A search theory model for the Buy Wine matchmaking algorithm in Tuscany.

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Abstract

Given the increasing concentration in the distribution of wine markets, the figure of export broker can have a significant role in the ex-ante contracting process over Tuscan wineries that seek to distribute to international outlets. Adopting a search theory approach, this paper aims to develop a basic model that describes the role of the Buy Wine algorithm and its intermediation function. The model contributes to understand how the quality of matches can influence the intermediaries' bargaining power and the relative influence on wine prices. In these terms, the bargaining solution is still compatible with previous search theory (i.e. see Rubinstein and Wolinsky, 1987; Wong and Wright, 2011) and family economics (Browning et al., 2014) results, but the model provides an explanation of the influence that the different matching alternatives have on price determination. Our results show that the strategy set up by the Tuscany Region to facilitate the contact between regional producers and international buyers, guarantees a positive economic return for Tuscan wine producers. The statement of buyers' preferences towards a seller profile and vice-versa may reduce the risk to occur into hidden information on the quality of traded good and then claim for a lower ex-ante search cost for the buyer.

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1. Introduction

The global wine match is dominated by the competition between two blocks of producing countries, the New World wine (Australia, Chile, USA and New Zealand), and the Old World producers (France, Italy, Spain and Portugal).

Until a few years ago, this competition was mainly played on a downward price. Especially in cheaper market segments where the emerging countries have been particularly successful with their greater capacity to produce new wines according to the evolution of the international taste (e.g. the Chilean wine Carmenère, the Australian Shiraz and the Argentinean Malbec). However, today the export success is related to the development of quality, with a high degree of novelty and variety according to the increase of consumer needs (Wu, 2014; Salas, 2016). Therefore, since a low-cost strategy alone is not sufficient to increase competitiveness, the game has moved into the higher market segments and success depends on the capacity to realize investments in R&D, innovation, training, infrastructures, branding as well as creating more stable relationships with global distributors and supply networks (Visser and Langen, 2006). In this context, thanks to a well-established winemaking tradition and investments realized in the past, the old producer countries still manage to play a predominant role confirmed by their higher share of exports over the total (62%) (Nomisma, 2008). However, this leading role is not easy to maintain in a market characterized by a decreasing wine consumption and profound changes of consumer needs. These changes are likely to influence the institutional arrangements of the industry, the organization of the supply chains, the producers' distribution modes and the regulation governing them.

In addition to the uncertainty of demand and the pressure on sale prices, wine producers often face also the structural weaknesses of the supply chain due to excessive fragmentation; in fact, the extreme atomization of the supply chain that characterizes the Italian wine industry does not facilitate the development of clusters nor other forms of coordination (Humphrey and Schmitz, 2002). This kind of situation appears when there is a common strategy in which investments on the marketing and trade side lead to a weaker bargaining power of producers with respect to large wholesalers and distributors. Conversely, Australian wine producers are importantly involved in wine industry programs to promote and support the export of Australian wine.

In this context, only a few large producers or cooperative manage to deal with pressures on sales due to the strong international competition and concentration, while the rest of the sector shows clear signs of suffering. A literature review and producers interviews highlight the increase of concentration on the distribution side (Santiago and Sykuta, 2016) in favor of large players, which can offer to the consumer a wider choice and ease of access. The increase of concentration creates bottlenecks for medium size and smaller producers seeking to access the retail market. Moreover, the modern trade (i.e. large distributors or retailers) is the channel that has the highest bargaining power able to impose particularly stringent requirements in terms of price, quantity and quality.

In this extremely competitive environment, an alternative to the modern trade, particularly relevant for small and medium-sized wineries, can be the contact with third parties agents such as wholesale intermediaries or export brokers. Marketmakers and matchmakers, as defined by the literature on marketing channels (Yavas, 1992; Baritaux et al., 2006), can play a key role, connecting wineries (i.e. sellers) to other distribution channels in domestic and external outlets.

These types of actors (i.e. wholesale merchants, industrial distributors, importer or exporter, agents and brokers) maintain relations with distributors and merchants (i.e. buyers). Since they follow the individual capillary outlets, they can be considered as manufacturers' representatives (Rindfleisch and Heide, 1997) which can substitute producers in the marketing phase (ISMEA, 2008). Such relevant actors are independent third parties that help agents from the initiation until the enforcement of transactions. According to Williamson and Ouchi (1981) and Williamson (1985), they take part in the institutional framework in which contracts are initiated, negotiated, monitored, as well as adopted, enforced and terminated. These "middlemen" can help producers to find and develop exchanges in new distribution channels overcoming the bottlenecks created by the concentration of large distributors. Moreover, the contact with these intermediaries creates also the opportunity to reduce the transaction costs associated with the research and development of new marketing channels and, therefore, it can represent a successful strategy for small and medium enterprises to boost their competitiveness.

Thus, aware of the strategic importance of these intermediaries, especially for small producers, seven years ago, the Tuscany Region decided to create an annual international reference event for brokers worldwide interested in Tuscan wines, called "Buy Wine". For the regional administration, the scope of this meeting is to encourage the development of the relationship between regional producers and the international importers. Then more recently, this event has been further enhanced, thanks to the contribution of an innovative web agency, named Uplink that developed a CSM-2 intelligent matchmaking algorithm that helps sellers and buyers to manage the pre-trading stage (i.e. organizing the search, matching and meeting phases). This algorithm works in the pre-contractual phase between parties and like real matchmakers (Baritaux et al., 2006) do not participate directly in the ownership flow, but simply match buyers and sellers, helping them to transact.

