Technical efficiency and firm exit in the wine and meat sector: Policy implications

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Jel classification: Q180, L660

Abstract

Our paper seeks to assess the determinant factors that drive wine and meat industries in Catalonia (Spain) to abandon their activities as well the timing of their decision. More specifically, we use *Duration Analysis* (DA) to determine why firms exit the market and the diffusion aspects of abandoning behavior. Economic and non-economic factors were used as explanatory variables, especially, the Technical Efficiency (TE) ratio that has been assessed by the Stochastic Frontier (SF) model. Results demonstrate a significant impact of TE as well as other economic factors on exit duration. Policy makers will be more able to target those agro-industries with higher hazard of abandoning market and thus maintain their contribution to the social fabric associated to them.

Key words: Market exit, Stochastic Frontier, Duration Analysis, wine and meat industries.

Résumé

Notre article vise à évaluer les facteurs déterminant qui conduisent les industries viticoles et de viandes en Catalogne (Espagne) à abandonner leurs activités ainsi que le moment choisi pour cette décision. Plus précisément, nous utilisons l'analyse de durée afin de déterminer les facteurs qui affectent leur sortie du marché. Des facteurs économiques ou non ont été utilisés comme variables explicatives, en particulier, l'efficacité technique qui a été estimée en utilisant le modèle de la frontière stochastique. Les résultats montrent un impact significatif de l'efficacité technique, ainsi que d'autres facteurs économiques sur la durée de sortie. Les décideurs seront plus capables de prévoir la sortie des agro-industries à haut risque pour abandonner le marché et ainsi maintenir leurs contributions au tissu social.

Mots clés: *Sortie du marché, Frontière stochastique, Analyse de durée, industries viticoles et de viandes.*

1. Introduction

Wine and processed meat agro-industries have a strategic position and a significant social and economic relevance within the Spanish agro-industrial sector. This position is strengthened by the interaction with other sectors. The input-output tables show a strong interrelationship with other economic sectors such as agricultural input suppliers (50% of total input), logistic, banking, technological, etc, representing 43% of the total agro-food sales.

The choice of wine and meat industries for this study has been motivated by their economic and social importance and the prominent position which occupy within the agro-food industry at Spanish as well as Catalan level. The Spanish wine sector plays an important role given its economic importance (it represents 1% of the Spanish Gross Domestic Product (GDP). Spain has the largest grapevine-growing area in the EU and the world with 1.2 million hectares of grapes (representing 30% and 15% of the total area of the EU and world area respectively, OIV, 2008). 97.4% of total Spanish vineyards area goes for wine production, where Spain occupies the third position behind France and Italy and the second position for exportation behind Italy (15.3 million hectoliters exported and 17% of the market share). The wine industry is an important job creation sector employing 22,863 persons (5.98% of total employed by the food industry in 2006). The value of sales accounts for 5.319 million euro, representing 6.76% of the total agro-industry sales. The number of companies in the wine industry represents 12.40% of the total food industry which place this industry in the third place of importance (INE, 2006).

In the same line, the Spanish meat industry is composed of 3,550 companies, representing 22.4% of the total food industries. This sector plays an important role in the job creation being a source of 85,625 workers. The total sales account for 16,000 million euro, representing 20.2% of the total Spanish food industry sales. In this context, with respect to the total food industry, this sector uses 23.84% of the raw materials and represents 13.5% of the total amount of investment.

Within the Spanish regions, the wine and meat sector occupies a prominent position and plays an important role in the food industry in Catalonia. The wine sector occupies the second position in wine production with 3.36 millions of hectoliters, representing 10% of the national production (OIV, 2008). The Catalan meat industry has the highest number of workers (33% of total employees in the Spanish meat industry), sales (33.4% of total sales of the Spanish meat industry), as well as investment (31.9% of total meat industry investment in Spain) comparing to the other food industries. Catalonia occupies the second position with 17% of the total production compared to the other regions of Spain.

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Due to the relevant economic and social function and the important territorial role both sectors play in Catalonia, the determinants factors that drive these agro-industries to abandon their activities and the timing of such decision deserve our in-depth analysis.

