TITLE: *THE DYNAMICS OF FIRM GROWTH AND FAILURE UNDER ALTERNATIVE FORMS OF OWNERSHIP*

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To my parents

ABSTRACT

This thesis extends the literature on the dynamics of firm growth and failure by testing the robustness of past findings for capitalist firms to alternative ownership structures. While the theoretical results are altered by the internal organisation of the firm, the empirical findings are unchanged. This suggests that the theoretical models place excessive emphasis on the organisational structure and inadequate emphasis on more basic and fundamental factors affecting firm growth.

The thesis applies the learning models of growth to the case of the Illyrian labour managed firm, where members maximise profits per worker. The critical efficiency-size relationship is indeterminate under labour management. Thus, the majority of the clear cut empirical predictions of the model for profit maximisation no longer hold. Three possible explanations for the breakdown of the results are examined.

One explanation is that the Illyrian model is overly simplistic and does not accurately reflect the actual behaviour of cooperatives. This is rejected using an institutional structure model of the French producer cooperative which yields predictions which are remarkably similar to those of the Illyrian model.

The second explanation considered is that the growth and survival of cooperatives in fact substantially differs from capitalist firms. This explanation is rejected in the empirical section which tests the actual growth and survival relationships using a dataset of French producer cooperatives. The estimated survival-size relation is convexly positive and the

growth-size relation convexly negative, exactly as they have been found previously for conventional firms.

The final remaining explanation is that the theoretical models are structured so as to overemphasize the internal structure of the firm to the neglect of more generic factors affecting growth and survival. This is accepted in a final section which proposes new directions for theoretical research on the growth and survival of all firms.

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<u>CHAPTER I</u>: Introduction and Motivation

I would like to thank John Sutton for providing much of the motivation for this chapter, and Saul Estrin and Paul Geroski for helpful comments and suggestions. Any remaining errors are my own.

1. Overview

The literature on growth and survival has been characterised by a movement back and forth between theoretical work explaining empirical regularities, and new empirical regularities driving further theoretical work. The early theoretical literature on stochastic models of firm growth (Gibrat, 1931, Hart and Prais, 1956, Simon and Bonini, 1958) began by explaining an empirical regularity in existing firm datasets which suggested that firm growth was independent of firm size. These writers proposed explanations for this regularity by estimating the size distribution of firms and evaluating how this distribution should shift over time. The datasets used by these writers were typically based on large firms only.

As time passed and new technology allowed datasets to became larger and more comprehensive, it became possible to include increasing numbers of small firms, and it became clear that the conclusions of the early literature did not hold for this new class of firms. In fact it became apparent that growth and size were negatively related for small to medium sized firms. This prompted the development of new theoretical models, culminating most recently with the evolutionary learning models of Jovanovic (1982) and Ericson and Pakes (1989). These models use heterogeneous firm efficiencies to establish growth-size relationships for small to medium sized firms, and use the learning process to bring the firm's age into the analysis as a new dimension to be studied.

The predictions of these latter models have been put to test on data for conventional profit maximising firms (Dunne, Roberts and Samuelson, 1989, Evans, 1987a and 1987b, Hall, 1987), and the results have lent added support to the theoretical modelling. However, the robustness of the latter class of theoretical models to changes in the internal structure of the firm has never been tested.

This thesis extends the literature on the dynamic behaviour of firm growth to explore the impact of the firm's internal organisational and ownership structure on the process of growth and survival, in both theoretical and practical terms. It is shown here that using the recent class of evolutionary models, the past strong theoretical predictions are indeed altered when instead of profit maximisation, a different type of firm objective function is assumed. In particular, we explore here the case of the firm which is owned and managed by its workforce, and which maximises income per worker. It is well know in the labour management literature (Ward, 1958, Vanek, 1970, Ireland and Law, 1982) that such firms respond perversely in the short run to an improvement in output price by contracting rather than expanding output. In the context of the theoretical growth models, changes in efficiency are analogous to changes in output price. It is shown in Chapters II and III that changing the type of ownership structure to labour management renders the predictions of the new theoretical growth models indeterminate.

In Chapter IV we test growth and survival dynamics for producer cooperatives in France. The choice of France was based on the fact that this country has one of the largest and longest standing cooperative sectors in the Western world, and data collection on this sector is much better than anywhere else. The findings indicate that French producer cooperatives grow and survive in much the same way as has been documented for conventional profit maximising firms elsewhere.

Thus we find that the theoretical results are delicately dependent on the assumption of profit maximisation, while the empirical regularities that are known to hold for conventional firms also hold across a broader class of organisational forms. This leads us to conclude that some rather broad and generic empirical regularities are being accounted for by rather specific theoretical models. In fact the empirical findings here are consistent with any of a broader class of models which model growth as the outcome of a stochastic process which is age-dependent.

The structure of this chapter is as follows: Section 2 provides an overview of the early literature on the dynamics of firm growth and failure, beginning with the early work in the 1950's which was based on Gibrat's Law of Proportionate Effect. Section 3 proceeds to examine the more recent literature which has moved away from Gibrat's Law towards emphasizing an evolutionary learning process which leads to a natural selection of the most efficient firms. A brief overview of the empirical literature testing the latter class of models follows in Section 4.

The overview of the main content of the thesis begins in Section 5, which details the findings of Chapter II of the thesis. In this chapter, the robustness of the theoretical results of the learning models of firm growth and failure to alternative internal organisational structures is put to test using an ownership structure known to behave differently in certain cases from the conventional profit maximising firm. This ownership structure is the "Illyrian firm" model of the labour managed firm, where an all member firm maximises member income, or "dividends", defined as profits per worker. Chapter II shows that when dividend maximisation is assumed, the sharp theoretical results for pure profit maximisation become indeterminate and in certain conditions are even reversed. The Illyrian firm model has been criticised in the labour management literature for being overly simplistic. In order to show that the breakdown of the theoretical results is not due to the simplicity of the Illyrian firm model, Section 6 describes the model of Chapter III which incorporates the institutional details of the French cooperative sector. Even with this added detail, the results remain indeterminate.

Given the impact of the internal organisation of the firm on the theoretical results, the next step is to determine whether the empirical findings are also altered when the internal structure of labour management is analyzed. Section 7 describes how this is done in Chapter IV with a dataset of French producer cooperatives. The empirical relationships are found to be identical to previous results for profit maximising firms. Section 8 discusses the implications of the fact that the theory breaks down when the internal structure of the firm is changed, while the empirical relationships are unaffected, as laid out in the conclusion to the thesis in Chapter V. This suggests that the theoretical models are overly specific and overemphasize the internal organisational structure of the firm, while neglecting the wide variety of learning activity and efficiency gains occurring over time within the firm. This leads us to conclude that the route for future theoretical research requires combining the simpler models of the past with the age dimension of the recent models to find a class of models that are able to explain the empirical regularities and at the same time remain robust to alternative forms of ownership.

2. The Early Growth Literature

The early growth literature includes a range of studies which attempt to explain the skew distribution of firm sizes in a given economy. For the most part, the research from the 1950's onwards emphasized the need to move away from a static examination of size determinants and to explore the impact of the dynamic growth of firms on the steady state size distribution.

The early literature was built on the foundation of the Law of Proportionate Growth, attributed first to Gibrat (1931) in his book Les Inegalités Economiques, and developed further by Hart and Prais (1956) and Simon and Bonini (1958). In his book, Gibrat argues that the log-normal distribution closely approximates the actual size distribution of firms, and the Law of Proportionate Effect is a direct outcome of using the log-normal distribution. The main idea is that:

> "...while a larger firm may have a better chance of increasing its size by a given amount, the chance of a given proportionate increase is the same for firms of all sizes. This is the law of proportionate growth treated by Gibrat and is, perhaps, the most important consequence of the log-normal hypothesis."[1]

The datasets used for these studies principally include large firms. Hart and Prais (1956) use a U.K. dataset of firms quoted on the London Stock Exchange to analyze the evolution of the size distribution of firms and the impact of births and deaths of firms on the size distribution. Simon and Bonini (1958) use data on large American firms in 1955 as published in *Fortune* magazine, as well as reusing the Hart and Prais (1956) data.

[1]P. E. Hart and S. J. Prais (1956), p. 161.

Hart and Prais use the log-normal hypothesis to examine the properties of the Lorenz curve and to explore the implications for the size distribution of firms. They find the growth of surviving incumbents can be shown to depend on a probability scheme with parameters which are the same as those which determine changes in business concentration. Using aggregate data, they find that the probability of firm failure decreases with size, and that new born firms are smaller in average size and variance than surviving incumbents. In support of the law of proportionate effect, they find:

> "... evidence for saying that the number of companies which quadruple their size is approximately equal to the number that quarter it, that the number that grow sixteenfold is approximately equal to the number that are only a sixteenth of their original size, and so on; further, the frequency of these proportionate growths is distributed approximately as the normal curve of error."[2]

Simon and Bonini (1958) use U.S. aggregate data to analyze the size distribution of firms examining additional distributions to the log-normal. They take Gibrat's Law of Proportionate Effect as an assumption, and justify its use on the basis of two points: first, because it is consistent with empirical results, and second, assuming constant returns to scale beyond a minimum efficient size, they see the law as a natural conclusion. They hypothesise that actual firm growth for firms above the minimum efficient size will depend on profits, dividends, new investment, and merger activity. These factors in turn depend on the firm's efficiency, overall demand conditions, product characteristics, etc.

Quandt (1966) criticises the studies of Hart and Prais (1956) and Simon and Bonini (1958) for their use of aggregate data, noting that cost functions and entry and exit

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[2]Ibid, p. 171.

conditions are likely to vary across industries, and that for certain industry definitions asset size distributions will not be Pareto distributed causing the composite industry not to be Pareto distributed either. He proposes instead that firm size transition matrices should depend on four factors: (1) the nature of the short run cost function, since the slope of this around the profit maximising point will affect the extent to which output can change in that neighbourhood and how costly it will be to diverge from that point; (2) the nature of the long run cost function, which would determine the ease of expanding capacity; (3) possible oligopolistic arrangements; and (4) product configurations, and changes in technology and demand conditions.

Quandt uses a Pareto distribution of the form:

$$F(x) = 1 - \left(\frac{k}{x}\right)^{a}$$

where $F(x)$ represents the probability of observing a size less than or equal to x, and k and a are parameters. He finds that the fit using industry data is not very good. He concludes that this contradicts the view that firm sizes are Pareto distributed and that the distributions are insensitive to sampling methods. He does not, however, reject the law of proportionate effect:

> "... In all likelihood the law of proportionate effect operates together with such complicated conditions of birth and death as to be incapable of yielding a pure test of the law itself."[3]

In summary, the basic conclusion of the early literature is that the pattern of firm growth follows a stochastic process that is proportionally independent of current period size, at

[3]Quandt (1966), p.431.

least above the minimum efficient scale. The early literature uses data on large firms only and does not consider the role of the firm's age in determining growth and survival. In later years, the law of proportionate effect came under attack, especially for its neglect of two key empirical points: (1) there *does* appear to be a relation between growth and size at least for small to medium sized firms; and (2) growth rates of firms appear to have a life cycle effect, with the pattern of growth and failure being age-related. The new literature addresses these issues.

3. The New Theoretical Growth Literature

The new growth literature examines growth and survival as outcomes of a joint decision process. There are two main models which both stress "learning" by firms, and bring in the concept of age through the learning process. The theoretical literature has two main examples: the passive learning model of Jovanovic (1982) and the active exploration model of Ericson and Pakes (1989). Both models have heterogeneous firms of differing efficiencies competing in a given market. Over time each firm acquires noisy information on its current and future efficiency relative to its competition, and this information helps it determine its overall viability and profitability. The models differ in that the passive learning firm passively learns the value of its time-invariant efficiency level while the active exploration firm actively invests to improve its efficiency relative to its competition.

More critically for the discussion here, both models share in common the feature that efficiency is *positively* linked to size for profit maximising firms, in that more efficient firms select larger operating scales to better exploit their efficiency advantage. This positive efficiency-size relationship is the key driving force in determining the theoretical predictions of the models relating growth and survival to size and age. Because of this common positive efficiency-size relationship which drives all the other results, the growth and survival predictions of the two models are empirically indistinguishable.[4]

The new growth models predict that surviving firms are those who have been improving their efficiencies (in expectations or in actual levels, depending on which model is considered), since inefficient firms are weeded out in the selection process. But the positive efficiency-size relationship stipulates that size should increase when efficiency increases - i.e., growth of surviving firms should be positive. However, since the models impose an upper bound on efficiency, and through efficiency on size, the largest firms are increasingly constrained by the upper bound and so their growth rates ultimately converge to zero.

Thus, the prediction is that above a certain size, growth and size should be positively related for surviving firms, since these firms are on average revising their efficiency exposures (and therefore their sizes) upwards. In the limit as efficiencies approach the upper bound, growth is predicted to approach zero independently of size. In terms of the past literature, Gibrat's law of proportionate effect is only expected to hold in the limit, that is for the very large sizes, since for this category growth is near zero regardless of the actual level of size.

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[4]That is not to say that the models themselves are empirically indistinguishable, and Pakes and Ericson (1990) develop a nonparametric test to distinguish between the two types of learning. But regardless of the type of learning involved, the outcome is driven by the efficiency-size relationship which is identical for both models.

The relationship between growth and age for surviving firms is also predicted to be increasing beyond an initial period, as the survivors on average are those who have received "good" information on their efficiencies. In the limit as age becomes large, the variability of the firm's efficiency (expected or level, once again depending on the model) diminishes, and growth rates are predicted to approach zero independently of age.

In addition, these models predict that the relation between survival and size will be positive, since more efficient firms are larger and at the same time less likely to fail. The models also predict the relation between survival and age will be positive as the learning process leads to a weeding out of inefficient firms, so as a cohort ages the remaining firms are increasingly efficient and decreasingly likely to fail.

4. Empirical Robustness of New Growth Models

When taken to data these predictions are quite robust. A number of papers have explored the empirical relationship of growth and survival vis à vis size and age, using data on small and young firms as well as large and well established ones. Dunne, Roberts and Samuelson (1989), Evans (1987a and 1987b) and Hall (1987) all provide strong empirical support for the new theoretical models. They establish convexly increasing survival-age and survival-size relationships, and convexly decreasing growth-size and growth-age relationships. But all these papers only use data for conventional profit maximising firms. Like the theoretical literature, they implicitly assume that the ownership structure and internal organisation of the firm is not at issue, and rather the profit maximising firm is the standard case on which to base analysis.

5. Theoretical Robustness to Ownership Form

The positive efficiency-size prediction of the theoretical learning models is the driving force behind a number of the predictions on growth and survival: (1) Since less efficient firms tend to be selected out of the market, then the mean size of the survivors of a cohort should be increasing in age; (2) If less efficient firms are smaller and at the same time they are more likely to fail, then survival probabilities should be increasing in size; (3) If the least efficient firms are most likely to fail, those that survive must be receiving favourable (positive) news on their efficiencies and are therefore likely to grow positively as they age; (4) The models impose an upper bound to efficiency which implicitly places an upper bound on size for larger firms; therefore for large sizes, growth must be decreasing in size reaching zero near the upper limit.

Given the significance of the positive efficiency-size result from the comparative statics of the models, it becomes a rather important question to what extent this result depends on the assumption of profit maximisation. More precisely, to what extent do the results for profit maximisation hold generally for other forms of ownership and organisational structure?

The second chapter of the thesis addresses these questions by taking a form of internal organisation that is known to select its optimal scale differently from the conventional profit maximising firm - that is the case of the firm that is owned and managed by its workforce. In particular, we examine the case of the Wardian Illyrian firm[5], where an all member worker cooperative maximises member incomes, given by the rate of profits

[5]Ward (1958).

per worker (dividends). This is the simplest and the most extensively studied model of the labour managed firm. It is well known in the labour management literature that such firms respond to an improvement in output price in the short run by contracting output, and in the long run, with capital and labour both allowed to vary, the sign of the response is indeterminate.[6]

In terms of the modelling here, an increase in efficiency is analogous to an increase in price. Thus, when the dividend-maximisation objective function is used in conjunction with the learning models of firm growth, and capital and labour are both allowed to vary, the critical comparative statics result on the efficiency-size relationship becomes indeterminate, where it was strictly positive under profit maximisation. As a result, only a few of the empirical predictions hold definitively and the model has very little to say about the growth and survival relationships described above. The only empirical predictions that are unaffected by the change in the objective function are those that are independent of the efficiency-size relationship and are direct outcomes of the nature of the learning process.

A special example is also presented in Chapter II in which the efficiency-size relationship is shown to be negative. This example serves to illustrate that a negative efficiency-size relationship is in fact possible, and would lead to a reversal of most of the predictions of the evolutionary learning models. Because it is such a special case, however, the significance of the example in predicting the actual behaviour of these firms should not be overemphasized.

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[6]See for example Ireland and Law, 1982, Stephen, 1984, Estrin, 1982.

Although the Illyrian firm model of Chapter II is used extensively for theoretical purposes, it has often been criticised in the literature on labour managed firms for being unrealistically simple relative to the actual rules and constraints that govern the behaviour of these firms. A considerable body of research has been devoted to modifying the simple Illyrian firm model to offset the perversity of the short run supply response.[7] Some of these models have added institutional features such as the inclusion of nonmember labour (Miyazaki, 1984, Ben Ner, 1984) to test whether the short run perversity and long run indeterminacy remain.

To preclude any possibility that the evolutionary models fail to produce sharp predictions because of the over-simplicity of the Illyrian firm model, Chapter III replicates the analysis of Chapter II using a model of the French producer cooperative which closely reflects the actual institutional rules and features governing cooperatives in France.

6. The Membership Model of the French Producer Cooperative

The French producer cooperative model in Chapter III incorporates a number of key institutional rules and features. First, it includes the membership remuneration process, whereby all workers receive both a fixed wage and a variable profitsharing, and members receive an additional return on their membership shares. To this is added the most significant institutional rule governing the behaviour of these firms, the condition of Free Access. Free Access enables nonmember workers to convert to membership status at will by purchasing at face value a single share in the firm; it also enables members to become

[7]See for example Bonin (1984), Brewer and Browning (1982), Spinnewyn and Svejnar (1989), Svejnar (1982).

nonmember workers in the firm by redeeming their shares at face value. It is shown that the effect of Free Access is to drive the return on membership shares to always equal the market rate of interest, as long as some nonmembers remain in the firm. Third, the method of financing the maintenance and purchase of the firm's capital is also incorporated: In this model, as long as there exist some nonmembers the firm is shown to always resort to internal equity financing through membership shares. Only when the entire workforce is comprised of members will the firm resort to external financing. Finally, the laws governing the shutdown of cooperatives are also incorporated. These laws stipulate that in the event of shutdown, any residual profits over and above the face value of outstanding shares may not revert to the members of the firm.

In terms of the issue of interest, the efficiency-size relationship, the French producer cooperative model provides a guarded defense of the use of the more manageable Illyrian firm model in theoretical work. It is shown that under external financing, the French model with all its detail simplifies into the general form of the Chapter II Illyrian firm model. If internal financing is used, the model remains remarkably similar to the Illyrian firm model, with the same choice of returns to scale and the same worker earnings resulting from both models. In either case of financing the efficiency-size relationship remains indeterminate for the French cooperative, similar to the Illyrian firm model in Chapter II.[8]

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[8]However, as a separate issue of principal relevance to the literature on labour management, the French cooperative model provides explanations for two empirical facts: first, it gives a theoretical explanation for the lower observed cooperative hazard rates relative to conventional firms; and second, it explains the lack of virtually any observed degeneration of cooperatives into capitalist firms in France.

Thus it is clear that the breakdown of the sharp predictions of the theoretical learning models can not be attributed to the excessive simplicity of the model of the labour managed firm. Furthermore, at least one example exists where the results of the learning models of growth and survival are not left unchanged by the assumption of alternative ownership structures. It remains to be seen if in fact the empirical behaviour of such firms differs in any marked way from past findings for profit maximising firms.

7. Empirical Findings on French Cooperative Growth and Survival

Chapter IV tests the theoretical predictions of the first two chapters using a dataset of the entire population of French producer cooperatives between 1979 and 1989. While it is not possible to measure the efficiency-size relationship in practice since no proper measure of efficiency is available, the growth-size and survival-size relationships can be used to infer the efficiency-size relationship. The empirical results show the growth-size relationship to be convexly negative, while survival-size is positive and slightly convex. Growth-age is found to be convexly negative, approaching zero for older ages, while survival-age is convexly positive with older firms more likely to survive. These results are consistent with a positive underlying efficiency-size relationship similar to past findings for conventional firms.

The fact that the empirical results under labour management are exactly identical to those found for profit maximising firms (Dunne, Roberts, and Samuelson, 1989, Evans, 1987a, 1987b, and Hall 1987) is in stark contrast to the impact of the labour management assumption on the theoretical results. Thus the conclusion is that the empirical relationships are broad and generic empirical regularities independent of the organizational form of the firm, unlike the theoretical results which depend delicately on the objective function considered.

Chapter IV also examines the shifts in predicted survival rates over the business cycle to find that young firms and firms that are very small or very large are jeopardised to a greater extent by business cycle slowdowns than old and medium-sized firms. Additionally, predicted growth rates for the smallest and youngest surviving firms, which are normally the fastest growing firms in the economy, are found to decline proportionally more in times of high unemployment than larger and older firms, with growth rates across all size and age classes converging together as unemployment rises. The conclusion is that small and young firms, and to a lesser extent very large firms, are the class of firms most vulnerable to exogenous shocks.

8. Implications for Future Research

Thus the main finding of the thesis has been that the theoretical learning models rely to a great extent on the ownership structure of the firm to generate the positive efficiency-size relationship that is the driving force behind the results. Yet the empirical regularities they explain appear to be entirely independent of the internal organisation of the firm, and could just as well be explained by any of a much broader class models which share in common certain specific features. The nature of such a class of models is discussed further in Chapter V, where it is shown that the nature of the learning process is all-important in determining the sign and causality of the efficiency-size relationship. By broadening the definition of efficiency gains from learning beyond pure cost reduction, any of a class of learning models can be used to generate growth and survival predictions that are robust to alternative forms of ownership.

Thus it appears that future research on the theories of stochastic firm growth would benefit from taking a step back to reexamine the current state of research on this subject. It is clear, however, that the age dimension introduced in the new growth literature has a significant role to play in modelling both growth and survival. An all-encompassing new class of models could model growth as a stochastic process which is not only state dependent, as in the early literature, but also age-dependent, as in the new literature, with the learning process more broadly defined than before. This sets one possible route for future research in this area.

CHAPTER II: A Comparison of Labour-Managed and Capitalist firm Growth and Survival Dynamics*

*I would like to thank Saul Estrin, John Sutton, Norman Ireland, Klaus Schmidt and Paul Geroski for helpful comments and discussions. Any remaining errors are, of course, my own.

1. Introduction

In the past, a number of studies have examined the relationship between firm survival, growth, size, and age from both theoretical and empirical standpoints. In particular, Jovanovic (1982) introduced a model of passive learning which has since been used as the foundation for much of the subsequent analysis of these issues (Dunne, Roberts and Samuelson, 1989, Evans 1987a, 1987b, Hall 1987, etc.) Subsequently, Ericson and Pakes (1989) presented an alternative model, the active exploration model of firm growth and failure, which they tested against the passive learning model in Pakes and Ericson (1990). Yet all the work to date has focused on the case of the profit maximizing capitalist firm. This paper tests the robustness of the results of the passive learning and active exploration models to alternative ownership and internal organisational structures using the case of the labour managed firm, a type of firm known to select its scale of operations differently from the conventional profit maximising firm. In doing so, we are able to determine the extent to which previous findings depend specifically on the organisational structure of the firm.

Sections 2 and 3 present modified versions of the passive learning and active exploration models for the PMF, and most of the predictions of the models on growth and survival are shown to depend on the positive efficiency-size result in the comparative statics analysis. Both learning models are shown to yield the same efficiency-size relationships, but with one key difference: the dependence of the passive learning firm's size on its initial size does not erode over time while for the active learning firm it does. Section 4 extends the analysis on firm growth and failure to the case of the Illyrian labour managed firm. The effect of an improvement in efficiency on the size (and therefore growth) of the labour managed firm under both learning models is found to be indeterminate. Section 5 explores a special example of a labour managed firm where the efficiency-size relationship is negative. Section 6 presents the main theoretical findings, while the empirical predictions of the model are presented in Section 7. Section 8 summarizes and concludes.

2. The Modified Passive Learning Model

For the purpose of this analysis, we assume firms are operating under perfect competition and are thus price takers in both input and output markets. Furthermore, the smaller cooperative sector exists side by side a larger capitalist sector in the same economy, and workers are assumed to be able to move freely between firms in the two sectors.

The analysis will study the behaviour of two types of firm: First, the traditional Wardian Illyrian type of dividend-maximising labour managed firm is considered, where all workers are members. The opportunity cost for these workers of remaining in the cooperative sector is the capitalist wage, which is exogenously determined. All firms in both sectors are assumed to be too small relative to the industry to affect prices in any period. All price vectors, i.e., $\{p_t\}$, $\{r_t\}$ and $\{w_t\}$ are known in advance and are assumed to change at the same rate $\{\gamma_t\}$ from one period to the next.

The capitalist "twin" is a firm in the same industry with access to the same technology, facing the same input and output prices and the same shocks, with only one difference: unlike the LMF, it maximises profits, rather than profits per worker (i.e., dividends).

The passive learning model operates under the assumption that firms in a given industry have the same cost functions which are U-shaped for all input prices, and production functions which are locally concave.[1] The key difference between firms is in their relative efficiencies in producing sellable output. Specifically, in each period, the firm's actual output is given by the basic production function multiplied by a random variable which is a noisy indicator of the firm's true relative efficiency. The efficiency factor could be thought to represent a wastage rate, as some of the output produced falls below minimum specifications. Alternatively, it could represent the advantageousness of the firm's choice of technology, location, management, etc. Because the firm is unaware of its true efficiency, it forms an expectation of this random variable. It updates this expectation every period using Bayes' Law, after observing its profits for that period.

Firms produce a single homogeneous product. The level of output is given by the production function in which the efficiency rate normalised to one. Firms entering this industry are endowed at birth with certain immutable efficiency characteristics (quality of management, location, labour force skills, etc.) which determine their true rates of efficiency relative to the production function's normalised rate of one.

The relative efficiency of the firm is characterised by a parameter θ representing

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[1]See Ireland and Law (1982) pp. 27-28 for a discussion of why the production function for a labour managed firm may not be globally concave, except for a firm which only employs a single worker.

performances above or below the normalised rate given by the standard production function. The firm does not know its true efficiency endowment, but knows the distribution from which it is drawn. It is therefore forced to deduce its efficiency from its observed sales, which provide a noisy estimate (η_t) in each period of the true endowment (θ), where the noise (ϵ_t) consists of zero mean i.i.d. shocks:

$$\eta_t = \theta + \epsilon_t$$
$$\theta \sim N(\bar{\theta},\sigma_\theta^2)$$
$$\epsilon_t \sim N(0,\sigma^2)$$

Since the firm is unable to observe its true efficiency endowment θ, it bases its decision-making on the sequence $\{\eta_{t-1},\eta_{t-2},\ldots,\eta_1\}$. The ϵ_t shocks are assumed to be firm-specific, and are independent over time and across firms.

The true (noiseless) relative efficiency multiple of the firm is a transformation of θ, labelled x, and is given by the function $x \equiv \xi(\theta)$, where $\xi(\theta)>0$, $\xi'(\theta)>0$ and continuous, $\lim_{\theta\to -\infty} \xi(\theta)=\alpha_1>0$ and $\lim_{\theta\to \infty} \xi(\theta)=\alpha_2<\infty$. That is, the multiple is always positive, (to preclude negative output), and is increasing in θ; i.e., the more efficient the firm is, the more sellable output it can get out of the same inputs. The upper bound α_2 is needed because the most efficient firm can at best produce 100% sellable output. Since the firms are unable to actually observe θ, and in fact only observe η, they are forced to develop expectations on the value of x based on the observed sequence of $\{\eta\}$.

The firm's expected relative efficiency factor is a random variable denoted x^*_t and given by:

$$x^*_t = E_t[x \mid \eta_{t-1}, \eta_{t-2}, \ldots, \eta_1]$$

The firm updates its expectations on its relative efficiency multiple by means of Bayes' Law: in each period t, the firm estimates the probability of its having a certain efficiency factor x given that it has observed to date the sequence of $\{\eta_{t-1}, \eta_{t-2}, \ldots, \eta_1)$ noisy estimates of θ. It revises its estimate of its x^* to correspond to its new expected value.

The evolution of x^* is governed by the following probability function:

$$P(x^* | x^*_\tau, n_\tau) = Pr(x^*_{t+1} = x^* | x^*_t = x^*_\tau, n_t = n_\tau)$$

The x^*_t sequence is a Martingale so all currently available information is incorporated in x^*_t. It follows that the current expectation of x^* for all future periods is the current value of x^*_t:

$$E_t[x^*_{t+k}] = x^*_t \qquad \forall\, k>0$$

In this context we can now set up the firm's objective function. Considering the two input case, actual output is given by the efficiency-adjusted production function:

$$x^* q_t = x^* q(K_t, L_t)$$

where $q_K>0$, $q_L>0$, $q_{KK}<0$, $q_{LL}<0$, and $q_{LK}=q_{KL}>0$. So in each period, the profit maximising firm (PMF) maximises profits subject to the condition that the expected discounted value of future cash flows exceeds the opportunity cost, Φ. We define the binary variable, χ_t, equal to one if the firm operates in period t and zero otherwise. Thus, in any period τ, the PMF maximises the expected discounted value of future cash flows:

$$V^*_\tau = \max_{\{d \in \Delta\}} \sum_{t=\tau}^{\infty} \beta^t \int_{\alpha_1}^{\alpha_2} [\pi_t(x^*_t, n_t)\chi_t + (\chi_{t-1} - \chi_t)\phi] \cdot P(x^*_t = s | x^*_\tau, n_\tau) ds$$

$$d = \{ [\chi_\tau, K_\tau, L_\tau], [\chi_{\tau+1}, K_{\tau+1}, L_{\tau+1}], \ldots \} \tag{2.1}$$

where:

π^*_t= expected single period profits
K_t= capital
L_t= labour
n_t= number of periods since firm was created
β= discount rate
Φ= opportunity cost of remaining in business

The firm will exit only if the expected discounted value of future cash flows from remaining in business is less than Φ. Otherwise, the firm selects its input levels to maximize current period profits:

$$\max_{\{K_\tau, L_\tau\}} \pi^*_\tau = p_\tau x^*_\tau q(K_\tau, L_\tau) - r_\tau K_\tau - w_\tau L_\tau$$

where:

p_τ= output price
r_τ= cost of capital
w_τ= market wage

The first order conditions for profit maximization become (omitting time subscripts):

$$px^* q_K = r \tag{2.2}$$

and

$$px^* q_L = w \tag{2.3}$$

Differentiating (2.2) and (2.3) with respect to x^* yields:

$$\frac{\partial K}{\partial x^*} = [\frac{-q_K}{x^*} - q_{KL}\frac{\partial L}{\partial x^*}]\frac{1}{q_{KK}} \tag{2.4}$$

and

$$\frac{\partial L}{\partial x^*} = [\frac{-q_L}{x^*} - q_{LK}\frac{\partial K}{\partial x^*}]\frac{1}{q_{LL}} \tag{2.5}$$

Solving simultaneously yields:

$$\frac{\partial K}{\partial x^*} = \frac{q_{LL}}{q_{KK}q_{LL}-q_{KL}^2}[\frac{-q_K}{x^*} + \frac{q_L q_{KL}}{x^* q_{LL}}] \tag{2.6}$$

and

$$\frac{\partial L}{\partial x^*} = \frac{q_{KK}}{q_{LL}q_{KK}-q_{LK}^2}[\frac{-q_L}{x^*} + \frac{q_K q_{LK}}{x^* q_{KK}}] \tag{2.7}$$

Since by the second order condition for maximisation the determinant of the Hessian matrix, $(q_{LL}q_{KK}-q_{LK}^2)$, is positive, both expressions are strictly positive.

