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Mediator Learning and Dowry Determination in an Arranged Marriage Setting[1]

by

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Abstract

Recently, Batabyal (2005) has analyzed a game model of dowry determination in which a mediator plays a key role. Batabyal's analysis shows that the equilibrium dowry offers from the bride and the groom optimally trade off the desire to make an assertive offer with the likelihood that this offer will be selected by the mediator. We extend the Batabyal (2005) analysis by studying the impact that learning—about the circumstances of a prospective marriage—by the mediator has on the tripartite interaction between the bride, the groom, and the mediator. Specifically, we first determine the optimal dowry offers from the bride and the groom in a separating perfect Bayesian equilibrium. Next, we show that the mediator perfectly infers the private information of the two parties from their dowry offers and that he then uses this information in part to select his preferred dowry offer.

Keywords: Arranged Marriage, Dowry, Learning, Mediator, Uncertainty

JEL Codes: O150, D810, J120

1. Introduction

In contemporary times, the word "dowry" has many meanings. Even so, one standard meaning of this word refers to the money, goods, or property that are offered by the family of a prospective bride to the family of a prospective groom at the time of marriage. Although this practice of making dowry payments was and is common in many parts of the world, today, it is most common in countries such as India where a substantial proportion of all marriages are arranged.[4] In the case of India, Sheel (1999) has pointed out that the practice of making dowry payments can be tracked back to Vedic times in which valuable clothes, jewelry, and other goods were routinely given voluntarily to both the bride and to the groom's families at the time of marriage. This tells us that the initial purpose of dowry payments was to sanctify material wealth and also to enhance one's status at the time of marriage.

Unfortunately, in modern times, the practice of making dowry payments has changed considerably. In many arranged marriages in India and in other countries, dowry payments are largely involuntary. Further, as Leslie (1998) and others have noted, such payments are now frequently utilized by the groom's family to impoverish the bride's family by extracting large amounts of monetary and/or material resources as a precondition for marriage. The groom's family is able to do this because in India and in other countries where arranged marriages are common, women tend to occupy an inferior position in the relevant nation's patrilineal kinship and family system.

The economic and the social standing of the groom's family has a significant bearing on the

[4] For informative accounts of the phenomenon of dowry, the reader should refer to Bumiller (1990), Menski (1998), and Sheel (1999). For more on decision making in arranged marriages, see Batabyal (2001, 2004), and Batabyal and Beladi (2003).

actual amount of the dowry that is demanded in any particular instance. In this regard, given the work of Sheel (1999, p. 18), it is fair to say that the higher the socioeconomic standing of the groom's family, the higher is generally the demand for dowry. This situation gives rise to two questions of considerable interest. First, how do the involved parties in an arranged marriage setting come to an agreement over the actual amount of the dowry payment? Second, if a mediator is used, how does the presence of this individual influence the dowry offers made by the bride and the groom's families?

There is a large literature in the social sciences on the first question of the previous paragraph.[5] The same is however not true of the second question and hence, in what follows, we shall be concerned exclusively with this second question. In this regard, the work of Jaggi (2001), Reddy (2002), and others tells us that in some arranged marriage settings, the two involved parties conduct the dowry negotiations with the assistance of a mediator. Now, economists have certainly contributed to increasing our understanding of alternate aspects of dowries.[6] Even so, to the best of our knowledge, the only paper that has explicitly analyzed the tripartite mediator/bride's family/groom's family interaction is the one by Batabyal (2005).

Batabyal (2005) uses a game model to account for the above mentioned tripartite interaction. He shows that the Nash equilibrium dowry offers from the bride and the groom optimally trade off the desire to make an aggressive offer with the likelihood that this offer will be selected by the

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Research by economists and by other social scientists provides a clear answer to this first question. Specifically, we learn that in many arranged marriage settings, the bride and the groom's families directly negotiate with each other to ascertain the amount of the dowry. However, this is not always the case and hence the second question of the previous paragraph is germane. For more on these issues, see Rao (1993), Sharma (1993), Agnihotri (2003), and Dalmia (2004).

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For more on research by economists on alternate aspects of dowries, see Rao (1993), Bloch and Rao (2002), Anderson (2003), Dalmia (2004), and Dalmia and Lawrence (2005).

mediator. Now, it should be clear to the reader that a mediator will function most effectively when he has as much information as possible about the circumstances of a prospective marriage. However, this information is typically private and hence the best a mediator can do is to *learn* this information over time from the observed behavior of the bride's and the groom's families. Batabyal's (2005) analysis is conducted with a *static* game of complete information. Therefore, this analysis is unable to study the implications that learning—about the circumstances of a forthcoming marriage—by a mediator has on the tripartite mediator/bride's family/groom's family interaction.

