Can Population Growth Cause Dowry Inflation? Theory and the Indian Evidence*

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ABSTRACT

The empirical evidence on the role of a demographic marriage squeeze in the Indian dowry inflation of the last century has been mixed. Moreover, Anderson (2005) argues in a theoretical setting, that a population growth-led marriage squeeze must cause dowry *deflation* if the spousal age gap is to narrow over time. In this paper, I show that the apparently contradictory findings of the economic literature are perfectly consistent with each other. I demonstrate, using Anderson's theoretical framework, that a demographic squeeze may lead to higher dowries in the periods of the squeeze compared with periods of no squeeze. Furthermore, I show that data drawn from such a dowry path can replicate the results obtained in the empirical literature on the Indian dowry inflation. I conclude that a demographic marriage squeeze remains a plausible explanation for the Indian dowry inflation.

Keywords: Dowry; Marriage squeeze; Population growth
JEL classifications: J11; J12; J16; D10

1. Introduction

The practice of transfer of goods and services at marriage has been observed in many traditional societies. When the transfers made are from the bride to the groom they are referred to as 'dowry', while the reverse transaction is called 'bride price'. In India, both dowry and bride price have been practised, often concomitantly, in different parts of the country, with the north typically paying dowry and the south bride price.

In the latter half of the last century, a sharp rise in dowries was observed in north India and several regions of the south were observed to switch from bride price to dowry (Epstein (1973), Billig (1991, 1992), Rao (1993)). A popular explanation for this dowry inflation is the 'marriage squeeze' hypothesis, (Bhat and Halli (1999), Billig (1991, 1992), Caldwell et al (1982, 1983), Epstein (1973), Rao (1993)) which attributes the phenomenon to population growth. The argument runs as follows: a higher rate of population growth leads to larger numbers of younger relative to older cohorts in the population. When older men marry younger women (as in India), this leads to an excess supply of brides in the marriage market, causing a bidding up of the price of grooms, viz. dowry inflation. The Indian population started to grow in the 1930s and the dowry inflation was observed to begin around the 1950s, which is about the time the babies of the 'boom' reached marriageable age. This makes the marriage squeeze hypothesis a plausible explanation for dowry inflation in India.

How does the empirical evidence comport with this hypothesis? I focus on two distinct, albeit related, correlations within the empirical literature, which I call the 'time effect' and the 'squeeze effect'. These are, respectively, the correlation between dowries paid and year of marriage, and the correlation between dowries paid and the ratio of women to men at their ideal ages of marriage (which is an indicator of the strength of the marriage squeeze).

Rao (1993) finds a significant positive association between the marriage squeeze indicator and dowries[1]. Rao also finds a positive (but insignificant) association between dowries and the year of marriage, affirming the view that a dowry inflation had occurred in the period between the 1920s and 1970s (the range of years of marriage in his data). Thus Rao finds a positive squeeze effect as well as a positive time effect. Edlund (2000) repeats Rao's analysis using the same data but fails

[1]Each of the analyses - Rao (1993), Edlund (2000) and Dalmia and Lawrence (2005) - run linear regressions of net dowry payments on the marriage squeeze indicator, year of marriage and a set of other controls such as the characteristics of brides, grooms and their families.

to reproduce his results. Although she finds a positive association between the marriage squeeze indicator and dowries, this is no longer significant in her analysis. However, she too finds a positive (insignificant) association between dowries and the year of marriage.

Dalmia and Lawrence (2005) conduct a similar analysis to Rao's but using a different dataset. They find a positive but insignificant association between the marriage squeeze indicator and dowries for the all-India regression. However, their analysis shows a significantly *negative* association between the year of marriage and dowries over the period between the 1950s and 1990s (the range of years of marriage in their data), which seems to contradict the fact of the dowry inflation in India.

It would appear, therefore, that the empirical evidence for the marriage squeeze hypothesis is mixed at best. While the time effect (the association between dowries and the year of marriage) is positive in two of the studies cited above, it is significantly negative in the third. Also, while each of these studies finds a positive squeeze effect (the association between dowries and the marriage squeeze indicator), the effect is not always significant.

Furthermore, in a recent paper, Anderson (2005) argues, using a theoretical framework, that a demographic marriage squeeze *cannot* cause dowry inflation. She demonstrates that if, following the onset of a marriage squeeze, the age gap between spouses narrows and all women continue to marry (as has been observed in India and many other societies), then dowries must decline over time, and a dowry *deflation* has to occur in the periods of the squeeze. In other words, Anderson's model implies a negative time effect during the periods of the squeeze.

Anderson's result, coupled with the inconclusive findings of the empirical literature, suggest that a demographic marriage squeeze cannot be a potential explanation for dowry inflation. I argue here that this is not the case.

In this paper, I present a unified interpretation that explains the apparently contradictory findings in the literature in a single consistent setting. I demonstrate that Anderson's (2005) theoretical model is consistent with both the positive time effect found by Rao (1993) and Edlund (2000) and the negative time effect found by Dalmia and Lawrence (2005); it is also consistent with the positive squeeze effect found in all three empirical studies. Since the only shock to the marriage market in the theoretical model comes from population growth, I conclude that a demographic marriage squeeze remains a plausible explanation for dowry inflation in India.

I begin by constructing a numerical example that uses Anderson's two-sided matching framework to show that dowries can rise from their initial steady state level *in the first period of the marriage squeeze*. Although dowries must then decline over time – the negative time effect highlighted by Anderson – these subsequent payments could still be higher, *in every period of the squeeze*, than the payments that prevailed in the initial steady state equilibrium with zero population growth. Thus population growth *can in theory* lead to higher dowries, even within Anderson's framework. Figure 1 depicts the dowry path for this numerical example.

The jump in dowries in the first period of the squeeze follows from the fact that old women appropriate a lower utility from marriage than do young women in the initial steady state equilibrium, because the ideal age of marriage for women is 'young'. The onset of the marriage squeeze forces women to postpone marriage and accept a lower utility level as an older bride, thereby causing dowries to be bid up in the first period of the squeeze. I show that a low outside option of marriage of women and a high ideal age gap between spouses are sufficient to generate a dowry path similar to the one in my example.

Note, however, from Anderson's result and my example, that a one-period population growth cannot lead to a *persistent* rise in dowries over time. Is the dowry path exhibited in my example then inconsistent with the empirical evidence on dowry inflation as observed in India?

To answer this question, I use data simulated from my numerical example to run OLS regressions akin to Rao, Edlund and Dalmia and Lawrence. I demonstrate that the initial dowry hike (see Figure 1) may account for the positive (linear) association between dowries and year of marriage in Rao and Edlund, because in their data the years of marriage range from periods before the squeeze sets in to just after. Dalmia and Lawrence use data from later periods, so the negative association with year of marriage that they obtain is also perfectly consistent with the theory. This resolves the apparent inconsistency in the sign of the time effect obtained by different researchers.

Next, I show that in my simulated data, the ratio of women to men at the ideal age of marriage declines over the periods of the squeeze. Since marriage payments also decline over the periods of the squeeze (as shown by Anderson and demonstrated by my example), dowries are highest when the squeeze (as per this ratio) is strongest. This suggests a positive association between dowries and the squeeze indicator used in the empirical literature – a positive squeeze effect – which again matches the empirical evidence.

Recall that the simulated data stem from a theoretical example where the only shock to the marriage market is population growth. Within the framework of this example I am able to replicate the seemingly contradictory empirical results of Rao, Edlund and Dalmia and Lawrence – positive and negative time effects, and positive squeeze effects. This demonstrates that a population growth-led marriage squeeze could indeed be an explanation for the dowry inflation observed in India.

2. The Model

This section outlines Anderson's theoretical structure. It is a brief reproduction of Section 2 in Anderson (2005).