Within the framework of collaboration between our research unit, the Tuscany Region and the Uplink company, adopting a search theory approach, this paper aims to develop a basic model that describes the role of the Buy Wine algorithm and its intermediation function in the bilateral meeting between wine producers and export brokers. Moreover, the model contributes to understand how the quality of matches can influence the intermediaries' bargaining power and the relative influence on wine prices. In these terms, the bargaining solution is still compatible with previous search theory (i.e. see Rubinstein and Wolinsky, 1987; Wong and Wright, 2011) and family economics (Browning et al., 2014) results, but the model provides an explanation of the influence that the different matching alternatives have on price determination.

Although the buyer/seller relationship has been covered by the economic research, to the best of our knowledge, this topic is still marginal on wine and agricultural economics literature. In addition, one key innovative aspect of our work, if compared with previous search theory studies, is the focus on the relationship between the matching and trading equilibrium patterns. Moreover, we also set up the modeling environment differently, in several ways, from previous studies. Thus, our modeling assumptions and the consequent searching, matching, and trading stages have been customized with a realistic approach based on the real Buy Wine event. Finally, yet importantly this work constitutes the first attempt to describe the function of intermediations made by a matchmaker machine (i.e. the Buy Wine algorithm).

The remainder of the paper is organized as follows. The second section describes the buyer/seller relationship and develops the buy wine modeling framework. The theoretical model and the equilibrium solution is presented and discussed in the third section. We conclude in sections four with the implications of this work for both theory and practice as well as limits and directions for further research.

2. Brokerage characteristics within the Buy Wine modeling framework

2.1. Introducing the buyer/seller relationship

The concept of buyer-seller relationship can be attributed to the sphere of relationship marketing (Gronroos, 1994a; Gronroos, 1994b) which was developed on the basis of export marketing literature (Aaby and Slater, 1988; Madsen, 1989; Zou and Stan, 1998; Love and Holt, 2000) driven by the evolution of complex and increasingly competitive domestic and offshore markets (Beaujnot et al., 2004). Not only academics but also manager and export companies benefited from this theoretical knowledge that allowed companies to realize efficient export strategies, maintaining long-term trades and improving their competitiveness. According to this literature, in the rest of the discussion, we will refer to business markets rather than consumer markets. This distinction allows us to focus on those wine producers that operate with a business-to-business model (B2B), but we do not exclude that generally, producers operate with many other distribution channels (i.e. direct sales at the farm gate, local markets etc.).

Under a B2B perspective, the wine companies try to sell their products (e.g. grape wine, bulk wine, bottled wine) to wholesalers, retailers and other merchants adopting both a transaction cost and a relationship marketing approach (Gummesson, 2002; Shet, 2002). In order to achieve the desired results, they must commit their time, effort and money to build a strong and longer “value-laden relationship” with these actors (Beaujnot et al., 2004). Especially for a sector like wine, in which is relevant the export context, the relationship marketing focuses on the importance of retaining existing customers (Payne and Ballantyne, 1991) than to acquire new ones. According to Dabholkar and Neely (1998), the time horizon (i.e. short-term and long-term) associated with the interaction between buyer and seller can be one of the most important determinants of the type of interaction and of the performance between parties. The literature also stresses that the ability to develop stable long-term relationships is connected with the desire on both buyers and sellers to create a non-conflicting relationship based on adaptation, cooperation and capacity to solve conflicts. According with Anderson and Weitz (1998), from the realization of these conditions depends on the development of trust that is another important determinant of long-term relationship.

2.2 Define Wine brokerage

The wine brokers as many other wholesale intermediaries often figure in the middle of the buyer-seller relationship, constituting a link between the production and the distribution phase (Stern and El-Ansary, 1992). According with Hackett (1992), Yavas (1992) and Bartiaux et al. (2006) the marketmakers and the matchmakers define the two main types of intermediaries in the marketing channels' literature. The distinction between these two categories derives from the products' ownership. The first is a middleman that acquire products’ ownership from the sellers and then he transfers it to the buyers. Instead, the matchmaker is focused on matching buyer and seller and he helps them to negotiate and transact. While the first receive an offer that is included as a compensation in the purchase price of the products, the latter receive a form of revenue from commissions.

Moreover, the matchmakers in relation to the form of interaction they have with the parties, they can be representatives and commissioned to transact on behalf of one party or they can remain independent (i.e. do not conclude any transaction in their name or in the name of a principal). According with Bartiaux et al. (2006) wine brokers generally belong to this category acting as intermediaries in wine exchanges between wine producers and distributors.

Despite there is a considerable bulk of literature about intermediaries’ existence and legitimacy, the role of matchmaker has been often neglected. For example, Wilkinson and Brouthers (2006) recognize for export companies the potential of the creation of stronger relationships with trade partners, but their focus remains on export programs and promotion without considering the role played by intermediaries in these programs. Moreover, within the literature about export intermediaries, they have been mostly considered as producers’ representatives that constitute a potential sale force for producers, which can be integrated to production or managed in outsourcing (Dutta et al., 1995).

However, as emerged by Charters et al. (2008) there is a need for competencies in managing export and sales, thus the role of middleman can be far from negligible. In the wine industry is becoming crucial to select those reliable distributors, particularly one who worked for the good of the particular winery and their brand and does not behave opportunistically. Thus, brokers can facilitate the process of selection and they can entertain for producers even more stable relation with distributors and retailers.

