# Location and Survival of New Entry*

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ABSTRACT. Drawing from two different strands of literature, industrial ecology and spatial analysis, the paper attempts to examine the role that location plays in determining firm survival. A time-varying covariates hazard model is used on Greek firms, which enter manufacturing in the early 1980s and are followed up to 1992. Location in Greater Athens vs. the rest of the country affects survival positively, especially when smaller firms are concerned. Other firm variables such as current size, profitability, leverage and capital together with growth and industry contestability are also found to affect survival, which becomes more difficult for firms established closer to recessions.

## 1. Introduction

Industrial ecology has been a fast growing field of empirical industrial organization investigating issues such as firm entry and exit, post-entry performance and industry evolution (Audretsch and Mata, 1995). The analysis presented so far, though, has essentially been of a non-spatial nature. The role of location, especially once entry is established, has not been investigated. The present research introduces a spatial dimension to the analysis of firm survival by imposing an explicit research question. Namely, is the hazard facing new firms considerably different between major urban hubs and non-metropolitan areas? This might carry significant policy implications for dealing with industry development in countries facing spatial dualism due to extensive concentration of activities in just a few urban centres.

Our survival analysis adds to the literature by offering new evidence on a fresh question. It does so using detailed information on firms entering Greek manufacturing, a new approximation for industry contestability, and a less restrictive than usual econometric framework. Being motivated by insights found in distinctive economics strands, the analysis introduces a spatial dimension to mainstream firm survival literature. The research builds upon earlier work, which investigated the effects of financial structure on survival (Fotopoulos and Louri, 2000), but introduces significant differences. Independent variables are allowed to vary from birth until death for firms that ceased operations at some time during the study period or until the end of the study period for surviving firms. This methodological approach has been rarely used in applied research of firm survival (Audrestsch and Mahmood, 1995; Mata et al., 1995), despite the fact that covariates are likely to vary during spells when analyzing duration data. Instead of assuming that initial conditions determine the entire life-path for new firms, it would be more appropriate to employ an econometric model that incorporates the ability of firms to learn and adapt to their environment over time. The bottom line is that the ability of firms to evolve might be far more important in determining their survival in a business environment that is evolving too, rather than initial conditions. Thus, employing a less restrictive model does not refute the importance of initial conditions in determining the likelihood of failure, especially in the shorter run, but seeks to lend a dynamic view to firm survival.

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The evidence from the 1982–1992 period suggests that firms heavily committed in fixed assets, profitable and fast growing, lower leveraged and operating in less contestable markets face reduced hazard. Firm size is of marginal significance in mitigating hazard for all firms independently of their location. Firms located in greater Athens seem to face increased chance for survival when compared with firms located in the rest of Greece, and there are traces of a positive nexus between urban location, smaller size and higher probability of survival.

Section 2 reviews the mainstream industrial economics literature on survival. Section 3 surveys the spatial literature the present research draws upon. Section 4 deals with data issues and non-parametric analysis of firm survival in a spatial context. Section 5 presents an econometric investigation of hazard confronting new entry in Greek manufacturing. Conclusions follow in the last section.

## 2. Firm survival: Mainstream industrial economics analysis and evidence

In industrial economics firm survival was first dealt with as a side issue to firm growth, since it was only surviving firms that could grow. Joint estimations of survival and growth were then used to overcome this selectivity-bias problem. Later, it also became a side issue in the entry and exit literature, survival being the inevitable in-between stage. If entry barriers could be more effectively justified as barriers to survival, this would help to reconcile the repeated occurrence of sub-optimal entry with the presence of high entry barriers, and the often recorded positive correlation between entry and exit rates across industries (Geroski, 1995). Finally, in the 1990s survival established its independent position in the literature, giving rise to a considerable amount of empirical research. Audretsch (1991), essentially deploying explanatory variables defined at the industry level, finds that industry concentration, capital intensity and economies of scale all have a negative effect on new firm survival, thus supporting the idea that entry barriers are more effective as barriers to survival. In contrast, industry growth reduces the cost disadvantage, which penalizes sub-optimal entrants, enhancing survival prospects.

