The Role of Quantity and Quality in B2B Platform Competition*

Zhiwen LI[†], Thierry PENARD[‡]
UNIVERSITY OF RENNES 1-CREM

Draft: June 11, 2011

*We thank Michael Arnold for useful comments on an earlier version. We also thank David Crowder, one of the administrators at MFG.com, for answering our questions.

[†]School of Economics, University of Rennes 1, France. e-mail: zhiwen.li@univ-rennes1.fr

[‡]School of Economics, University of Rennes 1, France. e-mail: thierry.penard@univ-rennes1.fr

Abstract

A B2B (business-to-business) marketplace is a typical example of two-sided platform with a seller side and a buyer side. The success of a two-sided platform relies on the magnitude of indirect network effect. But network effects are often reduced to the number of agents on each side. Even if buyers are sensitive to the number of sellers and vice versa, they are also interested by the quality, reliability and variety of sellers. In this paper, we analyze the quantity and quality aspects of indirect network effects and how they impact pricing and trading decisions on a B2B marketplace. We build a theoretical model to examine the matching of sellers and buyers when quality matters and information is incomplete. We consider a mechanism of reverse auction in which a buyer posts a request for quote to procure an input and suppliers bid against each other without knowing the extent of fit with the buyer. We find that upstream firms compete more intensively when quality standards required by the buyer are more stringent. We also analyze how two marketplaces compete when buyers have heterogeneous preferences. This model allows us to derive some propositions that are tested using an original data set collected on MFG.com (one of the most prominent B2B marketplace in the USA). The data set contains transaction records from 2004 to 2010 covering 31 categories of products. MFG.com is subdivided into different geographical marketplaces, but the two largest are the US suppliers marketplace and the Chinese suppliers marketplace. Buyers can select the geographical marketplaces in which they want to post their requests for quote. Our data enable us to obtain the market shares of the US suppliers and Chinese suppliers marketplaces (in terms of value and volume) per period and per category and to relate market shares to the number and quality of suppliers on each geographical platform. Our results provide evidence of quantitative and qualitative network effects on MFG.com. The higher the number of suppliers and the greater their average quality on a geographical marketplace, the larger its market share. However, we find that quality effects tend to substitute for quantity effects as the size of the marketplace increases. These findings suggest that the quantity of suppliers present on the platform is crucial in the early stage, but suppliers quality matters much more in the maturity stage (when the platform has reached a critical mass).

Keywords: quantity, quality, competition, B2B platform, two-sided markets, indirect network effect

1 Introduction

B2B (business-to-busines) electronic marketplaces serve to facilitate regional or global transactions. According to eMarket services[1], more than 600 international marketplaces are active around the world. A B2B electronic marketplace has the following characteristics: gathering several buyers and several sellers, acting as a trading platform that does not directly sell or buy goods or services and having several trading services. B2B marketplaces can be classified along two criteria (Popović, 2002): vertical/horizontal and neutral/non neutral. A vertical marketplace gathers the two sides (suppliers and buyers) of a specific industry (for example the steel industry or the car industry), while a horizontal marketplace covers several industries. Moreover, a marketplace is neutral when it is managed by a third party independent of the suppliers or the buyers whereas it is non neutral or biased when it is owned by either suppliers or buyers (Yoo et al., 2007).

A B2B platform (especially the neutral platforms) can be considered as a typical example of "two-sided markets" (Belleflamme and Toulemonde, 2004) where the indirect network effects are central as the gain or utility derived by members in one side depends on the number of members on the other side (Armstrong, 2006; Evans, 2003). A supplier is more incited to join a B2B platform if there are numerous buyers on board (as trade opportunities increase); likewise, a buyer prefers to be on a B2B platform that has a wide choice of suppliers. A B2B platform faces the well-known problem of "chicken & egg". The platform needs to have a large base of users on one side in order to attract the users on the other side. A strategic issue is to determine which side to attract first and how to incite them to join the platform (Caillaud and Jullien, 2003). But each side will be also sensitive to the quality and variety of users as well as their willingness to trade (Weyl, 2010).

Much of the existing literature on two-sided markets assume that indirect network effects are driven by a preference for quantity (measured by the number of members on the other side). In this paper, we want to investigate the different sources of indirect network effects. More specifically, we analyze the relation between the quantity and quality aspects of network effects and how they impact pricing and trading decisions on a B2B marketplace. We build a theoretical model to examine the matching of sellers and buyers when quality matters and information is incomplete. We consider a mechanism of reverse auction in which a buyer posts a request for quote to procure an input and suppliers bid against each other without knowing the quality of their input. We find that upstream firms compete more intensively when quality standards required by the buyer are more stringent. We also analyze how two marketplaces compete when buyers have heterogeneous preferences. This model allows us to derive some propositions that are tested using an original data set collected on MFG.com, one of the most prominent B2B marketplace in the US. MFG.com is a vertical independent marketpkace that enables buyer to source customized inputs through a mechanism of request for quote [2]. Our

[1] eMarket services is an international independent collaboration of trade promotion organisations(www.emarketservices.com).

[2] This business process makes MFG.com different from general B2B platforms, like Al-

data set contains transaction records from 2004 to 2010 covering 31 categories of products. MFG.com is subdivided into different geographical marketplaces, but the two largest are the US suppliers marketplace and the Chinese suppliers marketplace. Buyers can select the geographical marketplace in which they want to post their requests for quote. Our data allow us to obtain the market shares of the US suppliers and Chinese suppliers marketplaces (in terms of value and volume) per period and per category and to relate market shares to the number and quality of suppliers on each geographical platform.

Our results provide evidence of quantitative and qualitative network effects on MFG.com. The higher the number of suppliers and the greater their average quality on a geographical marketplace, the larger the trading activity of this procurement platform. However, we find that quality effects tend to substitute for quantity effects as the size of the marketplace increases. These findings suggest that the number of suppliers present on the platform is crucial in the early stage, but suppliers quality matters much more in the maturity stage (when the platform has reached a critical mass).

Our paper contributes to the literature on electronic marketplaces. B2B platforms are expected to increase the efficiency and fluidity of markets by reducing transaction costs and causing productivity gains for firms (Lucking-Reiley and Spulber, 2001). A body of economic and management literature has examined the impact and performance of B2B platforms, as well as the different forms of governance and business models adopted by these platforms (Sülzle, 2009; Milliou and Petrakis, 2004). The theory of two-sided markets has also largely contributed to a better understanding of B2B platforms. This literature focuses on pricing strategies and competition issues (Caillaud and Jullien, 2001; Caillaud and Jullien, 2003; Hagiu, 2009a; Schmalensee and Evans, 2007; Rochet and Tirole, 2006; Rochet and Tirole, 2003). For instance, Armstrong (2006) shows that competition outcomes between two-sided platforms largely depend on the extent of network effect and multihoming. Pricing strategies have been extensively analyzed (entry and usage fees set by the platform), but non-pricing strategies have recently received more attention, e.g. the design of a platform (Hagiu, 2009a), the product variety (Hagiu, 2009b; Galeotti and Moraga-Gonzalez, 2009) and product quality provided by the platform (Damiano and Li, 2007; Damiano and Li, 2008; Suen, 2007; Kennes and Schiff, 2008; Belleflamme and Peitz, 2010). However, understanding how platforms manage both pricing and non pricing issues and how the different pricing and non pricing instruments interact with each other is important, but remains largely unexplored except Hagiu (2009a). Our paper indirectly addresses this question, by empirically examining the interaction between the number of suppliers registered (that mainly depends on the access fees set by the platform) and their average quality (that depends on the screening policy and quality regulation enforced by the platform). A few empirical studies exist on two-sided platforms, in the magazine or newspaper industry (Kaiser and Wright, 2006; Argentesi and Filistrucchi, 2007), yellow pages industry (Rysman, 2004) or payment card industry (Rysman, 2007). But to our knowledge,extensive empirical studies on electronic marketplaces are limited.

Our paper is also related to the literature on online auctions, especially

ibaba, Tradekey and so on.

on reverse auctions (also called "procurement auctions"), i.e. the format that buyers use to select their suppliers. The role of online auction in the success of B2B platforms is underlined by Sashi and O'Leary (2002) and the business and research issues raised by this mechanism is well summarized in Pinker et al. (2003). Our theoretical part builds on the work of Gal-Or et al. (2007) that investigates the profitability of Internet-based procurement service. We integrate their model of online reverse auction in the setting of a two-sided platform.

The rest of the paper is organized as follows. Section 2 presents a theoretical model of marketplace with online reverse auction to analyze bidding strategies and the impact of the number and quality of suppliers. Section 3 describes the data. Section 4 explains the econometric models and comments the results. Section 5 concludes.

2 Theoretical Model

In this section, we develop a model of reverse auction (procurement auction) on a B2B marketplace under incomplete information.