In a typical wine exchange process the broker is almost active and relevant in all the stages (Figure 1). Before the matching stage the intermediary, acquire the information on the buyer side by regular contacts with merchants and distributor. Once the necessary knowledge about the demand has been gathered, the contacting step starts and the broker searches the products needed on the supply side. In this stage, he can realize the first match on buyers and seller needs. During the contacting step, he collects general information about supply characteristics by meeting the different wine producers selected in order to taste their wine, to gather samples and to acquire more informal and strategic information about the market (e.g. the available quantities and quality). Then a pre-negotiation stage occurs in which the broker can send samples and informs the buyer about the producer prices and available quantity. If the information combines the merchants need he or she can reply with a purchase order. According with Baritaux et al. (2006) the negotiation stage starts at this time and it regards not just only price and quantity, but also delivery time (wine removal terms) and payment. Wine removal terms are relevant in wine contracts since a delay in delivery time can comprise the product quality and the seller reliability. After the negotiation a written agreement or contract occur and despite the brokering activity theoretically stops here, he actually still follows the final process of closing the deal between the parties acting as a guarantor of the enforcement of the contract. The broker checks the products quality and make sure that the contract terms are enforced. In the case of conflict, he can mediate to solve it and maintain stable the relationship. Depending on the types of broker, he can receive his compensation at the time of delivery or as a commission for the terminated contract.

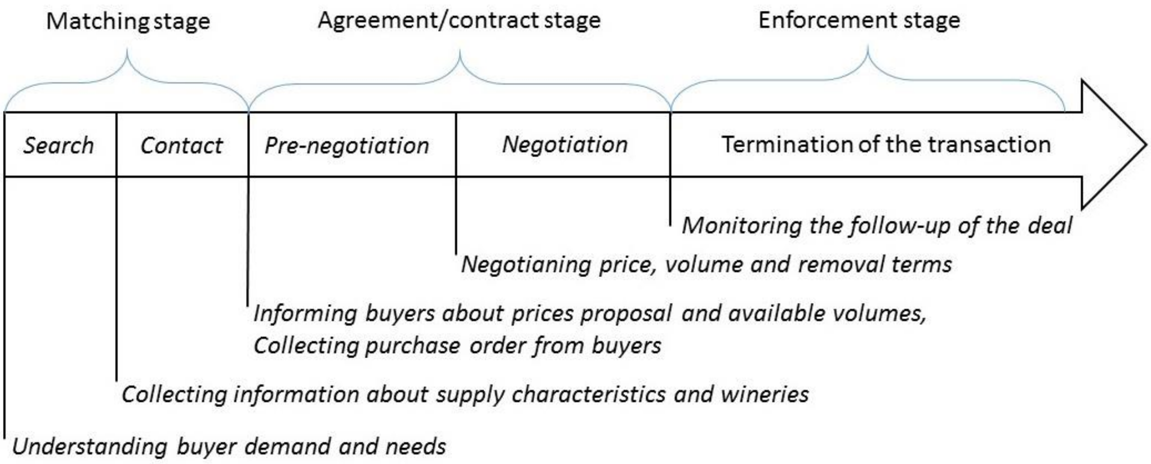

Figure 1. The Broker's role during wine exchange stages

2.3. The background of the Buy Wine model

In this section, we briefly introduce all the elements that compose the Buy Wine event from which we developed in the next section the theoretical model.

The whole Buy Wine architecture can be viewed as a tool created by the Tuscany Region to promote the excellences of Tuscan wine sector towards foreign markets. The Buy Wine represents the largest commercial initiative for Tuscan wines. It takes place every year in Florence (Italy) from

2011. In the course of its seven editions, it has acquired popularity and is now recognized by the industry as a reference event for importers worldwide interested in Tuscan wines.

This tool aims to create a contact point between regional wine producers and export brokers that are interested in buying Tuscan wine and import it into foreign countries. Thus, for Tuscan producers became a great opportunity to meet these buyers at a significantly lower cost than traditional ways of contact with these intermediaries (i.e. visits in foreign countries, other trade fairs). Thus, we define Buy Wine as a mechanism that promotes the meeting between the real actors of the wine industry, particularly between wine producers and those foreign brokers who occupy the upper part of the wine supply chain.

Since the process of matching and bargaining are interconnected (Rubinstein and Wolinsky, 1985) according with Figure 1, we can divide the action of the tool into three main chronological stages: the actors' enrolment by the web portal, the selection and matching stage and the B2B meetings. The entire online architecture (i.e. Buy Wine web portal and smartphone application) provides the CSM algorithm to manage the participant selection process, the matching stage and the B2B meeting during the Buy Wine event in Florence. Thus, as evident from the above description, the Buy Wine tools directly operates between the search and the pre-negotiation stages. Let us clarify the connections between these two stages describing the order of events for a typical agent 1 (i.e. a seller) at a certain time (the similar description will suit for the agent of type 2, the buyer)

During the enrolment stage, the agent 1 and 2 (i.e. wine producers and export brokers) can sign up to the initiative. Then, the system guides each actor to the creation of a proper business profile. Each profile detects the main actor characteristics, such as the type of production or type of distribution, geographic origin, annual turnover, etc. Thus, each profile that contains the agent's specific information and characteristics is created in order to facilitate the subsequent selection and matching stage.

