Therefore, further research on switching cost should incorporate these features to obtain richer insights.[5]

The U-shaped relationship between switching costs and average prices has implications for how to interpret existing empirical work and how to design new tests on the ways switching costs affect competition. For example, Viard (2007) finds that allowing number portability (a reduced switching cost) in mobile telephony lowered prices. This result may appear to be superficially inconsistent with DHR's finding. However, when we recognize the U-shaped relationship, the result can be consistent with DHR's result if the switching cost before number portability was in the high-switching-cost range. Given the typical long-term contracts that customers sign, the mobile telephony market is consistent with being a high-switching-cost market. Other recent studies have estimated switching costs to be greater than the cost of the product in frequently purchased product categories (e.g., Shum 2004).

As DHR show in their Figure 1, if firms act myopically (or discount the future heavily), prices rise with switching costs; if firms are forward looking and dynamically optimal, prices fall in a wide range of switching costs. This suggests a possible line of empirical work to study the extent to which firms act in a dynamically optimal manner in setting prices (e.g., Che, Sudhir, and Seetharaman 2007). We believe that DHR's result will spawn both theoretical and empirical work that expands insights into the effect of switching costs on prices and competition.

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[5]This result has some similarities to the recent work of Shin and Sudhir (2008), who show that the decision whether to reward one's own customers is crucially dependent on the changing preferences over time.

Small Switching Costs Lead to Lower Prices

*LUÍS CABRAL**

Consumers frequently must pay a cost to switch from their current supplier to a different supplier (Farrell and Klemperer 2007; Klemperer 1995). These costs motivate some important questions: For example, are markets more or less competitive in the presence of switching costs? Specifically, are prices higher or lower under switching costs?

As Dubé, Hitsch, and Rossi (2009) state, echoing Farrell and Klemperer (2007), among others, the effects of switching costs can be divided into two categories: "harvesting" and "investment." The former corresponds to the idea that switching costs increase a firm's static market power, which in turn leads the firm to increase prices. The latter corresponds to the dynamic incentives of a firm to increase its market share, which lead the firm to decrease prices.

Which of the two effects dominates? Conventional wisdom and the current economics literature suggest that the harvesting effect dominates (Farrell and Klemperer 2007).

Dubé, Hitsch, and Rossi cast doubt on this assertion, claiming that small levels of switching costs may actually decrease equilibrium prices (see also Doganoglu 2005; Viard 2007). In this note, I expand the theoretical argument underlying Dubé, Hitsch, and Rossi's result. In doing so, I hope to clarify the intuition for the result and suggest the extent to which it generalizes. In a nutshell, though recognizing that, in general, the harvesting effect is positive (higher prices) and the investment effect is negative (lower prices), I argue that for small values of the switching cost, the harvesting effect is of a second order of magnitude, whereas the investment effect is of a first order of magnitude.

This commentary, which summarizes some of the results in Cabral (2008), is structured as follows: I begin by presenting a fairly general framework of dynamic competition and characterizing the harvesting and the investment incentives that are present in dynamic pricing. Then, I argue that if switching costs are small, their effect on harvesting is of a lower order of magnitude than their effect on investment. Finally, I present some concluding remarks.

HARVESTING AND INVESTING

Consider the dynamic optimization problem faced by a generic firm i. Its value is given by

$$V_i(\mathbf{x}, \mathbf{p}; s) = (p_i - c_i)q_i(\mathbf{x}, \mathbf{p}; s) + \delta\tilde{V}_i(\mathbf{x}, \mathbf{p}; s),$$

where **x** denotes a vector of state variables (e.g., market shares), **p** denotes a vector of current prices, and s denotes the level of switching costs. (Although I consider the problem of switching costs, much of what I develop in this section can be applied to other exogenous parameters as well, such as the degree of product differentiation or the steep-

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ness of learning curves.) The variables indexed with an i are firm i–specific variables: p_i is price, c_i is unit cost, q_i is quantity sold, V_i is value, and $\tilde{V}_i$ is the continuation value. Finally, δ is the discount factor.

Maximization with respect to p_i implies the following:

$$(1)\quad q_i(\mathbf{x}, \mathbf{p}; s) + (p_i - c_i)\frac{\partial q_i(\mathbf{x}, \mathbf{p}; s)}{\partial p_i} + \delta\frac{\partial \tilde{V}_i(\mathbf{x}, \mathbf{p}; s)}{\partial p_i} = 0.$$

At first, this seems to be a complicated expression. I try to show that it is actually quite simple. Define

$$q_i' \equiv \frac{\partial q_i}{\partial p_i} \text{ and } \tilde{V}_i' \equiv \frac{\partial \tilde{V}_i}{\partial q_i}.$$

(Note that the first derivative is taken with respect to p_i, whereas the second is taken with respect to q_i.)

