Player Pricing and Valuation of Cricketing Attributes: Exploring the IPL Twenty-Twenty Vision

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Abstract

In April 2008, BCCI initiated Indian Premier League, a cricket tournament of Twenty-Twenty overs to be played among eight domestic teams. Team owners bid for the services of cricketers for a total of US$ 42 million. Not much is known about how the valuation of cricketers might have occurred. Given the data on final bid prices, cricketing attributes of players, and other relevant information, we try to understand which attributes seem to be important and what could be their relative valuations. We employ the bid and offer curve concept of hedonic price analysis and econometrically establish a relation between the IPL-2008 final bid prices and the player attributes. Number of half centuries, number of wickets taken, and number of stumpings in all four forms of the game, batting average in the twenty-twenty form of the game, batting strike rate in one-day international (ODI), age, nationality, iconic status, and non-cricketing fame seem to be the critical attributes in the valuation of players. With the auction of incumbent and new players for the IPL-2009 underway till February 2009, we hope that the analysis of this kind would facilitate better understanding of player price formation and underscore the predictive value of such data driven analysis.

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Player Pricing and Valuation of Cricketing Attributes: Exploring the IPL Twenty-Twenty Vision

1. Introduction

The Indian Premier League (IPL), a tournament modelled on the lines of National Basketball Association (NBA) of USA and the English Premier League of England, made its debut in India in April 2008. IPL is a professional Twenty-Twenty cricket league, launched by Board for Control of Cricket in India (BCCI) and has the backing of International Cricket Council (ICC). The tournament is played among eight teams, where twenty overs are bowled by each team in any given match. The eight teams represent eight different cities of India, the franchisee rights of which are auctioned-off for ten years to successful bidders. Some of these successful bidders include industrial houses such as Reliance Industries and United Breweries, which own the teams Mumbai Indians and Royal Challengers Bangalore respectively.

The first round of the tournament is played on a double round-robin basis, where each team plays the other seven teams at home and away. The top four teams play the two semi-finals, followed by a final at the end. This makes for 56 league matches, two semi-finals, and a final match. Thus, the tournament involves a total of 59 matches of twenty-twenty overs each, to be played among eight teams. While eleven players take the field in a match, each team maintains at least sixteen players. Five of the teams have a designated icon player, who is paid an amount fifteen percent higher than the highest paid player in that team. The icon players belong to the regions that the team represents. The principal behind icon players is that an iconic player from the vicinity of home city would be able to generate keen interest in the team and for the tournament. The icon players and their teams are Virender Sehwag for Delhi, Sourav Ganguly for Kolkata, Rahul Dravid for

Bangalore, Yuvraj Singh for Punjab, and Sachin Tendulkar for Mumbai. For every team, there is a catchment area defined as per the geographical location of the city they represent. The team must have at least four players from their respective catchment area and four Under-22 players. The players from catchment areas could be an icon player, a Ranji Trophy player, or an Under-22 player. Each team can buy a maximum of eight overseas players; however, only four would take the field in a match.

Given the above ground rules, the franchisee owners formed their teams by participating in an auction of the cricket players organized by the IPL authorities. The prices received by the players varied quite significantly. For example, among the highly prized cricketers, Mahendra Singn Dhoni toped the list with a price of US$ 1.5 million, i.e., about Rs. six crores then, and at the other end, players like Dominic Thornely received US$25,000, or Rs. Ten lakhs then. Details of the teams, players, and their final bid prices are given in Appendix 1. The total auction payment to the players exceeded US$ 42 Million. Such sky-high payments pose the questions - How are the bidding prices decided? What cricketing attributes and other factors are implicitly decisive in the final bid prices? And, among these attributes, which are valued more than the others? With the announcement of the second IPL season beginning in April 2009 and the auction of incumbent and new players already underway till February 2009, these questions become even more pertinent.

In Section 2 we present literature review and methodology. The methodology describes hedonic price analysis, which enables relative valuation of constituent attributes of a product that lead to its final price formation. In Section 3 we describe the data and results of the regression equation that bring out relative importance of specific attributes that go into formation of the final bid prices. Finally, in Section 4 we interpret the results and make concluding comments.