Thus a capitalist firm raising its expectation of its relative efficiency (x^*) will increase the use of both inputs. The change in the level of output will be given by the total differential of the efficiency-adjusted production function:

$$\frac{d}{dx^*}(x^* q) = q + q_L\frac{\partial L}{\partial x^*} + q_K\frac{\partial K}{\partial x^*} \tag{2.8}$$

With q non-negative, q_L and q_K positive, and $(\partial L/\partial x^*)$ and $(\partial K/\partial x^*)$ both positive, it follows that an upward revision of x^* will result in an *increase* in the level of current output chosen by the PMF. Thus we arrive at Jovanovic's key result: ***the relationship between efficiency and size is positive.***

3. The Modified Active Exploration Model

Ericson and Pakes (1989) present a model in which the firm is formed to exploit some Schumpeterian "idea". However, the firm can not determine the true value of its idea unless it invests capital in the development and exploitation of the idea. In this world, an efficient firm is one with a "good idea" who successfully exploits it. Unlike the passive learning model, in any given period the firm knows exactly what its current "state of efficiency" is. Moreover this state of efficiency, which reflects the firm's overall viability, is no longer static but evolves over time in response to the outcomes of the firm's exploratory investment.

Uncertainty enters the model through the assumption that the firm does not know what the outcome of its investment in development will be, it only knows the underlying probability distribution of moving from its current state to other states. The outcome of (exploratory) investment depends on the firm's own past investment, investment by other firms in the industry and overall demand conditions.[2] The firm's state may indeed deteriorate if exploration is unsuccessful or insufficient. The firm is unable to observe current or past investment by its rivals, but can observe the outcomes of rivals' past investments which contribute to determining the firm's own current state. If the firm's state deteriorates over time, it may signal that the idea is not worth pursuing and in such case, the firm will shut down.

To formalise the model, we let $\sigma \in \Sigma$ represent an index of the firm's state of efficiency, and $i_t \in \mathbb{R}_+$ represent the firm's exploratory investment activity in period t. The function

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[2]The firm's present investment can only affect its future states.

$A(\cdot|\sigma_t)$ provides current period profits, determined by the market equilibrium. In the two input case, this function is given by:

$$A_t = p_t\, x_t(\sigma_t)\; q_t(K_t, L_t) - r_t\, K_t - w_t\, L_t \tag{3.1}$$

where $x \equiv \zeta(\sigma_t)$ once again represents the relative efficiency multiple of the firm. The value of this multiple reflects the advantages the firm can exact due to its state relative to other firms in the industry. For ease of comparison with the passive learning case, we assume $\zeta(\sigma_t) > 0$ and $\zeta'(\sigma_t) > 0$, with $\lim_{\sigma_t \to -\infty} \zeta(\sigma_t) = \alpha_1$ and $\lim_{\sigma_t \to +\infty} \zeta(\sigma_t) = \alpha_2$. The cost of capital is given by r_t, the market rate of interest.[3] In any period, if the firm operates and invests in development, the current returns are given by:

$$R_t \equiv R(x(\sigma_t), i_t) = A(\cdot|\sigma_t) - r_t i_t \tag{3.2}$$

The opportunity cost of remaining in business is given by Φ. We define the binary variable χ_t equal to one if the firm operates in period t and zero otherwise. We assume current investment only affects future states, and the evolution of future states is governed by the state-dependent transition probability function:

$$p(\sigma'|\sigma, i) = Prob(\sigma_{t+1} = \sigma' | \sigma_t = \sigma, i_t = i) \tag{3.3}$$

the realisations of which fully determine $A(\cdot|\sigma_t)$, and $p(\cdot|\sigma_t)$. In each period, the firm evaluates the expected discounted value of future cash flows from remaining in business. If this value is not below the opportunity cost, Φ, the firm continues to operate. It then makes the optimal level of exploratory investment based on its investment history and its

[3]Ericson and Pakes allow the cost of capital to vary with σ_t. Here, we use an exogenous market rate for ease of comparison with the passive learning model.

current and past states. Given the level of current investment, it chooses inputs to maximize the level of current period profits.

This leads to the following entrepreneurial optimisation problem:

$$\underset{\{d \in \Delta\}}{Max}\; V^{*}_{\tau} = \sum_{t=\tau}^{\infty} \beta^{t} \int_{\alpha_1}^{\alpha_2} [R(x(\sigma'_{t}), i_{t})\chi_{t} + (\chi_{t-1} - \chi_{t})\phi] \cdot P^{t}_{\sigma_{\tau}}[x(\sigma'_{t}) = x(\sigma) \mid \{i_{s}\}_{s=0}^{t-1}]\, dx(\sigma) \tag{3.4}$$

$$where \quad d = \{\, [\chi_{\tau}, i_{\tau}, K_{\tau}, L_{\tau}],\ [\chi_{\tau+1}, i_{\tau}, K_{\tau+1}, L_{\tau+1}],\ \ldots \,\}$$

where β is the firm's discount factor.

Once the firm decides to operate and chooses its' optimal level of exploratory investment, it chooses inputs to maximise current period profits given i_t. Current profits are identical to the passive learning case, except exploratory investment appears as a lump sum current cost. But exploratory investment does not impact the current period state, σ_{τ}, or x_{τ}, so it does not affect the marginal choice of current input levels. Thus, the first order conditions for production inputs are identical to those for the passive learning case (2.2) and (2.3).

$$pxq_{K} = r \tag{3.5}$$

and

$$pxq_{L} = w \tag{3.6}$$

It follows then, that the comparative statics on the effect of a change in the efficiency factor, x, on production inputs and output is also exactly the same as in the passive learning case and will not be repeated here. What matters principally is that ***the critical***

relationship between efficiency and size remains positive.

Because of the identical behavioral predictions regarding size, Pakes and Ericson (1990) develop a separate test to determine which model is more relevant for their data on profit maximising firms. They show that for a passive learning firm which spends its life trying to determine the value of a *stationary* efficiency parameter, the dependence of the firm's size in any period on its initial size does not erode over time. This arises from the fact that the information acquired in the first period carries a weight in determining the firm's current expectation of its efficiency equal to the weight of the most recent observation. This is not true for the active exploration firm, whose state of efficiency *evolves* over time causing older information to be increasingly less relevant to the firm's current state. We will show that this test is unaffected by the imposition of the LMF objective function.

4. The Labour Managed Firm Models

4.1 The Passive Learning Model of the Labour Managed Firm

Beginning with Ward's seminal paper on "The Firm in Illyria" in 1958, the labour management literature has adopted the assumption that labour managed firms (LMFs) maximise member incomes, or "dividends", defined as the rate of profits per worker. One outcome of this assumption is that faced with an increase in output price, in the short run the firm will reduce both labour and output. This perverse short run supply response has been the subject of much research, and the Illyrian firm objective function has been criticised mainly because it does not account for the fact that revisions in the level of the firm's labour input may cause certain members to be forced to leave the firm, and this fact should affect a democratic firm's labour input decision.

Numerous modifications and constraints on the objective function have been suggested by various authors and countless papers have been written on the issue.[4] For this reason, we will not delve further into the subject and define the voting structure of the firm as follows: the firm elects a management committee for a fixed period of time. This committee then makes decisions in each period on the level of inputs required to maximise expected dividends for those who *ultimately remain in the firm,* since only these latter individuals will be around to vote when the committee comes up for reelection.[5]

Thus, the LMF objective function is taken to be (expected) dividend maximisation,[6] where dividends are defined as profits divided by the level of the workforce. We now formally define the problem of the LMF as maximising the expected discounted value of future cash flows per worker:

$$\underset{\{d\in\Delta\}}{Max}\ Z_\tau = \sum_{t=\tau}^{\infty} \beta^t \int_{\alpha_1}^{\alpha_2} [D(x^*_t, n_t, K_t, L_t)\chi_t + (\chi_{t-1}-\chi_t)\frac{\Phi}{L_{t-1}} + (1-\chi_t)w_t] \cdot P(x^*_t = s | x^*_\tau, n_\tau)ds$$

$$where\ d = \{\ [\chi_\tau, K_\tau, L_\tau],\ [\chi_{\tau+1}, K_{\tau+1}, L_{\tau+1}],\ \ldots\ \} \qquad (4.0)$$

and D^*_t = expected single period dividend
K_t = capital
L_t = labour
n_t = number of periods since firm was created
β = discount rate

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[4]There are many examples in the literature. A small selection includes Sertel (1982), Spinnewyn and Svejnar (1986), Brewer and Browning (1982), Bonin (1984), and Miyazaki (1984).

[5]This procedure in fact closely approximates the actual decision structure of most firms above a minimum size in most countries.

[6]An alternative and more complex objective function is examined in Chapter III.

If $Z_\tau < ((\Phi/L_{\tau-1})+\Sigma\beta_t w_t)$, i.e., if LMF workers prefer to leave the cooperative sector to become hired workers for a PMF, then the firm exits. The residual value of the firm is divided among the number of workers from the previous period, since no decision is made on current employment if the firm is to close down. If the firm continues to operate, it chooses inputs to maximise single period dividends:

$$\underset{\{K_\tau, L_\tau\}}{Max}\ D(K_\tau, L_\tau | x^*_\tau, n_\tau) = \frac{p_\tau x^*_\tau q(K_\tau, L_\tau) - r_\tau K_\tau}{L_\tau} \tag{4.1}$$

where:

p_τ= output price
r_τ= cost of capital
n_τ= age of firm

The first order conditions become:

$$px^* q_K = r \tag{4.2}$$

and

$$px^* q_L = \frac{px^* q(K,L) - rK}{L} = D^* \tag{4.3}$$

where (4.2) is identical to the PMF choice of capital in (2.2), but by (4.3) the LMF chooses its workforce to set the expected marginal revenue product of labour equal to the endogenous dividend, rather than the exogenous PMF wage.

Differentiating (4.2) and (4.3) with respect to x^* yields:

and

$$\frac{\partial K}{\partial x^*} = [\frac{-q_K}{x^*} - q_{KL}\frac{\partial L}{\partial x^*}]\frac{1}{q_{KK}} \qquad (4.4)$$

$$\frac{\partial L}{\partial x^*} = [\frac{\frac{q}{L} - q_L}{x^*} - q_{LK}\frac{\partial K}{\partial x^*}]\frac{1}{q_{LL}} \qquad (4.5)$$

Equation (4.4) is exactly identical to (2.4); the LMF revises its level of capital in exactly the same way the PMF does. The new level of capital input is different only because $\partial L/\partial x^*$ (and the resulting new level of output) differ between the two types of firm.

Equation (4.5) differs from equation (2.5), the PMF labour-revision equation, by the addition of the term $q/(Lx^*)$. This term reflects the fact that the endogenous LMF dividend, unlike the exogenous PMF wage, is affected when x^* changes.

Solving (4.4) and (4.5) simultaneously yields:

$$\frac{\partial K}{\partial x^*} = \frac{q_{LL}}{q_{KK}q_{LL} - q_{LK}^2}[\frac{-q_K}{x^*} - \frac{q_{KL}}{q_{LL}}\frac{\frac{q}{L} - q_L}{x^*}] \qquad (4.6)$$

and

$$\frac{\partial L}{\partial x^*} = \frac{q_{KK}}{q_{LL}q_{KK} - q_{LK}^2}[\frac{q_K q_{LK}}{x^* q_{KK}} + \frac{\frac{q}{L} - q_L}{x^*}] \qquad (4.7)$$

In both equations, the first expressions on the right hand side are strictly negative by the second order condition for maximum and the assumption of diminishing marginal returns. The second (bracketed) expressions are in both cases indeterminate in sign. In each case, the first of the two terms in brackets is negative, the second positive. Looking at the bracketed expressions, the difference between these and the PMF twin conditions (2.6) and (2.7), lies in the addition of the positive terms $q/(Lx^*)(-q_{KL}/q_{LL})$ to (4.6) and $q/(Lx^*)$ to (4.7). When multiplied by the negative first expression, these have a negative effect on both $(\partial K/\partial x^*)$ and $(\partial L/\partial x^*)$ causing the overall sign to be indeterminate. It is useful to note that this result parallels the long run supply response of the labour managed firm, which is also indeterminate (Ireland and Law, 1982, Estrin, 1982). This arises from the fact that in this model structure an improvement in efficiency has exactly the same impact on the firm as an increase in demand.

It is clear, however, that the revision in capital and labour for the LMF will always be *strictly less* than the corresponding revision for a twin PMF of identical efficiency because of the additional negative term appearing in the LMF equations (4.6) and (4.7).

$$\left(\frac{\partial K}{\partial x^*}\right)^{LMF} < \left(\frac{\partial K}{\partial x^*}\right)^{PMF} \quad ; \quad \left(\frac{\partial L}{\partial x^*}\right)^{LMF} < \left(\frac{\partial L}{\partial x^*}\right)^{PMF} \tag{4.8}$$

Intuitively, this is due to the fact that in its labour decision, the LMF balances the loss in dividends from having more workers sharing in profits against the improvement in dividends from having more workers sharing capital costs. For the PMF, payments to labour are exogenously determined and fixed, and of course capital costs are not borne by workers. So unlike the LMF, it need not consider the feedback effect of an increase in employment on the marginal cost of labour. This feedback effect constrains the LMF from expanding labour by as much as the PMF. The first order conditions for capital are exactly the same for both types of firm: they both equate the marginal revenue product of capital to the cost of capital, *for a given level of labour*. But if the LMF revises labour by less than the PMF, the revision in the marginal product of capital will also be less, and therefore the ensuing revision in capital will have to be less.

The lower revisions in capital and labour additionally imply that the LMF's revision in output (also given by equation (2.8)) will be strictly less than the PMF's. This leads us to the following observation:

Observation: The surviving LMF's revision in both inputs and output in response to an improvement in expected efficiency will always be strictly less than that of the twin PMF.

Whether the LMF actually will choose to increase output depends on the precarious balance between capital, labour and dividends. If the firm is allowed to increase its capital relative to labour, and there exists a technology which enables the firm to increase revenues per worker by more than capital costs per worker, the firm will expand. Otherwise, it will contract to enjoy a higher dividend rate. It is precisely this ability to substitute capital for labour that makes the second bracketed expressions in (4.6) and (4.7) indeterminate in sign.

4.2 The Active Learning Model of the Labour Managed Firm

Once again assuming dividend-maximisation, the objective of the labour-managed firm is to maximise the expected discounted value of future cash flows per worker:

$$Max\ Z_\tau = \sum_{t=\tau}^{\infty} \beta^t \int_{\alpha_1}^{\alpha_2} [D(x(\sigma'_t),i_t,K_t,L_t)\chi_t + (\chi_{t-1}-\chi_t)\frac{\Phi}{L_{t-1}} + (1-\chi_t)w_t] \cdot$$

$$\{d \in \Delta\} \qquad P^t_{\sigma_\tau}[\sigma'_t = \sigma \,|\, \{i_s\}_{s=0}^{t-1}]d\sigma \qquad (4.9)$$

$$where\ d = \{\ [\chi_\tau,i_\tau,K_\tau,L_\tau],\ [\chi_{\tau+1},i_{\tau+1},K_{\tau+1},L_{\tau+1}],\ ...\ \}$$

The firm will remain in operation if the net present value to members of remaining in business, $Z_t(\chi_t=1)$, exceeds the opportunity cost to the member. The opportunity cost to the worker is his share of the shutdown value, Φ, plus the present discounted value of receiving the capitalist wage from this period onwards:

$$Z_\tau(\chi_\tau=1) \geq \frac{\Phi}{L_{\tau-1}} + \sum_{t=\tau}^{\infty} \beta_t w_t$$

Once the firm decides to operate and chooses its' sequence of optimal levels of exploratory investment, $\{i_t\}$, it chooses its inputs for the current period to maximise current dividends given $\{i_t\}$. As in the case of the profit maximising firm, the problem is identical to the passive learning case and the reaction of firm size to a change in the efficiency parameter will be computed in exactly the same way as before.

The comparative statics will again be given by (4.6) and (4.7), and the sign of the efficiency-size relationship will be indeterminate depending on the actual specification of the production function and the location of the firm along the production function. Of key importance to the discussion here, *the efficiency-size relationship will be identical in the active exploration and passive learning models for the LMF, just as they were for the PMF.* The Pakes and Ericson test between the two learning models is unaffected by the change in the organisational structure of the firm since the test is derived from the nature of the learning process and not from the firm's response to changes in its (expected) efficiency. This is discussed further in section 6.

First, however, we note that the main cause of the sign ambiguity of equations (4.6) and (4.7) arises from the impact of an improvement in efficiency on the choice of inputs. Holding inputs constant, an improvement in efficiency raises dividends leaving the cost of capital unchanged, creating an incentive for the firm to *increase* capital relative to labour. At the same time the marginal revenue product of capital has risen above its rental cost, creating an incentive to *lower* capital. The net effect is therefore indeterminate, unlike the profit maximisation case where the efficiency-size relation is unambiguously positive. In fact, it is not implausible for the LMF's efficiency-size relationship to be negative, as is shown in a special case example in the next section.

5. Special Case: Perverse Efficiency-Size Relationship

In this special case, we explore the effect of using a short run production function of the form:

$$q(L,\bar{K}) = L^{\beta} \tag{5.1}$$

where $0<\beta<1$.

Under this production technology, PMF profits are given by:

$$\pi(x^*, \bar{K}) = px^*L^{\beta} - r\bar{K} - wL \tag{5.2}$$

The only choice variable in the short run is labour, and the first order condition will be given by:

$$\frac{\partial\pi}{\partial L} = px^*\beta L^{\beta-1} - w = 0 \tag{5.3}$$

Differentiating (5.3) with respect to x^*:

$$\left(\frac{\partial L}{\partial x^*}\right)^{PMF} = \frac{1}{x^*(1-\beta)L}$$
$$> 0 \quad \textit{for } 0<\beta<1 \tag{5.4}$$

The effect on output will be positive as well:

$$\frac{d}{dx^*}(x^*L^\beta) = L^\beta + x^*\beta L^{\beta-1}\frac{\partial L}{\partial x^*}$$
$$> 0 \quad \textit{for } \frac{\partial L}{\partial x^*} > 0 \tag{5.5}$$

Now we consider the same example for the LMF. The short run LMF dividend becomes:

$$D(x^*, \bar{K}) = \frac{px^*L^\beta - r\bar{K}}{L} \tag{5.6}$$

Once again the only choice variable is labour, the first order condition for which is:

$$\frac{\partial D}{\partial L} = (\beta-1)px^*L^{\beta-2} + \frac{r\bar{K}}{L^2} = 0 \tag{5.7}$$

which simplifies to:

$$x^*L^\beta = \frac{r\bar{K}}{(1-\beta)p} = \textit{constant} \tag{5.8}$$

So the level of efficiency-adjusted output is always constant for an LMF operating under this technology regime.

Differentiating with respect to x^*:

$$L^{\beta} + x^{*}\beta L^{\beta-1}\frac{\partial L}{\partial x^{*}} = 0$$

$$\text{or} \quad \left(\frac{\partial L}{\partial x^{*}}\right)^{LMF} = \frac{-L}{x^{*}\beta} < 0 \tag{5.9}$$

From equation (5.9), the impact of an increase in efficiency is to unambiguously lower labour input. However, we know from (5.8) that efficiency-adjusted output is constant, so, the decrease in labour must be exactly offsetting the increase in efficiency.

We can make this even more clear by examining the total differential of efficiency-adjusted output:

$$\begin{aligned} \frac{d}{dx^{*}}(x^{*}L^{\beta}) &= L^{\beta} + x^{*}\beta L^{\beta-1}\frac{\partial L}{\partial x^{*}} \\ &= L^{\beta} + x^{*}\beta L^{\beta-1}\left(\frac{-L}{x^{*}\beta}\right) = 0 \end{aligned} \tag{5.10}$$

Thus efficiency-adjusted output is left unchanged following an increase in the level of the firm's efficiency. The effect on output will be *negative* if we add an assumption that an improvement in efficiency leads to a lowering of fixed costs, for example through a reduction in the cost of capital. If the cost of capital r, is given by $r(x^{*})$, where $r'(x^{*})<0$ and $r''(x^{*})>0$, then equation (5.9) would be rewritten as:

$$\frac{\partial L}{\partial x^{*}} = -\frac{L}{x^{*}\beta} + \frac{\bar{K}r'(x^{*})}{(1-\beta)\,px^{*}\beta\, L^{\beta-1}} < 0 \tag{5.11}$$

The effect on efficiency-adjusted output, $x^{*}q$, would be:

$$\begin{aligned} \frac{d}{dx^{*}}(x^{*}L^{\beta}) &= L^{\beta} + x^{*}\beta L^{\beta-1}\frac{\partial L}{\partial x^{*}} \\ &= L^{\beta} + \frac{r'(x^{*})\bar{K}}{x^{*}(1-\beta)p} - L^{\beta} \\ &< 0 \end{aligned} \tag{5.12}$$

Thus we have shown that a "perverse" case exists in which an improvement in efficiency actually leads the firm to contract output, at least in the short run. Whether or not this case is generally applicable, the broader result still holds: ***The learning models' clear and unambiguous results for the PMF become indeterminate for the LMF.*** In the special "perverse" case, of course, the PMF results are actually reversed for the LMF.

Table 1

	GENERAL CASE		PERVERSE CASE	
	PMF	LMF	PMF	LMF
$\partial L/\partial x^*$	positive	indeterminate but <PMF	positive	negative
$\partial K/\partial x^*$	positive	indeterminate but <PMF	zero	zero
$d/dx^* (x^*q)$	positive	indeterminate but <PMF	positive	negative

The efficiency adjusted output results here are analogous to the *revenue* effect of an increase in price, rather than the related output effect which has been extensively studied in the perverse short run supply literature. In the next section we proceed to show the main comparative results of the two types of ownership.

6. Results

It is quite clear that predictions from the comparative statics results all hinge on the response of current period size to a change in the firm's level of (expected) efficiency. These comparative statics results are identical for passive learning and active exploration.

Lemma

The net present value of future cash flows, V^*_t for the PMF and Z^*_t for the LMF, must be strictly increasing in x^*.[7]

Remark

Exit occurs at the point of zero net present value of expected profits (excess dividends) where $V^*_\tau = \Phi$ for the PMF and $Z^*_\tau = (\Phi / L_{\tau-1}) + \Sigma\beta_t w_t$ for the LMF). This leads us to the following result:

Theorem 1

Both firms will exit at the same level of (expected) relative efficiency (x_0). At this point, both firms exactly cover the opportunity cost of remaining in business.

Proof The detailed proof is listed in the appendix to this chapter, but the intuition behind the result is as follows: At the zero profits point, the LMF dividend exactly equals the PMF wage and both firms are just breaking even. Below this point, both will choose to exit.

Thus we have $(x_0)^{PMF} = (x_0)^{LMF}$ for both types of LMF, meaning that both firms exit at the same level of expected relative efficiency. It remains to be shown that this level of x_0 is the only point at which both firms choose the same level of inputs and outputs.

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[7] The proof of this lemma is identical to the Proof of Theorem 1 in Jovanovic (1982), and is laid out in detail in the Appendix (p. 666) of that paper.

Theorem 2

The zero profit point, (x_o), is the only point at which twin PMF and LMF firms will select the same production technology and output levels.

Proof The intuition behind the result is as follows: Since the LMF dividend exactly equals the PMF wage at x_0, both firms select exactly the same levels of inputs to produce the same level of output.

The choice of labour in each period is given by the first order conditions for maximisation. For the PMF,

$$px^*q_L = w$$

and for the LMF,

$$px^*q_L = D^*$$

For both firms the choice of capital is given by:

$$px^*q_K = r$$

In each period, the choice of labour input will be the same if and only if:

$$D^* = w$$

Whenever the choice of labour is the same, the choice of capital will automatically be the same since the first order conditions for capital are identical, given the same choice of labour. But the only time the dividend will exactly equal the wage rate is when the firms are just breaking even, that is at the point x_0 at which no economic rents are being earned. At this point the firm is indifferent between staying in the industry and exiting. Since there are no positive rents to be distributed as excess dividends or capitalist profits, the expected dividend exactly equals the wage rate, expected profits equal zero, and both firms choose the same level of labour and capital (and therefore output.)

Theorem 3

Under the passive learning model of firm growth, the dependence of firm size in any period t on size in period t-k (k>0) does not erode as k becomes large. Under the active exploration model, it does.

Proof

The formal proof of this theorem is given in Pakes and Ericson (1990). As discussed in Section 3, this test arises from the fact that for the passive learning model, the efficiency parameter θ is stationary; that is, unlike σ in the active exploration model, it does not evolve with the passage of time. The intuition behind the Pakes and Ericson result is that through exploratory investment, the active exploration firm is able to change its value of σ over time so in period t, it may in no way resemble the value in period t-k, especially if k is large. The passive learning firm, however, is always trying to figure out the level of the same fixed relative efficiency parameter, so the information from an observation in any particular period carries *exactly the same weight* in determining the firm's expectation as the most recent observation the firm has received.

7. Empirical Predictions

For the PMF, a number of interesting empirical predictions emerge from the theoretical results. However, it will be shown here that the indeterminacy of the efficiency-size relationship renders the majority of these predictions ambiguous for the LMF.

The empirical predictions arising from the results of the model can be grouped in four parts: (1) predictions for surviving versus failing firms of the same cohort; (2) predictions across ownership form for survivors from the same cohort; (3) predictions for surviving firms of the same size across ownership forms; and (4) predictions for all firms across growth models. These predictions are grouped and displayed in Tables 2 to 5.

Table 2

Proposition 1

Within a sample of PMFs, failing PMF firms from a given cohort will be smaller (in terms of both inputs and outputs) than PMF survivors of the same cohort. Within a sample of LMFs the survival-size relationship is indeterminate.

Failing firms are those which on average have been receiving bad news or who have been observing a deterioration in their "state". These firms tend to have relatively low values of x^* (x in the active exploration model) in the period prior to failure and are on average the firms with efficiency values closest to the exit level of efficiency, x_0.

If efficiency and size are positively related, as they are for PMFs, then firms about to fail will on average have relatively smaller operating scales. For the LMF the efficiency-size relationship is indeterminate and we are unable to draw any conclusions on the relationship between size and survival probabilities.

Table 2

Surviving v. Failing Firms of the Same Cohort

	PMF	LMF
LABOUR	Survivors > Failures	Indeterminate
CAPITAL	Survivors > Failures	Indeterminate
OUTPUT	Survivors > Failures	Indeterminate

Table 3

Surviving Firms of the Same Cohort

Across Ownership Form

	PMF	LMF
LABOUR	> LMF twin	< PMF twin
CAPITAL	> LMF twin	< PMF twin
OUTPUT	> LMF twin	< PMF twin
d/dx^* (x^*q)	> 0; $\rightarrow 0$ as $x^* \rightarrow \alpha_2$	< PMF twin, but <>0 in sign; $\rightarrow 0$ as $x^* \rightarrow \alpha_2$
LARGEST FIRMS	$g \rightarrow 0$	g Indeterminate
SMALLEST	g Indeterminate	g Indeterminate
MEDIUM	$g > 0$	g Indeterminate

Table 4

Surviving Firms of the Same Size

Across Ownership Form

	PMF	LMF
GROWTH (K) (% CHANGE)	$\rightarrow$ 0 with Age $>$ 0 before $\rightarrow$ 0	$\rightarrow$ 0 with Age $><$ 0 before $\rightarrow$ 0
GROWTH (L)	Same as above	Same as above
GROWTH (Q)	Same as above	Same as above
σ^2_K	$\rightarrow$ 0 with Age	$\rightarrow$ 0 with Age
σ^2_L	$\rightarrow$ 0 with Age	$\rightarrow$ 0 with Age
σ^2_Q	$\rightarrow$ 0 with Age	$\rightarrow$ 0 with Age
FAILURE PROBABILITY	Declines with Age	Declines with Age

Table 5

Surviving Firms of the Same Age

	PASSIVE LEARNING	ACTIVE EXPLORATION
DEPENDENCE ON INITIAL SIZE	Remains with passage of time	Dissipates with passage of time

Table 3

Proposition 2

Taking a matched sample of PMFs and LMFs and looking at surviving firms of the same cohort, PMFs will tend to use more labour and more capital to produce more output than twin LMFs of the same true efficiency, receiving identical shocks.

The model predicts that for identical firms receiving the same shocks, the PMF will always be larger in terms of both inputs and outputs than the LMF twin. Empirically, however, this prediction is difficult to test since many shocks are in fact idiosyncratic to the firm and it is therefore never possible to observe two identical firms of different ownership forms.

Proposition 3

Taking a matched sample of PMFs and LMFs, surviving PMFs of the same cohort will tend to grow positively over time, while the predicted growth-age relationship for LMFs is indeterminate.

Surviving firms in both cases are those which on average have been receiving favourable information (or have been moving to better states). These firms have been revising their value of x^* (or x in the active exploration case) upwards over time. If efficiency and size are positively related, as they are for the PMF, upward revisions in efficiency will entail upward revisions in size, and therefore positive growth rates. For the LMF, the ambiguity of the efficiency-size relationship means we can make no prediction on the average sign of growth rates over time.