Time is discrete and an equal number, N, of males and females are born in each period. Women prefer to marry at age b and men at age g, where $b < g$. Agents marry either at the desirable ages (b, g) or later. Let a_b (a_g) denote the number of years beyond the ideal age of marriage that the bride (groom) actually marries. The costs associated with delaying marriage beyond the ideal age are represented by $c(a_b)$ and $k(a_g)$, which are increasing and convex. Marriages are monogamous and there is full information and costless search in the marriage market. Dowry payments, d, are made from the bride to the groom – these are derived endogenously and vary by agents' respective ages at marriage, a_b and a_g, and potentially also by the time period of marriage. Let the dowry payment made in period t by a woman of age a_b to a man of age a_g be represented by $d(a_b, a_g, t)$.

Assume, for simplicity, that all benefits and costs of marriage occur in one period only and that individuals do not discount the future. Consider the following quasilinear specification of utility of a bride:

$$U(a_b, a_g, t) = -d(a_b, a_g, t) - m(a_g) - c(a_b) \tag{u1}$$

where the disutility from marrying an older groom is represented by $m(a_g)$. This cost is also increasing and convex. Costs are normalized so that $m(0) = c(0) = 0$.

Similarly, a groom's utility from marrying is

$$V(a_b, a_g, t) = d(a_b, a_g, t) - k(a_g) - q(a_b) \tag{u2}$$

where the disutility from marrying an older bride is represented by $q(a_b)$ which is also convex. Here too, costs are normalized such that $k(0) = q(0) = 0$.

If unable to find a partner, women obtain a utility of $\overline{U}$ and men, $\overline{V}$. These are the outside options of marriage to women and men, respectively.[2]

[2] Note the distinction between 'reservation utility' and 'outside option of marriage'. The

2.1. Marriage Market

Marriage market equilibrium requires the satisfaction of three conditions:

1. Feasibility of a match (a_b^*, a_g^*) :[3]

$$-d(a_b^*, a_g^*, t) - m(a_g^*) - c(a_b^*) \geq \overline{U} \; for \; brides \qquad (m1.1)$$

$$d(a_b^*, a_g^*, t) - k(a_g^*) - q(a_b^*) \geq \overline{V} \; for \; grooms \qquad (m1.2)$$

   $for\ a_b^* \geq 0,\ a_g^* \geq 0\ and\ -\infty < t < \infty$

2. Stability of a match (a_b^*, a_g^*) :

$$-d(a_b^*, a_g^*, t) - m(a_g^*) - c(a_b^*) \geq -d(a_b, a_g, t + a_b - a_b^*) - m(a_g) - c(a_b), \qquad (m2.1)$$

$$for\ brides$$

$$d(a_b^*, a_g^*, t) - k(a_g^*) - q(a_b^*) \geq d(a_b, a_g, t + a_g - a_g^*) - k(a_g) - q(a_b), \qquad (m2.2)$$

$$for\ grooms$$

   $for\ all\ a_b \neq a_b^*,\ a_g \neq a_g^*,\ where\ a_b^* \geq 0,\ a_g^* \geq 0, a_b \geq 0, a_g \geq 0\ and\ -\infty < t < \infty$

3. Market Clearing:

$$S(a_g^*, t) = S(a_b^*, t) \qquad (m3)$$

   $for\ a_b^* \geq 0,\ a_g^* \geq 0\ and\ -\infty < t < \infty$, where $S(a_m, t)$ denotes the supply of individuals of age a_m $(m = b, g)$ in the marriage market in period t.

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former is the lifetime utility that agents are guaranteed if they do not marry at a certain age, say x. The outside option is the utility obtained from never marrying. The two are equal only when agents may not find a partner upon postponing marriage beyond age x. The marital surplus refers to the difference between marital utility and the *outside option* of marriage (see footnote 3).

[3] The marital surplus of women is, therefore, $[-d(a_b^*, a_g^*, t) - m(a_g^*) - c(a_b^*) - \overline{U}]$ and of men, $[d(a_b^*, a_g^*, t) - k(a_g^*) - q(a_b^*) - \overline{V}]$.

2.2. Population Growth

Assume that there is a one-shot population growth in period 0 in which γN males and females are born $(1 < \gamma < 2)$. From period 1 onwards the birth rate reverts once again to N boys and girls in each period.

In period b, there will be more women (γN) than men (N) in the marriage market, hence some women of the ideal age b must postpone marriage. If all these women eventually find a partner – i.e. if there is continuing universality of marriage – then the spousal age gap will narrow over time. Alternatively, the age gap will remain the same but the number of single women in the population will be observed to rise. This paper shall focus on the former case of universal marriage and narrowing spousal age gap, since this fits the empirical evidence on India.

3. Example: Population growth and dowry inflation

This section outlines an example in which population growth leads to dowry inflation *and* a narrowing of the spousal age gap. Consider the following functional forms consistent with the model assumptions made above:

$$\begin{aligned} m(a_m) &= 15a_m^2 \\ k(a_m) &= 15a_m^2 \\ c(a_m) &= 3a_m^2 \\ q(a_m) &= 3a_m^2 \\ \overline{U} &= -15 \\ \overline{V} &= -5 \\ g &= b+2 \end{aligned} \tag{A}$$

Since we are interested in the empirically observed case where all agents eventually marry and the spousal age gap narrows over time, I shall assume that older women are matched first when men are indifferent to the age of spouse. Also, when there are multiple equilibria in payments, I shall assume that each of these payments is equally likely. That is, dowries follow a uniform distribution, viz. $d(a_b, a_g, t) \sim U[l, u]$ where l and u denote the lower and upper limits of the dowry payments, determined by the reservation utilities of agents. Finally, I shall assume that agents are informed of population dynamics only through their observation of the marriage market. For example, if there is a one-shot population growth in period t, agents learn of it in period $(t + b)$ when its impact on the marriage market is first manifested.[4]

Then the following claims are true for the example cited above:[5]

Claim 1. *Grooms must marry at age* 0*. Brides may marry at age* 0 *or* 1*.*

Claim 1 follows from the the fact that the participation constraints of *both* brides and grooms are not satisfied except at $a_g = 0$ and $a_b = 0$ or 1. Henceforth, I shall refer to women of age $a_b = 0$ as 'young' and those of age $a_b = 1$ as 'older' women. Clearly, the ideal age of marriage for women is 'young'.

Claim 2. *Suppose the population and marriage market are in a steady state equilibrium with zero population growth (i.e.* N *boys and girls are born in every period) and identical expected dowry payments over time, viz.* $Ed(a_b, a_g, t) = Ed(a_b, a_g, t + 1)$*. Then women prefer marriage at age* 0 *to marriage at age* 1*.*

Claim 2 follows from two facts. First, women value marriage more, ceteris paribus, when they marry at the ideal age. Second, when age-specific (expected) dowry payments are the same over time, women expect to pay a higher dowry if they postpone marriage beyond the ideal age, since men prefer young to older brides. Hence, in a steady state equilibrium with no population growth and constant dowries, women (and men) marry at the ideal age.

Claim 3. *Suppose that the population is initially in a steady state equilibrium with zero population growth* (N *boys and girls are born in every period) and constant expected dowries. Let a one-time population growth occur in period* 0*, i.e.* γN *boys and girls are born in period* 0 $(1 < \gamma < 2)$ *and* N *boys and girls are born in periods* $t > 0$*. Then dowry payments will be higher in period* b *than in periods* $t < b$*. Dowry payments will decline in the periods of the marriage squeeze, viz.* $b \leq t \leq (g - 1)$*, but are higher in these periods than prior to* b*.*

To understand the intuition of Claim 3, consider the composition of the marriage market in different periods, when all agents find a partner in their lifetime and the spousal age gap narrows over time, . Let $f_i^t(m_j^t)$ denote the number of unmarried women (men) of age $a_b = i$ $(a_g = j)$ in any period t. Then the marriage market structure is as follows:[6]

[4] Recall that it is in period $(t + b)$ that the baby girls of the population 'boom' enter the marriage market in search of a partner. Boys of the 'boom' generation do not enter the market till period $(t + g)$, hence the marriage squeeze extends from periods $(t + b)$ to $(t + g - 1)$.