Concentrating the analysis entirely at the industry level,[1] when dealing with the determinants of hazard confronting new firms, was recognized as a limitation of Audretsch (1991). Hence, firm-specific variables were subsequently introduced. Start-up size was empirically established to exert a significant negative effect on hazard implying a positive influence on survival of new firms in various country contexts (U.S., Canada, Portugal, Greece).[2] This follows the rationale that the larger the start-up size is, the less is the distance to be covered by newcomers in approaching an industry's minimum efficient size and hence the less handicapped they are when compared with more cost-effective competitors. However, Agarwal and Audretsch (1999) offer evidence that refines this theorization, suggesting that the size-survival relationship is crucially shaped by the stage of industry life-cycle and the associated potential for smaller firms to occupy market niches in their effort to overcome size-related disadvantages. Mahmood (1992) estimates that the negative effect of firm size on hazard is significant in both low tech and high tech industries but somewhat more important for the latter. Doms et al. (1995) demonstrate that capital intensive plants and plants employing advanced technology are less likely to fail and enjoy higher growth rates. An industry's overall innovation rate affects negatively firm survival but not in industries where small firms have innovative advantage (Audretsch, 1991; Audretsch and Mahmood, 1995). Agarwal (1996; 1998) shows that new and small firms enjoy a higher probability of survival in more technical-product industries and in phases of higher technological activity in an industry's life cycle. Evidence on ownership status shows that the hazard confronting branches of multi-plant firms, subsidiary firms and firms participating in other firms is higher than that of single-plant entrants (Audretsch and Mahmood, 1995) suggesting that exit may as well be a strategic decision, taken more easily by diversifying firms.

The effect of wider economic conditions on new firm survival has been dealt only in just a few papers. Audretsch and Mahmood (1995) provide evidence that the hazard rate for new establishments is higher during downturns as indicated by

higher unemployment rates. A rather counter-intuitive result in this study is the negative effect of interest rates on the hazard confronted by new firms. The explanation offered is that most new firms in the U.S. are not crucially dependent on external capital. Boeri and Bellman (1995), on the other hand, suggest that exit (aggregate hazard) in German manufacturing is not responsive to the economic cycle. In contrast, Fotopoulos and Louri (2000) are explicit about the importance of the economic cycle, to the extent that the evidence provided demonstrates that Greek firms established closer to economic downturns have an increased exposure to failure, probably because of adverse market conditions less experienced firms are faced with. In the same paper, the importance of initial financial structure is investigated. The evidence supported the hazard-reducing role of larger initial financial size, conservative borrowing, heavier fixed asset commitment, higher profitability and lower diversification.

Thus, in a nutshell, mainstream industrial economics analysis suggests that variables specific to the firm as well as variables specific to the industry affect the hazard faced by new entrants. At the firm level, size, growth, ownership status, life cycle stage, technology employed and financial structure are among the most celebrated determinants of firm survival. At the industry level traditional entry barriers, affecting industry contestability, and technology conditions are found to play a significant role in determining hazard. Macro-economic conditions may also facilitate or obstruct survival.

## 3. Firm survival: Spatial considerations and implications

Another strand of economic literature, that of urban-regional economics has sought to explain the spatial patterns of firm entry and exit, often using industry aggregates. Unlike industrial economics, spatial analyses have only rarely been concerned with post-entry firm performance, since the emphasis was on post-entry relocation patterns of new firms rather than on firm survival *per se* and its prospects within an urban environment. Fundamental to such a theorization has been the "inner-city incubator" hypothesis (Vernon, 1960) and the "filtering-down" theory (Thompson, 1968).

The inner city incubator hypothesis suggests that a high manufacturing birth rate takes place in the core of metropolitan areas being facilitated by external economies, arising from close proximity to suppliers and customers, increased information circulation etc. The inner city location, although preferable in the early days of a new firm, may be later abandoned as the firm grows and internalizes more efficiently services previously assigned to other firms. The filtering-down theory maintains that large urban areas offer an environment that is more conducive to innovation possessing, diversified and skilled labor markets, and information and interaction opportunities with other firms. Following a life-cycle theorization of an industry, new innovative firms are thought to have a higher propensity to set up in urban areas. However, as the product or the processes mature and become more standardized, firms may well tend to flee to less sophisticated and more peripheral areas.[3]