After profiling, each participant goes through the next stages of selection and matching. We suppose the agent 1 seeks on the portal the most attractive profiles (i.e. based on his or her needs and requirements) among the profiles of agent 2. The agent 1 set a research using the searching tools composed by different criteria based on the required characteristics. The Buy Wine algorithm provides to the agent 1 a list of agents of type 2 that can be suitable to meet based on those characteristics he or she is looking for. In other words, the system suggests to the agent 1 an order of preferences. Then, the agent 1 can put a like to the most preferred ones. If the counterpart (i.e. agent 2), who receive the "like" can respond with another "like" confirming the order of preference that the system has provided. In this case, the algorithm matches the two profiles and assign to this "first pair" a meeting slot at the Buy Wine event and we define this double like process as the "perfect match".

However, if the agent 2 do not respond with a like, the system do not create the match between these actors, but it keeps the record of this like and automatically generates several best matches (i.e. sub-matches) that suggest to the agents. More in details, the algorithm scan the database in order to find the agent of type 2 that have similar characteristics and needs of the one for which the agent 1 has expressed a like and that might be interested in meeting during the event. This new order of preference becomes automatically a sub-match representing a kind of second-best choice. Then, if both actors agree on these options the system assign to these sub-matches the other available meeting slots.

Moreover, the system also assists agents giving suggestion during the search stage and help each actor to select those profiles that are more close to their real needs. At the same time, it helps to exclude those profiles that have elements of concrete divergence, which can lead to waste of time and efforts by actors (i.e. a seller who can offer just 10.000 bottles per year and a buyer who is searching more than 50.000 bottles per year). Moreover, if a meeting during the event "break" the web application can help participant to find the best agent available at this time and provide a new meeting.

The matching stage end with an agenda of meeting for each participant. In each agenda, there can be a number of perfect matches and sub-matches depending on the number of participants and their preferences, but each agent does not meet the same person for more than once.

After the matching stage, the system is also operative during the B2B meetings. Each actor uses the Buy Wine smart-phone application during the Buy Wine event in order to manage the agenda (i.e. to replace a meeting, to take notes, leave reports about the meeting and to control the information about the agents). Each B2B meeting scheduled in the agenda can last a maximum of 25 minutes each. The Buy Wine objective is to offer at least 26 meetings for each buyer or seller during the 2 working days of the event.

In order to complete the framework from which our analysis starts, we report here some numbers of the last Buy Wine edition according to the data provided by the Tuscany Region. The Buy Wine 2017 has opened its doors to 210 Tuscan companies (i.e. seller) and around 190 export broker (i.e. buyer), which were selected from a larger sample based on the chronological order of participation requests in addition to some exclusion criteria based on the past experiences in order to eliminate potential interferences and optimize meeting slot and expected results. The 191 buyers come from 35 countries, of these more than the 45% (i.e. about 88) was at his/her first participation. It is worth to notice here that among the participating countries, the US was present with 29 buyers, Canada with 28 and China with 22. Of the 210 Tuscan wine producers that participated, they have been represented from boutique wineries with a distinctive portfolio to bigger and well-known companies. Among these regional producers, the largest number comes from Florence (68) and from Siena (66).

For participation, both producers and export broker have paid an entry fee in order to contribute to cover some operative costs, while logistics, promotion and implementation costs were covered directly by the Region. During this edition, they have held about 5000 meetings. Each buyer arranged to meet about 26 companies in the average.

3. The Model

In the previous section, we introduced all the elements that compose from the reality of the Buy Wine event our modeling environment. Thus according to the previous approach in search theory (Rubinstein and Wolinsky, 1985; Wong and Wright, 2011; Nguyen et al., 2013) and family economics (Browning et al., 2014), we introduce here the resulting Model.

3.1 Basic Assumptions of the matching stage

We consider a given number of sellers $S_i = \{S_1, S_2, \dots S_n\}$ and of buyers $B_j = \{B_1, B_2, \dots B_n\}$, which enroll to the Buy Wine portal adding their relevant characteristics and features in order to participate to the searching, matching and meeting/trading stage as we described above.

Defining m_h the vector of seller's characteristics (i.e. m_1=price range, m_2 =produced quantity, m_3= production types, m_4= quality range, etc.), with a hxi matrix we can represent the whole sets of information acquired from the seller during the enrollment stage on the Buy Wine portal (Table 1).

Table 1. Seller's characteristics matrix

	S_i	S_1	S_2	...	S_n
m_h	m_{hi}	m_{h1}	m_{h2}	...	m_{hn}
m_1	m_{1i}	m_{11}	m_{12}	...	m_{1n}
m_2	m_{2i}	m_{21}	m_{22}	...	m_{2n}

…	…	…	…	…	…
m_n	m_{ni}	m_{ni}	m_{n2}	…	m_{nn}

Then we define n_k the vector of buyer's characteristics (n_1= price range traded, m_2 =quantity demanded, m_3= production types, m_4= required quality range, etc.) with a kxj matrix we can represent the whole sets of information acquired from the buyer (Table 2).

Table 2. Buyer's characteristics matrix

	B_j	B_1	B_2	…	B_m
n_k	n_{kj}	n_{k1}	n_{k2}	…	n_{km}
n_1	n_{1j}	n_{11}	n_{12}	…	n_{1m}
n_2	n_{2j}	n_{21}	n_{22}	…	n_{2m}
…	…	…	…	…	…
n_n	n_{mj}	n_{m1}	n_{n2}	…	n_{nn}

Once the agents inserted their relevant information, they start the selection of profiles using the selection tools and the matching algorithm directly on the portal as we described above.