[5] Proofs are provided in Appendix A.

[6] Recall that older women are matched first when men are indifferent to the age of spouse.

Table A

$Time\ (t)$	f_0^t	f_1^t	m_0^t	$Market\ Structure$
$t < b$	N	0	N	$f_0^t = m_0^t;\ f_1^t = 0$
b	γN	0	N	$f_0^t > m_0^t;\ f_1^t = 0$
$b + 1 = g - 1$	N	$\gamma N - N$	N	$f_1^t < m_0^t < f_1^t + f_0^t$
g	N	$\gamma N - N$	γN	$m_0^t = f_1^t + f_0^t$
$t \geq g + 1$	N	0	N	$f_0^t = m_0^t;\ f_1^t = 0$

The marriage squeeze operates in periods b to $(g - 1)$ when there are more women than men in the market.

What are the equilibrium marriage payments corresponding to the marriage market structure described in Table A? In the steady state equilibrium with zero population growth, the number of ideal brides and grooms is exactly equal. Since there is one groom for every bride there may be multiple payments consistent with such an equilibrium, but women will extract a positive surplus from marriage even at the maximum feasible dowry payment. This is because at the maximum dowry that women are willing to pay, they receive the expected utility from postponing marriage to the next period. The women in the market, being of the ideal age b, know that they can find a partner if they postpone marriage by a period[7]. Hence even at the maximum dowry, they are not reduced to their outside option of never finding a partner and appropriate a positive post-payments marital surplus.

A backward induction approach demonstrates how equilibrium payments are determined in the periods of the squeeze, $b \leq t \leq (g - 1)$. Notice that in period g, the number of women and men in the market are exactly equal. Hence there will again be multiple payments in this period, with the limits determined by the reservation utilities of agents. Since there are both young and older women in the marriage market in this period, they may both be reduced to their reservation utility. Moreover, since older women may not find a match in the next period of their lives, their reservation utility is equal to the outside option of marriage.

Consider the marriage market in the previous period $(g - 1)$. Competition for a spouse in this period will ensure that the marital utility of young women is

The marriage market structure in Table A has been formulated assuming that this is true.

[7] Note that women of age $(b+1)$ must be able to find partners (at appropriate payments), else the marriage squeeze could not have been accompanied by a narrowing of the spousal age gap. This is ensured by the assumption that older women are matched first when men are indifferent to the age of the bride.

equal to the expected utility of older women in period g. In other words, young women in period $(g-1)$ must bid up dowries to the point that they receive the expected marital utility of older women in period g.

Compare now the expected marital utilities of young women in period $(g-1)$ and of those in periods $t < b$. In the steady state equilibrium $(t < b)$, young women were guaranteed a marital utility greater than the outside option, even at the maximum feasible dowry payments. Note also that the maximum feasible payments – hence, the minimum marital utility of young women – were driven by the disutility of postponing marriage to age $a_b = 1$, viz. -3 (see $(u1)$ and (A)). In period $(g-1)$, however, young women foresee the possibility of being compelled to postpone marriage and be reduced to the outside option in the next period. Since the outside option of marriage is far less than the (dis)utility of marrying at $a_b = 1$, (recall $\overline{U} = -15$), the expected utility of young women in $(g-1)$ is lower and they pay a higher dowry than do women in the steady state equilibrium[8].

By Anderson's argument, however, dowry payments must decline over the periods of the squeeze, from b to $(g-1)$. This is because the young women who postpone marriage in any period of the squeeze t_s value it less in the next period due to their having passed the 'ideal' age of marriage. Hence they should be willing to pay less for a groom in period (t_s+1) than as young women in period t_s. Since men prefer young women, the young women in period (t_s+1) must pay even less than older women in this period in order to secure a match. But this clearly means that young women in period (t_s+1) pay less dowry than did young women in period t_s.

Anderson's argument implies that in the current example, the dowry paid by young women is even higher in the periods of the squeeze before $(g-1)$ than in this period. Hence, the dowry in each period of the squeeze is higher than those paid in the initial steady state equilibrium.

Thus an anticipation of lower marital utility in a future period (on account of being compelled to postpone marriage beyond the ideal age) can raise the dowry paid in periods of the squeeze, compared with those that prevailed before.

Table B lists the values of equilibrium dowries for this example in particular. These are also plotted in Figure 1.

[8] Recall that when there are multiple equilibria, the lower limit of payments is determined by the outside option of grooms, since they may only marry at the age g. Therefore the expected dowry (and hence, the expected marital utility of women) depends on the upper limit of payments, determined by the reservation utility of the bride. E.g. the expected dowry is higher (expected marital utility of women is lower) when the reservation utility of the bride is lower.

Table B

Time (t)	*Min* $d(0,0,t)$	*Max* $d(0,0,t)$	$Ed(0,0,t)$
$t < b$	-5	7	1
b	14	14	14
$b+1 = g-1$	8	8	8
g	-5	7	1
$t \geq g+1$	-5	7	1

Notice that after an initial jump in the first period of the squeeze, dowries decline over time in subsequent periods of the squeeze. Anderson focuses on this 'negative time effect' to conclude that a demographic marriage squeeze cannot be responsible for dowry inflation. But this conclusion is incomplete. To correctly resolve the issue of whether a population growth-led marriage squeeze can cause dowry inflation, we need to ask two questions. First, can population growth lead to a marriage squeeze (defined as the phenomenon of there being more potential brides than grooms in the marriage market)? And second, can a marriage squeeze lead to higher dowries? In other words, we need to focus on the squeeze effect, not the time effect in the periods of the squeeze.

It is clear that in the dowry path exhibited above, the answer to both of these questions is 'yes'. The only shock to the marriage market in this example is a one-shot population growth, and this leads to there being more brides than grooms in the market; hence population growth *can* lead to a marriage squeeze. And the dowries paid in those periods when there are more brides than grooms in the market are higher than those paid when there are equal numbers of brides and grooms; hence a marriage squeeze *can* lead to higher dowries. Thus, even though dowries decline over time after the onset of the squeeze (the negative time effect), they may still be higher in those periods than in the initial steady state equilibrium with zero population growth (a positive squeeze effect).

The above example demonstrates that population growth can lead to a narrowing of the spousal age gap, continuing universality of female marriage and higher dowries in the periods of a population-growth-led marriage squeeze. Hence the marriage squeeze hypothesis remains a plausible theoretical explanation for dowry inflation.

There remains the question of whether this theoretical explanation fits the empirical evidence. Specifically, Anderson's model and my example both indicate that population growth cannot lead to *persistent* dowry inflation over time. Is the model then inconsistent with the Indian data? I return to this question in a later section.

4. Sufficient Conditions for Dowry Inflation

Under what conditions will a dowry path like that in Figure 1 be observed? In this section, I show that a low outside option of marriage for women and a high ideal age gap of spouses are sufficient to cause higher dowries in periods of the squeeze compared with periods of no squeeze.

Suppose there is a one-shot population growth as assumed by Anderson. To be consistent with the empirical observation of declining spousal age gaps and universality of marriage, I focus on paths that guarantee the same. I shall, therefore, continue to assume that older women are matched first when men are indifferent to the age of the bride. Also, as before, I assume that when there are multiple equilibria, payments follow a uniform distribution over the feasible range and that the population and marriage market is in an initial steady state equilibrium with zero population growth. Lastly, I shall assume, that men may marry at age $a_g = 0$ and that women may marry at age $a_b = 0$ or 1.