Leone and Struyk (1976) find limited evidence in support of the incubator hypothesis that is confined to New York, while Nicholson et al. (1981) demonstrate that for London the only evidence than can be used in favour of this hypothesis relates to the use of old premises by new firms. The de Jong and Lambooy (1986) research for new firm formation in the Netherlands places particular emphasis on Amsterdam and points out that the clustering of new firms within or near urban areas could be attributed to the attractiveness of urban labour markets. Garofoli (1994) does not find any support for the validity of the incubator-hypothesis as a possible determinant of spatial variations in new firm formation in Italy at a provincial level. In contrast, Santarelli and Piergiovanni (1995) offer some evidence for the filtering-down theory in the producer services sector in Italy, suggesting that higher-order and more innovative producer services tend to locate within the largest urban areas. There is also some evidence from U.S. metropolitan areas (Malecki, 1990) suggesting that geographical differences in sectoral markets and in agglomerations of complementary activities influence new firm formation, especially in high technology service sectors. On the other hand, Reynolds (1994) in analyzing

spatial patterns of firm births across U.S. labor market areas, demonstrates that various proxies of urbanization/agglomeration have a positive effect on business services start-ups.[4] The same, however, is not evident for manufacturing firm births, indicating a shift of manufacturing away from dense high cost regions but remaining in some reasonable proximity to major metropolitan labor market areas

Keeble and Walker (1994) maintain that population density should be interpreted as measuring the wider existence of either agglomeration economies or diseconomies which are related to costs of premises, labour and accessibility/ congestion. The effect of population density on manufacturing and all-sector new firm formation activity has been found positive and significant confirming that large cities still act as nurseries or incubators for enterprise. While urban environments act as new firm incubators or nurseries, agglomeration diseconomies result in firm death or relocation. This has been evidenced by the positive and significant effect of population density on firm deaths when both sector-specific and sector-independent new firm formation rates were analyzed.

The effect of agglomeration economies on new firm formation has not always been found to be significant, as both the Audretsch and Vivarelli (1995) and Gerlach and Wagner (1994) studies for Italy and Lower Saxony respectively show. Conversely, Guesnier (1994) notes that in France higher new firm formation rates are associated with higher population densities and this was also evident in the Audretsch and Fritsch (1994) research on spatial variations of firm births in Germany. Fritsch (1997) depicts that in West German planning regions over the 1986–1989 period more than half of all start-ups took place in highly congested areas. Analysis of new firm formation patterns in Sweden (Davidsson et al., 1994) also reveals that the most populated market areas are among those exhibiting the highest rates of firm start-ups and that among regions recording the lowest rates appear to be those dominated by large plants. Spilling (1996) finds rather complicated patterns for regional variations of start-up rates in Norway with respect to the center-periphery dimension. Although there is a tendency for major urban areas and small towns to exhibit higher start-up rates, this pattern is disturbed as some of the most peripheral areas also exhibit high start-up rates.

In a Greek context Louri (1988) finds that sizeable urbanization economies provide an explanation for the strong tendency of manufacturing firms to locate in urban centres. Fotopoulos and Spence (1998) offer empirical evidence suggesting that agglomeration economies, proxied by population density, together with extensive small firm structures, local production links, and regional specialization positively account for spatial variations in new firm formation. Fotopoulos and Spence (1999) suggest that local economic conditions determine spatial variations in net entry rates across Greek manufacturing sectors, especially for small firms. Moreover, Louri and Anagnostaki (1994) submit that as far as entry preferences in Athens and the rest of Greece are concerned, urbanization economies play a more significant role than the usual factors given by entry theory.

This sort of theoretical considerations and international empirical evidence on spatial variations of firm births and deaths seem to suggest that location and its relation to agglomeration economies together with the extent of vertical integration and production links in relation to firm size, might have further implications for post entry performance.

## 4. Data and non-parametric analysis of hazard rates and firm survival

Data in individual, manufacturing firms have been derived form the ICAP directories, which provide financial information based on the balance sheets of all Plc and Ltd. firms in Greece together with their employment, establishment date and location. Our data basis was constructed identifying the firms that were established in each of the years 1982, 1983 and 1984 and tracking information on their existence and performance in subsequent ICAP directories up to year 1992. If a firm did not report accounts for more than two consecutive years, it was confirmed “dead”. Of the firms established in 1982–1984 a large number had to be discarded in order to maintain the consistency of the sample eventually used. The “consistency” rule applied restricts the analysis of survival only

for those firms whose first available balance sheet comes in the year that is immediately following the reported establishment year and have no missing variables. Eventually the operational data set was left with 209 firms the average size of which was 46 employees.[5] Most of them (120) located in Greater Athens area, while 89 located in the rest of the country. Since the firms are followed to 1992, the total number of observations provided is 1115.

