UNDERSTANDING THE FORMATION OF NETWORKS BY SMALL AGRICULTURAL FIRMS

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Abstract

It is recognised that participation in networks in the agro-food chain provides farmers important opportunities to innovate. This is particularly important for small agricultural firms because these organisations face barriers that prevent them from innovate by means of some specific sources that are available in other industries. Surprisingly, no research has been developed to understand what motivates farmers to be involved in these networks. The paper fills this gap by proposing a decision making multivariate model. A probit analysis based on the proposed model revealed that farmers' decision on participating in networks depends on goals and socio-psychological variables.

Keywords: Network innovation; Small agricultural firms; Multivariate model

1. Introduction

Innovation is related to the creation of value by the application of knowledge in order to improve, change or develop specific activities (Edwards, *et al.*, 2004). It also helps firms to create competitive advantages (Lawson and Samson, 2001).

Small agricultural firms in the UK face important barriers that prevent them from innovate by means of some specific sources that are available in other industries. For example, it is recognised the fact that rearranging organisational structures can facilitate the flow of information that is needed to innovate (Johnson *et al.*, 2001). However, because farmers in the UK operate on a family base (Ministry of Agriculture, Fisheries and Food, 2000), it is difficult to support the idea that changing this organisational structure can help farmers to innovate. This is because family members cannot be regrouped into different arrangements such as functional of divisional departments in order to favour the flow of relevant information. Strategic alliances, on the other hand, have been identified as useful tools to increase market power. Market power, in turn, helps farmers to access different markets having the information that is required to innovate (Hagedoorn and Duysters, 2002). In spite of the beneficial effects of the formation

of cooperative alliances on the capacity to increase negotiation power, these alliances are not common in the UK (Ministry of Agriculture, Fisheries and Food, 2000). According to Hingley *et al*. (2006), this is due to the fact that insider suppliers in asymmetric power relationships are not willing to form strategic alliances with other suppliers.

The formation of networks has also been identified as a strategy to innovate in agriculture. For example, Boahene *et al*. (1999) found that farmers benefit from their social networks because they help them to adopt either new product or new technologies. Likewise, Virkkala (2007) found that small farm businesses in peripheral rural areas obtain relevant knowledge on process innovations from their client located in the region and from their relationships with other firms.

Fortunately, network participation is a feasible strategy for small agricultural firms. Moreover, since other strategies are not available for farmers as it was explained above, the participation in networks becomes an extremely important determinant of innovation in agriculture. Surprisingly, while researchers have already identified the link between network and innovation, no study has been conducted to determine farmers' motivations to be involved in beneficial networks.

The objective of the present paper is to fill this gap by proposing a multivariate model that explains farmers' decisions on participating in networks. The proposed framework is based on the contributions of Bergevoet *et al*. (2004) and Willock *et al*. (1999). These authors found that some farmers' strategic behaviours (*e.g.* entrepreneurial behaviour of Dutch dairy farmers under a milk quota system and attitudes toward environmentally oriented farming) depend on both goals and socio-psychological variables referred to as non-economic drivers. Following this finding, the proposed multivariate model assumes that farmers decide to participate in networks considering non-economic drivers. The framework was applied to a sample of ex-Sugar Beet Farmers of the West Midlands of the UK (ESBF). A probit analysis was adopted to test the hypothesis that the participation in networks related to both free market (*i.e.* spot market) and contract market (*i.e.* forward market) depends on different goals and socio-psychological variables. Finally, significant non-economic drivers identified by the probit analysis were used to study how to encourage the formation of beneficial networks.

The paper is structured as follows. Section 2 describes the proposed framework. Section 3 shows the material and methods used in the investigation. Section 4 shows the results, and section 5 concludes the paper.

2. The proposed multivariate model

The proposed framework is based on the contributions of Bergevoet *et al*. (2004) and Willock *et al*. (1999). These researchers developed a framework that integrates two different approaches with the objective to include a large range of valid variables that can explain farmers' decision making. This integrative framework is referred to as multivariate model. One of the approaches considered by this model is the multiple goals approach which postulates that farmers consider non-economic targets when making their decisions (Gasson, 1973). The other approach corresponds to the theory of planned behaviour (Ajzen, 1985). This theory establishes that intention is a good predictor of behaviour, and that intention is determined by attitudes, subjective norms and perceived behavioural control. That is, a person will have an intention to behave in a particular way when she/he has a positive attitude toward this behaviour, when the people who are important for him/her think that he/she should perform this behaviour, and

when the person has the conviction that she/he will successfully execute a behaviour leading to a particular outcome.