Before presenting the sufficient conditions for a squeeze-led dowry inflation, I shall outline the various forms of inflation that may occur. These are presented in Definition 1.

Definition 1. *Suppose that the population and marriage market are in a steady state equilibrium with zero population growth. Consider a one-shot population growth in period* 0*. Dowry inflation in the periods of the squeeze* t_s $(b \leq t_s \leq g-1)$ *can take the following forms:*

1. *Dowries in each period of the squeeze are higher than the maximum dowry in the initial steady state equilibrium, i.e.* $d(0,0,t_s) > Max\ d(0,0,t < b)$ *for all* t_s
2. *The dowry in the first period of the squeeze* (b) *is higher than the maximum dowry in the initial steady state equilibrium,*

   i.e. $d(0,0,b) > Max\ d(0,0,t < b)$ *for all* t_s
3. *Dowries in each period of the squeeze are higher than the expected dowry in the initial steady state equilibrium, i.e.* $d(0,0,t_s) > Ed(0,0,t < b)$ *for all* t_s

Note that dowry inflation of type 1 is a sufficient condition for dowry inflation of types 2 and 3. Hence, type 1 is the most stringent variety of dowry inflation. The example presented in the previous section demonstrates dowry inflation of type 1.

In the propositions that follow, I shall outline sufficient conditions for the different forms of dowry inflation defined above.

Lemma 1 provides a necessary condition for the existence of a path in which all women find a partner in their lifetime[9].

Lemma 1. *Suppose that men may marry at age* $a_g = 0$ *and women at age* $a_b = 0$ *or* 1*. Consider a one-shot population growth in period* 0*. A necessary condition for all agents to continue to marry in the periods* t_s *of the marriage squeeze* $b \leq t_s < g$*, is that*

$$d(0,0,b) = \frac{\overline{V} - \overline{U} + (2g - 2b - 1)[q(1) + c(1)]}{2} \leq -\overline{U} \qquad (p1)$$

This is the participation constraint of young women in the first period, b*, of the marriage squeeze.*

Lemma 1 follows from the fact that on any payments path that guarantees universality of marriage, the composition of the marriage market in each period must be as given in Table A. The only payments path that is consistent with this composition of the marriage market is the one that is derived by backward induction using the equilibrium payments that must exist in period g. For this path to be feasible however, the highest possible dowry payment - in the first period of the squeeze, b - must be feasible. Condition $(p1)$ in Lemma 1 states the participation constraint of women - which ensures the feasibility of the equilibrium dowry payments - in period b.

Propositions 1 and 2 outline sufficient conditions for dowry inflation when a one-shot population growth (in period 0) is accompanied by a narrowing of spousal age gap and continuing universality of marriage[10].

Proposition 1. *Suppose that men may marry at age* $a_m = 0$ *and women at age* $a_b = 0$ *or* 1*. Suppose that* $(p1)$ *holds. Let* t_s *denote the periods of the marriage squeeze,* $b \leq t_s < g$*. Then the following statements are true:*

[9] See proof in Appendix B.

[10] See proofs in Appendix C and D respectively.

1. *If the ideal age gap is greater than 2, the dowry in each 'squeeze' period is higher than the maximum dowry in the initial steady state equilibrium, i.e.* $d(0,0,t_s) > Max\ d(0,0,t < b)$ *for all* t_s *if* $(g - b) > 2$.

2. *If the ideal age gap is 2, then the form of dowry inflation depends on whether* $(p1)$ *binds. In particular,*

    1. *if* $(p1)$ *does not bind, the dowry in each 'squeeze' period is higher than the maximum dowry in the initial steady state equilibrium, i.e.* $d(0,0,t_s) > Max\ d(0,0,t < b)$ *for all* t_s *if* $(g - b) = 2$ *and* $(p1)$ *does not bind*

    2. *if* $(p1)$ *binds, then*

        1. *the dowry in each 'squeeze' period is higher than the expected dowry in the initial steady state equilibrium, i.e.* $d(0,0,t_s) > Ed(0,0,t < b)$ *for all* t_s *if* $(g - b) = 2$ *and* $(p1)$ *binds; also,*

        2. *the dowry in the first 'squeeze' period* (b) *is higher than the maximum dowry in the initial steady state equilibrium, i.e.* $d(0,0,b) > Max\ d(0,0,t < b)$ *if* $(g - b) = 2$ *and* $(p1)$ *binds.*

3. *If the ideal age gap is less than 2, then the form of dowry inflation depends on whether* $(p1)$ *binds. In particular,*

    1. *if* $(p1)$ *does not bind, then the dowry in each 'squeeze' period is higher than the expected dowry in the initial steady state equilibrium, i.e.* $d(0,0,t_s) > Ed(0,0,t < b)$ *for all* t_s *if* $0 < (g - b) < 2$ *and* $(p1)$ *does not bind*

    2. *If* $(p1)$ *binds, there is no dowry inflation, because the dowry in each period of the squeeze is equal to the expected dowry in the initial steady state equilibrium, i.e.* $d(0,0,t_s) = Ed(0,0,t < b)$ *for all* t_s *if* $0 < (g - b) < 2$ *and* $(p1)$ *binds.*

Proposition 2 relaxes the assumption that women must marry by age $a_b = 1$.

Proposition 2. *Suppose that men may marry at age* $a_m = 0$ *and women at any age* $a_b \geq 0$. *Let* t_s *denote the periods of the marriage squeeze,* $b \leq t_s < g$. *Consider the path on which the spousal age gap narrows and there is universality of female marriage. Then the following statements are true:*

1. *The dowry in each period of the squeeze is higher than the expected dowry in the initial steady state equilibrium, i.e.* $d(0,0,t_s) > Ed(0,0,t < b)$ *for all* t_s

2. *If the cost of marrying a bride of age* $a_b > 1$ *is sufficiently high for both the bride and groom, then the dowry in each 'squeeze' period is higher than the maximum dowry in the initial steady state equilibrium, i.e.* $d(0,0,t_s) > Max\ d(0,0,t < b)$ *for all* t_s *if* $[q(a_m) + c(a_m)]$ *is 'sufficiently convex', i.e. if* $\frac{q(2)+c(2)}{q(1)+c(1)} > 3$

3. *If the ideal age gap is sufficiently high, then the dowry in the first period of the squeeze is higher than the maximum dowry in the initial steady state equilibrium, i.e.* $d(0,0,b) > Max\ d(0,0,t < b)$ *if* $(g - b) > 2.5 - \frac{q(2)+c(2)}{2[q(1)+c(1)]}$

Propositions 1 and 2 demonstrate that on a path that guarantees universality of female marriage, a low outside option of marriage for women, $\overline{U}$, and a high ideal age gap of spouses, $(g - b)$, are sufficient to cause higher dowries in the periods of the squeeze.

To see the intuition of the above, consider the necessary condition for universality of female marriage ($p1$). Notice that a low value of $\overline{U}$ guarantees the satisfaction of this condition because a low outside option of marriage ensures that women are willing to pay a high dowry rather than remain single. But a low value of $\overline{U}$ also lowers the reservation utility of old women in period g, and hence, by backward induction, lowers the expected utilities of young women in previous periods of the squeeze. This causes young women to bid higher dowries in those earlier periods of the squeeze.

If the difference in ideal ages of marriage of men and women is high, then the squeeze lasts for a longer stretch of time. Since dowries must decline over the periods of the squeeze, the longer the squeeze extends the higher must be the equilibrium dowry in the first period, b.[11] Hence, a low outside option from marriage and a high ideal age gap of spouses ensure that dowries are higher during the squeeze than in the initial steady state equilibrium, if all agents are to eventually find a partner in their lifetime.

