Measuring Bargaining Power from Manufacturer-Retailer Matching Decisions

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Abstract

Manufacturer-retailer interaction has received considerable attention from researchers in economics and marketing over the last two decades. More recently, researchers have explored the nature of bargaining between manufacturers and retailers. We contribute to this literature by proposing a simple structural model to recover the implied relative bargaining powers of manufacturers and retailers from data on matches. We apply our idea to a unique dataset on rural mobile phone markets in four administrative regions of China. The dataset features both matches and non-matches between different manufacturer-retailer pairs. This feature of the data allows us to apply our method to estimate the match-specific relative bargaining powers of the manufacturers and retailers. After estimating the bargaining powers we look into their possible determinants and find that a manufacturer's bargaining power is higher if it: operates in more markets; has a higher match rate in other markets; is a listed company; and is dealing with large retailers as measured by the retailers' total revenue or match rate.

Keywords: Manufacturer-Retailer Interaction; Bargaining Power; Horizontal Strategic Interaction; Vertical Strategic Interaction; Matching; Structural Estimation; China

JEL Codes: C78; L14; M31

1 Introduction

The manufacturer-retailer (M-R) interaction has received considerable attention from researchers in economics and marketing over the last couple of decades [Ailawadi et al. (2010)]. One aspect of the M-R interaction that has received particular attention is the relative bargaining power of the parties [Draganska et al. (2010), Iyer and Villas-Boas (2003), Kadiyali et al. (2000), Sudhir (2001), Villas-Boas (2007) and Villas-Boas and Zhao (2005)]. We contribute to this literature by structurally estimating the relative bargaining power of the parties from data on the M-R matches and non-matches. A 'match' between a manufacturer and a retailer means that they do business with each other.[1] A novel feature of our approach, as we explain below, is to incorporate non-pecuniary payoffs into the bargaining game between the manufacturer and the retailer. We also contribute by providing fresh insights into the determinants of channel bargaining power by using a unique dataset.

When a manufacturer and a retailer consider doing business with each other, they take into account the expected pecuniary as well as non-pecuniary payoffs from the match. The pecuniary payoff is the profit from the match. It is usually defined as the difference between the retail price and the marginal cost, multiplied by the number of units sold. The non-pecuniary payoff is the net sum of all non-monetary benefits and costs that the parties get from the match.[2] They divide the total payoff, which is the sum of the pecuniary and non-pecuniary payoffs, according to their relative bargaining powers. A party will agree to match if the division of total payoff is favorable to it. If it is not, the party may rationally decide not to match. Hence the information on matches and non-matches, combined with an appropriate economic model of M-R behavior, can inform us about the relative bargaining power of each party in the M-R pair.

[1] Specifically, when a retailer sells a positive quantity of a manufacturer's product(s) during the sample period, which in our case is one year, we say that the pair matched. We focus on a cross-section and ignore any dynamic elements of matching. So in our set up an M-R pair is either matched or not matched and there is no possibility of a transition from a match to a non-match and *vice versa*.

[2] For example, a retailer may benefit from carrying a famous manufacturer's products because it may increase customer traffic to her store and hence to an overall increase in sales. Similarly, a manufacturer's products may become more acceptable to general public if they are carried by a well-known retailer. A manufacturer may also benefit if her product is displayed more prominently than her rivals' on the retailer's shelves. The non-pecuniary benefits can also be negative. For example, a manufacturer may find it costly to deal with a small local retailer situated in a remote rural area.

Bargaining power is typically hard to define and even harder to measure. In this paper we aim to use a simple bargaining model, together with some unique features of our dataset (see below), to recover the relative bargaining powers of the parties. In our setting, in the first stage the manufacturers need to choose the *retail* prices before meeting with the retailers. We model this pricing decision as a Bertrand-Nash game between multiple manufacturers. The demand side of this game is based on a discrete-choice model of consumer behavior. The first-order conditions of the Bertrand-Nash game allow us to recover the marginal cost of each manufacturer and hence determine the pecuniary payoff defined as the difference between the retail price and the marginal cost. In the second stage, after choosing the retail price, manufacturers bilaterally meet with the retailers and bargain over the wholesale price. The total payoff considered in bargaining includes both the pecuniary and non-pecuniary payoffs. The inclusion of non-pecuniary payoffs in the model enables us to explain why some M-R pairs match while some others do not. We model this as a Nash bargaining problem (Nash (1950)). M-R pairs maximize the generalized Nash product to find equilibrium wholesale prices. After bargaining, in the last stage, the parties privately observe a match-specific payoff shock and decide whether or not to match with each other. The private payoff shock serves as an econometric error and allows us to match the model's predictions about matches and non-matches to the data.

The simple theoretical model shows that the relative matching abilities of the parties are directly related to their relative bargaining power as defined in the Nash bargaining game. We apply the above idea to estimate the match-specific relative bargaining powers of manufacturers and retailers in the mobile-phone handset markets in Chinese rural markets. An important feature of these markets is that not all manufacturers do business with all retailers and hence we see both matches and non-matches in the data. Our identifying assumption is that a party's matching ability within a market remains the same when it bargains with different potential partners. After estimating the matching abilities, we use our model to calculate the match-specific relative bargaining powers of the parties. Furthermore we look into the potential determinants of the bargaining power. We find that a manufacturer's bargaining power is higher if it: operates in more markets; has a higher match rate in other markets; is a listed company; and is dealing with large retailers as measured by the retailers' total revenue or match rate.

1.1 Related Literature

A number of authors, either directly or indirectly, have touched upon the measurement of the relative bargaining power of manufacturers vis-à-vis that of retailers. If we consider only the pecuniary payoff then, at least conceptually, the measurement of the relative bargaining power is straight forward. If p is the retail price and c is the manufacturer's marginal cost then the channel payoff is $p - c$.[3] If p^W is the wholesale price then the manufacturer's bargaining power, which is equal to her share of the channel payoff, is $\left(p^W - c\right) / (p - c)$ and the retailer's bargaining power is $\left(p - p^W\right) / (p - c)$. So if we knew p, p^W and c, the measurement of bargaining power would be straightforward. However, most of the time a researcher only observes either one or two of these quantities and needs to either estimate or infer the rest. This is where the problem becomes difficult because the modeling details about the horizontal interaction among the maufacturers, the vertical interaction between manufacturers and retailers, the horizontal interaction among retailers and the nature of demand all affect the results. Depending on the research question and the empirical application, different researchers have modelled these aspects differently.

Kadiyali et al. (2000) are among the first to use a structural model to recover bargaining power from the data. They observe retail price, calculate the wholesale price from data on cents margin per brand and infer marginal cost from manufacturer's optimization problem. In each of the two product categories that they study, refrigerated juice and tuna, there are three brands (i.e. manufacturers) and one retail chain. They find that the retailers have more bargaining power than the manufacturers.

Villas-Boas and Zhao (2005) study a ketchup market with many manufacturers and one retailer. They observe retail price and also have data on cost shifters. Their primary interest is not in measuring the bargaining power but in testing for the degree of manufacturers' competition and the category pricing of the retailer. Because they find that the manufacturers set prices lower than the Nash prices, they conclude that there is some evidence for higher retailer bargaining power.

[3] To simplify the notation we are assuming that the retailer's marginal cost is zero. This is without loss of generality and we can easily relax this assumption. However, at the estimation stage, the identification of the retailer's marginal cost separately from the manufacturer's is generally not possible. Hence we maintain this assumption throughout the paper.

Villas-Boas (2007) uses demand estimates to compute price-cost margins under various supply-side models and compares these with the margins obtained from direct cost estimates to see which supply-side model best explains the data. She finds that the wholesale prices are close to marginal cost and concludes that retailers have more bargaining power.

Draganska et al. (2010) take a different approach. They model the vertical interaction between manufacturers and retailers as a bilateral Nash bargaining game. They model demand using a discrete choice model. Given demand, the retailers play a Bertrand-Nash game to choose retail prices. The retailers also engage in bilateral bargaining with manufacturers to decide the wholesale prices. The retail and wholesale prices are jointly determined in equilibrium. By combining the optimality conditions from the Bertrand-Nash game to choose the retail prices and the Nash bargaining game to choose the wholesale prices, they get their final estimation equation that relates price to marginal cost and includes the relative bargaining power as a parameter. They estimate the bargaining parameter as a retailer-manufacturer fixed effect. One of their key empirical findings is that the bargaining power is M-R-pair specific: the same manufacturer may have different bargaining powers when dealing with different retailers.

Our appoach is closest to that of Draganska et al. (2010), from here on 'DKV', but there are important differences mostly arising from different empirical settings. We provide a summary comparison between DKV and this paper in Figure 1 (p. 29). DKV model retailer interaction as a Bertrand-Nash game and do not model the interactions among manufacturers. We do the reverse. In our model, manufacturers play a Bertrand-Nash game to choose retail prices before they meet with the retailers. We explain the reasons for this modeling choice in the next section. The M-R interaction in our model is similar to that in DKV as both papers assume bilateral Nash bargaining between a manufacturer and a retailer. However, in our model we include net non-pecuniary payoffs as well as a random match-specific payoff shock to total payoff. These features of our model enable us to make use of data on matches and non-matches to recover the relative bargaining powers. On the demand side, DKV use a discrete-choice logit model. We try two specifications. We comment on them in the section on estimation methodology.

To sum up, our paper differs from the literature in at least the following two aspects. First, we use data on matches and non-matches to recover the relative bargaining powers. Second, we include non-pecuniary payoffs into the bargaining equation. These two new aspects are motivated by the institutional set up that we describe in the next section.