3.2. The matching stage

Using the selection tools the system scan among agents characteristics those that are suitable for matching, for which we necessary have h=k (Figure 2).

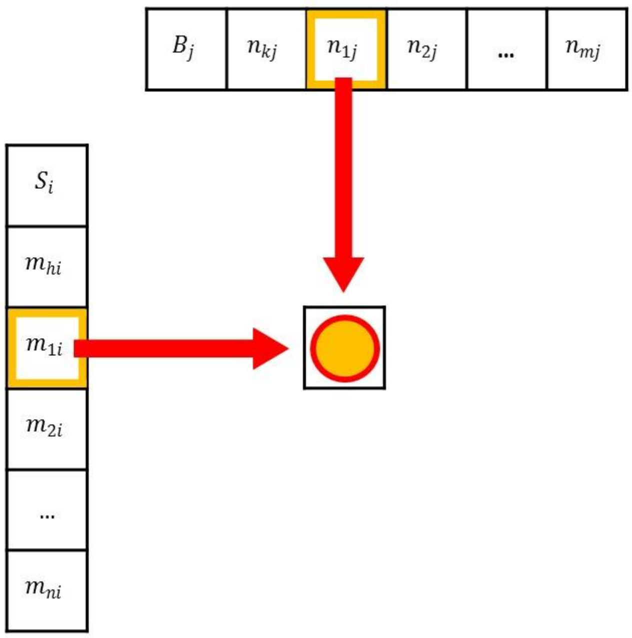

Figure 2. The selection and matching stage

Then the system suggests a preference order for each type of agent. If for example, we consider the seller 1 and two hypothetical suggested preferences (i.e. for buyer 1 and 2), the suggested preferences must respect the following properties:

$$\sum n_{k\mathrm{i}} = N_1 \geq \sum n_{k\mathrm{j}} = N_2 \quad (1)$$

Which means that the system suggests to seller 1 that the set of N characteristics of buyer 1 is more suitable than the set of N characteristics of buyer 2.

From the selection process then the system allows the match of participants when m_{hi}=n_{kj}. Thus, in a pair of matched agents, we have: $m_{hi} = n_{kj}$ with h=k

The perfect match is when the selection of a seller i attributes made by the buyer j, exactly correspond to the selection of buyer j attributes made by the seller i (i.e. when they like each other). Considering that these two vectors have the same characteristics, it results in the following properties of a perfect match:

$$\sum m_{hi} = M_n = \sum n_{kj} = N_n \quad (2)$$

Once the agents confirm a perfect pair the system allocates them to a meeting slot. Otherwise when $M \neq \mathrm{N}$, the selection made by each agent do not represents a perfect like, thus the system suggest to the agents a "sub-match", starting from the most suitable or preferred agent and so on according with equation (1). According to the available meeting slot, in this case, the algorithm formulates and suggest different sub-matching options.

Every time that the system creates a preference order we assume, independently if they are perfect or sub-match, that it create for each agent a new set of seller $M_a = \{M_1, M_2, \ldots M_n\}$ and of buyers $N_b = \{N_1, N_2, \ldots N_n\}$. These new sets must respect the equation (1), for which for a hypothetical seller i "M_a" the following relationship represents his or her meeting agenda $N_1 \geq N_2 \geq \ldots \geq N_n$ and vice-versa for a generic buyer j "N_b" we have $M_1 \geq M_2 \geq \ldots \geq M_n$.

Then if we hypothesize transferable utilities of agents (i.e. total output can be divided between two parties), when the matching stage end, we assume that each seller has a preference ranking all buyers that constitutes "the meeting agenda". It follows that each buyer has an order of preferences over all sellers. Such meeting agenda can be represented by a M_ax N_b matrix with a pair of utility payoffs (y_{ab}, u_{ab}) that synthesizes the expected output of the matching phase (Table 3).

Table 3. Meeting agenda

	N_b	N_1	N_2	...	N_n	M_{tot}
M_a	y_{ab}, u_{ab}	y_{a1}, u_{a1}	y_{a2}, u_{a2}	...	y_{an}, u_{an}	M_{a0}
M_1	y_{1b}, u_{1b}	y_{11}, u_{11}	y_{12}, u_{12}	...	y_{1n}, u_{1n}	M_{10}
M_2	y_{2b}, u_{2b}	y_{21}, u_{21}	y_{22}, u_{22}	...	y_{2n}, u_{2n}	M_{20}
...	....	...	...	...	...	...
M_n	y_{nb}, u_{nb}	y_{n1}, u_{n1}	y_{n2}, u_{n2}	...	y_{nn}, u_{nn}	M_{n0}
N_{tot}	N_{0b}	N_{01}	N_{02}	...	M_{0n}	

Where M_{a0} represents the expected total output from the meeting agenda of M_a and N_{0b} for N_b.

Assuming that $y_{ab} = \sum n_{kj} p_0$ can represent the expected utility for the seller i to trade the unit "x" with the buyer j, n_{kj} is a vector of buyer j characteristics k, p_0 is an expected average price from trade. At the same time, $u_{ab} = \sum m_{hi} p_0 + (p_1 - p_0)$ represents the expected utility for the buyer j to trade the unit "x" with the seller i, $(p_1 - p_0)$ is an expected gain from trade which we can call the intermediary's margin (Wong and Wright, 2011).