Suppose that firm i's future value depends only on current choices through firm i's output level. This is true in many models with switching costs, learning curves, and so forth. Then,

$$\frac{\partial \tilde{V}_i(\mathbf{x}, \mathbf{p}; s)}{\partial p_i} = \frac{\partial \tilde{V}_i(\mathbf{x}, \mathbf{p}; s)}{\partial q_i}\frac{\partial q_i}{\partial p_i} = \tilde{V}_i'\frac{\partial q_i}{\partial p_i}.$$

It is now possible to rewrite the first-order condition (Equation 1) in simpler notation (also omitting the functional arguments for simplicity):

$$(2)\quad p_i - c_i = \left(\frac{q_i}{-q_i'}\right) - \delta\tilde{V}_i'.$$

The right-hand side of Equation 2 depicts the two main incentives present in dynamic strategic pricing: the harvesting incentive and the investment incentive. The harvesting (investment) incentive is the extent to which current profitability (future profitability) influences optimal prices. The harvesting (investment) effect is the influence of switching costs on price through harvesting (investment) incentives. The harvesting incentive is the increase in price–cost margin that follows from a firm's market power. In Equation 2, this increase in market power comes from a greater market share (greater q_i) and a more inelastic demand curve (lower $|q'_i|$).

Now, consider the second term. To the extent that greater sales today increase a firm's future value—that is, $\tilde{V}_i' > 0$—a firm will tend to lower its price cost margin. By doing so, the firm "invests" in market share; that is, it lowers its current profit margin in exchange for a greater market share in the future. This is the investment incentive.

SMALL SWITCHING COSTS

How do switching costs influence pricing? Because switching costs do not alter a firm's costs, Equation 2 shows that the question amounts to evaluating the effect of switching costs on harvesting and on investment pricing incentives. Specifically,

$$\frac{dp_i}{ds} = \frac{d}{ds}\left(\frac{q_i}{-q_i'}\right) - \delta\frac{d}{ds}(\tilde{V}_i').$$

Then, I go by parts. I begin by examining the effect of switching costs on harvesting. The harvesting effect is given by

$$\frac{d}{ds}\left(\frac{q_i}{-q_i'}\right).$$

Intuitively, higher switching costs would be expected to lead to lower $|q_i'|$ and, thus, to higher p_i: Switching costs lead to more inelastic demand, and all else being equal, this leads to higher prices. What about the effect of switching costs on q_i? Suppose that going into period t, Firm 1 has a larger market share than Firm 2. Then, an increase in switching costs would be expected to increase Firm 1's market share in period t and decrease Firm 2's market share in period t. Indeed, some of the customers that Firm 2 expected to attract in period t will now prefer to purchase from Firm 1 because of higher switching costs. In other words, the effect of switching costs on q_i is likely to be positive for some firms and negative for others.

Consider the effect of switching costs on $\tilde{V}'_i$—that is, the investment effect. Suppose that the only intertemporal links are due to switching costs. In the limit when switching costs are zero, $\tilde{V}'_i = 0$: The firm's continuation value is independent of its current sales. The greater the value of switching costs, the more sensitive future value is to current sales. It follows that $\tilde{V}'_i$ increases as switching costs increase. Note that unlike the harvesting effect of switching costs, the investment effect is positive for all firms. For large firms, $\tilde{V}'_i$ increases because there is more to be lost from decreasing market share, and for small firms, $\tilde{V}'_i$ increases because there is more to be gained by increasing market share. In summary, the harvesting effect of higher switching costs is positive for some firms and negative for others, whereas the investment effect is negative for all firms.

In Cabral (2008), I show that under some additional assumptions, the overall effect is negative. Higher switching costs lead to lower average equilibrium prices. Specifically, I show that the average harvesting effect (average across all firms) is approximately equal to zero, whereas the investment effect is negative for all firms (and so is the average investment effect).

