Firm Survival and Quality Labels in the Food Industry

Christophe Bontemps[*], *Zohra Bouamra-Mechemache*[†] *and Michel Simioni*[‡]

May 3, 2010

Abstract

Both industry and firm characteristics influence the survival of a firm in an industry over time. Aging, size, structure are factors often discussed in the literature, but public intervention effects -through public quality labeling for example - may also have an effect that is examined here. We use data on French firms producing cheese under public quality label or not over the period 1990-2006. We perform a nonparametric estimation using Kaplan-Meier estimators as well as proportional hazard rate models.

Our results confirm existing findings on firm survival determinants. We also shed light on the effect of public intervention into that industry. More precisely, our focus on public quality labeling in the French cheese industry shows that quality label reduces the risk of exiting for firms and more particulary for small firms. In other words, public intervention in this industry is well designed to increase the competitiveness of small firms enabling the coexistence on the market of both small and large firms.

Selected paper prepared for presentation at the Agricultural & Applied Economics Association 2010 AAEA,CAES & WAEA Joint annual meeting, Denver, Colorado, July 25-27, 2010[1]

[*]Toulouse School of Economics, Gremaq-INRA

[†]Toulouse School of Economics, Gremaq-INRA

[‡]Toulouse School of Economics, Gremaq-INRA and IDEI

[1]We gratefully acknowledge financial support from the department of agricultural economics from INRA.

1 Introduction

The quality of food products is becoming an important issue for public authorities. Consumers care about some quality attributes of products and are willing to pay for them. Consumers increasingly value the quality and the geographical characteristics of agricultural products (Marette (2005)). However some of these characteristics are unobservable to them. Then the quality of such products, called credence goods, cannot be recognized as such by consumers. In this situation, producers may not have the incentive to produce high quality products (Akerlof (1970)). Public intervention, though, may enhance social welfare by providing public labels that certifies the quality of the product (Auriol and Schilizzi (2003)). In particular, smaller firms that can find it too expensive to signal individually the quality of their products can collectively signal it by sharing the cost of quality signal through public quality label. For instance, it has been empirically shown in the case of a specific French cheese industry that firms engaging in such a label were mostly small size firms (Bouamra-Mechemache and Chaaban (2010)).

Some countries have adopted this kind of regulation for many years. For instance, the AOC (Appellation d'Origine Controllée) regulation in France and the DOC (Denominazione di Origine Controllata) in Italy have been respectively created in 1935[2] and in 1963. In line with the successive reforms of the Common Agricultural Policy that tends to eliminate price support and use non distortional measures that are decoupled from production in the European Union, the European Commission (EC) has also developed an EU quality policy. Its objective is to valorize and protect agricultural and food products through the diversification of agricultural production in order to 'achieve a better balance between supply and demand on the markets' (European-Commission (1996)).

High quality reputation is expected to sustain competitiveness and profitability of the agricultural sector. Different quality labels have been introduced from 1992 (Regulation (EEC) No 2081/92) for geographical indications mainly: protected designations of origin (PDO) and Protected Geographical Indications (PGI). The PDO label certifies both a higher product quality and its geographical origin. Its quality is inherent to a limited geographical area characterized by geological, agronomic, climatic and historical factors. It also depends on specific manufacturing process and human factors requirements. The number of PDO certified products has continuously increased in the EU and mainly concerns wine, cheese, fruit and vegetable, butter and oil, and meat.

[2] AOC recognition follows the creation of the Inao (National Institute for Appellation of Origin) in 1935 in the wine and liquor sector and has been extended to cheese in 1955. A specific regulation for Roquefort cheese allowed the creation of the first AOC cheese in 1925. From 1992, AOC also applies to all agricultural and food products.

Our goal is to assess the ability of such public policy for quality to sustain the competitiveness of firms involved in such a policy and determine which firms have benefited from it. From the theoretical literature on PGI, we know that public label are an efficient tool to provide quality. In a perfect competitive market with free entry, Moschini et al. (2008) shows that an equilibrium exists where PDO producers benefit from positive externalities linked to the sharing of PDO certification cost, which makes possible the production of PDO. When producing PDO, producers earn zero profit and their surplus remains unchanged compared to a generic product in the case of non-upward slopping supply but is increased if they use specialized inputs in scare supply. The perfect competitive setting for PDO products may not always be the adequate market structure to consider given the specificity of the territory, the input and process requirements required in the certification regulation. This is at least the case in the average run where entry adaptation is difficult and even impossible (Hayes et al. (2004)). Moreover, perfect competition applies when the PDO geographical area is large enough and when there is no land constraint so that the PDO products do not cover much of the local agricultural production and production cannot be controlled. For instance, Chambolle and Giraud-Héraud (2003) developed a framework with an exogenous production restriction for PDO, based on the French AOC wine example where the production is adapted to the geographical territory with a limitation of yield per hectare and a control of restrictive processing technology requirements. Certification implies technological requirements that are most of the time not fulfilled above a production threshold (cf. Giraud-Heraud et al. (2003)). One might thus consider the profitability of PDO in a context of non competitive markets where production is somehow controlled and where this supply control may enhance the development of geographical indication market (cf. Marette and Crespi (2003) and Lence et al. (2007)).
More generally, production can be controlled through different ways: the access control to the use of some specific ingredients or process, the choice of a selected area that takes into account the specificity of the region, the limitation of the membership in the producer group, the compliance to strict quality production standard (Hayes et al. (2004)). In this case, if the quality label meets the consumer needs, the innovation in production and marketing developed by the operators for labeled products may lead to a successful activity for those operators.
The role of certification cost also plays a determining role in the profitability of PDO production. Without (or low) certification cost, producers may have the incentives to produce the high quality. However, if this cost is high, then this incentive is reduced and producers may opt to produce the low quality (generic product). The collusion on quantity can then be a tool to overcome this quality provision concern. Actually, when certification costs are high, collusion allows for individual profits that may compensate for the PDO cer-

tification cost and for the cost generated by the PDO technical requirements, so that the PDO emergence is more likely to occur in a monopoly structure than in a perfect competition one, the intermediate structures leading to intermediate likelihood (Lence et al. (2007)).