2. Literature Review and Methodology

There have been several studies on players' compensation in various sports. For example, Estenson (1994), MacDonald and Reynolds (1994), and Bennett and Flueck (1983) have studied player compensation in baseball. Similarly, Dobson and Goddard (1998) and Kahn (1992) have considered compensation issues in football. Moreover, there are also related studies in ice-hockey (Jones and Walsh, 1988) and basketball (Berri, 1999, and Hausman and Leonard, 1997). In cricket, there are a few studies which deal with scheduling the cricket matches (Armstrong and Willis, 1993; Wright, 1994; and Willis and Terrill, 1994). Barr and Kantor (2004) sought to determine the important characteristics for a batsman in one-day cricket. However, we do not come across any study that links compensation to player attributes. Also, none of the studies use hedonic price analysis, which we describe now, as a unique way of measuring valuation of (cricketing) attributes leading to the formation of player price.

Hedonic Price Analysis is based on the hypothesis that a good/service can be treated as a collection of attributes that differentiates it from other goods/services. Waugh (1928) propounded this concept based on his observation of different prices for different lots of vegetables. Waugh sought to identify the quality traits influencing daily market prices. Later, Rosen (1974) based his model of product differentiation on the hypothesis that goods are valued for their utility generating attributes. According to him, while making a purchase decision, consumers evaluate product quality attributes, and pay the sum of implicit prices for each quality attribute, which is reflected in observed market price. Hence, price of a product is nothing but summation of the shadow prices of all quality attributes.

Shapiro (1983) presented a theoretical framework to examine halo effect on prices. Developing an equilibrium price-quality schedule for high-quality products, assuming competitive markets and imperfect information, he showed that reputation facilitates a price premium; hence, reputation building can be considered as an investment good. Weemaes and Riethmuller (2001) studied the role of quality attributes on preferences for fruit juices. The study involved market valuation of various attributes of fruit juice. The study did not consider consumers' preferences *per se* but generated quality attributes from the product label. The study revealed that consumers paid a premium for nutrition, convenience, and information. In a similar study on tea, Deodhar and Intodia (2004) showed that color and aroma were the two important attributes of a prepared tea.

Extending the analogy to cricket, a cricket player is valued for his on-the-field (and perhaps, off-the-field) performance. We propose that a cricket player sells his cricketing services for the IPL tournament. The franchisee team owners bid for the player services, for team owners would like to maximize their utility (chances of winning and maximizing profit), and, player performance is an important arguments of their utility function. In equilibrium, the final bid price of a player must be a function of the valuation of winning attributes of a player. Therefore, given the data on values of various attributes of cricket players and their final bid prices, one can estimate the following hedonic price equation econometrically,

$$P_i = g (z_{i1}, \ldots, z_{ij}, \ldots, z_{in}),$$

where P_i is the final bid price paid to a cricketer i for the IPL tournament and z_{ij} is the value of the attribute j of the cricket player i. The hedonic price equation, in this context, is a locus of equilibrium final bid prices and player attributes, where buyers (team

owners) and sellers (cricket players) participate in an auction. Derivation of the hedonic price equation is reported in Appendix 2.

3. Data and Regressions Results

Data on final bid prices and values of vey many cricketing attributes of players are readily available for the IPL 2008. The data sources include the offical website of IPL and two other websites, Cricinfo and Wikipedia. The bidding process involved 99 players; however, data is available only for 96 players. Country representation of the players is given in Table 1 below. While we consider the final bidding price as the dependent variable, we have a problem of plenty as far as the independent variables are concerned, for there is a wealth of data available on the cricekting attributes of IPL players. We had data from various forms of the game: Tests matches, one-day internationals (ODIs), twenty-twenty mathes, and first class cricket.