2.1 Assumptions

We consider a B2B marketplace that provides electronic procurement services for a vertically-related industry with m differentiated dowstream firms. The downstream firms (the buyers) use the marketplace to procures inputs from the upstream firms (the suppliers) to manufacture a final product (by transforming one unit of input into one unit of final product). The cost of production for the upstream firms is normalized to zero and the downstream firms have no additional cost except the input price. The quality of the final product manufactured by a downstream firm depends on the quality of matching between the supplier and the buyer, denoted x, which is uniformly distributed and only observed by the buyer (the suppliers only know the distribution of the quality parameter). In other words, the downstream firm is better informed than the supplier about the exact fit of input with the buyer's specification [3].

The model is as follows. We suppose that all the inputs are procured through the electronic marketplace. When a downstream firm releases a RFQ (request for quote) on the platform, each supplier can potentially participate and return a quote. Then the buyer compares the quotes and the extent of fit with the upstream suppliers and chooses the quote that yields the largest profit. The price paid by the manufacturer is the bid quoted by the selected supplier (first-price auction). On the final market, the quadratic surplus function for the representative consumer is given by

$$U(q_1, q_2...q_m, x_1, x_2...x_m) = \sum_{i=1}^{m}(a+ax_i)q_i - \frac{1}{2}(\sum_{i=1}^{m} q_i^2 + 2\gamma \sum_{j=1}^{m} \sum_{j=1, j\neq i}^{m} q_i q_j) - \sum_{i=1}^{m} p_i q_i$$

[3] The e-marketplace can also help buyers to infer the extent of fit, by providing information about suppliers' profile, their certifications, their past transactions and other feedback,...

where $q_1, .., q_i, ...q_m$ correspond to the quantity of the m differentiated downstream firms and γ is the degree of substitution (with γ=0 when products are perfectly independent and γ=1 when products are homogeneous). The first-order conditions allow us to derive the linear inverse demand schedule for each firm i,

$$p_i = a(1 + x_i) - q_i - \gamma Q_{-i}$$

where p_i, q_i, x_i are the retail price, output and the quality of firm i, and Q_{-i} is the aggregate output of the $m-1$ rivals. The parameter a measures the market expansion effect of a better fit between the upstream firm and downstream firm. For simplicity, we consider the case γ=0 (i.e. the downstream firms are not competing directly with each other [4].

We summarize the timing of the game as follows:

1. A buyer posts a request for quote (RFQ) on the marketplace.
2. n suppliers characterized by a minimum quality of $\underline{x}$ decide to simultaneously bid for this RFQ on the procurement platform [5]. Then the buyer compares the bids and selects the supplier that maximizes its profit.
3. The downstream firm chooses the quantity to produce and sell on the final market

2.2 Equilibrium

2.2.1 Single Platform

We start by the last stage of the game. Suppose the upstream firm i with a bid ω_i and a fit of x_i is the winner of the reverse auction. Then the downtream firm maximizes its profit by producing a quantity q (meaning that it will order a quantity q of input to the selected supplier i at an unit price ω_i)

$$\max_q [a + ax_i - q - \omega_i]q$$

The optimal quantity of inputs is given by

$$q^* = \frac{a + ax_i - \omega_i}{2}$$

The quantity of inputs increases with the extent of fit x_i. We derive the profit function of the downstream firm

$$\Pi_d = \frac{(a + ax_i - \omega_i)^2}{4}$$

[4]In this case, we neglect competition effects among buyers (no intra-group externality on the buyer side of the marketplace. The intra-group externality issue is discussed by Belleflamme and Toulemonde (2009)) and focus on indirect network effects between the two sides of the marketplace. To some extent, this restriction is not too strong because on MFG.com, most buyers are not direct competitors because they belong to very distinct industries.

[5]Despite consistent evidence of price dispersion on Internet markets, prior works found little price dispersion exists in B2B marketplaces, for example Ghose and Yao (2010).

Turning out to the second stage, we analyze the bidding strategies of upstream firms. We only consider symmetric equilibrium because suppliers are not informed of their quality and are initially with the same information (they only know that x is uniformly distribution on the range $[\underline{x}, 1]$.) Suppose that the k other suppliers submit identical bids $\hat{\omega}$ and the supplier i posts a bid of ω_i. Firm i will be the winner of the electronic procurement if given its level of quality x_i (observed by the buyer), its bid ω_i provides the highest profit to the buyer, i.e. if

$$ax_i - \omega_i \geq ax_k - \hat{\omega} \quad (k \neq i)$$

Then we derive the probability of this event

$$\Pr\left\{\underline{x} \leq x_k \leq \frac{ax_i + \hat{\omega} - \omega_i}{a}\right\} = \frac{(\frac{ax_i+\hat{\omega}-\omega_i}{a} - \underline{x})^{n-1}}{(1-\underline{x})^{n-1}} \quad (k \neq i)$$

Since the upstream firm i cannot assess the exact value of x_i, it will choose ω_i that maximizes its expected profit if it is selected by the buyer

$$\begin{aligned}\max_{\omega_i} E\Pi_{u_i} &= E[\Pr\left\{\underline{x} \leq x_k \leq \frac{ax_i + \hat{\omega} - \omega_i}{a}\right\}\omega_i q] \\ &= \omega_i \int_{\underline{x}}^{1} \frac{(\frac{ax_i+\hat{\omega}-\omega_i}{a} - \underline{x})^{n-1}}{(1-\underline{x})^{n}} \frac{a + ax_i - \omega_i}{2} dx_i\end{aligned}$$

From first order condition, we derive that

$$\hat{\omega} = \omega_i = \frac{a(n+1)(2n+1-\underline{x}) - a\sqrt{4n^2(n+\underline{x})(n+1) + (1-\underline{x})(1-\underline{x}+n-5n\underline{x})(n+1)}}{2n(n+1)}$$

It implies that

$$\frac{\partial\hat{\omega}}{\partial\underline{x}} < 0, \quad \frac{\partial\hat{\omega}}{\partial n} < 0, \quad \frac{\partial^2\hat{\omega}}{\partial n \partial\underline{x}} > 0$$

The input price logically decreases with the number of suppliers competing for the RFQ. However, the impact of the minimum quality $\underline{x}$ among suppliers is less intuitive. A higher minimum quality means that the buyer has a higher probability to find a better match and this should increases demand on the final market (and the derived demand for the input). Suppliers should be incited to bid more aggressively as the expected order of inputs is larger. But a higher minimum quality means that suppliers have more homogenous inputs, and have a lower probability to win the reverse auction. This second effect reduces the incentives to post low bids. It appears that the former effect dominates the latter effect and that the input price decreases as the minimum quality (and the average quality of suppliers) rises.

The expected profit of the upstream firm i is given by

$$E\Pi_{u_i} = \frac{\hat{\omega}[(n+1)(2a-\hat{\omega}) - a(1-\underline{x})]}{2n(n+1)}$$

with

$$\frac{\partial E\Pi_{u_i}}{\partial\underline{x}} < 0, \quad \frac{\partial E\Pi_{u_i}}{\partial n} < 0, \quad \frac{\partial^2 E\Pi_{u_i}}{\partial n \partial\underline{x}} > 0$$

The expected profit of each supplier decreases with the minimum quality and the number of suppliers (as both factors make firms bid more agressively). Based on symmetric bids $\hat{\omega}$, the expected quantity of input ordered by the downstream firm is

$$\begin{aligned} Eq &= \frac{1 + E[\max\{x_1, x_2, ..x_s.., x_n\} \,|x_s \geq \underline{x}, s = 1...n] - \hat{\omega}}{2} \\ &= \frac{(n+1)(2a - \hat{\omega}) - a(1 - \underline{x})}{2(n+1)} \end{aligned}$$

with

$$\frac{\partial Eq}{\partial \underline{x}} > 0, \quad \frac{\partial Eq}{\partial n} > 0, \quad \frac{\partial^2 Eq}{\partial n \partial \underline{x}} < 0$$

and the expected profit of the downstream firm is

$$E\Pi_d = E[\max\left\{(\frac{a + ax_1 - \hat{\omega}}{2})^2, (\frac{a + ax_s - \hat{\omega}}{2})^2 ..., (\frac{a + ax_n - \hat{\omega}}{2})^2\right\} |x_s \geq \underline{x}, s = 1...n]$$

$$= \frac{(n+1)(n+2)(2a-\omega)^2 - 2a(n+2)(2a-\omega)(1-\underline{x}) + 2a^2(1-\underline{x})^2}{4(n+1)(n+2)} \quad (1)$$

with

$$\frac{\partial E\Pi_d}{\partial \underline{x}} > 0, \quad \frac{\partial E\Pi_d}{\partial n} > 0, \quad \frac{\partial^2 E\Pi_d}{\partial n \partial \underline{x}} < 0$$

The profit of the downstream firm increases with the number of posted bids and with the minimum quality. Buyers benefit from indirect network effects stemming from the number and the quality of suppliers on the other side of the platform. Considering the joint effect of the quantity and quality of suppliers, we find that more suppliers on the marketplace decrease the marginal effect of supplier quality on the buyer's profit (and vice versa). It suggests that quantitative network effect shoule substitute for qualitative network effect and vice versa (see Figure 1).

