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Fixed Costs Matter

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Abstract

According to standard economic wisdom, fixed costs should not matter for pricing decisions. However, outside economics, it is widely accepted that firms need to increase their prices after a fixed cost rise. In this note, we show that a liquidity-constrained firm that maximizes lifetime profits should increase its price after a fixed cost increase, if future profits depend positively on current sales. The reason is that then the optimal price is lower than the one that maximizes the current profit. Because the higher cost necessitates higher current profits to avoid bankruptcy, the firm needs to increase its price.

Keywords: fixed costs, sunk costs, switching costs, pricing (JEL codes: D42, L11)

1 Introduction

Economics textbooks teach us that the fixed cost of the firm does not affect its price and quantity in the short run. Only in the long run, there is an indirect effect via investment decisions. Avoidable fixed costs, for instance, affect decisions regarding entry, capacity, and exit. This may result in a more or less competitive environment leading to higher or lower prices. In the short run, however, a change in the firm's fixed cost should not affect its own prices.

Yet, there is considerable evidence that many firms do let their fixed costs affect their prices. For instance, survey studies as early as Govindarijian and Anthony (1983) and Shim and Sudit (1995) made clear that pricing a product based on its average total cost is common business practice. Moreover, the supposed need of a firm to increase its price after a fixed cost increase seems commonly accepted in public debate. For example, regarding the high proceeds of the 5G spectrum auctions in Italy, a contributor to the New York Times[1] states that "The big winners — Telecom Italia and Vodafone — can probably break even on their investments over time, [...], *but only by hiking prices.* That would effectively make the auction a tax on mobile users" (emphasis added).

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[1]October 3, 2018, by Liam Proud in the Deal Book of the New York Times; https://www.nytimes.com/2018/10/03/business/dealbook/italy-5g-auction.html.

In this paper we offer a new formal explanation of why and when firms may choose to adjust prices in response to a change in fixed costs. The basic idea is as follows.[2] Consider a firm for which a higher output now has a positive impact on future profits, for instance because of switching costs. Then the net present value of the firm's total profits is maximized at a lower price than the price that maximizes current profits. Now suppose that the firm is liquidity constrained: it goes bankrupt if it incurs a loss during the first period. Then, if fixed costs are so high that maximizing total discounted profits would lead to losses in the first period, it is optimal to set the first-period price precisely at the average cost level. By setting a higher current price, the firm shifts profits from the future to the current period to ensure that it survives. However, if the firm was less liquidity constrained, it could have set a lower price, increasing the firm's total profits.

The two key assumptions of our model are that (*i*) future profits depend positively on current sales and (*ii*) firms are liquidity constrained. If either assumption is violated, then the model predicts no effect of fixed costs on prices. Nonetheless, we believe that both assumption are valid in many markets. There are many reasons why future profits may depend positively on current sales, including learning by doing, network externalities, and, most notably, switching costs. A large body of empirical literature show that switching costs are commonplace in many markets, confirming the importance of our first assumption (e.g. Samuelson and Zeckhauser, 1988; Burnham et al., 2003).[3] An even larger literature in empirical finance demonstrates that liquidity-constrained firms grow slower and shrink faster after times of economic hardship, suggesting that firms' operational business decisions are constrained by their access to liquid assets (e.g., Fazzari et al., 1988; Andrade and Kaplan, 1998; Campello et al., 2010; Banerjee and Duflo, 2014).

Of course, we are not the first to offer an explanation for the effect of fixed costs on prices. The most influential line of literature was started by the seminal contribution of Baumol (1971). He shows that if fixed costs *are not yet sunk*, then higher fixed costs can lower the optimal capacity and output while increasing the optimal prices. This insight found its way into the management accounting literature where his theory serves as a foundation for modern cost-based pricing schemes.[4] Our paper differs from this literature in two ways. First, our theory explains how fixed costs can affect optimal prices when fixed costs *are sunk*. Second, the literature following Baumol (1971) requires firms to be capacity constrained. Instead, in our paper firms are liquidity constrained.

