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# A note on the relation between size, ownership status and plant's closure: sunk costs vs. strategic size liability

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**Abstract**

In this paper we test both sunk cost and strategic size liability predictions by looking at the exit behavior of a sample of Italian manufacturing plants. For this purpose, we focus on plants' size and ownership status. In particular, we distinguish independent plants from plants that belong to multi-unit organizations. As to these latter, we further distinguish State-owned from privately-owned plants. We also consider the impact upon the likelihood of closure of the size and nationality of the parent firm. In addition, and contrary to previous empirical work, data allow us to control for differences in the cost structure of plants. Namely, we use technology adoption dummies to take into account plants' technological heterogeneity. 

*Keywords:* Closure; Exit; Sunk costs; Ownership status

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## 1. Introduction

Theory traditionally suggests that plants (firms) terminate operations as soon as the price level does not allow to recover variable costs. Accordingly, high-cost firms will exit first. However, more recent theoretical and empirical work has shown that this may not always be the case. In particular, sunk costs and strategic size liability explanations have been put forward as key in influencing exit decisions.

When (a) sunk costs are high and (b) future market conditions are uncertain, then real option theory (Dixit and Pindyck, 1994) points out that even if the traditional exit condition applies, a firm's management may find it optimal to delay exit until new information is collected. Thus differences in

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exit (and re-entry) sunk costs might cause drastic differences in plants' exit behavior. In particular, exit and re-entry sunk costs differ according to the ownership status of plants. On the one hand, neither closure of an establishment by a multi-unit organization implies death of the firm nor it means exit from a product market if production is carried out in (or will be transferred to) other plants; it follows that re-entry sunk costs are avoided. On the other hand, multi-unit enterprises are likely to benefit from lower sunk costs in terminating a plant's operations than single-plant firms due to the alleged greater efficiency of their internal factor markets in re-deploying production equipment and disposing of the labor force of the closed plant (Baden-Fuller, 1989). In accordance with such line of reasoning, the empirical literature on survival provides clear evidence that ownership status does matter. Dunne et al. (1989) show that in the US manufacturing industry in the period 1967 to 1982 small plants owned by single-plant firms were more likely to survive than those owned by multi-plant organizations; however, the opposite pattern applies to large plants. Audretsch and Mahmood (1995) find that the hazard rate (i.e. the probability of closure in time $t$ conditional on survival up to $t$) of new plants is significantly higher for units owned by multi-plant firms. Similarly, in Mata et al.'s (1995) study new establishments owned by newly created single-plant firms exhibit a lower hazard rate than those owned by both new and established multi-plant firms, with everything else (notably the start-up and current sizes of plants) being equal.

Besides the sunk cost explanation, a stream of game-theoretic literature has addressed exit and capacity reduction in declining industries. Such works point out the existence of a strategic effect associated with firm and plant size. Ghemawat and Nalebuff's (1990) model suggests that when firms can divest incrementally, larger firms have larger strategic incentives to reduce capacity; accordingly, they will do so until their capacity equals that of their smaller rivals. Reynolds (1988) obtains similar results under the assumptions that capacity is lumpy and all plants are of equal size. Such predictions are consistent with Lieberman (1990) results, who examines the sequence of divestments in declining chemical industries: his findings suggest that plant closure is more likely for large sized multi-plant firms than for the remaining firms in his sample. These theoretical results are extended to all stages of the industry life cycle by Londregan (1990).

In this paper we test both sunk cost and strategic size liability predictions by looking at the exit behavior of a sample of Italian manufacturing plants. For this purpose, we focus on plants' size and ownership status. In particular, we distinguish independent plants from plants that belong to multi-unit organizations. As to these latter, we further distinguish State-owned from privately-owned plants. We also consider the impact upon the likelihood of closure of the size and nationality of the parent firm. In addition, and contrary to previous empirical work, data allow us to control for differences in the cost structure of plants. Namely, we use technology adoption dummies to take into account plants' technological heterogeneity.