Considering an example of a game with a number of four agents, during the matching process the system gives the following alternative expected payoffs from the potential meeting (Table 4):

Table 4. Expected payoff from a matching game of four agents

	B_1	B_2	S_{tot}
S_1	y_{11}, u_{11}	y_{12}, u_{12}	s_{10}
S_2	y_{21}, u_{21}	y_{22}, u_{22}	s_{20}
B_{tot}	b_{01}	b_{02}	

For a given j the entries y_{ab} describes the seller preferences ordering buyer j over all feasible buyer (i.e. j=1,2) and vice-versa for u_{ij}.

Remembering equation (1) and (2), if i and j form a match we have:

$$y_{ij} + u_{ij} = \tau_{ij} \tag{3}$$

Where τ_{ij} is the expected output from the match (i.e. τ_{ij} is given and y_{ij}, u_{ij} are variables).

In our game, we assume that when i=j it must be a stable match (Browning et al., 2014) with “stable=perfect match” (double like), which means that the perfect assignment must maximize the total output over all possible assignment.

If we assume that a perfect match (double like) dominate the single state and also the sub-match, and if any two individuals remain alone, without any appointment, they can gain by forming one sub-match. Here we synthesize all the possible assignments:

S1 match B1, S2 match B2

S1 match B2, S2 match B1

Let now hypothesize that this combination is stable: S1 match B2, S2 match B1, it results that to be true the following inequalities must hold:

$$y_{12} + u_{21} \geq \tau_{11} \tag{4}$$

$$y_{21} + u_{12} \geq \tau_{22} \tag{5}$$

If the first equation (4) falls to hold S1 and B1 who are currently not matched to each other can arrange a sub-match (the system will arrange it on the basis of their expressed preferences) with a division of utilities which will improve their current individual state (without any appointment or match) defined by y_{12}, u_{21}

The same happen if the second equation (5) falls.

Thus, from equation (4) we can derive:

$$\tau_{12} = y_{12} + u_{12} \tag{6}$$

$$\tau_{21} = y_{21} + u_{21} \tag{7}$$

So that equation (4) can be rewritten:

$$\tau_{12} - u_{12} + \tau_{21} - u_{21} \geq \tau_{11} \tag{8}$$

That adding with equation (3) we obtain:

$$\tau_{12} + \tau_{21} \geq \tau_{11} + \tau_{22} \tag{9}$$

Which means that an assignment along main diagonal will be a perfect match only if the equation (9) is reversed. According with Browning et al. (2014), this is a sufficient condition for assigning to the main diagonal the condition of perfect match, which means that it is impossible for both parties to gain from an eventual reassignment, thus the other potential assignment despite the main diagonal are sub-match.

Let now pass through the trading stage using game theory approach to verify these properties.

3.3. Basic assumption of the trading stage

The main output of the matching stage is an agenda of the meeting which establishes the order of meeting among sellers and buyers. In the trading stage according with Wong and Wright (2011), we assume that when a seller S_i meet a buyer B_j it starts a bilateral trading (B2B meeting) between the two agents. Then the seller begins with an offer: "I give you an indivisible unit of good x_{ab} in exchange of y_{ab}. Moreover, we assume that if the seller does not trade, he can consume the unit x_{ab} obtaining a utility γ_{ab} that we can consider as the opportunity cost of trading x. Since the seller during the trade cannot increases the production, γ_{ab} measures the best outside option for S_i for exiting the trade. At the same, time we assume that when B_j acquires the unit x his gross utility is defined by λ_{ab}.

The following graph represents the basics of trade with the set of two nodes S_i, B_j that have been connected by the Buy Wine algorithm (Figure 3).

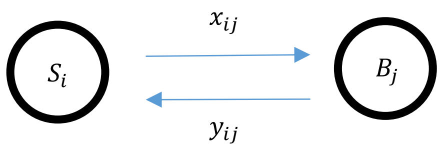

Figure 3. The trading game

3.4. The Trading stage

If we hypothesize the following meeting agenda for the seller S_1:$\{N_1 \geq N_2\}$, according with Wong and Wright (2011) when S_1 meet the first buyer N_1 the trade necessary conditions are:

$\lambda_{11} \geq \gamma_{11}$, which means that the expected payoff from trade must be greater than do not trade and eventually consume the good.

If the trade starts, then the second to move in the trading game is the buyer N_1 that can accept or refuse the seller's offer.

- If he accepts, it means the end of the game.

The total payoff in case the first buyer accepts is $[y_{11}, \lambda_{11} - y_{11}]$, where $\lambda_{11} - y_{11}$ is the buyer's net utility from trade.

If the buyer refuses the offer, we go to the next move into $subgame$[1].

The third move "Nature" (Wong and Wright, 2011) means that we can have a probability β_1 that S_1 makes N_1 a take-or-leave-it offer and a probability $(1 - \beta_1)$ that N_1 makes S_1 a take-or-leave-it offer. In other terms with probability β_1, S_1 gets the whole surplus λ_{11} leaving N_1 with outside the option (0) and with probability $(1 - \beta_1)$, N_1 gets the surplus $(\lambda_{11-}\gamma_{11})$ and S_1 takes his outside option γ_{11}. In this case, the game end with a sub-game equilibrium and the seller 1 move to the next buyer N_2 repeating the same game.

The following picture represents the overall game for S_1according to his or her meeting agenda, including the matching and trading stages (Figure 4).