Given this background, the purpose of our paper is to extend the Batabyal (2005) analysis by explicitly modeling the learning dimension of the problem and then studying the impact of this learning on dowry determination in an arranged marriage setting. The rest of this paper is organized as follows. In section 2, we describe our game theoretic model of the dowry determination problem. Section 3 determines the equilibrium of our game theoretic model and then this section comments on the salient properties of this equilibrium. Section 4 concludes and offers suggestions for future research on the subject of this paper.

2. The Game Model

In general, there are several ways in which a mediator can interact with the bride's family and with the groom's family to determine the actual dowry payment. Following Batabyal (2005), we shall think of the mediator as an arbitrator. Our game model of dowry determination is based on Gibbons (1988) and the game itself is a dynamic game of incomplete information.[7] There are three players. First, there is a representative from the bride's family who we shall refer to as the *bride* b. Second, there is a representative from the groom's family who we shall refer to as the *groom* g.

[7] For more on dynamic games of incomplete information, see Fudenberg and Tirole (1991, section IV) or Gibbons (1992, chapter 4).

Finally, there is a mediator who we shall designate with the letter m.

The timing of the game between the bride, the groom, and the mediator is as follows. In the first stage, the bride and the groom simultaneously make dowry offers d_b and d_g respectively. In the second stage, the mediator selects $d_m \in \{d_b, d_g\}$ as the final dowry amount that is agreed upon by both the bride and the groom. The objective functions are $-E[d_m]$ for the bride, $+E[d_m]$ for the groom, and $E[-(d_m - \alpha)^2]$ for the mediator, where $E[\cdot]$ is the expectation operator. The reader should note four things about these three objective functions. First, the bride simply seeks to minimize the mediator's expected dowry amount and the groom, in contrast, seeks to maximize this amount. Second, the mediator's ideal dowry amount depends on the (random) *state* of the negotiations about the prospective marriage between the bride and the groom and we denote this random state variable by α. Third, a key task for our mediator is to learn as much as he possibly can about what the bride and the groom know about the random state variable α. Finally, if we think of α as a "bliss point," then our mediator simply wishes to be as close to his bliss point as possible.

The state variable α is assumed to be normally distributed with mean μ and precision k, where the precision of a normally distributed random variable is defined to be the inverse of the variance.[8] The mediator, the bride, and the groom receive noisy signals about α. In particular, the bride and the groom receive the same signal $s_{bg} = \alpha + \epsilon_{bg}$ and our mediator receives the signal $s_m = \alpha + \epsilon_m$. Like α, the random variables ϵ_{bg} and ϵ_m are also assumed to be normally distributed

8 See DeGroot (1970, p. 38) for more on the precision of a normally distributed random variable.

with means 0, 0, and precisions k_{bg}, k_m, respectively. The outstanding task now is to determine the perfect Bayesian equilibrium of our dowry determination game. However, before we proceed with the computation of the relevant equilibrium, we note three things. First, given the opposing interests of the bride and the groom in our dowry determination game, pooling equilibria are not particularly interesting and hence, in the rest of this paper, we focus on a separating equilibrium. Second, in this separating equilibrium, the sum of the dowry offers by the bride and the groom, i.e., $d_b + d_g$ perfectly reveals the signal s_{bg} to the mediator. Finally, even though the bride and the groom may want to mislead the mediator's learning process, in the separating perfect Bayesian equilibrium that we compute, they do not submit misleading dowry offers.

3. The Perfect Bayesian Equilibrium

To compute the equilibrium of interest, we shall make repeated use of formulae for the normal learning model presented in DeGroot (1970, pp. 166-172) and in Gibbons (1988, p. 900). The basic point to recognize here is that the mathematical expectation of a variable given independent and normally distributed signals is the weighted average of the signals where the weights are the precisions.

We now state the central claim of our paper. In the separating perfect Bayesian equilibrium of interest, the bride and the groom observe the signal s_{bg} and they then make dowry offers given by

$$d_b = \frac{k\mu + k_{bg}s_{bg}}{k + k_{bg}} - \sqrt{\frac{\pi}{2k_m}} \text{ and } d_g = \frac{k\mu + k_{bg}s_{bg}}{k + k_{bg}} + \sqrt{\frac{\pi}{2k_m}}. \tag{1}$$

In addition, after hearing the dowry offers $\hat{d}_b$, $\hat{d}_g$, and observing the signal s_m, the mediator selects the offer $\hat{d}_i$, $i=b,g$, which minimizes

$$|\hat{d}_i - \frac{k\mu + k_{bg}\hat{s}_{bg} + k_m s_m}{k + k_{bg} + k_m}|, \tag{2}$$

where $\hat{s}_{bg}$ is defined implicitly by $k_{bg}\hat{s}_{bg} = (k+k_{bg})\{(\hat{d}_b + \hat{d}_g)/2\} - k\mu$.