Figure 1 is about here

2.2.2 A marketplace with two differentiated platforms

Now we consider two differentiated sub-platforms: sub-platform 1 with a number of suppliers n_1 and a minimum level of quality $\underline{x}_1$ and sub-platform 2 with n_2 suppliers and a minimum level of quality x_2. When a buyer wants to procure inputs, we suppose that the buyer must choose between these two platforms [6]. We also suppose that the buyers are uniformly distributed on a unit segment and that the two platforms are located at the extremes (platform 1 is located at 0 and platform 1 is located at 1). In other words, these two platforms are horizontally differentiated (in terms of services provided for instance). When a buyer chooses to procure inputs on one of the platforms, it bears a (transaction) cost that is proportional to the distance between its (optimal) location

[6] We suppose that a RFQ can not be simultaneously posted on the two platforms — no multihoming for a RFQ. On MFG.com, buyers are proposed to choose a geographical sourcing location before they distribute RFQs.

and the location of the platform. These transaction costs reflect the degree of trust (or mistrust) between the buyer and the platform or the extent of fit between the buyers and the services provided by each platform, it can also depaned on past experiences on each platform. A buyer will choose the platform that maximizes its profit by comparing the expected profit (based on the number and quality of suppliers) and the transaction costs on each platform. We assume that the transaction cost is equal to the distance times d [7].

The buyer that is indifferent between the two platforms is located at φ_1 characterized by

$$E\Pi_d^1(\underline{x}_1, n_1) - \varphi_1 d = E\Pi_d^2(\underline{x}_2, n_2) - (1 - \varphi_1)d$$

φ_1 can also be interpreted as the market share of the platform 1

$$\varphi_1 = \frac{1}{2} + \frac{E\Pi_d^1(\underline{x}_1, n_1) - E\Pi_d^2(\underline{x}_2, n_2)}{2d} \tag{2}$$

Note that

$$\frac{\partial \varphi_1}{\partial \underline{x}_1} > 0, \quad \frac{\partial \varphi_1}{\partial n_1} > 0, \quad \frac{\partial^2 \varphi_1}{\partial n_1 \partial \underline{x}_1} < 0 \tag{3}$$

$$\frac{\partial \varphi_1}{\partial \underline{x}_2} < 0, \quad \frac{\partial \varphi_1}{\partial n_2} < 0, \quad \frac{\partial^2 \varphi_1}{\partial n_2 \partial \underline{x}_2} > 0 \tag{4}$$

The market share of platform 1 increases with the number and quality of suppliers belonging to this platform (indirect network effects) and decreases with the attractiveness of the rival platform. Based on the distribution of buyers between the two platforms, we can also derive the market share in terms of quantity traded (or transaction volume) ψ_1 for the platform 1

$$\psi_1 = \frac{\varphi_1 E q^1}{\varphi_1 E q^1 + (1 - \varphi_1) E q^2}$$

We find similar effects of the size and quality of each platform on the volume market share of platform 1:

$$\frac{\partial \psi_1}{\partial \underline{x}_1} > 0, \quad \frac{\partial \psi_1}{\partial n_1} > 0, \quad \frac{\partial^2 \psi_1}{\partial n_1 \partial \underline{x}_1} < 0 \tag{5}$$

$$\frac{\partial \psi_1}{\partial \underline{x}_2} < 0, \quad \frac{\partial \psi_1}{\partial n_2} < 0, \quad \frac{\partial^2 \psi_1}{\partial n_2 \partial \underline{x}_2} > 0 \tag{6}$$

In the next section, we use this framework to test the impact of qualitative and quantitative network effect on the market shares of the US suppliers and Chinese suppliers sub-platforms on the MFG marketplace.

3 Data and variables

3.1 The MFG B2B Platform

Our data come from MFG.com, a US marketplace founded in 2000. MFG.com is reportedly being the largest online marketplace for manufacturers to source

[7] We implicitly assume that the subscription fees for these two platforms are identical.

custom parts, standard components, assemblies or textiles. MFG.com has experienced a rapid growth over the last few years. Firstly, Jeff Bezos invested in this company in 2005, then MFG acquired SourcingParts.com, a large e-marketplace in Europe and opened its second largest office in China in October, 2006. The same year, MFG.com was named by Business 2.0, one of the 15 companies that would change the world. In 2007, Fidelity Ventures invested in the company. Now MFG reportedly has more than 200,000 members around the world and its platform is available in 7 languages and offer payment service in 50 currencies.

The MFG B2B plaform is designed to facilitate the matching between buyers and suppliers all over the world. Since 2000, several billions of dollars of sourcing opportunities have been enabled by MFG. Practically, buyers post request for quote on MFG and indicate the estimated annualized quantity of parts or components with the technical specifications (design, geometry, dimensions, quality, ..). MFG classifies the RFQs into more than 40 categories such as machining, fabrication, molding, assembly, stamping, electronics and electrical components, materials, services and textiles [8]. The buyers have the option to select the geographical area in which the RFQ is posted (i.e. to select which suppliers are eligable to bid). As we mainly observe transactions between US buyers and US and Chinese suppliers, we will assume that MFG.com of composed of two procurement platform, buyers on MFG.com can select either the US suppliers platform or the Chinese-suppliers platform to post a RFQ. For simplicity, we label the US suppliers platform as platform 1 and the Chinese suppliers as platform 2. Figure 2 presents the structure of MFG.com.

Figure 2 is about here

According to our theoretical framework, we hypothesize that:

H1: In each input category, the market share of the US suppliers platform should increase with the number and the average quality of US suppliers and decreases with the number and average quality of Chinese suppliers.

H2: The qualitative network effects should substitute for the quantitative network effect on each geographical platform.

3.2 Data Description

The data collected are the monthly engineered-to-order[9] components transactions. The dataset contains 54,053 records of transactions from January 2004 to September 2010. For each transaction, we have informaton about the category of inputs, the buyer and supplier location, and the date of the RFQ (see Figure 3 in the Appendix). Most of buyers are from USA (49,281 transactions originated by US suppliers, accounting for 91.2% of total records). The

[8]Total value of open RFQs in each category is released every day on MFG website.

[9]Engineered-To-Order (ETO) is a manufacturing process whereby finished goods are built on unique customer specifications. Parts and raw materials may be stocked but are not assembled into the finished good until a customer order is received . Engineered-To-Order products may require a unique set of items, bills of material, and routings - and are typically complex with long lead times. Customers are heavily involved throughout the entire design and manufacturing process for engineer to order products.

large majority of transactions sourced by US buyers are awarded to two groups of suppliers: US suppliers and Chinese suppliers, with 46,887 transactions accounting for 95.1% of total records. Among these transactions, US suppliers have a market share of 91% and Chinese suppliers are only involved in 9% of these transactions. Since there are a limited number of transactions sourced by non-USA buyers and awarded to other suppliers than US and Chinese suppliers, we focus on the transactions that are sourced by US buyers and awarded either to US or Chinese suppliers.

When buyers launch a RFQ on MFG.com, they have to indicate the estimated annualized volume. This ex ante annualized volume is helpful for the potential suppliers to determine their bids (and whether they will participate to the bidding process). For each open RFQ (not yet attributed to a supplier), MFG calculates the current annualized value by multiplying the estimated annual volume of pieces (specified by the buyer) by the average bids or quotes submitted. In our sample of RFQ, only 11,308 records provide information about the annualized value, with 9,925 records for US suppliers and 1,383 records for Chinese suppliers (87.8% and 12.2% repectively). The RFQs without annualized values can be explained by the fact that some RFQs are a one-shot transaction or a way to test suppliers in order to find a long-term partner [10]. Therefore, it is reasonable to assume that the transaction volumes from the RFQs without publicly observed annualized value are small.

Table 1 is about here

In our data set, the transaction records are classified into 31 categories (following the classification of MFG): apparel, assembly, bearings, casting, extrusions, fabrication, gears, machining, molding, springs & wire forming, stamping, tube modification, fasteners & hardware, electronics manufacturing, ferrous metals, tool, die & mold making, woodworking, fabric & trim, forging, grinding, home textiles, packaging, powered metal, forming, rapid prototyping, seal & gaskets, coating, cutting tools (special), electronic components & devices, engineering & design services, engraving & marking.

Table 2 is about here

We aggregate transactions by category and month to obtain panel data. We calculate the monthly number of RFQs and their annualized value per category for the two sub-platforms (US suppliers and Chinese suppliers). Table 1 presents the available observations per category: the panel is unbalanced because we have missing observations for some categories over the period. Our panel data contain 1,351 observations (965 observations with annualized values) from January 2004 to September 2010. In 60.9% of the cases, all monthly RFQs of a category are awarded via the sub-platform 1, i.e. to US suppliers; in 7.8% of the cases, all RFQs are awarded via the sub-platform 2, i.e. to Chinese suppliers; and in 31.3% of the cases, RFQs are awarded via both sub-platforms, i.e. shared between US and Chinese suppliers.

[10]MFG reports that the value of a one-shot RFQs is generally small, sometims a few of dollars.