Several studies (Agarwal, R. and Gort, 1996, Doi, 1999, Segarra and Callejón, 2002, Álvarez and Otero, 2006, Tsionas and Papadogonas, 2006, Dimara *et al.*, 2008 and Audretsch, *et al.*, 2000, Esteve-Pérez, *et al.*, 2010) have reviewed and summarized factors that influence exit market decisions and the likelihood of firm dissolution in different sectors. According to these studies, factors influencing the decision of market could be resumed as follows:

- *Manager characteristics:* age, gender, education, experience, etc.
- *Firm characteristics*: firm size (Capital, employee number), firm age, legal form, location, etc.
- *Firm management*: number of brand, Total Assets Turnover, diversification of activities, economies of scale, etc.
- *Economic and financial results*; profitability, leverage, solvency, financial ratios, Technical Efficiency, etc.
- *Risk behavior:* risk behavior, attitudes and opinions toward risk, firm objectives and strategies, etc.
- *Exogenous factors*: market size and concentration, industry growth, input prices, subsidies, information access, reforms, etc.

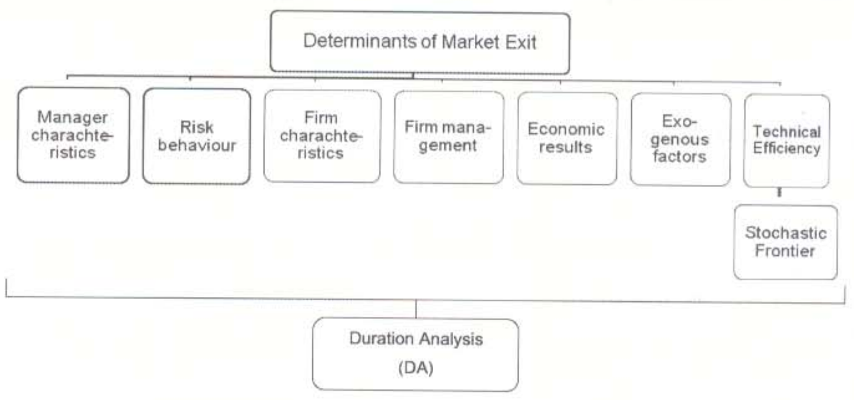
Among the economic factors, Technical efficiency has been shown to play a relevant role in exit decisions (Tsionas and Papadogonas, 2006 and Dimara *et al.,* 2008). However, few studies have analyzed the impact of TE and other factors on exit decision in the agro-industries sectors including, especially in Spain. In this line, our paper focuses on assessing the determinants factors that drive wine and meat agro-industries to abandon their activities as well the timing of their decision. In a first step we will apply the Stochastic Frontier (SF) method for assessing the Technical Efficiency. Second, a Duration Analysis (DA) is used due to its potential to analyze both the decision and diffusion aspects of abandoning behavior. The dependent variable used in the DA is the time agro-industries remain active before deciding to leave the market as from their first year of establishment.

The remainder of this paper is organized as follows. Section 2 provides details on both stochastic frontier model as well as Duration Analysis. In the third section we present the empirical application. Results are discussed in section 4. Finally, some conclusions are outlined.

2. Methodology

Following our mythological Diagram (Figure 1) we shall first analyze the Technical Efficiency (TE) ratio for both wine and processed meat sectors using the Stochastic Frontier method. In a second step, we apply the Duration Analysis (DA) not only to determine why firms decide to exit market but also the timing of this decision and the factors that influence the observed time patterns.

Figure 1 – *Methodological Diagram.*



We used stochastic frontier methodology to measure a firm's technical efficiency (Aigner, Lovell and Schmidt (1977), and Meeusen and van den Broeck (1977)).

A stochastic frontier production function can be expressed as follows:

$$y_{it} = f(x_{it}, t; \beta) e^{v_{it} - u_{it}} \tag{1}$$

where y_{it} is the output of the -th firm ($i = 1, ..., N$) in period $t = 1, ..., T$, where $f(x_{it}, t; \beta)$ represents the production technology, x_{it} is a $(1 \times K)$ vector of inputs and other factors influencing production associated with the -th firm in period t, and β is a $(K \times 1)$ vector of unknown parameters to be estimated.