Tables I and II present the results of follow-up life table analysis for the firms of our sample according to their location. It has to be stressed that since we have pooled three consecutive cohorts of firms entering in 1982–1984, the intervals presented in the tables do not coincide with calendar years, but correspond to nine distinct "exit" or failure times.

Athens, accounting for 34% of all manufacturing units according to the 1993–1994 Industrial Surveys (and 35% of Greek population in 1992), remains the country's most important industrial and urban centre. It concentrates 57% of new entry in our sample. For Athenian firms the mean size in employment terms is 37.72 employees with a 70.34 standard deviation. This contrasts markedly with the considerably larger mean employment of 66.16 (standard deviation 94.93) for firms located elsewhere in Greece. Hazard rates for firms located in Greater Athens start as high as 23% in the first interval, are reduced to 4% in the fifth, reach a lower peak in the 7th interval (16%) and drop dramatically to 4% in the last interval. The overall pattern for Athenian firms shows a tendency (though non-monotonic) for reduced hazard as firms age.[6] Thus, in the last interval the survival rate is 96%, while the cumulative survival rate is 32%.

TABLE I
Life table analysis for all cohorts combined: Firms located in Athens area

| Time | Observations | Censored | Risk set | Exits | Exit rate | Survival rate | Cumulative survival rate | Hazard rate |
|---|---|---|---|---|---|---|---|---|
| $j$ | $n_j$ | $C_j$ | $r_j = n_j - C_j/2$ | $x_j$ | $xr_j = x_j/r_j$ | $sr_j = (1 - xr_j)$ | $P_j = sr_jP_{j-1}$ | $h_j = 2xr_j/(2 - xr_j)$ |
| [1–2) | 120 | 0 | 120 | 25 | 0.2083 | 0.7917 | 0.7917 | 0.2326 |
| [2–3) | 95 | 0 | 95 | 12 | 0.1263 | 0.8737 | 0.6919 | 0.1348 |
| [3–4) | 83 | 0 | 83 | 8 | 0.0964 | 0.9036 | 0.6250 | 0.1013 |
| [4–5) | 75 | 0 | 75 | 10 | 0.1333 | 0.8667 | 0.5417 | 0.1429 |
| [5–6) | 65 | 0 | 65 | 3 | 0.0462 | 0.9538 | 0.5167 | 0.0472 |
| [6–7) | 62 | 0 | 62 | 8 | 0.1290 | 0.8710 | 0.4500 | 0.1379 |
| [7–8) | 54 | 0 | 54 | 8 | 0.1481 | 0.8519 | 0.3833 | 0.1600 |
| [8–9) | 46 | 10 | 41 | 5 | 0.1220 | 0.8780 | 0.3366 | 0.1299 |
| [9–10) | 31 | 12 | 25 | 1 | 0.0400 | 0.9600 | 0.3231 | 0.0408 |

TABLE II
Life table analysis for all cohorts combined: Firms located in rest of Greece

| Time | Observations | Censored | Risk set | Exits | Exit rate | Survival rate | Cumulative survival rate | Hazard rate |
|---|---|---|---|---|---|---|---|---|
| $j$ | $n_j$ | $C_j$ | $r_j = n_j - C_j/2$ | $x_j$ | $xr_j = x_j/r_j$ | $sr_j = (1 - xr_j)$ | $P_j = sr_jP_{j-1}$ | $h_j = 2xr_j/(2 - xr_j)$ |
| [1–2) | 89 | 0 | 89 | 18 | 0.2022 | 0.7978 | 0.7978 | 0.2250 |
| [2–3) | 71 | 0 | 71 | 8 | 0.1127 | 0.8873 | 0.7079 | 0.1194 |
| [3–4) | 63 | 0 | 63 | 6 | 0.0952 | 0.9048 | 0.6404 | 0.1000 |
| [4–5) | 57 | 0 | 57 | 8 | 0.1404 | 0.8596 | 0.5506 | 0.1509 |
| [5–6) | 49 | 0 | 49 | 8 | 0.1633 | 0.8367 | 0.4607 | 0.1778 |
| [6–7) | 41 | 0 | 41 | 6 | 0.1463 | 0.8537 | 0.3933 | 0.1579 |
| [7–8) | 35 | 0 | 35 | 4 | 0.1143 | 0.8857 | 0.3483 | 0.1212 |
| [8–9) | 31 | 3 | 29 | 5 | 0.1695 | 0.8305 | 0.2893 | 0.1852 |
| [9–10) | 23 | 12 | 17 | 3 | 0.1765 | 0.8235 | 0.2382 | 0.1935 |