Table 1: Number of Players from Different Countries

Country	No. of Players	Country	No. of Players
India	31	Australia	18
South Africa	12	Sri Lanka	11
New Zealand	7	Bangladesh	1
Zimbabwe	1	Pakistan	11
West Indies	3	England	1

The independent variables were divided into two sets – dummy variables identifying qualitative attributes and measurable variables based on past statistics of the cricketing attributes. We considered various forms of regressions equations such as double log, log-linear, linear-log and the linear regression, and experimented with the comprehensive data at hand. For all the functional forms of the regression equation, we progressively

eliminated highly correlated variables, variables with low t-statistics, and selected ones that provided higher values of R-square and adjusted R-square. The best fit among all the functional forms was the linear regression equation. The specification of the equation is given below and the description of the variables is presented in Table 2.

$$Y_{bp} = \alpha + \beta_1 Micon + \beta_2 Icon + \beta_3 Exicon + \beta_{4j} Country_j + \beta_5 Age + \beta_6 Ttbatavg + \beta_7 Obatsr + \beta_8 Hcent + \beta_9 Stump + \beta_{10} Wkts + \varepsilon$$

Dummy variables include icon players receiving more than 1 million US$ final bid prices (Micon), icon status player receiving less than US$ 1 million final bid price (Icon), other famous players with a price tag exceeding US$ 1 million (Exicon), and country dummies ($Country_j$). Icon players may garner local/regional support for reasons other than their cricketing attributes. The dummy variables Micon and Icon control for such non-cricketing attributes. They capture the iconic value of the player to the team owners. There are two non-icon players who crossed the US$ 1 million price tag. One is Mahendra Singh Dhoni, very much liked by Indians for his personal charisma and association with film actresses, and, the other is Andrew Symonds, famous for the controversies arising out of his racial background. Both players are big crowd pullers and the dummy variable Exicon captures the fame value of these players to the team owners.

Table 2: Description of Variables

Variable	Description
Y_{bp}	Final bid price of a player in US dollars.
Micon	Dummy variable with value 1 for four Icon players receiving final bid price exceeding 1 million US$, and 0 for others. The millionaire Icon players are: Youvraj Singh, Punjab; Sourav Ganguly, Kolkata; Rahul Dravid; Bangalore, and Sachin Tendulkar, Mumbai.
Icon	Dummy variable with value 1 for the Icon player receiving less than a million US$ final bid price and 0 for others. The player is Virender Sehwag, Delhi.
Exicon	Dummy variable with value 1 for two Non-Icon players receiving final bid price of more than US$ 1 million and 0 for others. The millionaire non-Icon players are: Mahendra Singh Dhoni and Andrew Symonds.
$Country_j$	Country dummy for player's nationality. Base dummy is Australia. j = 1 to 6 for countries India, New Zealand, Sri Lanka, South Africa, Pakistan, and Other. Other includes Bangladesh, England, Zimbabwe, and West Indies with 3 or less players in IPL-2008
Age	Age of the player in completed years
Ttbatavg	Batting average in all twenty-twenty international matches
Obatsr	Batting strike-rate in all one-day international matches
Hcent	Total number of half-centuries in all four forms of cricket
Stump	Total number of stumpings in all four forms of cricket
Wkts	Total number of wickets taken in all four forms of cricket

It is obvious that cricket is the most popular game in India and people almost worship their Indian cricket players. Therefore, we introduced the dummy variable, $Country_j$, to gauge the premium players may receive for being Indian *vis-à-vis* the foreign players. Since the Australian team has been a top ranked team for a number of years, we considered it as the base dummy. Very few players from Bangladesh, England, Zimbabwe, and West Indies participated in the player auction, therefore, we put them all together in the country dummy, Other. We also considered a few other dummy variables

such as batting hand, bowling hand, and bowling style, however, these variables turned out to be statistically very insignificant. In fact, removing these dummies improved the goodness of fit of the regression equation considerably.

The other set of independent variables are the measurable variables based on past statistics of the cricketing attributes. And, there are plenty of such statistics available that are related to the batting, bowling, fielding, and wicket-keeping attributes. For example, batting related statistics includes variables such as runs scored, batting average, batting strike rate, number of centuries, and number of half centuries. Similarly, bowling related statistics includes variables such as number of wickets taken, bowling average, bowling economy rate, and bowling strike rate. The other important variables include number of stumpings, number of catches taken, and age. One could have considered using ICC ratings as well. However, these ratings keep changing and there are different ratings for different forms of the game. Moreover, these ratings are not available for many players who participated in IPL.