3.1. The optimality of the mediator's action

We now confirm that our central claim in the previous paragraph is valid. To this end, let us first verify that the mediator's action described in equation (2) is indeed a best response. Now, if the bride and the groom play their equilibrium strategies, then after observing d_b and d_g our mediator assigns probability one to $s_{bg} = (k+k_{bg})\{(d_b + d_g)/2\} - k\mu$. Undertaking this action is, in effect, the same as our mediator observing both signals s_{bg} and s_m. Therefore, the standard multivariate normal regression model with independent random variables tells us that given the signals s_{bg} and s_m, the conditional distribution of the state variable α is normal with mean $(k\mu + k_{bg}s_{bg} + k_m s_m)/(k + k_{bg} + k_m)$ and precision k_m.

We can now state our mediator's optimization problem. This individual solves

$$\max_{\{d_m\}} -E[(d_m - \alpha)^2]. \tag{3}$$

Using the law of iterated expectations—see Ross (1996, p. 21) or Wooldridge (2001, p. 29)—the expectation in equation (3) can be expressed as $E[(d_m - \alpha)^2] = E[(d_m - E[\alpha] + E[\alpha] - \alpha)^2] =$ $E[(d_m - E[\alpha])^2] + 2E[(d_m - E[\alpha])(\alpha - E[\alpha])] + E[(\alpha - E[\alpha])^2] = (d_m - E[\alpha])^2 + E[(\alpha - E[\alpha])^2]$. This last expression is clearly minimized when $d_m = E[\alpha]$. Therefore, we conclude that our mediator is indeed playing a best response by selecting the dowry offer that is closest to the conditional mean of the random state variable α given the signals s_{bg} and s_m.

3.2. The optimality of the bride's strategy

Having verified the optimality of our mediator's action, let us now show that the bride is also playing a best response to the strategies of the groom and the mediator. To this end, first note that given the strategies of the groom and the mediator, it makes no sense for the bride to offer $\hat{d}_b \geq d_g$.

Therefore, for a dowry offer $\hat{d}_b = d_b + \hat{q}_b < d_g$, the bride's expected payoff is

$$E[u_b(\hat{q}_b)] = -(d_b + \hat{q}_b) Prob\{\frac{k\mu + k_{bg}\hat{s}_{bg} + k_m s_m}{k + k_{bg} + k_m} \leq \frac{(d_b + \hat{q}_b) + d_g}{2}\} -$$

$$d_g Prob\{\frac{k\mu + k_{bg}\hat{s}_{bg} + k_m s_m}{k + k_{bg} + k_m} > \frac{(d_b + \hat{q}_b) + d_g)}{2}\}. \quad (4)$$

Note that as $\hat{q}_b$ varies, the bride affects not only the payoff if her dowry offer is accepted but also the probability that her offer is accepted by the mediator.

We now wish to demonstrate that the bride's payoff $E[u_b(\hat{q}_b)]$ is maximized when $\hat{q}_b=0$. To this end, let $h(\hat{q}_b)$ denote the first probability in equation (4) above. Then, it is clear that

$$\frac{\partial E[u_b(\hat{q}_b)]}{\partial \hat{q}_b} = -h(\hat{q}_b) - (d_b + \hat{q}_b)h'(\hat{q}_b) + d_g h'(\hat{q}_b). \tag{5}$$

From equation (5) we deduce that $\hat{q}_b=0$ satisfies the first order necessary conditions for a maximum as long as $h(0)=(d_g-d_b)h'(0)$. Now, to see that this equality does in fact hold, we have to study the $h(\cdot)$ function in greater detail.

Equation (4), the definition of the $h(\cdot)$ function, and several steps of algebra together tell us that

$$h(q)=Prob\{\frac{k\mu + k_{bg}(s_{bg} + \frac{k+k_{bg}}{2}q) + k_m s_m}{k+k_{bg}+k_m} \leq \frac{k\mu + k_{bg}s_{bg}}{k+k_{bg}} + \frac{q}{2}\} = Prob\{s_m \leq \frac{k\mu + k_{bg}s_{bg}}{k+k_{bg}} + \frac{q}{2}\}. \tag{6}$$

The probability on the extreme right-hand-side (RHS) of equation (6) can be expressed as the conditional cumulative distribution function of s_m given s_{bg}. Let us denote this function by $G(\cdot)$. Then we have

$$Prob\{s_m \leq \frac{k\mu + k_{bg}s_{bg}}{k+k_{bg}} + \frac{q}{2}\} = G_{s_m/s_{bg}}(\frac{k\mu + k_{bg}s_{bg}}{k+k_{bg}} + \frac{q}{2}). \tag{7}$$