[11] Recall that the equilibrium dowries in period g are determined by the reservation utilities of men and women. Hence the expected dowry in period g is independent of the length of the squeeze. Since dowries in previous periods are derived by backward induction, the longer the length of the squeeze, the higher the dowry in the first period, b.

When parameters are such that women may marry beyond age $a_b = 1$, the reservation utility of 'older' women ($a_b = 1$) in period g depends on the costs of marrying at the age $a_b = 2$. The higher these costs – $q(2)$ and $c(2)$ – relative to the utility from marrying at age $a_b = 1$ (governed by $q(1)$ and $c(1)$), the lower the reservation utility of older women and the higher the maximum and expected dowry paid by them in period g. Since the dowries in previous periods are derived by backward induction from the expected dowry in period g, high values of $q(2)$ and $c(2)$ relative to $q(1)$ and $c(1)$ also ensure that dowries are higher in the periods of the squeeze.

Therefore, a low outside option of marriage for women and a high ideal spousal age gap can ensure a squeeze-driven dowry inflation.

Interestingly, observations on the Indian marriage market have been quite consistent with the sufficient conditions outlined above. Rao points out that "in the Indian marriage market there are strong social and economic pressures for women to be married within an 'acceptable' age range... This is due both to a lack of job-market opportunities for women, as well as to an extreme drop in social status associated with having (or being) an older unmarried daughter." This suggests a low outside option of marriage of Indian women, i.e. a low $\overline{U}$. The age gap at marriage has also been relatively high in India compared with other countries. Bhat and Halli (1999) estimate the difference in singulate mean age of marriage of men and women in India to be 6.9 years in 1911; the gap declined to 5.4 years in 1951. Festy's (1973) estimation of the differences in mean age of marriage of men and women in Canada, USA, Australia and New Zealand in 1911-1915 are, respectively, 2.7, 2.8, 2.6 and 2.3 years. In 1936-1940, the estimates of the age gaps in these countries were, respectively, 2.5, 2.4, 3.6 and 3 years.

5. Theory versus Empirical Evidence

In the previous sections, I have shown that a one-period population growth can lead to a higher dowry in each period of the squeeze compared with periods of no squeeze. However, the dowry inflation is not persistent over time since dowry payments must decline once the squeeze sets in. Does this violate the evidence on the dowry inflation in India? Inconsistency of the theory with the evidence would indicate that while population growth *can* cause higher dowries in theory, it could not have been the reason for the dowry inflation as observed in India. In this section, therefore, I investigate if the dowry path demonstrated by the example in Section 2 is consistent with empirical evidence on dowries in India.

To do so, I attempt to test if data simulated from the example can replicate the findings in the empirical literature (Rao (1993), Edlund (2000), Dalmia and Lawrence (2005)).

In the ensuing analysis, I assume that there is a single period population growth in which $1.5N$ boys and girls are born, following which the initial birth rate of N boys and girls is reverted to. Also, all other assumptions made in previous sections hold. Table 1 presents the data generated from my example, under these assumptions. I use 14 time periods such that the squeeze begins in period 6, lasting till period 7. The marriage market composition presented in Table A and the assumed birth rates yields the ratio of women to men at ideal age in each period. In the empirical literature, this ratio has been used as an indicator of the marriage squeeze.

I use the above data – simulated from my example – to run OLS regressions of dowry payments on the marriage squeeze indicator and year of marriage. I run regressions separately for all 14 periods and also for the early periods ($t < 8$) and the later periods ($t > 4$). Henceforth, I shall refer to these regressions (that use simulated data) as 'theoretical' regressions. As I shall discuss in the following paragraphs, the early periods' theoretical regression (Table 2, column (13)) is akin to those run by Rao and Edlund whereas those using later years (Table 2, column (15)) is akin to that of Dalmia and Lawrence.

I use two measures of the marriage squeeze in my analysis. The first is an indicator variable for whether a particular time period is a period of squeeze. The second is the indicator used in the empirical literature – the ratio of women to men at the ideal age of marriage. The results of these theoretical regressions are presented in Table 2.

The first point to note in the results is that the coefficient on the indicator of the squeeze is positive in each theoretical regression, regardless of how the squeeze is measured – the positive 'squeeze effect'. This reflects the theoretical prediction that dowries are, on average, higher when the squeeze is stronger. As Figure 1 shows, dowries are indeed higher in each period that there is a squeeze than in each period that there is not (the first measure of the squeeze). Moreover, as the data in Table 1 demonstrates, the ratio of women and men at the ideal age of marriage is declining over the periods of the squeeze. Since dowries also decline over the periods of the squeeze, once again dowries are highest when the squeeze is strongest. In this sense, therefore, the squeeze can 'cause' dowry inflation.

How does the above finding line up with the empirical evidence? Table 3 presents the coefficients on the marriage squeeze indicator and year of marriage obtained by Rao, Edlund and Dalmia and Lawrence. The sign on the squeeze indicator is positive in all three studies, just as obtained in Table 2 (Panel 2). Hence, the effect of the squeeze predicted by the theoretical example does not contradict the evidence obtained from empirical studies.

The second important point to note in the theoretical regressions is that the sign of the coefficient on the year of marriage depends on which periods of the dowry path the data is drawn from. In the regressions using the early periods (Table 2, columns (4), (13)), dowries are increasing with year of marriage whereas in regressions of the later periods (Table 2, columns (7), (15)), they are decreasing. Both these effects are consistent with the results obtained in the empirical literature. In the data used by Rao and Edlund, the year of marriage ranges from the 1920s to the 1970s – the period before the squeeze hits to just after. They both obtain a positive association between year of marriage and dowries (as in Table 2, column (13)). In Dalmia and Lawrence's data, the years of marriage belong to the period after the squeeze has begun – the 1950s to the 1990s. As predicted by the theoretical regressions, they obtain a negative association between year of marriage and dowries (as in Table 2, column (15)).

Tables 2 and 3 demonstrate that the theoretical regressions can match the signs of coefficients in the regressions conducted in the empirical literature. Note, further, that dowry inflation of the least stringent type – type 3 (see Definition 1) – is sufficient to generate the results of the theoretical regressions presented here. The path presented in Figure 1 also demonstrates the more stringent form of dowry inflation, viz. type 1.

The analysis above underlines, once again, the important distinction between the 'squeeze' effect and the 'time' effect of population growth on dowries. In pointing to the dowry deflation that must occur after the squeeze has set in, Anderson highlights the 'time' effect, *controlling* for the squeeze. This is demonstrated by the negative coefficient on period of marriage when the first measure of the squeeze – the indicator for period of squeeze – is used (Table 2, Panel 1). But the time effect is not the whole story. In order to determine if a marriage *squeeze* can cause dowry inflation, it is necessary to focus on the effect on dowries of measures of the squeeze. The theoretical regressions make the clear distinction between these two effects and in doing so, also successfully predict the signs of the coefficients that have been obtained in the empirical literature.

Lastly, recall that in the data used in the theoretical regressions, the only shock to the marriage market is population growth and the associated squeeze. Hence, the fact that the results obtained in the empirical literature can be replicated using this data clearly indicates that population growth *can* have a role to play in the dowry inflation observed in India. A demographic marriage squeeze, therefore, remains a plausible explanation for the dowry inflation observed in India.

6. Summary and Conclusion

A population growth-led marriage squeeze has been a much-cited explanation for the Indian dowry inflation of the last century. However, empirical evidence on the role of the squeeze in the Indian dowry inflation has been mixed. Moreover, a recent theoretical paper by Anderson argues that there must be dowry *deflation* in the periods of the squeeze, if the empirically observed facts of narrowing spousal age gap and universality of marriage are to be ensured.

The combined findings of the theoretical and empirical literature on dowry inflation are puzzling and hard to reconcile with each other. In particular, they undermine the potential significance of the marriage squeeze hypothesis as an explanation for dowry inflation.

