.421 ($P<0.001$). After we add the mediator, the direct effect drops to 0.06 (P value not significant). This finding is further supported by the drop in direct effect from our independent variable to our dependent variable after adding the mediator, as well as by the presence of the indirect effect ($b=0.385$; $P=0.006$).

Second, the hypothesized impact of pricing capabilities ($b=0.67$, $P<0.01$) on relative firm performance is significant, providing support for Hypothesis 2.

We control for nature of the firm, geographical region of the firm's headquarters and firm size. Our analysis reveals a significant relationship between firm size and relative firm performance ($b=0.12$, $P<0.01$). Our final statistical model with all significant relationships is in Figure 3.

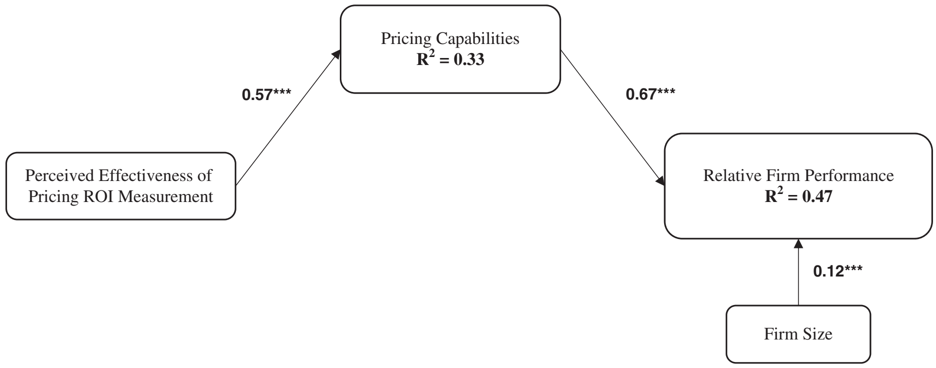

Figure 3: Final structural model.

DISCUSSION

Measuring marketing performance is a top priority (Commander *et al*, 2007). It is also a challenge for marketing executives: many companies 'prefer to fumble around in the dark. It's easy to see why. Fumbling has a lot going for it ... You may not like what you see when the lights do go on' (Ambler, 2003, p. 17). Other companies fall into the trap of measuring 'what is easy to measure' rather than what is 'relevant' (Ambler, 2003, p. 270). Ambler (2003) implies that many companies are either unable or, worse, unwilling to measure marketing performance. Marketing executives seem unconvinced that measuring performance will lead to better results. This study aims to resolve this important issue.

We find that measuring the effectiveness of pricing leads to superior firm performance only if pricing capabilities are high. The relationship between effectiveness of pricing ROI measurement and firm performance is not significant when pricing capabilities are low.

This research, based on responses from 166 pricing and marketing managers from B2B companies around the world, enables us to resolve the contrasting findings of the current literature on the relationship between measurement effectiveness and firm performance. As outlined, recent quantitative studies do suggest that performance measurement contributes to firm performance; earlier qualitative studies, however, suggest the contrary, highlighting that measurement is costly and can delay effective action.

To this ongoing debate this study essentially adds two substantial contributions. First, we show that the relationship between the effectiveness of pricing ROI measurement and firm performance is fully mediated by pricing capabilities. Measurement effectiveness, by itself, does not improve performance. Under conditions of high pricing capabilities, however, the effectiveness of pricing ROI measurement is strongly and positively related to firm performance. This finding suggests that investments in improving measurement effectiveness – for example, investments in pricing tools, in pricing analytics or in pricing software – contribute to firm performance only if current pricing capabilities are high. The development of routines could play a role in this process. Second, in this study we develop the construct *perceived effectiveness of pricing ROI measurement* – a construct that encompasses the ability to measure the returns from investment in the organization of pricing (for example, a dedicated pricing function), in pricing activities (for example, price promotions), in the infrastructure of pricing (for example, IT systems) and in the overall organizational transformation related to pricing (for example, CEO championing of pricing) – and we show that this construct acts as an antecedent to firm performance under certain conditions.

To the current literature on pricing capabilities, which documents a direct link to firm performance, this study adds a further, complementary, perspective: pricing capabilities, as perceived by respondents, are an important mediator between the perceived effectiveness of pricing ROI measurement and firm performance.

Implications for B2B marketing practice are twofold. First, pricing is an activity which touches many business functions. This study shows that efforts to measure the returns from pricing activities need to reflect the broad impact of pricing on the organization and should include the following four domains: the organization of pricing, pricing activities, the pricing infrastructure and the overall organizational transformation related to pricing. Second, this study shows that the effectiveness of pricing ROI measurement drives firm performance only if pricing capabilities are well developed. This finding has important implications for industrial marketing managers and suppliers alike: industrial companies are investing substantial amounts in marketing analytics software, including pricing software. A survey by Ernst & Young of Fortune 1000 companies reports the following: 81 per cent of buyers say that they expect IT vendors to quantify the value proposition of their solutions, including ROI analysis (Cooper, 2002). As B2B suppliers, software vendors are increasingly asked to justify and document the incremental benefits of their products to customers. The simple contribution of this study to these findings is that an improved ability to measure the return from pricing activities via software, for example, is worthless unless firm-specific pricing capabilities are well developed in the first place: IT suppliers do and will claim an improved ability to measure performance as a result of software investments. We contend that this improved ability to measure the performance of pricing will lead to improved firm performance only after firms have developed their pricing capabilities. Investments in IT systems are thus misguided unless firms have already developed substantial pricing capabilities.