<u>Proposition 4</u>

Taking a matched sample of surviving PMFs and LMFs of the same age, PMF growth rates will on average be positive for surviving small firms, approaching zero for larger sizes. The theory can make no prediction on the relationship between growth and size for the LMF because of the indeterminacy of the efficiency-size relationship.

The upper bound on firm efficiency means that PMF size is bounded from above. Smaller surviving PMFs are on average receiving favourable information on their efficiencies, and are therefore on average growing positively. Because the efficiency-size relationship is indeterminate for the LMF, we are unable to make any similar predictions on the growth-size relationship for these firms.

Table 4

<u>Proposition 5</u>

Regardless of ownership form, surviving firms have growth rates of inputs and outputs which approach zero for old firms.

This is the first of four predictions of the learning models which are unaffected by the change in ownership form, as the predictions arise from the nature of learning and do not depend on the efficiency-size relationship. In terms of the passive learning model the intuition is simple: the firm's efficiency is stationary over time, and as the firm has more and more observations on which it bases its expectation of x^*, the more precise its estimate becomes and the less it changes with each subsequent observation. If x^* does not change much, then output revisions are smaller as well.

In terms of the active exploration model, over time the firm's idea eventually becomes fully exploited and it is no longer possible to move to better states. (The exception is if the firm comes up with new ideas.) In the long run, all ideas become outdated as newer and better ideas emerge, and the firm who does not innovate will die. However, in the medium to long run, once the firm's idea has been fully exploited and before it has been overtaken, the firm may remain in the same state for a long time before it begins to decline. Thus growth rates will approach zero as the firm's state ceases to change.

Proposition 6

The growth rate of inputs and output for the PMF will tend to be positive before approaching zero with age. For the LMF, due to the indeterminacy of the efficiency-size relationship, the theory is unable to make any predictions on the sign of growth rates before the convergence to zero occurs.

Because survivors tend to be revising their estimates of x^* upwards, and efficiency is positively related to size for PMFs, surviving PMFs are on average growing positively. Without an unambiguous sign on the efficiency-size relationship for LMFs, the theory can not determine whether growth rates for these firms will on average be positive or negative.

Proposition 7

The variance of firms' inputs and output declines with age for both LMFs and PMFs.

This follows from Proposition 5 and is the second of the four predictions of the learning models unaffected by the change in ownership form. As the state of the firm stabilises at a certain level, changes to inputs and output become smaller, so the variance of inputs and outputs declines.

Proposition 8

For surviving firms of the same size, the likelihood of failure declines with age for both PMFs and LMFs.

This is the third of four predictions of the learning models that do not depend on the organisational form of the firm. As the firm's state stabilises at a certain level with age, the likelihood of a big enough shock to throw the firm into the failure zone is less. In terms of the passive learning model, it would take a particularly disastrous draw for a single observation to force a drastic enough revision in x^* to force the firm to close. Similarly, it would require a drastic outcome to investment by the firm or by its competitors to send the active exploration firm into liquidation.

Proposition 8: Corollary

The learning models assume that upon entry the firm sets its expectation of its efficiency equal to the mean value of the distribution from which efficiencies are drawn. If, however, we assumed entrants were "optimistic", in the sense of setting initial expectations *above* the mean of the efficiency distribution, then we would observe the following: For a given cohort in the initial few years many firms would be revising their expectations downwards, but in very few cases will these revisions be large enough to induce exit. After the first few years have passed, most of the truly inefficient firms which are still alive will have expectations near the exit threshold. From this point on, further bad news will induce exit in large numbers and for the remaining firms survival likelihoods will be increasing in age. Thus the survival-age relationship will be initially downward sloping, reaching a minimum after some period of time, and rising thereafter.

Table 4

Proposition 9

The ratio of current period size (t) to last period size (t-1) and size (t-k) periods ago will not depend on size (t-k) under the active exploration model. Under passive learning, it will.

See Proof of Theorem 3.

8. Summary and Conclusion

The clear and sharp predictions of the evolutionary learning models of Jovanovic and Ericson and Pakes become indeterminate when the ownership structure of the firm is assumed to be "Illyrian" labour management. The Jovanovic and Ericson and Pakes results are shown to depend principally on the establishment of a positive efficiency-size relationship, and it has been shown that this relationship becomes ambiguous when the LMF organisational structure is assumed. Furthermore, we have shown that at least one example exists where this relationship is unambiguously negative.

The predictions of the learning models are: above the exit threshold, LMF output will lie below that of an identical PMF of the same efficiency receiving the same shocks; both types of firm will close down at the same efficiency level of zero present value (net of opportunity cost) of remaining in business; at the point of closure, both firms will be employing the same level of inputs and producing the same level of output; and finally, the Pakes and Ericson (1990) test of the passive learning versus the active exploration models of firm growth also holds for the case of the LMF, and is therefore unaffected by the internal organisational assumptions made here.

Most of the empirical predictions of the learning models collapse due to the indeterminacy of the LMF efficiency-size relationship. Only a small number of the predictions are unaffected by the change in ownership form: (1) Surviving firms have growth rates approaching zero with age; (2) the variance of inputs and output for all firms declines with age; (3) the likelihood of failure declines with age for firms of the same size; and (4) the Pakes and Ericson test holds for both types of firm.

For the LMF, the theory is unable to provide unambiguous predictions on a number of the more interesting empirical relationships that it predicts for the PMF. These include: (1) the relation between efficiency and output; (2) the relation between efficiency and inputs; (3) the relation between survival and output; (4) the relation between survival and inputs; (5) the relation between growth and age; (6) the relation between growth and output; (7) the relation between growth and inputs; and (8) the sign of growth rates for younger surviving firms.

There may be at least three possible explanations for the contrast in the results between the two types of firm: First, the Illyrian firm model has been attacked in many studies for being overly simplistic relative to the actual organisational structure of these firms.

In particular, under the perverse short run supply response it does not provide a satisfying solution to the problem of how the firm decides which workers will go, and how these workers will be compensated. Furthermore, it does not allow for the complex rules and regulations which govern the behaviour of these firms in the Western world. This explanation is addressed and rejected in the next chapter, which develops a model specific to the French system of producer cooperatives. A second explanation is that these firms in fact behave substantially differently from profit maximising firms, and this is being reflected in the indeterminacy of the comparative statics results. However, as will be seen in Chapter IV, the empirical behaviour of these firms is remarkably similar to conventional profit maximising firms. The third possible explanation is that the theoretical models are structured in such a way as to overemphasize the internal structure of the firm to the neglect of more basic and fundamental factors. This latter explanation is addressed in the final chapter of this thesis.

In addition, the structure of the model presented here presumes that it is greater efficiency which leads some LMFs to operate at a smaller size. However, plausible stories involving agency problems or transactions costs may imply a reverse causality: i.e., it is precisely because some firms are smaller that they have lower costs and are therefore more efficient. The direction of causality between efficiency and size is addressed in some further detail in Chapter V.

APPENDIX: Proof of Theorem 1

We restate the objective function of the PMF:

$$Max\ V_\tau = \sum_{t=\tau}^{\infty} \beta^t \int_{\alpha_1}^{\alpha_2} [\pi(x^*_t)\chi_t + (\chi_{t-1} - \chi_t)\Phi] \cdot P(x^*_t = s | x_\tau, n_\tau) ds \tag{A1}$$

At the point of exit, the firm is indifferent between remaining in business and exiting.

If it exits, $\chi_\tau = 0$ so (A1) reduces to:

$$V_\tau = \Phi \tag{A2}$$

Equating (A1) and (A2):

$$\sum_{t=\tau}^{\infty} \beta^t \int_{\alpha_1}^{\alpha_2} [\pi(x_0)\chi_t + (\chi_{t-1} - \chi_t)\Phi] \cdot P(x^*_t = s | x_\tau, n_\tau) ds = \Phi \tag{A3}$$

We restate the objective function of the LMF:

$$Max\ Z_\tau = \sum_{t=\tau}^{\infty} \beta^t \int_{\alpha_1}^{\alpha_2} [D(x^*)\chi_t + (\chi_{t-1} - \chi_t)\frac{\Phi}{L_{t-1}} + (1 - \chi_t)w_t] \cdot P(x^*_t = s | x_\tau, n_\tau) ds \tag{A4}$$

At the point of exit the firm sets $\chi_\tau = 0$ so (A4) reduces to:

$$Z_\tau = \frac{\Phi}{L_{\tau-1}} + \sum_{t=\tau}^{\infty} \beta^t w_t \tag{A5}$$

Equating (A4) and (A5):

$$\sum_{t=\tau}^{\infty} \beta^t \int_{\alpha_1}^{\alpha_2} [(D_t(x_0)-w_t)L_{\tau-1}\chi_t+(\chi_{t-1}-\chi_t)\frac{\Phi}{L_{t-1}}L_{\tau-1}] \cdot$$

$$P(x^*_t=s|x_\tau,n_\tau)ds = \Phi \qquad \text{(A6)}$$

Comparing (A6) with (A3) it is clear that the only time these two equations will be identical is when the firm fails in period $t=\tau$. In that case, $L_{t-1}=L_{\tau-1}$, and $(D_t-w_t)L_{\tau-1} = (D_\tau-w_\tau)L_{\tau-1}$, but since the firm fails, L_τ is not revised from $L_{\tau-1}$ so $L_\tau=L_{\tau-1}$. But $(D_\tau-w_\tau)L_\tau=\pi_\tau$ so (A6) reduces to (A3).

CHAPTER III: A Membership Model of the French Producer Cooperative*

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1. Introduction

The Illyrian firm model of the labour managed firm, where an all-member firm maximises profits per worker, is the most commonly used objective function in the literature. Yet this objective function has been criticised for being overly simplistic and for ignoring the complex network of rules and constraints which typically govern the behaviour of these firms. This paper will present a model of producer cooperatives in France which incorporates most of the institutional rules that govern the behaviour of French labour managed firms. We will show that the implications of this more complicated model are strikingly similar to the Illyrian firm model, and under certain conditions the model simplifies into an identical version of the Illyrian firm model.

In terms of the dynamics of firm growth and survival, Chapter II showed that the strong positive efficiency-size relationship of the Jovanovic (1982) and Ericson and Pakes (1989) models becomes indeterminate when the Illyrian type of internal organisation of the firm is assumed. In fact, under certain plausible assumptions this critical efficiency-size relationship becomes negative. This chapter addresses and rejects the possibility that the sharp theoretical predictions for profit maximisation break down because of the Illyrian firm model's neglect of the actual institutional rules and regulations governing these firms, and we find that the more complicated French cooperative model here behaves remarkably similarly to the Illyrian firm model in Chapter II.

The model of the French producer cooperative will, however, provide explanations for a number of unexplained stylized facts in the literature on labour managed firms. First, a great deal of anecdotal evidence along with empirical findings by Ben Ner (1988a) and Pérotin (1986) suggest that worker cooperatives have lower hazard rates than conventional capitalist firms (See Appendix). The principal explanation to date has been that cooperatives benefit from higher efficiency due to the internalisation of conflict between workers and owners (Ben Ner, 1988a), better flow of information, and higher accumulation of firm-specific human capital due to longer worker time horizons (Estrin, Jones, and Svejnar, 1987). In the case of cooperatives formed from bankrupt capitalist firms, it has been argued that workers may be willing to give up some earnings in exchange for avoiding the search process for new jobs (Ben Ner, 1988a). All these explanations provide support for worker cooperatives having lower failure thresholds than capitalist firms, by relying on empirically nonmeasurable influences on the failure threshold. This paper will use the Jovanovic passive learning framework to provide an explanation on a purely pecuniary basis why French cooperatives will remain in business over a range of conditions where both conventional firms and Illyrian labour managed firms will exit.

A second stylized fact in the LMF literature is that although much has been written in theoretical papers about the degeneration hypothesis[1] (Ben Ner, 1984, Miyazaki, 1984), whereby successful cooperatives degenerate into capitalist firms by replacing departing members with cheaper hired workers, very few conversions are actually observed. In

[1]The degeneration hypothesis is explained in greater detail in the appendix on labour management at the end of the thesis.

fact, Estrin and Jones (1988) test and reject the degeneration hypothesis for French producer cooperatives. Yet no explanation has been offered why degeneration should not occur. In the French producer cooperative model presented here, we will show that degeneration is theoretically impossible given the rules which govern the behaviour of these firms, and therefore it is not surprising that the degeneration hypothesis should be rejected in empirical testing.

Four key features of the French system are incorporated into our model: first, the remuneration system, which is in fact much more complicated than the simple profits per worker rule; second, the Free Access Rule, which enables uninhibited conversion of status between member and nonmember workers within the firm by the purchase or sale of membership shares at face value; third, the financing system of the firm with internal and external financing considered separately; and fourth, the shutdown rules which specify that any residual value over and above the outstanding capitalization may never revert to the members themselves.

The remainder of this paper is divided into five further sections. Section 2 outlines the existing laws governing French cooperatives, while section 3 provides an introduction to passive learning. The passive learning model of the Illyrian firm is reviewed in Section 4, and the passive learning model of the French producer cooperative is presented and compared to the Illyrian firm model in Section 5, and the solution is worked out in section 6. The final section summarises and concludes.

2. French Cooperative Law

French law on cooperatives dates back to the 19th century, but the main law governing their behaviour is the law of July 1978. French law places a large number of restrictions and requirements on the operations of producer cooperatives.[2] We will focus here on the four main institutional rules which we consider most influential in determining the behaviour of these firms: (1) the worker remuneration rules, (2) the Free Access rule, (3) capitalization rules, and (4) the shutdown conditions.

2.1 Remuneration of Workers

The workforce of the French producer cooperative can be divided into two distinct groups: worker-members and "hired" workers. There are two main distinctions between these two classes: (1) members participate democratically in the firm's decision making structure while nonmembers have no voice; and (2) members hold ownership shares in the firm which entitle them to participate in any surplus produced.

All workers are paid a fixed wage, whether they are members or nonmembers. In addition, a portion of profits is paid out to *all* workers, both member and nonmember.[3] The remaining surplus is then divided among members only, on a per share basis.[4]

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[2]The rules and regulations are listed in 400 detailed pages in Guide Juridique des SCOP, 1988, Syros, Paris.

[3]By law, overall profitsharing must represent at least 25% of net revenues. Profitsharing portions paid to each worker normally reflect the relative contribution of the worker in terms of time worked and output produced. However, we will be considering a homogeneous workforce so this factor will not be significant to the model.

[4]The dividend payments may not exceed total profitsharing payments to labour, and the actual rate of return may not exceed 8.5% or the nominal rate of return on corporate bonds issued in the previous six months, whichever is higher.

This differs from assumptions made in the existing labour managed firm (LMF) literature, where either workers in an all-member firm simply share the surplus, or in the case of hired-workers being present, hired workers receive a fixed wage and the remaining member-workers share the surplus.

The remuneration rules are significant in terms of modelling because nonmember workers have profitsharing earnings rather than just a fixed wage. Thus if the firm is profitable, *all* workers may receive earnings in excess of their opportunity cost given by the capitalist wage.

2.2 Free Access

While the literature on the degeneration of labour managed firms (Ben Ner, 1984, Miyazaki, 1984) has extended the Illyrian model to address the issue of hired workers in the firm, it has neglected one essential point. In the French case, and in certain other countries, ***nonmember workers may at any time elect to purchase membership shares and become members in the firm, and the firm must accept them.*** Likewise, members may at any time redeem their membership shares at face value and become nonmember workers in the firm.

The essential theoretical outcome of Free Access is that it forces the two classes of workers to earn (ex ante) exactly the same amount; otherwise, any gap in earnings will be eroded by the conversion of workers from one class to another.

2.3 Capitalization

Capitalization is defined as the outstanding value of all equity shares. For the French producer cooperative these shares are always priced nominally. When the firm is created the founding members bring the initial capital with them, and they are allocated shares based on their contribution to the total stock. The share price is set at this time. If the firm earns positive rents, this is not reflected in an appreciation of the share price; it simply means there will be a higher dividend. However, if the firm makes losses this will result in a downward revision of the share price unless there is a capital infusion.[5]

The addition of new members and the departure of existing members both result in changes in the firm's capitalization but leave the share price unchanged. This is because new members must pay the nominal share price to purchase at least one share, thereby injecting new capital into the firm. Departing members redeem their share(s) at nominal value, thereby reducing the firm's capitalization.

Once again this feature differs from assumptions made in the existing literature. Even where the share price has been incorporated into modelling, it has been a mechanism to reflect the value of the firm, freely traded between workers with the price set in an internal market. However, at least in the French system, shares can only be bought from and sold to the firm itself, and by law, all transactions involving these shares must be made at face value.

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[5]By law, the share price must always be kept within the 100 FF to 500 FF range. There are also restrictions on the maximum percent of shares a single member may own at any time.

The capitalization rules are significant in that the outstanding value of the firm's equity changes with changes in the level of membership. In the case of internal financing, it links the firm's capital input to the level of membership.

2.4 Shutdown Procedure

If the firm disbands, the nominal value of shares owned are paid to members but any remaining residual profit must revert to the umbrella cooperative organization (CG-SCOP)[6] or be paid to another producer cooperative, but may under no circumstances be paid to the individual members. The key outcome of this rule is that profits in excess of the firm's capitalization are nonrecoverable in the event of shutdown, so all else equal the French producer cooperative will remain in operation over a range of circumstances where the Illyrian firm and capitalist firms would shut down.

Compared to the Illyrian firm model, this framework provides a much more realistic picture of how the LMF operates in France. The next step is to present a general model of the dynamics of firm growth and failure using the special case of the French producer cooperative. We will consider here the passive learning model of Jovanovic (1982), which belongs to a class of models which establish a positive relationship between capitalist firm efficiency and firm size.

3. Passive Learning

The passive learning framework developed by Jovanovic and applied in Chapter II to the Illyrian model of the labour managed firm is based on the notion that all firms are born

[6]Confédération Générale des Sociétés Coopératives Ouvrières de Production.

with a certain efficiency endowment which remains constant over time. However, this efficiency endowment is not revealed to the firm; the firm only knows the underlying distribution from which it is drawn. The model is set up so that uncertainty over efficiency is the *only* source of uncertainty to the firm. The firm develops expectations on its efficiency by observing its own sequence of sales, and in each period it uses the new information it receives to update its expectations. Under profit maximisation, the firm's optimal choice of inputs and output are *positively* linked to efficiency.

If the firm's expectation of its efficiency falls below a certain threshold, then the expected value of remaining in business falls below the opportunity cost, and the firm shuts down. The key result of the model is that a relationship exists between the pattern of growth and failure and the size and age of firms.

To formalise the model, we assume all firms have the same cost functions which are U-shaped for all input prices, and production functions which are locally concave.[7] The key difference between firms is in their relative efficiencies in producing sellable output. The differences in relative efficiency are manifested through a firm-specific multiplicative factor applied to the production function. The efficiency endowment may be thought to represent a firm-specific wastage rate, managerial ability, technology choice, firm location or any other firm-specific efficiency factors which remain constant over time.

The modelling strategy is to provide the firm at birth with an unknown time-invariant efficiency parameter labelled θ. The firm's expectation of this efficiency parameter

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[7]See Ireland and Law (1982) pp. 27-28.

determines its scale of operations. Growth and failure are then modelled as outcomes of a stochastic process involving the firm's expectation of its θ.

Since the firm is unaware of its θ draw, it forms expectations on its θ from its observed sales. The realisation of the firm's sales provide it with a noisy estimate (η_t) in each period of the true endowment (θ), where the noise consists of zero mean i.i.d. shocks (ϵ_t):

$$\eta_t = \theta + \epsilon_t$$
$$\theta \sim N(\bar{\theta},\sigma_\theta^2)$$
$$\epsilon_t \sim N(0,\sigma^2) \tag{3.1}$$

The firm bases its decision-making on the sequence $\{\eta_{t-1}, \eta_{t-2},\ldots, \eta_1\}$. The ϵ_t shocks are assumed to be firm-specific, and are independent over time and across firms.

The true (noiseless) relative efficiency multiple of the firm is labelled x, and is given by the function $x \equiv \xi(\theta)$, where $\xi(\theta)>0$, $\xi'(\theta)>0$ and continuous, and $\lim_{\theta \to -\infty} \xi(\theta)=\alpha_1>0$ and $\lim_{\theta \to \infty} \xi(\theta)=\alpha_2<\infty$. That is, the multiple is always positive, (to preclude negative output), and is increasing in θ; i.e., the more efficient the firm is, the more sellable output it can get out of the same inputs. The upper bound α_2 is needed to preclude infinite output. Since the firm is actually unable to observe θ, and in fact only observes η, it develops expectations on the value of $x(\theta)$ based on the observed sequence of $\{\eta\}$.

The firm's expected relative efficiency factor is a random variable denoted x^*_t and given by:

$$x^*_t=E_t[x \mid \eta_{t-1},\eta_{t-2},\ldots,\eta_1] \tag{3.2}$$

The firm updates its expectations on its relative efficiency multiple by means of Bayes' Law: in each period t, it estimates the probability of having a certain efficiency factor x given that it has observed to date the sequence of $\{\eta_{t-1}, \eta_{t-2}, \ldots, \eta_1)$ noisy estimates of θ. It then revises its estimate of x^* to correspond to the new expected value.

The evolution of x^* is governed by the following probability function:

$$P(x^*|x^*_\tau,n_\tau) = Pr(x^*_{t+1}=x^*|x^*_t=x^*_\tau,n_t=n_\tau) \tag{3.3}$$

The x^*_t sequence is a Martingale so all currently available information is incorporated in x^*_t. It follows that the current expectation of x^* for all future periods is the current value of x^*_t:

$$E_t[x^*_{t+k}] = x^*_t \qquad \forall\ k>0 \tag{3.4}$$

Considering the two input case, the production function for firms in the industry is given by:

$$q_t = q(K_t,L_t) \tag{3.5}$$

where $q_K>0$, $q_L>0$, $q_{KK}<0$, $q_{LL}<0$, and $q_{LK}=q_{KL}>0$.

In any given period, the expected sales revenues of the firm are given by the product of the output price, the production function, and the efficiency multiple x^*_t:

$$\begin{aligned} R^*_t &= f(x^*_t(\theta),K_t,L_t) \\ &= p_t x^*_t q(K_t,L_t) \end{aligned} \tag{3.6}$$

The firm uses the information available to it to evaluate the expected discounted value of future cash flows if it remains in business. This value is contrasted with the fixed opportunity cost, labelled Φ, and the firm operates only if the value of remaining in business exceeds Φ. Because profits are monotonically increasing in efficiency, there is a single value of the expected efficiency factor, x^*, at which the firm is indifferent between exiting and remaining. For all values below that critical value, the firm will choose to exit.

While this framework has been used almost exclusively to analyze the growth and survival behaviour of profit maximising firms, it can be adapted to study the behaviour of labour managed firms. Chapter II applied this framework to examine the behaviour of the Illyrian firm, and the findings are briefly reviewed in the next section.

4. The Passive Learning Model of the Illyrian Firm

Traditionally, the literature on labour-managed firms has adopted the objective function proposed by Ward (1958) and extended by Domar (1966) and Vanek (1970). Sometimes referred to as the Ward-Domar-Vanek objective function, it is assumed that workers in a cooperative maximize member income, or "dividends", i.e., the rate of net revenues (after capital costs) per worker.

In the passive learning Illyrian firm model, all workers are assumed to be homogeneous and risk neutral expected earnings maximisers. The LMFs are assumed to operate in an economy dominated by conventional profit-maximising firms. All firms are price-takers in input and output markets. The capitalist sector employs workers at the market wage, and workers are able to move freely between the two sectors. Thus the worker's opportunity cost of working in an LMF is the capitalist wage, *w*. Capital is externally financed by all firms at the market rate, *r*. All price vectors, i.e., $\{p_t\}$, $\{r_t\}$, and $\{w_t\}$ are known in advance and are assumed to change at the same rate from one period to the next. In each period, the firm updates its expectations on its relative efficiency parameter and maximises the expected present discounted value of future earnings per worker. If the firm remains in business, this is given by the discounted value of the stream of future dividends; if it exits, it is given by the worker's one-time share of the shutdown value, Φ, plus the discounted value of the stream of future capitalist wages he will earn thereafter:

$$\underset{\{d\in\Delta\}}{Max}\ Z_\tau = \sum_{t=\tau}^{\infty} \beta^t \int_{\alpha_1}^{\alpha_2} [D(x^*_t,n_t,K_t,L_t)\chi_t+(\chi_{t-1}-\chi_t)\frac{\Phi}{L_{t-1}}+(1-\chi_t)w_t]\cdot P(x^*_t=s|x^*_\tau,n_\tau)ds$$

$$where\ d=\{[\chi_\tau,K_\tau,L_\tau],[\chi_{\tau+1},K_{\tau+1},L_{\tau+1}],...\} \tag{4.0}$$

and

D^*_t= expected single period dividend
K_t= capital
L_t= labour
n_t= number of periods since firm was created
x^*_t= expectation of firm efficiency at time t
χ_t = 1 if firm survives, 0 otherwise
Φ= shut down value of firm
w_t= capitalist wage
β= discount rate

If the firm continues to operate, it chooses inputs to maximise single period dividends, given by expected revenues net of capital costs shared out among the workforce:

$$\underset{\{K_\tau,L_\tau\}}{Max}\ D(K_\tau,L_\tau|x^*_\tau,n_\tau) = \frac{p_\tau x^*_\tau q(K_\tau,L_\tau)-r_\tau K_\tau}{L_\tau} \tag{4.1}$$

where:

p_τ= output price
r_τ= cost of capital

The first order conditions become (omitting time subscripts):

$$px^*q_k = r \tag{4.2}$$

and

$$px^*q_L = \frac{px^*q(K,L)-rK}{L} = D^* \tag{4.3}$$

Thus the firm chooses its capital input so that the marginal revenue product of capital exactly equals the cost of capital, like a conventional profit maximising firm. However it chooses employment so that the marginal revenue product of labour equals the dividend, which is not exogenous like the capitalist wage, but varies with changes in capital and labour employed by the firm.

Equations (4.2) and (4.3) can be solved simultaneously to yield:

$$q = Lq_L + Kq_K \tag{4.4}$$

Equation (4.4) is, of course, Euler's Theorem. That is, the Illyrian firm only produces along those portions of the production function where there are constant returns to scale. This is a well known result in the literature on labour managed firms, and leads to a multiplicity of possible equilibriums if the production function exhibits constant returns to scale over a range of output levels (Ireland and Law, 1982, Estrin, 1982).

To determine the comparative statics of a revision in the expected efficiency multiple x^*, we differentiate (4.2) and (4.3) with respect to x^* yielding:

and

$$\frac{\partial K}{\partial x^*} = \left[\frac{-q_K}{x^*} - q_{KL}\frac{\partial L}{\partial x^*}\right]\frac{1}{q_{KK}} \tag{4.5}$$

$$\frac{\partial L}{\partial x^*} = \left[\frac{\frac{q}{L} - q_L}{x^*} - q_{LK}\frac{\partial K}{\partial x^*}\right]\frac{1}{q_{LL}} \tag{4.6}$$

Solving (4.5) and (4.6) simultaneously yields:

$$\frac{\partial K}{\partial x^*} = \frac{q_{LL}}{q_{KK}q_{LL}-q_{LK}^2}\left[\frac{-q_K}{x^*} - \frac{q_{KL}}{q_{LL}}\frac{\frac{q}{L}-q_L}{x^*}\right] \gtrless 0 \tag{4.7}$$

and

$$\frac{\partial L}{\partial x^*} = \frac{q_{KK}}{q_{LL}q_{KK}-q_{LK}^2}\left[\frac{q_K q_{LK}}{x^* q_{KK}} + \frac{\frac{q}{L}-q_L}{x^*}\right] \gtrless 0 \tag{4.8}$$

In both equations, the first expressions on the right hand side are strictly negative by the second order condition for maximum and the assumption of diminishing marginal returns. The second (bracketed) expressions are in both cases indeterminate in sign. In each case, the first of the two terms in brackets is negative and the second positive, causing the overall sign to be indeterminate. Intuitively, this is due to the fact that in its labour decision, the LMF balances the loss in dividends from having more workers sharing in profits, against the improvement in dividends from having more workers sharing capital costs.

With the capital and labour effects both indeterminate, it follows that the output effect, given by the efficiency-adjusted production function, will also be indeterminate:

$$\frac{d}{dx^*}(x^*q) = q + q_K\frac{\partial K}{\partial x^*} + q_L\frac{\partial L}{\partial x^*}$$

$$>< 0 \qquad (4.9)$$

The growth and survival predictions of the Jovanovic model and that of Ericson and Pakes for profit maximising firms were shown in Chapter II to depend delicately on establishing a positive efficiency-size relationship. It was suggested in Chapter II that the breakdown of the strong relationship found for capitalist firms may be attributable to the excessive simplicity of the Illyrian firm model. Indeed, the Illyrian firm model has been criticised for lacking any of the institutional detail typical of cooperative firms in practice. In particular it does not determine how the firm decides who will go if it contracts employment, it does not allow for nonmember labour and differing remuneration between the member and nonmember classes, nor does it incorporate the institutional rules that govern the internal structure of these firms. However, we will show that once all these features are included, the indeterminacy of the results still remains, and the more complicated version of the model bears a striking resemblance to the simpler and much more manageable Illyrian firm model.

5. The Passive Learning Model of the French Producer Cooperative

This section presents a model of the French producer cooperative incorporating the four conditions and constraints described in Section 2. But first, a number of new assumptions are needed: For convenience, the fixed wage paid to all workers is set to zero.[8] Furthermore, under the internal financing regime the firm uses its capitalization entirely to purchase the capital goods needed for production. Under external financing

[8]This has no impact on the results of the model.

the firm borrows at the market rate to finance capital expenditures, and invests the outstanding capitalization at the market rate *r* on which it receives interest in each period. In both regimes, capital goods are bought and sold in a perfect second hand market with no fixed or sunk costs to the firm, as long as the firm remains in business.

5.1 Remuneration

The French cooperative's net revenues are distributed in two[9] parts: the first part is divided among all workers in the form of profitsharing; the remaining part is divided among all members in the form of return on shares.

Following French law, all workers in the firm receive in payment a certain fraction of revenues, regardless of whether or not they are members. We denote this fraction by γ, where $0<\gamma<1$. The level of γ is assumed to be set at the creation of the firm and remains constant thereafter.