In this paper, I bring together the findings of the economic literature on the Indian dowry inflation to demonstrate that they are perfectly consistent with each other and with the marriage squeeze hypothesis. I show, using a numerical example based on Anderson's theoretical framework, that population growth *can in theory* lead to a narrowing of the age gap between spouses, universality of female marriage and higher dowries in the periods of the squeeze. I also demonstrate that a low outside option of marriage for women and a high ideal age gap between spouses are sufficient to generate a dowry path similar to that in my example. Finally, I use data simulated from this example to run regressions akin to those found in the empirical literature on the Indian dowry inflation. I show that the signs on regression coefficients obtained in the empirical literature can be replicated using the simulated data from the theoretical dowry path.

Since the only shock to the marriage market in the simulated data comes from population growth and the associated squeeze, the replicability of empirical results clearly indicates that the squeeze *can* have a role to play in dowry inflation, as observed in India. Hence, the marriage squeeze hypothesis remains a plausible explanation for the Indian dowry inflation of the twentieth century.

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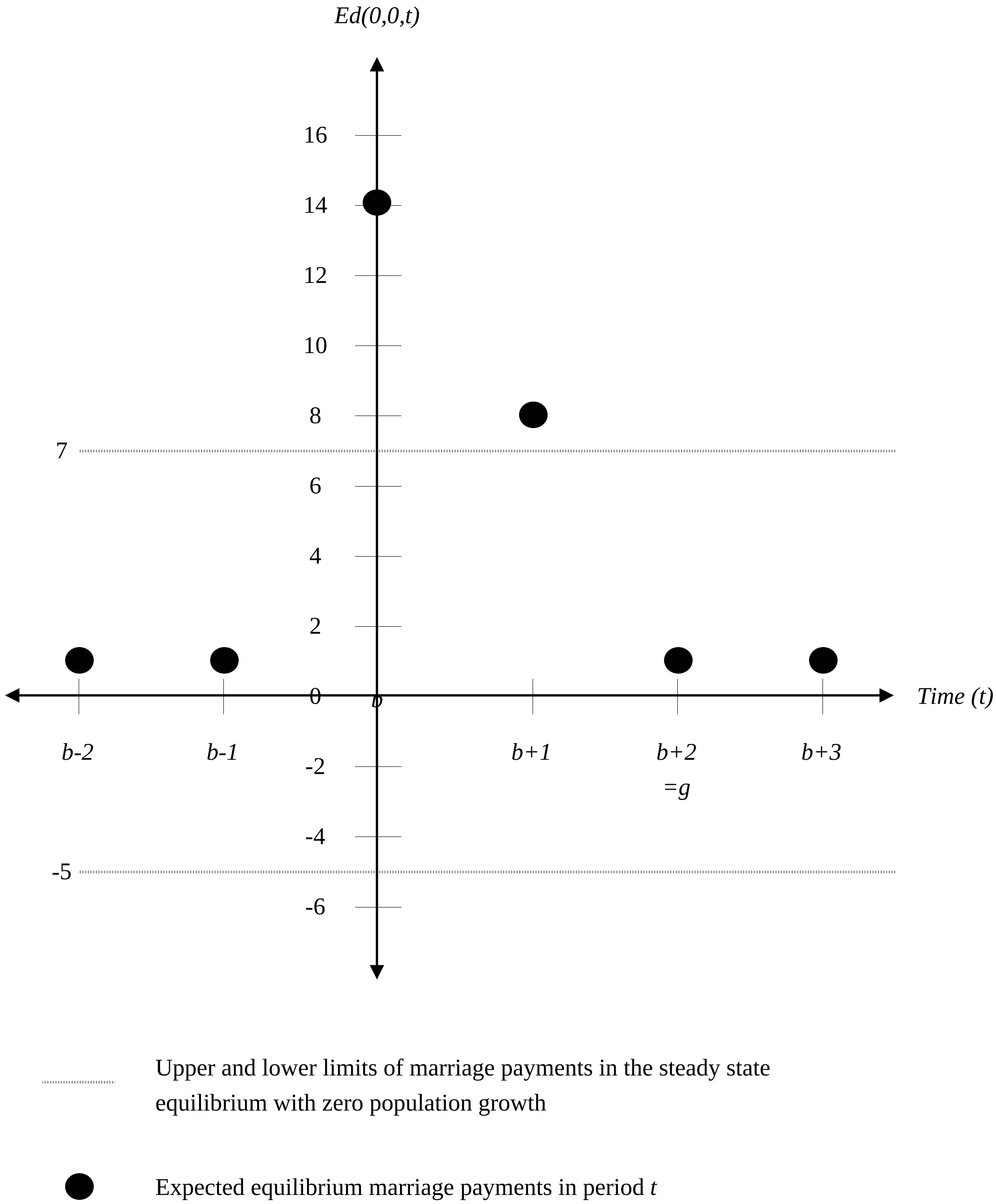
Figure 1: Equilibrium Path of Expected Marriage Payments, *Ed(0,0,t)*, over time [1]



[1]By assumption, dowry payments *d(0,0,t)* follow a uniform distribution *U[-5, 7]* when there may be multiple equilibrium payments, viz. in periods $t < b$ and $t > b+1$.

Note: The marriage squeeze against women operates in periods *b* and *(b+1)*.

Table 1: Data for Theoretical Regressions in Table 2

Period of Marriage (t)	Dowry[a]	If period of squeeze	(Women/Men) of Ideal Age[b]
1	1	0	1
2	1	0	1
3	1	0	1
4	1	0	1
5	1	0	1
6	14	1	1.5
7	8	1	1
8	1	0	0.666
9	1	0	1
10	1	0	1
11	1	0	1
12	1	0	1
13	1	0	1
14	1	0	1

[a] These are the expected dowries paid in marriages of men and women of the ideal age (see Table B and Figure 1)

[b] Computed, based on the assumption that there is a single period population growth in which the birth rate grows from N boys and girls to 1.5N boys and girls. (See Table A for the marriage market composition in each period.)

Table 2: 'Time' and 'Squeeze' Effects in Theoretical Regressions using Simulated Data from Table 1

Dependent Variable: Dowry on the Equilibrium Path

Panel 1: Measure of Squeeze: Indicator Variable for Period of Squeeze

	All t			Early t (t < 8)			Late t (t > 4)		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Period of marriage (t)	-0.101	-	-0.013	1.679	-	-0.286	-0.764	-	-0.05
If period of squeeze	-	10	9.984	-	10	11	-	10	9.813
Constant	3.187	1	1.102	-2.857	1	1.857	10.255	1	1.512
Observations	14	14	14	7	7	7	10	10	10
R-squared	0.01	0.9	0.91	0.49	0.89	0.89	0.27	0.9	0.9

Panel 2: Measure of Squeeze: Ratio of Women to Men at the Ideal Age of Marriage

	All t		Early t (t < 8)		Late t (t > 4)	
	(10)	(11)	(12)	(13)	(14)	(15)
Period of marriage (t)	-	-0.031	-	1	-	-0.531
(Women/Men) at ideal age	17.417	17.337	23.667	19	17.191	15.341
Constant	-15.195	-14.88	-21.5	-20.5	-14.476	-7.547
Observations	14	14	7	7	10	10
R-squared	0.58	0.58	0.75	0.89	0.6	0.72

Note 1: There is a single period population growth in which the birth rate grows from N boys and girls to 1.5N boys and girls.

