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## Time preferences and the pricing of complementary durables and consumables☆

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### ABSTRACT

There is strong empirical evidence that consumers discount at significantly higher rates than firms. Yet, most research abstracts from the effect of discount rates on marketing decisions such as pricing. We study the effects of a consumers' discount rate that is higher than a firm's discount rate on prices, profits and consumer surplus of complementary products in four competitive settings and an infinite time setting: the firm is a monopolist or competes in the durable market and either ties the consumable to the durable or sells untied products. Our analysis yields five main results: First, a higher time preference of consumers than the firm never increases the optimal durable price and never decreases the optimal consumable price. Second, the optimal consumable price of tied goods is always higher than the optimal consumable price of untied goods, whereas the optimal durable price is always higher when goods are untied. Third, a higher time preference of consumers than the firm never increases profit, always decreases consumer surplus and, as a result, always decreases welfare. Fourth, the ability of the firm to commit to future prices and of consumers to commit to future purchases benefits both consumers and the firm. Fifth, if the firm competes in the durable market, then tying increases consumer surplus when consumers commit to purchasing the consumable. We discuss the implications of our results for firms' pricing strategies.

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### 1. Introduction

Behavioral research in marketing and economics argues that consumers discount future benefits and payments at a much higher rate than firms. Annual discount rates for 3-year delays, for example, lie in the range of 36%–46% and for a 1-year delay in the range of 83%–100% (Frederick, Loewenstein, & O'Donoghue, 2002; Thaler, 1981; Zauberman, Kim, Malkoc, & Bettman, 2009). By contrast, a firm's weighted average cost of capital, a good indicator of a firm's discount rate, broadly lies in the range of 7% to 12% (KPMG International, 2014). Yet, despite strong evidence that consumers discount at higher rates than firms, the effects of differences in

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time preferences of consumers and firms on marketing decisions like pricing, and ultimately on profit and welfare, have rarely been studied (Ho, Lim, & Camerer, 2006).

Consumers' time preferences influence consumers' choices when expenditures or benefits occur at least partly in the future as opposed to instantaneously. In the case of complementary products, such as razors and blades, consumers typically purchase the durable (the razor) today but most units of the consumable (the blades) in the future. Likewise, benefits largely arise in the future. A firm aiming to set profit-maximizing prices for its durable and consumable therefore needs to understand how consumers' time preferences affect their willingness to pay and hence its prices and profit.

Complementary product strategies are widespread in consumer goods markets. They include tied products where the consumable can only be used with the same firm's durable, such as the patented Polaroid cameras in the 1980s that required Polaroid film, Procter & Gamble's Swiffer mops, Brita's water pitcher/filter system, or burglar alarms that require yearly servicing.<sup>1</sup> They also include open (or untied) systems where the consumer is free to use a competitor's consumable with the firm's durable, such as the iPod and audio/video files that can be purchased at both the iTunes store or elsewhere, or printers and cartridges.

In this paper, our aim is to analyze how the fact that consumers typically discount future expenditures and benefits more strongly than a firm affect optimal prices of complementary products, profit, consumer surplus and ultimately welfare in a wide range of settings. We also analyze how the firm's ability to commit to future prices and consumers' ability to commit to future purchases of the consumable impact these results.

The effect of a higher discount rate of consumers, relative to that of a firm, on profit from complementary products is difficult to predict. Intuitively, one might predict that if consumers discount later payments at greater rates than the firm, then the firm should increase the consumable price (which consumers discount) and decrease the durable price (which is paid immediately). The result might be an increase in profit beyond the profit they would obtain if the firm and consumers had the same time preferences. However, consumers with higher discount rates will also more strongly discount the consumer surplus that comes with the consumption of the consumable. This stronger discounting may decrease the present value of the consumer surplus of the consumable, forcing the firm to lower the durable price. This example illustrates that the question of how the firm should adjust prices when consumers have stronger time preferences than the firm, and how these discount rates affect profits, is difficult to answer.

The literature on complementary products typically argues that tying is disadvantageous for consumers (Economides, 2011). Yet, it is less clear that this argument holds when consumers discount more strongly than the firm: under tying, the firm is able to more flexibly shift payments between current and later periods, and so may be in a better position to respond to changes in consumers' time preferences.

We analytically model the effect of time preferences of consumers and the firm on optimal prices of complementary products, profit, consumer surplus and welfare. We consider heterogeneous demand functions of consumers and explicitly model the infinite-period nature of the transactions. The durable is purchased immediately (i.e., in the first period, here denoted as period 0) and the consumable in each of the later periods. When consumers purchase the durable, they evaluate the payment for the durable and the discounted value of payments and benefits of the consumable.

Methodologically, because of the similarities between two-part tariffs and complementary products, we extend the modeling approach typically used for the pricing of two-part tariffs (Oi, 1971; Png & Wang, 2010) to account for multiple competitive settings and different time preferences of consumers and the firm. In doing so, our work contributes to four streams of research.

First, it contributes to research on the pricing of complementary products. This research has largely focused on how heterogeneity in consumer tastes affects durable and consumable prices (Emch, 2003; Leland & Meyer, 1976), whether firms can use tying to price discriminate between consumers (Gil & Hartmann, 2009; Liebowitz, 1983), the effect on prices of a firm's inability to commit to future aftermarket prices (Borenstein, MacKie-Mason, & Netz, 2000), whether firms benefit from shrouding add-on prices (Gabaix & Laibson, 2006), or manufacturer/retailer interaction in the presence of complementarity products (Hartmann & Nair, 2010). Other work has examined why firms offer add-ons, the effect of offering add-ons on firms and consumers (Ellison, 2005) and the type of inferences consumers draw from the availability of add-ons. But as of yet, this research does not account for differential discount rates of firms and consumers and examine their impact on profit and consumer surplus. An exception is Heubrandner and Skiera (2010) who show that tying products increases welfare if consumers discount more strongly than the firm. Yet, they assume homogeneous demand, use only a two-period setting and do not analyze the effect on profit. In sum, research on complementary products provides little insights on how different time preferences of consumers and firms affect prices, profit, consumer surplus and welfare.

Second, our results add to work that has examined how consumers' discounting and time preferences impact prices. Empirically, Oster and Scott Morton (2005) find that magazine publishers' subscription prices reflect consumers' present bias. Yao, Mela, Chiang, and Chen (2012) show that underestimating discount rates can result in suboptimal pricing decisions. Further, Dubé, Hitsch, and Jindal (2014) find in data from lab experiments that consumers' discount rates affect their durable goods adoption decisions. Theoretically, Schaaf and Skiera (2014) outline how differences in time preferences affect optimal prices of advance selling. Stokey (1979) shows that heterogeneity in time preferences makes, under certain conditions, temporal price discrimination a profitable strategy. Related, Landsberger and Meilijson (1985) find that intertemporal price discrimination can be profitable if consumers discount at higher rates than monopolistic firms. Mandy (1991) allows for different time preferences of firms and consumers in the context of two-part tariffs but abstracts from demand heterogeneity. We add to this literature by extending the analysis of time preferences to the pricing of complementary products.

<sup>1</sup> We refer to a tie-in when the consumer can use the durable only with the consumable of the same firm. On purchase of the durable, the consumer may or may not enter a legally binding contract to later on purchase the consumable. The durable is not compatible with the consumable of a competitor and does not provide a benefit in itself. In this sense, complementary products are not tied when the consumer can use the durable in conjunction with the consumable of competitors.

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