Expected gross revenues are given by the product of the output price p, the expected relative efficiency multiple x^*, and the production function, q. Under internal financing, revenues are distributed gross of capital costs. This is because all capital is owned by the firm and payments to capital and payments to labour are determined endogenously and simultaneously as part of the members' earnings maximisation process. Then under internal financing net revenues, R^I, are the same as gross revenues, and are given by:

[9]There are also provisions requiring some of the surplus to go to various reserve and development funds which we ignore here.

$$R^I(x^*_t,n_t) = p_t x^*_t q(K_t,L_t) \tag{5.1}$$

Under external financing, capital costs (rK) are exogenous and must be paid before earnings distribution. The firm receives additional earnings (rSM) from having invested the outstanding shares at rate *r*, so net revenues, R^E, become:

$$R^E(x^*_t,n_t) = p_t x^*_t q(K_t,L_t) - r_t K_t + r_t S M_t \tag{5.2}$$

The expectation of shared earnings for a typical worker in any period is given by E^*, where (omitting time subscripts):

$$E^* = \frac{\gamma}{L} R(x^*,n) \tag{5.3}$$

where x^* represents the Jovanovic expected efficiency multiple of the firm as discussed in Section 3, γ is the portion of earnings shared among all workers, and n is the firm's age. R represents net revenues under either financing regime.

The remaining fraction (1-γ) of revenues is then distributed to members on a per share basis. The expected return per share, denoted r^*_s, is given by:

$$r^*_s = \frac{(1-\gamma)}{MS} R(x^*,n) \tag{5.4}$$

where M is the number of members and S is the firm's share price. The share price is assumed to be set when the firm is created and remains constant thereafter.[10] We let

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[10]As will be seen, the firm only operates if it expects to earn a surplus. If the realised surplus is negative, this will be financed by means of lower realisations of the return on membership shares and profitsharing. Since revenues can never be negative, any operating losses will always be covered.

r denote the single market rate of interest at which both individuals and firms may lend or borrow funds. We assume all members borrow funds at this market rate of interest to finance the purchase of their membership shares. Furthermore, for simplicity we assume that because of collateral constraints each member only owns one share.[11] So in any period, the expected earnings of any given member, Z^*, is given by the expected profitsharing of all workers, plus the expected return paid on the membership shares, less the cost of servicing the loan taken to purchase the membership share:

$$\begin{aligned} Z^* &= \frac{\gamma}{L}R(x^*,n) + \frac{1-\gamma}{M}R(x^*,n) - rS \\ &= (\frac{\gamma}{L}+\frac{1-\gamma}{M})R(x^*,n) - rS \end{aligned} \tag{5.5}$$

5.2 Free Access

Next, we incorporate into the analysis the **Free Access Condition.** That is, any nonmember wishing to become a member may do so by borrowing funds externally to invest the price of a single share in the firm and acquire membership rights. Assuming workers are expected earnings maximisers, the implications of the Free Access Condition will depend on the difference between the incomes of members and nonmembers, which enters this model in the form of the (excess) return on membership shares.

For any choice of capital and labour, the Free Access Condition produces a Nash equilibrium in membership. In such an equilibrium, no members will wish to sell their shares to become nonmembers and repay their loans; i.e., membership will be internally

[11] Whether they own one share or the same finite number of shares makes no difference.

stable. Likewise, no nonmember will wish to borrow funds on the open market to purchase a share in the firm and become a member; i.e., membership is externally stable.[12]

Observation: For internal and external stability to hold, it must be the case that the return on the firm's shares exactly equals the market rate of interest, i.e.,[13]

$$r^*_s = \frac{1-\gamma}{MS} R(x^*,n) = r \tag{5.6}$$

In terms of modelling the LMF, Free Access is probably the single most important institutional rule, and by itself it explains why cooperative degeneration is seldom observed in France. For degeneration to occur, the firm must be able to replace departing members receiving profitsharing with cheaper hired workers receiving a fixed wage, thereby increasing profits per remaining member. In terms of this model, members must be able to raise the return on membership shares, r^*_s, at the expense of the profitsharing accruing to all workers, E^*. But under Free Access, the (ex ante) return on membership shares is always fixed at the market rate of interest, and although members can determine overall employment they are powerless to control the level of membership.

Result 1: In the French cooperative system, the Free Access rule prevents degeneration from occurring.

[12]The notions of internal and external stability of membership are drawn from the literature on cartels. See in particular, d'Aspremont et al. (1983).

[13]The exception is the case of an all member cooperative ($\rho=1$) where members would indeed be able to maintain $r^*_s > r$ in equilibrium.

5.3 Capitalization

French law requires shares to be priced nominally and for all outstanding shares to be fully subscribed to by members at any given time.[14] Members may at any time redeem their shares for their nominal value.

In practice, cooperatives raise financing in four ways: (1) retained earnings; (2) internal equity financing by selling shares to new or existing members; (3) loans from workers; and (4) loans from external sources.

The firm will only expand capital if the return on capital is above the market rate of return. But in that case $r^*_s > r$, so the expansion will be willingly financed by the conversion of nonmember to member labour until the marginal worker is indifferent whether or not to become a member, that is when $r^*_s = r$. Under risk neutrality if workers attach any value to participation they will always prefer to purchase membership shares rather than lend to the firm. And since capital financed through retained earnings can not be recovered in the event of shut down, workers always prefer internal equity financing to retained earnings. Thus in this model the firm will *always* use internal equity financing until it has exhausted the credit capacity of its members. Only at this point will the firm resort to external financing.

However, under Free Access for the firm to resort to external financing it necessarily means that (1) no nonmember workers remain who can buy up new equity, i.e., M=L;

[14]For certain types of firm there is a lag between the time shares are issued and the time by which they must be subscribed to. We abstract from these exceptions here.

and (2) the firm still expects to earn a marginal return on capital above ***r***. Thus we arrive at the following result:

Result 2: The ex ante cost of capital for the French producer cooperative is <u>always</u> equal to the market rate of interest.

As long as membership falls short of employment, the firm will always use internal equity financing, and the cost of capital will be $r^*_s = r$. Once membership equals employment, the firm will use external financing if it seeks to achieve further capital expansion, and the cost of capital will still equal ***r***.

Here we will consider the case where the membership is less than employment and the firm uses internal equity financing. We will return to the external financing case in Section 6. If the firm raises capital for investment through internal equity financing and shares are fully redeemable at nominal value, then at any time the sum of the value of all shares outstanding (MS) should exactly equal the current economic value (adjusted for depreciation and inflation) of the capital stock.[15] This leads to the ***Internal Financing Condition***:

$$K = MS \tag{5.7}$$

where

M= number of members
K= capital stock

[15]This would not be true if we included raw materials in the production function as another variable input. In this simple model investment is only in capital assets which can be sold to generate the cash necessary to pay redemptions on shares. Depreciation of the capital stock and inflation in the price of capital goods could be treated in this model via adjustments in the nominal share price.

S= share price

Because only members of the labour managed firm participate in decision making, these members will choose the level of capital and labour in each period to maximise their own earnings given their expectation of the firm's relative efficiency. With M<L we can combine the Free Access and Internal Financing Conditions (5.6) and (5.7) to get:

$$rK = (1-\gamma)px^*q \tag{5.8}$$

That is, since capital is fully financed by membership shares, the funds expended on capital must exactly equal the funds expended on membership share dividends.

If exit does not occur, current period earnings, Z, subject to internal financing and free access are given by equations (5.5) and (5.8):

$$Z = \frac{\gamma}{L}px^*q + \frac{rK}{M} - rS \tag{5.9}$$

This is to be contrasted with the Illyrian model current period dividend, in equation (4.1):

$$D = \frac{px^*q-rK}{L}$$

Subtracting (4.1) from (5.9) to compute the difference between the French cooperative and Illyrian firm earnings per member:

$$\begin{aligned} Z-D &= \frac{\gamma}{L}px^*q+\frac{rK}{M}-rS-\frac{px^*q}{L}+\frac{rK}{L} \\ &= \frac{px^*q}{L}(\gamma-1)+r(\frac{K}{M}-S+\frac{K}{L}) \end{aligned} \tag{5.10}$$

In an equilibrium with internal financing, rK= $(1-\gamma)px^*q$, and K=MS, so (5.10) reduces to:

$$Z-D = r(\frac{K}{M}-S-\frac{K}{L}+\frac{K}{L})$$
$$= 0 \qquad (5.11)$$

Result 3: Although the earnings for the French cooperative worker are split between profitsharing and return on membership shares, in equilibrium the member's ex ante earnings exactly equal the Illyrian firm's ex ante dividend.

Lemma: Cooperative earnings (Z) are comprised of profitsharing (E) and the net return on membership shares (r^*,S), with the net return equal to zero in equilibrium. Therefore, if cooperative earnings (Z) equal the Illyrian dividend in equilibrium, then cooperative profitsharing (E) equals the Illyrian dividend as well.

5.4 The Shutdown Condition

We set the opportunity cost, Φ, of remaining in business equal to zero in accordance with French law which specifies that upon closure, any residual left after refunding the face value of all shares may never be paid back to the members.

Since in equilibrium members and nonmembers will always earn the same net income, and the residual value of the firm does not accrue to members, the firm will exit from the industry if the expected discounted value of future earnings from remaining in business falls below the present discounted value of receiving the opportunity wage, w:

$$\sum_{t=\tau}^{\infty} \beta^t \int_{\alpha_1}^{\alpha_2} Z(x^*_t,n_t)\ P(x^*_t=s|x^*_\tau,n_\tau)ds < \sum_{t=\tau}^{\infty} \beta^t w_t \tag{5.12}$$

The Illyrian firm will exit when the expected discounted value of future cash flows per worker falls below the present discounted value of receiving the opportunity wage, w, *plus* a one-off payment comprising the worker's share of the shut down value:

$$\sum_{t=\tau}^{\infty} \beta^t \int_{\alpha_1}^{\alpha_2} D(x^*_t,n_t)\ P(x^*_t=s|x^*_\tau,n_\tau)ds < \sum_{t=\tau}^{\infty} \beta^t w_t + \frac{\Phi}{L_{\tau-1}} \tag{5.13}$$

From *Result 3,* we know that the French cooperative earnings, Z, and the Illyrian firm dividend, D, are equal. Then the only difference between equations (5.12) and (5.13) is the inclusion of the term $\Phi/L_{\tau-1}$ on the right hand side in (5.13). This additional term results in a higher exit threshold for the Illyrian firm, and therefore we should observe the French producer cooperative remaining in operation over ranges of the efficiency parameter where the Illyrian firm would exit.

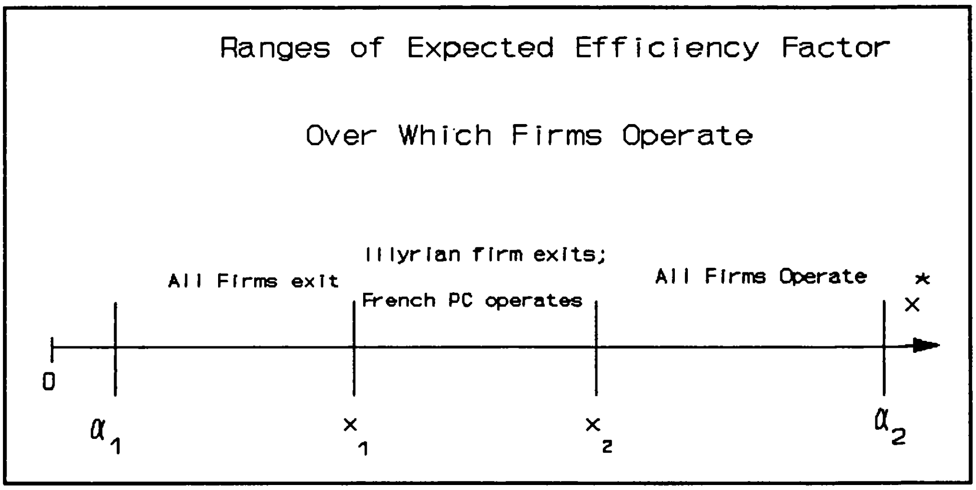

Figure 1

Result 4: The exit threshold for the French producer cooperative will lie <u>below</u> that of the Illyrian firm, and also that of the capitalist firm, since the latter two firms are able to recover the shutdown value of Φ while the French cooperative can not.

6. The Model Solution

6.1 Internal Financing

Under passive learning and internal financing the cooperative firm's objective function and constraints (equations (5.5) and (5.8)) become:

$$\underset{\{d \in \Delta\}}{Max}\ Z^*_t = \sum_{t=\tau}^{\infty} \beta^t \int_{\alpha_1}^{\alpha_2} \{ [(\frac{\gamma}{L_t} + \frac{1-\gamma}{\rho_t L_t})\, p_t x^*_t q_t - r_t S_t]\chi_t + (1-\chi_t) w_t \} \cdot P(x^*_t = s \mid x^*_\tau, n_\tau) ds \tag{6.1}$$

$$\textit{where} \quad d = \{[\chi_\tau, K_\tau, L_\tau], [\chi_{\tau+1}, K_{\tau+1}, L_{\tau+1}], \ldots\}$$

$$s.t. \quad r_t K_t = (1-\gamma) p_t x^*_t q_t$$

where:

p_t = output price
K_t = capital
L_t = labour
ρ_t = membership ratio
S_t = share price
γ = share of revenues distributed to all workers, constant
r_t = capital market lending and borrowing rate
w_t = capitalist wage
n_t = number of periods since firm was created
β = discount factor
χ_t = 1 if the firm operates in period t, zero otherwise

The firm will remain in operation if and only if the value of remaining in business exceeds the opportunity cost:

$$Z_\tau(x^*,n|\chi_\tau=1) \geq \sum_{t=\tau}^{\infty} \beta_t w_t \qquad (6.2)$$

It should be noted that the members are not concerned that in any resulting equilibrium, they may become nonmember workers. This is because in equilibrium, members and former members becoming nonmembers will expect to earn exactly the same income. It follows from the fact that in equilibrium $r^*_s = r$ by the Free Access Condition, so the member's return on shares exactly covers the cost of servicing his loan, i.e., the expected excess return on membership shares is zero. Furthermore, the shared expected earnings E^* is by definition equal for members and nonmembers. So by maximising his income as a member, the member is implicitly maximizing his income if he were to become a nonmember as well.

The worker must worry, however, that if he becomes a nonmember, and some workers are fired, that he may be one of those who are fired.[16] This possibility is partially precluded by the internal financing assumption that there are always some nonmembers and that members always vote to fire nonmembers before former members. To completely exclude this possibility, we assume further that there are always enough nonmembers in the current period to ensure the safety of the position of the former member. In future periods the expected value of the revision of x^* is always zero since all currently available information is incorporated into x^*. Thus the risk neutral worker does not anticipate a need for any future cutbacks and is not worried about losing his job.

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[16]Brewer and Browning (1982) show that in a profitable all member labour managed firm where members first vote whether to lay off workers, and then lay off these workers randomly, members may choose not to reduce membership at all even if this would raise earnings per head for remaining members.

To solve the problem of the French cooperative member, we rewrite (6.1) (conditional on no exit) in Lagrangian form:

$$\underset{\{\lambda_\tau, K_\tau, L_\tau\}}{Max}\ \mathcal{L} = \left(\frac{\gamma}{L}+\frac{1-\gamma}{\rho L}\right)px^*q \ - \ rS \ + \ \lambda(rK-(1-\gamma)px^*q) \tag{6.3}$$

The maximisation problem yields the following three first order conditions:

$$\frac{\partial\mathcal{L}}{\partial L} = \frac{\gamma}{L}\left(px^*q_L-\frac{px^*q}{L}\right)-\lambda(1-\gamma)px^*q_L = 0 \tag{6.4}$$

$$\frac{\partial\mathcal{L}}{\partial K} = \frac{\gamma}{L}px^*q_K + \lambda[r-(1-\gamma)px^*q_K] = 0 \tag{6.5}$$

$$\frac{\partial\mathcal{L}}{\partial\lambda} = rK - (1-\gamma)px^*q = 0 \tag{6.6}$$

In (6.4), the addition of a new worker raises the revenues to be shared out among all workers by the (expected) marginal revenue product of labour (MRP_L), px^*q_L. However, the increased revenues lead the expected return on membership shares to rise above the market rate of interest, leading the marginal nonmember to become a member. The return on the membership share of the new member becomes a new cost, so a fraction ($1-\gamma$) of the MRP_L of the last worker goes towards covering this cost. And of course, the new worker himself must be paid his profitsharing as well. So in (6.4) the firm sets employment so that the increase in profitsharing due to the last worker is exactly offset by the cost of the profitsharing that must be paid to him plus the cost of financing the return on new membership shares purchases induced by his addition to the workforce, weighted by λ, the shadow cost of capital.

Clearly this bears a close resemblance to the Illyrian firm employment condition (4.3) where the firm adds workers until the MRP_L of the last worker exactly equals the profit sharing that must be paid to him. However, in the Illyrian firm model there is no feedback effect of employment on membership or on capital.

In choosing the level of capital in (6.5) the firm knows that the addition of capital also raises the revenues to be shared among all workers. But each new unit of capital will raise costs by the amount r, while only raising internal financing by $(1-\gamma)px^*q_K < r$. So the firm adds capital until the marginal improvement to profitsharing due to the last units is exactly offset by the shortfall between the cost incurred for that unit (r) and the revenues generated by it for paying returns on shares, $(1-\gamma)px^*q_K$, weighted by λ, the shadow cost of capital.

In the Illyrian firm model, capital is externally financed so the MRP_K is not diluted to finance new membership shares; the firm sets the MRP_K exactly equal to the exogenous cost of capital, r, to maximise profitsharing.

Solving (6.4) and (6.5) for λ and equating, the equations reduce to:

$$q - Lq_L - Kq_K = 0 \tag{6.7}$$

This, of course, is Euler's Theorem, which holds that the firm will only produce along those areas of the production function where there are constant returns to scale. Thus while the mechanisms for arriving at the result differ between the two models, the Illyrian firm and the French cooperative both choose their operating scale based on the condition of constant returns to scale.

Result 5: Under internal financing, the equilibrium operating scale for the French producer cooperative satisfies the condition of constant returns to scale, which is identical to the case of the Illyrian firm.

The comparative statics analysis on changes in x^* yields the following system of equations:

$$\mathcal{L}_{LL}\frac{\partial L}{\partial x^*} + \mathcal{L}_{LK}\frac{\partial K}{\partial x^*} + \mathcal{L}_{L\lambda}\frac{\partial \lambda}{\partial x^*} = \mathcal{L}_{Lx^*} \tag{6.8}$$

$$\mathcal{L}_{KL}\frac{\partial L}{\partial x^*} + \mathcal{L}_{KK}\frac{\partial K}{\partial x^*} + \mathcal{L}_{K\lambda}\frac{\partial \lambda}{\partial x^*} = \mathcal{L}_{Kx^*} \tag{6.9}$$

$$\mathcal{L}_{\lambda L}\frac{\partial L}{\partial x^*} + \mathcal{L}_{\lambda K}\frac{\partial K}{\partial x^*} + \mathcal{L}_{\lambda\lambda}\frac{\partial \lambda}{\partial x^*} = \mathcal{L}_{\lambda x^*} \tag{6.10}$$

But, $\mathcal{L}_{Lx} = \mathcal{L}_{\lambda\lambda} = 0$, and $\mathcal{L}_{LL}$ and $\mathcal{L}_{KK}$ are both negative by the second order condition for maximum. $\mathcal{L}_{\lambda x^*}$ is given by:

$$\mathcal{L}_{\lambda x^*} = -(1-\gamma)pq < 0 \tag{6.11}$$

and $\mathcal{L}_{Kx^*}$ by:

$$\mathcal{L}_{Kx^*} = \frac{\gamma}{L}pq_K\frac{q}{Lq_L} > 0 \tag{6.12}$$

Using Cramer's Rule we can solve for the effect of a change in x^* on employment:

$$\frac{\partial L}{\partial x^*} = \frac{1}{|H|} - \frac{\gamma}{L}(1-\gamma)^2\, p^3x^2q^2\Big[\frac{Lq_{LK}+Kq_{KK}}{LK}\Big] \tag{6.13}$$

$$\geq 0 \quad \textit{if } (Lq_{KL}+Kq_{KK}) \geq 0$$

$$< 0 \quad \textit{otherwise}$$

where H is the 3x3 bordered Hessian matrix, the determinant of which is negative by the second order condition. The employment effect is indeterminate since we can not determine the sign the expression *(Lq_{LK} + Kq_{KK})*. The capital effect is also indeterminate:

$$\frac{\partial K}{\partial x^*} = \frac{1}{|H|}\Big\{-\frac{\gamma}{L}(1-\gamma)^2\, p^3x^2q^2\Big[\frac{Lq_{LL}+Kq_{LK}}{LK}\Big]\Big\} \tag{6.14}$$

$$\geq 0 \quad \textit{if } (Lq_{LL}+Kq_{KL}) \geq 0$$

$$< 0 \quad \textit{otherwise}$$

With both these effects indeterminate, the effect of an improvement in expected efficiency on efficiency-adjusted output is also indeterminate:

$$\frac{d}{dx^*}(x^*q) = q + q_K\frac{\partial K}{\partial x^*} + q_L\frac{\partial L}{\partial x^*} \tag{6.15}$$

$$= q + \frac{1}{|H|}\Big\{-\frac{\gamma}{L}(1-\gamma)^2p^3x^2q^2\Big[\frac{1}{KL}(qq_{KL}+q_{LL}q_KL+q_{KK}q_LK)\Big]\Big\}$$

$$>< 0$$

Result 6: Under internal financing and passive learning the firm's first order conditions are intuitively similar to the Illyrian firm case; and identically to the Illyrian firm, the French cooperative chooses to operate under constant returns to scale in accordance with Euler's Condition. The comparative statics of a change in x^* on both inputs and

output are indeterminate in both models.

6.2 External Financing

Under external financing we assume the firm borrows at the market rate r to finance its capital expenditures and invests its outstanding capitalization at rate r in the market. Constraint (5.7) is no longer binding, and since the firm is an all member firm the distinction between profitsharing and return on membership shares becomes irrelevant and all worker-members share the net revenues in equal proportions.

If the firm uses external financing, the French producer cooperative model collapses into the Illyrian firm model. Revenues to be shared are given by equation (5.2), so if the firm does not exit member income becomes:

$$Z(x^*,n) = \left(\frac{\gamma}{L}+\frac{1-\gamma}{M}\right)(px^*q-rK+rSM)-rS \tag{6.16}$$

But external financing is only used when M=L, so (6.16) reduces to:

$$\begin{aligned} Z(x^*,n) &= \left(\frac{\gamma}{L}+\frac{1-\gamma}{L}\right)(px^*q-rK+rSL)-rS \\ &= \frac{px^*q-rK}{L} \end{aligned} \tag{6.17}$$

which is *exactly* the Illyrian firm model.

Result 7: Under external financing, the objective function of the French producer cooperative is identical to that of the Illyrian firm.

The results are summarised in Table 1 below:

Table 1

	French PC Internal Financing	**French PC External Financing**	**Illyrian Firm**
Member Earnings	$Z^*=D^*$ (same)	$Z^*=D^*$ (same)	$D^*=Z^*$ (same)
Cost of K	$r^*_s=r$ (same)	r (same)	r (same)
Cost of L	$E^*=D^*$ (same)	$E^*=D^*$ (same)	$D^*=E^*$ (same)
Returns to scale chosen	constant	constant	constant
$\partial L/\partial x^*$, $\partial K/\partial x^*$, dq/dx^* (x^*q)	indeterminate	indeterminate	indeterminate
Exit threshold	lower than Illyrian	lower than Illyrian	higher than French PC
Degenerates?	no	no	yes[17]

[17]Degeneration occurs in the version where hired workers receive fixed wage.

7. Conclusion

In this chapter we have shown that the efficiency-size relationship which is crucial to the Jovanovic and Ericson and Pakes growth and survival predictions remains indeterminate even when the institutional detail of a specific cooperative sector is considered. This suggests that either cooperative firms do in fact behave empirically substantially differently from conventional capitalist firms, or the theoretical structure of the models are imposing excessive emphasis on the internal organisation of the firm. Both these possibilities are addressed in later chapters.

The French producer cooperative model does, however, provide explanations for two stylised facts in the labour managed firm literature: First, the Illyrian firm model overestimates the failure threshold of these firms since it does not account for the nonrecoverability of the firm's accumulated rents. This is the underlying explanation for the lower anecdotal and estimated hazard rates for cooperatives vis à vis capitalist firms; i.e., it is the institutional rules which *induce* lower hazard rates for cooperatives relative to conventional firms rather than simply the willingness of workers to forgo income in exchange for participatory privileges.

The second stylized fact explained by the French producer cooperative model is the lack of any observed degeneration of French cooperatives into capitalist firms. We find that the free access condition is the main reason why very few conversions of cooperative firms to capitalist firms are in fact observed in France and the degeneration hypothesis is empirically rejected. This suggests that attempts to introduce nonmember workers into the simple Illyrian firm model without imposing institutional rules and constraints are misleading, in that they lead to degeneration predictions which under free access to membership are theoretically impossible.

Otherwise, we find that the Illyrian model closely approximates the predictions of the French producer cooperative model. Both firms locate at the point(s) of constant returns to scale on the production function. Worker earnings under both models are identical. Under internal financing, the input and output responses of both models to an improvement in expected efficiency are indeterminate, and under external financing, the two models are exactly identical.

These findings provide a guarded defense for using the Illyrian firm model for theoretical work in labour management, provided empirical testing of the theoretical predictions are not done without regard to the institutional rules that govern the behaviour of the firms under analysis.

APPENDIX

Hazard Estimates: UK capitalist firms (CFs) and Worker Owned Firms (WOFs)

A. Ben-Ner, Empirical observations on worker-owned and capitalist firms

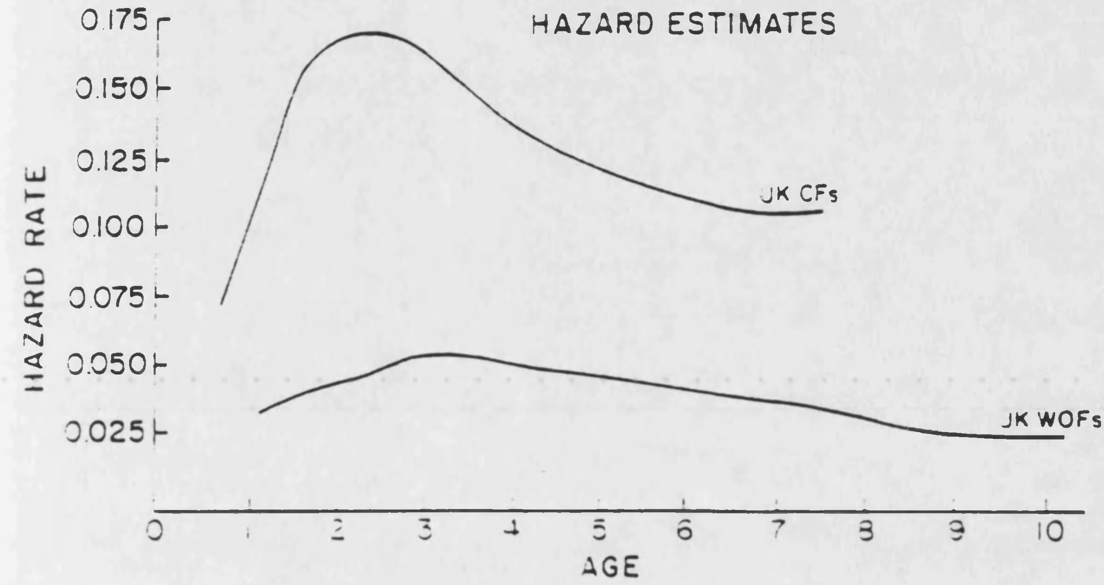

Fig. 2

Taken from: Ben Ner, Avner, 1988, "Comparative empirical observations on worker owned and capitalist firms," International Journal of Industrial Organisation, vol. 6, page 19.

CHAPTER IV: An Empirical Study of the Pattern of French Producer Cooperative Survival and Growth*

* The author would like to thank Saul Estrin, John Sutton, Hugh Wills, Mark Roberts and Paul Geroski for their helpful comments, and CG-SCOP for providing the data. The views in this chapter do not necessarily reflect the views of CG-SCOP. Any remaining errors are the author's sole responsibility.

1. Introduction

The recent research on the dynamics of firm growth and failure has applied evolutionary learning models to generate predictions on the survival and growth of firms relative to their size and age (Jovanovic, 1982, Ericson and Pakes, 1989). All the theoretical and empirical work to date has focused exclusively on the case of the profit maximising firm. Chapters II and III for the first time applied the evolutionary learning framework to the special case of the labour managed firm, to test the robustness of past results to alternative ownership forms. It was found that the sharp predictions derived for profit maximisation become indeterminate under labour management due to the sign ambiguity of the efficiency-size relationship. In Chapter III we were able to reject the possibility that the indeterminacy of the theoretical results under labour management stem from the excessive simplicity of the Illyrian firm model used in Chapter II.

This chapter presents estimates of the actual labour managed firm survival and growth relationships using a dataset of French producer cooperatives. In doing so we seek to determine whether these firms behave substantially differently from what has been found for conventional firms (Dunne, Roberts, Samuelson, 1989, Evans 1987a, 1987b, Hall 1987) or if indeed the role of the internal organisation of the firm is being overstated by the theoretical models used in Chapters II and III. We find that in spite of the indeterminate theoretical predictions, on the whole French producer cooperatives survive and grow in much the same way as American capitalist firms. We also explore the impact of business cycle fluctuations on both the survival and the growth rates of firms across size and age classes.

Results indicate that French cooperatives' survival rates are positively related to age after an initial period. This is consistent with past studies for conventional firms and with the predictions derived from theoretical models of learning and evolution applied to the case of the labour managed firm. The results show a positive relationship between survival and size, which is identical to past findings for capitalist firms, and inconsistent with a negative efficiency-size relationship.[1]

The relationship between firm growth and size is found to be negative. This is consistent with past findings for conventional firms but in conflict with Gibrat's Law, which holds that firm size and growth should be unrelated. If efficiency were negatively related to size, we would expect growth rates for surviving firms would on average be negative. Yet estimated growth rates here are consistently positive over almost all sizes. Firm growth is found to decline with age, similar to past findings for conventional firms, and consistent with theoretical predictions of learning models of firm growth.

