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ABSTRACT

Old Money, the Nouveaux Riches and Brunhilde's Marriage Strategy*

A woman assessing the wealth of a potential husband may observe some, but not all, of his wealth. She may screen, leading to status consumption and wasteful gift giving. The screening activity is costly not only for the potential husband, but also for the woman, as it reduces the wealth of the man she may marry. A sound observable financial background ('old money') benefits the candidate but also the woman, and reduces wasteful status consumption spending. Also, aging and attractiveness of the woman affect the equilibrium conspicuous spending pattern.

JEL Classification: J12, D82

Keywords: marriage, screening, search, conspicuous consumption, status

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1 Introduction

Courting Mrs. or Mr. Right is often costly. In the epic poem 'The Song of the Nibelungs,' courtship rules are straightforward and simply announced by the courted lady named Brunhilde. She applies a screening mechanism: she will marry only a candidate who emerges victorious in a fight with her. Candidates who fail may pay with their life. Courtship rules may now be less violent, but courting is still costly. Qualities such as beauty, material wealth, earnings ability, and career prospects matter.[1] Some qualities are easily assessed, such as beauty and physical appearance. But the lifetime income that a man can bring into a marriage is, at least partially, private information.

Overcoming this information problem is costly. Candidates with high unobserved lifetime income potential may simply wait until this information problem unravels later in life. Bergstrom and Bagnoli (1993) argue that such a delay may turn courtship into a waiting game — in which the low-income potentials marry early. This approach has the drawback that prosperous candidates need to incur high waiting costs. Another prominent feature of courtship is conspicuous consumption that is at least partially wasteful, but may reveal information about income potential. A famous example is the engagement ring (Ng 1987), but a proof of income potential may also involve a Rolex watch, a Ferrari, a Hermès handbag, Cartier jewelry or other conspicuous consumption products which the candidate displays or gives to the person he courts. Conspicuous consumption also has drawbacks. Such expenditure is at least partially wasteful.[2] Also, conspicuous consumption may involve further considerations.[3]

[1] Marriage may be about more than money, income, or wealth. The resource motive, however, finds much support among evolutionary biologists (e.g., Trivers 1972). They emphasize the resource capacity that the husband may bring into a marriage and which benefits the couple's offspring. We follow this tradition, disregarding love and affection as marriage motives for our analysis here.

[2] The economic theory on status consumption highlights the instrumental role of conspicuous consumption for attracting a better marriage partner. This instrumental aspect of status lies behind many models of status-seeking. De Fraja (2009) explicitly links utility maximization to the biological problem of fitness maximization. Men face a trade-off between investing in their survival, and conspicuous consumption that signals their quality and thus increases their matching probability. Much of the theory emphasizes the role of status goods as signals of income (Bagwell and Bernheim 1996; Corneo and Jeanne 1997; Frank 1985, 1986; Ireland 1994, 1998, 2001; Glazer and Konrad 1996; Moav and Neeman 2012) often with consideration of the role of the income of potential grooms in the context of marriage matching.

[3] Men may incur debt to provide a dishonest signal of their desirability as a mate (Gallup and Frederick 2010). Kruger (2008) finds that men who spend more than they save are likely to have more sex partners compared to men with a more frugal lifestyle. Buying conspicuous goods may not

This sets the stage for our analysis. We consider courtship as a simple mechanism design problem with one-sided incomplete information. One partner's quality is perfectly observed; this partner uses screening tools to assess whether a potential applicant is sufficiently wealthy. A common convention that was probably more applicable in the past is that 'she' is sought after because of her beauty, which is directly observed, whereas a candidate has some unobserved income. The convention has received support by sociobiological reasoning that combines two aspects. The joint production of offspring is an important purpose of marriage (Edlund 2006), and the resources required for child rising are particularly high for human species, compared to other, even closely related species (Diamond 1993). For our purpose the convention is not essential, and the gender assignment is only a language convention in what follows. One could even claim that, in modern life, the gender roles and the assignment of relevant qualities to gender is blurred and has partially reversed. But what remains relevant in courtship is that the beauty finds the wealthy, and that beauty is directly observable, whereas wealth is not.

We analyze the optimal screening contract used by Brunhilde, the person with the observable quality. Her screening problem has several new and interesting features.

First, screening expenditure by a candidate typically also hurts Brunhilde: such spending reduces the resources a candidate can otherwise contribute to the marriage. This cost needs to be taken into consideration when Brunhilde chooses the screening contract. As a result, she will typically require a threshold level of conspicuous expenditure and will marry the candidate if conspicuous consumption is of precisely this amount, but not higher.

Second, our approach can explain why conspicuous spending patterns differ widely, even within the same society. Our model substantiates the observation that, in contrast to people from an 'old money' background, the 'nouveaux riches' flaunt luxury goods when it comes to marriage matching. Indeed, a candidate with 'old money' will be requested to spend less money conspicuously compared to a self-made man who made it into the class of 'new money' but has little observable wealth.[4] Candidates with 'old

signal the desirable qualities of a partner but rather the opposite: interest in status goods is found to be triggered by feelings of powerlessness (Rucker and Galinsky 2008, 2009) or a need to restore one's self-worth (Sivanathan and Pettit 2010).

[4]Whereas, in our model, conspicuous consumption is decreasing in observable income, in Moav and Neeman (2012) conspicuous consumption decreases with observable human capital. They argue that the poor and the nouveaux riches do not hold diplomas or professional titles and therefore rely on conspicuous consumption to signal their success.

money' have major advantages: they need to spend less money conspicuously, and they are acceptable to Brunhilde even if their expected overall quality is lower.