2 Institutional Environment and Data

In 2007 the Chinese government launched a large-scale subsidy program called "Household Electric Appliances Going to Countryside." The program was designed to allow farmer households to buy household appliances at subsidized prices. The program was initially implemented in four administrative regions and later expanded to the entire country. The duration of the program was four years. The product categories covered in the initial phase were television, refrigerator, washing machine and mobile phone. To keep the analysis focused, in this paper we concentrate on a single category: mobile phone.[4]

Every year the government specifies the price ceiling and other requirements for the products that are eligible for inclusion in the program.[5] It then invites applications from the mobile phone manufacturers to participate in the program. In the application, a manufacturer needs to include a list of the mobile phone models, together with their retail prices, which they would like to sell under the program. The government also invites applications from retailers to participate in the program. After reviewing the applications, the government issues a list of approved manufacturers and licensed retailers. The manufacturers and retailers then make their own arrangements to do business with one another.

Although the government does not prevent the retailers from selling the product at a price lower than the approved one, in reality all the manufacturers strictly require the retailers to sell the product at the approved price. Hence in our empirical setting, it is the manufacturer who chooses the retail price.[6]

In this paper, we use data on mobile phones for the year 2009. The data cover three provinces (Henan, Shandong and Sichuan) and one large provinical city (Qingdao).[7] These regions are sub-divided into counties. We define a market to be the same as a county.

[4] For further details on the subsidy program see Xiao et al. (2015).

[5] The approval process took place afresh every year.

[6] This is the strictest possible form of retail price maintenance. Here the manufacturers are not asking the retailers to maintain a minimum or maximum price, instead they are asking them to charge a given price.

[7] In China a provincial city enjoys the status of a province under the State Economic Plan. Although the city of Qingdao is geographically situated in the Shandong province, it is considered a separate administrative region because of its special status as a provincial city.

As we explain below, we restrict our sample to the counties that have a sizable number of manufacturers and retailers. Our final sample includes 210 counties. There are 17 manufacturers in our dataset.[8] They include both domestic and international manufacturers of mobile phone handsets. The manufacturers operate in multiple markets while the retailers are market specific and operate locally. The number of manufacturers in a single market varies from 5 to 16 with mean of 10. The number of retailers in a single market varies from 5 to 157, with mean of 24. The average farmer population in a county is 641 thousand.[9] In the year 2009, the total mobile phone sales in the 210 counties under the subsidy program were 573 million yuans. For each transaction, we have data on price, quantity, manufacturer's name, mobile phone handset model, retailer's name and address.

An important feature of our dataset is that not all the manufacturers that operate in a particular market match, i.e. do business, with all the retailers operating in that market. The average match rate is 24%. In Table 1 (p. 7) we show matches in a typical market. There are 8 manufacturers $\{m_1, ..., m_8\}$ and 9 retailers $\{r_1, ..., r_9\}$ in this market. A 1 represents a match and a 0 represents a non-match. In total there are 20 matches in this market out of a maximum possible 72. So the match rate in this market is 28%.

3 Model

Motivated by the institutional background of the program, our model has in the following timeline. In the first stage, the manufacturers and retailers apply to the government to participate in the program. At this stage the manufacturers need to choose the *retail* prices for their products. We model this decision as a Bertrand-Nash game among the manufacturers who take the expected national-level demand for their products as given. We derive demand from a discrete-choice model of consumer behavior.

In the second stage, when the identities of approved manufacturers and retailers become known to all parties, the manufacturers and retailers need to have some estimate of

[8] They are: 1) Amoisonic; 2) Bodao; 3) Chang Hong; 4) Haier; 5) Hengji; 6) Hisense; 7) Huawei; 8) Jingli; 9) Kongka; 10) LG; 11) Motorola; 12) Nokia; 13) Qingdao Haier Telecommunications; 14) Samsung; 15) Tian Yu Lang Tong; 16) TCL; 17) ZTE. Four of these (LG, Motorola, Nokia and Samsung) are foreign brands. The rest are domestic.

[9] We have population data on 144 out of the 210 counties in the sample. The average is based on these 144 counties.

Table 1: Matches and Non-matches in a Typical Market

	r_1	r_2	r_3	r_4	r_5	r_6	r_7	r_8	r_9
m_1	0	0	0	1	1	0	0	0	0
m_2	1	0	0	0	1	0	0	0	1
m_3	0	0	0	0	1	0	0	0	0
m_4	0	0	0	1	1	0	0	1	0
m_5	0	1	0	0	1	1	1	1	1
m_6	1	0	0	0	0	1	0	0	1
m_7	0	0	0	1	0	0	0	0	0
m_8	0	0	1	0	0	0	0	0	0

Note: 1's represent matches.

the match-specific total revenue[10] before they bargain bilaterally over the wholesale price. We consider both non-parameteric and parameteric models to estimate the match-specific total revenue. In the same stage, the manufacturers and retailers bilaterally bargain over the wholesale price. We model this as a Nash bargaining game in which the equilibrium wholesale price maximizes a generalized Nash product.

Once the bilateral wholesale price has been agreed upon, in the third and final stage, the parties privately observe a match-specific payoff shock and decide whether to match, i.e. to do business with each other at the agreed upon wholesale price, or not to match. Each party independently makes the decision to match and a match takes place only if both parties agree to it. If the match takes place, the manufacturer supplies the goods (in this case, the mobile phone handsets) at the agreed upon wholesale price and the retailer sells them at the manufacturer-determined retail price. If the match does not take place, the parties just walk away without doing any business. We summarize the three stages in Table 2 (p. 8).

In the light of the above sequence of events our model has three components: 1) National-level demand (Stage 1); 2) Bargaining over the wholesale price (Stage 2); and 3) matching (Stage 3). We now provide details on each component of the model.

[10] Because the retail price has already been chosen by the manufacturers in the first stage, the match-specific total revenue is simply the match-specific demand multiplied by the pre-determined retail price.

Table 2: Three Stages

Stage 1:
· The manufacturers and retailers apply for particiaption in the program
· The manufacturers specify the retail price in their applications
· The government issues the list of approved manufacturers and retailers
Stage 2:
· The manufacturers and retailers meet bilaterally
· They bargain over the wholesale price
Stage 3:
· The manufacturers and retailers learn about their private payoff shocks
· They independently decide whether to match or not
· A match takes place if both parties want it

3.1 Stage 1: National-level Demand and Channel Margins

As stated above, in the first stage we need a model of national-level demand because the manufacturers need to choose retail prices at the time of application. The utility that consumer i gets from buying model l produced by manufacturer m is

$$u_{ilm} = \underbrace{\eta\,(1-\tau)\,p_{lm} + X_{lm}\beta + Z_m\gamma + \xi_{lm}}_{\tilde{u}_{lm}} + \varepsilon_{ilm}, \tag{1}$$

where p_{lm} is the retail price of the model. The consumers pay the subsidized price $(1-\tau)\,p_{lm}$, where τ is the rate of subsidy which is fixed and chosen by the government.[11] X_{lm} are the observed model characteristics and ξ_{lm} are the unobserved model characteristics. Z_m are manufacturer characteristics. η, β and γ are demand parameters and ε_{ilm} is an idiosyncratic shock. If we assume ε_{ilm} to follow the Type I Extreme Value distribution, the expected market share of model l produced by manufacturer m is given by:

$$s_{lm} = \frac{e^{\tilde{u}_{lm}}}{1 + \sum_{l=1}^{L_m}\sum_{m=1}^{M} e^{\tilde{u}_{lm}}}, \tag{2}$$

where $\tilde{u}_{lm} = \eta\,(1-\tau)\,p_{lm} + X_{lm}\beta + Z_m\gamma + \xi_{lm}$, L_m is the number of models produced by manufacturer m and M is the number of manufacturers in the sample. If a consumer

[11] The subsidy was 13% of the retail price, hence $\tau = 0.13$.

decides not to buy a mobile phone, she uses the outside option and her utility is normalized to zero, i.e. $\tilde{u}_0 = 0$.

Let N denote the total number of consumers in the market. Then the expected demand for model l produced by manufacturer m is

$$q_{lm} = N s_{lm}.$$

Given this expected demand, manufacturer m chooses a retail price vector

$$p_m = [p_{1m}, p_{2m}, ..., p_{L_m m}],$$

by taking the retail prices of all rival models as given. When choosing their price, the manufacturers also need to take the expected retailer markup into account. Note that in our empirical environment, the manufacturers choose retail prices at the time of application and bargain with the retailers over the wholesale prices later. Since the manufacturers do not know the wholesale price when they choose the retail price, they must form some expectations about it.[12] We assume that all manufacturers expect a certain average retailer markup of $\bar{\mu}_r = \left(p - p^W\right)/c$, where p is the retail price, p^W is the *ex ante* wholesale price and c is the marginal cost of production. Solving for p^W we get

$$p^W = p - \bar{\mu}_r c.$$

The objective of manufacturer m is to choose a retail price vector p_m to maximize profits as follows:

$$\max_{p_m = \{p_{1m}, p_{2m}, ..., p_{L_m m}\}} \sum_{l=1}^{L_m} \left[\left(p_{lm}^W - c_{lm}\right) q_{lm}\right].$$

Substituting for p_{lm}^W the problem becomes:

$$\max_{p_m = \{p_{1m}, p_{2m}, ..., p_{L_m m}\}} \sum_{l=1}^{L_m} \left[\left(p_{lm} - \left(1 + \bar{\mu}_r\right) c_{lm}\right) q_{lm}\right].$$

The solution to the problem gives us the equilibrium retail price:

$$p_{lm}^* = \left(1 + \bar{\mu}_r\right) c_{lm} - \frac{1}{\eta \left(1 - \tau\right) \left[1 - \sum_{l=1}^{L_m} s_{lm}\right]}. \tag{3}$$

[12] The *ex post* wholesale price need not be the same as the *ex ante* wholesale price. The *ex post* wholesale price is decided at the bilateral bargaining stage and also depends on the match-specific non-pecuniary payoffs. See Section 3.2.2 for details.