LIMITATIONS

This study has important limitations. First is the use of subjective performance measures and, more broadly, the use of perceptional survey items. Subjective performance measures are widely used in the strategy literature (Spanos and Lioukas, 2001; Gruber *et al*, 2010) as well as the marketing literature (Kohli and Jaworski, 1990; Narver and Slater, 1990). Nevertheless, subjective performance measurement is based on perceptions and is potentially biased. Future studies would benefit from measuring subjective and objective performance indicators simultaneously. Our other survey items measure respondent perceptions of, for example, pricing capabilities, pricing ROI dispersion, use of pricing tools and so forth: since our survey is self-administered, results may not reflect what respondents actually do when engaging in pricing activities. Babbie (2007, p. 276) writes: 'Surveys cannot measure social action: they can only collect self-reports of recalled past action or of prospective or hypothetical action'. In other words, to truly understand the factors that drive the perceived effectiveness of pricing ROI measurements in firms, it might be useful to augment our results with field observations and qualitative inquiry. Second is common method bias. We attempt to minimize common method bias through statistical analysis but cannot rule it out completely. Future studies would benefit from collecting multiple responses per firm. Third is causality. The directionality in our hypothesized research model is based on previous empirical research as well as on established theoretical frameworks. Nevertheless, we cannot entirely rule out reverse causality – that high performance leads respondents to rate pricing ROI effectiveness highly – as opposed to the causal path in our model. Future research should address this issue via the use of longitudinal data. The fourth and final limitation concerns the sample and response rate: we poll members of the PPS, an organization that includes an estimated 30 per cent of the Global Fortune 500 companies and a large number of medium-sized companies. There are reasons to assume that the membership base is representative of the overall population of firms globally, but we cannot completely rule out a sample selection bias. The comparatively low response rate of 3 per cent may limit the ability to generalize findings from this study.

Our suggestions for future research include the following avenues. We would welcome further research that explores the causal paths linking formal pricing performance measurement systems with firm performance.

As indicated, a fruitful avenue for future research is the exploration of the effectiveness of intuitive decision-making processes for other elements of the marketing mix. While this study finds that the formal measurement of ROI is positively correlated to firm performance under the condition of high pricing capabilities for the domain of pricing, we are curious to learn whether intuitive decision-making processes improve firm performance for decisions related to product development, branding, advertising or distribution.

Future research is warranted also with regard to examining learning processes in pricing: How do individual actors learn, and how do pricing capabilities emerge? How does the interplay between individual learning and collective exposure to common environmental challenges facilitate (or obstruct) learning processes in pricing? Finally, we would welcome efforts to examine antecedents to effective pricing ROI measurement.

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APPENDIX

Table A1: Constructs and scales

Measures	*Items*	*Other comments*
Pricing capabilities	Please rate your organization relative to your major competitors in terms of its capabilities in the following areas: Using pricing skills and systems to respond quickly to market changes Knowledge of competitors' pricing tactics Doing an effective job of pricing products/services Monitoring competitors prices and price changes Sticking to price list and minimizing discounts Quantifying customers' willingness to pay Measuring and quantifying differential economic value versus competition Measuring and estimating price elasticity for products/services Designing proprietary tools to support pricing decisions Conducting value-in-use analysis or Total Cost of Ownership Designing and conducting specific pricing training programs Developing proprietary internal price-management process	12 items, 7-point scale (anchored at 'much worse than competitors' and 'much better than competitors') Scale is adapted from Liozu and Hinterhuber (2014)
Effectiveness of pricing ROI measurement	How well does your firm calculate the ROI of pricing for the pricing function (all dimensions of pricing function in the firm)? How well does your firm calculate the ROI of pricing for specific pricing initiatives and projects (for example, training, pricing tools, price increases)? How well does your firm calculate the ROI of pricing for pricing systems (for example, IT systems)? How well does your firm calculate the ROI of pricing for the overall pricing transformation (including programs outside of pricing)?	4 items, 7-point scale (anchored at 'very poorly' and 'very well') New scale
Firm performance	Please evaluate the performance of your major line of business in 2011 relative to your major competitors: Absolute price levels Pricing power in the market Operating profitability (EBIT/sales) Please evaluate the performance of your major line of business in 2012 relative to your major competitors: Absolute price levels Pricing power in the market Operating profitability (EBIT/sales)	3 items, 7-point scale (anchored at 'much worse/lower than competitors' and 'much better/higher than competitors') Firm performance is average of performance in 2011 and performance in 2012 Scale is adapted from O'Sullivan and Abela (2007)

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