Of the numerous statistics/variables mentioned above, we considered the ones that best satisfy the goodness of fit criteria in terms of t-statistics, R^2, adjusted R^2 and the F-statistics for various forms of regression equations. These variables include: Batting average in twenty-twenty international matches, total number of half-centuries scored in all four forms of cricket, batting strike-rate in one-day international matches, age of the player in completed years, total number of stumpings in all forms of cricket, and total number of wickets taken in all forms of cricket. As reported in Table 3 below, most regression coefficients are significant at 1% two-tail test except for a few country dummies. R-Square and adjusted R-Square take the value of 0.77 and 0.70, and the F-statistics is 10.56 at the 0.001 significance level. These statistics indicate that the

regression fit is quite robust. We take up the interpretation of the result and concluding comments in the next section.

Table 3: Regression Results

Variables	Parameter	Estimate	t-values*
Intercept	α	647092	1.98
Micon	β_1	499037	3.15
Icon	β_2	382274	1.91
Exicon	β_3	794580	5.17
India	β_{41}	203156	1.86
New Zealand	β_{42}	-14846	-0.15
Sri Lanka	β_{43}	-66081	-0.73
South Africa	β_{44}	-2261.32	0.02
Pakistan	β_{45}	-156183	-1.63
Other	β_{46}	-204409	-1.89
Age	β_5	-29484	-2.77
Ttbatavg	β_6	4658.04	2.82
Obatsr	β_7	3111.12	1.83
Hcent	β_8	2682.87	4.07
Stump	β_9	2595.67	2.78
Wkts	β_{10}	377.31	4.63

* Coefficients significant at 1% two-tail test except for a few country dummies.
R-Square = 0.77, Adj. R-Square = 0.70, F-stat = 10.56 at significance level 0.001
Total number of observations for which data on all variables was available: 64

4. Interpretation and Concluding Comments

Ceteris paribus, the parameter estimate of $499,037 for the variable Micon reflects the premium Sachin Tendulkar, Saurav Ganguli, Rahul Dravid, and Yuvaraj Singh earn for their regional iconic popularity. However, another icon player, Virender Sehawag, enjoys an iconic premium of only US$ 382,274. Of course, it does not come as a surprise that IPL auction regulations stipulate that icon players would receive 15 percent higher price than the highest paid player in their respective teams. The premium for two other players, though not having iconic status but who received a final bid price of more than US$ 1 million is $794,580. Having controlled for the cricketing attributes, this high premium

seems to be a reflection of their ability to draw huge crowds nationally due to their charismatic association with film actresses and the racial controversies surrounding them respectively. Thus, out of the total price of $1.5 million and $1.12 million received by Mahendra Singh Dhoni and Sachin Tendulkar, the value of their cricketing attributes is $705,420 and $622,213 respectively, and, their net crowd pulling business value is about $794,580 and $499,037 respectively.

Does an Indian player command a premium over foreign players? The answer is, Yes. We considered Australian player as the base dummy. Among the foreign players, none receives any premium for their nationality, however, an Indian player, on an average, controlling for other attributes, is likely to receive a premium of US$ 203,156 over non-Indian players. One would also expect age to play a role in the final bid prices. Regular participation in games as well as biological aging is likely to make a person less fit progressively. Implicitly, this may get reflected in the final bid prices. Lo and behold, the coefficient for age is found to be negative and statistically significant. On an average, a player loses out US$ 29,484 for getting older by one more year. Thus, premium for being younger in a twenty-twenty IPL tournament is well established in this study.

Among the cricketing attributes, results show that an increase in twenty-twenty batting average by one run fetches additional US$ 4,658 to the cricketer's final bidding price. Similarly, number of half-centuries in all forms of game is also found to be rewarding with US$ 2,683 for every additional half-century. This goes to show that substantive quick runs are more sought after and rewarded in a IPL twenty-twenty match[1]. Moreover, a one point increase in the strike rate in one-day-international (ODI) matches seems to fetch US$ 3,111. Number of stumpings is also found to be significant and rewarding for a wicket-keeper. An additional stumping contributes about US$ 2,595. Finally, the only

[1] In fact, we had considered the variable, "number of centuries," however it did not turn out to be statistically significant at all in any form of the regression equations.

bowling related variable that finds importance in the player pricing is the total number of wickets taken in all forms of the game. Every additional wicket taken earns a player US$ 377. This should not come as a surprise, for the twenty-twenty form of game seems to be dominated by batsmen[2].