The average monthly RFQs and annualized values per category are presented in Table 2. On average, 32 RFQs are awarded to US suppliers in each category and each month, 10 times more than for Chinese suppliers and the monthly annualized value per category is 30 times larger on the US suppliers platform than the Chinese suppliers platform.

Table 3 is about here

We also collected information on the supplier members of the two geographical sub-platforms. For each member, MFG provides its profile including its location, the DUNS (Data Universal Numbering System), the number of employees, its certifications, the services and products that the supplier can offer, the categories of these products, some photos and videos about the products, the date of entry on MFG (see Figure 4 in the Appendix). We are able to collect the profile of 495 Chinese suppliers and 993 USA suppliers [11]. From this, we can determine the number of active US and Chinese suppliers per category for each month (based on the entry date on MFG). It indicates the potential number of bidders for any RFQ submitted on each geographical sub-platform. We do not observe the actual number of bidders per RFQ, but we think that the registered (active) number of suppliers should be positively correlated with the number of bids received for a RFQ. We conjecture that the attractiveness and the market share of a geographical platform (US or Chinese) should increase with the number of potential suppliers.

An interesting information in the profile of each supplier is the listing of certifications obtained. These certifications are a signal of quality. We checked for each supplier whether they have the four following certifications: ISO (International Organization for Standardization), ANSI (American National Standards Institute), ASME (American Society of Mechanical Engineers), AS (Aerospace Basic Quality System Standard). Some suppliers have at least one certification, but no supplier have the four certifications[12]. Then we calculated a monthly quality index for each category and sub-platform, as follows

$$\text{certification index} = \frac{\text{Total number of certifications}}{4 \times \text{Total number of active suppliers}}$$

This index is a measure of the average quality of suppliers on the two sub-platforms. We expect that this supplier quality index on a platform is positively correlated with its market share (qualitative network effect).

3.3 Descriptive Analysis

Based on our theoretical model, we use the market share of US suppliers platform as the explained variable. Two metrics of market share are used: (1) MSRFQ: share of RFQs; (2) MSAV: share of RFQs annualized value. MSRFQ is the percentage of RFQs that are awarded via the US suppliers platform and MSAV is the percentage of the annualized value awarded of RFQs via the US

[11] We collected information about the suppliers at the end of 2010. A limitation is that we can not observe a supplier that was present on MFG before 2010 but decided to exit during our observation period

[12] Perhaps because some of these certifications are redundant.

suppliers platform. It is worth noting that MSRFQ and MSAV have not the same number of observations because some RFQs have no annualized value (MSRFQ and MSAV have 1351 and 965 observations respectively).

Table 2 displays the average market shares measured by MSRFQ and MSAV. Whatever the metric, the US suppliers platform accounts for more than 80% [13]. The dominance of the US suppliers platform can be explained by some differences in transaction costs between the two sub-platforms (US buyers can perceive transactions with Chinese suppliers as more risky and be more prone to trust local supplier than distant one). But we also suspect that indirect network effects play a role in the choice of US buyers between the US and Chinese suppliers platforms.

Table 3 presents the average quantity and quality of the suppliers in each geographical platform by category. On average, the number of suppliers in the US suppliers platform is significantly larger than that on the Chinese Suppliers platform. This difference can be explained by the fact that the Chinese platform was opened later (in 2006); the quality of suppliers on the US suppliers platform is higher comapared to the second platform (the difference is significant with a t test). Probably because many of these certifications are managed by US organizations and are better known by US suppliers.

4 Results

Based on the data from MFG and the theoretical framework, we estimate the relation between the market share of the two geogaphical sourcing platforms and the magnitude of indirect network effect on each platform. We also test whether the quantity and quality of suppliers are complement or substitute through interaction variables. Let i denote the product category, t the month, NP1 the number of US suppliers, NP2 the number of Chinese suppliers, and QP1 and QP2 the certification index for US suppliers and Chinese suppliers respectively. The estimated models are given by:

- Model 1

$$\mathrm{MSRFQ}_{it} = \beta_0 + \beta_1 \mathrm{NP1}_{it} + \beta_2 \mathrm{NP2}_{it} + \beta_3 \mathrm{QP1}_{it} + \beta_4 \mathrm{QP2}_{it} + \beta_5 \mathrm{NP1}_{it} \times \mathrm{QP1}_{it}$$
$$+ \beta_6 \mathrm{NP2}_{it} \times \mathrm{QP2}_{it} + \beta_7 \mathrm{D200610} + \beta_8 \mathrm{D200610} \times \mathrm{NP2}_{it} + \beta_9 \mathrm{D200610} \times \mathrm{QP2}_{it} + \xi_{it}$$

- Model 2

$$\mathrm{MSAV}_{it} = \beta_0 + \beta_1 \mathrm{NP1}_{it} + \beta_2 \mathrm{NP2}_{it} + \beta_3 \mathrm{QP1}_{it} + \beta_4 \mathrm{QP2}_{it} + \beta_5 \mathrm{NP1}_{it} \times \mathrm{QP1}_{it}$$
$$+ \beta_6 \mathrm{NP2}_{it} \times \mathrm{QP2}_{it} + \beta_7 \mathrm{D200610} + \beta_8 \mathrm{D200610} \times \mathrm{NP2}_{it} + \beta_9 \mathrm{D200610} \times \mathrm{QP2}_{it}$$
$$+ \beta_{10} \mathrm{RFQAV1}_{it} + \beta_{11} \mathrm{RFQAV2} + \xi_{it}$$

The dependent variable is the market share of the US supplier platform, using the two alternative metrics: MSRFQ and MSAV. The independent variables are the quantity and quality of suppliers on each platform. We add the

[13] This corresponds to the statistics reported by MFG.com, stating that 82% of US buyers sourced from US supplier.

interaction terms between the quantity (NP) and quality (QP) of the two platforms in Model 2 to identify the nature of relationship between quantitative and qualitative network effects.

Some other control variables are also included. RFQAV1 and RFQAV2 are the number of RFQs with publicly-observed annualized value (to take into account the potential measurement bias of unobserved RFQs when we use MSAV as dependent variable). D200610 is a dummy variable that is equal to 1 after October 2006 (to control for the opening of an office in China in October, 2006). The presence of MFG in China may also modify the magnitude of network effects: we control for this by introducing interaction terms between the time dummy variable (D200610) and the number and quality of Chinese suppliers. Finally, ξ is the disturbance term and βs are parameters to be estimated.

Table 4 displays the descriptive statistics and Table 5 the correlation matrix for the independant variables.

Table 4 and 5 are about here

4.1 Results: Estimating Indirect Network Effects

The dependent variables MSRFQ and MSAV take values between 0 and 1, with a concentration of observations at 0 and 1. For MSAV, 580 observations have a value of 1 and 103 observations are equal to 0 (60.1% and 10.7% of the sample, respectively). This means that MSRFQ and MSAV are left and right censored, and that OLS estimates may be biased (Greene 1999). In this case, a Tobit model is more appropriate and performs consistent estimations (McDonald and Moffitt 1980; Amemiya 1973; Greene 1999).

The results of panel data Tobit model on both MSRFQ and MSAV without the interaction terms are presented in the first two columns of Table 6 and Table 7. The number of US suppliers has a significant positive effect on the market share of the US suppliers platform, with a coefficient of 0.0009 ($p < 0.05$) in the MSRFQ equation and 0.0015 ($p < 0.01$) in the MSAV equation. An additonal supplier increases by 0.09 point the market share of the US suppliers platform in terms of RFQs and by 0.15 point in terms of annualized value. Moreover, the number of Chinese suppliers has a significant negative impact on the attractiveness of the US suppliers platform: an additional Chinese supplier reduces the market share of the US suppliers platform by 0.22 point in terms of RFQs and 0.4 points in terms of annualized value. This suggests that these two geographical platforms are actively competing to enroll more suppliers and increase their respective market share.

The quality of US suppliers (Chinese suppliers) has also a positive (negative) effect on the market share of the US suppliers platform. A one-point improvement in the average quality of US suppliers is associated with an increase of 7.8 point in the RFQ market share and 4.2 point for the value market share of the US suppliers platform. We also find that a one-point improvement in the proportion of certified Chinese suppliers reduces by 2 point the RFQ market share and by 3.6 points the value market share of the US suppliers platform.

These results are consistent with Hypothesis 1. Buyers seem to take into account both the quality and quantity of suppliers before choosing a platform to procure their inputs. However quantitative network effects tend to be larger on the smallest platform (the Chinese suppliers platform) whereas the magnitude of qualitative network effect is higher on the largest platform (the US suppliers marketplace). This suggests that in the early phase of a marketplace, the buyers value more the number of suppliers, and in the maturity phase, they pay more attention on the quality of suppliers.

In the MSAV model, we also find that the number of RFQ with a publicly observed annualized value has the expected effect (positive for RFQAV1 and negative for RFQAV2).

Finally, the opening of a permanent office in China (measured by the dummy D200610) has reduced the RFQ market share of the US suppliers platform by 29.3 point.