The disturbance term is composed of two parts. First, is a symmetric component that permits random variations of the frontier across firms and captures the effects of statistical noise outside the firm's control, and is assumed to be iid N(m, σ_v^2). Second, u_{it} is a one-sided, non-negative component associated with output-oriented technical inefficiencies and assumed to be iid as truncations at zero of the N(m, σ_{it}^2) distribution. It is further assumed that the distributions of the two error terms are independent. Following the Battese and Coelli (1992) specification, we have adopted the temporal pattern of technical inefficiency (e.g. Battese *et al.,* 1997 and Coelli *et al.*, 1998)). Maximum likelihood techniques are used for an estimation of the stochastic frontier model.

As mentioned before, the next step consists in analyzing the determinants factors of exit decision using the Duration Analysis (DA). Duration modeling, as known in the economic field, models the time length of a spell or the duration of an episode or «*event*». The spell starts at the time of entry into a specific state and ends at a point when a new state is entered. As mentioned before, we apply DA to identify and determine why firms exit the market and the diffusion aspects of abandoning behavior as well as the probability of a farm to exit market at time t, given it has not been adopted by that time. We assume that the end of an event or the entering into a new state happens just once for each subject[1].

The conceptual foundations of DA rely on probability theory. Instead of focusing on the time length of a spell, one can consider the probability of its end or the probability of transition to a new state. To determine this probability, DA analysis uses the *hazard function* instead of the familiar probability distribution function. The probability of a duration end or a regime change in the next short interval of time Δt, given that the spell has lasted up to t is:

$$\Pr\left(t \le T < t + \Delta t \,\middle|\, T \ge t\right) \qquad (7)$$

On the basis of this probability we define the hazard function or hazard rate that specifies the rate at which a spell is completed at time $T = t$, given that it survives until time t. Besides the length of a spell, a set of explanatory variables of economic and non-economic nature may be expected to influence and alter the distribution of the duration. With the inclusion of additional explanatory variables in the DA, the hazard function needs to be redefined and re-formulated as being conditional on these variables (Lancaster, 1992):

The semiparametric *Cox proportional hazards model* has been used and estimated by the partial likelihood function introduced by Cox (1972, 1975). The Cox's semiparametric model has been widely used in the analysis of survival data to explain the effect of explanatory variables on hazard rates. Though the semiparametric model could potentially be less efficient than the parametric models in its use of the information provided by the data (D'Emden *et al.*, 2006), the loss of efficiency is likely to be quite small (Efron, 1977 and Lawless, 1982). Moreover, when using this model we can gain robustness in return (Allison, 1995), because the estimates have good properties regardless of the actual shape of the baseline hazard function. In this context, the advantage of a semiparametric model is that no assumptions need to be made about the shape of the hazard function. For more details about Duration Analysis consult among others Allison, (1995).

3. Empirical implementation

Data used in this analysis were obtained from the 'Iberian Balance Sheet Analysis System' (SABI) database. The SABI collects extensive economic and non economic information on the firms. General information and annual accounts are available for more than 1 million Spanish companies and more than 325,000 Portuguese ones. A company record typically contains: contact information, balance sheet and profit and loss account that can be displayed in varying levels of detail, ratios, import/export indicator, shareholders, subsidiaries, management, auditors, banker and for public companies security and price information, annual and current stock valuation, annual and current stock data and monthly pricing series. From the abovementioned database, our sample size for the wine and processed meat sectors is formed by 231 and 288 active firms respectively, while the inactive industries are 20 and 47.

For the stochastic frontier model, the production function is specified as a Cobb-Douglas with no neutral technical, which takes the form:

$$y_{it} = \beta_0 e^{\beta_t t} \prod_{k=1}^{K} x_{it}^{(\beta_k + \beta_{kt} t)} e^{v_{it} - u_{it}} \qquad (7)$$

Production, y_{it}, is defined as a deflated total sales for both meat and wine product. The vector x_{it} is defined as a (1×3) vector that contains three inputs.

The first input x_1, includes labour measured in wages expenses, x_2 comprises costs of intermediate inputs, and x_3 represents capital employed in the production process.

β is a $(K \times 1)$ vector of unknown parameters to be estimated, and the disturbance term is composed of two parts: v_{it} and u_{it}.

All variables in the stochastic frontier are expressed in logs in the estimation process. The parameters of the stochastic production frontier model are estimated by using the maximum likelihood method.

