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Modelling mergers among polluting firms when environmental policy is endogenous

Mahelet G. Fikru

Department of Economics, Missouri University of Science and Technology, 500 W 13th Street, Rolla MO 65409, USA

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ABSTRACT

This article builds a theoretical model to study merger decisions among polluting firms. We adopt the idea of endogenous policies where governments adjust optimal policy after the occurrence of mergers. We find that the adjustment in policy provides additional incentives to merge. Given a specific model of merger process with endogenous policies, we find that the optimal merger is the one among highly polluting firms. Therefore, in the post-merger market the merged entity is dirtier compared to stand-alone firms.

1. Introduction

The literature on horizontal mergers has established that the primary motive for such deals is efficiency gain. Given two or more firms with different marginal cost of production, the acquisition of a high-cost firm by a low-cost firm would result in profitable mergers (Farrell and Shapiro, 1990; Levin, 1990; Barros, 1998; Collie, 2003; Qiu and Zhou, 2007). This is because, with no capacity constraints, the merged entity can shift production from the high-cost plant to the low-cost plant without changing total output. This article extends the discussion to firms producing a good with negative externality. We extend the horizontal merger model to polluting firms and address the following research question: What is the relationship between policies that regulate polluting firms and merger deals?

Extending the merger theory to polluting firms is practical and has important policy implications for at least two reasons. First, evidences suggest that most of the merger deals take place among manufacturing firms, a majority of which contribute to pollution and greenhouse gas emissions. For instance, during 2009/2010 in Europe the value of mergers in pollution-intensive sectors identified by Hettige et al. (1995) accounted for about 80% of the value of deals and 81% of the volume of deals in the manufacturing sector (FactSet, 2010a). Another example is the USA in 2009 where among the top industries with the highest merger and acquisition (M&A) deal volume, M&As in polluting sectors accounted for over 55% of the total value of deals (FactSet, 2010b). This suggests that most of the M&As involve polluting firms, some with higher pollution than others. Therefore, one has to explicitly take into account pollution variables in the model of M&As. This study provides an introduction to integrating the 'theory of M&A' and the 'theory of pollution'.

Second, recent anecdotes suggest that manufacturing companies ought to be cautious of environmental liability when they purchase a competitor's plant(s) (Gillston and Meyer, 2013). For example, there are many insurers that provide

E-mail address: fikruma@mst.edu.

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solutions to managing environmental risks that arise from acquiring 'dirty' plants (ACE Group Website, 2015). Furthermore, firms planning to make acquisition deals should evaluate the effect of environmental policy on those businesses they wish to acquire (Gehsmann and McCeney, 2009). Thus, merger theories that incorporate environmental policies and pollution parameters provide further insights on how merger incentives could be affected by pollution and resulting regulation affecting participating firms.

In this article we use endogenous policies where governments adjust optimal policy after the occurrence of M&As. That is, optimal policies are sensitive to whether a merger has taken place or not; and pre-merger policies may differ from post-merger ones. Such endogeneity of policies has been discussed to some extent in theoretical environmental studies. For instance, Katsoulacos and Xepapadeas (1996) show that emission tax can be affected by a change in the number of firms in a sector. One possible cause for change in number of firms is consolidation through M&As. Barrett (1994b) argues that governments may lower emission tax for sectors with fewer firms to increase their competitiveness. Collie (2003) introduced endogenous trade policies to examine the effect of mergers on welfare. Similarly, Huck and Konard (2004) use endogenously determined trade policy to examine the profitability of mergers.

With endogenous policies, we find that the adjustment in policy provides additional incentives to merge. Furthermore, our theoretical result suggests that, given a specific merger process, the highest incentive to merge is for firms with the highest pollution intensity in the industry. We also find that cleaner firms fair better when they remain independent than acquiring a dirtier firm. As a result in the post-merger market the merged entity (made up of highly polluting firms) is dirtier compared to stand-alone firms.

The results obtained from this study have important policy implications. So far antitrust and industrial policies are determined independently from environmental factors and pollution issues. If highly-polluting firms have a significantly higher probability to merge as compared to less polluting firms in a given sector, then anti-trust agencies may find it useful to incorporate environmental criteria when accepting or rejecting merger proposals.

In Section 2 we present a model of profit maximizing firms where asymmetries are introduced in terms of pollution intensity. In Section 3 we set up the endogenous policy model and study the incentive to merge. Section 4 endogenizes the merger decision to determine which of the firms, i.e., highly polluting or less polluting, actually engage in M&A at equilibrium. Section 5 concludes the discussion.

2. The model

Following Lommerud and Sorgard (1997), Barros (1998), Fridolfsson and Stennek (2005a,b) and Kao and Menezes (2010) we introduce a Cournot triopoly industry where firms produce a homogeneous good. The economy is closed and all resources are fully employed. Demand for the good is linear and given by $p = a - X$ where $X = X_1 + X_2 + X_3$, a represents the market size, X_i is the output level of firm i, $i = 1, 2, 3$, X is total output level and p is consumer price.

All firms use an end-of-the-pipe-type abatement technology as in Lahiri and Symeonidis (2007) where initially production takes place producing gross pollution out of which the firm abates a certain amount whereas the rest is emitted. Each firm pays a per unit emission tax, t, for each unit of pollution it fails to abate. Firms incur cost of abating pollution, where the abatement cost function is assumed to be quadratic as in Barrett (1994a). Each firm's abatement cost depends on its own abatement and no one else's.

$$g(A_i) = \frac{rA_i^2}{2} \tag{1}$$

$$A_i = \theta(X_i) - e_i \tag{2}$$

$$\theta(X_i) = Z_i X_i \quad \text{where } Z_i > 0 \tag{3}$$

$g(A_i)$ is the abatement cost of firm i and fulfills $g'(A_i) > 0$ and $g''(A_i) > 0$. A_i is the abatement level of each firm, r is an efficiency parameter of the abatement technology and $\theta(X_i)$ is gross pollution. Z_i is pollution intensity and indicates how clean the production technology is. e_i is emission level of each firm i. We assume $Z_1 > Z_2 > Z_3$ where firms can be ranked according to their pollution intensity. Thus, firm 3 is the most clean firm whereas firm 1 is the most dirty firm in the given industry.

The model involves two types of market distortions: oligopoly distortion where there is less competition and pollution distortion where there is disutility from emission. Environmental policies such as an emission tax are primarily designed to reduce the level of emission. On the other hand, the government would also like to reduce oligopoly distortion by providing a production subsidy. The objective of the production subsidy is to expand production without increasing consumer price. Governments pay production subsidies when consumers are not willing to pay a price that is high enough for a producer to recover costs. The production subsidy is assumed to be a specific subsidy, T, and the producer's price is re-defined as the consumer price plus the subsidy, $P = p + T$, where P is the producer's price and p is the consumer price (Keen and Lahiri, 1993).

Similar to Salant et al. (1983) and Qiu and Zhou (2007) firms have identical marginal cost of production, c. The purpose of assuming identical and constant marginal cost is to control for merger incentives arising from more complex cost structures. Each firm i maximizes profit with respect to output and abatement level as follows

$$\max_{X_i, A_i} \pi_i = (P - c)X_i - \frac{rA_i^2}{2} - te_i. \tag{4}$$