Because we observe p_{lm}, s_{lm} and τ in the data, we can use (3) to recover marginal cost for a given value of expected retail margin ($\bar{\mu}_r$). In other words, (3) defines the total margin $p_{lm} - c_{lm}$.

3.2 Stage 2: Bargaining over Wholesale Price

3.2.1 Match-specific Total Revenue

Before meeting bilaterally over the wholesale price, manufactuturers and retailers need to estimate the match-specific total revenue. We observe the match-specific quantities and prices, and hence the match-specific total revenue, in the data. However, we do so only for the matches that actually took place. In order to estimate the match-specific bargaining powers, we also need the estimates of total revenue in the cases of non-matches. We need to know what the match-specific total revenue would have been had a particular match, which did not actually take place, taken place. We experiment with two different approaches to estimate the match-specific total revenue: 1) Non-parametric; and 2) Reduced-form. Both appoaches are based on the same underlying idea: the match-specific total revenue depends on some manufacturer-specific, retailer-specific and market-specific characteristics. We provide more details in Section 4.

3.2.2 Bargaining

The literature on vertical strategic interaction favors Manufacturer-Stackelberg as the preferred model [Ailawadi et al. (2010)]. However, for our empirical setting a bargaining framework is more suitable. The reason is that the manufacturers need to choose retail prices before matching with the retailers. So when the manufacturers and retailers meet, the pecuniary payoff, $(p - c)\, q$ has already been determined. The only thing left to decide is the wholesale price.

Think of a single market k. There are M_k manufacturers and R_k retailers in the market. Let m denote an individual manufacturer ($m = \{1, 2, ..., M_k\}$) and r an individual retailer ($r = \{1, 2, ..., R_k\}$). For the ease of notation, let i denote the pair (m, r). The manufacturers have already chosen the retail prices after playing a Bertrand-Nash game at the national level.[13] Manufacturers and retailers meet bilaterally and bargain over the wholesale price

[13] In the first stage we estimate demand at the model level and a manufacturer could be producing more

p_i^W. They choose the wholesale price to maximize the following generalized Nash product:

$$\max_{p_i^w} \left[(p_i^w - c)q_i + B_i^m - E\left(\omega_i^m\right)\right]^{\alpha_i} \left[(p - p_i^w)q_i + B_i^r - E\left(\omega_i^r\right)\right]^{1-\alpha_i}. \tag{4}$$

The retail price of the product is p and the marginal cost of production is c. Both the manufacturer and the retailer expect q_i to be the match-specific demand. B_i^m denotes the net non-pecuniary payoff to manufacturer m from matching with retailer r.[14] B_i^r denotes the net non-pecuniary payoff to retailer r from matching with manufacturer m.

$E\left(\omega_i^m\right)$ and $E\left(\omega_i^r\right)$ are the expected values of privately observed match-specific payoff shocks. The shocks are private information but not known at the time of bargaining. This assumption is reasonable because the parties do not need to make a firm commitment to do business with each other when they meet in Stage 2 to negotiate the whoelsale price. They may need more time to decide whether it is worthwhile to do business at the negotiated wholesale price. They may also need more time to collect further information about the other party. This information is revealed in the form of a private payoff shock in Stage 3. We assume the shocks to be i.i.d. and follow a Gaussian distribution with zero mean and σ^ω standard deviation. Hence $E\left(\omega_i^m\right) = E\left(\omega_i^r\right) = 0$. These shocks serve as the econometric errors that help us match the model's predictions to the data. An alternative could be to assume that the distribution of the privately observed payoff shocks is left-truncated such that the actual final payoff (after the realization of the shock) is always positive. The problem with this alternative assumption is that it cannot explain non-matches that we observe in the data.

The match-specific bargaining power of the manufacturer is given by parameter α_i and that of the retailer by $1 - \alpha_i$. That the bargaining power is match specific is in line with the empirical findings in Draganska et al. (2010). It also makes intuitive sense because a manufacturer with the same ability to bargain will have different relative match-specific bargaining powers depending on the bargaining abilities of the retailers with whom it matches.

It is possible for one party to make a monetary transfer to the other in order to induce

than one model. However, to simplify the bargaining game, we assume that each manufacturer produces a single composite model. To find the equilibrium price of the composite model we take a sales-weighted average of individual model prices. This assumption simplifies the bargaining problem between an M-R pair from that of many wholesale prices to that of just one wholesale price.

[14] We use the term 'net non-pecuniary payoff' to highlight the fact that there could be multiple non-pecuniary payoffs, some positive, some negative, and we only take into account their 'net' sum.

the latter to match. However, in our set up such monetary transfer cannot be separately identified from the wholesale price.

We assume that the disagreement payoffs are zero for both parties. Although one reason for this assumption is to keep our model simple, there are at least two other reasons. First, Draganska et al. (2010) carefully model the disagreement payoffs but their empirical results are almost the same as they would be if they had assumed zero disagreement payoffs. Specifically, if the non-zero disagreement payoffs had any effect on the estimates of bargaining power then the entries in columns 3 and 4 of their Tables 6 would be different [Draganska et al. (2010), p. 67].[15] However, these entries are almost identical, which suggests that the disagreement payoffs are almost zero.

The second reason for assuming zero disagreement payoffs is the following. In our empirical setting there are, on the average, 24 retailers in each market. The average distance between any two retailers within the market is 15.4 kilometers. So the retailers are small and generally located far from one another. Hence if a manufacturer does not do business with a particular retailer, the manufacturer is not likely to re-allocate that output to some other retailer. This justifies our assumption of zero disagreement payoffs for the manufacturers. In other words, if a manufacturer does not match with a particular retailer, it expects a zero payoff. The same may not be true for the retailer but to keep the bargaining game simple and symmetrical, we assume that if a retailer does not match with a particular manufacturer the retailer also does not re-allocate the freed demand to other manufacturers.

The solution to the bargaining problem is a mutually agreed optimal wholesale price given by

$$p_i^{w*} = \alpha_i \left(p + b_i^r p\right) + \left(1 - \alpha_i\right)\left(c - b_i^m p\right), \tag{5}$$

where $b_i^r = B_i^r/pq_i$ and $b_i^m = B_i^m/pq_i$ (see appendix A for the derivation of (5)). We can see the intuition of this wholesale price in Figure 2 (p. 30). To see this, first assume that $b_i^m = b_i^r = 0$, i.e. the non-pecuniary payoffs are zero. Then the equilibrium wholesale price is given by

$$p_i^{w*} = \alpha_i p + \left(1 - \alpha_i\right) c.$$

We depict this scenario in Panel (a) of Figure 2 (p. 30). The equilibrium wholesale price is just a weighted average of retail price p and marginal cost c. The weights are the bargaining

[15] The same applies to columns 3 and 4 of their Table 7.

powers of the manufacturer and the retailer, respectively. If $\alpha_i = 1$, the wholesale price is equal to the retail price and the manufacturer gets the entire pecuniary payoff. On the other extreme, if $\alpha_i = 0$, the wholesale price is equal to the marginal cost and the retailer gets the entire pecuniary payoff. In other words, a party's share of pecuniary payoff depends on the party's bargaining power. In this case the total pecuniary payoff is equal to $(p - c)\, q_i$.

Next consider the case when b_i^m and b_i^r are allowed to be non-zero. We show this scenario in Panel (b) of Figure 2 (p. 30). Now the total payoff, which is the sum of pecuniary and non-pecuniary payoffs, from the match is $(p - c)\, q_i + B_i^m + B_i^r$. The equilibrium wholesale price reflects how this total payoff is split between the parties. In this scenario, it is possible, at least theoretically, to have the wholesale price greater than the retail price if the match brings large non-pecuniary benefits to the retailer and the manufacturer has substantial bargaining power. Similarly, it is also possible to have the wholesale price lower than the marginal cost if the match brings large non-pecuniary benefits to the manufacturer and the retailer has substantial bargaining power. Also note that in Figure 2(b) both B_i^m and B_i^r are positive. This need not be the case. It is possible that a match may bring negative net benefits to one or both parties. Indeed, in many cases we estimate these benefits to be negative in order to rationalize non-matches in the data.

If we substitute (5) in the manufacturer's expected payoff given by $(p_i^w - c)q_i + B_i^m$ and simplify, we get:

$$\alpha_i \left(\frac{p - c}{p} + b_i^m + b_i^r \right) pq_i.$$

Similarly, by substituting (5) in the retailer's payoff, $(p - p_i^w)q_i + B_i^r$, we get:

$$(1 - \alpha_i) \left(\frac{p - c}{p} + b_i^m + b_i^r \right) pq_i.$$

These results show that the manufacturer gets α_i fraction of the total payoff generated by the match and the retailer gets the remaining fraction $1 - \alpha_i$.