Note 2: Column (13): akin to Rao (1993), Edlund (2000)

Note 3: Column (15): akin to Dalmia and Lawrence (2005)

Table 3: 'Time' and 'Squeeze' Effects in the Empirical Literature on Dowry Inflation in India

Dependent Variable: Net Dowry Transfer[a]

Measure of Squeeze: Ratio of Women to Men at Ideal Age of Marriage

	Early t (Mean ≈ 1954, SD ≈ 10)						Late t (Mean ≈ 1979, SD ≈ 9)
	Rao (1993)		Edlund (2000): Table 4[b]		Edlund (2000): Table 5[c]		Dalmia and Lawrence (2005): All India
Year of marriage (t)	-	281.16	-	288.33	-	552.65	-0.08
		(0.9)		(0.8)		(1.50)	(26.93)
(Women/Men) at ideal age	81,547.00	71,423.00	34,341.94	22,000.31	25,720.32	7062.73	0.16
	(2.5)	(2.1)	(1.5)	(0.8)	(1.1)	(0.3)	(0.56)
Observations	141	141	127	127	127	127	1037
R-squared	0.129	0.128	0.126	0.123	0.291	0.3	0.5264

t statistics in parentheses

[a] Rao and Edlund use net dowry transfer in constant 1984 rupees, Dalmia and Lawrence use net dowry transfer in constant 1994 rupees. All regressions have controls for characteristics of the bride, groom and their families. Other controls used are location, labor force participation ratio, distance of marriage migration etc.

[b] Replication of Rao's results, using difference in the bride's and the groom's traits as controls (see Edlund (2000), pp.1331)

[c] Traits of the bride and groom are included individually in the controls (see Edlund (2000), pp. 1332-33)

APPENDICES

A. Example

A.1. Proof of Claim 1

Proof. For the participation constraint of brides and grooms (of age a_b and a_g respectively) to hold simultaneously, we require, (see $(m1.1)$ and $(m1.2)$)

$$k(a_g) + q(a_b) + \overline{V} \leq d(a_b, a_g, t) \leq -\overline{U} - m(a_g) - c(a_b)$$

a necessary condition for which is:

$$k(a_g) + m(a_g) + c(a_b) + q(a_b) \leq -(\overline{V} + \overline{U}) \qquad (A.1)$$

where $a_m \geq 0$ $(m = b, g)$.

Notice that a necessary condition for $(A.1)$ is that it be true at $a_b = 0$, since $c(.)$ and $q(.)$ are minimized at $a_b = 0$.

Consider $a_g = 1, a_b = 0$. At this value, $(A.1)$ is not satisfied since the left hand side is 30 and the right hand side is 20. Since the left hand side is increasing in a_g for $a_g > 0$, this means that $(A.1)$ is not satisfied for all $a_g \geq 1, a_b \geq 0$.

At $a_g = 0, a_b = 0$, $(A.1)$ is satisfied.

Hence, men may only find a willing partner when they are of age $a_g = 0$.

Since grooms must marry at age 0 (see previous claim), let us now consider matches in which grooms are of age 0.

At $a_b = 1, a_g = 0$, $(A.1)$ is satisfied since the left hand side is 6 and the right hand side is 20. This means that $(A.1)$ is true for $a_b = 0, 1$ $(a_g = 0)$ since the left hand side is increasing in a_b for $a_b \geq 0$.

At $a_b = 2, a_g = 0$, $(A.1)$ is not satisfied since the left hand side is 24 and the right hand side is 20. Hence $(A.1)$ is not true for $a_b \geq 2, a_g = 0$.

Hence women may marry at ages 0 or 1. ■

A.2. Proof of Claim 2

Proof.

$$\text{Expected lifetime utility from marrying at age } 0 = -Ed(0,0,t) - m(0) - c(0) \qquad (A.2)$$

$$\text{Expected lifetime utility from marrying at age } 1 = -Ed(1,0,t) - m(0) - c(1) \tag{A.3}$$

where $Ed(.)$ denotes expected dowry payments.

Suppose that women prefer to marry at age 1 in period $(t+1)$ than at age 0 in period t. Then, from $(A.2)$ and $(A.3)$, we have:

$$-Ed(0,0,t) - m(0) - c(0) < -Ed(1,0,t+1) - m(0) - c(1) \tag{A.4}$$

Also, men of age 0 must prefer to marry women of age 1 in $(t+1)$. This is true if:

$$-k(0) - q(0) + Ed(0,0,t+1) < -k(0) - q(1) + Ed(1,0,t+1) \tag{A.5}$$

Adding $(A.4)$ and $(A.5)$, we get:

$$Ed(0,0,t+1) - Ed(0,0,t) < -q(1) - c(1) \tag{A.5'}$$

At the intitial steady state equilibrium, $Ed(0,0,t+1) = Ed(0,0,t)$. Hence $(A.5')$ implies:

$$0 < -q(1) - c(1)$$

which is clearly not satisfied since $q(1) = 1 > 0$, $c(1) = 1 > 0$.

Hence, at the initial steady state equilibrium, women prefer to marry at $a_b = 0$. Men have to marry at age 0, since they cannot find partners at ages higher than 0. ■

A.3. Proof of Claim 3

Proof. I shall demonstrate this claim by using backward induction to compute the equilibrium marriage payments in each period. The payments are determined by the marriage market structure in each period, outlined in Table A.

First, I shall solve for the steady state equilibrium payments in $t < 0$ and $t \geq g+1$. Note that in these periods the number of men and women in the marriage market are perfectly matched. Hence there will be multiple equilibria in marriage payments since neither party has a credible threat point for marriage.

The stability conditions of women (see $(m2.1)$) yields:

$$d(0,0,t) \leq Ed(1,0,t+1) + c(1)$$

Conbined with the stability constraint of men $(m2.2)$, this becomes

$$d(0,0,t) \leq Ed(0,0,t+1) + q(1) + c(1) \tag{A.6}$$

From the participation constraint of men $(m1.2)$ we obtain

$$d(0,0,t) - k(0) - q(0) - \overline{V} \geq 0 \tag{A.7}$$

where $\overline{V} = -5$ is the outside option of marriage of men.
$(A.6)$ and $(A.7)$ yield the condition

$$\overline{V} \leq d(0,0,t) \leq Ed(0,0,t+1) + q(1) + c(1) \tag{A.8}$$

Note that since the number of men and women are exactly equal marriage payments may settle anywhere in this range. Suppose that each of these payments are equally likely, i.e. dowries follow a uniform distribution. Then we have

$$d(0,0,t) \sim U[\overline{V}, Ed(0,0,t+1) + q(1) + c(1)]$$

so the expected payments in each period t such that $t < b$ or $t \geq (g+1)$, are

$$Ed(0,0,t) = \frac{\overline{V} + Ed(0,0,t+1) + q(1) + c(1)}{2}$$

$$Ed(0,0,t) = Ed(0,0,t+1) = q(1) + c(1) + \overline{V} \tag{A.9}$$

In the case of the present example, we have (using $(A.8)$ and $(A.9)$):

$$\begin{aligned} Ed(0,0,t) &= Ed(0,0,t+1) = 1 \qquad (A.10) \\ -5 &\leq d(0,0,t) \leq 7 \end{aligned}$$

in periods t, $t < b$ or $t \geq (g+1)$.

Next I will determine the equilibrium payments in period g. In this period too, there may be multiple equilibria in marriage payments since the total number of men and women in the marriage market are equal.