The relative picture for non-Athenian firms appears quite different in that hazard rates are slightly lower than those in Athens for the fisth two intervals but contrasting sharply in both the fifth and last two time intervals being as high as 17%, 18% and 19% respectively. There are no signs of hazard being reduced with age,[7] actually it reaches a new peak in the last interval. Subsequently, the survival rate in the last interval is 82%, while the cumulative survival rate is only 24%, i.e. 75% of the Athens' respective rate. Median survival time, that is, the time point by which half of the firms are expected to fail, is estimated to be 6.25 years for firms located in Athens and 5.56 for other firms. Thus, it takes around 8 more months for the 50% of firms to cease operations in Athens than in the rest of Greece.

Despite the differences in the evolvement of hazard rates in time, when using a Wilcoxon test for comparing the survival distributions of the two groups, the test does reject the null hypothesis that these do not differ. However, this result that relates to essentially unconditional statistical inference might considerably obscure the differences observed. In the next section the locational aspect of new firm survival is incorporated in a flexible econometric analysis framework for testing the hypothesis that hazard prospects differ between the two groups conditional on other covariates.

## 5. Econometric analysis of new firm hazard rates

The methodological workhorse for analyzing the lifetimes of firms has been the econometric model proposed by Cox (1972; 1975). The usefulness of the Cox model has been recognized by Kiefer (1988) who explained that the method allows the analysis of the duration (lifetime) of a sample of firms that belong to different cohorts (different time origins). It should be understood that these durations (or spells) do not need to refer to "real time" unless the time origin is the same for every individual. The central concept of the Cox model is the probability that a firm exits in *t*, conditional on that it has survived up to the time just before *t*.

The basic (static)version of the Cox model can be extended to allow for time-varying covariates along with time-invariant ones. Following Lancaster (1990, p. 26) the hazard, that is the probability of exit at *t* for firms that had not exited earlier and whose covariates had followed the path $X_{(t)}$ is given by:

$$\lambda(t;\, X_{(t)}) = \lim_{\mathrm{d}t \to 0} \frac{P(t \le T < t + \mathrm{d}t \mid T \ge t,\, X(t + \mathrm{d}t))}{\mathrm{d}t}. \tag{1}$$

The discrete exit times version of this hazard can be written as:

$$\begin{aligned}\lambda(t_j;\, X(t_{(j)})) &= P(\text{exit at } t_j \mid \text{survival to } t_j,\, X(t_{(j)})) \\ &= P(T = t_j \mid T \ge t_j,\, X(t_{(j)})).\end{aligned} \tag{2}$$

If, for the *i*th individual, the hazard takes the form (ibid., p. 259): $\lambda_i(t) = \mu_i(t)\lambda_0(t)$ where $\lambda_0(t)$ is the baseline hazard and $\mu_i$ is a firm specific term such as $\mu_i = e^{x_i(t)\beta}$, then a general form of partial likelihood that allows for time varying covariates is given by:

$$P\ell = \prod_{j=1}^{M} \left[ \frac{\mu_{i_j}(t_{(j)})}{\sum_{\kappa \in \Re_j} \mu_\kappa(t_{(j)})} \right]. \tag{3}$$

Lancaster (ibid.) suggests that an important feature of this expression is that, as the *j*th term of the product is calculated at time $t_{(j)}$ for each of the $j = 1, \ldots, M$ observed exit times, and $\Re_j$ defines the set of individuals at risk at each time, the entire path of covariates for each firm (*i*) up to time *t*, when the firm becomes censored or exits, can be accommodated.[8] That is, it allows for multiple observations per firm. The internal workings of the econometric model require that the status indicating variable, for a firm that survives for less than the entire study period, takes the value of zero, as it would if it were censored, in all times but the last one, when the event has occurred. For firms that survive up to the end of the study period the status variable takes the value of zero throughout the period. The lifetime variable (dependent) is an increasing count of the years that a firm survives, each year the firm is being observed.[9] In addition all firms have been coded (identified) appropriately as to allow the model to distinguish observations between firms

and not to confuse all observations available as independent firms.[10]