Other interesting explanations have been offered by Thépot and Netzer (2008), Janssen (2006), and Janssen and Karamychev (2007). The first two papers point out that fixed costs

[2] Although this paper is the first to present this idea formally, the intuition can be found in empirical studies. For instance, Borenstein and Rose (1995) observe that "*There are a variety of channels through which financial distress, and bankruptcy in particular, might influence pricing decisions by the affected firms or their rivals. [...] Second, bankruptcy may lead an airline to discount future revenues more heavily. This could raise prices, as in models with consumer switching cost, where low current prices can be viewed as an investment in future market share*" (p.397). Similarly, Chevalier (1995) shows empirically that supermarkets often raise prices after a leveraged buyout. One of the explanations she offers for the effects is that supermarkets operate in a market with switching costs. Insofar as a leveraged buyout tightens the liquidity constraint of the supermarket, it may force the supermarket to increase price in order to avoid bankruptcy at the cost of future profits.

[3] Hendel (1996), on the other hand, presents a model to rationalize why in some markets, a negative shock to the incumbents' profits leads the firms to optimally lower their prices. The idea is that, in times of economic hardships, a firm might want to transform planned inventories into short-term cash. This makes sense in markets where firms sell storable products so that, in contrast to our first key assumption, their future demand depends *negatively* on their current sales.

[4] See Balakrishnan and Sivaramakrishnan (2002) for an excellent review of this literature.

can facilitate collusive outcomes. Thépot and Netzer (2008) show that full cost pricing leads to higher prices, and may therefore be an attractive collusive pricing standard for an industry. Janssen (2006) studies spectrum auctions. He argues that the willingness to pay a higher license fee signals collusive intentions to other potential winners of the auction.[5] There are two main differences between these two papers and ours. First, our model can also explain why a monopolist would choose a higher price if fixed costs increase. Second, our paper is not about equilibrium selection, but about how liquidity constraints may necessitate firms to focus on current profits.

Finally, Janssen and Karamychev (2007) consider an environment with uncertain demand. They show that less risk averse firms choose less competitive strategies, while they are also willing to pay a higher cost (e.g. in a license auction) to enter a market. Thus higher fixed costs can be positively correlated with higher prices via the selection of firms in a market. By contrast, our argument does not rely on firm heterogeneity, uncertain demand or risk aversion. Rather it proves that fixed costs of a firm can directly affect its optimal price, if the firm is, or becomes, liquidity constrained.

Our model is most closely related to Klemperer (1995) and Chevalier and Scharfstein (1996). Using a model with switching costs, business cycles and liquidity constraints, the authors show that firms may choose disproportionately high prices during economic downturns. The reason is, similar to ours, that the worse conditions constrain a firm's ability to invest in future profits. In this paper, we show that this setting also explains why firms may increase optimal prices in response to an increase in their fixed costs.

Our paper is structured as follows. Section 2 presents the model. Our main results are presented in Section 3. Section 4 discusses the case of soft liquidity constraints. Section 5 concludes.

2 The Model

Our model is a simplified version of the models in Chevalier and Scharfstein (1996) and Klemperer (1995, Section 5.2), where a liquidity-constrained firm sells to consumers with switching costs. Consider a monopolist, active in two periods. In each period t, $t \in \{1, 2\}$, the monopolist chooses the quantity it sells, Q_t. Profits in period t, π_t, are equal to operational profits, π_t^o, minus fixed costs F_t, which may be partially or even fully unavoidable (sunk), so $\pi_t = \pi_t^0 - F_t$.

Key to our story, the second-period profit depends positively on first-period output,

$$\frac{\partial \pi_2^o\left(Q_1, Q_2\right)}{\partial Q_1} > 0$$

This may, for instance, be due to switching costs, learning by doing or network externalities.