While the theoretical literature on the profitability of public quality label is extensive, empirical findings are scarce. This paper tries to fill this gap by analyzing how PDO-like label can contribute to the success of firms that voluntary enter into such a quality certification scheme. To accomplish this, we provide an empirical analysis of the French AOC label, which is older than its EU equivalent PDO. In 2010, the AOC labeled products included 49 dairy products and 40 other foodstuffs (among which 13 AOC for fruits and vegetables, 13 for olive and olive oil and 6 for meat) in addition to the 394 wine and liquor appellations.[3]

The performance of dairy firms is measured through their life duration on the market or "survival". It is one of the most widely used empirical measure of performance (Foster et al. (2008)). Firm survival has been shown to be strongly related to other performance measures as profitability and growth and gives a better understanding on industrial strategies (cf. Dunne et al. (1988)). It is used to analyze how AOC quality label has contributed to the development of dairy firms and to the current structure of the dairy industry.

We use two data sets that cover the period 1990-2006 and provide information on the characteristics of firms and products in the dairy sector. The first one is an annual firm survey that cover firm-level data while the second one is an exhaustive survey of all dairy plants that provides information on individual production at a detailed level of product category. Such information which is quite difficult to obtain at the individual level enables us to distinguish among AOC and non AOC plants. We use it for the first time to assess the impact of AOC on firm performance. Because cheese represents all but one dairy product under AOC, we focus on AOC cheese and analyze the role of AOC on the dynamics of the French cheese sector.

The article is organized as follows. The next section review the determinants of firm survival. Section 3 provides an overview of the data set and discusses its strengths and weaknesses for measuring firm survival rate. Section 4 presents the methodology used to estimate survival rate and Section 5 provides the main estimation findings. The final section discusses conclusions and implications for future research.

2 Determinants of Firm Survival

The relation between performance and survival has been empirically shown. Measure of performance through total factor productivity affects

[3] A specific European regulation applies for PDO wine.

survival (Bellone et al. (2006) and Foster et al. (2008)). Lower performance is observed some years before their failure (Kiyota and Takizawa (2006)). Different factors may explain survival. Actually, various "stylized facts" have been drawn from the empirical literature on firm survival, entry and exit. These facts apply in many countries and for many industrial sectors (Geroski (1995) and Caves (1998)). Both industry and firm characteristics influences firms' duration length. Substantial rates of entry and exit is recurrently found in a number of countries. In this section, the main findings are summarized. We use these findings to construct the empirical strategy when testing the determinants of cheese firm dynamics.

Table 1 summarizes the determinant of firm survival found in the literature. The age of firms is an important feature of firm survival. New firms face high risk of failure during the first years of their existence (newness). Their capacity to survive depends on their ability to gather market information and to modify their strategy to the post-entry environment. Firm mortality then declines over time. The oldest firms may suffer from erosion of technology and products (obsolescence) over time so that their failure rate may be high (aging). However, they may also benefit from strong trademarks that help them increase their longevity. Firm size is also a major determinant of survival (smallness). This factor is relevant both for new and older firms but its impact is stronger on the dynamics of new firm. According to Aldrich and Auster (1986), different factors may explain this fact. First, small-sized firms may have more difficulty to raise capital. Second, tax law can be more detrimental compared to larger firms. Third, public regulation affects more smaller firms. In addition, large firms may be favored in the competition on the labor market. Considering that the failure rate is increasing with the size of irretrievable outlay needed to move from minimal or fringe entry to optimal-scale operation, the size of irretrievable outlays also acts of the survival of firms. It results that small firms may have a higher failure rate as they will find it more difficult to reach the minimum efficiency size at which they will be able to operate. Another explanation of the size impact on survival is related to the costs of labor and capital. If they are high, this could be detrimental to new/small firms that will have more difficulty to develop their activities and favor older/larger firms. In addition to age and size, the structure of the firm may also affect firms' dynamic. As shown by Disney et al. (2003), when an establishment is part of a group, it increases its survival rate relative to a single establishment. This result supports the idea that establishments that are part of a group can learn from other establishments of the group and get better market information compared to single establishments.

The dynamics of firms also depend on the characteristics of the industry under consideration. Comparison between different industries in different countries reveals common industry determinants for survival patterns. Both entry and concentration depend on the sunkness of incumbents' com-

Table 1: Determinants of firm survival

Determinant	Impact on survival
Firm characteristics	
Newness	-
Aging	+/-
Obsolescence	-
Smallness	-
Capital and labor cost	-/+
Establishment part of a group	+
Productivity	+
Industry characteristics	
Barrier to entry	-/+
Innovativeness	-/+
Early stage in life cycle	-/+
Agglomeration and technological spillover	+

mitment and more generally on trade barriers, which has an incidence on survival length. Trade barriers in an industry can arise from high minimum efficiency scale (MES), capital intensity, advanced technology or product differentiation and innovation. On the one hand, a high MES implies relative large amount of resources that are needed to reach the MES. If firms cannot achieve this level of resources, they may not be able to survive on the market. On the other hand, firms that have entered the market will be less sensitive to exit when they have incurred large sunked resources. A high level of innovative activity in an industry may make entry more risky and increase failure risk (Jensen et al. (2008)). However the reverse could be also true if there is a self selection process of firms before entry decision. Moreover, it may exist some knowledge spillovers for firms that are close to innovative firms. Agglomeration or regional advantages may compensate negative effects of higher costs and competition from other firms located in the the same area. Falck (2007) and Fritsch et al. (2006) empirically show the importance of these regional effect on survival. The distribution of innovations between new and incumbent firms changes over the industry life cycle. These changes affect the probability of survival for firms (Agarwal and Gort (2002)). Lower survival rate occurs at the early phase of life cycle when innovation is high and entry risky while higher survival occurs in the later phase when the market is mature and competitiveness increased as innovation and technical change rate are limited. When the phase of obsolescence of initial endowments is reached, the failure rate increases again.

Our analysis focus on a specific industry, the French cheese industry.