The dependent variable used in the DA is the time firm waited before market exit. As Kiefer (1988) mentions, DA requires a precise beginning time to compute the duration. In our case, it was set as the date of starting. It is also necessary to define a time scale which is «years» in our case, as well as the event ending duration (the year when the firm exit the market). Because not all firms had left the market by the time of analyzing the data (2009), a right censoring characterizes our data.

The explanatory variables introduced into our models are[2]: a) age of the firm represented by the date of firms' setting–up, b) leverage which is the ratio of debt to total assets, c) current ratio which is equal to current assets divided by the current liabilities. It is an indication of a company's ability to meet short-term debt obligations. Thus, the higher the ratio, the more liquid the company is, d) Technical efficiency as a result from the stochastic frontier model, e) firm size, expressed by the number of employee in the agro-industry, f) extraordinary results, representing the disinvest-

[1] When events happen more than once, a multilevel modeling for *recurring events* or *repeated events* should be applied (for more information see Box-Steffensmeier and Zorn, 2002 and Steele, 2008 among others).

[2] The appearance of substitute products could have an impact on duration to exit. However, considering the wine as a healthy product and a part of the Mediterranean diet, consumers try to differentiate it from other alcoholic products, where there are no clearly substitute products. On the other hand, for the meat sector, the possible presence of substitute products is not important since we have selected firms that process all kind of meat products, and thus this impact on exit duration will be not relevant.

ment decision of firms and i) Return on invested capital as a financial measure that quantifies how well a company generates cash flow relative to the capital it has invested in its business. External factors were approximated using several proxy variables, such as the industry profit growth as a way to represent the trend from each economic activity and a set of dummy variables that represent changes occurred along the years from the eldest starting year (oldest firm) to the recent exit years (the year of the last firm which decided to exit the market). Another external important factor to be taken into consideration as determinant factors for abandoning the market is the appearance of new technologies in both sectors. However, due to the lack of information about the technology used by firms in our dataset, the abovementioned dummy variables could represent proxies of the years where the new technologies had have impact on market evolution.

4. Results and discussion

Following the methodology diagram (Figure 1), a Technical Efficiency ratio was estimated for both sectors following the Stochastic Frontier model. Results show a mean technical efficiency value of 0.53 for the meat industry and 0.48 for wine industry.

Table 1 – *Firm comparison / classification using TE ratio.*

Sectors	processed meat agro-industry		wine agro-industry	
Efficiency interval	% of firm	TE average	% of firm	TE average
<30	14.30	16.84	24.80	17.70
30-40	12.30	35.63	7.98	36.10
40-50	17.60	45.37	15.96	45.53
50-60	19.00	54.4	22.53	55.37
60-70	10.80	64.32	13.61	65.39
70-80	12.70	74.40	14.20	75.31
80-90	12.10	85.61	0.92	88.94
90>	1.20	92.09	-	-

As can be seen in Table 1, for processed meat agro-industry, three industries are the most efficient with an average TE equals to 92.09%. Compared to this group, an important part of the industries (19%) is located within the 50-60% interval with 54.4% as an average of TE, followed by the 40-50% interval with a TE average of 45%. In this context, 37% of the firms are distributed between the intervals 30-40%, 70-80% and 80-90% with an approximately average TE of 35.6%, 74.4% and 85.6%, respectively. The less efficient firms represent only 14% of the total firms and are concentrated in the interval of TE <30%. In the case of wine agro-industry, two industries are the most efficient with an average TE equal to 88.94%. Compared to this group, the less efficient firms (TE<30%) are the most frequent and represent 24.8% of the industries with an average TE equal to 17.7%. This result is followed by the intervals 50-60%, and 40-50% representing 22.53% and 16% of the industry respectively with 55.3% and 45.5% of TE average level.

As abovementioned, the TE at firm level was introduced in a posterior step as explanatory variable in the Duration Analysis (DA).

Different DA models were estimated using different combinations of the variables available from the SABI Data base. We followed the Akaike Information Criterion (AIC) and the Schwarz Information Criterion (SIC) to compare between the competing duration models and determine the list of variables to be included in the final model. The resulting model is presented in Table 2 and 3 for the meat industry and wine, respectively. At a 95% confidence level, we can reject the null hypothesis that all coefficients are jointly equal to zero.