The multivariate model proposed in this paper extends the contributions of Bergevoet *et al.* (2004) and Willock *et al.* (1999) with the objective to determine whether the motivation to participate in social networks is explained by farmers' goals, farmers' attitudes toward farming, perceived control, subjective norm, and market barriers (*i.e.* non-economic drivers). This model is shown in Figure 1.

Figure 1: Multivariate model of social network participation
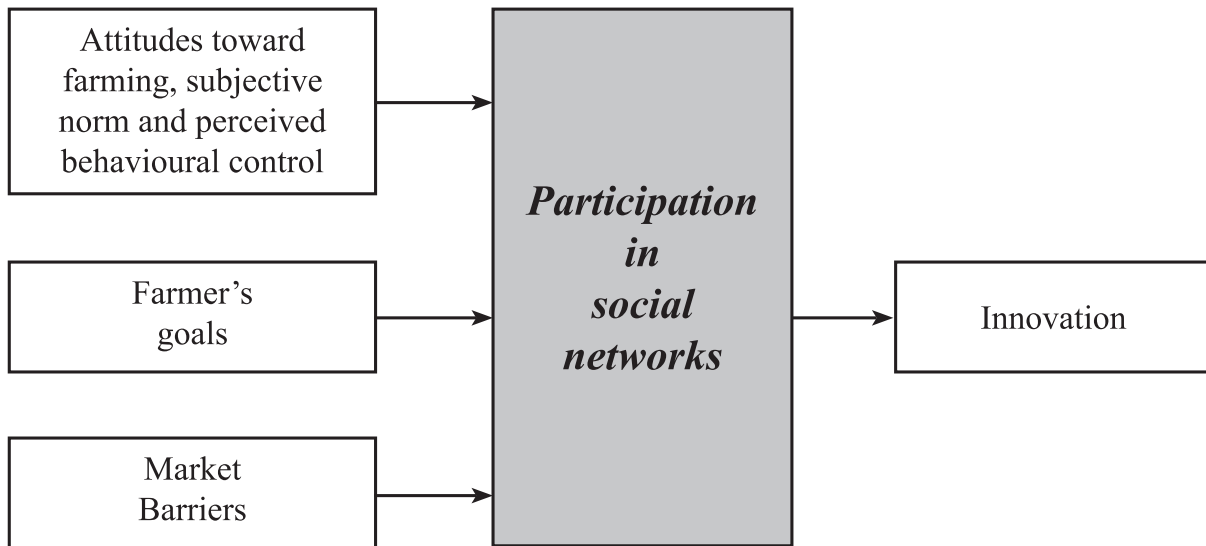
The present paper uses this framework to test two different hypotheses. The first one, named the Hypothesis of Free Market Networks (HFN), establishes that the participation in networks in the free market depends on non-economic drivers. In order to test the HFN, the following null and alternative hypotheses have been specified:

H_0: Farmers' participation in networks in the free market does not depend on non-economic drivers.

H_1: Farmers' participation in networks in the free market depends on non-economic drivers.

The second hypothesis, named the Hypothesis of Contract Networks (HCN), establishes that the participation in networks in the contract market depends on non-economic drives. In order to test the HCN, the following null and alternative hypotheses have been specified:

H_0: Farmers' participation in networks in the contract market does not depend on non-economic drivers.

H_1: Farmers' participation in networks in the contract market depends on non-economic drivers.

3. Methods and materials

The methodology used in this research is closely related to that developed by Bergeovet *et al.* (2004).

3.1 The questionnaire

A questionnaire was used to collect the relevant data on: (*i*) participation in networks in free and contract markets; (*ii*) different social and geographical variables; and (*iii*) statements on farmers' goals, attitudes toward farming, perceived behavioural control, subjective norms and market barriers that prevent farmers from choosing more profitable enterprises. A five point Likert scale was used for questions regarding statements. The statements used in the questionnaire are presented in Appendix A.