Downswings in the business cycle are found to affect the survival of young firms far more adversely than older firms, and very small and very large firms far more than medium-sized firms. Additionally, macroeconomic slowdowns reduce growth rates for young and small firms by far more than old and large firms. Clearly these findings have

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[1]See Chapter II.

important implications for targeting public policy attempts to mitigate job losses in recessionary periods. In addition, they highlight the inadequacy of panel data estimation of these models with year dummies on the intercept alone, as has been the norm for most previous empirical work in this area.

Following the work of Dunne, Roberts, and Samuelson (1989), Evans (1987a, 1987b), and Hall (1987), this chapter examines firm growth and survival jointly, in order to take account of sample selection bias induced by firm exit. However, this chapter differs from previous papers in that it also endogenises the firm's decision on whether to report its accounts to the relevant authorities, thereby addressing potential sample selection bias from this source. Sample selection bias is found to be unimportant, since the distortion it creates is irrelevant to growth. Finally, this chapter uses a new approach to correct estimates for heteroscedasticity, a frequent problem in cross-sectional estimations involving size which, if not addressed, may lead to an overstating of the significance attached to coefficient estimates.

The remainder of the chapter is divided into four further sections. Section 2 provides a description of the database used, while Section 3 outlines the theoretical models which this chapter sets out to test. Section 4 presents the empirical model and the results of the chapter. Section 5 concludes.

2. The Data

The data used in this study is a new panel dataset of French producer cooperatives, provided by the Confédération Générale des Sociétés Coopératives Ouvrière de

Production (CG-SCOP). The panel spans the years 1979-1989, and includes a total of 15,127 observations on 2,692 firms, with entry and exit occurring during all of these years. There are 781 firms in 1979, with the number rising to a peak of 1,661 in 1986, and falling steadily afterwards to 1,448 in 1989.

We examine the data in cross-sections, because the panel is neither rectangular nor continuous. The nonrectangularity arises from entry and exit of firms, while the noncontinuity arises from the incidence of missing values. Examining the data in cross-sections allows us to examine changes in the intercept and slope coefficients across the years, in order to determine the impact of business cycle fluctuations on the estimated relationships.

While estimations were performed for all the years in the sample for all the equations, the pattern of results were quite similar over the years. For this reason we report results for all the years in a separate appendix, and only include a single year's results in the main text of the chapter. The year 1985 was chosen as the main year of analysis, since

Figure 1

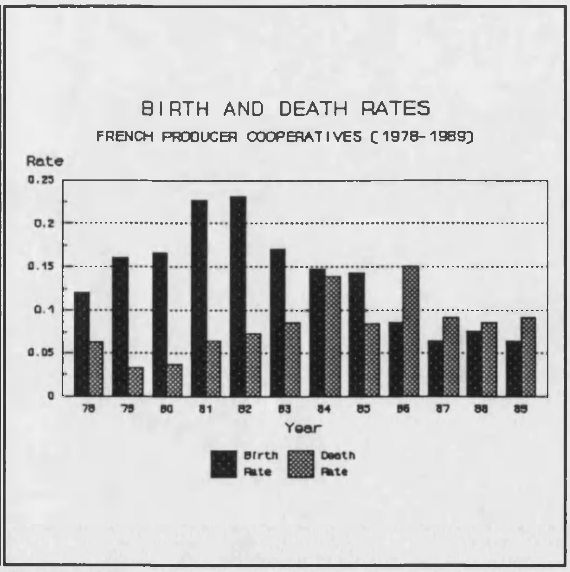

Figure 2

it is approximately in the centre of the sample period and provides one of the largest number of observations to work with. The results for 1985 are fairly typical of the other years in the sample, as can be seen from the appendices to this chapter.

The amount of entry and exit in the dataset is considerable, as can be seen in Figures 1 and 2, and Table 1. Entry peaks in 1982, and follows a declining trend thereafter. Exit rates peak in 1986, which is also the first year in our sample that the exit rate overtakes the entry rate, and the number of firms in the cooperative sector reaches its maximum.

Table I

Year	Number of Firms*	Births	Birth Rate	Deaths	Death Rate
1978	656	85	12.1%	44	6.3%
1979	781	125	16.0%	26	3.3%
1980	905	150	16.6%	33	3.6%
1981	1128	256	22.7%	72	6.4%
1982	1373	317	23.1%	100	7.3%
1983	1536	263	17.1%	131	8.5%
1984	1648	243	14.7%	228	13.8%
1985	1658	238	14.4%	140	8.4%
1986	1661	143	8.6%	250	15.1%
1987	1507	96	6.4%	137	9.1%
1988	1482	112	7.6%	127	8.6%
1989	1448	93	6.4%	133	9.2%

*For example, 781 firms existed at some point during 1979 of which 125 were created in 1979 and 26 did not survive to 1980.

The variables in the dataset are of two types: first, the descriptive variables (industry, region, legal form, creation mode, year of creation and cessation[2]) which are constant over the length of the panel; and second, the accounting variables (labour force,

[2]Although we have no data on mode of closure, we were advised by CG-SCOP that all but two cases in the entire dataset were economic deaths, and those two cases were omitted.

membership, and sales), which vary by year.[3] There are no missing values in the descriptive variables, but there are numerous missing values in all the accounting variables.

2.1 Descriptive Variables

Industry: The firms in the dataset are categorized into 15 broad industrial categories, equivalent in most cases to 2-digit SIC categories, although some sectors with too few observations are grouped together. Traditionally, the largest industrial sector for cooperatives has been construction and construction-related activities. In the more recent

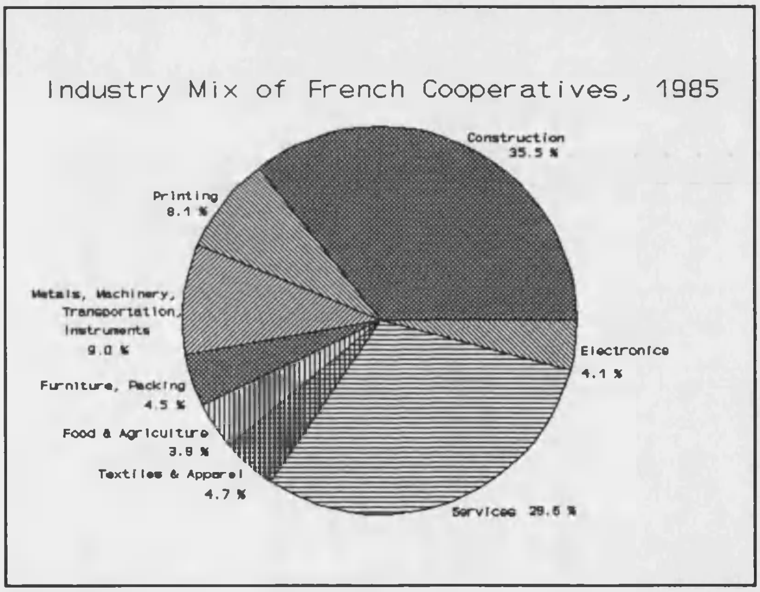

Figure 3

years a new large sector has emerged in services. Cooperatives also exist in substantial numbers in printing, electrical and nonelectrical machinery, metals, transportation, and instruments. Smaller cooperative sectors are leather products, furniture and wood products, packaging, food and agricultural products, textiles, apparel, and miscellaneous

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[3]There is also some data on profits, but these are so sparsely reported they are not empirically useful.

manufacturing.

Creation mode: Most French cooperatives are created de novo, i.e., from scratch; in any given year, the proportion of de novo firms in the population is between two thirds and three-fourths. Of the remaining firms about 10 percent are "mutations", created from firms with other ownership structures, and 25 percent are "reanimations", created from defunct cooperatives. In the first half of the panel, the rate of entry by reanimations is very high until about 1983, after which it declines. Some theories (Ben Ner, 1988a) suggest that during recessions increasing numbers of capitalist firms should convert to the cooperative form to avoid complete shutdown: As recession drives more and more capitalist firms to the brink of closure, workers in these firms are faced with the choice of entering the search for a new job in a worsening job market, or reorganising the firm as a cooperative and using the efficiency gain from the cooperative organisational form to help keep the firm afloat. Yet we see no apparent cyclical pattern in the share of mutation-entrants, which remains fairly constant in our sample in spite of the fact that the period was one of economic slowdown. It seems instead that prospective cooperative formers found it easier to revive defunct cooperatives or create new cooperatives than to convert distressed capitalist firms.

Region: The largest proportion of these firms are located in the Parisian area; in any given year the proportion of firms in Paris lies between one-fourth and one-third, although most recent entry has occurred outside Paris. The region definitions used in the estimations correspond to the eleven regional divisions of CG-SCOP.

Legal form: All firms must adopt one of two legal forms at inception. They must choose between société anonyme (S.A.) or société à responsabilitée limitée (S.A.R.L.) The main difference between the two types is in the size limits on the firm: S.A.R.L. firms must always have between 4 and 50 members; their minimum level of capitalization is 25,000 francs; and most decisions are made by a manager elected by the membership. S.A. firms must always have over 7 members (with no upper limit on membership); capitalization must always exceed 125,000 francs; and most decisions are made by an administrative council elected by the members. Slightly less than half of all 1985 firms were of legal form S.A.

Table II

T-Test Results on Test of Equality of SA and SARL Means
Testing H_0: Means are Equal in 1985

	SALES	EMPLOYMENT	MEMBERSHIP
Age 0-5			
Manufacturing	-9.2333	-14.2695	-14.4578
Nonmanufacturing	-5.0327	7.3930	-10.4559
Age 5-9			
Manufacturing	-4.2139	-7.1831	-6.4823
Nonmanufacturing	-4.0573	-3.3808	-5.9838
Age 10-19			
Manufacturing	-1.3804	-1.6889	-1.4998
Nonmanufacturing	-2.2422	-2.9365	-3.5587
Age 20-34			
Manufacturing	-2.4555	-3.9351	-2.1895
Nonmanufacturing	-1.5742	-1.8919	-1.3714
Age 35-50			
Manufacturing	-1.5025	-1.3304	-1.2116
Nonmanufacturing	N/C	-1.8839	-2.3470
Age 50+			
Manufacturing	-1.2410	-1.9446	-1.5867
Nonmanufacturing	N/C	N/C	N/C

N/C: Not computed; all firms were of same class.

There are at least two important empirical points to keep in mind while using the S.A./S.A.R.L. distinction as a proxy for size. First, all large firms must be of type S.A.; however, not all small firms are of type S.A.R.L. This is because the smallest S.A. firms are smaller than some of the larger S.A.R.L. firms. In fact, a simple t-test on the hypothesis that mean size of the pooled data is equal between the S.A. and S.A.R.L. classes can not be rejected for any of the size variables (employment, membership and sales) in any of the years. Examining the data by age, Table II shows t-test results comparing means between S.A. and S.A.R.L. classes in 1985 by age grouping and for manufacturing and nonmanufacturing. Results indicated that for firms under 10 years old we accept the null hypothesis that the means are the same, but as the firms become older, there are increasingly more cases where we reject the null hypothesis.

It is important to note that firms decide at the time of formation which legal form to take, and firms choosing type S.A. must expect to *eventually* grow large, even if they are initially small. In terms of Table II, this can be interpreted in a number of ways. If there is asymmetric information between the firm and its creditors, the creditors may require time to accept that the firm has a good idea, whereas the firm itself believes its idea is good from the start and indicates its expectation to grow large by choosing the S.A. legal form. Thus the firm will initially be small due to capital constraints, but as time passes, it either fails or it proves itself to its creditors and is able to grow large. A second (complementary) interpretation of the legal form is as a proxy for sunk costs. A firm believing it is more efficient will be willing to incur larger sunk costs, perhaps to establish a larger capacity which it may not fully exploit initially until it has established a reputation for its product or business. As time progresses, it will expand production to increase its capacity utilisation. Unfortunately we have no data on capital or capacity utilisation for these firms to test this hypothesis, and it remains simply a plausible interpretation. However, in both these cases we would expect that as a cohort of firms ages, the difference between the means of surviving S.A. and S.A.R.L. firms should increase, as is suggested by Table II.

Age: For every firm in the sample we have a creation date, and if applicable, a closure date, so there are no missing values for age. The mean firm age in 1985 was about 11 years, with the oldest firm 120 years old and 108 firms (6.5% of total) over 50 years old. The mere existence of so many old firms in the dataset raises doubts about the degeneration hypothesis, (Ben Ner, 1984, Miyazaki, 1984) which posits that over time successful cooperatives will necessarily degenerate into capitalist firms. In fact, the rules governing French cooperatives are such as to make degeneration extremely unlikely.[4]

Because of the high rate of entry and the relatively high mortality rate of these firms, the resulting age distribution of the data is very skewed. The population is dominated by young firms, as can be seen from Figure 4. The firms are grouped according to whether they are under or over 20 years old. Firms under 20 are measured on the left hand axis, and the large number of young firms reflects the wave of entry that began in the late 70's. Looking at the firms over 20, measured on the right hand axis, the distribution of firms continues to follow a declining trend with age, although less consistently.

[4]See Chapter III and Appendix on Labour Management.

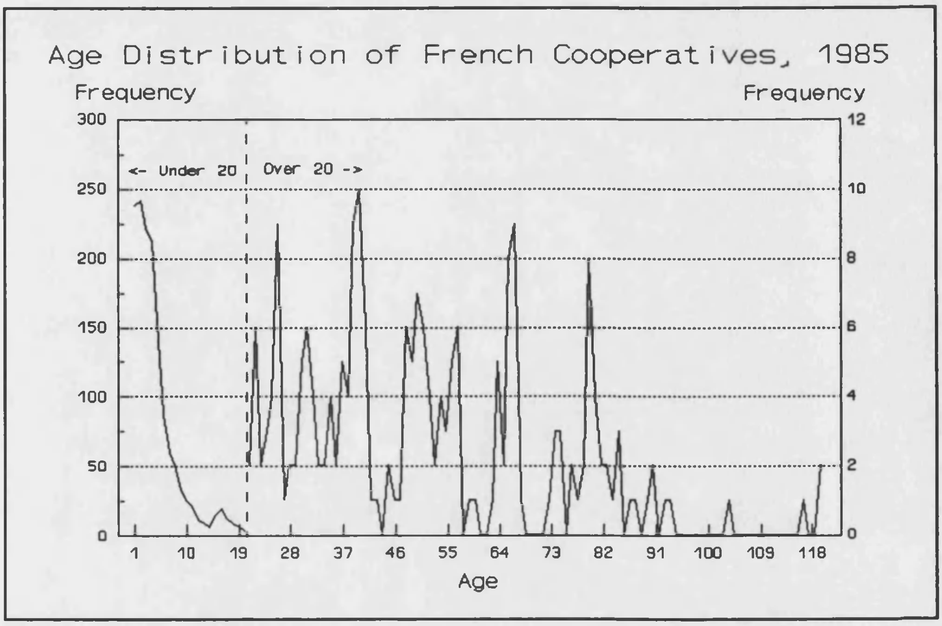

Figure 4

2.2 Accounting Variables

Labour Force: Reported employment in the French cooperative sector was at 37,000 in 1985, with the mean firm employing about 25 workers. Employment is measured at year-end, and is the most consistently reported of the accounting variables.

Membership: In the context of French producer cooperatives, a member is a worker who owns an equity stake in the firm. In addition to the fixed wage and variable profitsharing paid to all workers, members also receive a dividend on their membership shares. Out of the total 1985 reported employment of 37 thousand, almost 22 thousand workers were members. Like employment, membership is measured at year-end. However, the level of membership exhibits much less variability over the course of the panel than total employment. Among firms reporting both employment and membership, the membership ratio averaged 74 percent in 1985.

Sales: Sales are measured in thousands of 1980 French francs, and are deflated using French industry level producer price indexes.[5] The incidence of missing values in sales is substantially higher than for employment or membership. For those firms reporting sales in 1985, the mean value was about 6.5 million (1980) FF (about 1.5 million 1980 US$) with a very large standard deviation of 20 million FF.

2.3 Missing Values

The incidence of the missing values appears to be nonrandom, with at least two apparent sources: first, it appears that in the initial few years following formation, firms are much less likely to report data than later; second, firms are much less likely to report in the years immediately prior to failure. The pattern of missing values suggests that there are certain substantial costs associated with either gathering and/or reporting data to CG-SCOP. Among the accounting variables, the incidence of missing values is worst for sales followed by membership and labour force.[6] Any estimations using data excluding these missing values risks introducing biases which must be modelled specifically.

Reporting in some years is clearly worse than others, since failing firms do not report, and the failure rate jumped in 1984 and again in 1986. Even excluding failing firms, in the last four years of the sample the incidence of missing values for employment and membership is altogether higher than before. In the same years, the differential in the

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[5]In the retail sectors, the relevant consumer price index was used.

[6]This pattern suggests that the cost of reporting is principally in the gathering rather than the reporting of the data, since presumably taking a head count of the number of workers at year end is much simpler than calculating overall sales. It may also reflect tax avoidance reasons.

Table III

Year	% of Firms Failing	% of Values Missing in Survivors: Labour Force	Member-Ship	Sales	Sales Growth
1979	3.3	3.5	11.4	15.7	36.7
1980	3.6	3.0	13.4	20.2	33.5
1981	6.4	2.8	10.0	19.5	38.0
1982	7.3	3.0	9.7	22.3	38.8
1983	8.5	3.2	9.3	23.2	37.7
1984	13.8	3.7	14.5	47.6	51.6
1985	8.4	3.2	14.6	30.1	58.5
1986	15.1	19.9	20.1	23.3	32.9
1987	9.0	16.5	16.6	20.2	30.0
1988	8.6	15.4	15.4	19.4	25.6
1989	9.2	16.1	16.1	18.9	24.3

reporting rates for employment and membership relative to sales declined substantially, with most firms apparently reporting everything or nothing at all.

3. The Theoretical Models

Theoretical work by Jovanovic (1982) and Ericson and Pakes (1989) has modelled the process of firm growth and survival as part of an overall learning process whereby in each period the firm evaluates the new information it has on its long-term viability and decides whether or not to remain in business. If it remains, it chooses its operating scale. The main difference between the two models is that the Jovanovic "passive learning" model has the firm spending its life accumulating noisy information on its level of efficiency, *which is stationary*. The Ericson and Pakes "active exploration" model allows the firm to invest in order to improve its efficiency, but the outcome of these investments is stochastically driven. The level of efficiency for an active exploration firm is *variable,* and changes in response to the firm's own investments, its rival's investments, and shifts in market demand.

Both these models belong to a class of models which establish a *positive* linkage between firm efficiency and size for conventional profit maximising firms. This yields predictions on the relationship between the firm's current beliefs about its efficiency (proxied by size), and the likely sign and magnitude of revisions in those beliefs (proxied by the firm's growth rate). Because over time, less efficient firms of a cohort will tend to exit, the mean efficiency of surviving firms will rise. This leads to further predictions between survival and firm size and age.

Chapters II and III examine the impact of applying the passive learning model of Jovanovic and the active exploration model of Ericson and Pakes to the special case of the labour managed firm. Chapter II examines these models in the context of the Ward-Domar-Vanek "Illyrian" labour-managed firm, and finds the previously positive efficiency-size relationship for conventional firms becomes indeterminate under labour management.

Chapter III builds on the work of the second chapter by modelling the special case of the French producer cooperative, while building in the actual institutional rules and constraints under which it operates. In particular, it divides the labour force into member and nonmember workers, and models the remuneration of these workers explicitly, taking account of rules enabling nonmembers to convert to membership status and rules affecting the financing of the firm's capital input. The theoretical relationship between efficiency and size is indeterminate, and identical to the Illyrian firm model. As a result, all the empirical predictions of the French producer cooperative model regarding growth and survival are identical to the Illyrian labour managed firm.

Survival-Age: The predictions of the theoretical models in terms of the probability of firm survival vis à vis firm *age* are unaffected when the objective function of the labour managed firm is imposed. Due to the nature of the learning process all types of firm are more likely to survive as they age. In a special case of the learning models where firms enter with above average expectations on their efficiencies, the theory predicts survival likelihoods to initially decline with age before rising.

Survival-Size: The survival-*size* relationship for capitalist firms is predicted to be positive, since more efficient firms will be simulataneously larger and more likely to survive. For the French cooperative the relationship is indeterminate, since the theoretical learning models are unable to provide an unambiguous signing of the efficiency-size relationship.

Growth-Age: The growth rate of surviving capitalist firms is expected to decrease with age until the firm becomes very old, at which time the growth rate becomes independent of age. Growth rates are expected to be positive on average, since surviving firms are adjusting their efficiency and therefore their sizes upwards. For the French producer cooperative the theory is once again unable to provide any prediction on the growth-age relationship due to the indeterminacy of the efficiency-size relationship.

Growth-Size: The predicted relationship between growth and size for a given age group is negative for the capitalist firm and growth rates are expected to be positive on average. This is due to the fact that the upper bound on efficiency induces an upper bound on firm size. In the case of the labour managed firm, however, the theoretical models once again fail to provide any precise predictions for growth-size relationship or on the average sign of the growth rate.

Table IV

Predicted Relationships:	Profit Maximising Firm	French Producer Coop
Efficiency - Size	+	?
Efficiency - Age	+	+
Growth - Size*	-	?
Growth - Age	-	?
Survival - Size	+	?
Survival - Age	+	+
Average Sign of Growth Rate	+	?

4. The Empirical Model and Results

The empirical work to date has focused on two key issues which will also be considered here. The first is the issue of bias caused by sample selection in measuring firm survival and growth, since size is not always reported and we are only able to measure growth for surviving firms. In the case of survival, we will examine the differences in estimating survival probabilities using first the SA/SARL distinction as a proxy for size, and second using employment in conjunction with a sample selection equation measuring the relationship between not reporting and survival. For the growth estimation, we must determine whether firms who exit or do not report are on average faster or slower growing than those left behind.

The second issue is that of heteroscedasticity in the estimation of both the survival and the growth equations. Cross-sectional estimations involving size variables are particularly prone to heteroscedasticity problems, which tend to result in very low estimated standard errors and an exaggeration of the significance of the estimated coefficients. The equations in this chapter are estimated and results presented with corrections for heteroscedasticity.

4.1 Survival

We estimate firm survival using a probit model, where the underlying variable is a Jovanovic-type of firm efficiency variable, labelled x, which is unobserved. Although efficiency can not be observed, the theoretical models posit relationships between efficiency and size (See Table IV.) Furthermore, because less efficient firms tend to exit, the efficiency of surviving firms is predicted to be increasing in age. Efficiency may vary across industries due to differentials in technology, and across regions due to differentials in cost and infrastructure. Thus we estimate efficiency as a log-quadratic function of firm size and age, and descriptive variables such as creation type, industry and region, all contained in **z**. Efficiency is expected to be increasing in age, due to the exit of less efficient firms in the cohort. The relationship between efficiency and size is more ambiguous; the theory suggests it depends on the ownership structure of the firm as can be seen from Table IV.

The firm survives ($sur_i = 1$) if its efficiency variable, x_i, lies above the exit threshold, x_0:

$$\begin{aligned} x_i &= \beta' z_i + \epsilon_i \\ sur_i &= 1 \quad \text{if } x_i - x_0 > 0 \\ sur_i &= 0 \quad \text{if } x_i - x_0 \leq 0 \\ \epsilon_i &\sim N(0,1) \end{aligned} \tag{4.1}$$

where x_0 may be industry and/or region-specific.

To estimate equation (4.1) it was necessary to pick a proxy for size. The legal form distinction has the advantage of being available for all observations in the dataset, so it does not induce any sample selection bias; it has the disadvantage that it is a binary measure and it is not a clear cut proxy for size. Labour force is the best reported of the accounting variables, and has the advantage of being a clear and continuous size measure. However, it has the disadvantage that using it entails losing a substantial portion of the population in a nonrandom way. In particular, the lag of the labour force must be used since none of the failing firms have contemporaneous labour force data. Using the lag removes all one year old firms from the sample, plus older firms which did not report employment in the previous year, which in 1985 altogether eliminates about 12 percent of the population. In 1980, and after 1986 survival equations can not be estimated using employment for size since almost all of the failing firms are selected out of the sample.

Because both size options suffer from different drawbacks, equation (4.1) was estimated twice for all the cross-sections in the sample period, first using the legal form as a proxy for size, then using employment in conjunction with a sample selection equation.[7] Results for 1985 are given in Tables V (legal form) and VI (employment) while results for other years are listed in Appendices 1 (legal form) and 3 (employment).

Beginning with the legal form estimation in Table V, the likelihood of survival is found to have a convex relationship with firm age, with the minimum occurring at about age four.[8] The relation becomes concave after about age ten. The inclusion of the SA dummies and the heteroscedasticity correction in the middle column of Table V are found to be significant, with the predicted values depicted in Figure 5.[9] SA firms are found

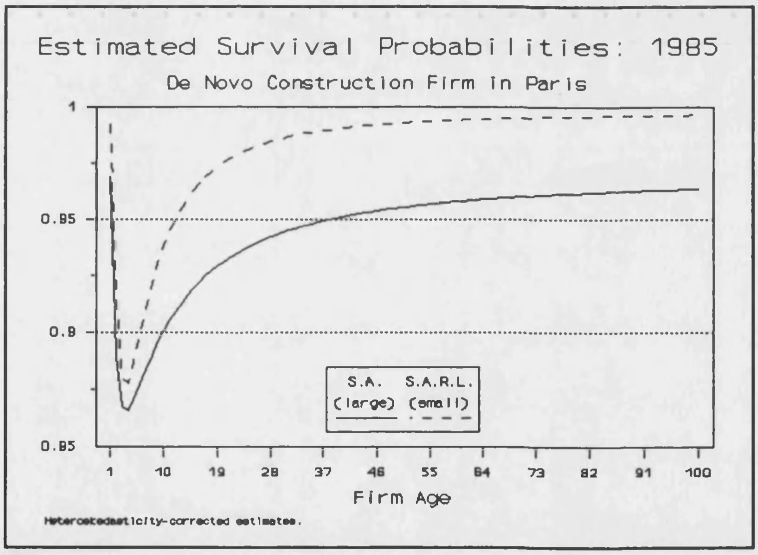

Figure 5

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[7]All estimations in this paper were done in LIMDEP/386 Version 6.0.

[8]Ben Ner (1988) estimates hazard functions for UK worker-owned and conventional firms and finds they both peak at age three. His results are shown in the appendix to Chapter III.

[9]De Novo construction firm in Paris represents the intercept in all estimated equations.

Table V

PROBIT MODEL OF FIRM SURVIVAL: SUR=1 if Survives; 0 if Fails
Coefficient, Standard Error, t-statistic

	Basic Probit	Heteroscedasticity-Corrected w/ SA dummies	Heteroscedasticity-Corrected w/o SA dummies
Constant	2.2677	2.6438	2.3216
	0.2132	0.3089	0.2073
	10.638	8.560	11.200
SA	-0.7562	-0.7785	
	0.3222	0.4156	
	2.347	1.873	
Log(Age)	-0.1460	-0.1913	-0.1138
	0.0317	0.5136	0.0291
	4.605	3.724	3.910
Log(Age)*SA	0.1073	0.1128	
	0.0393	0.0623	
	2.729	1.809	
$(\text{Log(Age)})^2$	0.0048	0.0103	0.0057
	0.0012	0.0032	0.0021
	4.077	3.219	2.657
$(\text{Log(Age)})^2$* SA	-0.0037	-0.0046	
	0.0013	0.0024	
	2.878	1.935	
Heteroscedasticity Correction			
Log(Age)		0.0381	0.0335
		0.0127	0.0105
		3.006	3.197
Log-L	-452.127	-448.471	-452.373
Log-L (0)	-479.957	-479.957	-479.957
Model Chi^2	55.66*	62.97*	55.17*
% Correct	91.6%	91.6%	91.6%

Creation, industry, and region dummies omitted from table.

Log-likelihood ratio tests:	Chi^2	D.o.F.
1) Inclusion of heteroscedasticity correction	7.312*	1
2) Inclusion of SA dummies	7.805**	3

* Significant at 1 percent. ** Significant at 5 percent.

to be less likely to survive than SARL firms, particularly beyond about age four. This finding holds for four of the ten years estimated (see Appendix 1.)

Comparing this to the actual mean rates of survival across legal form for 1985 in Figure 6, the pattern is similar, but not quite as sharp. Except for the middle period from ages 10-34, firms of type S.A. have failed more often than S.A.R.L. firms, although Figure 6 does not control for industry and region in order to maintain enough observations.

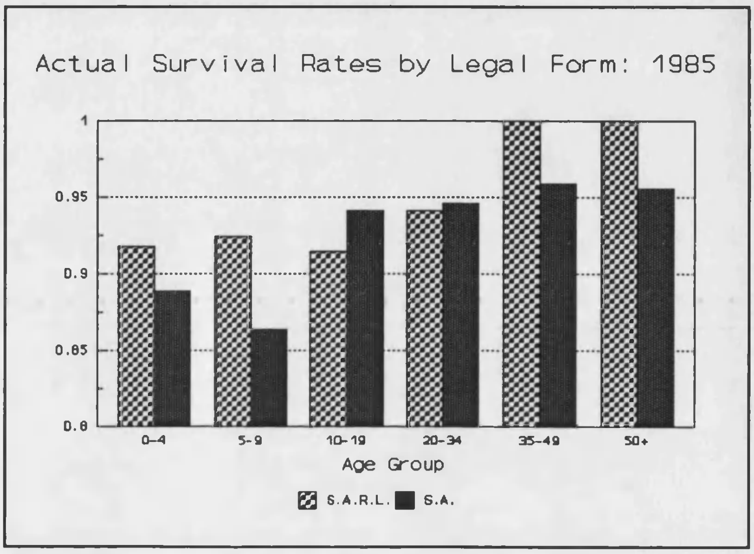

Figure 6

If the legal form S.A. is truly proxying for larger sizes, then these results suggest a weak inverse relation between size and survival, at least for very young and very old firms. However, we know the SA class also includes a number of small firms who at birth expected to eventually become large. These smaller SA firms may discover after an initial period that their high expectations were unjustified, and close down. If so, this would create the false impression that large (as proxied by SA) firms are more vulnerable to failure. The only way to determine which explanation is correct is to compare the results with the estimation using employment for size.

Before this could be done, it was necessary to test whether bias was being introduced into the equation by the nonreporting of lagged employment by some firms. Specifically, we wanted to test whether those firms which failed to report employment the year before were as a group more or less likely to survive this year than those remaining in the sample. The likelihood of sample inclusion was estimated for the entire population as a probit model with reporting a function of firm age, legal form, creation form, and industry. Firm age was included to capture nonreporting by younger firms and firms about to fail. Legal form was included since CG-SCOP may prefer to devote its limited resources to collection of data for the S.A. firms which it perceives as larger and economically more important. Creation form and industry were included to capture group effects. Results from the selection equation for all years are reported in Appendix 2 at the end of this chapter.