3.3 Stage 3: Matching

After bargaining, each party privately observes a match-specific payoff shock and decides whether to go ahead with the match or not. A match is defined to have happened if the *ex post* match-specific total revenue is greater than zero in the data. Otherwise we assume that the parties did not match. Let ω_i^m and ω_i^m be the realizations of the payoff shocks for the manufacturer and the retailer respectively. The manufacturer will be willing to match with the retailer if her net payoff is non-negative, i.e.

$$\alpha_i \left(\frac{p-c}{p} + b_i^m + b_i^r \right) pq_i - \omega_i^m \geq 0. \tag{6}$$

Similarly, the retailer will be willing to match if her net payoff is non-negative, i.e.

$$(1-\alpha_i) \left(\frac{p-c}{p} + b_i^m + b_i^r \right) pq_i - \omega_i^r \geq 0. \tag{7}$$

A match takes place if both parties are willing to match.

We assume that matching is one-to-one instead of many-to-many. We explain in the next section the reason for not using a many-to-many matching framework.

4 Estimation Methodology

4.1 National-level Demand and Channel Margins

We need the national-level demand estimates to recover the price-cost margins—or in our terminology, the pecuniary payoffs—given by $p - c$. We begin by taking the logarithm of the market share of model l, as given in (2), relative to the outside good. This gives us the following demand equation:

$$\ln (s_{lm}/s_0) = \eta (1-\tau) p_{lm} + X_{lm}\beta + Z_m\gamma + \xi_{lm}. \tag{8}$$

This is the demand equation that we estimate using data on mobile phone prices and market shares. Because at this stage the manufacturers take into account the demand at the 'national level', when we estimate (8) we aggregate total sales of each manufacturer across all markets in our sample to compute the market shares.

Because we observe p_{lm}, s_{lm} and τ in the data, after estimating (8), we can use (3) to recover marginal cost for a given value of expected retail margin ($\bar{\mu}_r$). In other words, (3) defines the total margin $p_{lm} - c_{lm}$.

Although we have estimated the price-cost margin at the model level, to simplify the bargaining game later, we assume that each manufacturer produces a single composite model and we find the manufacturer-level price-cost margins by simply taking a weighted average of $p_{lm} - c_{lm}$ by manufacturer, where the weights are the sales share of each model in a manufacturer's total sales.

4.2 Match-specific Total Revenue

We experiment with two different models to estimate the match-specific total revenue: 1) Non-parametric; and 2) Reduced-form.

The first model is non-parametric. Let $\overline{TR}_m$ denote the average match-specific total revenue from all matches—within the market—in which manufacturer m is involved. Let $\overline{TR}_r$ denote the average match-specific total revenue from all matches in which retailer r is involved. Then our non-parametric estimate of the match-specific total revenue is simply the geometric mean of these averages:

$$TR_{(m,r)}^{nonpara} = \left(\overline{TR}_m \times \overline{TR}_r\right)^{\frac{1}{2}}.$$

The second model of match-specific total revenue is a reduced-form model. We regress the observed match-specific total revenues on some manufacturer-specific, retailer-specific and market-specific characteristics.[16] These estimates suffer from the classical selection problem because we only observe the total revenues for the matches that actually took place. We correct for selection using Heckman's method.[17]

4.3 Bargaining Abilities and Powers

Our objective is to estimate the match-specific bargaining power α_i. We do so by taking (6) and (7) to the data. ω_i^m and ω_i^r are assumed to be drawn from a known Gaussian distribution with 0 mean and σ^ω standard deviation. We treat σ^ω as a free parameter but later show that our estimates of match-specific relative bargaining power are independent of the value of σ^ω. The match-specific total revenue pq_i is obtained by the procedures described in Section 4.2, and $\frac{p-c}{p}$ can be obtained from the demand estimation in the first stage. This leaves us with the following 3 match-specific parameters: α_i, b_i^m and b_i^r. In a given market there are M manufacturers and R retailers so there are $M \times R$ possible matches. It is clearly impossible to estimate $3 \times M \times R$ parameters with $M \times R$ observations on matches so we need to impose some identifying restrictions on our parameters.

Our idea is to impose the following identifying restriction. Let a_m be the matching ability of manufacturer $m \in \{1, 2, ..., M\}$. Let a_r be the ability of retailer $r \in \{1, 2, ..., R\}$.

[16] A complete list of manufacturer-specific, retailer-specific and market-specific characteristics is given in Table A.1 (p. 34) in the appendix.

[17] For brevity the details are omitted and available from the authors upon request.

We assume that

$$a_m = \alpha_i \left(\frac{p-c}{p} + b_i^m + b_i^r \right) \tag{9}$$

and

$$a_r = (1-\alpha_i) \left(\frac{p-c}{p} + b_i^m + b_i^r \right). \tag{10}$$

We then use data on matches (and non-matches) to estimate a_m and a_r. This requires estimating $M + R$ parameters with $M \times R$ observations. In other words, this identifying restriction allows us $M \times R - (M + R)$ degrees of freedom. This also explains why we need to have a sizable number of manufacturers and retailers in each market. If there are very few participants in the market, we may not have enough degrees of freedom to estimate the parameters. In our estimation we restrict our sample to the markets that allow us at least 30 degrees of freedom, i.e. $M \times R - (M + R) \geq 30$.

By adding (9) and (10) we get

$$a_m + a_r = \frac{p-c}{p} + b_i^m + b_i^r. \tag{11}$$

Substituting (11) into (9) we get

$$\alpha_i = \frac{a_m}{a_m + a_r}. \tag{12}$$

Similarly, substituting (11) into (10) gives

$$1 - \alpha_i = \frac{a_r}{a_m + a_r}. \tag{13}$$

So by estimating a_m and a_r we can recover match-specific bargaining power. These results imply that the bargaining power of a party is directly related to its own matching ability and inversely related to its partner's ability. The economic intuition of the ability is that it is the equilibrium share, in units of total revenue, of a party in the total expected payoff from the match. Our identifying restriction is equivalent to the assumption that this fraction is the same for a party across all matches (and non-matches). Another implication is that a party will be willing to accept a lower share of total payoff if its matching partner helps it generate a bigger pie. In other words, conditional on a given match-specific total revenue, the slice of the pie that a party is willing to accept varies inversely with the size of the pie. To see it clearly let us consider manufacturer m who is considering a match with retailer r. Given the match-specific total revenue pq_i, the manufacturer m's share of the pie is α_i while the size of the pie, in units of match-specific total revenue, is $\left(\frac{p-c}{p} + b_i^m + b_i^r\right)$.

We can write it as

$$\alpha_i\left(\frac{p-c}{p}+b_i^m+b_i^r\right)=\frac{a_m}{a_m+a_r}\times(a_m+a_r)=a_m.$$

A bigger a_m+a_r corresponds to a bigger size of the pie, i.e. a bigger $\left(\frac{p-c}{p}+b_i^m+b_i^r\right)$, but at the same time it reduces the bargaining power α_i. Our identifying restriction is equivalent to assuming that these two effects cancel out and hence a_m is constant across retailers. Similarly for retailer r, a_r is constant across manufacturers.

We can use Figure 2(b) (p. 30) to further understand the intuition behind our identifying restriction. In the figure the total payoff is given by the area $abgh$. If p^W is the equilibrium wholesale price then the manufacturer's share of the total payoff is given by the area $abep^W$ and that of the retailer is given by the area $p^W egh$. Our identifying restriction is that the ratio of the manufacturer's share to total revenue $(abep^W/Oqfp)$ is the same for a manufacturer across all retailers in the market. Likewise the ratio of the retailer's share to total revenue $\left(p^W egh/Oqfp\right)$ is the same for a retailer across all manufacturers in the market.

Our identification strategy does not work if the non-pecuniary benefits are zero because then $a_m+a_r=(p-c)/p$ and a_r would have to be the same for all the retailers that do business with the manufacturer m. Another related and equally important reason for the inclusion of non-pecuniary payoffs in the model is that they rationalize non-matches that we observe in the data.

With the above identifying restriction, the probability that manufacturer m would be interested to match with retailer r can be written as

$$\Pr\left(a_m p q_i-\omega_i^m\geq 0\right),$$

where we have substituted a_m for $\alpha_i\left(\frac{p-c}{p}+b_i^m+b_i^r\right)$. Because ω_i^m is drawn from a Gaussian distribution with 0 mean and σ^ω standard deviation, this probability is equal to

$$\Psi_{(0,\sigma^\omega)}\left(a_m p q_i\right), \tag{14}$$

where $\Psi_{(0,\sigma^\omega)}$ is the Guassian cumulative density function (c.d.f.). Similarly, the probability that retailer r will be willing to match with manufacturer m is given by

$$\Psi_{(0,\sigma^\omega)}\left(a_r p q_i\right).$$

Because ω_i^m and ω_i^r are drawn independently, the probability that a match between m and r takes place is

$$\lambda_i = \Psi_{(0,\sigma^\omega)} (a_m p q_i) \Psi_{(0,\sigma^\omega)} (a_r p q_i) . \tag{15}$$

It is easy to see from (15) that the a's (i.e. a_m and a_r) are the matching abilities of the parties over and above what is reflected in the expected match-specific total revenue.

This formulation leads to the following log likelihood function

$$LL = \sum_{i=1}^{M \times R} \log \left[\mathbf{1} (match) \lambda_i + [1 - \mathbf{1} (match)] [1 - \lambda_i] \right] , \tag{16}$$

where $1 (match)$ is an indicator variable that takes the value 1 if we observe a match in the data and 0 otherwise.