## 2. The data set and the econometric model

The data used in this paper are provided by the FLAUTO database developed at Politecnico di Milano. The sample is composed of 810 plants and is stratified by industry, localization and plant size so as to faithfully represent the universe of all Italian metalworking plants with more than 10

employees which were in operation in 1986 (for a detailed description of the FLAUTO database see Colombo and Delmastro, 1999). The metalworking sector includes the following two-digit NACE-CLIO industries: fabricated metals (31), non-electrical machinery (32), computers and office equipment (33), electrical machinery and electronics (34), automotive and other transportation equipment (35–36), and scientific, precision, medical and optical instruments (37).

For each sample plant, FLAUTO provides information as to whether it was shut down during the period June 1989 to June 1997. Plant closure is distinguished from situations where a plant has changed either its ownership structure as a consequence of merger and acquisition activity or its location. Thus, we were able to avoid possible measurement errors resulting from localization, ownership and other administrative changes (e.g. change of the name of the parent firm) which are quite usual in this type of exercise (for a discussion of such problems see Dunne et al., 1988). Out of the 810 plants, 708 turned out to be still in operation in 1997.

FLAUTO contains detailed information on the characteristics of the sample plants. In this paper we shall estimate a series of probit models, where the dependent variable ''*Closure*'' takes the value ''1'' if a plant which was in existence in 1989 was shut down in the period 1989 to 1997. Unfortunately, the precise date when the plant was shut down is not available. This prevents use of survival data analysis models. Table 1 presents the definition of the explanatory variables of plant's closure including, of course, information on the plant's ownership status.

Table 1
The explanatory variables of plant closure[a]

| Variable | Description |
|---|---|
| SIZE | Logarithm of the number of plant's employees |
| LARGE GROUP | 1 for plants that belong to business groups with more than 10,000 employees; 0 otherwise |
| SMALL GROUP | 1 for plants that belong to business groups with less than 10,000 employees; 0 otherwise |
| STATE OWNED | 1 for State-owned plants; 0 otherwise |
| PRIVATE IT | 1 for plants that belong to private Italian business groups; 0 otherwise |
| FOREIGN MNE | 1 for plants that belong to foreign multinational enterprises; 0 otherwise |
| CAD/CAM | 1 for plants that had adopted computer-aided design or engineering equipment; 0 otherwise |
| NC/CNC | 1 for plants that had adopted NC and/or CNC stand alone machine tools and/or programmable robots; 0 otherwise |
| MC | 1 for plants that had adopted machining centers; 0 otherwise |
| FMS | 1 for plants that had adopted flexible manufacturing systems or cells; 0 otherwise |
| AIMS | 1 for plants that had adopted automated inflexible manufacturing systems; 0 otherwise |
| SOUTHERNIT | 1 for plants located in Southern Italy; 0 otherwise |
| INDDISTR | 1 for plants located within an industrial district; 0 otherwise |

[a] All variables are measured at June 1989.

## 3. Empirical evidence

The analysis of the impact upon likelihood of closure of a plant's size and ownership status can be carried out with the help of Table 2, which contains the results of the econometric estimates, and Table 3, where tests of hypotheses are illustrated.

In models I and II, plants are classified into three categories: those belonging to large business groups, those owned by small and medium sized groups, and independent plants, which constitute the baseline in the regressions. In line with theoretical predictions, the coefficients of LARGEGROUP and SMALLGROUP in regression I are positive and statistically significant (at 99 and 95% respectively); in addition, the magnitude of the former coefficient is larger than that of the latter. With plant size being equal, large multi-plant organizations possibly enjoy lower costs of closing the plant than smaller ones due to larger and more efficient internal markets for productive factors. In turn these latter organizations are more likely to shut down plants than single-unit firms, as neither plant closure necessarily means exit from a product market nor it leads to the dissolution of the firm. However, one should recognize that such results are also consistent with the ''strategic size liability'' argument set