We analyze the impact on firm dynamics of the most relevant factors identified above, age, size, MES and single establishment firm. In this specific industry, we will study the impact of some form of innovation through public labeling (AOC). When adopted by firms, AOC may incur higher costs linked to quality requirement and certification costs on the one hand but they can benefit from the higher quality signaled to consumers and increase their competitiveness on the other hand. We asses the impact on AOC label on survival on the relative importance of these factors.

3 Data and Descriptive Statistics

We use firm and plant surveys covering the period 1990-2006 provided by the French Administrative Direction of Statistics (INSEE). The first main set information reports economic and administrative information at the firm level (EAE) while the second set is reporting production, activities and more detailed information on the industrial process at the plant level for dairy firms (EAL). [4] The first set is available only for firms with more than 20 employees, while the second set is exhaustive at the France level.

The proportion of AOC in the total production of cheese amounts to around 17%. We focus in this study on AOC cheese made from cow (30 AOC) and sheep milk (3 AOC) which represents 97% of milk used in the processing of AOC cheese.[5] Each observation gives us information on firms that might be constituted of different plants.

The survival analysis is performed on the 1430 firms observed during the period 1990-2006, for which we were able to identify if the firm was producing cheese with AOC label or not. We have information on all firms (of more than 20 employees) involved in cheese production. Among those 485 firms observed on the period, cheese production may or not be the main activity of the firm. When firms have other activities, cheese is most often the main one. Other activities include dairy products other than cheese. We also consider as firms individual plants that are reported in EAL and that are not linked with firms present in the EAE baseline. These firms, for which accounting data are not available are reported as small firms of less than 20 employees. We choose to do the analysis at the firm level rather than at the plant level. An analysis at the firm level is more relevant as AOC like strategy is decided at the firm level and not at the plant level. Moreover, it enables us to take into account firm characteristics that may

[4]EAE stands for *Enquête Annuelle d'Entreprise* while EAL is the *Enquête Annuelle Laitière*, both provided by INSEE (Institut National de la Statistique et des Etudes Economiques.)

[5]Data from EAL do not allow the identification of AOC cheese from goat milk. AOC cheese from goat milk have been mainly developed from the nineties and concerns 13 AOC cheeses.

influence firm survival as its number of plants or its product mix.[6] Entry and exit data thus correspond to the creation and destruction of firms and firms are considered to be active as long as at least one of its plant is active (i.e. produces cheese).

We are able to compute the time spells corresponding to the survival of the surveyed firms using the previously described data sets. By construction these time spells are evaluated as intervals measured in years over the period 1990-2006. Indeed, our data indicate that a firm was present in the sample during a given year. But, when a firm disappeared in the following year, the exact time (day or week) the exit has occurred is not known. In this case the transition times are said to be grouped and discrete-time hazard models are used to deal with such data. Thus the minimum value of a time spell is one year, and its maximum value is 17. As in Disney et al. (2003), we consider that a firm exit in a given year t if it is observed in year t and if it was already present in year $t-1$ but absent in year $t+1$ and we consider that a firm enter if it were absent in year $t-1$ but present in year $t+1$. Some firms may be absent both in $t-1$ and in $t+1$. They are considered as one year only entrant. Finally, stayers are firms that are observed to be active in t and that are neither an entrant, an exitor nor a one year observed firm. Then, the number of firms observed a given year is equal to the sum of the number of entrants, exitors and stayers minus the number of one-year-only firms. All the previous definitions are summarized in Table 2.

Table 2: Definition of entry and exit

	t-1	**t**	**t+1**
Exitors	Observed	Observed	Non-observed
Entrants	Non-observed	Observed	Observed
One-year-only	Non-observed	Observed	Non-observed
Stayers	Observed	Observed	Observed

The pattern of entry and exit is summarized in Table 3. Compared to other studies, the cheese sector in France exhibits a lower rate of turnover with only 8% of firms being on the market a given year exit the market while only 5% enter, meaning that the French cheese sector became more concentrated with time. It results that the number of firms on the market decreases in time. From 1990 to 2006, the number of firms have decreased by 40% from 924 to 559. Entry and exit rates in the French cheese sector are in the range of values found in the literature for manufacturing industries. For instance, Caves (1998) reports a study comparing entry and exit rates in several countries and found entry rates varying from 3 to 13% and exit rates from 5 to 13%. These values are higher in the study of Disney et al. (2003)

[6] We have also performed the survival analysis at the plant level excluding the variable linked to firm (product mix, number of plants) and similar results were found.

that found an entry rate of 18.5% and exit rate of 16.5% in the food, drink and tobacco sector in U.K. on the period 1986-1991. Similarly, Fritsch et al. (2006) find that the survival rate after two years for start-ups in the food sector is around 72%.[7] In addition, reported entry and exit rates in these articles suggest that the food sector are among the industries showing the lowest entry and exit rates. Another feature is that entry and exit rates are both relatively low, which is consistent with the facts reported in Geroski (1995) (stylized fact 3) that states that net entry rates and penetration are modest fractions of gross entry rates and penetration. Moreover, the net exit rate is quite low (3%), which suggests that the French cheese sector is in a rather mature stage of its lifecycle (Agarwal and Audretsch (2001) and Jensen et al. (2008)).

Table 3: Number of firms: Stayers, Entrants and Exitors

Year	**All**	**Stayers**		**Entrants**		**Exitors**		**One-Year**	
		N	*%*	*N*	*%*	*N*	*%*	*N*	*%*
1990	924	795	86 %	58	6 %	71	8 %	0	0 %
1991	872	771	88 %	21	2 %	85	10 %	5	1 %
1992	809	725	90 %	25	3 %	64	8 %	5	1 %
1993	783	685	87 %	39	5 %	62	8 %	3	0 %
1994	753	621	82 %	32	4 %	102	14 %	2	0 %
1995	707	589	83 %	63	9 %	59	8 %	4	1 %
1996	674	610	91 %	25	4 %	41	6 %	2	0 %
1997	653	518	79 %	21	3 %	117	18 %	3	0 %
1998	642	518	81 %	99	15 %	28	4 %	3	0 %
1999	652	573	88 %	38	6 %	41	6 %	0	0 %
2000	643	569	88 %	34	5 %	43	7 %	3	0 %
2001	614	577	94 %	13	2 %	24	4 %	0	0 %
2002	607	562	93 %	17	3 %	28	5 %	0	0 %
2003	596	546	92 %	15	3 %	36	6 %	1	0 %
2004	585	528	90 %	24	4 %	38	6 %	5	1 %
2005	570	519	91 %	21	4 %	32	6 %	2	0 %
Mean	693	607	87.6%	34	5 %	54	8%	2	0.3 %

Now consider the covariates that can affect the survival of the dairy firms. In Tables 4 and 6, we define several variables of prime interest for the analysis performed here. These variables include the main determinants of firm survival found in the literature.