To capture the liquidity constraint, we assume that the firm goes bankrupt unless it makes at least D profits during the first period (where D may be negative). In line with Chevalier and Scharfstein (1996) we assume that the lifetime profit of the firm is equal to 0 if it goes

[5] Offerman and Potters (2006) and Durham et al. (2004) both offer experimental evidence that participants are indeed more willing to coordinate on less competitive outcomes after paying an entrance fee.

bankrupt, so if[6]

$$\pi_1^o(Q_1) - F_1 < D.$$

The firm, thus, maximizes the lifetime profit function

$$\Pi(Q_1, Q_2) = \begin{cases} \pi_1^o(Q_1) - F_1 + \delta\left[\pi_2^o(Q_1, Q_2) - F_2\right] & \text{if } \pi_1(Q_1) \geq D, \text{ and} \\ 0 & \text{otherwise} \end{cases}$$

The objective of this paper is to show that liquidity-constrained, profit maximizing firms may rationally increase prices (reduce outputs), if their fixed costs increase. To keep things simple, we thus assume that the profit function has the following common properties. Let each per-period profit function be twice differentiable, strictly concave and single peaked in that period's quantity. In particular, there exists a unique, positive quantity, Q_1^*, which maximizes first-period profits. Similarly, for any Q_1, there exists a unique positive quantity, $Q_2^*(Q_1)$, that maximizes second-period profits. Likewise, we assume that the unconstrained lifetime profit function, $\pi_1^o(Q_1) - F_1 + \delta(\pi_2^o(Q_1, Q_2) - F_2)$, is twice differentiable, strictly concave and single peaked at a unique, positive pair (Q_1^{**}, Q_2^{**}), where obviously $Q_2^{**} = Q_2^*(Q_1^{**})$.

Our final two assumptions restrict our attention to the most interesting cases. First, there exists Q_1 such that $\pi_1^0(Q_1) - F > D$. This ensures that the firm can survive the first period if it wants to. Second, there exists a pair (Q_1, Q_2) such that $\Pi(Q_1, Q_2) > 0$. This ensures that the firm wants to stay in business, if it can.

3 Results

The analysis of the interesting case proceeds in two steps. First, we derive the optimal outputs. Then, we analyze how a change in the first-period fixed cost F_1 affects them.

3.1 Optimal strategy

In the second period, the firm maximizes current profits. If the firm went bankrupt in the first period, $\Pi = 0$. If instead the firm is still in business, the first-order condition results in

$$Q_2^*(Q_1): \quad \frac{\partial \pi_2^o(Q_1, Q_2^*)}{\partial Q_2} = 0$$

In the first period, the firm maximizes its total discounted profits. If the first-period's profits are higher than D, then the total discounted profits include second-period profits. Otherwise, the firm goes bankrupt and earns 0 in the second period.

Let Q_1^D be the highest quantity such that first-period profits $\pi_1^o(Q_1) - F \geq D$. This means that for any $Q_1 > Q_1^D$ the firm will go bankrupt. Because we focus on the case where the firm can survive the first period if it wants to, $\pi_1^0(Q_1^*) - F > D$, we have $Q_1^D > Q_1^*$. We now show that also $Q_1^{**} > Q_1^*$. Q_1^{**} is defined to be the optimal first-period quantity in case the liquidity constraint has no bite. So Q_1^{**} is obtained by solving

$$\frac{\partial \pi_1^o(Q_1)}{\partial Q_1} + \delta \frac{\partial \pi_2^o(Q_1, Q_2^*(Q_1))}{\partial Q_1} = \frac{\partial \pi_1^o(Q_1)}{\partial Q_1} + \delta \frac{\partial \pi_2^o(Q_1)}{\partial Q_1} = 0,$$

[6] For our results, it does not matter whether, in case of bankruptcy, period-one profits are zero or $\pi_1^o - F_1 - D$. What is crucial is that a bankrupt firm does not benefit from its customer base in the second period, i.e., that $\pi_2 = 0$.

where the first equality follows from the envelope theorem. As Q_1^* solves $\frac{\partial \pi_1^o(Q_1)}{\partial Q_1} = 0$ and by $\frac{\partial}{\partial Q_1}\pi_2^o(Q_1) > 0$ we have $Q_1^{**} > Q_1^*$. So Q_1^{**} exceeds Q_1^* because, at Q_1^*, marginally increasing Q_1 does not affect first-period profits while it does increase second-period profits. At Q_1^{**}, the loss of first-period profits by marginally increasing Q_1 exactly offsets the increase in the discounted second-period profits.