A number of variables being either sector- or firm-specific were deployed as potential covariates. In particular, firm size in terms of employment (SIZE) is used, being allowed to vary with time. Mata et al. (1995) maintain that current firm size (as the one used here) is a better predictor of failure than initial size. Expectations regarding the effect of this variable are, as previously explained, that it has a negative effect on hazard (positive on survival). Firm growth (GROWTH), in employment terms, from the establishment year until the time corresponding to the final observation for each firm was included among the regressions and is also expected to have a negative effect on hazard. This expectation derives from a rationale that the ability to grow reflects a superior firm potential which increases the probability of survival (Agarwal, 1977) and was confirmed by results reported in Mata et al. (1995) inferring a negative effect of firm growth on hazard. Return on assets is a profitability ratio (PROFIT) that is defined as net profits over total assets. This is thought to be an efficiency index whose higher values would determine the viability of a firm enhancing at the same time its capacity to attract investment capital. The degree of the debt burden of a firm to its capacity is defined by the ratio of current and medium to long term liabilities over total assets (LEVERAGE). A positive effect on hazard is expected since servicing a high debt absorbs funds, which are taken away from other productive uses, reducing survival chances. The structure of a firm's assets comes next and the ratio of fixed to total assets (CAPITAL) is hypothesized to restrict a firm's liquidity on the one hand, and to indicate a more "sound" but also committed firm entity, on the other. In both cases its effect is assumed to be positively associated with firm survival. All firm variables (except growth) are allowed, by the specification adopted, to vary with time.[11]

At the industry level, contestability[12] is proxied by a sunk cost variable (SUNK) which provides an approximation for the extent of second hand markets for capital components and varies also with time. SUNK has been defined as 1 minus the ratio of second hand bought machinery and equipment over the total investments in machinery and equipment. It is thought that higher sunk costs (lower contestability) discourage both entry and exit and hence prolong survival (Baden-Fuller, 1989; Schary, 1991). Subsequently, a negative effect on hazard faced by new firms is expected.

Next comes a spatial variable (ATHENS) that provides information about the location of new firms in the data set used in this research. This is a binary variable that takes the value of 1 if a firm is located in Athens and 0 otherwise. According to the rationale put forward in the third section of this paper, it would be expected that firms located in an urban environment such as Greater Athens face a lower hazard when compared to their counterparts located elsewhere. However, as it has been already mentioned, there is considerable lack of empirical evidence regarding the spatial aspects of firm failure. Storey and Wynarczyk (1996) maintain that as far as most small firms serve local markets, drawing on a "new firm is a small firm" nexus, local market buoyancy should be a major factor affecting firm survival. Areas dealt with in their research included the high unemployment area of Teeside, prosperous Reading, former steel town but considerably prosperous Corby, Morecambe/Lancaster, Glasgow and London. It appears that Reading, Glasgow and London have lower survival rates than Lancaster (reference category) and both Teesside and Corby higher. However, these results are statistically insignificant with the only exception the Teesside dummy.

In order to make our hypothesis more relevant to some aspects of the "incubator" hypothesis an interaction variable (INTERACTION) was constructed and used interchangeably with ATHENS. This interaction tern is the product of the spatial dummy ATHENS and a size dummy that takes the value of 1 if a firm employs less than 30 employees.[13] The hypothesis to be tested becomes that, conditional on other covariates, smaller firms in Greater Athens might face different hazard than their counterparts located in the rest of Greece. The urban environment is assumed to be more decisive in determining the survival prospects of smaller firms.