[7]The study of Disney et al. (2003) analyzes the pattern of industries using plant data and the one of Fritsch et al. (2006) considers only very small firms. These features may explain why they find higher values. The smaller the production unit, the higher the turnover will be.

Table 4: Time-Constant Variable description

Variable name	**Unit**	**Description**
Year	[1990 – 2006]	current year
Survival	#	survival of the firm (in years)
AOC	dummy	= 1 if Firm is producing AOC cheese
Multi	dummy	= 1 if firm with multi-plants , 0 if single
Old	dummy	= 1 if firm created before 1990
IMES	dummy	= 1 if firm's production above the Minimum Efficiency Scale of its specific Cheese industry
IGroup	dummy	= 1 if firm has been affiliated to another firm, 0 if independent

Table 5 reports descriptive statistics on the variable created and useful for the first step of the survival analysis presented below. These variables are time-constant variables. We consider that the firm is producing an AOC cheese whenever at least one of its plant produces an AOC cheese during the whole period. Half of the observed firms have produced AOC at least one year. $Multi$ is a dummy variable indicating that the firm had more than one plant during the whole period. This variable can be viewed as a proxy of the size of the firm as 90% of single firms employless than 51 employees, while 50% of the multi-plant firms employ more than 39 people (the median for single firms being 20).[8] The sample is mainly composed of single plant firms (78%). *Old* indicates whether the firm was present or not before the beginning of the period under scrutiny. $IMES$ indicates whether a firm has reached or not the minimum efficiency scale defined as the median firm production by category of cheese during the whole period.[9] Finally, $IGroup$ denotes that a firm has been a subsidiary firm.

Table 6 describes the time-varying variables we use in the second step of the survival analysis. These variables were previously used in order to build some of the firms time-constant features presented above. Table 7 presents some summary statistics of those variables.

4 Empirical Methodology

By the definition or the period covered by the surveys (1990-2006), three different time spells can be observed:

[8] In our dataset, more precisely in the EAL survey, we cannot recover the exact number of employees for firms with less than 20 employees.

[9] The repartition of firms according to cheese production category shows that on third of them devotes their main production to hard cheese, 22% to semi hard cheese and 18% to soft cheese, the remaining firms producing blue cheese, processed cheese, fresh cheese and other cheese.

Table 5: **Time-Constant Summary Statistics**

variable	mean	sd	min	max	N
Survival	8.12	5.51	1.00	17.00	1430.00
AOC	0.50	0.50	0.00	1.00	1430.00
Multi	0.22	0.42	0.00	1.00	1430.00
IMES	0.54	0.50	0.00	1.00	1430.00
Old	0.62	0.49	0.00	1.00	1430.00

Table 6: **Definition of time-varying variables**

Variable	Definition
$AOCshare_t$	Share of AOC production relative to the total cheese production of the firm in year t
MES_t	= 1 if Firm's production is above the Minimum Efficiency Scale of its specific Cheese industry in year t
$Group_t$	= 1 if Firm has been affiliated to another firm in year t

Table 7: **Summary Statistics of time-varying variables**

variable	mean	sd	min	max
AOCshare	0.69	0.86	0.00	16.00
MES	0.50	0.50	0.00	1.00
Group	0.17	0.38	0.00	1.00

1. complete time spell when a firm enters the sample before 1990, and exits before 2006,

2. right-censored time spell when a firm enters after 1990, and is still alive in 2006, and

3. left-truncated time spell when a firm entered before 1990, and exits before 2006 or is still alive in 2006.

We can identify this latter type of time spell because the surveys indicate if a firm was active or not before 1990. But, for most of the firms that were active before this year, we do not know when they have been created. Fortunately, left truncation will not affect the maximum likelihood estimators presented below. Indeed, it can be easily shown that the correct contribution under delayed entry is simply obtained by letting the firm start contributing observations after entering the study in 1990 and discarding the periods preceding 1990.

The starting point of modeling the survival of firms using the previously defined time spells, is then to define the discrete-time hazard function as the probability of exit at discrete time t, given that it has not yet occurred, i.e.

$$h_t = Pr\left[T = t | T \geq t\right] \tag{1}$$

The discrete-time survivor function, i.e. the probability that duration before exit exceeds t, can then be obtained recursively from the hazard function (1) as

$$\begin{aligned} S(t) &= Pr\left[T > t\right] \\ &= \prod_{s=1}^{t} (1 - h_t) \end{aligned} \tag{2}$$

Given the definition of the discrete-time hazard function in (1), a natural estimator of this function is

$$\widehat{h}_t = \frac{d_t}{n_t} \tag{3}$$

where d_t is the number of non censored time spells ending at time t, and n_t is the number of firms at risk at time t_j. More precisely, when time spells can only be right censored, the number of firms at risk at time t equals the number of firms that were alive at time $t-1$ minus the number of firms that exit at this time, their time spells being censored or not. Left truncation refers to firms which do not come under observation until they are at risk. By the time you begin observation of such firms, they have already survived for some time, and you observe them only because they did not exit during that time. Thus, when such firms become at risk, n_t is simply increased by adding their number to reflect this fact. The Kaplan-Meier estimator or product limit estimator of the survivor function defined in (2) is then defined as

$$\begin{aligned}\widehat{S}(t) &= \prod_{s=1}^{t}\left(1-\widehat{h}_s\right) \\ &= \prod_{s=1}^{t}\frac{n_s-d_s}{n_s}\end{aligned} \tag{4}$$

This is a decreasing step function with jump at each discrete time t. The Kaplan-Meier estimator can be shown to be the nonparametric maximum likelihood estimator of the survivor function (Kalbfleisch and Prentice, 2002).