Among the sports researches in general and research on cricket in particular, this paper is a first attempt to provide an objective valuation of cricketers based on the valuation of their cricketing and non-cricketing attributes as perceived by the business of cricket. With this paper, we hope to open a new innings in cricket related research, wherein players' attributes are used to objectively evaluate their market value. In fact, we hope that this kind of research would facilitate better understanding of player price formation and underscore the predictive value of such data driven analysis. The issue is very topical, for auctioning of incumbent and new players for IPL 2009 is underway till February 2009 and such analysis can help ascertain a new player's worth to the team owners.

[2] In fact, we considered many bowling related variables but none other than "number of wickets" turned out to be statistically significant in any form of the regression equations.

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Appendix 1: Teams, Players, and Prices

Team	Player	Bid Price US$
Chennai Super Kings	Matthew Hayden	375,000
Chennai Super Kings	Stephen Fleming	350,000
Chennai Super Kings	Suresh Raina	650,000
Chennai Super Kings	Michael Hussey	350,000
Chennai Super Kings	Mahendra Singh Dhoni	1,500,000
Chennai Super Kings	Parthiv Patel	325,000
Chennai Super Kings	Jacob Oram	675,000
Chennai Super Kings	Albie Morkel	675,000
Chennai Super Kings	Viraj Kadbe	30,000
Chennai Super Kings	Muttiah Murlidharan	600,000
Chennai Super Kings	Joginder Sharma	225,000
Chennai Super Kings	Makhaya Ntini	200,000
Delhi Daredevils	Virender Sehwag	833,750
Delhi Daredevils	Tilakratne Dilshan	250,000
Delhi Daredevils	Gautam Gambhir	725,000
Delhi Daredevils	Manoj Tiwary	675,000
Delhi Daredevils	Dinesh Kartik	525,000
Delhi Daredevils	AB de Villiers	300,000
Delhi Daredevils	Daniel Vettori	625,000
Delhi Daredevils	Shoaib Malik	500,000
Delhi Daredevils	Farveez Maharoof	225,000
Delhi Daredevils	Mohammed Asif	650,000
Delhi Daredevils	Glenn McGrath	350,000
Delhi Daredevils	Brett Geeves	50,000
Rajasthan Royals	Graeme Smith	475,000
Rajasthan Royals	Mohammad Kaif	675,000
Rajasthan Royals	Justin Langer	200,000
Rajasthan Royals	Younis Khan	225,000
Rajasthan Royals	Kamran Akmal	150,000
Rajasthan Royals	Yusuf Pathan	475,000
Rajasthan Royals	Dimitri Mascarenhas	100,000
Rajasthan Royals	Shane Watson	125,000
Rajasthan Royals	Sohail Tanvir	100,000

Rajasthan Royals	Shane Warne	450,000
Rajasthan Royals	Munaf Patel	275,000
Rajasthan Royals	Morne Morkel	60,000
Kings XI Punjab	Yuvraj Singh	1,063,750
Kings XI Punjab	Mahela Jayawardene	475,000
Kings XI Punjab	Ramnaresh Sarwan	225,000
Kings XI Punjab	Simon Katich	200,000
Kings XI Punjab	Luke Pomersbach	54,000
Kings XI Punjab	Kumar Sangakkara	700,000
Kings XI Punjab	Irfan Pathan	925,000
Kings XI Punjab	Ramesh Powar	170,000
Kings XI Punjab	James Hopes	300,000
Kings XI Punjab	Brett Lee	900,000
Kings XI Punjab	S. Sreesanth	625,000
Kings XI Punjab	Piyush Chawla	400,000
Kings XI Punjab	Kyle Mills	150,000
Royal Challengers Bangalore	Rahul Dravid	1,035,000
Royal Challengers Bangalore	Shivnarine Chandrapaul	200,000
Royal Challengers Bangalore	Wasim Jaffer	150,000
Royal Challengers Bangalore	Misbah-Ul-Haq	125,000
Royal Challengers Bangalore	Ross Taylor	100,000
Royal Challengers Bangalore	Mark Boucher	450,000
Royal Challengers Bangalore	Shreevats Goswami	30,000
Royal Challengers Bangalore	Jacques Kallis	900,000
Royal Challengers Bangalore	Cameron White	500,000
Royal Challengers Bangalore	Anil Kumble	500,000
Royal Challengers Bangalore	Zaheer Khan	450,000
Royal Challengers Bangalore	Nathan Bracken	325,000
Royal Challengers Bangalore	Dale Steyn	325,000
Royal Challengers Bangalore	Praveen Kumar	300,000
Royal Challengers Bangalore	Abdur Razzak	50,000
Mumbai Indians	Sachin Tendulkar	1,121,250
Mumbai Indians	Sanath Jayasurya	975,000
Mumbai Indians	Robin Uthappa	800,000
Mumbai Indians	Loots Bosman	175,000