3.2 The sample

According to DEFRA statistics, the number of ex-sugar beet growers in the West Midlands region (ESBF) in 2005 was 592. The sample of the ESBF considered in the study consisted of 48 farmers which correspond to 8.1 per cent of this total, and this sample was visited in a period of six months.

3.3 Statistical analysis

The statistical analysis was based on two steps:

a) Step 1: Factor analysis. A factor analysis with varimax orthogonal rotation was employed with the objective to reduce the data concerning farmers' goals (Bergeovet *et al.*, 2004). Only Factors having an eigenvalue larger than one were considered (Bergeovet *et al.*, 2004, and Kobrich *et al.*, 2003). According to Stevens (1992), for a sample of 50 observations a loading of 0.722 can be considered significant. In line with Stevens' recommendation, the present research considered a loading of 0.73 because the sample used in this study had 48 farmers. Finally, in order to carry out regression analysis, goals that resulted to be related were replaced by variables created from the factor scores (Bergeovet *et al.*, 2004). The factors on goals obtained from the factor analysis are presented in Appendix B.

b) Step 2: Probit analysis. A probit analysis was used to determine whether the participation in networks depends on non-economic drivers. The statements "I have a contact network in the free market" and "I have a contact network in the contract market" were used as proxies of network participation. Farmers that responded agree or strongly agree were considered as having a contact network. These farmers were assigned a value equal to one. In contrast, farmers that responded either indifferent, disagree or strongly disagree to this statement were considered as not having a contact network. These farmers were assigned a value equal to zero. The variable p_i summarises this information. That is, $p_i = 1$ for farmer i means that this agent has a contact network. Conversely, $p_i = 0$ for farmer i means that this agent does not have a contact network. The probit model adopted to test the HFN and the HCN is presented as follows (see Dougherty, 2007, and Davidson and Mackinnon, 1993):

$$p_i = \int_{-\infty}^{Z} \frac{1}{\sqrt{2\pi}} e^{-\frac{1}{2}Z^2} dZ \qquad (1)$$

where Z is a linear combination of farmers' goals (F_i), farmers' attitudes toward farming (A_j), perceived control (P_k) , subjective norm (N_l) and market barriers (B_m), respectively (see Appendices A and B). That is, Z corresponds to:

$$Z = \beta_0 + \sum_i \beta_i F_i + \sum_j \beta_j A_j + \sum_k \beta_k P_k + \sum_l \beta_l N_l + \sum_m \beta_m B_m \qquad (2)$$

The probit model was estimated using Maximum Likelihood. Considering this model, the null and the alternative hypotheses of both the HFN and the HCN have been specified as follows:

$$H_0: \beta_i = \beta_j = \beta_k = \beta_l = \beta_m = 0$$
$$H_1: \beta_i \neq 0, \text{ or } \beta_j \neq 0, \text{ or } \beta_k \neq 0, \text{ or } \beta_l \neq 0, \text{ or } \beta_m \neq 0$$

In words, the null hypothesis establishes that none of the non-economic drivers is statistically significant. If this hypothesis is rejected when considering free markets, then the HFN holds. Likewise, if the null hypothesis is rejected when considering contract markets, then the HCN holds.

Let X_j be the non-economic driver j. In order to determine the marginal effect of each significant non-economic driver on the probability of participating in a network, the following transformation has been adopted (Dougherty, 2007):

$$\frac{\partial p}{\partial X_j} = \frac{dp}{dZ}\frac{\partial Z}{\partial X_j} = f(Z)\beta_j \tag{3}$$

where $f(Z)$ is the standardised normal distribution:

$$f(Z) = \frac{1}{\sqrt{2\pi}}e^{-\frac{1}{2}Z^2} \tag{4}$$

This latter was computed by evaluating at the mean values of the non-economic drivers in equation 2.

4. Results and discussion

54.2% of the farmers in the sample responded that they had a contact network in the free market, 37.5% responded that they did not have a contact network, and 8.3% did not respond the question. Regarding contract markets, on the other hand, 62.5% of the farmers in the sample responded that they had a contact network in this market, 29.2% responded that they did not have a contact network, and 8.3% did not respond the question.

4.1 Networks in free markets: testing the HFN

In order to test the HFN, the probit model described in equations 1 and 2 was estimated. The estimated model is presented in Table 1.

Table 1: Probit model of network participation in free markets.