The intuition behind the likelihood function is the following. The information on who matches with whom reveals the underlying matching abilities of the parties. A party with a higher matching ability is always more willing to match because it can extract a larger fraction of total payoff. However, it is less likely to find a partner because of the same reason. So the likelihood of a match depends on the relative abilities of the parties. A match is less likely to take place when the abilities are too asymmetric. Let a_m/a_r be the relative ability. The likelihood of a match for a given party has an inverted-U relationship with its relative ability. At very low or very high levels of relative ability the likelihood of the match is very low. There is a unique level of relative ability that maximizes the likelihood of a match for a given party. This feature of our model combined with data on matches and non-matches, identifies the unique abilities of manufacturers and retailers that make the observed matches most likely.[18]

The estimation of a_m ($m \in \{1, 2, ..., M\}$) and a_r ($r \in \{1, 2, ..., R\}$) using the above log-likelihood function is straightforward. We only need data on matches and match-specific total revenues.

Our estimation strategy is based on the assumption of one-to-one matching. It is natural to ask whether a many-to-many matching framework (see Fox (2008) and the papers that he cites) would lead to a better estimation strategy. The answer is negative. To see it clearly, let us fix α_i at any number between 0 and 1. Now think about a matched M-R pair

[18] The abilities that we estimate can be thought of as average abilities of the parties. We fix a party's ability within a market because of identification reasons as explained above.

i. If we set b_i^m and b_i^r to very large positive numbers approaching $+\infty$, the probability of match in (15) will approach one. Next think about a non-matched pair. If we set we set b_i^m and b_i^r to very large negative numbers approaching $-\infty$, the probability of match in (15) will approach zero. Hence a many-to-many approach will trivially suggest that all b_i^m's and b_i^r's should be very large positive numbers in the case of matches and very large negative numbers in the case of non-matches to maximize the likelihood in (16). Hence in our set up an estimation strategy based on a many-to-many matching framework does not identify the parameters of interest.

5 Estimation Results

5.1 National-level Demand and Channel Margins

We estimate (8) by OLS and 2SLS. We do not have data on model characteristics so we set $\beta = 0$. We use manufacturer fixed-effects for Z_m. The regressions are based on 150 observations, each corresponding to a unique mobile phone model. The OLS regression gives a small, positive and statistically insignificant estimate for the price coefficient η. For the 2SLS regression we use the manufacturer fixed-effects as instruments for price. The first-stage R^2 is 0.85 and F statistic is 48. Stock-Yogo tests easily reject the null of weak instruments. The 2SLS estimate of price coefficient is -0.015 and very precisely estimated (the standard error is just 0.0006).

Our estimates of price-cost margin depend on the manufacturers' expectation of retail margin $\bar{\mu}_r$ when they choose the retail price in the first stage. We report the average channel margin, $(p-c)/p$, for various values of $\bar{\mu}_r$ in Table 3.

Our preferred value for $\bar{\mu}_r$ is 10%. In other words, we assume that when the manufacturers choose the retail prices at the time of application, they expect a uniform retailer markup of 10%. With this assumption, the average value of the estimated price-cost margin is 21.2% and the price-cost margins for individual manufacturers vary between 16% and 31%.

Table 3: Average Channel Margin for Different *ex ante* Retail Margins

$\bar{\mu}_r = \frac{p-p^W}{c}$	$\frac{\bar{\mu}_r+\mu_m}{1+\bar{\mu}_r+\mu_m} = \frac{p-c}{p}$	$\mu_m = \frac{p^W-c}{c}$
0%	13.3%	15.8%
10%	21.2%	17.4%
20%	27.7%	19.0%
30%	33.3%	20.6%
40%	38.1%	22.2%
50%	42.2%	23.7%

5.2 Match-specific Total Revenue

In Table 4 we report some summary statistics on our estimates of match-specific total revenue and compare them with the actual total revenue that we obseve in the data.

Table 4: Match-specific Total Revenue in 000 of Yuans (Summary Statistics)

Total Revenue	Observations	Mean	S.D.	p_{10}	p_{50}	p_{90}
Actual	13,908	41.2	304.6	0.5	2.0	37.9
Non-parametric (a)	13,908	28.3	99.6	1.5	4.8	45.1
Non-parametric (b)	43,169	9.7	35.3	0.8	2.4	14.6
Reduced-form (a)	13,908	5.9	138.5	0.02	0.2	2.9
Reduced-form (b)	43,169	0.6	34.5	0.003	0.02	0.3

(a) Observed matches

(b) Observed non-matches (Counterfactual matches)

First, let us compare the total revenues from matches. The mean of actual total revenue (i.e. the observed total revenue) is 41.2 thousand yuans and the 10th, 50th and 90th percentiles are 0.5, 2.0 and 37.9 thousand yuans. The mean of the match-specific total revenue based on the non-parametric (NP) model is 28.3 thousand yuans and the three percentiles are 1.5, 4.8 and 45.1 thousand yuans. Although the mean of NP estimates is lower than the mean of actual total revenue, the three percentiles are higher. The mean of the estimates based on the reduced-form model is 5.9 thousand yuans and the three percentiles are 0.02, 0.2 and 2.9 thousand yuans. These numbers suggest that our reduced-form model almost always under-estimates total revenue.

When we compare the estimated match-specific total revenue for both matches and non-matches, the numbers are lower for non-matches. For example, the mean of the non-parametric estimate is 28.3 thousand yuans for matches, but only 9.7 thousand yuans for non-matches. Similarly, the mean of the reduced-form estimate is 5.9 thousand yuans for matches and only 0.6 thousand yuans for non-matches. Hence our counterfactual total revenue estimates suggest that the expected match-specific total revenue for the non-matched pairs, if they had matched, is on the average lower than the match-specific total revenue facing the matched pairs. This is quite intuitive: one reason that these pairs did not match was that they expected a low match-specific total.

The correlations of the non-parametric estimate and the reduced-form estimates with the actual-specific total revenue are 0.80 and 0.15, respectively. It is clear from these correlations that the in-sample performance of the non-parametric estimates is much better than that of the reduced-form estimates. Based on these corrletaions, we use the non-parametric estimates in the rest of the paper.

5.3 Abilities

Before we present the estimation results, it is important to explain how to interpret the results. We cannot interpret the absolute size of the estimated abilities because it depends on our choice of σ^ω: the higher the value of σ^ω, the greater the absolute value of estimated abilities. To see this, note that if we multiply σ^ω and the a's in (15) with a scalar $\kappa > 0$, the left-hand side of the equation, i.e. the probability of the match, will remain unaffected. In symbols:

$$\lambda_i = \Psi_{(0,\sigma^\omega)}\left(a_m p q_i\right)\Psi_{(0,\sigma^\omega)}\left(a_r p q_i\right) = \Psi_{(0,\kappa\sigma^\omega)}\left(\kappa a_m p q_i\right)\Psi_{(0,\kappa\sigma^\omega)}\left(\kappa a_r p q_i\right). \qquad (17)$$

However, our primary interest is in the measurement of bargaining power. Because the bargaining power is defined as a ratio of abilities, it is scale free and does not depend on the value of σ^{ω}. If we multiply both a_m and a_r in (12) with $\kappa > 0$, α_i remains the same:

$$\alpha_i = \frac{a_m}{a_m + a_r} = \frac{\kappa a_m}{\kappa a_m + \kappa a_r}. \tag{18}$$

We start our discussion of the results with the estimates for a specific market in. This will help the reader see how the abilities are related to the match-specific revenues and the match rates of the parties. We use the same market as our example as the one in Table 1 (p. 7). Our example market has 8 manufacturers ($M = 8$) and 9 retailers ($R = 9$).

Table 5: Match-specific Total Revenue (000 yuans) and Estimated Abilities (One Market)

	r_1	r_2	r_3	r_4	r_5	r_6	r_7	r_8	r_9	$\hat{a}_m$
m_1	4.4	2.5	1.8	4.6 (0.4)	48.1 (22.5)	6.1	1.7	11.2	43.9	0.03
m_2	2.2 (2.7)	1.2	0.9	2.2	23.5 (1.0)	3.0	0.8	5.5	21.4 (4.5)	0.25
m_3	5.6	3.3	2.4	5.9	61.5 (18.8)	7.8	2.2	14.4	56.2	0.01
m_4	2.6	1.5	1.1	2.7 (0.5)	28.5 (0.8)	3.6	1.0	6.7 (10.8)	26.0	0.56
m_5	19.9	11.5 (0.6)	8.3	20.7	216.5 (964.7)	27.4 (4.3)	7.7 (0.2)	50.6 (11.3)	197.7 (413.9)	22.06
m_6	7.1 (0.7)	4.1	3.0	7.4	77.2	9.8 (2.1)	2.8	18.0	70.5 (85.9)	−0.00
m_7	2.8	1.6	1.2	2.9 (4.6)	30.6	3.9	1.1	7.2	27.9	−0.43
m_8	0.7	0.4	0.3 (0.3)	0.7	7.8	1.0	0.3	1.8	7.1	−4.72
$\hat{a}_r$	−0.15	0.20	−3.56	−0.14	2.08	0.17	0.31	0.07	0.02	

Notes: (1) This market had 165,100 farmer households in it. (2) All estimated abilities are significant at 1% level except those for m_5 and r_5.