Now suppose that the firm is liquidity constrained: $Q_1^D < Q_1^{**}$. Then $Q_1 = Q_1^{**}$ is a suboptimal choice. By selecting Q_1^{**} the firm goes bankrupt and obtains a lifetime profit of 0, which is strictly less than $\pi_1(Q_1^*)$. The strict concavity of the (non-liquidity-constrained) lifetime profit function implies that the optimal quantity is the highest quantity Q_1^{**} for which the firm does not go bankrupt: Q^D. Concluding, the optimal first-period quantity, $Q_1^{\max}$, is equal to Q_1^{**} if $Q_1^{**} \leq Q_1^D$. Otherwise $Q_1^{\max}$ is equal to Q_1^D. If $D = 0$, then Q_1^D is the break-even output, so where the average total costs of the firm are equal to its price.

3.2 The role of fixed costs

Knowing $Q_1^{\max}$, we can see how a fixed-cost increase affects it. Let the fixed cost increase from F_1 to F_1', $F_1' > F_1$, and let $Q_1^{D'}$ be the highest quantity such that $\pi_1^o(Q_1^{D'}) - F_1' \geq D$. Of course, $Q_1^D > Q_1^{D'}$, because first-period profits decline in Q_1 for any $Q_1 > Q_1^*$. There are three outcomes are possible:

First, if $Q_1^{D'} \geq Q_1^{**}$ then the optimal quantity $Q_1^{\max}$ was and remains Q_1^{**}. The liquidity constraint still has no bite and the firm can choose its unconstrained first-best quantity. This is the standard result. Second, $Q_1^{D'}$ may become so small that bankruptcy becomes unavoidable. This is the case when $Q_1^* > Q_1^{D'}$.

The third case is the one we are interested in. If $Q_1^{**} > Q_1^{D'} \geq Q_1^*$ the liquidity constraint becomes (more) tight, the quantity is reduced to $Q_1^{D'}$, and the firm sells at a higher price. This is consistent with claims that a fixed-cost increase necessitates an increase in price to stay in business. Because of the higher fixed cost, the firm needs to raise its current profits. Life time profits are reduced for two reasons. First, because of the increase in fixed costs, and second because the firm cannot afford to invest as much in future profits as before.

By the same arguments, a decline in F_1 (or, equivalently, a financial windfall) implies a higher output and lower price if and only if the liquidity constraint was binding.

4 Soft Liquidity Constraints

In our model, the liquidity constraint is hard. If the firm fails to meet it it goes bankrupt. Our results carry over to situations with a soft liquidity constraint: the less liquid a firm is, the higher the costs of capital it faces. Then an increase in the firm's fixed costs increases its costs of capital. That lowers the attractiveness of any investment into future profits, including investments into the customer base if there are switching costs. Consequently the firm invests less in its customer base and, thus, charges a higher price.[7]

5 Conclusion

In this paper, we make a point which is both simple and relevant. Consider any market where future profits of a firm depend positively on its current sales. This could be markets

[7] A formal proof is available from the authors upon request.

characterized by switching costs, (new) experience goods or network externalities. Then, the firm wants to forego some profits now in order to obtain more profits in the future. A binding liquidity constraint forces the firm to make sufficient profits in the current period. Therefore, it restricts how expansionary the firm can be. A fixed-cost increase forces a liquidity-constrained firm to make more current profits and thus to be less expansionary.

This result is relevant for both firms and policy makers. For firms, it is relevant because standard economic advice is misleading, if the firm is liquidity constrained, because a change in fixed costs should affect its operational strategy. For policy makers, this insight may for example be relevant when designing spectrum auctions, such as the current round of $5G$ license auctions. In case of the Italian 5G auction, two firms (Telecom Italia SpA and Vodafone Group Plc) paid around $2.8 billion each for the largest blocks. If, as a result, these firms face a (more) binding liquidity constraint, consumer prices may increase. Moreover, contrary to the conventional view among competition authorities, our results imply that mergers that only lead to fixed cost savings may still benefit consumers.

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