The likelihood of sample inclusion is found to be increasing in age, but at a decreasing rate. This in part reflects the fact that there is a considerable amount of missing data for firms in their first few years. Sample inclusion likelihoods are found to be lower for young SA firms, but higher for old SA firms. This may be due to the overseeing organisation having limited resources which it prefers to target at data collection from the more established SA firms. Firms created as mutations from capitalist firms or reanimations of defunct cooperatives are also more likely to report than firms created de novo. This may be due to the former two groups receiving more startup aid from CG-SCOP, and therefore feeling more obliged to provide data. The equation fit is very good with 96 percent of observations correctly predicted in 1985 and a model chi-square of 892 with 7 degrees freedom.

Table VI

PROBIT MODEL OF FIRM SURVIVAL: Year=1985, N=1358
Dependent variable SUR=1 if survives, 0 otherwise
Coefficient, Standard Error, t-statistic

	Basic Model	Sample Selection Model	Hetero-scedasticity Correction
Constant	1.0622 0.1535 6.919	0.9565 0.2998 3.191	1.0359 0.1782 5.812
Log $(Employ_{t-1})$	0.1590 0.0566 2.811	0.1601 0.0567 2.824	0.2101 0.1008 2.084
$(Log\ (Employ_{t-1}))^2$	N/S	N/S	N/S
$Log(Age_{t-1})$	-0.2816 0.1351 2.084	-0.1896 0.2612 0.726	-0.2527 0.1907 1.325
$(Log(Age_{t-1}))^2$ *	0.0850 0.0331 2.565	0.0663 0.0562 1.179	0.1459 0.1700 0.858
Lambda		0.2636 0.6446 0.409	
Heteroscedasticity Correction			
$Log(Age_{t-1})$			0.1528 0.2468 0.619
Log-L (L)	-391.5	-391.4	-389.9
Log-L zero-slopes (L_0)	-403.3	-403.3	-403.3
Model Chi^2	24.69*	23.86*	26.97*
% Correct	91.3%	91.2%	91.2%

Creation, industry and region dummies omitted from table.

Log-likelihood ratio tests:	Chi-squared	D.o.F.
1) Inclusion of sample selection correction:	0.200	1
2) Inclusion of heteroscedasticity correction:	3.200	1

*Significant at 1 percent. **Significant at 5 percent.

Equation (4.1) was reestimated using employment for size and an inverse Mills ratio, denoted lambda, to measure sample selection bias. The results for this estimation are listed in Table VI. In 1985, sample selection bias was found to be insignificant, as evidenced by the low t-statistic on lambda in column 2 of Table VI, and by the chi-square test on the inclusion of lambda, which is insignificant. In fact, the only year in which sample selection bias was found to be significant was 1984 (See Appendix 3), when a number of very large firms failed.

Next it was necessary to check for heteroscedasticity. Wherever Lagrange multiplier tests detected heteroscedasticity this was purged by modelling the disturbances as:

$$Var[\epsilon_i] = e^{\gamma' y_i} \tag{4.2}$$

where the y vector used here is simply the log of firm age.[10] This follows from the theoretical notion that firms learn as they age, so the amount of noise evident in observations on younger firms will be greater. The predicted probabilities then become:

$$Prob(sur_i = 1) = \Phi\left(\frac{\beta' z_i}{e^{\gamma' y_i}}\right) \tag{4.3}$$

In 1985, the heteroscedasticity correction is not significant, but in three of the six years estimated it is, with the residuals showing a strong age trend. Depending on the year, the estimated coefficient is of the order of .3 to .5, suggesting an increasing, slightly concave relation of the variance with age. At first glance this is somewhat surprising,

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[10]See Godfrey (1978), Greene (1990) p. 685. With y=ln(age), this simplifies to

$$Var[\epsilon_i] = Age^{\gamma'}$$

since theory would suggest that the variance would be decreasing in age as the amount of noise in the learning process diminishes. However, the equation is weighted by the *inverse* of this function, and the inverse is declining in age. Thus, effectively the errors are scaled down most for the lowest ages, which is consistent with the theoretical learning model.

The predicted survival-age relationship is unchanged from before. The basic pattern that emerges is an initially high survival probability that declines rapidly in the early years until somewhere between ages 2 and 6, depending on the year. After bottoming out, the survival likelihood then rises monotonically with age. This is consistent with a version of the theoretical model in which entrants enter with "optimistic" expectations about their efficiencies. It takes a few years for the inefficient firms to lower their expectations by enough to make exit a genuine likelihood. Once this stage is reached, survival likelihoods are increasing in age thereafter.

The predicted survival-size relationship is significantly positive in all years when employment is used to proxy for size (See Figure 7). This suggests that the Table V results reflect a large number of the smaller SA firms failing in 1985, rather than a negative relationship between survival and size. The positive survival-size relationship is similar to past findings for conventional capitalist firms, and inconsistent with a negative efficiency-size relationship. Thus the survival-age and survival-size results for these firms are exactly identical to past results for conventional firms.

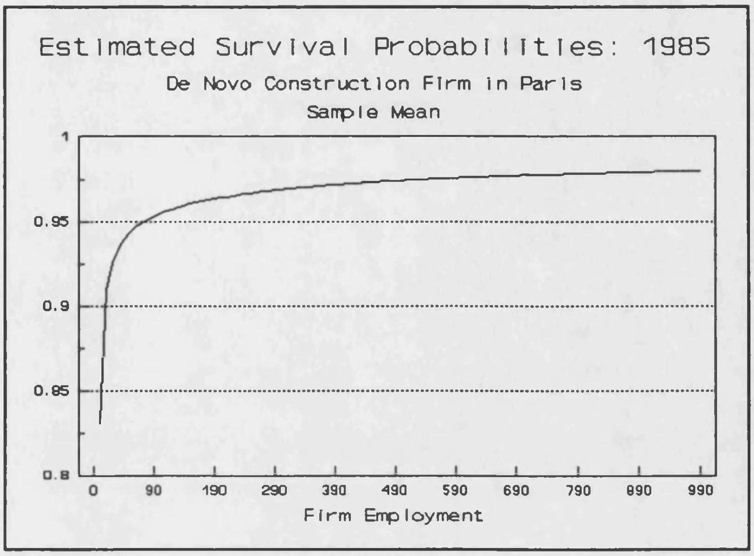

Figure 7

By estimating the data in cross sections, we were able to identify changes in the estimated survival-size and survival-age relationships over the French business cycle. For the survival-age relationship, we use the estimations using the legal form classification since it allows us to observe more years. We find the business cycle appears to have an impact on the curvature of the survival-age relationship. In downswing years this curvature becomes more pronounced, with the gap in survival likelihoods for young and older firms increasing, while in recovery years the relationship tends to flatten out. Between 1980 and 1987, France's unemployment rate rose continuously from 6.3 percent to 10.5 percent, falling thereafter. Between 1980 and 1987, annual real GDP growth ranged from 0.8 percent to 2.4 percent, with the trough occurring in 1983. Only in 1988 did the economy spring back into strong growth at a (real) rate of 3.6 percent with unemployment falling to 9.4 percent.

The business cycle effect on the likelihood of firm survival appears to lag real GDP

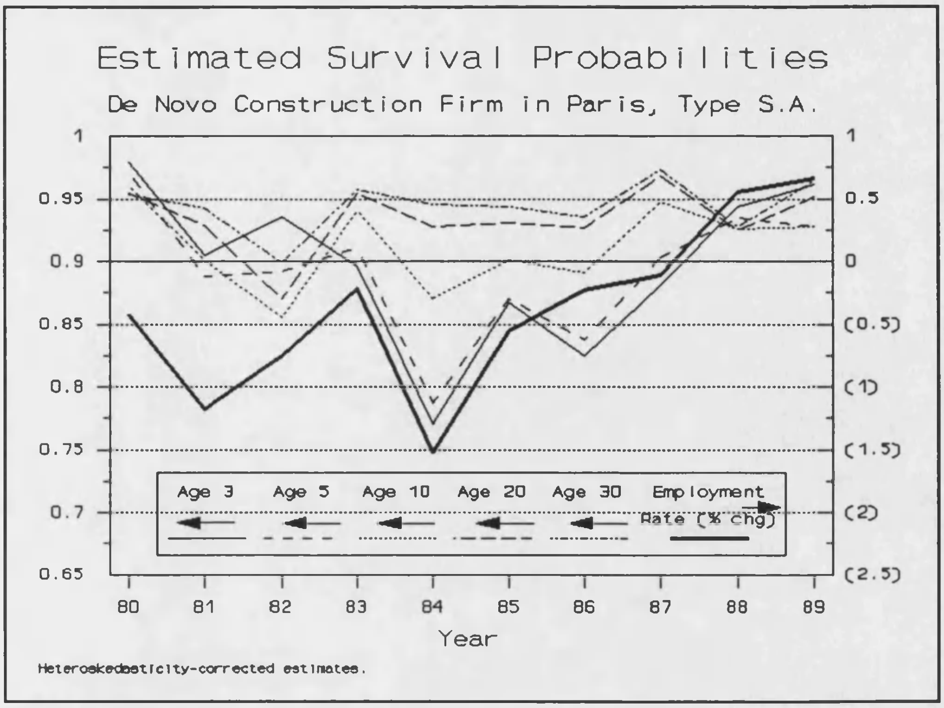

Figure 8

growth by about a year, but is closely related to the rate of change of the unemployment rate. The impact of the business cycle is clearly reflected in Figure 8, which plots on the left axis the survival likelihood of several age groups over the sample period, and on the right axis the rate of change of France's employment rate (one minus the unemployment rate). For the younger ages, the predicted probabilities track changes in macroeconomic employment conditions while the linkage is weaker for the older age groups. Simply put, in most years younger firms (except for "new-borns") are more vulnerable to failure than older firms, and in bad years the vulnerability of younger firms to failure rises by more than for older firms.

The survival-size relationship also shows a business cycle effect, although we can only observe this for 1981-1986 since we were unable to estimate survival using lagged employment in the other years. The predicted relationship over the business cycle is pictured in Figure 9, which plots on the left hand axis the estimated survival probabilities

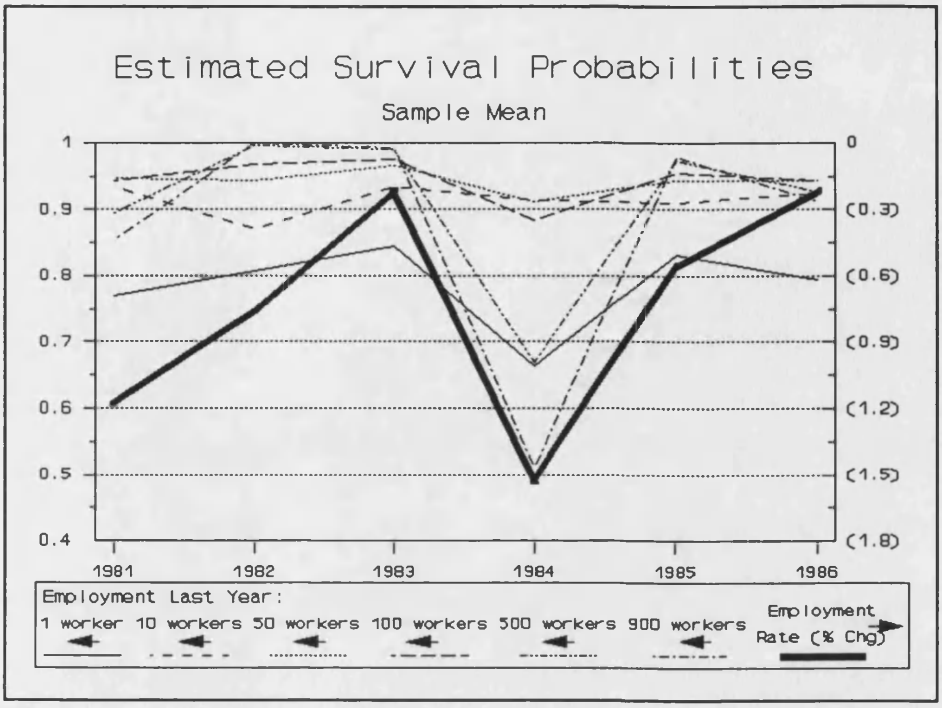

Figure 9

for six size groups, and on the right hand axis the rate of change of the employment rate (one minus the unemployment rate). Business cycle downswings appear principally to have adverse effects on both very large firms and very small firms, but less so for medium sized firms.

The size ranking of the survival probabilities is less consistent than the age ranking over the years, and in particular in 1984 when a number of very large firms fail, the largest firms are predicted to have the poorest survival odds, followed by the very small firms. This year coincides with the sharpest contraction in the employment rate in the sample period. The other year where employment contracts very sharply is 1981, where again, the very small and very large firms are predicted more likely to fail than the medium sized firms.

Thus it appears that the business cycle does not affect small firms in the same way it affects young firms. In fact this is intuitive since young firms, whether large or small, are not yet well established in their markets, and are therefore more vulnerable to shocks. This "liability of newness" is well documented in the life-cycle literature (Freemont et al., 1983, Ben Ner, 1988). Not so for small firms, especially older small firms, who may be small simply because they have found this to be their optimal scale of operations, and can be well-established enough to be able to survive most exogenous shocks.

To summarise the results on firm survival, we find a positive relationship between survival and both size and age for French producer cooperatives, except for very young ages. This is precisely the same as past findings for both conventional and labour managed firms and is inconsistent with a negative efficiency-size relationship. We also find that downswings in the business cycle appear to affect the survival odds of young firms far more than older firms, causing the differentials in survival likelihoods between young and old firms to increase greatly. Finally, business cycle downswings are found to adversely impact very small and very large firms by more than medium-sized firms.

4.2 Growth

Having determined the relationship of survival probability with size and age, we would like to proceed to testing the theoretical predictions for firm growth. But before examining the pattern of firm growth, we must first address the sample selection bias induced by exit and non-reporting. Since we measure growth based on sales, we are principally interested in whether the firm survives and reports sales in two consecutive years.

To control for sample selection bias due to exit and non-reporting of two consecutive years of sales data, we create the variable:

$$repsur = 1 \text{ if firm survives and reports a growth rate}$$
$$= 0 \text{ otherwise}$$

This variable can be interpreted as the joint probability a firm survives and reports a growth rate. We use the same functional form we used for the sample selection equation estimated in conjunction with equation (4.1). To this we added two dummies representing firms who fail one year hence and firms who fail two years hence. Where significant, creation type, industry and regional dummies were also included. We denote the vector of explanatory variables as **v**. The equation becomes:

$$P(repsur_i=1) = \alpha' v_i + u_i$$
$$u_i \sim N(0,1) \tag{4.4}$$

Results for 1985 are reported in Table VII. In column 1 is a basic probit estimation of (4.4), and in columns 2 and 3, estimates derived from the joint estimation of (4.4) with the growth equation. Column 3 includes heteroscedasticity-corrected estimates, the technique for which is described in the next section. Results for other years are reported in Appendix 5. The likelihood of selection is found to have a concave relationship with age. The legal form has little impact on the selection probability for young firms, but older SARL firms are much less likely to be selected into the sample than older SA firms. Finally all firms are much less likely to be included into the sample if they are about to fail, because prior to failure very few firms bother to report.

Table VII

Dependent Variable REPSUR=1 if Survives and Reports
0 otherwise
Coefficient, Standard Error, t-statistic
Year=1985, MLE Estimates

		Sample Selection Model	
	Basic Probit MLE	Heteroscedasticity Uncorrected MLE	Corrected MLE
One	-1.2246	-1.2247	-1.2316
	0.1318	0.1384	0.1835
	9.289	8.846	6.713
SA	0.44289	0.44329	0.60355
	0.1979	0.198	0.2233
	2.238	2.239	2.702
Log(Age_{t-1})	0.9476	0.9476	1.0466
	0.1454	0.1525	0.1916
	6.517	6.212	5.462
Log(Age_{t-1})*SA	-0.6141	-0.6141	-0.7953
	0.2168	0.2195	0.2463
	2.833	2.798	3.229
$(Log(Age_{t-1}))^2$	-0.1873	-0.1873	-0.2138
	0.0386	0.0395	0.0487
	4.854	4.739	4.390
$(Log(Age_{t-1}))^2$*SA	0.1868	0.1868	0.2275
	0.0513	0.0518	0.0580
	3.641	3.609	3.923
FAIL IN 1 YR	-1.422	-1.422	-1.4406
	0.1545	0.1532	0.1875
	9.204	9.281	7.683
FAIL IN 2 YRS	-0.3277	-0.3280	-0.2204
	0.1585	0.1523	0.1352
	2.068	2.154	1.629
Log-Likelihood*	-776.516	-815.776	-661.865
Model Degrees Used*	10	20	20
N	1420	1420	1420
% Correct	70.8%	70.8%	70.6%

*Statistics for Columns 2 and 3 include growth equation. Creation type, industry, and regional dummies omitted from table.

Figure 10 plots the estimated selection probability for 1985 for SA and SARL firms. In the early ages, the likelihood of selection is very poor for all firms, due to high failure rates and poor reporting among survivors. However, after about age 10, the relative selection patterns between the two legal form categories diverge. SA firms continue to become increasingly likely to be selected into the sample. SARL firms, however, have their selection likelihood peak at age 10, and from there onwards, become increasingly less likely to be selected into the sample.

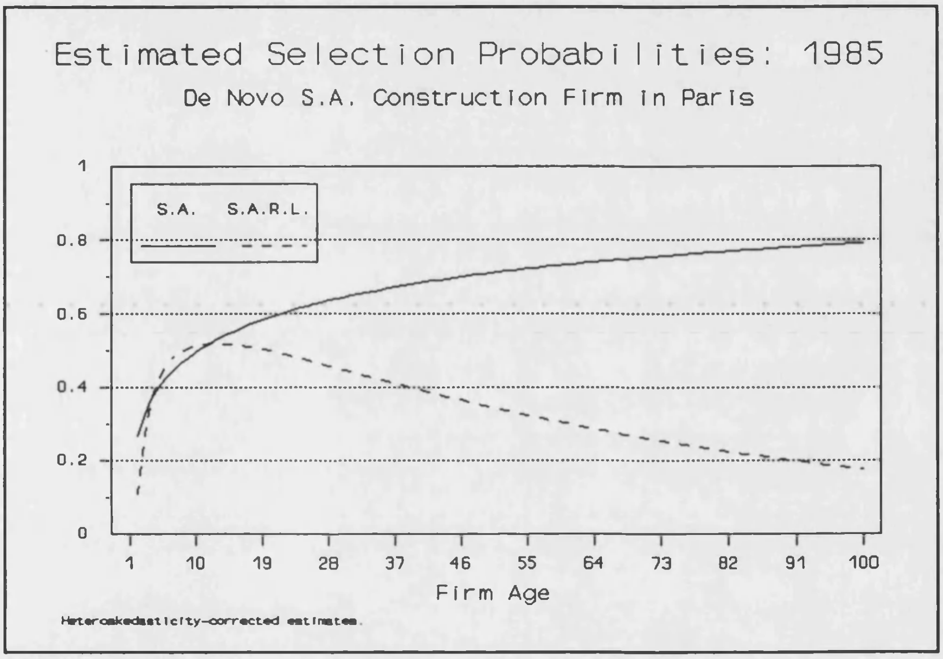

Figure 10

We know from Figure 5 that after the first 5 years, both types of firm are more likely to survive as they age. So there must be some factor coming into play with SARL firms which causes older ones not to report as frequently as younger ones. Perhaps SARL firms, as they age, learn that the costs of not reporting are fairly small, and the overseeing organisation prefers to devote its limited resources to maximising data collection on the old and established SA firms who employ the most workers. In terms of the econometrics, for young ages there is relatively little distortion in the data, but for older ages, the selected sample will include far more SA than SARL firms relative to the population. To the extent that the upper bound on SARL membership constrains the growth of these firms, we will be eliminating slower growing firms. In terms of age distortion, the sample will include far more older firms of type SA, but more middle-aged SARL firms relative to the population at large.

We are now able to proceed to a selectivity model of firm growth. We estimate the expectation of the firm's growth rate, contingent on the firm surviving and reporting. This is given by the following system of equations:

$$
\begin{aligned}
E[g_i|x_i, repsur_i=1] \\
&= E[g_i|x_i,\ \alpha' v_i + u_i > 0] \\
&= \beta' x_i + E[\epsilon_i | u_i > -\alpha' v_i] \\
&= \beta' x_i + (\rho\sigma_\epsilon\sigma_u)\frac{\phi(\alpha' v_i)}{\Phi(\alpha' v_i)} \\
&= \beta' x_i + (\rho\sigma_\epsilon)\lambda_i \qquad (4.5)
\end{aligned}
$$

where σ_ϵ is the standard error of the uncorrected growth equation and ρ is the correlation between the errors of the uncorrected growth and the selection probit equation. The vector $\mathbf{x}_i$ includes a set of explanatory variables for growth, including second order log expansions of age and size lagged, and dummies for industries and regions. In the Heckman estimation, since it is not possible to estimate σ_ϵ and ρ separately, σ_ϵ is normalised to equal one. The coefficient reported for λ represents the product of σ_ϵ and ρ. In the maximum likelihood estimation, these parameters are estimated and reported separately. The results for the Heckman and MLE estimations are reported in columns two and three of Table VIII.

Table VIII

DEPENDENT VARIABLE: FIRM GROWTH= $Log(Sales_t)-Log(Sales_{t-1})$
Coefficient, Standard Error, t-statistic
YEAR=1985

	Basic Ols	Sample Selection Models: Uncorrected Heckman	Uncorrected MLE	Heteroscedasticity Corrected Heckman	Heteroscedasticity Corrected MLE
One	1.5902	1.6148	1.6147	1.3495	1.3222
	0.2727	0.3051	0.2333	0.2886	0.2218
	5.8320	5.2920	6.9200	4.6760	5.9600
$Log(Age_{t-1})$	-0.4611	-0.4643	-0.4643	-0.3740	-0.3699
	0.0612	0.0635	0.0556	0.0579	0.0513
	7.529	7.312	8.345	6.456	7.207
$(Log(Age_{t-1}))^2$	0.0420	0.0425	0.0425	0.0404	0.0400
	0.0078	0.0083	0.0095	0.0071	0.0076
	5.357	5.123	4.471	5.665	5.274
$Log(Sales_{t-1})$	-0.1947	-0.1968	-0.1968	-0.1531	-0.1511
	0.0683	0.0688	0.0514	0.0637	0.0481
	2.852	2.860	3.830	2.402	3.141
$(Log(Sales_{t-1}))^2$	0.0055	0.0056	0.0056	0.0041	0.0040
	0.0045	0.0045	0.0034	0.0040	0.0032
	1.212	1.233	1.619	1.013	1.241
$Log(Sales_{t-1})*$	0.0239	0.0237	0.0237	0.0144	0.0144
$Log(Age_{t-1})$	0.0073	0.0073	0.0060	0.0058	0.0053
	3.273	3.26	3.975	2.469	2.694
$Membership_{t-1}/$	-0.0819	-0.0826	-0.0827	-0.0945	-0.0936
$Labour\ Force_{t-1}$	0.0514	0.0511	0.0573	0.0466	0.0498
	1.595	1.615	1.443	2.026	1.879
Lambda		-0.0102		-0.0109	
		0.0585		0.0586	
		0.174		0.185	
Sigma			0.2600		0.2325
			0.0049		0.0045
			52.689		51.733
Rho			-0.3765		0.0063
			0.1947		0.2028
			0.1930		0.0310
Adj. R-square	**0.2616**	**0.2603**	**0.2590**	**0.2178**	**0.2529**
F	**28.737**	**25.104**		**20.068**	
Log-Likelihood			**-815.776**		**-661.865**
k	**7**	**8**	**18**	**8**	**18**
N	**549**	**549**	**1420**	**549**	**1420**

Creation type, industry and regional dummies omitted from table.

A Lagrange multiplier test found the errors from these equations to be heteroscedastic. Heteroscedasticity was purged by using a weighting variable in the estimations reported in columns four and five of Table VIII. However, it was necessary to construct a weighting scheme which would correct heteroscedasticity not only in the growth equation, but also in the sample selection probit which is estimated jointly. To this end, the weights were derived as follows: The residuals from the estimation in column 3 of Table VIII existed only for those observations selected into the sample. These were squared and regressed against the variables from the selection probit model in Table VII.[11] (Results of this estimation are reported in Appendix 4.) The coefficients from the resulting estimation were used to generate "fitted" values of the squared errors for the observations selected *out* of the sample.[12] Weights were then derived for the entire population by taking the inverse of the square root of these fitted values. These weights were applied to the log-likelihood function and the derivatives in the iterations towards MLE convergence.

The predicted maximum likelihood relationship between firm growth and age is listed in Table VIII and plotted in Figure 11. All the age variables are found to be significant at 1 percent, with the coefficient on age negative and on age-squared positive implying a convex relationship between growth and age. The coefficient on the product of age and size is also positive, indicating that growth is expected to rise in age given size and vice versa. In all the years estimated, the coefficient on age is positive, and significant in all

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[11]The reasoning behind using the variables from Table VII is that these contain no missing values so the regression could then be used to generate weights for observations selected *out* of the sample as well as those selected *in*.

[12]The author would like to thank Hugh Wills for recommending this approach.

but one. Age-squared is significantly positive in 5 of the 8 years estimated while the product of size and age is significantly positive in 7 of the 8 years.

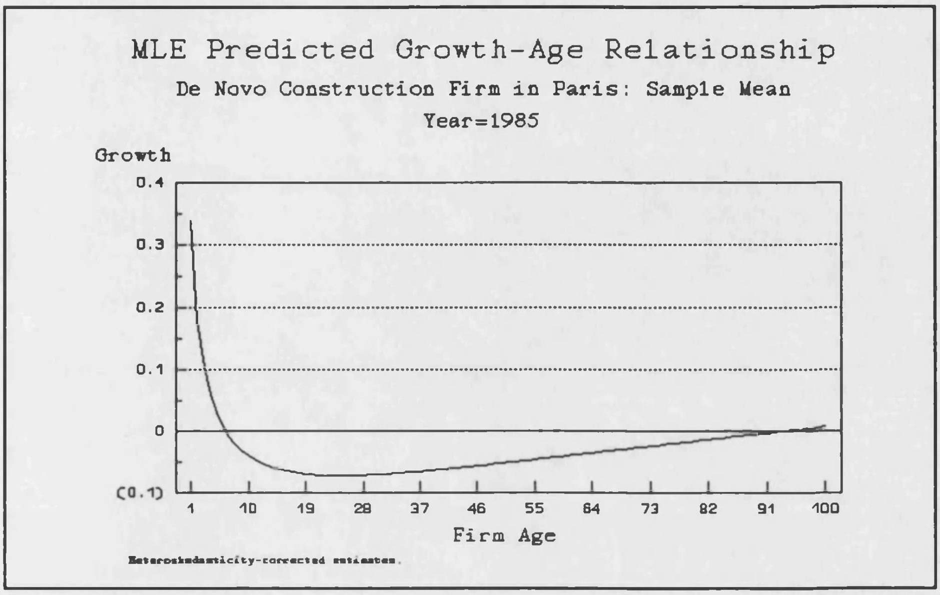

Figure 11

Figure 11 shows growth to be at its highest following creation, declining sharply in the first years and continuing to decline until about age 20. Thereafter, growth rises very gradually to approach zero for the older ages. The convex relationship between growth and age is consistent with the predictions of the theoretical models and similar to past findings for conventional firms. It is interesting that for a substantial range of firm ages in the case illustrated, growth becomes negative after an initial period and then eventually rises to approach zero. This is inconsistent with a model in which firm size is positively related to efficiency, as it is with conventional firms.[13] It may also simply reflect the choice of the quadratic functional form on age and the particular intercept dummies illustrated. The initial positive growth period is consistent with excessive noise in the

[13]It is also of course not inconsistent with the indeterminate predictions of the membership model of the French producer cooperative.

early years distorting the firm's evaluation of its own efficiency, and also with new firms entering at a very small scale due to capital and other constraints. However, Figure 12 plots the actual growth-age relationship for all firms, and does not lend strong support to the negative growth rate prediction of Figure 11, suggesting that this result is probably driven by a few outliers and not too much weight should be attached to this finding.

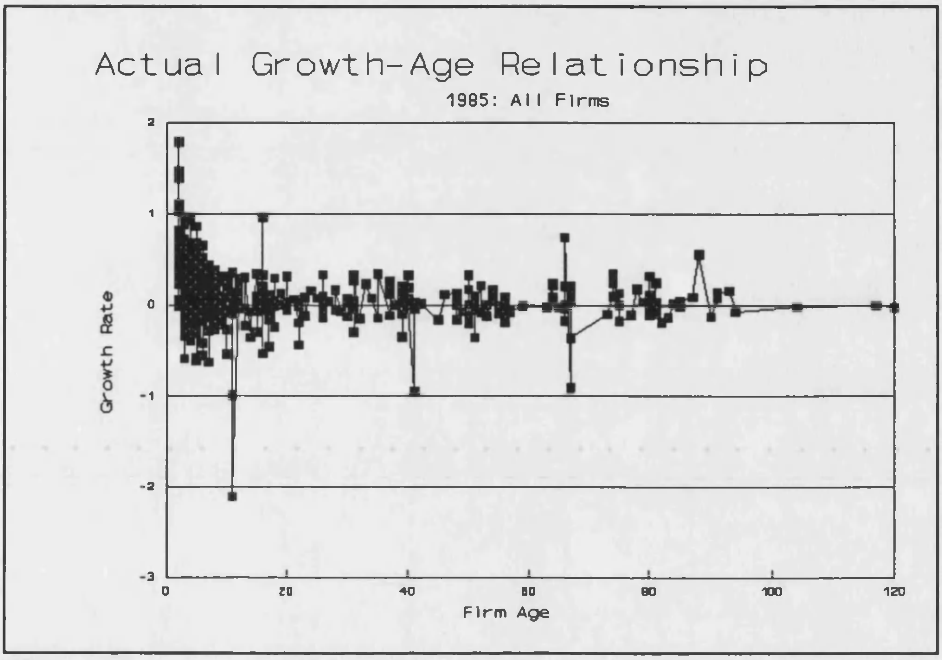

Figure 12

The predicted relationship between growth and size-lagged is similar to the growth-age relationship, and also with previous growth-size findings for capitalist firms. The coefficient on size is negative and significant, on size-squared it is positive but insignificant.[14] (However, in all the other years estimated (See Appendix 6) it is significantly positive.) Once again growth is highest at the smallest size levels, falling rapidly as firm sales increase until about 2 billion (1980) FF after which the decline

[14]However, in all the other years estimated (See Appendix 4) it is significantly positive.

slows. The predicted relationship is depicted in Figure 13.