Discrete-time hazard estimations can also be obtained as predicted probabilities using a logistic regression model where the covariates are dummy variables for each year, i.e.

$$\text{logit}\left(\text{Prob}[y_{i,s}=1|\ \mathbf{d}_{i,s}]\right) = \beta_1 + \alpha_2 d_{2,i,s} + \ldots + \alpha_J d_{J,i,s} \tag{5}$$

Here, $y_{i,s}$ is an indicator for the exit occurring at time s for firm i, $d_{2,i,s}, \ldots,$ $d_{J,i,s}$ are dummy variables for years 2, …, J, J referring to the last time period observed for any firm in the sample, and $\mathbf{d}_{i,s} = (d_{1,i,s}, \ldots, d_{J,i,s})'$ is a vector containing all the dummy variables for firm i. The constant term β_1 and the α_t, $t = 2, \ldots, J$, are parameters to be estimated. Indeed, the logistic model (5) can be interpreted as a linear model for the logit transformation of the discrete-time hazard, or

$$\begin{aligned}\text{logit}\left(\text{Prob}[y_{i,s}=1|\ \mathbf{d}_{i,s}]\right) &= \text{logit}(\text{Prob}[T_i = s|\ T_i \geq s,\ \mathbf{d}_{i,s}]) \\ &= \text{logit}\left(h_{i,s}\right)\end{aligned} \tag{6}$$

No functional form is imposed on the relationship between discrete-time hazard and year because dummy variables are used for year 2, …, J, the intercept β_1 representing year 1. Moreover, it can be shown that the obtained estimates of discrete-time hazards constitute the discrete limit of the better known Kaplan-Meier nonparametric estimate of continuous-time hazard rate (Kaplan and Meier (1958)), as time becomes more finely discretized.

Although it can be interesting to investigate how the population average or marginal hazard evolves over time, the main purpose of survival analysis is usually to estimate the effects of covariates on the hazard. This can be done by fitting a logistic discrete-time hazards model including covariates, i.e.

$$\text{logit}\left(\text{Prob}[y_{i,s}=1|\ \mathbf{d}_{i,s},\ \mathbf{x}_{i,s}]\right) = \beta_1 + \alpha_2 d_{2,i,s} + \ldots + \alpha_J d_{J,i,s} + \gamma'\,\mathbf{x}_{i,s} \tag{7}$$

where $\mathbf{x}_{i,s}$ denotes a vector of time-constant and time-varying covariates. Model (7) with only time-constant variables is sometimes referred to as the continuation-ratio logit model or sequential logit model. In this model, parameter estimates possess a direct interpretation in terms of odds ratio. Thus, for a given variable k, the odds ratio is estimated as $\exp(\widehat{\gamma}_k)$, implying that the odds of exiting in any given year (given that exit has not already occurred) increase (or decrease) by $(\exp(\widehat{\gamma}_k) - 1) \times 100\%$.

In the following, when assessing the effects of time-varying covariates on firm survival, we will use the complementary log-log transformation instead of the logit transformation because this transformation function holds if a proportional hazards model holds in continuous time and the survival times are interval censored (see Cameron and Trivedi (2005) or Rabe-Hesketh and Skrondal (2002) for a proof). The complementary log-log discrete time hazards model is defined as

$$\begin{aligned} \text{cloglog}(h_{i,s}) &\equiv \ln\{-\ln(1 - h_{i,s})\} \\ &= \alpha_1 d_{1,i,s} + \alpha_2 d_{2,i,s} + \ldots + \alpha_J d_{J,i,s} + \gamma' \mathbf{x}_{i,s} \end{aligned} \tag{8}$$

The parameters γ in equation (8) are the same regression parameters that are contained in the scale factor of the underlying continuous-time proportional hazards model, i.e. the function $\phi(\mathbf{x}, \gamma) = \exp(\gamma' \mathbf{x})$ in the factorized expression of the continuous-time hazard function $h(\tau|\mathbf{x}) = h_0(\tau) \times \phi(\mathbf{x}, \gamma)$. Similarly, the time-specific constants α_t can be written as function of the baseline hazard function, i.e. $h_0(\tau)$. By estimating these parameters freely for each time-point, no assumption is done regarding the shape of this baseline hazard function within the time intervals.

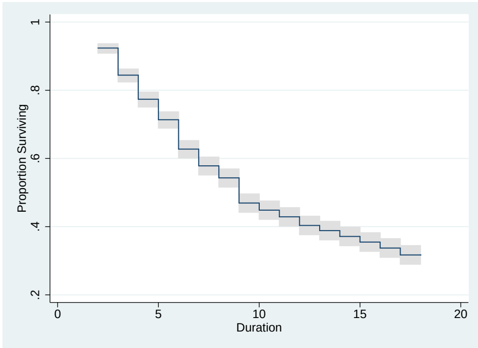
5 Results

Before setting up the multivariate analysis, we first evaluate the effect of each variable described in Table 4 separately using the nonparametric Kaplan-Meier estimator of survival function. Log-rank tests are then used to determine if the survival functions vary between the different groups of dairy firms defined by the modalities of these variables.