Table 6 and 7 are about here

To check the robustness of our results, we firstly calculate the variance inflation factor (VIF) scores for the independent variables to check for multi-collinearity. We don't find any VIF score above 3 that is much lower than the commonly accepted level of 10 and we can conclude on the absence of multi-collinearity (Kennedy 2003).

Secondly, we also ran panel data models with product category fixed effects and random effects. The estimation results are reported in the last four columns of Table 6 and 7. The coefficient for the quantity and quality effects are all significantly positive like in the Tobit regressions.

Thirdly, we try an alternative measure of quality, using the percentage of suppliers that have at least one of the four certifications. This is motivated by the concern that some of these certifications could be redundant or specific to some sectors. The results are reported in Table 8 and are quite similar to those obtained with our initial index of quality. [14]

Table 8 is about here

4.2 Results: Estimating the relation between Quantitative and qualitative network effects

Now we want to test whether quantitatitve network effects substitute for qualitative network effects. The results are reported in Table 10. First, we introduce interaction terms between D200610 (the dummy for the entry in China) and

[14] Another concern is that buyers with small orders of inputs may be constrained in their choice since the transaction costs to source abroad are too high with respect to the value of their orders. Similarly, product categories that have small trading activities on MFG could have a bias towards the US suppliers platform regardless of the extent of network effects (lack of experience, fixed costs, ...). We restricted our sample to the product categories that (i) have more than 100 transaction records during the period, (ii) have more than 200 transaction records. The sample contains 20 categories in the former case and 9 categories in the latter. The buyers belonging to these categories are supposed to focus more on network effects to choose between the US suppliers and Chinese suppliers platforms. The results displayed in Table 9 remain consistent with those reported in Tables 6 and 7.

the quantity or quality of Chinese suppliers to control for a change in network effects after MFG has opened a permanent office in China. Surprisingly, we find that the quantity of Chinese suppliers is less effective to increase the market share of the Chinese-suppliers platform, whereas the quality of Chinese suppliers plays a stronger role to increase the competitive advantage of this platform. After October 2006, a one point improvement in the quality of Chinese suppliers reduces the RFQ market share of the US suppliers by 4.6 point compared to the same situation before October 2006.

We also introduce interaction terms between the quality and quantity of US suppliers and Chinese suppliers. The coefficients are negative for US suppliers, but positive for Chinese suppliers. This suggests that an increase in the quality of suppliers diminishes the positive impact of the number of suppliers on market shares, and vice versa. These findings support our second hypotheses that qualitative network effects substitute for quantitative network effects. The results are not affected whether we consider market shares in volume or in value.

Table 10 is about here

5 Conclusion

In this paper, we have built a theoretical model to analyze the role of quantitative and qualitative network effects on B2B platforms. Then, we have empirically tested the positive impact of these network effects on the activity of a platform, using a data set of transactions collected on MFG.com. We have found that the attractiveness of a B2B platform depends on the number and quality of suppliers registered on the platform and that the quality of the suppliers is a substitute for the quantity of suppliers.

Some managerial implications can be drawn from our findings. Even if the managers of electronic marketplaces have to concentrate their efforts on enrolling a critical mass of suppliers in the early stage, they can not ignore quality issues and need to design screening mechanisms and enforce some minimum quality standards. In other words, the competitive advantage of a platform relies on finding the optimal mix of quantitative and qualitative network effect (Zhu and Iansiti 2010). Focusing only on the number of members, without monitoring quality can be detrimental to buyers' trust in the marketplace. This is well illustrated by the B2B electronic platform Alibaba. Recently, Alibaba reported that more than two thousands Chinese electronics suppliers cheated buyers on this marketplace during the period 2009-2010 and attempted to manipulate the reputation system (to appear as gold suppliers). This example shows the strategic importance to design pricing schemes that regulate the number of suppliers and incite them to provide the optimal level of variety, quality and trust.

Although our data are original and allow us to investigate the role of indirect network effects, our study has several limitations. First, we only consider a single electronic platform MFG, and it could be interesting to extend our empirical analysis to other B2B platforms. However, to our knowledge, MFG.com is the only B2B platform who is specialized in customized products or inputs, and many B2B platforms do not publicly release their transaction records. Another limitation is that transaction records collected on MFG.com do not cover all transations. As reported by MFG, some buyers or suppliers do not want to make their transaction public. For example, a buyer may prefer to keep the design of a product confidential. Besides, some suppliers on MFG.com are not publicly listed because they don't want or MFG.com selects the suppliers that are the most representative of the pool of suppliers. But such a bias exists on the US suppliers and Chinese suppliers platforms and should not substantially modify the market shares. Despite these limitations, our research paves the way for future research on the economics of B2B marketplace.

References

Amemiya, T. (1973). Regression analysis when the dependent variable is truncated normal. *Econometrica*, 41(6):997–1016.

Argentesi, E. and Filistrucchi, L. (2007). Estimating market power in a two-sided market: The case of newspapers. *Journal of Applied Econometrics*, 22(7):1247–1266.

Armstrong, M. (2006). Competition in two-sided markets. *RAND Journal of Economics*, 37(3):668–691.

Belleflamme, P. and Peitz, M. (2010). Platform competition and seller investment incentives. *European Economic Review*, 54(8):1059 – 1076.

Belleflamme, P. and Toulemonde, E. (2004). B2B marketplaces : Emergence and entry. Working paper, Universite catholique de Louvain, Center for Operations Research and Econometrics (CORE).

Belleflamme, P. and Toulemonde, E. (2009). Negative intra-group externalities in two-sided markets. *International Economic Review*, 50(1):245–272.

Caillaud, B. and Jullien, B. (2001). Competing cybermediaries. *European Economic Review*, 45(4-6):797–808.

Caillaud, B. and Jullien, B. (2003). Chicken & Egg: Competition among intermediation service providers. *RAND Journal of Economics*, 34(2):309–28.

Damiano, E. and Li, H. (2007). Price discrimination and efficient matching. *Economic Theory*, 30(2):243–263.

Damiano, E. and Li, H. (2008). Competing matchmaking. *Journal of the European Economic Association*, 6(4):789–818.

Evans, D. S. (2003). Some empirical aspects of multi-sided platform industries. *Review of Network Economics*, 2(3):191–209.

Gal-Or, E., Gal-Or, M., and Dukes, A. (2007). Optimal information revelation in procurement schemes. *The RAND Journal of Economics*, 38(2):400–418.

Galeotti, A. and Moraga-Gonzalez, J. L. (2009). Platform intermediation in a market for differentiated products. *European Economic Review*, 53(4):417–428.

Ghose, A. and Yao, Y. (2010). Using transaction prices to re-examine price dispersion in electronic markets. *forthcoming, Information Systems Research.*

Greene, W. (1999). *Econometric Analysis*. Saddle River, New Jersey, Prentice Hall.

Hagiu, A. (2009a). Quantity vs. quality and exclusion by two-sided platforms. Working paper, Harvard Business School.

Hagiu, A. (2009b). Two-sided platforms: Product variety and pricing structures. *Journal of Economics & Management Strategy*, 18(4):1011–1043.

Kaiser, U. and Wright, J. (2006). Price structure in two-sided markets: Evidence from the magazine industry. *International Journal of Industrial Organization*, 24(1):1–28.

Kennedy, P. (2003). *A Guide to Econometrics*. 5th Edition MIT Press, Cambridge, MA.

Kennes, J. and Schiff, A. (2008). Quality infomediation in search markets. *International Journal of Industrial Organization*, 26(5):1191–1202.

Lucking-Reiley, D. and Spulber, D. F. (2001). Business-to-Business electronic commerce. *Journal of Economic Perspectives*, 15(1):55 – 68.

McDonald, J. F. and Moffitt, R. A. (1980). The uses of tobit analysis. *The Review of Economics and Statistics*, 62(2):318–21.

Milliou, C. and Petrakis, E. (2004). Business-to-Business electronic marketplaces: Joining a public or creating a private. *International Journal of Finance & Economics*, 9(2):99–112.

Pinker, E. J., Seidmann, A., and Vakrat, Y. (2003). Managing online auctions: Current business and research issues. *Management Science*, 49:2003.

Popović, M. (2002). B2B e-marketplaces. European Commission's Electronic Commerce Team (Information Society Directorate General).

Rochet, J.-C. and Tirole, J. (2003). Platform competition in two-sided markets. *Journal of the European Economic Association*, 1(4):990–1029.

Rochet, J.-C. and Tirole, J. (2006). Two-sided markets: A progress report. *RAND Journal of Economics*, 37(3):645–667.

Rysman, M. (2004). Competition between networks: A study of the market for yellow pages. *Review of Economic Studies*, 71(2):483–512.

Rysman, M. (2007). An empirical analysis of payment card usage. *Journal of Industrial Economics*, 55(1):1–36.

Sashi, C. M. and O'Leary, B. (2002). The role of internet auctions in the expansion of b2b markets. *Industrial Marketing Management*, 31(2):103 – 110.