In other words, the result that Dubé, Hitsch, and Rossi obtain numerically is valid more generally. Similar to Dubé, Hitsch, and Rossi, I consider the case in which sellers compete for one single buyer. In one respect, I make an additional simplifying assumption: I consider the case in which there are only two sellers and there is no outside option; that is, the buyer always makes a purchase from one of the sellers. Other than this, my analysis is more general than that of Dubé, Hitsch, and Rossi. In particular, I make mild assumptions regarding the nature of product differentiation, My assumptions include as a particular case the extreme value distribution (i.e., the case considered by Dubé, Hitsch, and Rossi), in addition to many other standard distributions (e.g., normal, log-normal, uniform, t).

CONCLUDING REMARKS

Dubé, Hitsch, and Rossi show numerically that a small level of switching costs increases the level of market competition. A limitation of numerical simulations is that they depend on particular choices of functional forms and parameter values. In contrast, an advantage of analytical results, such as those I present in Cabral (2008), is that mild assumptions are made regarding functional forms. An additional advantage of the analytical approach is that the intuition for the results becomes more apparent.

Having established the generality of the results in Dubé, Hitsch, and Rossi, I conclude by noting two important assumptions on which they rely. First, as Dubé, Hitsch, and Rossi stress and as the title of my note suggests, the results depend on the value of switching cost being small. In Cabral (2008), I show that for higher values of the switching cost equilibrium, prices increase in the value of switching cost and eventually become higher than they would if there were no switching costs. (Dubé, Hitsch, and Rossi also show this pattern, though again for the particular case of preference shocks that follow an extreme value distribution.) The case of large switching costs is perhaps closer to the conventional wisdom regarding the anticompetitive effects of switching costs. Beggs and Klemperer (1992), the standard reference in dynamic competition with switching costs, assume infinite switching costs and show that equilibrium prices are higher than if there were no switching costs (for an elementary treatment, see Cabral 2000, p. 218).

Second, the competitive effect of switching costs depends on symmetry across firms. In the argument presented in Cabral (2008), which I summarized previously, I show that the harvesting effect of small switching costs is small; in particular, it is of a second order of magnitude. The idea is that a small switching cost leads the "incumbent" firm (the firm to which the consumer is attached) to increase its price and the "challenger" firm (the firm to which no consumer is attached) to lower its price. In absolute value, these price variations are of the same size. Therefore, if each firm is expected to make a sale with approximately the same probability, it follows that average price remains approximately constant. However, if the incumbent firm has a much higher probability of making the sale (e.g., because its product is better), the "harvesting" price changes no longer average to zero.

To summarize, the effect of switching costs on market competitiveness is largely an empirical question. For this reason, research such as that of Dubé, Hitsch, and Rossi represents important contributions to the understanding of this phenomenon.

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Rejoinder to Shin and Sudhir and to Cabral

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We begin by thanking our discussants, Jiwoong Shin and K. Sudhir (2009) and Luís Cabral (2009), for their thoughtful comments on our research (Dubé, Hitsch, and Rossi 2009). Both commentaries focus on the stylized ("simple") model in our article, which we used to motivate our more general empirical model.

Shin and Sudhir solve a two-period Hotelling model. They find a U-shaped relationship between switching costs and the average (expected) price across both periods. Though noteworthy in their own right, the results Shin and Sudhir obtain for the two-period model are not comparable to those we obtained in our infinite-horizon model. Shin and Sudhir acknowledge this point in their discussion.

In our model, the relationship between equilibrium prices and switching costs is influenced by both harvesting and investment motives. In Period 2 of Shin and Sudhir's model, there is no investment motive, because the firm ceases to exist in the next period. In Period 1 of the model, there are no existing loyal customers, so the harvesting motive is absent. Averaging the first and second period prices cannot be viewed as an approximation to the infinite-horizon steady-state price.

We also argue that our infinite-horizon model provides a good approximation to the actual marketing environment in which firms are not expecting to terminate products in the near future. In our empirical application, we consider long-standing products for which there is no known terminal period.

Cabral's discussion summarizes the results of a model he analyzed in Cabral (2008), which includes our simple, motivating model as a special case. In an infinite-horizon game, two symmetric firms compete for one buyer, who is loyal either to Firm 1 or to Firm 2 (alternatively, there are many buyers, but the firms can discriminate between loyal and nonloyal customers). Cabral (2008) shows that as long as the cost of switching is sufficiently small, average (expected) prices decrease. In his commentary herein, Cabral provides the following intuition for why this result occurs. The harvesting motive works in opposite directions for both firms: The firm that "owns" the loyal customer increases its price, while its competitor decreases price. For a sufficiently small switching cost, the average price stays

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