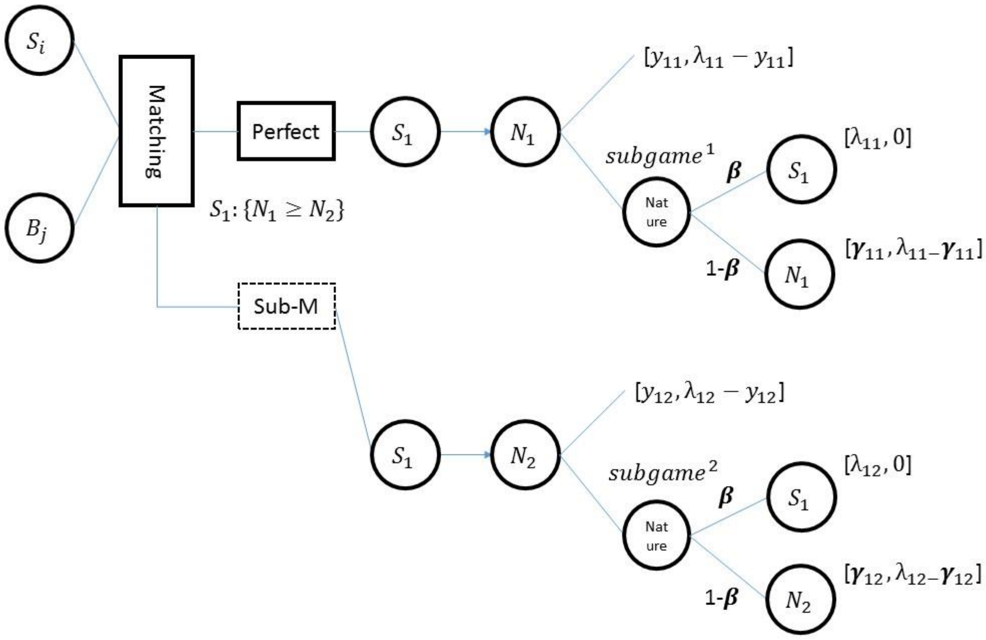

Figure 4. The overall game graph

According with Wong et al. (2016) at $subgame^1$ there is a unique perfect equilibrium:

- S_1 makes N_1 his reservation offer which means N_1 indifferent between accepting or rejecting, and he accepts.

We can write the indifference condition as:

$$y_{11} = (1 - \beta_1)\gamma_{11} + \beta_1\lambda_{11} \tag{10}$$

Defining the payoffs for the seller and the buyer respectively:

$$V_{11} = \gamma_{11} + \beta_1(\lambda_{11} - \gamma_{11}) \tag{11}$$

$$Z_{11} = (1 - \beta_1)(\lambda_{11} - \gamma_{11}) \tag{12}$$

After some algebra manipulations we obtain that (10) hold if:

$\lambda_{11} \geq \gamma_{11}$ and $V_{11} \geq \gamma_{11}$

Let now calculate the same indifference condition for $subgame^2$ in the case of a sub-match where S_1 makes N_2 his reservation offer which means N_2 is indifferent between accepting or rejecting, and he accepts.

The new indifference condition is:

$$y_{12} = (1 - \beta_1)\gamma_{12} + \beta_1\lambda_{12} \tag{13}$$

Defining the payoff for the seller and the buyer respectively:

$$V_{12} = \gamma_{12} + \beta_1(\lambda_{12} - \gamma_{12}) \tag{14}$$

$$Z_{12} = (1 - \beta_1)(\lambda_{12} - \gamma_{12}) \tag{15}$$

After some algebra manipulations, we obtain that (13) hold if:

$\lambda_{12} \geq \gamma_{12}$ and $V_{12} \geq \gamma_{12}$

Let now compare the total surplus (TS) from trading in the perfect match (PM) case in $subgame^1$ with the total surplus of trading in sub-match (SM) case in $subgame^2$.

We can define $Total\ surplus = \sum payoffs - outside\ options$

Thus taking equation 11, 12, 13, 14 and 15 with the respective outside options, we calculate the difference between the two total surpluses as:

TS(PM)-TS(SM)≥0 (16)

Equation (16) hold if the outside option for S_1 in the first subgame are lower than the outside option in the second subgame $\gamma_{11} \leq \gamma_{12}$

Let follows the demonstration:

$$(V_{12} - \gamma_{11} + Z_{11}) - (V_{12} - \gamma_{12} + Z_{12}) \geq 0$$

$$[\gamma_{11} + \beta_1(\lambda_{11} - \gamma_{11}) - \gamma_{11} + (1 - \beta_1)(\lambda_{11} - \gamma_{11})] - [\gamma_{12} + \beta_1(\lambda_{12} - \gamma_{12}) - \gamma_{12} + (1 - \beta_1)(\lambda_{12} - \gamma_{12})] \geq 0$$

$$\beta_1\lambda_{11} - \beta_1\gamma_{11} + \lambda_{11} - \gamma_{11} - \beta_1\lambda_{11} + \beta_1\gamma_{11} - [\beta_1\lambda_{12} - \beta_1\gamma_{12} + \lambda_{12} - \gamma_{12} - \beta_1\lambda_{12} + \beta_1\gamma_{12}] = 0$$

That after some algebraic simplification gives:

$\lambda_{11} - \gamma_{11} - \lambda_{12} + \gamma_{12} \geq 0$

That is true when

$$\lambda_{11} - \gamma_{11} \geq \lambda_{12} - \gamma_{12} \quad (17)$$

Then, we know that the utility of N_1 can be written as $u_{11} = \lambda_{11} - y_{11}$ and considering equation (2) we have:

$$\lambda_{11} = u_{11} + y_{11} = \tau_{11} \quad (18)$$

The same for

$$\lambda_{12} = u_{12} + y_{12} = \tau_{12} \quad (19)$$

Substituting (18) and (19) into (17) we obtain:

$$\tau_{11} - \gamma_{11} \geq \tau_{12} - \gamma_{12} \quad (20)$$

Remembering that according with equation (9) we have a perfect match if and only if $\tau_{12} \geq \tau_{11}$ is reversed.