From the standard regression formula it follows that given s_{bg}, the mediator's signal s_m is normally distributed with mean $(k\mu + k_{bg}s_{bg})/(k+k_{bg})$ and precision k_m. Using the above pieces of information, we can tell that

$$h(0) = G_{s_m/s_{bg}}(\frac{k\mu + k_{bg}s_{bg}}{k+k_{bg}}) = \frac{1}{2} \text{ and } h'(0) = g_{s_m/s_{bg}}(\frac{k\mu + k_{bg}s_{bg}}{k+k_{bg}}) \cdot \frac{1}{2}. \tag{8}$$

Now, let us use the formula for the normal density function and the equality on the RHS of (8). This gives us

$$h'(0) = g_{s_m/s_{bg}}(\frac{k\mu + k_{bg}s_{bg}}{k+k_{bg}}) \cdot \frac{1}{2} = \frac{1}{\sqrt{2\pi\sigma^2}}\exp(-\frac{1}{2}\cdot 0^2) = \frac{1}{2}\sqrt{\frac{k_m}{2\pi}}. \tag{9}$$

In addition, using the definition of $d_g - d_b$ (from equation (1)) and the expressions for $h(0)$ and $h^{\prime}(0)$ from equations (8) and (9), we can see that the first order necessary condition for an optimum is satisfied. Finally, because $g^{\prime}(0)>0$ and $g^{\prime\prime}(0)=0$, the second order sufficiency conditions for a maximum are also satisfied and hence we conclude that the bride is certainly responding optimally to the behavior of the groom and the mediator.

Computations similar to those we have undertaken in this section tell us that the groom's dowry offer in (1) is also a best response. Therefore, equations (1)-(2) do, in fact, describe a separating perfect Bayesian equilibrium of the dowry determination game that we have been analyzing thus far.

3.3. Discussion

A central finding in Batabyal (2005) is that when there is no learning by the mediator, the equilibrium dowry offers made by the bride and the groom—see equation (11) in that paper—are centered around the mean of the mediator's preferred dowry amount. The corresponding and more general central finding in our paper is that when there is learning by the mediator, the equilibrium dowry offers made by the bride and the groom—see equation (1)—are centered around the mean of the conditional distribution of the mediator's signal s_m given the signal s_{bg} received by the bride and the groom.

Second, in Batabyal (2005), the difference between the two equilibrium dowry offers is fundamentally a function of the bride and the groom's uncertainty about the mediator's preferred dowry amount. Specifically, as this uncertainty increased (decreased), the difference between the two equilibrium dowry offers also increased (decreased). A corresponding result holds in our paper as well. Recall that the precision of a normally distributed random variable is the inverse of its variance. Keeping this in mind and then inspecting equation (1) it is straightforward to confirm that the difference between the two equilibrium dowry offers is essentially a function of the uncertainty ($1/k_m = \sigma_m^2$) about the mediator's signal. As this uncertainty increases (decreases), the difference between the two equilibrium dowry offers also increases (decreases).

In addition to the above two points, three additional points concerning the analysis undertaken in the present paper are worth stressing. First, in the separating perfect Bayesian equilibrium, the sum of the two dowry offers $d_b + d_g$ perfectly reveals the bride and the groom's signal s_{bg} to our mediator. Second, in equilibrium, the bride and the groom do not mislead the mediator with their dowry offers. This is because when these two parties balance the opportunity to affect the mediator's belief with the benefit from having a more assertive dowry offer accepted and the diminished likelihood that this more assertive offer will be accepted, they do not find it in their interest to mislead the mediator. Finally, when the mediator has nothing to learn, i.e., when k_m approaches infinity or when the bride and the groom have nothing to communicate to the mediator, i.e., when k_{bg} approaches zero, learning by our mediator plays no role in the analysis undertaken in this paper.

4. Conclusions

In this paper, we extended the analysis in Batabyal (2005) by studying the impact that learning—about the circumstances of a prospective marriage—by the mediator has on the tripartite interaction between the bride, the groom, and the mediator. Specifically, we first ascertained the optimal dowry offers from the bride and the groom in a separating perfect Bayesian equilibrium. Next, we showed that the mediator perfectly infers the private information of the bride and the groom from their dowry offers and that he then uses this information in part to select his preferred dowry offer.

The analysis in this paper can be extended in a number of directions and in what follows, we suggest two possible extensions. First, one could analyze the case in which the bride and the groom receive dissimilar signals about the random state variable α. Second, it would be useful to examine a scenario in which the mediator is able to commit to a particular decision rule before the bride and the groom submit their dowry offers. Studies that analyze these aspects of the problem will increase our understanding of the attributes of mediated dowry determination in arranged marriage settings.

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