Table 2 – *Results of COX proportional Hazard model (processed meat agro-industry).*

Variable	Parameter	Std. Error	P-value	Hazard Ratio
Leverage	2.4526**	0.9936	0.0136	11.6180
Business extraordinary results	0.4579**	0.2325	0.0488	1.5810
Date of firms' setting -up	0.0012***	0.0003	0.0001	1.0010
Return on capital employed (%)	0.3269	0.2613	0.2109	1.3870
Technical Efficiency	-2.1821*	1.1754	0.0634	0.1130
Current Ratio	-1.5904***	0.5173	0.0021	0.2040
Employee number	-0.0076	0.0062	0.2176	0.9920
Industry profit growth	-0.0011	0.0009	0.2319	0.9990
Dummy year 2000	2.0176*	1.2008	0.0929	7.5200

Likelihood Ratio: 96.20 (0.000) , Wald test: 45.11 (0.000) , Lagrange Multiplier Test: 75.76 (0.000)

Table 3 – *Results of COX proportional Hazard model (wine agro-industry).*

Variable	Parameter	Std. Error	P-value	Hazard Ratio
Leverage	3.4227***	1.1542	0.0030	30.6530
Business extraordinary results	0.8460***	0.3087	0.0061	2.3300
Date of firms' setting -up	0.0009***	0.0003	0.0010	1.0010
Return on capital employed (%)	1.6610	1.4263	0.2442	5.2640
Technical Efficiency	-2.8863*	1.7368	0.0965	0.0560
Current Ratio	-0.4604	0.3476	0.1853	0.6310
Employee number	-0.1406**	0.0630	0.0257	0.8690
Industry profit growth	-0.0005	0.0011	0.6596	1.0000
Dummy year 1990	-2.1924*	1.2155	0.0713	0.1120

Likelihood Ratio: 44.91 (0.000) , Wald test: 22.29 (0.003) , Lagrange Multiplier Test: 24.70 (0.008)

In both sectors, economic results are shown to have impact on abandoning decision as mentioned by Rahim *et al.*, 2007. Thus, leverage (ratio of debt to total assets), is found to increase the hazard function and the likelihood of exit, involving a reduction in the time needed before the market exit. This result is in accordance with the findings of Tsionas and Papadogonas (2006), who conclude that leverage level is an important factor in determining the abandonment from the market. In this same line, extraordinary results suggest that agro-industries are more likely to leave market as this result increases. This could be interpreted as a consequence of the dis-investment decision in the firms, where values of selling the used machinery and equipment, from the accounting point of view, are considered as extraordinary results. Age is shown also as one of the key determinants of firm exit. As expected, we find that the likelihood of exit declines with age. This result is in accordance with several empirical studies as mentioned in the literature revision of Tsonias and Papadogonas (2006).

In accordance with other studies (Dimara *et al.*, 2008 and Tsionas and Papadogonas, 2006), Technical Efficiency is shown to decrease the hazard of exit and thus a higher duration-time before abandoning the market. Dimara *et al.*, (2008) used the Data Envelopment Analysis (DEA) for assessing Technical Efficiency. Their result demonstrates that high Technical Efficiency increases the median survival time and lowers the hazard rate of exit. Tsionas and Papadogonas (2006) used the Stochastic Frontier models and found a significant positive effect from Technical Inefficiency on the probability of exit.

On the entrepreneurs' side, factors that affect firm´s TE should be taken into consideration as an effective way to reduce their hazard to exit market. In this context, experienced entrepreneurs with good managerial skills (farmer's knowledge, information access…etc) are able to better understand the customer as well as the market which increase firm productivity and performance (Wilson et al., 2001). Investment seems to be an important factor that has a positive impact on TE (e.g. Berger and Mester, 1997, Lusch and Moon, 1984); thus, encouraging entrepreneurs to increase investment at firm level can be a good way to reduce firm hazard to exit market. Moreover, wage level per employee has an impact on the firm technical efficiency. Thus greater wage level makes it possible for the firm to attract more highly skilled labour force (Lusch and Moon, 1984), which improve its productivity (Carey and Otto, 1977).