In Table 5 m_1 represents the first manufacturer, m_2 the second, and so on. Likewise, r_1 represents the first retailer, r_2 the second, and so on. The cells corresponding to a manufacturer-retailer pair show our non-parametric estimates for the match-specific total revenue. Note that we estimate total revenue for both matched and non-matched pairs.

For the matched pairs, we also report the actual total revenue in parentheses. For example in the cell corresponding to m_1 and r_5 there are two numbers. The number at the top, i.e. 48.1 thousand yuans, is our non-parametric estimate of the match-specific total revenue. The number at the bottom, i.e. 22.5 thousand yuans, is the actual total revenue that we observe in the data. However, in the next cell to the right ($m_{1,}r_6$) there is only one number (6.1) at the top and no number at the bottom. Again the top number is our estimate of total revenue. The bottom part of the cell is empty becaue m_1 and r_6 did not match. So the table provides us information on total revenue as well as matches.

The last column of the table contains the estimates of manufacturers' abilities, i.e. $\hat{a}_m$. As expected, ability is directly related to the match rate. The relationship is not strictly monotonic because expected total revenue also plays a role. The last row contains the estimates of retailers' abilities, i.e. $\hat{a}_r$.

To have an idea about the overall distribution of the estimated abilities in all markets, we plot histograms of the estimated abilities in Figure 3 (p. 31).[19] The estimated abilities are concentrated around zero but have a wide range. Both distributions are slightly negatively skewed. This is because there are more unmatched M-R pairs in the data than the matched ones.

In Table 6 we report six scenarios for the estimated matching abilities of manufacturers and retailers for all 210 markets in our sample. The average probability of a match based on our estimates for all markets in the sample is 0.27. The average number of actual matches in the data is 0.24.

The scenarios are based on whether $\hat{a}_m$, $\hat{a}_r$ and $\hat{a}_m + \hat{a}_r$ are positive or negative.[20] Our goal is to estimate the relative bargaining powers: α_i and $1 - \alpha_i$. Our estimation strategy is to use the information on matches and non-matches, together with the estimates of the match-specific total revenue, and recover the implied bargaining abilities. We do not impose any restrictions, other than those required for identification, on the bargaining abilities at the estimation stage. After estimating the abilities, we examine what the estimates imply about the underlying bargaining game. To answer this question, it is convenient to divide

[19] In order to avoid the outliers we only show the abilities that are less than 2 in absolute value. 74% of the estimated a_m's (42,182 out of 57,077) and 82% of the estimated a_r's (47,020/57,020) fall in this range.

[20] We did not have a single estimate of a_m or a_r eaxactly equal to zero so we exclude these possibilities from Table 6.

Table 6: Estimated Abilities: Various Scenarios

Scenario	$\hat{a}_m$	$\hat{a}_r$	$\hat{a}_m + \hat{a}_r$	Matches	Non-matches	Total	Match rate
1	+	+	+	7,860	3,583	11,443	69%
2	+	−	+	2,156	5,506	7,662	28%
3	−	+	+	1,845	5,727	7,572	24%
4	+	−	−	560	4,673	5,233	11%
5	−	+	−	500	7,619	8,119	6%
6	−	−	−	987	16,061	17,048	6%
			Total:	13,908	43,169	57,077	24%

our estimates into six scenarios as we have done in Table 6.

Here it is important to recall equations (9), (10) and (11) that define $\hat{a}_m$, $\hat{a}_r$ and $\hat{a}_m + \hat{a}_r$. When $(\hat{a}_m + \hat{a}_r) < 0$ (Scenarios 4, 5 and 6), the total expected surplus from the match is negative. Under these scenarios the bargaining game is not essential because there is nothing to bargain over. So for our purpose of estimating the bargaining power, these scenarios are irrelevant.[21]

The total payoff is positive under scenarios 2 and 3 but $\hat{a}_m$ and $\hat{a}_r$ have opposite signs. These scenarios are also not consistent with the bargaining game in Stage 2 because they imply that the bargaining power is greater than one for either the manufacturer (Scenario 2) or the retailer (Scenario 3).[22]

This leaves us with Scenario 1 as the only scenario that is consistent with the bargaining game in Stage 2. From here on, we only use the estimated abilities under Scenario 1.

[21] We still see some matches under these scenarios though the percentages are very small: Senarios 4, 5 and 6 have only 11%, 6% and 6% matches. Our theoretical explanation for these matches is that the payoff shocks in Stage 3 were so favorable to both parties that they decided to match despite the initial expectations of a negative total payoff.

[22] Once again we see that in about a quarter of the cases under these scenarios a match took place. The theoretical explanation for these matches is the same as the one that we have given for the matches under Scenarios 4, 5 and 6 above.

5.4 From Abilities to Bargaining Powers

In Table 7, we show summary statistics for the estimated match-specific bargaining powers for all markets. Note that we report the results only for Scenario 1, i.e. the cases in which both parties had non-negative estimated abilities.

Table 7: Bargaining Powers (All Markets)

Bargaining Power of:	Observations	Mean	S.D.	p_{10}	p_{50}	p_{90}
Manufacturers	11,443	0.54	0.38	0.01	0.58	1.00
Retailers	11,443	0.46	0.38	0.00	0.42	0.99

We only estimate the relative bargaining powers. Although we can tell whether a manufacturer or a retailer in a particular match has more bargaining power, we cannot tell whether retailers or manufacturers as a group have more bargaining power. This is because the bargaining powers are derived from the observed match rates and the average match rate of the manufacturers in a market is eqaul to the average match rate of the retailers in the market. So the average bargaining power of manufacturers in a particular market will be roughly equal to the average bargaining power of the retailers.

Manufacturers in our dataset operate in multiple markets. Their estimated abilities may differ from market to market. This is because a manufacturer may have better connections or some past experience in one market but lack such advantage in the other.

6 Determinants of Bargaining Power

In this section we examine how the bargaining power of a party is related to its own, its partners' and market characteristics. In Table 8 (p. 32) we report four sets of regression results. The dependent variable in all regressions is $\hat{\alpha}_i$, the estimated match-specific bargaining power of the manufacturer.[23] The right-hand side variables include manufacturer

[23] The estimated match-specific bargaining power of the retailer is $1 - \hat{\alpha}_i$ and hence has a perfect negative correlation with $\hat{\alpha}_i$. Therefore, if we ran the same regressions with $1-\hat{\alpha}_i$ as the dependent variable, the signs of all the estimated coefficients would change but their absolute values would remain the same. In other words, if a variable is positively correlated with the manufacturers' bargaining powers, it will be negatively

characteristics (variables numbered 1 to 7), retailer characteristics (variables 8 to 11) and market characteristics (variables 12 to 15). The regression in column I does not include any fixed effects. The one in column II includes market fixed effects and the one in III includes both market and manufacturer fixed effects. The first three regressions are based on 11,443 observations that constitute Scenario 1 in Table 6 (p. 24). The regression in column IV is based on a further refinement: it is based on the estimated a's that are statistically significant at 1% level.

The results show that a manufacturer has more bargaining power if it is active in more markets and offers a greater number of models. The latter result does not hold in the model of column III. A manufacturer's bargaining power is also high if it is a large firm as measured by its total revenue. This result is reversed for the model in column III. Domestic manufacturers have lower bargaining powers than the foreigners and the listed manufacturers have higher bargaining powers than the unlisted ones. A counter-intuitive result is that the manufacturer's bargaining power is negatively correlated with its own average match rate in all other markets. This is despite the fact that own match rate in market k is highly correlated with own average match rate in other markets (correlation coefficient = 0.75).

The relationship between retailer characteristics and manufacturer bargaining power is intuitive. The manufacturer's bargaining power is generally higher when dealing with large, as measured by total revenue, retailers. This is intuitive because for a given match probability, a higher match-specific total revenue results in lower estimated abilities (see (15)). A manufacturer's bargaining power is lower if the retailer has a high match rate.

The effects of various market characteristics on the manufacturer's bargaining power are not robust and vary from one model to another. In the model with both manufacturer and market fixed effects (column III), a greater number of retailers in the market reduces the manufacturers' bargaining power and so does a higher level of value added per household. However, these effects disappear in the model of column IV.

Our preferred models are those in columns III and IV. If we concentrate on the estimates that have the same sign and are statistically significant in both columns III and IV, we find that a manufacturer's bargaining power is higher if: it operates in more markets; it has

correlated with the retailers' bargaining powers.

a higher match rate in other markets; it is a listed company; and it is dealing with large retailers as measured by their total revenue or match rate.

These regressions would more appropriately be interpreted as correlations instead of causality. In our preferred models in columns III and IV, we control for market and manufacturer fixed effects. These fixed effects help control for time invariant unobservables at the market and firm levels which may cause the endogeniety of some of the right-hand side regressors. However, we are not able to fully control for the time variant unobservables. Nonetheless, these regressions serve a useful purpose: at the minimum, they highlight some party characteristics and market characteristics that are correlated with the bargaining power and enrich our understanding of it.

7 Concluding Remarks

In this paper we structurally estimate the relative bargaining power of the parties from match outcome in the data. The main idea behind our approach is that the likelihood of a party to form a match (i.e. the theoretical porbability of the match) is directly related to the payoff that the party expects from the match (i.e. the party's relative bargaining power vis-à-vis its potential partner's). This enables us to recover the match-specific bargaining powers from data on matches and non-matches. We contribute to the literature on empirically measuring channel bargaining power and obtain insights on its determinants.

We find that a manufacturer's bargaining power is higher if: it operates in more markets; it has a higher match rate in other markets; it is a listed company; and it is dealing with large retailers as measured by their total revenue or match rate.