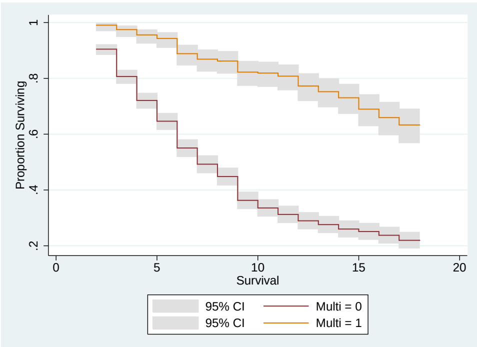
Figure 1a displays the Kaplan-Meier estimates of the survival function without any covariates. In the following figures 1(b-d) we report the estimated survival curves and their respective 95% confidence intervals, allowing the investigation of the influence of four of the variables identified in the literature as having an impact on firm survival (see section 2). Figure 1b present a clear-cut difference between the survival of single and multi plants firms. The variable *Multi* capturing a size effect, this means that larger firms are faced with a lower probability of exit whatever the duration. It is notable that the survivor curve of larger firms is less steep compared to the survivor curve of small firms. We observe less clear-cut results when considering the impact of group affiliation or efficiency scale (see Figure 1c and 1d). The affiliation to a group (resp. exceeding the minimum efficiency

Figure 1: Kaplan-Meier survival analysis

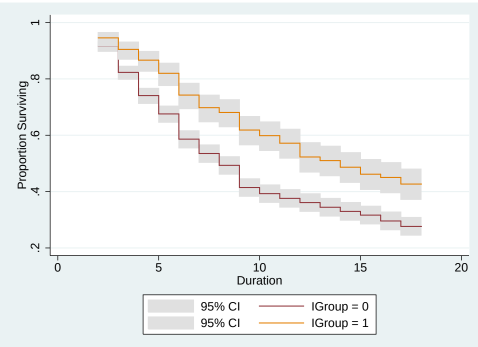
(a) all sample



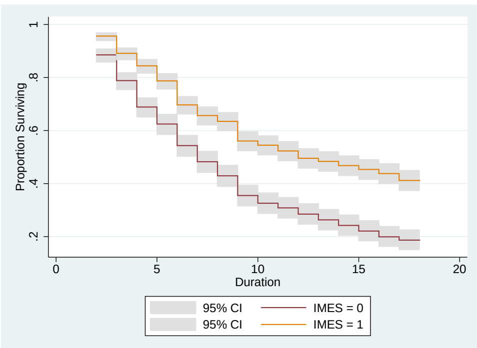
(b) by Multi (single *vs* multiple plantplants)



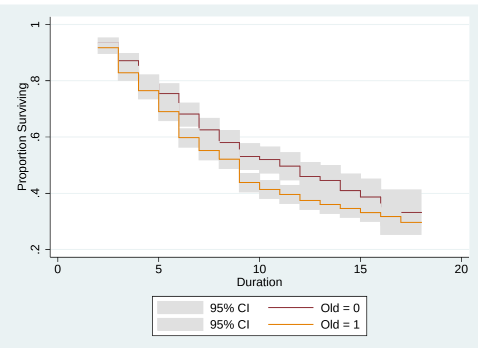
(c) by Group (Affiliated *vs* independent)



(d) by IMES



(e) by Age

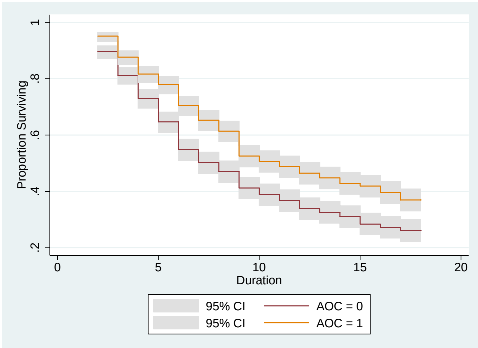


scale) significantly increases the survival of firms. We observe the same pattern for the age effect for the some values of the time spell, however the effect is more fuzzy (Figure 1e).

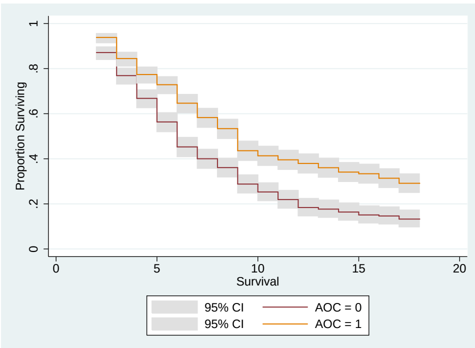
Statistical tests can be used to substantiate the validity of the previously observed differences of the survivor curves. We use the family of tests proposed by Harrington and Fleming (1982). These tests are designed to

Figure 2: AOC effect and firm survival

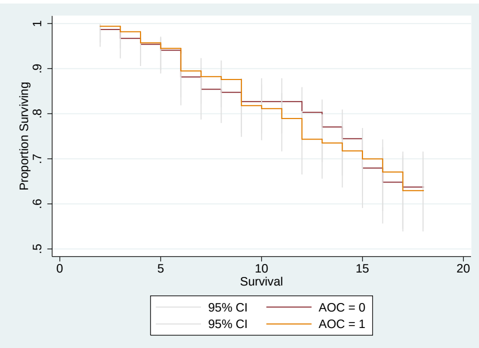
(a) all firms



(b) small firms



(c) large firms



test the null hypothesis that two survival curves that have been estimated by the Kaplan-Meier estimator are equal to each other. The particular version we apply is the log-rank test which is more sensitive to later differences between survival curves. The test outcomes (values of the statistics and their p-values) are given in Table 8. They show that the aforementioned differences between the survivor curves are not only visually apparent but also statistically significant. Thus multi plants, group affiliation, efficiency scale and age are important factors that lower the risk of exit at any time. These results are consistent with the main findings of the literature on firm survival discussed in section 2.

One feature of the French cheese industry is the existence of public labeling policy through AOC. We use the same methodology to asses the impact of AOC on firm survival. Figure 2a reports the estimated survival curves for two cohorts of firms, producing or not AOC labeled cheese. The two curves display slightly diverging patterns, AOC firms having a lower probability of exit than non AOC firms. The log-rank test (Table 8) confirms that this difference is significant. A closer investigation of this effect is provided in

Table 8: Log-rank tests

Variable	**log-rank statistics**	**p-value**
Multi	190.75	0.000
Igroup	36.29	0.000
IMES	86.34	0.000
Old	8.57	0.0034
AOC	29.68	0.0000
AOC- Single plant	47.55	0.0000
AOC- Multiple plant	0.03	0.8606

Figures 2b and 2c where we distinguish firms according to their size measured by the *Multi* variable.[10] We find a large and statistically significant effect of AOC labeling when considering small firms while this effect does not show up for large firms (see Table 8).