Finally, two cohort-dummies were included to contrast the hazard confronting new firms established in different years, the reference category being the youngest firms, that is those established in 1984. Firms established in different years, given

TABLE III
Cox-Regression with time varying covariates:
Results of the hazard confronting new firms in Greek manufacturing industries, 1982–1992

| Variables | Estimated Coefficents (Standard errors in parentheses) | | | | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| SIZE | –0.0600<br>(0.0780) | – | – | – | –0.1610*<br>(0.0918) | – |
| GROWTH | – | –0.1387**<br>(0.0765) | –0.1311*<br>(0.0745) | –0.1337*<br>(0.0749) | – | –0.1461**<br>(0.0771) |
| PROFIT | – | – | –0.8688*<br>(0.4971) | –0.8014*<br>(0.5022) | –0.8471*<br>(0.5036) | – |
| LEVERAGE | – | – | – | – | – | 0.5860*<br>(0.3613) |
| CAPITAL | –0.7972***<br>(0.2745) | –0.7484***<br>(0.2714) | –0.8205***<br>(0.2737) | –0.7874***<br>(0.2713) | –0.8689***<br>(0.2727) | – |
| SUNK | –0.3397**<br>(0.1491) | –0.3504***<br>(0.1495) | –0.3355**<br>(0.1501) | –0.3315**<br>(0.1500) | –0.3156**<br>(0.1496) | –0.3826***<br>(0.1488) |
| ATHENS | –0.3357**<br>(0.1758) | –0.3069*<br>(0.1695) | –0.2694*<br>(0.1704) | – | – | – |
| INTERACTION | – | – | – | –0.3162*<br>(0.1775) | –0.5090***<br>(0.2111) | –0.2841*<br>(0.1751) |
| COHORT_82 | –0.4951**<br>(0.2153) | –0.5123***<br>(0.2155) | –0.4842**<br>(0.2166) | –0.4886**<br>(0.2165) | –0.4567**<br>(0.2166) | –0.5470***<br>(0.2147) |
| COHORT_83 | –0.5255***<br>(0.2076) | –0.5275***<br>(0.2083) | –0.4907***<br>(0.2098) | –0.4910***<br>(0.2094) | –0.4946***<br>(0.2091) | –0.5253***<br>(0.2078) |
| Log Likelihood | –711.596 | –709.366 | –707.707 | –707.317 | –708.276 | –711.342 |
| N obs. | 1115 | 1115 | 1115 | 1115 | 1115 | 1115 |
| Chi-Square | 24.52***<br>(6df) | 28.97***<br>(6df) | 31.88***<br>(7df) | 32.66***<br>(7df) | 30.74***<br>(7df) | 25.02***<br>(6df) |

*** Significant at 1%; ** Significant at 5%; * Significant at 10%.

a uniform end-of-study year (1992), join the economy at different intervals. The introduction of these dummies helps picking up the effect of the differences in preparation times, firms had to confront the same phases of the economic cycle and hence their different levels of experience. Econometric results of the estimation of a Cox model with time varying covariates are given in Table III. These have been arranged in partitions as to avoid multicollinearity annoyances and all regressions have been significant in terms of an appropriate Chi-square test.

There is a rather solid core of results indicating that, irrespective of the arrangements in the right hand side (RHS) of the model, firms with higher capital commitment (CAPITAL), operating in less contestable industries (SUNK) and having been established earlier in economic cycle, face lower hazard prospects.

There is somewhat weaker evidence that higher current level of firm profitability (PROFIT), firm size (SIZE), and firm growth (GROWTH) reduce the hazard confronting new firms. In contrast, there is some evidence that higher (LEVERAGE) may become obstructive for the operation and eventually the existence of new firms. However, the statistical significance of these results seems to be considerably affected by the RHS configuration of the model.

As far as the most novel aspect of this research

is concerned, the spatial one, the ATHENS dummy has been negatively signed meaning that firms located in Greater Athens face lower hazard when compared with firms located in the rest of Greece. Beyond the economic importance of such a result and its implications, its statistical significance varies considerably across alternative model formulations, ranging between 5% (column 1) and 10% level of significance (column 3). The alternative use of the interaction term produced similarly signed results albeit more statistically sound, at least in some formulations (column 5). This seems to indicate that it might be more probable, whatever advantages there are in a major urban environment, that these are exploited by smaller firms whose survival prospects are enhanced when compared with larger firms located further from the country's largest market. The cohort-dummies showed that the youngest firms experienced significantly higher hazard rates as their establishment year was immediately before the introduction of an austerity economic program introduced in 1985 and the following recession in 1986–1987.