Empirically our approach may not be suitable for a sample full of markets with a small number of channel participants. It is also not suitable if the matching data do not have enough variation in terms of matches and non-matches. None of these limitations exist in our empirical setting so our approach works reasonably well. Future work along this line can be extended to study the channel bargaining power when the match-specific payoff shocks are potentially correlated across different pairs of matches.

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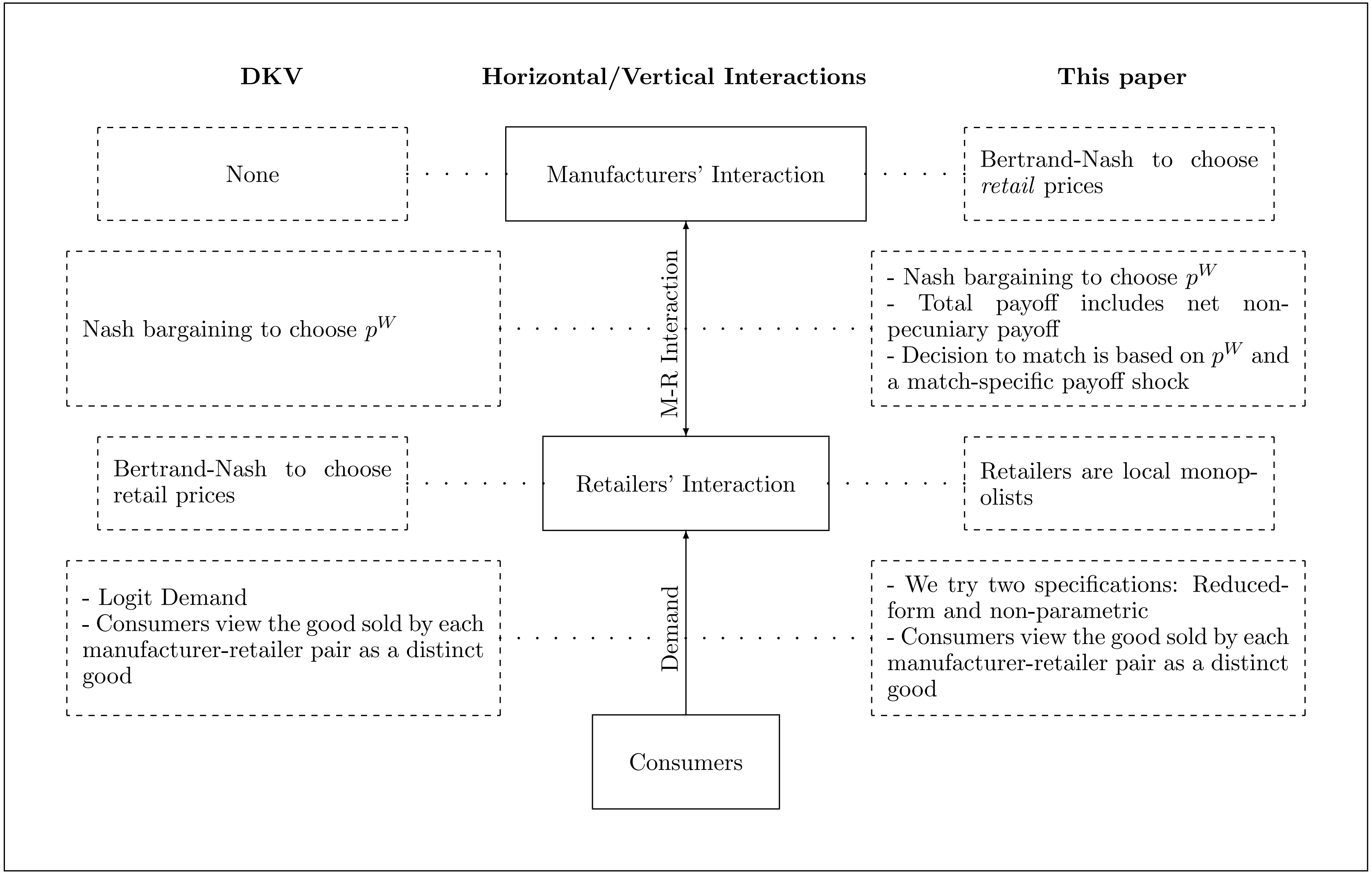