Schmalensee, R. and Evans, D. S. (2007). Industrial organization of markets with two-sided platforms. *Competition Policy International*, 3(1):151–179.

Suen, W. (2007). The comparative statics of differential rents in two-sided matching markets. *Journal of Economic Inequality*, 5(2):149–158.

Sülzle, K. (2009). Duopolistic competition between independent and collaborative business-to-business marketplaces. *International Journal of Industrial Organization*, 27(5):615 – 624.

Weyl, E. G. (2010). A price theory of multi-sided platforms. *American Economic Review*, 100(4):1642–72.

Yoo, B., Choudhary, V., and Mukhopadhyay, T. (2007). Electronic B2B marketplaces with different ownership structures. *Management Science*, 53(6):952–961.

Zhu, F. and Iansiti, M. (2010). Entry into platform-based markets. *forthcoming, Strategic Management Journal.*

Table 1: Observation distribution by product category

Category	Period Begin	End	AlltoSP1[a]	AlltoSP2[b]	ToBoth[c]	Obs.
1 Apparel	2007/06	2010/06	2	14	14	30
2 Assembly	2004/02	2010/09	51	1	19	71
3 Bearings	2004/03	2009/10	14	5	6	25
4 Casting	2004/03	2010/07	17	7	48	72
5 Extrusions	2004/02	2010/07	34	10	12	56
6 Fabrication	2004/01	2010/09	32	0	48	80
7 Gears	2004/01	2010/07	49	5	2	56
8 Machining	2004/01	2010/09	8	0	72	80
9 Molding	2004/01	2010/08	15	5	57	77
10 Springs & Wire Forming	2004/03	2010/09	55	1	18	74
11 Stamping	2004/01	2010/08	21	3	55	79
12 Tube Modification	2004/07	2010/07	49	1	8	58
13 Fasteners & Hardware	2004/05	2010/09	23	5	12	40
14 Electronics Manufacturing	2004/03	2010/08	34	9	8	51
15 Ferrous Metals	2007/01	2009/09	14	1	0	15
16 Tool, Die & Mold Making	2004/01	2010/07	29	8	10	47
17 Woodworking	2004/05	2010/08	46	1	4	51
18 Fabrics & Trim	2008/04	2009/08	3	3	5	11
19 Forging	2004/10	2010/03	15	8	5	28
20 Grinding	2004/01	2010/07	47	3	2	52
21 Home Textiles	2008/10	2010/05	4	3	2	9
22 Metal Spinning	2004/03	2010/05	24	0	0	24
23 Packaging	2004/06	2009/10	17	2	0	19
24 Powdered Metal Forming	2004/12	2010/06	10	7	0	17
25 Rapid Prototyping	2004/04	2010/06	54	0	6	60
26 Seals and Gaskets	2004/12	2010/09	44	0	3	47
27 Coating	2004/01	2010/03	25	0	0	25
28 Cutting Tools (Special)	2005/03	2009/07	14	0	2	16
29 Electronic Components & Devices	2007/10	2009/01	2	1	0	3
30 Engineering & Design Services	2004/03	2010/08	46	2	4	52
31 Engraving & Marking	2004/06	2009/11	25	0	1	26
		Total	823	105	423	1351

[a] Observations that all the RFQs are awarded via US suppliers sub-platform
[b] Observations that all the RFQs are awarded via Chinese suppliers sub-platform
[b] Observations that all the RFQs are shared via both sub-platforms

Table 2: Average number and annualized value of RFQs awarded by category and by platform

CatID	RFQ1	RFQ2	AV1 ($\times 10^3$\$)	AV2 ($\times 10^3$\$)	MSRFQ (φ_1)	MSAV (ψ_1)
1	2.67	5.37	415.99	279.42	0.24	0.32
2	5.52	0.48	171.61	253.68	0.90	0.89
3	0.96	0.56	10.32	0.88	0.68	0.82
4	3.40	2.31	419.65	44.42	0.63	0.70
5	2.14	0.70	341.76	12.46	0.74	0.80
6	87.43	4.75	738.24	128.38	0.95	0.91
7	2.29	0.14	47.89	3.63	0.90	0.91
8	397.80	31.76	7162.48	375.47	0.92	0.89
9	6.65	3.94	5553.76	195.06	0.62	0.68
10	4.50	0.35	13600	2.90	0.91	0.88
11	6.96	2.58	470.45	81.29	0.69	0.74
12	3.72	0.24	278.17	0.80	0.93	0.95
13	4.05	0.65	20.07	23.37	0.79	0.60
14	1.82	0.45	211.18	14.17	0.76	0.77
15	7.60	0.07	128.41	0.00	0.93	1.00
16	1.77	0.64	42700	4.10	0.74	0.71
17	2.49	0.20	482.34	26.18	0.94	0.94
18	1.36	1.82	17.63	176.36	0.50	0.45
19	1.36	0.71	40.00	38.44	0.62	0.64
20	1.85	0.10	12.13	1.31	0.93	0.84
21	3.67	1.89	42700	36.48	0.51	0.66
22	1.71	0.00	15.56	0.00	1.00	1.00
23	1.53	0.11	42.54	0.36	0.89	0.91
24	0.65	0.53	14.92	9.72	0.59	0.71
25	3.13	0.13	22.06	0.10	0.97	0.92
26	2.85	0.06	7.02	0.43	0.98	0.92
27	1.72	0.00	4.63	0.00	1.00	1.00
28	1.69	0.25	16.82	2.79	0.94	0.71
29	0.67	0.33	5.63	6.06	0.67	0.50
30	2.00	0.12	193.27	980.77	0.94	0.94
31	1.54	0.04	15.73	0.00	0.98	1.00
Total	31.68	3.02	3434.08	111.31	0.824	0.803

Table 3: Average quantity and quality of suppliers by category and by platform

CatId	Quantity1	Quantity2	Quality1	Quality2
1	5.93	14.73	0.02	0.07
2	300.10	14.45	0.10	0.11
3	51.96	4.36	0.17	0.10
4	99.49	37.71	0.12	0.11
5	75.11	7.80	0.12	0.07
6	308.55	29.66	0.10	0.07
7	66.57	3.20	0.16	0.09
8	401.23	61.65	0.10	0.09
9	123.16	37.03	0.12	0.07
10	64.93	2.78	0.14	0.02
11	134.51	46.24	0.13	0.08
12	73.29	3.26	0.13	0.02
13	75.13	12.20	0.13	0.09
14	63.35	3.20	0.13	0.05
15	1.13	1.33	0.00	0.00
16	115.81	12.81	0.11	0.05
17	47.92	1.75	0.12	0.01
18	4.27	7.27	0.00	0.08
19	67.14	14.54	0.13	0.08
20	69.56	2.08	0.14	0.00
21	4.89	11.33	0.00	0.06
22	44.29	1.54	0.14	0.03
23	48.00	1.16	0.14	0.00
24	49.76	4.41	0.15	0.04
25	84.65	1.25	0.11	0.00
26	56.98	2.79	0.15	0.09
27	64.60	1.36	0.12	0.05
28	55.38	1.13	0.13	0.00
29	37.33	3.67	0.12	0.11
30	85.50	1.29	0.10	0.00
31	56.35	1.15	0.13	0.00
Total	120.4	16.0	0.118	0.057

Table 4: Summary Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
MSRFQ	1351	0.82	0.31	0	1
MSAV	965	0.80	0.35	0	1
NP1	1351	120.4	125.5	1	819
NP2	1351	16.0	32.1	1	263
QP1	1351	0.118	0.033	0	0.188
QP2	1351	0.057	0.055	0	0.25
RFQAV1	1351	7.34	21.65	0	225
RFQAV2	1351	1.02	3.07	0	37
D200610	1351	0.63	0.48	0	1

Table 5: Correlation Matrix

	1	2	3	4	5	6	7	8	9
MSRFQ	1.000								
MSAV	0.826	1.000							
	0.000								
NP1	0.018	-0.001	1.000						
	0.507	0.973							
NP2	-0.286	-0.250	0.672	1.000					
	0.000	0.000	0.000						
QP1	0.240	0.192	-0.309	-0.272	1.000				
	0.000	0.000	0.000	0.000					
QP2	-0.278	-0.223	0.432	0.430	-0.162	1.000			
	0.000	0.000	0.000	0.000	0.000				
RFQAV1	0.107	0.128	0.527	0.222	-0.196	0.164	1.000		
	0.000	0.000	0.000	0.000	0.000	0.000			
RFQAV2	-0.180	-0.227	0.518	0.445	-0.290	0.249	0.580	1.000	
	0.000	0.000	0.000	0.000	0.000	0.000	0.000		
D200610	-0.296	-0.264	0.205	0.302	-0.427	0.405	-0.028	0.173	1.000
	0.000	0.000	0.000	0.000	0.000	0.000	0.312	0.000	