Variables	Dependent variable p_i ($n = 44$)
Intercept	-11.57** (-2.78)
F1	-1.25* (-2.51)
Ae	1.38** (2.90)
Ah	-0.52* (-2.02)
Pb	1.30* (2.28)
Bg	0.96* (2.18)
WV	2.62** (2.71)
McFadden R^2	0.60
S.E. Regression	0.31

$*P < 0.05, **P < 0.01, ***P < 0.001, z$–ratios in parenthesis.

This Table shows that the McFadden R^2 for this regression presented a value equal to 60%. It also shows that the coefficients of some social-psychological variables were significant. This implies that the null hypothesis specified for HFN (see section 2) has been rejected. It is concluded, therefore, that the participation in networks in the free market depends on non-economic drivers.

The marginal effects for the relevant variables are presented in Table 2:

Table 2: Probit estimations and marginal effects.

Variables	Mean	regression coefficient (b)	Mean*b	$f(Z)$	$bf(Z)$
F1	6.25E-7	-1.25	-7.79E-7	0.39	-0.48
Ae	4.06	1.38	5.61	0.39	0.53
Ah	3.48	-0.52	-1.80	0.39	-0.20
Pb	2.98	1.30	3.86	0.39	0.50
Bg	3.34	0.96	3.22	0.39	0.37
WV	0.35	2.62	0.93	0.39	1.01
Intercept	1.00	-11.57	-11.57		
Z			0.26		

The variables identified in this study and their marginal effects are explained as follows.

a) *Goals*

Family farm (F1): According to Table 2, a one-decimal increase in this goal score decreases the probability to have a contact network in the free market by 4.8%. According to some farmers in the sample, they preferred to specialise in few traditional crops in order to have more free time to maintain family tradition (*i.e.* family farm, F1). They said, in addition, that specialisation not only allowed them to have free time but also additional gross margin as a consequence of economies of scale. If farmers cared about family tradition and if they were satisfied with the gross margin that they obtained from specialisation, then having contact networks could not have been an interesting option for them because the search for beneficial networks could be costly and time consuming.

b) *Attitudes*

I like to try new things on my farm (Ae): According to Table 2, a one-decimal increase in this attitude score increases the probability to have a contact network in the free market by 5.3%. This result is consistent with the argument establishing that social networks facilitate innovation in terms of either new products or new technologies (Chang, 2003, and Boahene *et al.,* 1999). In the case of free markets, this means that farmers who were interested to try new things were more willing to participate in social networks in the free market because it is here where they can obtain the information required to innovate.

Off-farm income is important for sustaining our farm (Ah): According to Table 2, a one-decimal increase in this attitude score decreases the probability to have a contact network in the free market by 2.0%. A possible explanation for this result is that farmers who developed off-farm activities had less available time to participate in social networks than those who worked exclusively in this sector. In addition, networks seen as an alternative way to increase gross margin could be considered as substitutes of off-farm activities. As a result, it is expected to find that farmers who obtained off-farm income were less motivated to participate in social

networks in the free market.

c) *Perceived behavioural control*

I can further lower the cost of my production (Pb): According to Table 2, a one-decimal increase in this variable score increases the probability to have a contact network in the free market by 5.0%. It is possible that the ability to lower production costs is a consequence of the participation in networks in free markets. That is, since contact networks facilitate the adoption of new technologies, and because a new technology is normally associated with higher efficiency and lower unitary costs, it is expected to find a positive relationship between the ability to reduce production costs and the existence of contact networks.

d) *Market barriers*

Retailers demand a volume that I cannot produce (Bg): According to Table 2, a one-decimal increase in this market barrier score increases the probability to have a contact network in the free market by 3.7%. It is interesting to notice that retailers of profitable crops have addressed the implementation of quality control and traceability by selecting more efficient farmers for specific categories (O'Keeffe and Fearne, 2002). Since contact networks correspond to an indirect way to innovate into more efficient technologies, farmers who were interested to get access to more profitable markets could have increased production per area of land by increasing their participation in networks in the free market. In addition, networks can help farmers to obtain partners interested to carry out collaborative alliances with the objective to produce a joint volume of more profitable crops. In fact, a particular farmer in the sample was able to produce carrots by forming a collaborative alliance with a producer located in another region in the UK. The farmer argued that contact networks and collaboration were both important factors explaining the success of his business.

e) *Other variables*

Proximity to the city of Wolverhampton (WV): According to Table 2, a one-decimal increase in this dummy variable score increases the probability to have a contact network in the free market by 10.1%. This result can reflect the fact that many retailers such as supermarkets are located in cities. Therefore, the proximity to big cities could be coupled with the existence of farmers having contact networks.