## 6. Conclusions

In this paper the determinants of hazard rates of new firms entering Greek manufacturing in the 1982–1992 period are examined. The novel issue is primarily the use of spatial variables that aimed to contrast the hazard faced by new firms in different locations, specifically Greater Athens as opposed to the rest of Greece. The high level of spatial aggregation is justified by the high general degree of spatial concentration of industrial activity in Greece and by the fact that more than 50% of new firms in the data are located in Greater Athens. The results indicate that firms located in the country's largest urban environment, Athens, face better survival prospects and this appears to be particularly relevant for smaller firms located in Athens when compared to their counterparts elsewhere in Greece. This result might be used as evidence that "centripetal" forces such as agglomeration economies and other market-pull factors in Greece remain strong in resisting extensive decentralization of manufacturing activities.

Also, the present research, by adopting a less restrictive econometric estimation framework, allowed firm and industry characteristics to change during the course of the lives of firms. Thus, current values of firm-specific covariates were used to determine the hazard faced by new firms at each time, contrasting these values between exiting and remaining, but evolving, firms. The results obtained here suggest that large, fast growing, profitable and heavily committed in fixed assets firms face better survival prospects. In contrast, there is some weaker evidence that firms that remain highly leveraged have reduced survival prospects.

The business conditions in which firms operate appear to be important for their survival prospects in that firms operating in more contestable industries, that is industries exhibiting lower levels of sunk costs, face higher levels of hazard. More importantly, it becomes evident that firms established closer to an oncoming recession have increased exposure to failure, indicating that firm survival is indeed sensitive to the economic cycle.

## Notes

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[1] Mahmood (1997) provides evidence suggesting that the level of sectoral aggregation matters in this type of research, as a varying effect of R&D intensity on hazard was detected within the 2-digit and 3-digit low, moderate and high tech industries, and economies of scale were found to reduce hazard facing new firms in some medium to high tech 2-digit industries.

[2] Audretsch and Mahmood (1993; 1994), Dunne and Hughes (1994), Baldwin and Rafiquzzaman (1995), Mata et al. (1995) and Fotopoulos and Louri (2000) provide strong favourable evidence, while Wagner (1994) presents rather ambiguous results.

[3] An extensive review of theoretical considerations relating to these hypotheses along with a survey of empirical evidence can be found in Nicholson et al. (1981).

[4] Bryson et al. (1997) argue that South East of England and especially areas adjacent to Greater London have been the locations favoured by small business services firms in Britain.

[5] According to the 1993 and 1994 industrial surveys, average employment in large manufacturing was 41 employees in Athens and 44 in the rest of the country, producing an average of 43 for Greece.

[6] Similar findings are supported in the literature. Mata and Portugal (1994) and Mata et al. (1995) find that Portuguese firms have survival rates in the region of 49–52% up to the fourth year. When larger firms (20–49 employees) are included survival increases considerably (65%). Wagner (1994) using German data, demonstrates that the small-firm

survival rate is 72% for the third year after entry. Results for U.S. manufacturing (Audretsch, 1995) show that 35% of new firms survived up to the tenth year and Audretsch and Mahmood (1994) report hazard rates that range from 23% to 26% within the first two years depending on the level of technology.

[7] Wagner (1999) discusses a similar problem for German firms.

[8] Ties can be handled using Breslow's (1974) modification.

[9] Say for example that a firm survives 5 years. Then there are five observations of the dependent variable corresponding to this firm. The relative values of the dependent variable are {1, 2, 3, 4, 5} and the corresponding values of the status indicator are {0, 0, 0, 0, 1}, provided that the study period extends to more than five years in this example.

[10] Dafni and Tsiatis (1998) derive useful expressions as to how conventional software routines for the Cox model can be used to estimate extensions of the model that account for time-varying covariates.

[11] Their initial values have been successfully used earlier by Fotopoulos and Louri (2000).

[12] The annual entry rate at the industry level was also used as a proxy for market contestability. Higher entry is hypothesized to increase competition and consequently hazard. A positive but insignificant coefficient was estimated and hence the variable is left out of the final estimations.

[13] The Annual Industrial Sruveys conducted by the National Statistical Service of Greece define as larger scale industry those firms employing more than 10 employees, the next cut-off point being 20 employees. As the firms included in our data set are larger, a cut-off firm size of 30 employees was used.

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