Managing spillovers: An endogenous sunk cost approach☆

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ABSTRACT

For many real-world markets (such as media, telecommunications, high tech markets, commercial aircrafts, etc.), incurring endogenous sunk costs (in the form of quality enhancing expenditures), in the presence of R&D spillovers, is an essential feature of competition. We study the interaction between these sunk costs and R&D spillovers relying on the Sutton's concept of endogenous sunk costs and show that with spillovers increasing and the effectiveness of investment in raising quality decreasing, the lower bound on concentration for an industry decreases and ultimately collapses to zero when spillovers are large enough and/or effectiveness of investment is low enough. We also show that for an intermediate range of spillovers firms do invest in R&D although the market structure becomes fragmented as market size grows (no lower bound). In the second part, we allow firms to protect their investment against spillovers and focus on the symmetric equilibria, where all firms either protect their investment or do not protect at all. We show that higher spillovers and/or lower effectiveness of investment may induce firms to protect themselves against spillovers, leading to higher investment in quality, and to more concentrated market structure. Thus, the Sutton's result on the concentration bound is preserved.

1. Introduction

In his influential book, John Sutton (1991) provides us with the theory that explains why some markets remain highly concentrated. His theory predicts that in the presence of a certain type of sunk costs there is lower bound on the level of concentration in an industry. More precisely, the number of firms in a free entry equilibrium would reach some finite number, even if the size of the market approaches infinity. The reason for that is that the sunk costs "escalate" as market size grows. This special type of sunk costs that leads to such an outcome is coined "endogenous sunk costs". Sutton (1991) focuses on advertising outlays as the premier type of endogenous sunk costs, but any kind of R&D expenditures like cost-reducing investment, or investment into quality, can be considered as an endogenous sunk cost. For instance, in the media market (in particular, the newspaper industry) sunk expenditures on product quality increase in market size, yet the market remains concentrated: no matter how big it is, the largest newspaper publisher has about 20% of the market (see Berry and Waldfogel, 2010). Finally, note that in Sutton's approach both endogenous sunk costs and market concentration are endogenously determined in industry equilibrium by such parameters like market size and efficiency of the sunk costs in affecting the market outcome (say, preferences of consumers).

Much like Sutton (1991) and Sutton (2007), we focus on the markets at which incurring endogenous sunk costs is an essential feature of competition but these sunk costs stem from an investment in product quality improvement rather than advertisement. Moreover, we introduce the knowledge or R&D spillovers stemming from firms' investment in product quality.[1] A firm's effective quality of the good is thus influenced by both the firm's own investment in quality, and investment in quality by other firms. In other words, a firm's product quality is a sum of its own quality innovations, and some portion of quality innovations developed independently by other firms. Thus, spillovers are assumed to be mutual; each firm benefits from spillovers coming from the other firms ("receiving spillovers") but at the same time each firm involuntarily provides spillovers to all other firms in an industry ("giving away spillovers"). These features are consistent with the fact that innovations and imitations may be complements and reinforce each other (see Shenkar, 2010).

As for the empirical relevance of such setup, one of the stylized facts about R&D investment (endogenous sunk costs in our case) is knowledge diffusion and imperfect appropriability of innovations. Reverse-engineering,[2] labor force flows and strategic alliances among firms, among others, may serve as examples of such mutual knowledge spillovers and the mode by which they can be practically realized in an industry (see Shenkar, 2010, for many examples of these kind of knowledge leakages); see also Senyuta and Žigić (2012) for more detailed description of the modes of knowledge diffusion and for the related literature on it. Problem of imitation and imperfect appropriability is especially characteristic for high-tech product markets. For example, Koski and Kretschmer (2010) studies new product introduction in cellular phone market along several qualitative dimensions: size, battery duration, etc. Authors find that most product introductions consist of imitative innovations rather than true innovations.

In the basic version of our model we treat R&D spillovers as exogenous to firms (captured by a single parameter) in the sense that firms cannot affect the intensity of those spillovers, while in the second part of the paper, we allow for the possibility for firms to manage spillovers (protect from giving away spillovers). By that we mean deliberate actions of the firms to constrain giving away spillovers and to prevent a leakage of relevant knowledge to its competitors. In this case, we make distinction between ex ante spillovers (that are exogenously given from the point of view of the firm), and ex post spillovers, which are spillovers (if any!) that remain after the firms' protective actions. In other words, in the basic version of the model we consider only ex ante spillovers, while in the extended model we allow firms to use protective measures and so the notion of ex post spillovers appear. These protective measures, besides patents and copyrights, include also costly private protection that firms

undertake to reduce or eliminate spillovers if they find it optimal. In some cases, spillovers might be characterized as information leakage or imitations that are on the border of intellectual property rights (IPR) violations and cannot be effectively suppressed by the public IPR protection (patents or copyrights). In this case, private or technical protection (see Střelický and Žigić, 2011; Scotchmer, 2006, chapter 7) is an example of managing giving away spillovers.

Note that this extended setup (in which firms manage spillovers) can be also viewed as the situation in which both public (patents, copyrights, etc.) and private (secrecy, increasing product complexity, masquing, etc.) IPR protection are present. More specifically, the ex ante spillovers can be considered as the information leakages that do exist despite the public protection like copyright or even patents (and are, as we argued above, at the edge of IPR violations or even represent IPR violations). Ex post spillovers, on the other hand, can be considered as the information leakages that remain after the firms add their private protection on the top of already existing public IPR protection.

There are several aims of our analysis: First, we investigate the robustness of the lower bound on concentration in the above setup in which knowledge spillovers are exogenous, and study the impact of spillovers on the equilibrium values such as endogenous sunk costs or market concentration. More specifically, we aim to study the incentives of a firm to invest in quality enhancement in the presence of knowledge spillovers and to analyze how an interplay between spillovers, market size, the effectiveness of R&D investment in quality improvement (in further text shortened to "the effectiveness of investment") and free entry affects endogenous sunk costs (that is, R&D outlays) and, consequently, market concentration. In this respect, we decompose the change of endogenous sunk costs induced by change in market size into i) entry and ii) escalation effects and then study how the size of spillovers and the size of market affect these two effects and, consequently, the total change in endogenous sunk costs. Second, we allow firms to manage spillovers on their own, and study how the levels of spillovers and the effectiveness of investment in quality improvement would affect a firm's decision to protect or not against the giving away spillovers. In other words we investigate the interaction between the public and private protection given that our extended setup allows for simultaneous presence of both protections. That is, we, among the other things, explore how, say, relaxation of public protection affects its private counterpart. Third, we analyze how the possibility to restrain the giving away spillovers affects the lower bound of concentration and the level of endogenous sunk costs. Finally, we also investigate how the level of effectiveness of investment affects the endogenous sunk costs and, consequently, the market concentration in the situation when firms manage spillovers.

The effect of spillovers on the lower bound of market concentration is not only an interesting theoretical exercise but it also provides important insight to the antitrust authorities given the empirical relevance of spillovers. The competition office would surely like to know how the actual market concentration deviates from the corresponding lower bound in order to assess the possible barriers to

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[1] Note, however, that our analysis would be basically the same for the type of advertising known as "informative advertising" that spills over to the competitors and beneficially affects them.

[2] Reverse-engineering is disassembling of the product to learn how it was built and how it works.