4.2 Networks in contract markets: testing the HCN

In order to test the HCN, the probit model described in equations 1 and 2 was estimated. The estimated model is presented in Table 3.

Table 3: Probit model of network participation in contract markets.

Variables	Dependent variable p_i ($n = 44$)
Intercept	14.99** (2.86)
F1	-2.17** (-3.00)
F3	-1.34** (-2.74)
An	-1.52* (-2.36)
Bi	-2.71** (-2.69)
McFadden R^2	0.70
S.E. Regression	0.25

*$P < 0.05$, **$P < 0.01$, *** $P < 0.001$, z–ratios in parenthesis.

This Table shows that the McFadden R^2 for this regression presented a value equal to 70%. It also shows that the coefficients of some social-psychological variables were significant. This implies that the null hypothesis specified for HCN (see section 2) has been rejected. It is concluded, therefore, that the participation in networks in the contract market depends on non-economic drivers.

The marginal effects for the relevant variables are presented in Table 4:

Table 4: Probit estimations and marginal effects.

Variables	Mean	regression coefficient (*b*)	Mean*b	*f(Z)*	*bf(Z)*
F1	6.25E-7	-2.17	-1.40E-6	0.08	-0.18
F3	-2.10E-7	-1.34	2.80E-07	0.08	-0.11
An	2.38	-1.52	-3.60	0.08	-0.12
Bi	3.54	-2.71	-9.60	0.08	-0.22
Intercept	1.00	14.99	14.99		
Z			1.78		

The variables identified in this study and their marginal effects are explained as follows.

a) *Goals*

Family farm (F1): According to Table 4, a one-decimal increase in this goal score decreases the probability to have a contact network in the contract market by 1.8%. This result has also been found in the case of networks in free markets, so the same explanation applies here.

Farming as a way of life (F3): According to Table 4, a one-decimal increase in this goal score decreases the probability to have a contact network in the contract market by 1.1%. Because this goal is related to the statements "Enjoyment of work tasks" and "Enjoy my work", this result is consistent with the opinion given by some of the farmers in the sample. These producers said that they enjoyed working with traditional low risky crops because this allowed them to have more free time and to use it with their families. These agents argued that working with more profitable crops is more stressful and this reduces the pleasure of working in the farm. Thus, because farmers who were specialised in the production of traditional crops did not need innovation to be viable, it is not surprising that the producers who enjoyed working in their farms were less willing to form contact networks.

b) *Attitudes*

I would seriously advise young people not to become a farmer (An): According to Table 4, a one-decimal increase in this attitude score decreases the probability to have a contact network in the contract market by 1.2%. Farmers who were not satisfied with the farming life were probably less willing to be involved in contact networks in the contract market. This motivational problem could explain this result.

c) *Market barriers*

Producing these crops implies collaborative alliances that are difficult to form (Bi): According to Table 4, a one-decimal increase in this market barrier score decreases the probability to have a contact network in the contract market by 2.2%. This result can also reflect a motivational problem. That is, farmers who believed that forming collaborative alliances is difficult were less interesting to form contact networks in the contract markets because this was probably considered a waste of time.

5. Comments and conclusions

The research on network and innovation in agriculture has focussed on the analysis of the mechanism by which social networks facilitate innovation. However, no work has been developed to understand what motivates farmers to participate in these networks. The present paper fills this gap by proposing a multivariate model that assumes that farmers' decision on being involved in beneficial networks depends on goals and socio-psychological variables referred to as non-economic variables.

The results obtained from the probit analysis revealed that the formation of networks in free markets is negatively influenced by farmers' non-economic goals such as maintaining farming tradition, and by the participation of farmers in off-farm activities (*i.e.* negative determinants). In contrast, the formation of networks is positively influenced by attitudes toward innovation, by the ability to reduce production costs, by the existence of market barriers in the interface producer-retailer, and by the proximity to large cities (*i.e.* positive determinants). The results allow concluding that it is possible to stimulate the formation of networks in free markets by affecting some specific determinants. For example, a motivational initiative could be introduced in order to increase farmers' interest to try new things in their farms. In addition, local development programmes could be introduced in order to maintain farmers in the field and, by this way, prevent them from looking for off-farm activities.