Figure 1: A summary comparison with DKV

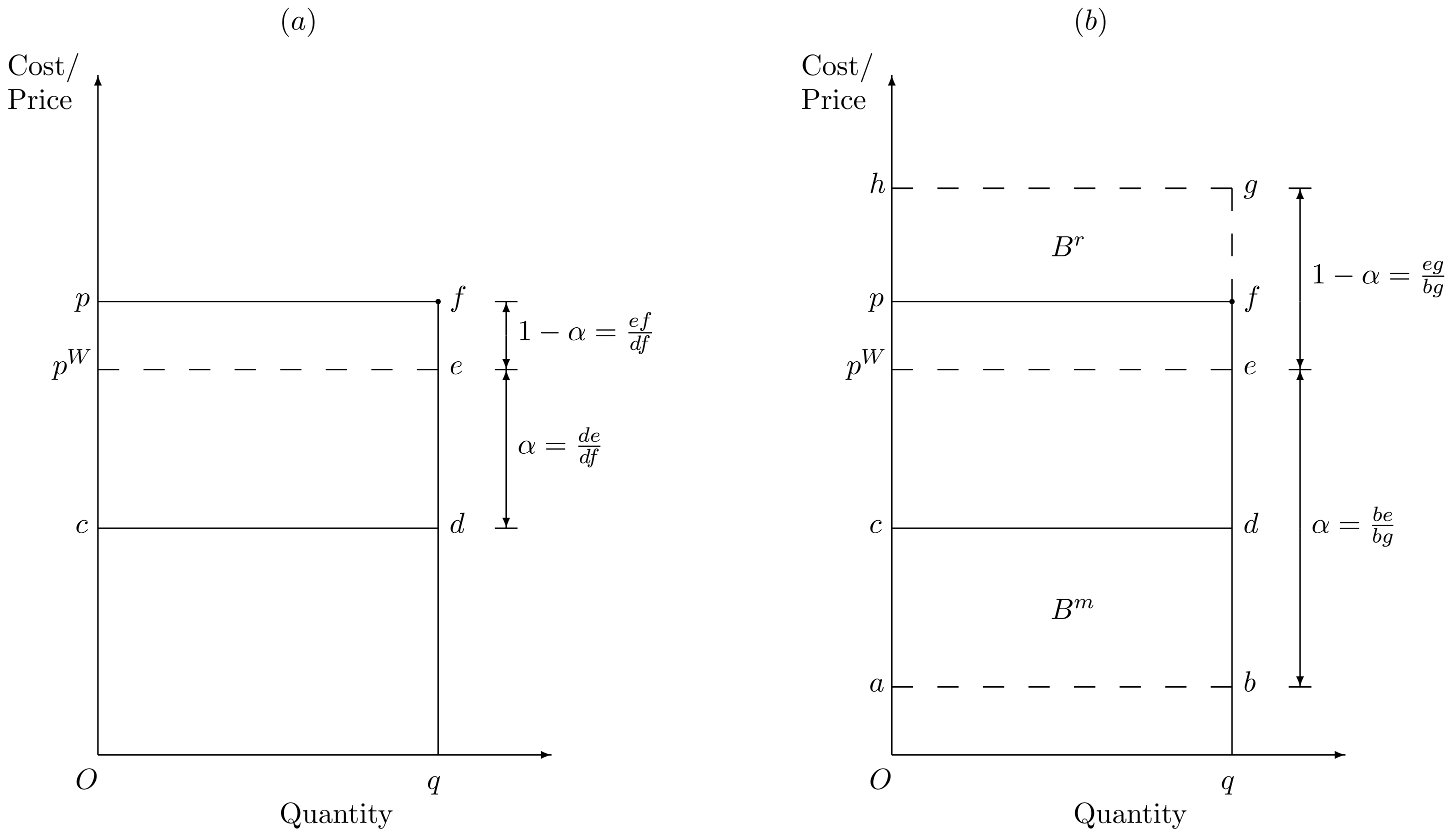

Figure 2: Effect of bargaining power α on wholesale price p^W

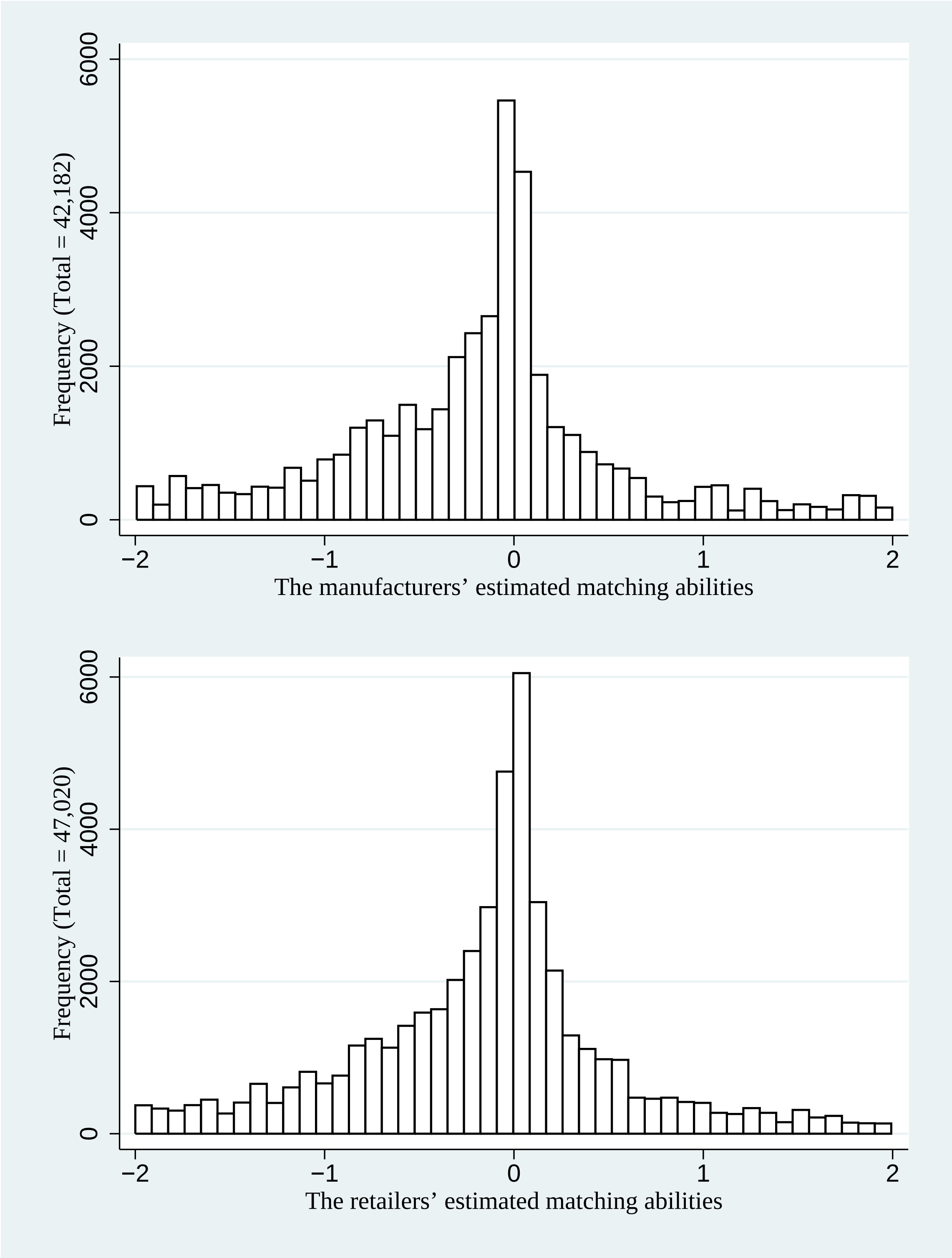

Figure 3: Estimated abilities

Table 8: Determinants of Bargaining Power

	Independent Variable: Manufacturer's Bargaining Power			
Dependent Variable	I	II	III	IV
1) # of market in which the manufacturer is active	1.32e-3***	1.23e-3***	0.18***	0.17***
	(2.38e-4)	(2.33e-4)	(3.68e-3)	(0.01)
2) # of models that manufacturer is offering	0.02***	0.02***	−0.03*	0.11**
	(2.82e-3)	(2.82e-3)	(0.02)	(0.05)
3) Total revenue excluding market k	1.95e-9***	1.90e-9***	−5.00e-9***	8.14e-9*
	(2.69e-10)	(2.72e-10)	(1.70e-9)	(4.69e-9)
4) Average match rate excluding market k	−1.27***	−1.11***	−106.30***	−114.06***
	(0.30)	(0.31)	(2.34)	(3.04)
5) Total revenue per match excluding market k	−9.45e-6***	−9.24e-6***	2.27e-5	−1.76e-5
	(1.58e-6)	(1.60e-6)	(2.24e-5)	(2.60e-5)
6) Local dummy (=1 if manufacturer is local)	−0.07***	−0.09***	Omitted[1]	Omitted[1]
	(0.02)	(0.01)		
7) Listed dummy (=1 if manufacturer is a listed company)	0.09***	0.07***	0.77***	10.57***
	(0.01)	(0.01)	(0.19)	(0.50)
8) Total revenue excluding that from match with m	−4.74e-9	1.39e-8**	1.72e-8***	1.82e-8***
	(5.70e-9)	(5.68e-9)	(5.16e-9)	(6.67e-9)
9) Total revenue share in the market excluding that from match with m	0.02	0.05	0.03	0.39***
	(0.03)	(0.03)	(0.03)	(0.05)
10) Match rate in the market excluding the match with m	−0.94***	−1.29***	−1.25***	−1.23***
	(0.02)	(0.02)	(0.02)	(0.02)
11) Total revenue per match excluding the match with m	5.00e-8**	1.73e-8	2.55e-8	−1.70e-9**
	(2.06e-8)	(1.94e-8)	(1.76e-8)	(1.85e-8)
12) # of manufacturers in the market	−6.09e-3***	0.04	0.02	0.01
	(1.75e-3)	(0.02)	(0.02)	(0.03)
13) # of retailers in the market	1.17e-3***	1.63e-3	−0.01***	−2.51e-3
	(1.36e-4)	(1.80e-3)	(1.64e-3)	(2.28e-3)
14) # of farmer households in the market	−1.77e-8	4.59e-7	4.62e-7	−4.92e-7
	(2.93e-8)	(5.00e-7)	(4.53e-7)	(7.33e-7)
15) Value added per farmer household in the market	−9.46e-4	2.32e-3	−4.02e-3***	0.01
	(1.24e-3)	(7.35e-3)	(6.66e-3)	0.01
Manufacturer fixed effects	No	No	Yes	Yes
Market fixed effects	No	Yes	Yes	Yes
Adjusted R^2	0.35	0.47	0.56	0.50
Observations	11,443	11,443	11,443	7,427

[1] Omitted due to multicolinearity.

A Derivation of (5)

Because $E\left(\omega_i^m\right) = E\left(\omega_i^r\right) = 0$, the problem in (4) becomes:

$$\max_{p_i^w} \left[(p_i^w - c)q_i + B_i^m\right]^{\alpha_i} \left[(p - p_i^w)q_i + B_i^r\right]^{1-\alpha_i}. \tag{19}$$

The first-order condition with respect to p_i^w is:

$$\left[(p_i^{w*} - c)q_i + B_i^m\right]^{\alpha_i} (1-\alpha_i) \left[(p - p_i^{w*})q_i + B_i^r\right]^{-\alpha_i} (-q_i) +$$

$$\alpha_i \left[(p - p_i^{w*})q_i + B_i^r\right]^{1-\alpha_i} \left[(p_i^{w*} - c)q_i + B_i^m\right]^{\alpha_i - 1} q_i = 0.$$

$\Leftrightarrow$

$$(1-\alpha_i) \left[(p_i^{w*} - c)q_i + B_i^m\right]^{\alpha_i} \left[(p - p_i^{w*})q_i + B_i^r\right]^{-\alpha_i} =$$

$$\alpha_i \left[(p_i^{w*} - c)q_i + B_i^m\right]^{\alpha_i - 1} \left[(p - p_i^{w*})q_i + B_i^r\right]^{1-\alpha_i}.$$

$\Leftrightarrow$

$$(1-\alpha_i) \left[(p_i^{w*} - c)q_i + B_i^m\right] = \alpha_i \left[(p - p_i^{w*})q_i + B_i^r\right].$$

$\Leftrightarrow$

$$(1-\alpha_i)\, p_i^{w*} q_i - (1-\alpha_i)\, c q_i + (1-\alpha_i)\, B_i^m = \alpha_i p q_i - \alpha_i p_i^{w*} q_i + \alpha_i B_i^r.$$

$\Leftrightarrow$

$$p_i^{w*} q_i = \alpha_i \left(p q_i + B_i^r\right) + (1-\alpha_i)\left(c q_i - B_i^m\right).$$

Let $B_i^m = b_i^m p q_i$ and $B_i^r = b_i^r p q_i$. Then the last equation becomes:

$$p_i^{w*} q_i = \alpha_i \left(p q_i + b_i^r p q_i\right) + (1-\alpha_i)\left(c q_i - b_i^m p q_i\right).$$

Dividing both sides by q_i, we get (5):

$$p_i^{w*} = \alpha_i \left(p + b_i^r p\right) + (1-\alpha_i)\left(c - b_i^m p\right).$$

Table A.1: A Complete List of Characteristics

The potential match is between manufacturer 'm' and retailer 'r' in market 'k'
Manufacturer-specific Characteristics:
1. No. of markets that the manufacturer is active in
2. No. of models that the manufacturer is offering
3. Aggregate total revenue from all matkets, excluding market 'k'
4. Aggregate total revenue from other matches in market 'k', excluding the match with 'r'
5. Total revenue share in all markets combined, excluding the match with 'r'
6. Total revenue share in market 'k', excluding the match with 'r'
7. Average match rate in all markets, excluding market 'k'
8. Match rate in market 'k', excluding the match with 'r'
9. Total revenue per match in all markets excluding market 'k'
10. Total revenue per match in market 'k', excluding the match with 'r'
Retailer-specific Characteristics:
1. Aggregate total revenue from other matches in market 'k', excluding the match with 'm'
2. Total revenue share in market 'k', excluding the match with 'm'
3. Match rate in market 'k', excluding the match with 'm'
4. Total revenue per match in market 'k', excluding the match with 'm'
Market-specific Characteristics:
1. No. of manufacturers in the market
2. No. of retailers in the market
3. No. of farmer households
4. Value added per farmer household