Note: p value below the correlation coefficient

Table 6: The determinants of market shares in volume

	(1) MSRFQ	(2) MSRFQ	(3) MSRFQ	(4) MSRFQ	(5) MSRFQ	(6) MSRFQ
	Tobit	Tobit	OLS(FE)	OLS(RE)	OLS(FE)	OLS(RE)
Intercept	0.118	0.643***	0.371***	0.544***	0.564***	0.666***
	(0.45)	(2.60)	(4.42)	(10.22)	(5.40)	(11.08)
NP1	0.000828*	0.000885**	0.000891***	0.000888***	0.000883***	0.000927***
	(1.95)	(2.14)	(5.38)	(6.38)	(5.35)	(6.74)
NP2	-0.00254**	-0.00220**	-0.00319***	-0.00344***	-0.00314***	-0.00335***
	(-2.43)	(-2.15)	(-8.18)	(-9.19)	(-8.08)	(-9.00)
QP1	11.41***	7.810***	3.718***	2.430***	2.364***	1.638***
	(5.48)	(4.21)	(6.13)	(6.37)	(3.16)	(3.90)
QP2	-3.179***	-1.977***	-0.749***	-1.035***	-0.531**	-0.743***
	(-4.91)	(-2.88)	(-3.71)	(-5.55)	(-2.49)	(-3.70)
D200610		-0.293***			-0.0707***	-0.0783***
		(-4.33)			(-3.09)	(-3.89)
sigma_u						
_cons	0.517***	0.461***				
	(4.95)	(5.48)				
sigma_e						
_cons	0.584***	0.579***				
	(24.65)	(24.73)				
N	1351	1351	1351	1351	1351	1351

t statistics in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 7: The determinants of market shares in value

	(1) MSAV	(2) MSAV	(3) MSAV	(4) MSAV	(5) MSAV	(6) MSAV
	Tobit	Tobit	OLS(FE)	OLS(RE)	OLS(FE)	OLS(RE)
Intercept	0.964***	1.192***	0.328**	0.673***	0.432***	0.719***
	(4.81)	(5.31)	(2.34)	(13.16)	(2.70)	(13.08)
NP1	0.00155***	0.00146***	0.00105***	0.000883***	0.00104***	0.000866***
	(2.91)	(2.74)	(4.68)	(5.82)	(4.62)	(6.19)
NP2	-0.00457***	-0.00382**	-0.00249***	-0.00271***	-0.00244***	-0.00260***
	(-2.92)	(-2.41)	(-4.38)	(-5.51)	(-4.27)	(-5.48)
QP1	5.387***	4.238**	3.836***	1.363***	3.085***	1.129***
	(3.39)	(2.57)	(3.76)	(3.60)	(2.66)	(2.99)
QP2	-4.761***	-3.639***	-0.860***	-1.258***	-0.689**	-1.101***
	(-5.44)	(-3.69)	(-2.76)	(-5.17)	(-2.05)	(-4.34)
RFQAV1	0.00366*	0.00359*	0.00358***	0.00326***	0.00357***	0.00315***
	(1.75)	(1.69)	(3.94)	(4.88)	(3.92)	(5.02)
RFQAV2	-0.0769***	-0.0734***	-0.0297***	-0.0315***	-0.0293***	-0.0312***
	(-6.82)	(-6.53)	(-7.64)	(-8.33)	(-7.52)	(-8.27)
D200610		-0.236**			-0.0448	-0.0438*
		(-2.47)			(-1.35)	(-1.66)
sigma_u						
_cons	0.274***	0.293***				
	(3.42)	(3.71)				
sigma_e						
_cons	0.768***	0.763***				
	(19.90)	(19.94)				
N	965	965	965	965	965	965

t statistics in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 8: Robustness check on the alternative measurement of quality

	(1) MSRFQ	(2) MSRFQ	(3) MSAV	(4) MSAV
	Tobit	Tobit	Tobit	Tobit
Intercept	0.332*	0.676***	0.617***	0.798***
	(1.69)	(3.36)	(3.38)	(3.96)
NP1	0.000862**	0.000951**	0.00174***	0.00161***
	(2.14)	(2.39)	(3.43)	(3.15)
NP2	-0.00284***	-0.00218**	-0.00435***	-0.00359**
	(-2.75)	(-2.14)	(-2.81)	(-2.27)
Alternative-QP1	2.329***	1.844***	1.988***	1.789***
	(6.15)	(4.97)	(5.27)	(4.64)
Alternative-QP2	-0.974***	-0.568***	-1.172***	-0.908***
	(-5.90)	(-3.13)	(-5.34)	(-3.66)
D200610		-0.318***		-0.214**
		(-4.98)		(-2.35)
RFQAV1			0.00383*	0.00366*
			(1.94)	(1.81)
RFQAV2			-0.0766***	-0.0729***
			(-6.89)	(-6.56)
sigma_u				
_cons	0.354***	0.362***	0.212***	0.231***
	(5.39)	(5.76)	(3.10)	(3.39)
sigma_e				
_cons	0.590***	0.580***	0.764***	0.760***
	(24.67)	(24.75)	(19.96)	(19.99)
N	1351	1351	965	965

t statistics in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 9: Robust check on the restrited sample of product category

	(1) MSRFQ[a]	(2) MSAV[a]	(3) MSRFQ[b]	(4) MSAV[b]
	Tobit	Tobit	Tobit	Tobit
Intercept	0.448*	1.072***	0.351**	0.752***
	(1.75)	(3.94)	(2.20)	(4.51)
NP1	0.000883**	0.00126**	0.00109***	0.00166***
	(2.42)	(2.52)	(4.91)	(5.14)
NP2	-0.00223**	-0.00340**	-0.00288***	-0.00433***
	(-2.51)	(-2.38)	(-5.29)	(-4.28)
QP1	8.174***	4.406**	5.606***	4.137***
	(4.26)	(2.16)	(4.72)	(3.44)
QP2	-1.863***	-3.177***	-1.184**	-3.088***
	(-2.85)	(-3.26)	(-2.14)	(-3.85)
D200610	-0.214***	-0.221**	-0.169***	-0.161**
	(-3.41)	(-2.41)	(-3.82)	(-2.38)
RFQAV1		0.00300		0.00153
		(1.56)		(1.41)
RFQAV2		-0.0594***		-0.0358***
		(-5.94)		(-5.35)
sigma_u				
_cons	0.375***	0.286***	0.149***	0.0685
	(4.67)	(3.52)	(3.50)	(1.36)
sigma_e				
_cons	0.501***	0.674***	0.293***	0.457***
	(24.49)	(20.00)	(23.80)	(20.39)
N	1148	852	621	561

t statistics in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

[a] with categories that have more than 100 transaction records
[b] with categories that have more than 200 transaction records

Table 10: The determinants of market shares with interaction terms

	(1) MSRFQ	(2) MSRFQ	(3) MSRFQ	(4) MSAV	(5) MSAV	(6) MSAV
	Tobit	Tobit	Tobit	Tobit	Tobit	Tobit
Intercept	0.873***	0.852***	0.972***	1.487***	1.347***	1.514***
	(3.32)	(3.68)	(3.92)	(6.17)	(5.78)	(6.05)
NP1	0.000939**	0.00481***	0.00421***	0.00165***	0.00636***	0.00541**
	(2.29)	(3.13)	(2.75)	(3.24)	(2.95)	(2.56)
NP2	-0.0680***	-0.0182**	-0.0743***	-0.105***	-0.0366***	-0.120***
	(-3.69)	(-2.35)	(-3.82)	(-4.03)	(-3.36)	(-4.39)
QP1	6.864***	8.733***	8.055***	3.425**	6.659***	5.718***
	(3.79)	(4.78)	(4.37)	(2.27)	(3.25)	(2.91)
QP2	2.174	-2.017***	2.047	2.068	-3.901***	2.013
	(1.43)	(-2.67)	(1.35)	(0.95)	(-3.55)	(0.92)
NP1×QP1		-0.0670***	-0.0565**		-0.0816***	-0.0648**
		(-2.93)	(-2.48)		(-2.59)	(-2.11)
NP2×QP2		0.143**	0.145**		0.301***	0.301***
		(2.03)	(2.02)		(3.03)	(2.97)
D200610	-0.400***	-0.251***	-0.311***	-0.449***	-0.221**	-0.327**
	(-3.84)	(-3.70)	(-2.94)	(-2.99)	(-2.36)	(-2.12)
NP2×D200610	0.0652***		0.0555***	0.1000***		0.0831***
	(3.59)		(3.05)	(3.90)		(3.23)
QP2×D200610	-4.561***		-4.646***	-6.122***		-6.755***
	(-2.87)		(-2.92)	(-2.63)		(-2.87)
RFQAV1				0.00477**	0.00783***	0.00833***
				(2.33)	(3.28)	(3.56)
RFQAV2				-0.0778***	-0.0741***	-0.0764***
				(-6.87)	(-6.59)	(-6.77)
sigma_u						
_cons	0.425***	0.414***	0.398***	0.240***	0.290***	0.254***
	(5.44)	(5.64)	(5.58)	(3.17)	(3.60)	(3.31)
sigma_e						
_cons	0.578***	0.577***	0.575***	0.758***	0.754***	0.750***
	(24.71)	(24.72)	(24.71)	(19.94)	(19.95)	(19.96)
N	1351	1351	1351	965	965	965

t statistics in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Figure 1: Buyer expected profit with respect to n and $\underline{x}$