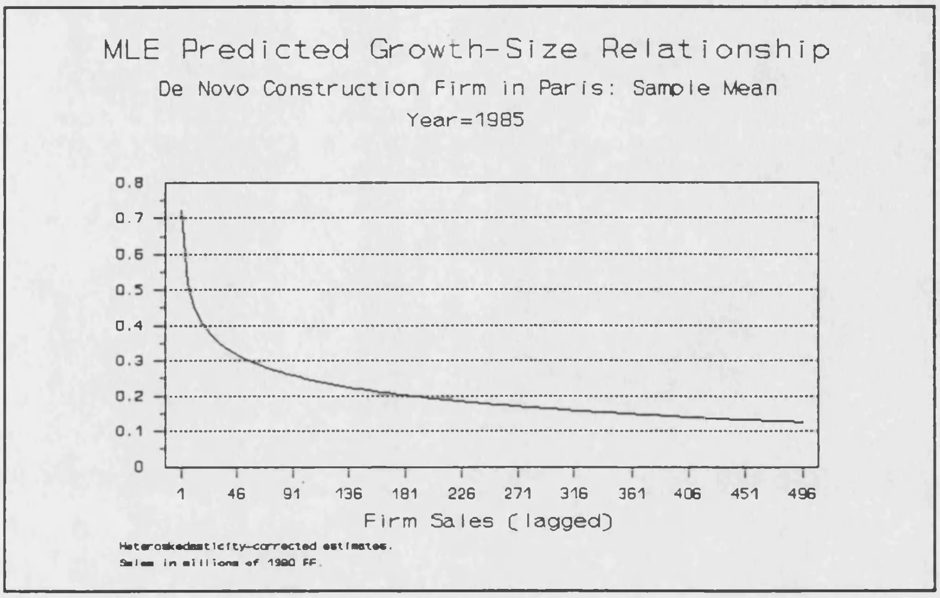

Figure 13

We find growth to be greatest (and positive) for small LMFs, falling to near zero for large LMFs. The rate of growth is shown to decline with size at a decreasing rate. This is consistent with a positive efficiency-size relationship, and with the theoretical notion of an upper bound to firm efficiency, and through efficiency to optimal size (See Dunne, Roberts and Samuelson (1989), and Chapter II.) The actual growth-size relationship for 1985 is illustrated in Figure 14.

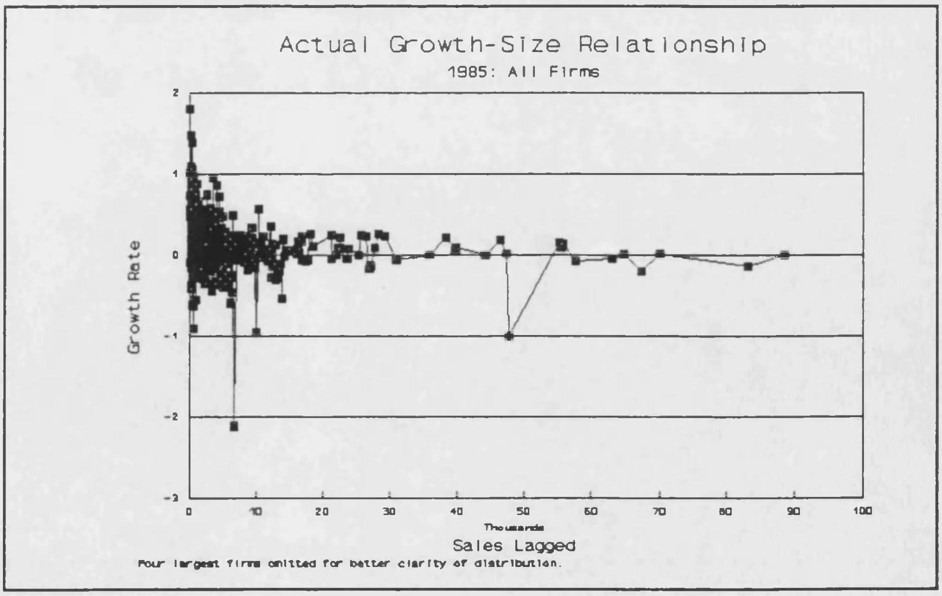

Figure 14

The relationship between growth and the membership-ratio is found to be negative, but only weakly significant.[15] In the French producer cooperative model, the membership ratio is correlated with the capital-labour ratio. While too much should not be read into this weakly significant finding, the suggestion is that the more capital intensive the firm is, the less likely it is to grow. This can be explained by the role of members in providing collateral for financing capital expansion, whether the members borrow funds individually under internal financing, or the firm borrows funds collectively under external financing. As long as the members provide collateral for loans, then all else equal, the lower the level of membership (or the higher the level of capital already being financed) the harder it will be for the firm to obtain new loans.

Finally, the sample selection correction is found to be insignificant in all the years estimated. None of the coefficients in column 5 of Table VIII are statistically different from column 1 of the same table. This finding is somewhat surprising given the strong age and size effects found in the sample selection results in Table VII. However, the selection bias appears to only enter for older firms, and if old SA and SARL firms both tend to have growth rates approaching zero, the selection bias will have little impact on the results.

Equation (4.5) was estimated in cross-sections for all the years 1980-1987,[16] and once

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[15]It is significant at 10 percent but not at 5 percent. In other years it is consistently negative but only significant at 5 percent in 3 of the 8 years estimated.

[16]The years 1988 and 1989 were omitted since the estimation requires a dummy variable for firms which fail one and two years hence, and this information was not available in the final two years of the sample.

again a cyclical pattern emerged in the estimations. As France's economy slowed down over this period, the gap between the predicted growth rates of young and old firms narrowed. Figure 15 illustrates growth rates for six age groups (on the left axis) over these years together with France's unemployment rate (on the right axis). The growth

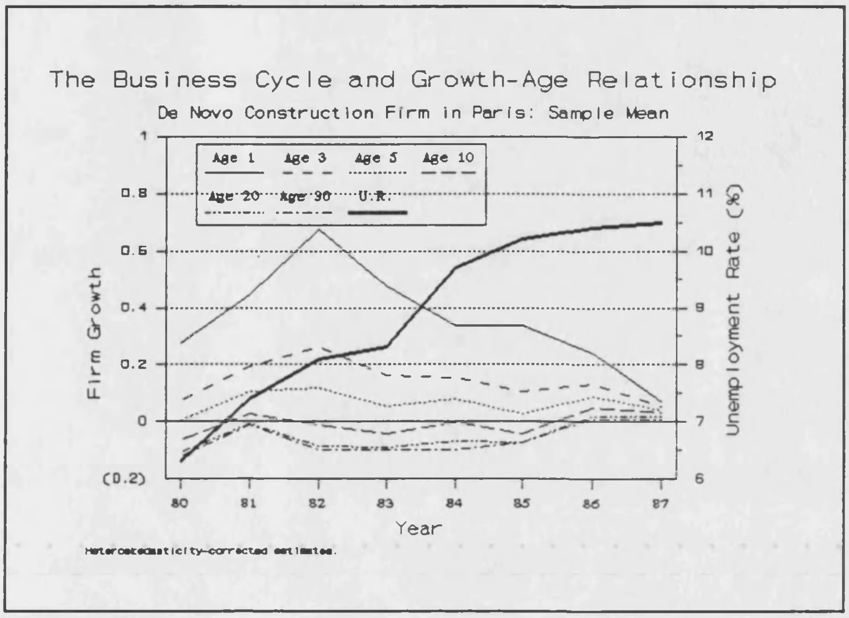


Figure 15

ranking of the age groups remains uniform over the period, but there is a clear convergence among the growth rates in the latter part of the sample period as the unemployment rate became very high. This suggests that in good times younger firms grow much faster than older firms, but in downswing years, all firms grow slowly and at about the same rate.

A similar business cycle effect is evident in the growth-size relationship depicted in Figure 16. In this period of rising unemployment, the gap between growth rates for small and large firms is initially high, declining over time and converging close to zero. The ranking of the size categories remains constant throughout.

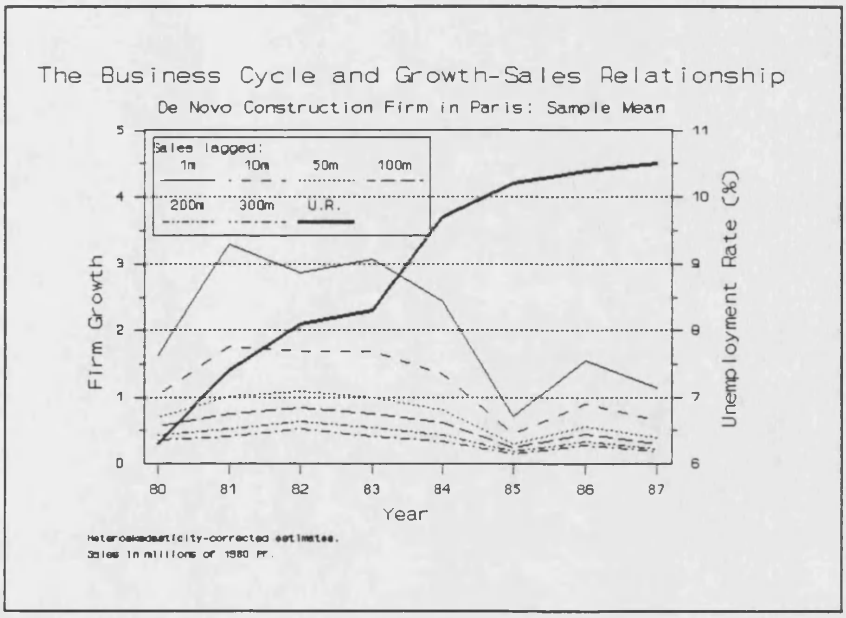


Figure 16

5. Conclusion

This chapter tested some of the theoretical hypotheses derived in Chapters II and III, where learning models of firm growth and survival were applied to the special case of the labour managed firm. In spite of the strong impact of the form of ownership assumptions on the theoretical predictions seen in Chapters II and III, the empirical results from this chapter indicate that French producer cooperatives survive and grow in much the same way as American capitalist firms. The different internal organisational structure appears to have no empirical impact on the growth and survival relationships of this firms over their life cycles and relative to their sizes.

As expected, survival was found to be positively related to age for cooperative firms in any given size category. Survival was found to be positively related to size (given age) for small sizes. These results are robust after having controlled for sample selection bias and heteroscedasticity.

Firm growth was also analyzed, taking into account potential bias caused by sample selection. Sample selection was found not to have induced any bias, since the bias only appears for the class of old firms where SA and SARL firms grow in much the same way. Growth was found to be inversely related to size and age, even after controlling for heteroscedasticity.

The business cycle plays an important role in the growth and survival of all firms, including labour managed firms. This chapter finds that downswings in the business cycle appear to have the greatest adverse impact on the survival of young firms on the one hand and very small and very large firms on the other hand. For surviving firms, business cycle downswings appear to reduce growth most for younger and smaller firms.

The findings on the relationship between firm growth, size and age exactly parallel previous empirical findings for conventional firms (Dunne, Roberts and Samuelson (1989), Evans (1987a, 1987b), Hall (1987)), and labour managed firms (Ben Ner, 1988). Yet if these empirical relationships hold so broadly and pervasively, why are the theoretical learning models only able to give vague or empirically incorrect predictions?

This leads us to suggest that perhaps the lack of success of the learning models in decisively explaining the growth and survival behaviour of labour managed firms is due to the fact that they attach too much significance to the firm's ownership structure, and attach too narrow an interpretation on the nature of efficiency gains through learning.

It is clear from the empirical results that some form of learning and adjustment is going on in these firms over time, as evidenced by the strong age relationships uncovered. Additionally, this learning process follows the same pattern for labour managed firms as it has been shown to follow for conventional profit maximising firms. The notion of learning by firms thus appears a valid modelling element to maintain, but the current structure that leads to efficiency-size relationships that vary with organisational form will need to be modified. This and other directions of possible future research are discussed further in Chapter V.

Appendix 1

PROBIT MODEL OF FIRM SURVIVAL: SUR=1 if survives, 0 otherwise
Coefficient, Standard Error, t-statistic

	1980	1981	1982	1983	1984	1985
Constant	2.5126	2.4606	1.7944	2.3673	2.8259	2.6438
	0.2736	0.2443	0.1490	0.2080	0.3009	0.3089
	9.184	10.074	12.044	11.382	9.392	8.560
SA	N/S	N/S	0.7636	N/S	N/S	-0.7785
			0.1763			0.4156
			4.330			1.873
Log(Age)	-0.5106	-1.1030	-1.2210	-1.9905	-3.0198	-1.9129
	0.2516	0.342	0.192	0.4677	0.5508	0.5136
	2.029	3.225	6.361	4.256	5.483	3.724
Log(Age)*SA	N/S	N/S	N/S	0.6032	N/S	1.1276
				0.2101		0.6232
				2.871		1.809
$(Log(Age))^2$	0.2771	0.5489	0.3419	1.2746	1.5209	1.0309
	0.1377	0.2630	0.0608	0.3651	0.3110	0.3203
	2.013	2.087	5.622	3.491	4.891	3.219
$(Log(Age)^2)$ *SA	-0.1986	N/S	-0.0937	N/S	N/S	-0.4581
	0.1213		0.0362			0.2368
	1.637		2.592			1.935
Heteroscedasticity Correction						
Log(Age)	N/S	0.342	N/S	0.5807	0.5430	0.3814
		0.1369		0.0766	0.0625	0.1269
		2.499		7.577	8.685	3.006
Log-L	-126.4	-248.9	-318.0	-402.5	-589.1	-448.4
Model Chi^2	30.4*	37.7*	80.3*	90.4*	146.6*	63.0*
N	905	1128	1373	1536	1648	1658
k	4	6	9	7	8	9
% Correct	96.4%	93.6%	92.7%	91.5%	86.2%	91.6%

Industry, region and creation dummies omitted from table.

*Significant at 1 percent.

PROBIT MODEL OF FIRM SURVIVAL: SUR=1 if survives, 0 otherwise
Coefficient, Standard Error, t-statistic

	1986	1987	1988	1989
Constant	2.7393	2.9548	1.8604	2.1081
	0.3087	0.6337	0.2185	0.3553
	8.872	4.663	8.514	5.933
SA	N/S	N/S	N/S	2.4401
				1.2200
				2.000
Log(Age)	-2.8667	-2.5455	-0.9408	-2.036
	0.5702	0.9721	0.2412	0.6661
	5.027	2.619	3.900	3.057
Log(Age)*SA	0.3988	N/S	0.6326	-0.723
	0.1651		0.1705	0.5975
	2.416		3.710	1.211
$(\text{Log(Age)})^2$	1.4495	1.7449	0.241	1.0604
	0.3228	0.5547	0.0687	0.391
	4.491	3.146	3.506	2.712
(Log(Age)^2)*SA	N/S	N/S	-0.1850	N/S
			0.0639	
			2.898	
Heteroscedasticity Correction				
Log(Age)	0.5847	0.5934	N/S	0.4166
	0.0643	0.0824		0.1082
	9.088	7.198		3.850
Log-Likelihood	-645.8	-417.0	-398.0	-374.3
Model Chi^2	115.6*	84.0*	70.8*	139.8*
N	1661	1507	1482	1448
k	8	9	11	14
% Correct	85.1%	90.9%	91.4%	90.9%

Industry, region and creation dummies omitted from table.

*Significant at 1 percent.

Sample Selection Model
Dependent Variable: NMISS=1 if firm reports lagged employment, 0 otherwise

	1985
Constant	-1.4076 0.1181 11.914
Log(Age)	3.3251 0.1742 19.089
Log(Age)*SA	-0.7053 0.1827 3.861
$(\text{Log(Age)})^2$	-0.6831 0.0454 15.051
$(\text{Log(Age)})^2$*SA	0.2466 0.0584 4.556
Mutation	0.5799 0.2195 2.642
Reanimation	0.5771 0.1388 4.158
Log-Likelihood	**-333.12**
Log-Likelihood (Zero Slopes)	**-779.38**
Chi Squared	**892.53***
Percent Correct	**96.0%**

Industry and region dummies omitted from table.
***Significant at 1 percent.**

Appendix 3

PROBIT MODEL OF FIRM SURVIVAL: SUR=1 if survives, 0 otherwise
Coefficient, Standard Error, t-statistic

	1981	1982	1983	1984	1985	1986
Constant	0.8659	1.0263	0.2745	-0.8130	1.0622	0.1549
	0.2852	0.1303	0.218	0.3555	0.1535	0.4024
	3.036	7.875	1.259	2.287	6.919	0.385
Log(Aget-1)	-0.3686	-0.4221	N/S	N/S	-0.2816	-0.8954
	0.1736	0.1482			0.1351	0.3185
	2.123	2.849			2.084	2.812
Log(Aget-1)^2	0.1011	0.1141	0.3657	0.3476	0.0850	0.7613
	0.0410	0.0372	0.2268	0.1403	0.0331	0.2698
	2.467	3.066	1.611	2.478	2.565	2.821
Log(Employment$_{t-1}$)	0.4695	N/S	0.3638	1.0468	0.1590	0.7374
	0.1995		0.0901	0.2385	0.0566	0.3534
	2.353		4.037	4.389	2.811	2.087
Log(Employment$_{t-1}$)^2	-0.0621	0.0457	N/S	-0.1677	N/S	-0.0847
	0.0310	0.0128		0.0418		0.0669
	2.004	3.583		4.015		1.266
Lambda	N/S	N/S	N/S	1.4462	N/S	N/S
				0.4564		
				3.168		
Heteroscedasticity Correction:						
Log(Age$_{t-1}$)	N/S	N/S	0.3712	0.3218	N/S	0.4620
			0.1359	0.0940		0.0916
			2.731	3.423		5.044
Log-L (Zero β)	-234.0	-307.0	-401.8	-602.85	-403.3	-641.3
Log-L	-224.7	-285.2	-356.3	-555.27	-391.5	606.7
Model Chi^2	18.60	43.54	91.15	95.15	23.69	69.12
n	844	1023	1228	1356	1358	1462
k	5	7	9	8	5	7
% Correct	92.1%	91.1%	89.9%	83.5%	91.2%	84.1%

Industry, region and creation form dummies omitted from table.

OLS Regression
Dependent Variable = Selection Equation Residuals Squared
Year=1985, N=549

Variable	Coefficient	Std. Error	t-statistic
Constant	0.1973	0.0417	4.730
SA	-0.1058	0.0567	1.866
$Log(Age_{t-1})$	-0.0969	0.0425	2.280
$Log(Age_{t-1})*SA$	0.1305	0.0570	2.289
$(Log(Age_{t-1}))^2$	0.2167	0.1014	2.137
$(Log(Age_{t-1}))^2*SA$	-0.3090	0.1258	2.457
Mutation	-0.0556	0.0262	2.119
Fail in 1 Year	0.0396	0.0594	0.667
Fail in 2 Years	-0.0415	0.0436	0.952
Western Region	0.0491	0.0256	1.921
Manufacturing	-0.0536	0.0215	2.488
Adj. R-Squared	0.0252		
F(10,538)	2.4177		
Durbin Watson	1.9749		
Sum of Squares	22.0988		

Sample Selection Model:
Heteroscedasticity-Corrected MLE
Dependent Variable:
REPSUR=1 if survives and reports, 0 otherwise
Coefficient, Standard Error, t-statistic

	1980	1981	1982	1983
One	0.1430	-0.2646	-0.1017	-0.1230
	0.1792	0.2162	0.1284	0.1261
	0.798	1.224	0.792	0.975
SA	N/S	0.7137	0.8851	0.4145
		0.3343	0.1820	0.0963
		2.135	4.865	4.304
$\text{Log}(\text{Age}_{t-1})$	0.2209	0.6087	0.3823	0.4679
	0.0495	0.2614	0.0573	0.1180
	4.460	2.329	6.677	3.965
$\text{Log}(\text{Age}_{t-1})*\text{SA}$	N/S	-0.7051	-0.2802	N/S
		0.3694	0.0713	
		1.909	3.932	
$(\text{Log}(\text{Age}_{t-1}))^2$	N/S	-0.1008	N/S	-0.0535
		0.0703		0.0296
		1.434		1.808
$(\text{Log}(\text{Age}_{t-1}))^2*\text{SA}$	N/S	0.1770	N/S	N/S
		0.0885		
		2.000		
Fail in 1 Year	-2.0585	-1.9023	-1.4533	-1.6107
	0.3169	0.2703	0.1737	0.1759
	6.495	7.038	8.368	9.158
Fail in 2 Years	-0.4127	N/S	N/S	N/S
	0.3015			
	1.369			
Log-Likelihood**	-327.997	-503.465	-747.146	-765.190
Chi-squared	188.1*	206.2*	259.8*	381.6*
(N,k)	(749,6)	(860,10)	(1055,7)	(1271,5)
% correct	81.3%	78.1%	77.3%	75.5%

**Log-likelihood statistic includes growth equation.
*Significant at 1 percent.

Sample Selection Model:
Heteroscedasticity-Corrected MLE
Dependent Variable:
REPSUR=1 if survives and reports, 0 otherwise
Coefficient, Standard Error, t-statistic

	1984	1985	1986	1987
One	-0.8619	-1.2316	-1.1326	-1.0610
	0.1565	0.1800	0.1573	0.1395
	5.509	6.713	7.202	7.607
SA	N/S	0.6036	0.7892	N/S
		0.2233	0.2425	
		2.702	3.254	
$\text{Log}(\text{Age}_{t-1})$	0.4346	1.0466	1.2186	1.2354
	0.1331	0.1916	0.1647	0.1384
	3.266	5.462	7.398	8.924
$\text{Log}(\text{Age}_{t-1})*\text{SA}$	N/S	-0.7953	-0.5775	-0.2296
		0.2463	0.2533	0.0329
		3.229	2.280	6.988
$(\text{Log}(\text{Age}_{t-1}))^2$	-0.0768	-0.2138	-0.2353	N/S
	0.0346	0.0487	0.0422	
	2.219	4.390	5.574	
$(\text{Log}(\text{Age}_{t-1}))^2*\text{SA}$	0.0705	0.2275	0.1469	0.0578
	0.0180	0.0580	0.0581	0.0132
	3.907	3.923	2.524	4.378
Fail in 1 Year	-1.3032	-1.4406	-1.9137	N/S
	0.2697	0.1875	0.1901	
	4.832	7.683	10.066	
Fail in 2 Years	N/S	-0.2204	N/S	N/S
		0.1352		
		1.629		
Log-Likelihood**	-813.568	-661.865	-839.267	-638.123
Chi-squared	251.5*	341.9*	464.2*	346.2*
(N,k)	(1405,6)	(1420,10)	(1517,10)	(1410,8)
% correct	68.0%	81.3%	74.0%	73.8%

**Log-likelihood statistic includes growth equation.
*Significant at 1 percent.

Dependent Variable:
Firm growth=log(Sales$_t$)-log(Sales$_{t-1}$)
Sample Selection Model:
Heteroscedasticity-Corrected MLE

	1980	1981	1982	1983
One	3.3423	4.0580	4.2912	3.8793
	0.1250	0.1016	0.1300	0.1566
	26.734	39.943	32.998	24.779
Log(Age$_{t-1}$)	-0.8457	-0.4708	-0.8779	-0.5814
	0.0503	0.0585	0.0552	0.0561
	16.810	8.048	15.914	10.359
(Log(Age$_{t-1}$))^2	0.0285	0.0424	0.0653	0.0518
	0.0088	0.0111	0.0105	0.0090
	3.250	3.832	6.236	5.764
Log(Sales$_{t-1}$)	-0.4437	-0.7896	-0.6600	-0.7176
	0.0292	0.0208	0.0315	0.0399
	15.190	37.996	20.975	17.970
(Log(Sales$_{t-1}$))^2	0.0067	0.0408	0.0252	0.0350
	0.0026	0.0024	0.0031	0.0033
	2.529	17.018	8.184	10.570
Log(Sales$_{t-1}$)*	0.0802	0.0246	0.0559	0.0307
Log(Age$_{t-1}$)	0.0074	0.0080	0.0078	0.0073
	10.776	3.062	7.131	4.178
(Membership/	-0.0012	-0.0613	-0.1556	-0.0448
Labour Force)$_{t-1}$	0.0562	0.0629	0.0576	0.0532
	0.021	0.975	2.701	-0.841
Sigma	0.2915	0.3224	0.3747	0.3362
	0.0045	0.0043	0.0069	0.0049
	65.002	74.876	54.454	68.177
Rho	-0.0966	-0.1201	-0.1871	-0.1331
	0.2188	0.1770	0.1982	0.1433
	0.442	0.679	0.944	0.929
Log-Likelihood	-327.997	-503.470	-747.146	-765.190
k	14	18	15	13
N	749	860	737	1271
Adj. R-squared	0.5406	0.5353	0.5830	0.4919

Dependent Variable:
Firm growth=log($Sales_t$)-log($Sales_{t-1}$)
Sample Selection Model:
Heteroscedasticity-Corrected MLE

	1984	1985	1986	1987
One	3.5483	1.3222	2.0983	1.3965
	0.2206	0.2218	0.1600	0.1841
	16.087	5.960	13.111	7.588
Log(Age_{t-1})	-0.5233	-0.3699	-0.2881	-0.0911
	0.0696	0.0513	0.0659	0.0633
	7.518	7.207	4.375	1.440
(Log(Age_{t-1}))^2	0.0178	0.0400	0.0143	-0.0005
	0.0113	0.0076	0.0091	0.0101
	1.577	5.274	1.574	0.048
Log($Sales_{t-1}$)	-0.6014	-0.1511	-0.3521	-0.2542
	0.0478	0.0481	0.0389	0.0406
	12.575	3.141	9.057	6.269
(Log($Sales_{t-1}$))^2	0.0262	0.0040	0.0153	0.0117
	0.0041	0.0032	0.0032	0.0033
	6.446	1.241	4.775	3.517
Log($Sales_{t-1}$)* Log(Age_{t-1})	0.0427	0.0144	0.0217	0.0095
	0.0085	0.0053	0.0076	0.0077
	5.040	2.694	2.836	1.231
(Membership/ Labour Force)$_{t-1}$	-0.2471	-0.0936	-0.0794	-0.0872
	0.0604	0.0498	0.0468	0.0414
	4.094	1.879	1.698	2.104
Sigma	0.3239	0.2325	0.2663	0.2405
	0.0108	0.0045	0.0030	0.0035
	29.902	51.733	89.017	68.761
Rho	-0.1604	0.0063	-0.0078	-0.0280
	0.2483	0.2028	0.1930	0.2388
	0.646	0.031	0.040	0.117
Log-Likelihood	-813.558	-661.865	-839.267	-638.123
k	14	18	18	16
N	1405	1420	1517	1410
Adj. R-squared	0.4921	0.2529	0.1799	0.0762

<u>CHAPTER V</u>: Conclusions and Implications for Future Research

I would like to thank John Sutton, Saul Estrin and Paul Geroski for helpful comments and suggestions. Remaining errors are my own.

1. Summary of Findings

This thesis examined the recent theoretical and empirical literature on the growth and survival of firms, and tested the robustness of past findings to alternative internal organisational structures. The analysis began with the most recent class of growth and survival models, the evolutionary learning models of Jovanovic (1982) and Ericson and Pakes (1989), which were developed for profit maximising firms. These models provide sharp predictions on the relationship between growth, survival, size and age: the likelihood of survival is predicted to increase in size and age, while the rate of growth is predicted to decline in both size and age.

The sharp predictions of the evolutionary learning models were shown to depend principally on the positive efficiency-size relationship derived in the comparative statics analysis of the model. Since increases in efficiency are modelled analogously to output price increases in the learning models, it was of interest to explore the predictions of the learning models for a class of firms known to have a "perverse supply response", as in the case of the labour managed firm. In Chapter II, the evolutionary learning models were solved using the objective function of the Wardian Illyrian firm in place of profit maximisation, and it was shown that the efficiency-size relationship that results from this exercise is either indeterminate, or under certain plausible assumptions, negative, leading to the breakdown of many of the growth and survival predictions of the learning models.

The literature on labour managed firms has devoted much time and research to models which overcome the perverse short run supply response by adding various degrees of complication to the Wardian Illyrian firm model. This model has indeed been criticised extensively for being overly simplistic relative to the actual nature of cooperatives in western economies and too naive to enable proper empirical testing. Before testing our results on a dataset of French producer cooperatives, we felt it necessary to address the issue of the over-simplicity of the Illyrian firm model by extending the model to incorporate a number of key institutional rules which govern the behaviour of cooperatives in France. In particular, the new model in Chapter III allows for nonmember labour, internal and external financing, free access to membership by nonmember workers, and shutdown rules similar to those that actually prevail in France. The net result was a much more complicated model that effectively behaved startlingly similarly to the simpler general case Illyrian firm model. The efficiency-size relationship crucial to the discussion here remained indeterminate. This led to the conclusion that the failure of the evolutionary models to produce sharp and clear predictions as in the case of profit maximisation could not be attributed to the simplicity of the basic Illyrian firm model.

With the breakdown of the clear positive relationship between efficiency and size, the models were unable to yield as many testable predictions as they had for the profit maximising firm. The only testable predictions that were robust to the change in ownership form were the few that were independent of the efficiency-size relationship. These results are derived from the nature of the learning process, and are unaffected by the ownership structure. The key difference between the behaviour of the two types of firm came from the comparative statics results: a labour managed firm would revise its output in response to an increase in efficiency by less than an identically efficient capitalist firm facing the same shocks. However, without any good proxy for efficiency and a matched sample of capitalist and labour managed firms, it was virtually impossible to test this finding.

The main result we were able to test was whether indeed the efficiency-size result was negative, as indicated in the special case of the Illyrian firm model. Chapter IV did exactly this, using a dataset of French producer cooperatives from 1979-1989. While efficiency could not be observed directly from the data, the underlying efficiency-size relationship could be inferred from the estimated growth-size, growth-age and survival-size relationships. The empirical results led to the rejection of the negative efficiency-size hypothesis and the conclusion that empirically these firms do not to behave substantially differently from conventional profit maximising firms.

2. The Anomaly

At the end of the analysis we discovered that the theoretical models are sensitive to changes in the internal organisation of the firm, yet the empirical relationships discussed hold generically across a broad range of different types of firm. The explanation that arises from this anomaly is that the theoretical models must be restricting the problem excessively by imposing too much structure on the determinants of fluctuations in firm size. Thus it appears that some extremely specific and detailed models are being used to explain what are in fact rather broad and generic empirical regularities.