Using the above analysis once again, the equilibrium dowries paid by young women is obtained to be

$$Ed(0,0,g) = q(1) + c(1) - 5 \tag{A.11}$$

The participation constraint of older women $(m1.1)$ and that of men marrying older women $(m1.2)$ yield the condition,

$$-5 + q(1) \leq d(1,0,g) \leq -c(1) + 15$$

Again, assuming $d(1,0,g) \sim U[-5 + q(1),\ -c(1) + 15]$ we get

$$Ed(1,0,g) = \frac{q(1) - c(1) + 10}{2} \qquad (A.12)$$

In the present example, therefore, we have

$$\begin{aligned} Ed(0,0,g) &= 1 \qquad (A.13) \\ -5 &\leq d(0,0,g) \leq 7 \\ Ed(1,0,g) &= 5 \\ -2 &\leq d(1,0,g) \leq 12 \end{aligned}$$

I shall now determine the equilibrium payments in period $(g-1) = (b+1)$. Using the stability constraint of young women $(m2.1)$ and $(A.12)$, we get

$$d(0,0,g-1) = \frac{q(1) + c(1) + 10}{2} \qquad (A.14)$$

Older women's payments are then (in order to satisfy the stability constraint of men):

$$d(1,0,g-1) = \frac{q(1) + c(1) + 10}{2} + q(1) \qquad (A.15)$$

In the present example, we have

$$\begin{aligned} d(0,0,g-1) &= 8 \qquad (A.16) \\ d(1,0,g-1) &= 11 \end{aligned}$$

Finally, I determine the equilibrium payments in period b.

Using the stability constraint $(m2.1)$ and $(A.14)$, young women's payments are determined by (recall $g = b + 2$),

$$d(0,0,b) = \frac{3q(1) + 3c(1) + 10}{2} \qquad (A.17)$$

In the present example this is

$$d(0,0,b) = 14 \tag{A.18}$$

Using $(A.10), (A.13), (A.16)$ and $(A.18)$, I can outline the dowry path in the present example:

	$Ed(0,0,t)$	$Ed(1,0,t)$	$Min\ d(0,0,t)$	$Max\ d(0,0,t)$
$t \leq b-1$	1	$*$	-5	7
$t = b$	14	$*$	14	14
$t = b+1 = g-1$	8	11	8	8
$t = g$	1	5	-5	7
$t \geq g+1$	1	$*$	-5	7

where $*$ denotes that there are no unmarried women of age $a_b = 1$ in the market in this period.

Therefore, when there is a one-time growth in the population in period 0, average dowries paid by young women rise in period b and subsequently decline in the periods of the marriage squeeze $b \leq t \leq (g-1)$. This is represented diagrammatically in Figure 1.1.

Also, the dowry paid in each period of the squeeze $(b \leq t \leq g-1)$ is higher than the steady state dowry levels. ■

B. Proof of Lemma 1

Proof. Suppose that men marry at age $a_g = 0$ and women at $a_b = 0$ or 1. Consider a one-shot population growth in period 0 in which the birth rate rises from N to γN $(1 < \gamma < 2)$.

If the spousal age gap is to narrow and all women continue to marry, then it must be the case that older women $(a_b = 1)$ are matched first in each period. This implies a unique marriage market structure, viz. that presented in Table A. The marriage payments on this path (derived by backward induction as in Appendix A) are given by:

$$d(0,0,g-k) = \frac{\overline{V} - \overline{U} + (2k-1)[q(1) + c(1)]}{2} \tag{B.I}$$

where $k \leq (g-b)$

A necessary condition for this dowry path to be feasible, is that the highest dowry on this path (in period b) is feasible. This implies, from $(B.I)$ and $(m1.1)$,

$$d(0,0,b) = \frac{\overline{V} - \overline{U} + (2g - 2b - 1)[q(1) + c(1)]}{2} \leq -\overline{U} \qquad (p1)$$

(putting $k = g - b$ in $(B.I)$). ■

C. Proof of Proposition 1

Proof. Applying the method of analysis presented in Appendix A, the dowries in the initial steady state equilibrium may be derived to be:

$$\begin{aligned} Ed(0,0,t &< b) = Ed(0,0,t+1) = q(1) + c(1) + \overline{V} \qquad (C.19) \\ Min\ d(0,0,t &< b) = \overline{V} \\ Max\ d(0,0,t &< b) = 2q(1) + 2c(1) + \overline{V} \end{aligned}$$

Also, $(B.I)$ in Appendix B derives the equilibrium dowry in each period of the squeeze:

$$d(0,0,g-k) = \frac{\overline{V} - \overline{U} + (2k - 1)[q(1) + c(1)]}{2} \qquad (B.I)$$

where $k \leq (g - b)$.

Suppose that $(p1)$ holds. $(p1)$ simplifies to

$$[2(g-b) - 1][q(1) + c(1)] \leq -(\overline{U} + \overline{V}), \qquad (p1')$$

which is a necessary condition for a dowry path on which the spousal age gap narrows and all women continue to find a partner.

Proposition 1 follows easily from proving the relation between $(C.19)$ (steady state dowries) and $(B.I)$ ('squeeze' dowries), implied by $(p1')$, for different ranges of $(g - b)$. ■

D. Proof of Proposition 2

Proof. Allowing women of age $a_b > 1$ to marry does not alter the dowries in the initial steady state equilibrium, given by $(C.19)$ in Appendix C.

As before I shall derive the equilibrium dowry path by backward induction from period g. Hence, consider the dowries of older women in period g.

The stability condition of older women $(m2.1)$ and the participation constraint of men $(m1.2)$ yield:

$$d(1,0,g) \sim U[\overline{V}+q(1), Ed(2,0,g+1)+c(2)-c(1)] \qquad (D.20)$$

The backward induction argument implies that the lower the expected dowry (paid by older women) in period g the lower will be the dowries in all previous periods of the squeeze. I shall focus on the minimum value of the expected dowry in period g so that the conditions I obtain for dowry inflation are sufficient conditions for the same. To derive this, consider the possible values of $Ed(2,0,g+1)$.

Participation constraints of men of age 0 and women of age 2 imply:

$$\overline{V}+q(2) \leq Ed(2,0,g+1) \leq -\overline{U}-c(2) \qquad (D.21)$$

Suppose that $Ed(2,0,g+1) = Min\ d(2,0,g+1) = \overline{V}+q(2)$, (from $(D.21)$). Then, from $(D.20)$

$$Ed(1,0,g) = \frac{2\overline{V}+q(2)+c(2)+q(1)-c(1)}{2} \qquad (D.22)$$

Therefore, in period $(g-1)$, we have (from $(m2.1)$):

$$d(0,0,g-1) = \overline{V} + \frac{q(1)+q(2)+c(1)+c(2)}{2} \qquad (D.23)$$

Using $(C.19)$ in Appendix C and $(D.23)$ above, it is easy to show that $d(0,0,g-1) > Ed(0,0,t<b)$ when:

$$q(1)+c(1) < q(2)+c(2) \qquad (i)$$

Since $q(.)$ and $c(.)$ are increasing funcions, (i) is true. Hence the dowry in period $(g-1)$ and (by Anderson's argument) in all previous periods of the squeeze are higher than the expected dowries in the initial steady state.

This proves Case 1 of Proposition 2.

By a similar analysis, once again using $(C.19)$ in Appendix C and $(D.23)$ above, it is possible to show that condition (ii) below is sufficient to ensure that $d(0,0,g-1) > Max\ d(0,0,t<b)$ (i.e. the dowry in period $(g-1)$ exceeds the maximum dowry in steady state).

$$\frac{q(2)+c(2)}{q(1)+c(1)} > 3 \qquad (ii)$$

Hence, by Anderson's argument, (ii) implies that dowries in all *previous* periods of the squeeze must also exceed the maximum dowry in steady state.

This proves Case 2 of Proposition 2.

To prove Case 3, consider the equilibrium dowry that must hold in the first period of the squeeze b. This is derived, by backward induction, to be

$$d(0,0,b) = \overline{V} + \frac{[2(g-b)-1)][q(1)+c(1)] + q(2) + c(2)}{2} \qquad (D.24)$$

Using $(C.19)$ in Appendix C and $(D.24)$ above, it is easy to show that $d(0,0,b) > Max\ d(0,0,t<b)$ when

$$(g-b) > 2.5 - \frac{q(2)+c(2)}{2[q(1)+c(1)]}$$

This proves Case 3 of Proposition 2. ■