Table 2
Failure rate and ownership status (probit model)[a]

| | | I | II | III | IV |
|---|---|---|---|---|---|
| | Constant | − 0.4915 (0.2893)[b] | − 0.8730 (0.3514)[c] | − 0.5689 (0.2880) | − 0.8790 (0.3519)[c] |
| $a_1$ | Size (ln) | − 0.2161 (0.0733)[d] | − 0.1189 (0.0886) | − 0.1949 (0.0728)[d] | − 0.1175 (0.0887) |
| $a_2$ | Small group | 0.4211 (0.1698)[c] | 2.0186 (0.7705)[d] | | |
| $a_3$ | Size x small group | | − 0.3388 (0.1600)[c] | | |
| $a_4$ | Large group | 0.6827 (0.2628)[d] | 1.1021 (1.0641) | | |
| $a_5$ | Size x large group | | − 0.1048 (0.1785) | | |
| $a_6$ | State-owned group | | | 0.4556 (0.3299) | 2.9047 (1.8054) |
| $a_7$ | Size x state-owned group | | | | − 0.4309 (0.3077) |
| $a_8$ | Private Italian group | | | 0.4890 (0.1877)[d] | 1.3216 (0.8051)[b] |
| $a_9$ | Size x private Italian group | | | | − 0.1831 (0.1658) |
| $a_{10}$ | Foreign MNE | | | 0.4279 (0.2295)[b] | 0.8372 (1.0100) |
| $a_{11}$ | Size x foreign MNE | | | | − 0.0962 (0.1859) |
| | CAD/CAM | − 0.2859 (0.1527)[b] | − 0.2815 (0.1522)[b] | − 0.2932 (0.1523)[b] | − 0.2991 (0.1521)[c] |
| $a_{12}$ | NC/CNC | 0.1795(0.1335) | 0.1772 (0.1336) | 0.1812 (0.1334) | 0.1888 (0.1336) |
| $a_{13}$ | MC | − 0.2034 (0.1574) | − 0.2065 (0.1581) | − 0.1995 (0.1577) | − 0.2143 (0.1587) |
| $a_{14}$ | FMS | 0.2969 (0.2467) | 0.3181 (0.2495) | 0.3195 (0.2455) | 0.3333 (0.2508) |
| $a_{15}$ | AIMS | − 0.4604 (0.2071)[c] | 0.4381 (0.2076)[c] | − 0.4719 (0.2070)[c] | − 0.4393 (0.2082)[c] |
| $a_{16}$ | Southern Italy | 0.4423 (0.1862)[c] | 0.4747 (0.1875)[c] | 0.4334 (0.1872)[c] | 0.4731 (0.1900)[c] |
| $a_{17}$ | Industrial district | − 0.0123 (0.1400) | − 0.0203 (0.1407) | − 0.0267 (0.1395) | − 0.0309 (0.1402) |
| | Log-likelihood | − 284.91 | − 282.60 | − 285.42 | − 283.89 |
| | LR test | 43.46 (16)[d] | 48.09 (18)[d] | 42.44 (17)[d] | 45.49 (20)[d] |
| | N. of obs | 810 | 810 | 810 | 810 |

[a] Standard errors and degrees of freedom between parentheses. For the sake of synthesis, illustration of industry effects is omitted.

[b] Significance level greater than 90%.

[c] Significance level greater than 95%.

[d] Significance level greater than 99%.