In particular, the over-restrictiveness of the learning models can be traced directly to the modelling of the efficiency gains from learning as cost-reducing (or productivity enhancing). This narrow view of efficiency gains leads to the modelling strategy of having an efficiency-related multiple to the cost (or production) function, which as has been shown, leads to the breakdown of the results under alternative organisational forms such as labour management.

3. The Way Forward

The age element introduced by the evolutionary learning models appears not only empirically legitimate, but it is also the only prediction of the theoretical models that is robust to changes in the firm's internal organisational structure. When the objective function of the Illyrian labour managed firm is used in the theoretical modelling, the positive survival-age relationship and the negative relation of the variance of growth to age result of the previous research is unaffected. The aging process appears to be stabilising in the sense that over time firms are increasingly unlikely to fail and increasingly unlikely to change their size of operations substantially. This suggests that the learning and adjustment going on within the firm over time leads ultimately to a convergence to some steady state equilibrium beyond a particular age.

Thus in order to create a broader and more generic model of firm growth and survival, it appears that some form of history-dependency in the probability transition matrix must be maintained while broadening the nature of the firm's learning process. Such a general formulation does not necessarily yield a specific model, but rather is satisfied by a broad class of models.

The first key ingredient of this broader class of models is some form of age-dependent learning which results in periodic revisions in the firm's "state" which is characterised by its size. Such revisions may lead to exit by the firm if its state falls below some exit threshold. However, the actual nature of the learning process does not need to be as sharply defined as in Jovanovic (1982) or Ericson and Pakes (1989). In fact, any of a class of learning processes in which the learning curve is initially steep and eventually asymptotically concave will yield an increasing concave (beyond an initial period) survival-age relationship and a decreasing convex relationship between the variance of the growth rate and age.

The second key ingredient required for the remainder of the results to hold is that efficiency and firm size must be positively related independently of the objective function of the firm. To this end, it is useful to broaden the nature of learning and extend the role of efficiency from the cost-reducing multiple of Jovanovic and the process innovation of Ericson and Pakes to encompass a more general class of possible improvements to the firm's "state" relative to its competitors. Malerba (1992) lists *six* classes of learning processes (See Table I), all of which need to be considered in determining the type of model we seek to construct. The Ericson and Pakes learning clearly falls in category 6, learning by searching, since their active exploration firm engages in costly learning through R&D to attempt to improve its market position relative to its rivals. To this list we add a seventh category, learning by observing, to incorporate Jovanovic's type of passive Bayesian learning in which the firm does not act to improve its production or technological knowledge but rather learns about its static and existing comparative advantage relative to its rivals.

Table I

TYPES OF LEARNING PROCESSES
1) Learning by doing (cumulative production, investment)
2) Learning by using (products and processes)
3) Learning from advances in science and technology (external to the firm)
4) Learning from inter-industry spillovers (also external)
5) Learning by interacting (with suppliers, users, and competitors)
6) Learning by searching (R&D, etc.)
7) Learning by observing (passive)

Consider first efficiency gains which are cost-reducing (or equivalently productivity enhancing). The learning process is of critical importance because its nature establishes the direction and sign of causality between efficiency and size, as can be seen from Table II. The different learning processes vary greatly in their implicit efficiency-size causality. In those cases where the causality runs from size to efficiency, then in the absence of large information and transaction costs within the firm the sign of the efficiency-size relationship will generally be positive irrespective of the internal structure and ownership of the firm. That is, by definition larger firms are *always* more efficient. Where the causality runs from efficiency to size or in both directions[1], further assumptions are

[1]The causality runs in both directions if on the one hand, efficiency gains lower costs and impact the firm's optimal scale, but on the other hand the firm's scale makes it more or less likely to learn (from technology changes, spillovers, interactions, etc.)

Table II

Implications of Learning Models for Direction and Sign of Efficiency-Size Relationship

Type of Learning	Efficiency-Size Causality	Efficiency-Size Sign**	Probability Transition Matrix
1. By Doing	$S^* \rightarrow E$	Positive	Observations up to learning threshold weighted equally.
2. By Using	$S^* \rightarrow E$	Positive	Same as 1.
3. From technological change	$S \leftrightarrow E$	Ownership-Dependent (OD)	Most recent observations carry greatest weight.
4. From spillovers	$S \leftrightarrow E$	OD	Same as 3.
5. By interacting	$S \leftrightarrow E$	OD	Same as 3.
6. By searching	$S \leftarrow E$	OD	Same as 3.
7. By observing	$S \leftarrow E$	OD	All observations carry equal weights.

* In these cases, size should be interpreted as cumulative size.

** Assuming no transaction or information costs exist within the firm which would make small firms more efficient.

needed to determine the sign of the relationship, but in general the sign will be affected by the ownership structure of the firm.

Observation: If efficiency is cost-reducing or productivity-enhancing, then as long as the causality runs from efficiency to size the sign of the efficiency-size relationship will depend on the ownership structure of the firm. Where size determines efficiency, the sign of the efficiency-size relationship will be independent of ownership structure.

Of course, the nature of the efficiency gain from learning may go well beyond the simple cost-reduction notion used by both Jovanovic and Ericson and Pakes, as well as by the learning by doing literature (Arrow, 1962, Dasgupta and Stiglitz, 1988). It may for instance lead to yield improvements, changes in production technology, horizontal and vertical product improvements, and the introduction of altogether new products, processes and marketing methods (Malerba, 1992). The above observation no longer holds if efficiency is characterised in this broader way since efficiency may affect size through, for example, the addition of new products.

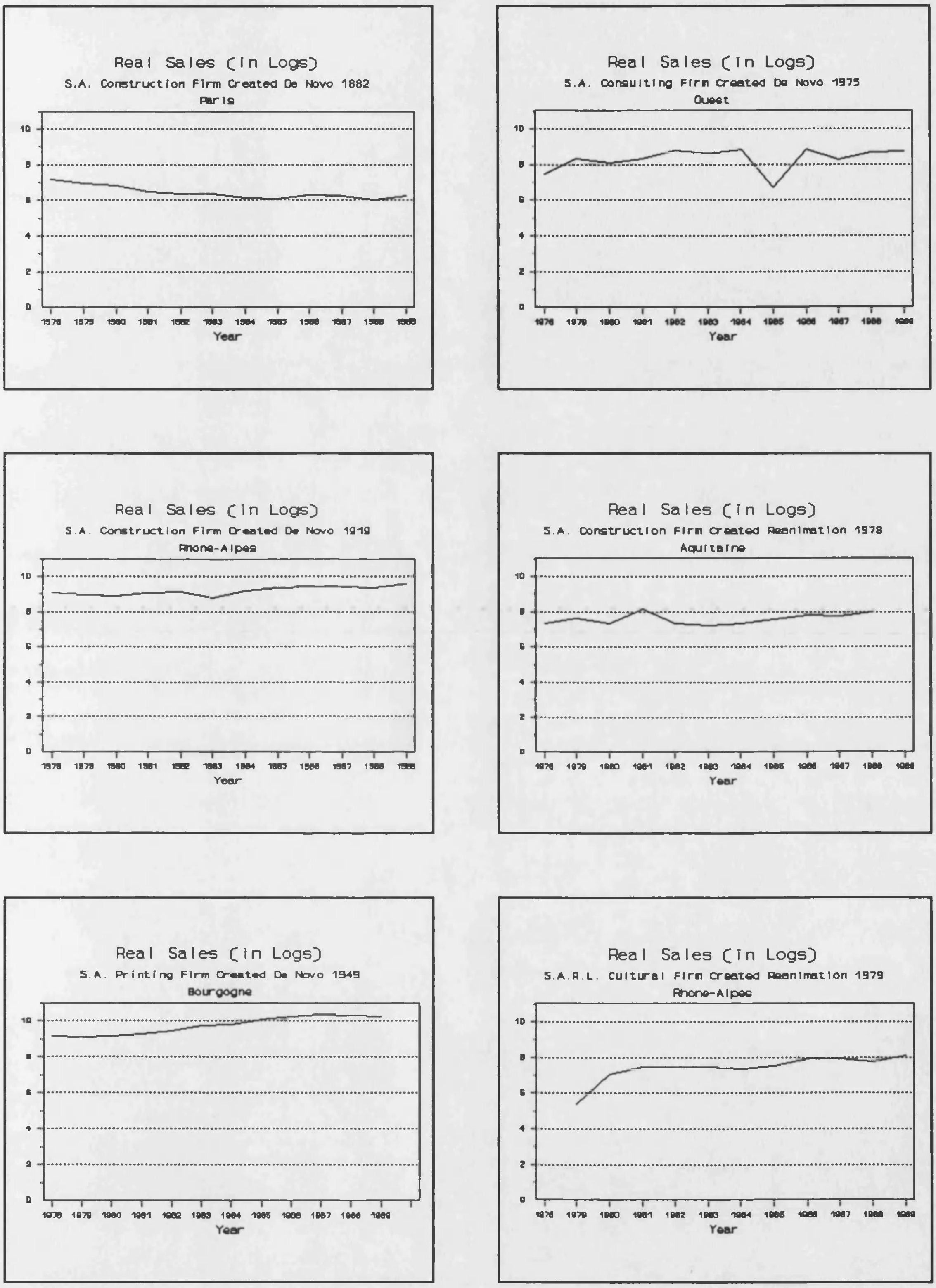
This provides a picture of a broad class of learning activity which leads to differing improvements in the firm's state. Although we can group the outcomes of all these learning processes as improvements in efficiency, in this context it clearly is no longer relevant to formulate efficiency as a cost (or production) function multiple. This is exactly what we would like to avoid doing, since the cost (production) function multiple is what is causing the models to be excessively sensitive to organisational form. But there is in fact no obvious mathematical characterisation of the broader efficiency improvements discussed here which can be used to replace the cost (production) function multiple. It is clear we will need to use a much more general framework.

Consider a model of firm size where in each period size can take any of a finite range of possible values {0,1,...,M}. The firm's succession of sizes over time constitutes a sequence of random variables, where at any time t, $\{S_t\}=\{S_0, S_1, \ldots S_t\}$. The state of the firm is given by its size, which we assume is correlated with its efficiency in the broad sense described above, although we leave the direction of causality open. Size zero is an absorbing state - that is if a firm's size falls to zero it exits and does not reappear. At any time t, if the firm's current size is given by state i, then the likelihood that the firm's size in the next period (t+1) will equal some other value j, (P_{ij}), is governed by a state dependent transition probability matrix:

$$\begin{vmatrix} P_{00} & P_{01} & \cdots & P_{0M} \\ P_{10} & P_{11} & \cdots & P_{1M} \\ \vdots & & & \vdots \\ P_{M0} & P_{M1} & \cdots & P_{MM} \end{vmatrix} \qquad \begin{array}{l} P_{ij}\geq 0, \quad \sum_{j=0}^{M} P_{ij}=1 \\ P_{00}=1, \\ P_{0j}=0 \textit{ for } j\neq 0 \end{array}$$

If the probability transition matrix were given by a simple Markov process, then each time the firm found itself in state i there will be the same fixed probability P_{ij} that it would next be in state j - that is the process would be memoryless. However, we know this not to be empirically correct if the state is given by firm size: Old firms are much less likely to experience a sudden spurt in growth or a reversion to state zero than young firms are (See Figure 1). Thus we would prefer that the probability transition should

Figure 1: Old Surviving Firms Are Less Likely than Young Firms to Experience a Sudden Spurt in Growth



Sales measured in thousands of 1980 French francs.
These 6 firms selected from a random sample of 20 surviving firms.

have memory, or equivalently that a learning process is in action, so that the history of the random variable is in some way relevant to the likelihood of its future value.

There are a number of ways to incorporate memory of the firm's history into the probability transition matrix (See Table II), and this will depend on the exact nature of the learning process being considered. The historic dependency of the probability transition matrix may be such that each past observation carries the same weight, as in Jovanovic's (1982) Bayesian learning model. In this model the firm is continuously accumulating information on a stationary efficiency parameter, so all past observations are equally important in determining the firm's current expectation of its efficiency. Conversely, in the active exploration model of Ericson and Pakes (1989) as well as the models in which learning is from sources external to the firm, the most recent observations carry correspondingly higher weights, since the firm's efficiency is evolving over time and very old information no longer bears much relevance to the current state.[2] The same applies to models 3 to 5 in Table II, all of which have external sources of learning and involve changing firm efficiencies over time so that the recent observations are most indicative of the current state of the firm.

The nature of the probability transition matrix is more complex in the first two models of Table II, where the firm's size determines its efficiency and firms prefer to be larger in order to be more efficient. In these models it is the firm's cumulative size which

[2]Pakes and Ericson (1990) find evidence in support of the notion that the Jovanovic model may be more relevant for retail firms whose efficiency is more likely to depend on stationary factors such as the location of an outlet, while their own (1989) model is more suited to manufacturing firms, where R&D plays a greater role.

determines its efficiency, at least up to some threshold beyond which it has little left to learn. If we assume there exists some maximum learning threshold above which the firm ceases to learn and efficiency reaches its maximum, then the probability transition matrix will have two distinct parts. Below the maximum learning threshold, the firm's size will depend on its cumulative size to date, so all past observations on size will be equally weighted in determining the probability of moving to other states. Above this threshold, the firm's size will follow a Markov process whereby the probability density function is centred around current size with a smaller variance than before.

In all these models the firm's learning increases over time at an eventually diminishing rate. Thus, we can imagine any of these learning models acting in the same way: In each period the firm adds to its stock of knowledge, and the new information it acquires constitutes the "news" for that period. This "news" generates shocks to its system which impact its size in the sense that if it receives bad news this generates new costs to the firm while if the news is good it leads to expansion (such as the addition of new products). Large firms at any age are better able to sustain shocks because their larger size and cash flow provide them with a cushioning from unexpected costs. But the nature of the shocks are age-dependent: As long as the learning curve is increasing, initially steep and eventually flat, it will be the case that the variability and magnitude of the "news" declines with age, causing older firms to be less likely to fail or to experience large deviations in size.

If we add to this structure heterogeneous initial firm efficiencies (due to differing managerial skills, location choice, initial technology, etc.) the learning process will yield a size distribution of firms with larger and older firms benefitting from a more advanced state of knowledge. These larger and older firms will be less vulnerable to failure, and as they reach the limits of their learning possibilities, they will settle into steady state growth rates which will no longer depend on their size or age.

The exact formulation of such a model is beyond the scope of this thesis, but it is clear that there is a good deal of work remaining to be done on modelling the growth and survival process of firms, and this topic will remain on the research agenda of industrial economists for some time yet.

APPENDIX: An Overview of Labour Management Theory and Practice

I would like to thank Saul Estrin and Lina Takla for helpful comments and suggestions on this section. Any remaining errors are my own.

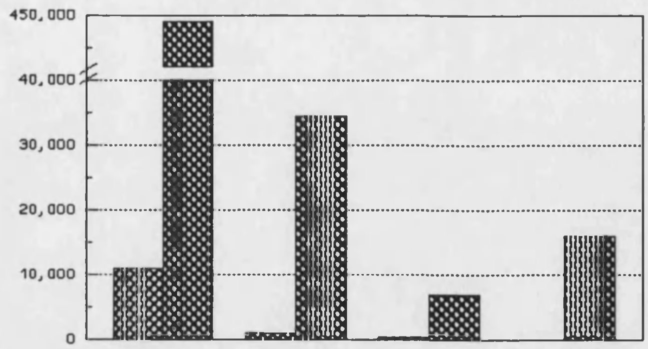
1. Introduction

This appendix is directed at readers unfamiliar with the nature of the cooperative sector in western economies, and with the theoretical literature on labour management. It is arranged as follows: Section 2 presents a brief overview of the institutional structure of the cooperative sector in the western world, highlighting some of the differences and similarities across countries. Section 3 provides an overview of the economic theory of the labour managed firm relative to the profit maximising firm, stressing some of the concepts key to the research in this thesis.

2. An Overview of the Cooperative Sector Worldwide

Producer cooperatives have existed in the western world economies for over a century. Although they still remain fairly rare relative to the overall population of firms, a number of nations have developed quite large and well established cooperative sectors, including France, Italy, Spain, Israel, and to a lesser extent, the United Kingdom, the United

Distribution of Cooperatives in 1981



	Italy	France	U.K.	Mondragon
Number of Firms	11,000	1,048	468	80
Employment	40,000	34,392	7,000	16,000

Source: Ben Ner (1988)

States, Germany, Sweden and Denmark and even developing countries such as Tanzania, Sri Lanka and Fiji. In addition the state cooperative sector in the former Yugoslavia has also been studied extensively (Estrin, 1983, Stephen, 1984).

Typically producer cooperatives have tended to locate in construction-related industries, light manufacturing, and more recently in services where production is fairly labour intensive and start-up costs tend to be low. While the institutional features of these firms vary greatly across these nations, for the most part a number of general features are held in common by cooperatives worldwide.

2.1 Membership Rights

Profitsharing

Membership in a cooperative is characterised by equity ownership which entitles workers to profitsharing as well as participatory rights. Members must typically own at least one share in the firm, and in most cases there exist restrictions on the maximum portion of shares any individual may own. All profitable cooperatives pay some share of their residual to workers; in France for example, this share must at least equal 25 percent. The mechanism for distributing profits varies; in some cases it is on an egalitarian per head basis (U.S., Israel), in others the maximum gap in earnings across the firm's labour force is restricted (Spain, Italy), and in others profit shares are weighted according to each member's contribution in hours, skill, seniority, etc. (France, U.K.) Similarly, if the firm incurs losses these must also be financed by members, and this typically occurs through a lowering of the share price and/or the issuing of new shares which must be purchased by new or existing members. If such measures are insufficient or impossible, typically the firm will shut down.

Most cooperatives may employ nonmember or "hired" labour. The principal exception to this rule is the sector of Mondragon cooperatives in the Spanish Basque provinces, where only temporary nonmember labour may be hired. In some countries, there is a cap on the maximum ratio of nonmember workers (50 percent in Italy) and/or a minimum required number of members (France, Italy, UK, US). The treatment of nonmember labour varies; these may be paid a fixed wage (U.S., U.K.) or they may receive profitsharing similar to members (France, Italy).

In countries such as France and Italy there exist rules of Free Access; that is, nonmember workers or even new workers wishing to become members are allowed entry by means of the purchase of membership shares. Similarly, members wishing to relinquish this status may give it up by selling back their membership shares to the firm. However, in practice it is unclear to what extent access to and exit from membership is freely available, and there is evidence of discriminatory and strategic behaviour by members to prevent admission to entrants they perceive as undesirable. In Spain and Israel, for example, potential members must apply and be accepted by the existing membership body before they can purchase membership shares.

Return on Equity

In addition to profitsharing, members are also in some cases entitled to receive some form of return on membership shares. For ideological reasons, this return has generally be small and has been capped (France, Italy, U.K.); in some cases it is set to zero.

Participation

Participatory rights vary greatly across countries, but in all cases members get one vote each regardless of the proportion of shares they own. In most cases cooperatives above a certain size of employment elect either a manager or a committee to run the day to day operations of the firm. Major decisions will normally be made by general assembly voting by all the members, although this varies and in the case of Yugoslavia it appears that most decisions were in fact made at the state level even though the workers nominally had decision-making powers.[1]

2.2 Financial Structure

Typically the cooperative's members own the firm's capital, either collectively (France, Italy, Spain, U.S.) or by a combination of collective and individual ownership (some UK firms). More unusual is the Yugoslav case where capital was socially owned by the nation at large.[2] Where capital is collectively owned, workers-members must hold an equity stake in the firm. Equity shares are typically valued at par (France, Italy), so appreciation in the value of the firm's capital is not directly realisable through share redemption. Membership is normally not tradable either, and new members must buy their equity from the firm while departing members must sell their equity to the firm, with all transactions at par value.

Financing is most often through internal equity financing or retained earnings. In fact in some countries, some portion of profits must be set aside by law for reinvestment.

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[1]See Estrin (1983), Stephen (1984).

[2]Estrin (1983).

Where this is inadequate, the firm may resort to external borrowing from the banking sector. In some countries there exist preferential borrowing arrangements or tax advantages for cooperatives (France, Italy, U.K., Spain.) More rarely, external purchases of equity in the firm can be permitted at times, although this tends to be discouraged since it violates the cooperative spirit of these organisations. In the Yugoslav system, debt financing was centrally allocated by banks to the firms and this formed the principal source of the firm's capital. Nevertheless, there was some self-financing by enterprises although the share of self financing was only 10 percent in 1953, rising to 38 percent by 1964. From 1964-1974 the state withdrew its direct control and enterprises became more active in their own financing.

2.3 Exit

Shutdown conditions vary as well across nations. In most cases, in order to preserve the cooperative sector from disappearance, laws have been enacted preventing the residual value of the firm over and above the face value of outstanding shares to be paid back to members. Typically, this value may be donated to other cooperatives, or revert back to the overseeing organisation (France), but may never revert back to owners. This is designed to prevent the liquidation of successful firms for the realisation of capital gains. In some countries where such rules do not exist, such as for certain classes of cooperatives in the U.K., there has been a tendency for profitable cooperatives to be liquidated.[3] Israel's producer, transportation and service cooperatives differ from the above framework in that the share price is continuously adjusted to reflect the value of the firm's assets. As a consequence, successful firms have accumulated considerable

[3]Estrin and Pérotin (1987).

amounts of capital raising the share price of the firm, and making it very difficult for prospective members to raise the cash necessary to purchase an equity stake in the firm. As a result the share of workers who are members has declined steadily over time.[4] In the Yugoslav system, shutdown was virtually unheard of and was rendered unlikely by the very high interlinkages created among firms by inter-enterprise credit.

2.4 Cooperatives in France

Much of the theoretical analysis and all of the empirical analysis in this thesis deals with the French producer cooperative sector, which is briefly surveyed in this section. The institutional rules governing French cooperatives have been particularly well designed to combat the pitfalls that typically have led to the demise of such firms elsewhere. To begin with, France has entirely avoided the issue known in the economics literature as "degeneration", that is that successful cooperatives will replace departing members with cheaper hired workers until there is only one member left and the firm is essentially a capitalist firm. The French have achieved this by a number of means: first, nonmembers are paid equal profitsharing to members in the firm, and since the return on shares is capped at low or even negative effective rates of return, there is little if any difference in incomes between the two classes of workers; second, free access to membership ensures that even if the ceiling on the return on membership shares is set high enough so that it becomes a nonbinding constraint, the conversion of nonmember to member labour will drive the real return on membership shares down to near zero. Additionally, the French system ties the maximum return on the firm's equity to the average yield on corporate bonds over the past six months, thereby preventing the return on membership

[4]Russell (1991).

shares in profitable firms from falling too far out of line with the market outside the firm. And finally, the French system precludes the reversion of the firm's accumulated surplus to members in the event of shutdown, eliminating the members' incentive to shut down a profitable firm in order to realize capital gains.

A major portion of the liberalising legislation was passed in 1978, prompting a boost in the rate of cooperative formation.

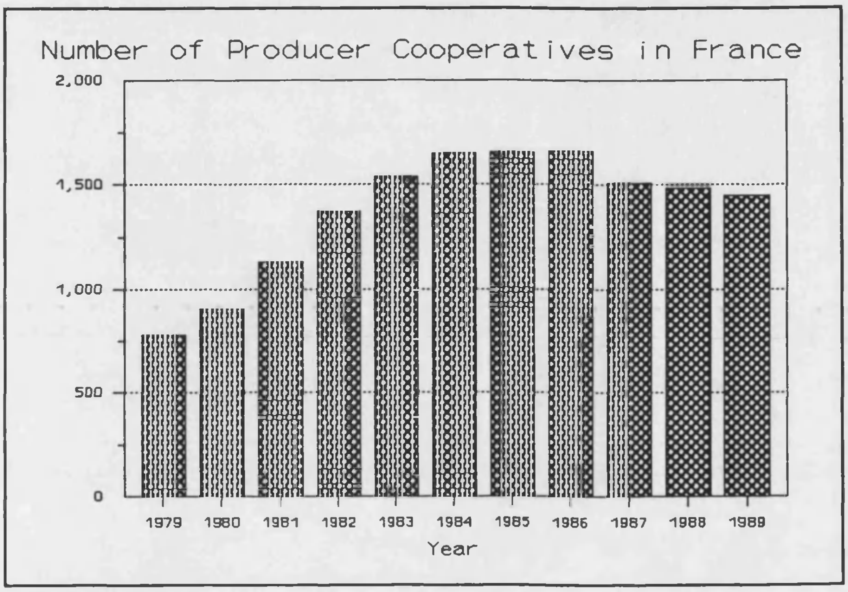

Figure 2

The 1980's saw a remarkable growth in the number of firms operating in the French cooperative sector, as can be seen from Figure 2 above.

3. Comparative Economics Literature

3.1 The Perverse Short Run Supply Response

From the start economists studying labour management discovered novel and unusual implications of cooperative behaviour relative to conventional profit maximising firms. This led to a burgeoning of the literature on the comparative behaviour of such firms.

Benjamin Ward's seminal paper (1958) laid the groundwork for much of the work that was to follow, and coined the phrase the "Illyrian firm" to denote the utopian cooperative he based his discussion on. Ward's firm was an all member cooperative in which workers received a fixed wage, capital was rented at a fixed rate, and all remaining profits were shared out on a per head basis to member-shareholders as dividends. He showed formally that with capital fixed in the short run, such a firm would respond to an increase in prices by contracting employment and output, leading to the famous "negatively sloped short run supply curve" result.

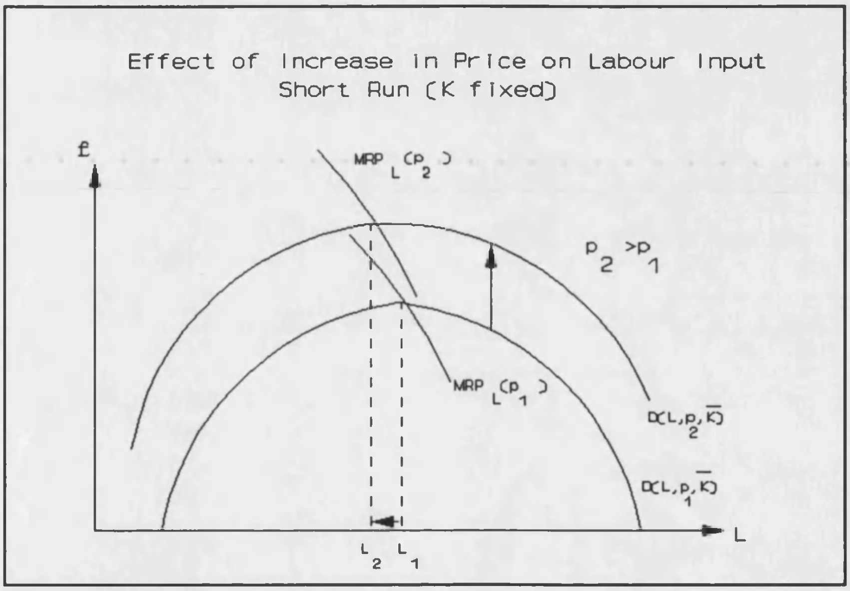

Figure 3

The intuition of the result is clear from Figure 3 above: The Illyrian firm sets the marginal revenue product from the last worker employed to equal the dividend that must be paid to him. An increase in price raises both the marginal revenue product of labour, and the dividend, but it raises the latter by more. This means that with the existing labour force the contribution of the marginal worker falls below what the firm must pay him. Thus the optimal course of action is for the firm to contract employment thereby increasing the dividend to its maximum possible level.

Over subsequent years the analysis of the Illyrian firm was extended further, most notably with the work of Domar (1966) extending the model to the multi-input and output case, and Vanek with the general equilibrium extension (1970), and as well as countless others. Later work extended the analysis to the long run behaviour of the Illyrian firm model, where the price response of the firm was shown to be indeterminate (Ireland and Law, 1982, Estrin, 1982.)

Most of the work dealt with the static analysis of such firms until Atkinson (1973) developed a steady state model of cooperative growth. In his model, which is a fixed input proportions model, he incorporates technological progress and scale economies. While aggregate demand is shifting out over time, Atkinson's firm can enhance its demand further by means of promotional spending. The firm's only incentive to grow is to achieve scale economies, so the rate of growth selected depends on the extent of scale economies and the effective discount rate of the workers. The latter, of course, determines how valuable scale economies achieved in the future will be to the firm. Atkinson shows that the steady state growth rate selected by the labour managed firm will always be less than that of the profit maximising firm over the regions that both firms will remain in business.

3.2 Life Cycle and Degeneration

It was somewhat later that papers addressing the life cycle of cooperative forms of organisation appeared, in particular Ben Ner (1988) who suggested a countercyclical pattern existed in cooperative formation. He posited that in recessionary periods we would witness large scale conversion of failing capitalist firms into cooperatives as workers would seek to retain their jobs and gain from the internalisation of the owner-worker conflicts.

A separate strand of literature, the degeneration literature, raised doubts about the long term viability of the cooperative form of organization. These ideas are attributed to Ben Ner (1984) and Miyazaki (1984). The idea here was that since it is common practice for these firms to employ hired workers, if such workers were paid a fixed wage they would cost a profitable firm less than the profitsharing paid to members. Thus the firm would always be made better off if departing members were replaced with cheaper hired workers. Of course in the limit, a sole member would remain and the firm would effectively have been transformed into a capitalist firm.

3.3 Underinvestment

Yet another strand of literature, associated principally with Furubotn and Pejovich (1974), emphasised the loss of property rights in the labour managed firm, and the impact this would have on investment policy. Where workers are unable to claim the residual surplus of the firm in the event of shutdown, the incentive is to distribute all surplus as dividends and to borrow externally to finance investment. If capital markets are in any way biased against these firms, this will result in capital shortage. Even if not, 100 percent debt financing is seldom possible or advisable in practice (Ellerman, 1986). And workers with the shortest time horizons will be disagreeable to even borrowing for investment, since they would rather receive the rental cost as income.

4. Summary

It is clear that the cooperative sector in the Western world is of substantial importance in absolute terms, even if it is small in relative terms. Furthermore the issues raised by the theoretical literature have underscored the contrast in the predicted behaviour of these firms vis-à-vis conventional capitalist firms. While this appendix does not (and is not meant to) represent a comprehensive survey of the labour managed firm literature, it should provide the reader who is unfamiliar with the area with adequate background to follow the rest of the thesis.

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