Dummy variables representing policy changes (1990 for wine sector and 2000 for processed meat sector) were statistically significant for both sectors. For wine sector, the year 1990 had a significant impact on the hazard of firm exit. Thus the negative coefficient implies that after 1990 wine industries are less likely to exit market and have high duration time. In this specific year, the European Commission (EC) approved the Regulation Nº 1014/90 laying down detailed implementing rules on the definition, description and presentation of spirit drinks. It seems that this regulation, as expected, increased wine industry trust toward wine market.

For the meat agro-industries sector, the year 2000 was shown to have a significant impact on the hazard of market exit. Beef sales were hard hit by the onset of the Bovine Spongiform Encephalopathy (BSE) crisis from 1996 until 2000 (EC, 2004). Among the measures to deal with BSE, the ban on the use of animal proteins in pig and poultry feed affected prices of feeding stuffs and producers' margins. Moreover, sheep meat consumption was also affected due to the foot and mouth disease. In order to rebuild consumer confidence, the EU has brought in several measures (EC, Nº 1760/2000), for example for beef labeling obliging retailers to label where beef is sourced from. Our results demonstrate that this uncertain environment and confidence loss of consumers have driven some meat industries to reconsider their activities and thus increase their likelihood to exit market.

Our results demonstrate almost a non significant impact of industry profit growth and return on capital as determinants factors for market exit in both sectors. In the wine sector, results show that as the number of employee increases, the likelihood of industries to exit market decreases. While in the meat industry results illustrate a significant impact of the current ration on the hazard of exit. Thus, as the current liability of meat industry increases (maintaining current assets) the likelihood to exit market increases as well and the duration that spends in the market decreases.

5. Conclusion

Our paper focuses on assessing the determinants factors that drive agro-industries to abandon their activities as well the timing of their decision. We carry out an empirical study using the Duration Analysis (DA) due to its potential to analyze both the decision and diffusion aspects of abandoning behavior. As well, we use the Stochastic Frontier Model to asses Technical Efficiency (TE) of industries as exploratory variable. The model is estimated using firm-level data from two relevant sectors; the wine and meat industries. Data were collected through the 'Iberian Balance Sheet Analysis System' (SABI) database where extensive economic and non economic information is available. The dependent variable used in the DA is the time agro-industries remain active before deciding to leave the market from their first year of establishment. Several explanatory variables were considered representing agro-industries characteristics, profitability, operations results, profit and exogenous factors among other factors.

Several variables are found to increase the hazard of market exit. Firms with high leverage, positive extraordinary results and which have recently undertaken the management of the firms is more prone to exit market in a shorter period of time. On the other hand, Technical Efficiency, firms' Current Ratio (in the meat industry) and employee number (in the wine industry), have a low hazard to exit market and therefore higher duration time in the market.

The results of analyzing the duration of time before market exit can play different role in assessing policy implication. It allows for policy makers to understand the potential impact that could have the implementation of regulations and instruments on the rate of market exit. On the other hand, it will help decisions to target those industries that have higher hazard to abandon market, trying to lengthen their «lives». By doing so, they will contribute to maintain the social fabric associated to these agro-industries and the other socio-cultural functions that represent for society. It is worth mentioning also that our analysis is based on a semi-parametric approach that still requires the parameterization of the hazard function. Our results should thus be interpreted carefully. To overcome this limitation, the literature on the topic has recently proposed the use of local estimation techniques. It would thus be interesting to compare our results with the ones derived from this alternative approach.

For policy makers, conclusions could be summarized through two main points:

- First this analysis allows identifying firms with higher risk to exit market. As a result, policy makers can support firms to improve their TE, establishing specific support program. This intervention could be applied as direct payment or reduction in credit interest devoted to invest in new technologies, in personal training initiatives, or in management improving.
- Second, DA could analyze the impact of any public intervention on the hazard of abandoning the market. Thus, this methodology could play an important role in evaluating the success of governmental program of any type of initiatives.

Our results could be a useful tool not only for policy makers but also for each entrepreneur offering them the possibility to compare his firm situation with the average of the sector. A possibility for applying this idea is creating a web page (that could be financed by the government as a result of the abovementioned support program) where firms can introduce their economic and accounting variables (following a simple visual framework of the web page) and their TE can be calculated comparing it with the mean of the sector. Moreover, following the DA models, the web page could give each firm' manager the hazard rate to exit market. This way could help firms to know their situation and could impulse them to improve their results.

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