Table 3
Failure rate and ownership status (tests of hypotheses)[a]

| | II | IV |
|---|---|---|
| Chi-squared LR test: | | |
| $a_3 = a_5 = 0$ | 4.62 (2)[b] | |
| Chi-squared LR test: | | |
| $a_7 = a_9 = a_{11} = 0$ | | 3.06 (3) |
| Wald test: | | |
| $a_1 + a_3 = 0$ | 10.52 (1)[d] | |
| Wald test: | | |
| $a_1 + a_5 = 0$ | 1.90 (1) | |
| Wald test: | | |
| $a_1 + a_7 = 0$ | | 3.39 (1)[b] |
| Wald test: | | |
| $a_1 + a_9 = 0$ | | 4.14 (1)[c] |
| Wald test: | | |
| $a_1 + a_{11} = 0$ | | 1.53 (1) |

[a] Degrees of freedom between parentheses.
[b] Significance level greater than 90%.
[c] Significance level greater than 95%.
[d] Significance level greater than 99%.

forth by the game-theoretic literature, according to which the incentives to plant closure increase with the size of a firm independently of any sunk cost advantage.

As to this issue, further insights can be gained by turning to regression II, where interactive terms are included among the explanatory variables with the aim of capturing differences in the marginal effect of plant size according to plants' ownership status. The null hypothesis that the coefficients of the interactive terms be equal to 0 can be rejected by a LR test, though only at 90% significance level (see Table 3). All the three coefficients of the plant size variables turn out to be negative, suggesting that the likelihood of closure decreases with plant size. However, only the coefficient of the small group category is statistically significant at 99%; in addition, it is much larger in absolute value than the ones of the two remaining plant categories. Note also that the coefficient of SMALLGROUP is almost twice as large as that of LARGEGROUP. Altogether, such findings are more supportive of the exit (and re-entry) sunk cost argument than of the strategic size liability argument. In order to make it clear, we have calculated estimated closure probabilities as a function of plant size for the three categories of plants; as is usual, dummies are set equal to 0 and other continuous variables are evaluated at their means. If we consider a small size plant with 20 employees, the estimated failure rate is higher (42.4%) in the small sized multi-plant organization category than in the two remaining ones (34.2 and 11.6% for the large business group and single-plant firm categories, respectively). This result clearly is in contrast to the strategic size liability argument. However, the relative advantage of small groups rapidly vanishes with plant size: from a 50 employees size threshold upwards large multi-unit organizations are characterized by a higher failure rate than smaller groups. We deduce that the cost advantage in plant closure enjoyed by multi-plant organizations with respect to single-unit firms does depend on the size of the plant to be shut down relative to that of the parent company. In particular, for large plants such advantage is confined to very large business groups.

In regressions III and IV a further distinction is made between State-owned plants, plants that belong to Italian private groups, and plants owned by foreign multinational enterprises. Failure rates of plants in both the Italian private group and foreign multinational categories turn out to be substantially larger than in the independent plant category, with the coefficients of such variables being positive and significant at 99% and 90% respectively. In addition, likelihood of survival would seem to be larger and less sensitive to plant size for foreign owned units than for establishments of Italian groups; in particular, in regression IV the coefficient of SIZE for foreign owned plants is not significant, while it is significant at 95% (and negative) for nationally owned ones (see the value of the Wald tests in Table 3). As the decision by a foreign multinational enterprise to close a plant often implies abandoning the country,[1] the lower failure rate of foreign owned units may be justified by the larger exit and re-entry sunk costs involved by plant closure. Instead, the exit behavior of Italian State-owned enterprises seems to diverge from that of their private counterparts. The coefficient of STATEOWNED in regression III is statistically not significant at conventional levels (even though it is positive). This may be regarded as a consequence of the peculiar social objectives pursued by State-owned enterprises; it may also signal the social and political pressures to which such firms are exposed, leading to higher exit costs. The estimates of regression IV also suggest that such reasoning especially applies to large sized State-owned units. Note in fact the large magnitude of the (negative) coefficient of the plant size variable significant at 90% (see again the Wald test in Table 3).

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[1] According to information provided by the REPRINT database, which monitors foreign direct investments in Italy on a regular basis since 1983, out of 1279 foreign multinationals, which were present in Italy in the manufacturing industry at the end of 1989, 1032 (that is, 80.7%) operated a single plant.

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