Mumbai Indians	Ashwell Prince	175,000
Mumbai Indians	Shaun Pollock	550,000
Mumbai Indians	Dominic Thornely	25,000
Mumbai Indians	Harbhajan Singh	850,000
Mumbai Indians	Lasith Malinga	350,000
Mumbai Indians	Dilhara Fernando	150,000
Deccan Chargers	V.V.S.Laxman	375,000
Deccan Chargers	Rohit Sharma	750,000
Deccan Chargers	Herschelle Gibbs	575,000
Deccan Chargers	Chamara Silva	100,000
Deccan Chargers	Adam Gilchrist	700,000
Deccan Chargers	Andrew Symonds	1,350,000
Deccan Chargers	Shahid Afridi	675,000
Deccan Chargers	Scott Styris	175,000
Deccan Chargers	Rudra Pratap Singh	875,000
Deccan Chargers	Chaminda Vaas	200,000
Deccan Chargers	Nuwan Zoysa	110,000
Kolkata Knight Riders	David Hussey	625,000
Kolkata Knight Riders	Ricky Ponting	400,000
Kolkata Knight Riders	Salman Butt	100,000
Kolkata Knight Riders	Sourav Ganguly	1,092,500
Kolkata Knight Riders	Tatenda Taibu	125,000
Kolkata Knight Riders	Brendon McCallum	700,000
Kolkata Knight Riders	Chris Gayle	800,000
Kolkata Knight Riders	Ajit Agarkar	350,000
Kolkata Knight Riders	Mohammad Hafeez	100,000
Kolkata Knight Riders	Ishant Sharma	950,000
Kolkata Knight Riders	Shoaib Akhtar	450,000
Kolkata Knight Riders	Murali Kartik	425,000
Kolkata Knight Riders	Umar Gul	150,000

Source: Wikipedia

Appendix 2: Hedonic Price Equation*

Consider a utility maximization problem of an individual. The objective function and the constraint for utility maximization can be specified as:

(1) $\text{Max } U = f(X, Z)$ s.t. $M - P_i - X = 0,$

where Z is a vector representing a particular good in question with n quality attributes, z_{i1}, …,z_{ij}, …, z_{in}. X is a numeraire, composite commodity of non-Z goods, and M is income. An implicit assumption is that each individual purchases only one unit of the product in a given period t.

The basic assumption of the Hedonic Price Analysis is that utility is enhanced not by the consumption of an economic good but by the characteristics of that good. Therefore, the market price of the good is the sum of the prices consumers are willing to pay for each characteristic that enhances its utility. With firms producing Z with a variety of combinations of its quality attributes, Z becomes a differentiated product. Applying first order condition for the choice of characteristics z_j we get:

(2) $$\frac{\delta U/\delta z_j}{\delta U/\delta X} = \frac{\delta P_i}{\delta z_j}$$

Equation (2) is nothing but stating the law of equimarginal utility between two goods, X and z_i. $\delta P_i/\delta z_j$ is the marginal implicit price for characteristic z_j. Further, the utility function U can be rewritten as:

(3) $U = U(M - P_i, z_{i1}, \ldots, z_{ij}, \ldots, z_{in})$.