Equation (20) confirm that the sub-game with S_1 and N_1 is a stable perfect match since we have $\tau_{11} \geq \tau_{12}$ if $\gamma_{11} \leq \gamma_{12}$.

Thus the unique perfect equilibrium in $subgame^1$ (perfect match case) dominate the equilibrium in $subgame^2$ if the outside option are lower in the first trade game compared to the second, as a consequence the TS(PM) is larger than the TS(SM) which mean that under the perfect match case increases the surplus for producer 1. This theoretical result confirms the goodness of the Buy Wine matching stage and verifies equation (9).

Although in this first version of the model, we assumed that the registration fees are negligible; this does not means that, in fact, they may not have some impact on the surplus that the agents receive from the participation to the event. However, for the purposes of our discussion, we can consider these transaction costs (i.e. the participation fee, the effort to enter information and follow the matching stage) as totally negligible if compared to, for example, the higher cost of participating in other industry events (i.e. international wine fairs). Generally, in these type of events, the organizers are not able to guarantee to the sellers any meeting with buyers and the only surplus they are able to offer is a kind of return in branding and image.

Let now compare the payoffs when in stage 2 under the perfect match case N_1 accepts the offer from S_1.

The payoffs are: $[y_{11}, \lambda_{11} - y_{11} = u_{11}]$.

As we defined at the beginning, we have that:

- $y_{11} = \sum n_{k1} p_0$
- $u_{11} = \sum m_{h1} p_0 + (p_1 - p_0)$

And according with (2) in a perfect match case we know that $\sum m_{hi} = \mathrm{M} = \sum n_{kj} = \mathrm{N}$

If we compare the two payoffs $y_{11} = u_{11}$, this is true only if:

$Np_0 = Mp_0 + (p_1 - p_0)$ for which we have

$$p_1 = p_0 \tag{21}$$

Which theoretically means that the expected margin of the buyer from trading in a perfect match is reduced. In other words, more is the level of information that the agent share in the matching stage then more is the reduction of the transaction cost from trading and as consequences the buyer margin. The perfect match can contribute to reducing the buyer's bargaining power due to the reduction in the asymmetry of information between the parties. The statement of buyers' preferences towards a seller profile and vice-versa may reduce the risk to occur into hidden information on the quality of traded good and then claim for a lower ex-ante search cost for the buyer.

4. Conclusion

As we began, the research carried out and the theoretical model contributes to explain the relevant role of intermediation in the wine industry (Baritaux et al., 2006). Our results show that in order to overcome the bottleneck in the retail market the strategy set up by the Tuscany Region in order to overcome this problem, guarantees a positive economic return for regional producers. Although the results are still theoretical, the Buy Wine architecture can stimulate the contact between producers and export brokers. Then, through the international meeting, according to a well-defined methodology of matching relying of modern information and communication technologies (i.e. what we called the buy wine CSM-2 algorithm) is able to deliver an increase in the economic surplus that producers can achieve during the trading stage with the export broker. Indeed this work delivers the first attempt to describe the present potentialities of considering the ICT technologies in combination with economic theory in order to address problems and issues related to the sustainability of agricultural producers. Our theoretical model confirms that the quality of match (i.e. perfect match versus sub-match) has a greater influence in terms of price determination that is related to the reduction of the risk to occur into hidden information. This result leads to a reduction of the bargaining power of intermediaries and of their margin confirming the previous achievements of Wong and Wright (2011). Moreover, the methodology relied on game theoretical approach has been able to explain the connections between the matching and trading equilibrium patterns.

Although the results seem satisfactory, there are still several limitations in this work, which can be overcome in the further analysis. The model does not consider the sellers and buyers' effort to find the event and participate and neither is considered the selection mechanism in the enrolment stage. Thus in further studies, the model need to consider the probability that the population of agents achieves a perfect match with respect to the sub-match. This probability deserves to be included in a subsequent development of the model in order to verify the impact on price determination and on the overall bargaining mechanism.

Further development of this research will take place thanks to the data collected in all the previous editions of the Buy Wine, through which it will be possible to verify the theoretical model. After that, it will be possible to analyse what are the agents' characteristics that have a greater influence on the payoff expectations during the bargaining process and consequently on prices.

Given the increasing concentration in the distribution of wine markets, the figure of export broker can have a significant role in the ex-ante contracting process over Tuscan wineries that seek to distribute to international outlets. The Regional policy can have a greater role to favor the contact with these commercial intermediaries, improving the quality of these relationships by supporting the reduction of trading friction and hidden information with distributors. In these terms, the level of completeness of information can play a significant role in the distribution agreements between wineries and brokers. In other words, our results help policy makers that aim to support the regional wine trade providing insight into the modes of which meeting can be designed to increase the economic benefits of local producers.

Keywords: search theory, wine supply chain relationship, producers bargaining power, experimental economics

JEL-Code: D23, L14, L22, L66

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