The Kaplan-Meier estimates of firm survival have the advantage to provide a good descriptive analysis of survival without specifying any functional form for the survival pattern and highlight the differences between cohorts of firms (AOC, age, type...). However, the Kaplan-Meier approach is limited when survival is investigated on sub-cohorts of firms and the effect of variables on the hazard of firms becomes hazardous. In order to overcome this problem and give more structure to the estimation, we now investigate the effects of covariates on the hazard in the multivariate framework presented in section 3. Table 9 presents the results of the estimation of a logistic discrete-time hazards model including the time-constant covariates described in Table 4. Results from the logistic regression strengthens the results from the Kaplan-Meier estimation. The coefficients of the variables *AOC*, *Multi*, *IMES* and *Old* have all the expected signs and are all significantly different from 0. In addition, the logistic estimates show that when a firm becomes multi-plant (become larger), its probability of failure decreases by 74%. The impact of AOC is also significative: a firm that engages in AOC production decreases its hazard probability by 40%. The production scale of the firm also plays a role but in a lower extent. If its size becomes equal or larger to the minimum efficiency scale, it reduces its hazard probability by 25%. For a firm created before 1990, the failure probability increases by 33% compared to a younger firm (created after 1990).

To assess the impact of AOC on survival by firm type, we estimate the model proposed above but we include an additional dummy (MultiAOC) that captures the cross effect of the variable *Multi* and *AOC*. Table 10 presents the results of the estimation. They show that if the firm is small

[10] We cross the AOC factor with other factors (age, type), without finding any significant effect.

Table 9: Logistic estimation of discrete-time hazard model

variable	**Coef**	**Std. Err.**	[95 % Conf. Interval]	
year==2	0.152	0.142	-0.127	0.431
year==3	0.179	0.146	-0.109	0.466
year==4	0.051	0.157	-0.256	0.358
year==5	0.700***	0.142	0.423	0.978
year==6	0.194	0.165	-0.130	0.519
year==7	-0.053	0.184	-0.414	0.308
year==8	0.914***	0.153	0.615	1.214
year==9	-0.358	0.238	-0.824	0.109
year==10	-0.213	0.243	-0.690	0.264
year==11	0.121	0.227	-0.323	0.565
year==12	-0.468	0.293	-1.043	0.106
year==13	-0.147	0.272	-0.681	0.386
year==14	-0.274	0.295	-0.852	0.305
year==15	-0.042	0.280	-0.592	0.507
year==16	0.090	0.274	-0.448	0.627
AOC	-0.511***	0.074	-0.657	-0.366
Multi	-1.335***	0.115	-1.560	-1.110
IMES	-0.354***	0.075	-0.501	-0.206
Old	0.284***	0.082	0.123	0.446
Constant	-2.099***	0.118	-2.331	-1.868

Table 10: Logistic estimation of discrete-time hazard model with cross effects

variable	**Coef**	**Std. Err.**	[95 % Conf. Interval]	
year==2	0.153	0.143	-0.126	0.433
year==3	0.181	0.147	-0.106	0.468
year==4	0.054	0.157	-0.253	0.361
year==5	0.707***	0.142	0.429	0.985
year==6	0.202	0.166	-0.123	0.526
year==7	-0.046	0.184	-0.407	0.316
year==8	0.924***	0.153	0.624	1.224
year==9	-0.346	0.238	-0.813	0.120
year==10	-0.199	0.244	-0.677	0.278
year==11	0.137	0.227	-0.307	0.581
year==12	-0.449	0.293	-1.024	0.126
year==13	-0.128	0.272	-0.661	0.406
year==14	-0.257	0.295	-0.835	0.322
year==15	-0.027	0.281	-0.576	0.523
year==16	0.105	0.275	-0.433	0.644
AOC	-0.592***	0.080	-0.748	-0.436
Multi	-1.627***	0.162	-1.944	-1.310
IMES	-0.353***	0.075	-0.500	-0.205
Old	0.302***	0.083	0.140	0.464
MultiAOC	0.629**	0.220	0.197	1.060
Constant	-2.079***	0.118	-2.310	-1.847

(unique plant), then engaging in AOC production increases its survival probability while if it is larger (multi-plants), the impact is very small, indicating that AOC production has no impact on larger firms.

Finally we estimate a complementary log-log model incorporating time-varying covariates ($AOCshare$, MES, $Group$ and the cross variable $AOCshare * Multi$). This model is consistent with an underlying continuous time hazard proportional model. The results provided in Table 11 confirm the significant effect of AOC, $IMES$ and $IGroup$ when taking their time-varying equivalents.

Table 11: **Complementary log-log model**

variable	**Coef**	**Std. Err.**	[95 % Conf. Interval]	
year==2	0.135	0.135	-0.130	0.400
year==3	0.153	0.139	-0.119	0.425
year==4	0.029	0.149	-0.263	0.321
year==5	0.621***	0.132	0.361	0.880
year==6	0.157	0.157	-0.151	0.464
year==7	-0.106	0.177	-0.452	0.240
year==8	0.790***	0.142	0.512	1.069
year==9	-0.409	0.231	-0.861	0.042
year==10	-0.279	0.235	-0.740	0.182
year==11	0.039	0.217	-0.386	0.464
year==12	-0.539	0.285	-1.099	0.020
year==13	-0.236	0.263	-0.751	0.279
year==14	-0.358	0.286	-0.918	0.203
year==15	-0.147	0.270	-0.676	0.382
year==16	-0.022	0.263	-0.537	0.494
AOCshare	-0.363***	0.059	-0.479	-0.246
Multi	-1.411***	0.139	-1.682	-1.139
MES	-0.218**	0.075	-0.366	-0.071
Group	-0.224	0.130	-0.478	0.031
Old	0.238**	0.078	0.086	0.391
AOCShareMulti	0.333**	0.113	0.112	0.554
Constant	-2.219***	0.112	-2.438	-2.000