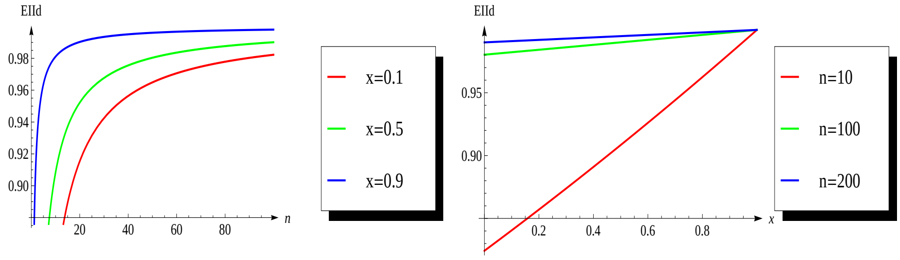
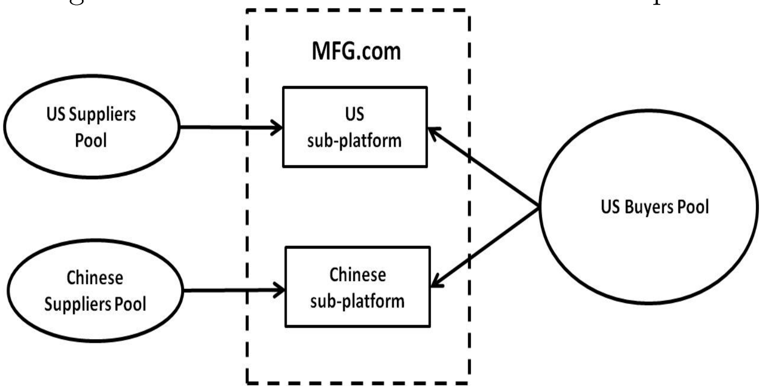


Figure 2: The structure of MFG.com marketplace



Appendix A Optimizing problem of upstream suppliers

The optimizing problem of upstream supplier i

$$\max_{\omega} E\Pi_{u_i} = E\Pr\{x_k \le x_i + \hat{\omega} - \omega | x_k \ge \underline{x}\}\,\omega q_i$$
$$= \omega \int_{\underline{x}}^{1} \frac{(x_i + \hat{\omega} - \omega - \underline{x})^{n-1}}{(1-\underline{x})^n} \frac{1 + x_i - \omega}{m+1} dx_i \qquad \text{(A.7)}$$

From the FOC

$$\int_{\underline{x}}^{1} (x_i + \hat{\omega} - \omega - \underline{x})^{n-1}(1 + x_i - \omega)dx_i - \omega(n-1)\int_{\underline{x}}^{1} (x_i + \hat{\omega} - \omega - \underline{x})^{n-2}(1 + x_i - \omega)dx_i$$
$$-\omega \int_{\underline{x}}^{1} (x_i + \hat{\omega} - \omega - \underline{x})^{n-1} dx_i = 0$$

Since we only consider symmetric equilibrium, with the condition of $\omega = \hat{\omega}$, then we derive that

$$\int_{\underline{x}}^{1} (x_i - \underline{x})^{n-1}(1 + x_i - \omega)dx_i - \omega(n-1)\int_{\underline{x}}^{1} (x_i - \underline{x})^{n-2}(1 + x_i - \omega)dx_i$$
$$-\omega \int_{\underline{x}}^{1} (x_i - \underline{x})^{n-1} dx_i = 0$$

After rearrangement

$$\frac{1}{n}\int_{\underline{x}}^{1} (1 + x_i - \omega)d(x_i - \underline{x})^n - \omega \int_{\underline{x}}^{1} (1 + x_i - \omega)d(x_i - \underline{x})^{n-1} - \frac{\omega}{n}\int_{\underline{x}}^{1} d(x_i - \underline{x})^n = 0$$

then

$$\frac{1}{n}(x_i - \underline{x})^n(1 + x_i - \omega)|_{\underline{x}}^1 - \frac{1}{n}\int_{\underline{x}}^{1} (x_i - \underline{x})^n dx_i - \omega(x_i - \underline{x})^{n-1}(1 + x_i - \omega)|_{\underline{x}}^1$$
$$+\omega \int_{\underline{x}}^{1} (x_i - \underline{x})^{n-1} dx_i - \frac{\omega}{n}(x_i - \underline{x})^n|_{\underline{x}}^1 = 0$$

which yields

$$\frac{1}{n}(1 - \underline{x})^n(2 - \omega) - \frac{1}{n(n+1)}(1 - \underline{x})^{n+1} - \omega(1 - \underline{x})^{n-1}(2 - \omega) = 0$$

We obtain

$$\omega = \frac{(n+1)(2n+1-\underline{x}) - \sqrt{4n^2(n+\underline{x})(n+1) + (1-\underline{x})(1-\underline{x}+n-5n\underline{x})(n+1)}}{2n(n+1)}$$

Appendix B Screenshots

Figure 3: Screenshot of a RFQ awarded on MFG.com

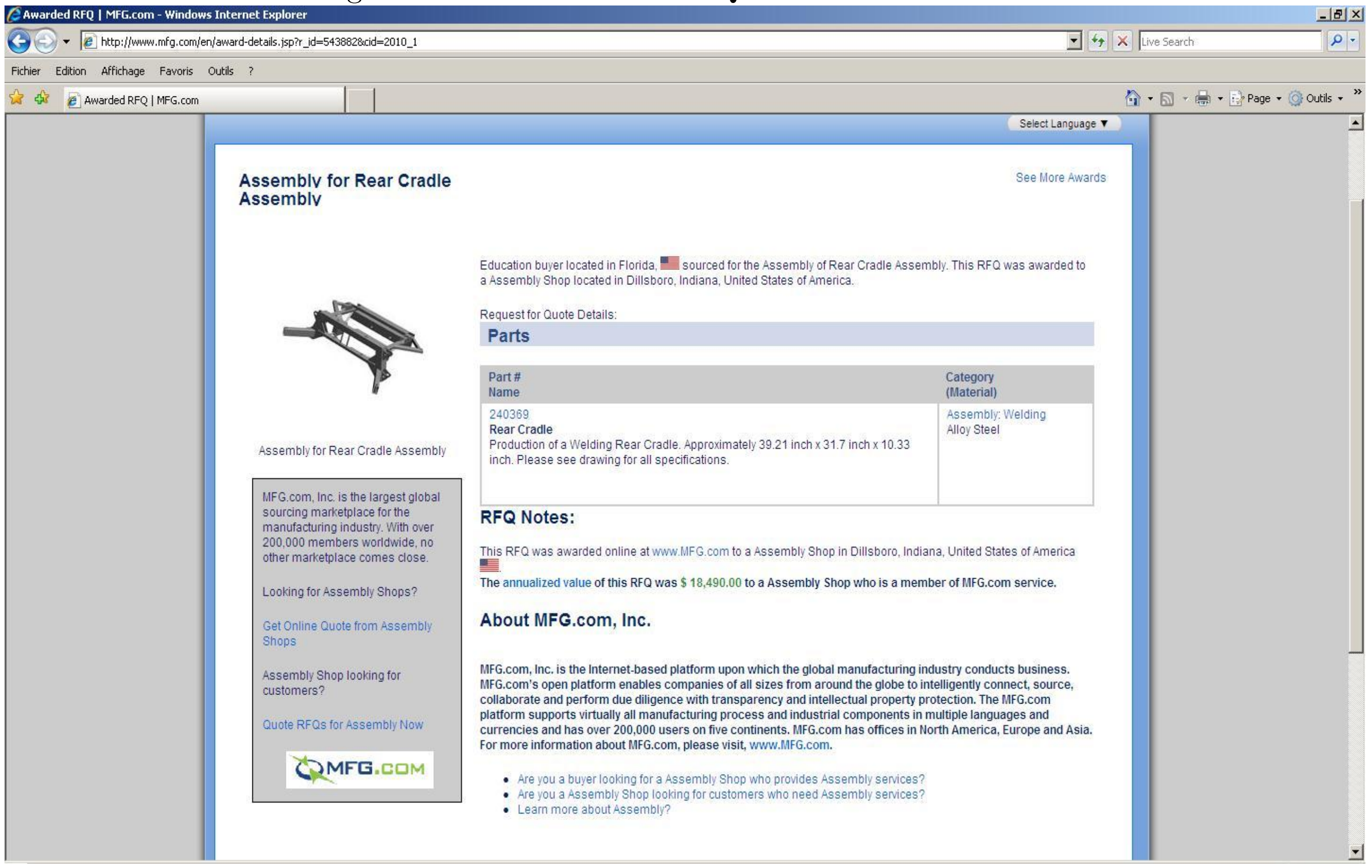


Figure 4: Screenshot of the profile page of a supplier