Regarding contract markets, the results revealed that the formation of networks in these markets is only determined by negative determinants. They correspond to farmers' non-economic goals, lack of motivation about farming, and the difficulty of forming collaborative alliances with other farmers. It appears that only the last determinant is suitable for policy intervention. That is, the incorporation of programmes to facilitate the formation of collaborative alliances could positively affect the formation of beneficial networks in contract markets because it is in these networks where farmers could eventually found suitable partners.

While the present research has considered the particular case of the ex-Sugar Beet Farmers of the West Midlands, it would be interesting to include in this analysis other types of farmers. This extension will be considered for future research.

Appendix A: Statements used in the questionnaire

Farmers' goals (G)
G1) Achieve an income as high as possible
G2) Enjoy my work
G3) Provide for next generations
G4) Have sufficient time for leisure
G5) Maintain nature and environmental value
G6) Produce a good and safe product
G7) Gaining recognition and prestige as a farmer
G8) Belonging to the farming community
G9) Maintaining the family tradition
G10) Working with other members of the family
G11) Feeling pride of ownership
G12) Enjoyment of work tasks
G13) Preference for a healthy, outdoor, farming life

G14) I enjoy having a purpose and value hard work
G15) Have independence and freedom from supervision
G16) Have the control in a variety of situations

Farmers' attitudes, perceived behavioural control and subjective norms
Attitudes **(A)**
A1) Achieve low debts on my farm
A2) My goals and objectives are clear
A3) I try to be among the highest producing farms
A4) I regularly negotiate with suppliers and buyers
A5) I like to try new things on my farm
A6) Keeping my farm up to date is very important to me
A7) In decision-making I take the environment into consideration, even if it lowers profits

A8) Off-farm income is important for sustaining our farm
A9) When making an important decision I ask for a lot of advice
A10) I take challenges more often than other farmers
A11) I use my equity capital as a risk buffer
A12) I try to minimise contract work
A13) Farming is still fun and satisfying
A14) I would seriously advise young people not to become a farmer

Perceived behavioural control **(P)**
P1) I'm well informed on the relevant legislation for my farm
P2) I can further lower my production costs
P3) Before I take important decisions I thoroughly inform myself
P4) When I need a new loan, I always go to the same bank
P5) I can increase the sales-price of my production
P6) Administrative obligations consume a lot of time on my farm
P7) I don't make plans because they don't work out in reality

Subjective norm **(N)**
N1) The way other farmers think about my farm is important to me
N2) I consider government policy unpredictable
N3) Legislation spoils the pleasure in my work
N4) The increasing amount of regulation interferes with my plans for the future

Market barriers preventing farmers from producing more profitable crops (B)
B1) The markets for these crops are very selective
B2) I am not familiar with the productive process of more profitable crops
B3) I am not interested in other alternatives
B4) My land is not appropriate to produce these crops
B5) I don't have the necessary capital and machinery to produce them
B6) Retailers demand quality that it is difficult to achieve
B7) Retailers demand a volume that I cannot produce

B8) Retailers have too much negotiation power

B9) Producing these crops implies collaborative alliances that are difficult to for

B10) I am not able to innovate to the extent required to enter the market

B11) I don't have the productive efficiency to the extent required to enter the market

Appendix B: Factorial analysis and the component of farmers' goals

Family farm (F1): This factor is composed of the variables "Maintaining the family tradition" and "Working with other members of the family".

Farm control (F2): This factor is composed of the variables "Have independence and freedom from supervision" and "Have the control in a variety of situations".

Farming as a way of life (F3): This factor is composed of the variables "Enjoyment of work tasks" and "Enjoy my work".

Quality of life and income (F4): This factor is composed of the variables "Achieve an income as high as possible" and "Have sufficient time for leisure".

Status (F5): This factor is composed of the variable "Gaining recognition and prestige as a farmer".

Self realization (F6): This factor is composed of the variable "I enjoy having a purpose and value hard work".

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