6 Concluding remarks

To sum up, on one side our results confirm existing findings on firm survival determinants. On the other side, we contribute to this literature and shed light on the effect of public intervention into an industry. More precisely, we focus on public quality labeling in the French cheese industry and show that quality label reduces the risk of exiting for firms and more particularly for small firms. In other words, public intervention in this industry is well designed to increase the competitiveness of small firms enabling the coexistence on the market of both small and large firms. This result is in line with Sutton's prediction (Sutton (1991)). Sutton (1991) predicts that in endogenous sunk cost industries (strategic choice of advertising and R & D expenditures), concentration remains bounded away from zero as market size increases and that concentration increases when price competition becomes tougher. However, if substitutability is low, then in spite of the effectiveness of R&D, concentration may also be low. If PDO enables small firms to reduce the substitutability of their products to those of larger firms, PDO can then act as a differentiation tool in the market where small niche firms are able to survive thanks to a reduced price competition. This generates a lower hazard rate for this firms that it would be without the implementation of the quality label. We can then presume that without the label policy, the market would be more concentrated.

References

Agarwal, R. and Audretsch, D. B. (2001). Does entry size matter? the impact of the life cycle and technology on firm survival. *Journal of Industrial Economics*, 49(1):21 –.

Agarwal, R. and Gort, M. (2002). Firm and product life cycles and firm survival. *American Economic Review*, 92(2):184 – 190.

Akerlof, G. (1970). The market for 'lemons': Quality uncertainty and the market mechanism. *Quarterly Journal of Economics*, 84(3):488 – 500.

Aldrich, H. and Auster, E. R. (1986). Even dwarfs starred small: Liabilities of age and size and their strategic implications. *Research in Organizational Behavior*, 8:165 –.

Auriol, E. and Schilizzi, S. (2003). Quality signaling through certification.

Bellone, F., Musso, P., Quere, M., and Nesta, L. (2006). Productivity and market selection of french manufacturing firms in the nineties. *Revue de L'OFCE*, pages 319 – 349.

Bouamra-Mechemache, Z. and Chaaban, J. (2010). Determinants of adoption of protected designation of origin label: Evidence from the french brie cheese industry. *Journal of Agricultural Economics*, 9999(9999).

Cameron, A. C. and Trivedi, P. K. (2005). *Microeconometrics: Methods and Applications.* Cambridge and New York:.

Caves, R. E. (1998). Industrial organization and new findings on the turnover and mobility of firms. *Journal of Economic Literature*, 36(4):1947 –.

Chambolle, C. and Giraud-Héraud, E. (2003). Certification de la qualité par une aoc: un modèle d'analyse. *Economie et Prevision*, 159.

Disney, R., Haskel, J., and Heden, Y. (2003). Entry, exit and establishment survival in uk manufacturing. *Journal of Industrial Economics*, 51(1):91–112.

Dunne, T., Roberts, M. J., and Samuelson, L. (Winter, 1988). Patterns of firm entry and exit in u.s. manufacturing industries. *The RAND Journal of Economics*, 19(4):495–515.

European-Commission (1996). Council regulation (ec) no 510/2006 of 20 march 2006 on the protection of geographical indications and designations of origin for agricultural products and foodstuffs. Official Journal of the European Union.

Falck, O. (2007). Survival chances of new businesses: do regional conditions matter? *Applied Economics*, 39(16):2039 – 2048.

Foster, L., Haltiwanger, J., and Syverson, C. (2008). Reallocation, firm turnover, and efficiency: Selection on productivity or profitability?. *American Economic Review*, 98(1):394 – 425.

Fritsch, M., Brixy, U., and Falck, O. (2006). The effect of industry, region, and time on new business survival :a multi-dimensional analysis. *Review of Industrial Organization*, 28(3):285 – 306.

Geroski, P. (1995). What do we know about entry? *International Journal of Industrial Organization*, 13(4):421 –.

Giraud-Heraud, E., Mathurin, J., and Soler, L.-G. (2003). Quelle legitimite a des mecanismes de regulation de l'offre dans les appellations d'origine protegee? (which justification of supply regulation in the appellations of origin? with english summary.). *Economie Rurale*, (277-278):123 – 134.

Harrington, D. P. and Fleming, T. R. (1982). A class of rank test procedures for censored survival data. *Biometrika*, 69(3):553–566.

Hayes, D. J., Lence, S. H., and Stoppa, A. (2004). Farmer-owned brands. *Agribusiness*, 20(3):269 – 285.

Jensen, P. H., Werster, E., and Buddelmeyer, H. (2008). Innovation, technological conditions and new firm survival. *Economic Record*, 84(267):434 – 448.

Kaplan, E. L. and Meier, P. (1958). Nonparametric estimation from incomplete observations. *Journal of the American Statistical Association*, 53(282):457–481.

Kiyota, K. and Takizawa, M. (2006). The shadow of death: Pre-exit performance of firms in japan. Discussion papers 06033, Research Institute of Economy, Trade and Industry (RIETI).

Lence, S., Marette, S., Hayes, D., and Foster, W. (2007). Collective marketing arrangements for geographically differentiated agricultural products: Welfare impacts and policy implications. *American Journal of Agricultural Economics*, 89:947 – 963.

Marette, S. (2005). The collective-quality promotion in the agribusiness sector: An overview. Midwest Agribusiness Trade Research and Information Center (MATRIC) Publications 05-wp406, Midwest Agribusiness Trade Research and Information Center (MATRIC) at Iowa State University.

Marette, S. and Crespi, J. M. (2003). Can quality certification lead to stable cartels? *Review of Industrial Organization*, 23(1):43 – 64.

Moschini, G., Menapace, L., and Pick, D. (2008). Geographical indications and the competitive provision of quality in agricultural markets. *American Journal of Agricultural Economics*, 90(3):794 – 812.

Rabe-Hesketh, S. and Skrondal, A. (2002). *Multilevel and longitudinal modeling using stata*. Stata Press, second edition.

Sutton, J. (1991). *Sunk costs and market structure: Price competition, advertising, and the evolution of concentration.* Cambridge, Mass. and London:.