Inverting equation (3) and solving for P_i with z_j as a variable and U* and z^*_{-j} being held constant at their optimal values associated with problem in (1), we can write a bid curve B_j as follows:

(4) $B_j = B_j(z_j, z_{-j}^*, U^*)$

Holding other things at the optimal level, (4) describes the maximum amount an individual would be willing to pay for a unit of Z as a function of z_j. A well-behaved bid curve is ought to exhibit a diminishing willingness to pay with respect to z_j. Based on their individual preferences and/or incomes, consumers can have different bid curves $B^1_j(z_j)$ and $B^2_j(z_j)$ as shown in Figure 1.

On the supply side as well, firm's cost of production depends on the characteristics of the product. Offer curve for the characteristic z_j derived from the firm's cost function can be represented by:

(5) $C_j = C_j(z_j, z_{-j}^*, \pi^*)$

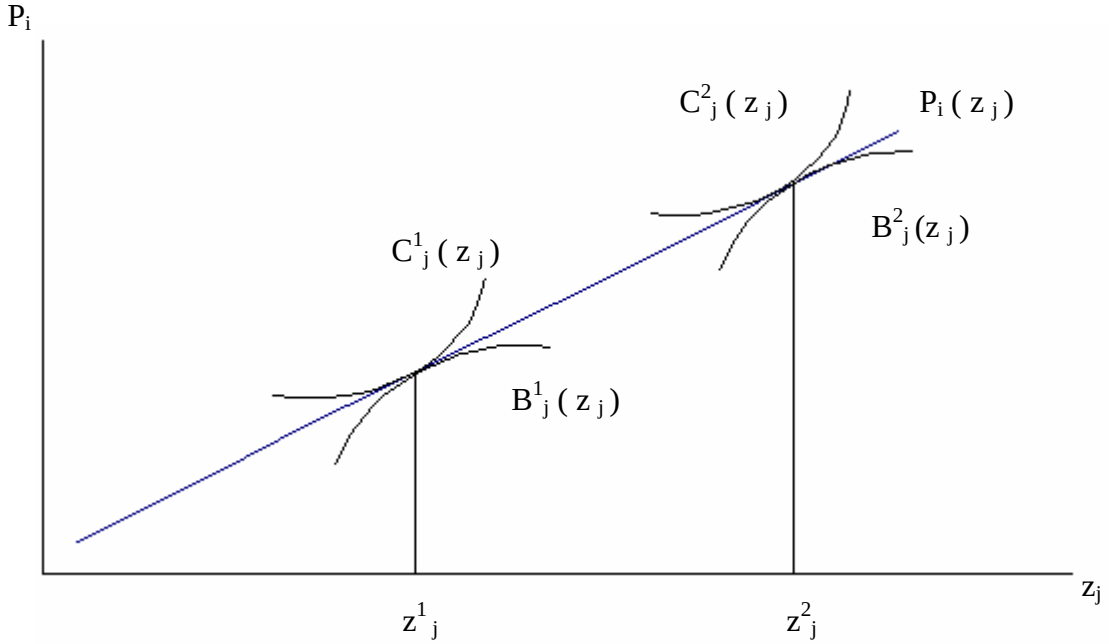
Equation (5) explains the minimum price a firm would accept to sell a unit of Z as function of z_j, holding other attributes and profit at the optimal level. Offer curves $C^1_j(z_j)$ and $C^2_j(z_j)$ for two individual producers are also shown in Figure 1. In equilibrium, i.e., situation in which consumers and producers trade Z for an agreed price, the bid and offer

curves for the quality attribute z_j for each market participant must be tangent to each other. We assume that a straight line P_i (z_j) represents these tangencies as shown in Figure 1. Thus, P_i (z_j) represents the equilibrium locus for all individual bid and offer curves. We call this function the Hedonic Price Function. For a commodity Z with n number of attributes this Hedonic Price Function can be represented by the following notation.

(6) $P_i = g (z_{i1}, \ldots, z_{ij}, \ldots, z_{in})$.

If the relevant information on various brands of the differentiated good Z is available, one should be able to estimate equation (6) econometrically. The results would indicate the relative importance consumers attach to the various quality attributes of Z.

Figure 1: Bid and Offer Curves in Hedonic Pricing



* Adapted from Schamel, Gabbert and Witzke (1998).