Third, an increase in Brunhilde's attractiveness can make the outcome more wasteful. Screening the candidates becomes more difficult for a potential bride who is particularly sought after (for example, because of her beauty or personality or due to a highly male-biased sex ratio). Men of all incomes may be willing to spend so much money conspicuously, generating a conflict with the potential bride's aim to marry a man who brings a large amount of resources into the marriage.

Fourth, we can draw conclusions about the effects of ageing. Finding a husband or a spouse is a two-sided matching problem that may take many iterations and many periods.[5] Much of our analysis focuses on a static choice problem of two given partners and the problem of incomplete information. We discuss, however, how this partial problem can be embedded in a dynamic framework. The analysis predicts a negative correlation between Brunhilde's age and the level of conspicuous consumption which she requires from a successful candidate.

Several papers relate to our analysis. Our paper may be seen as taking a new perspective on the argument put forward in Bergstrom and Bagnoli (1993), discussed above. We address the likely implications of Bergstrom and Bagnoli (1993) for our results in section 4. Asymmetric information and a direct link between status consumption and marriage markets is considered by Pesendorfer (1995). In his framework, wearing the latest fashion trends increases the probability of a match with a high-quality partner. His purpose is to explain fashion trends, not the mating process. Thomas (2013) addresses the role of conspicuous consumption for the initiation of a relationship. He focuses on the price of a single status good and identifies a critical price above which a separating equilibrium emerges. Corneo and Jeanne (1998) study the effect on aggregate savings of the timing of a status contest over a two-period life cycle. Matching takes place in social interaction groups that belong either to a high or low income class. Therefore, conspicuous consumption improves the matching outcome, as it allows men to be believed to belong to the high income class. Moav and Neeman (2012) also analyze income signaling. Their framework shares the property with ours that individuals have different components that determine their income. The observable component in their framework is human capital. Using an overlapping generations model, they endogenize the level of information (i.e., human capital) which

[5] See, e.g., Burdett and Coles (1997, 1999). Browning et al. (forthcoming) provide a broad treatment of family economics including matching theory.

is available in addition to the signal via conspicuous consumption. Furthermore, our paper relates to signaling models that account for information on the sender's type, which is available in addition to his signal.[6] We extend previous theoretical work in three ways: (1) screening: the commitment choice by the principal about how she would interpret possible signals, (2) the analysis of signals that are costly not only for the agent but also for the principal, and (3) partial observability (financial assets or family background may be observable, but other characteristics that also affect a male's income prospects are not).

The paper is organized as follows. The next section reviews some empirical evidence. Section 3 presents the framework of the model and derives the bride's sorting strategy in a static setting. Section 4 addresses dynamic implications. Section 5 discusses and concludes.

2 Empirical evidence

Our model has several elements supported by empirical evidence, including the importance of material resources for male success in courtship, the use of conspicuous consumption to signal wealth, the role of beauty, and the consequences of ageing in courtship.

Much evidence shows that wealth matters for courtship success. In ancient Egypt courtship involved a suitor bringing his possessions in a bundle to the house of his potential bride's family (McDowell 2001). Evolutionary psychology literature suggests that men (but not women) use costly signals such as flaunting luxury possessions to display their earnings capacity and ability to support their offspring, as this has proven an evolutionarily beneficial courtship strategy.[7] In line with this argument, whereas

[6] In Feltovich et al. (2002), apart from the endogenously chosen signal, the receiver observes some noisy exogenously given extra information about the sender. This extra information is not known to the sender when he chooses his signal. Equilibria are found in which medium types signal to distinguish themselves from low types. In contrast, high types choose to countersignal, i.e., they do not signal as they are confident that they will not be perceived as low types. Fremling and Posner (1999) distinguish between two components of status: one is a fixed endowment, and a second is affected by signaling. They discuss how, within the same income class, individuals endowed with high status choose to signal less compared to those individuals endowed with little status.

[7] For a comprehensive survey on consumer behavior from an evolutionary perspective, see Griskevicius and Kenrick (2013), who discuss so-called fundamental motives such as attaining status, and acquiring and keeping a mate. Pan and Houser (2011) also summarize evidence from experimental economics and evolutionary psychology explaining gender differences in pro-social behavior.

men put greater weight on physical attractiveness in mates, women place more value on intelligence, favor men who grew up in wealthier neighborhoods (Fisman et al. 2006), and prefer men who have a good earning potential (Buss and Barnes 1986). This finding is substantiated by a field experiment on a Chinese online dating website where women of all income levels visited profiles of high-income males more often, and where women's visits to these profiles were an increasing function of their own income (Ong and Wang 2013). Experimental evidence indicates that men in a mating mindset are more likely to pay attention to status goods (Janssens et al. 2011) and intend to buy more luxury products (and less functional products). In contrast, for women the mating motive triggers not conspicuous consumption but conspicuous benevolence (Griskevicius et al. 2007).[8] Moreover, women interpret men's signaling behavior correctly, and women find men who buy status goods more sexually attractive (Sundie et al. 2011). Also, women in the fertile phase of the menstrual cycle pay more attention to status products (Lens et al. 2012).

In China, much consumption of luxury products is reportedly driven by conspicuous gift giving to second wives (Doctoroff 2011). Also, in 2010 government action curbed boasts of wealth in a popular Chinese dating TV show (Yang 2010). Furthermore, empirical evidence highlights that ownership of conspicuous assets such as cars increases the probability of getting married. Using data from the National Longitudinal Survey of Youth 1979, Schneider (2011) studies the role of wealth in marriage entry. For men, both owning a vehicle and financial assets increased the probability of first-marriage entry. Likewise, Dew and Price (2011) analyze the relationship between young adults' financial assets and marital timing, conducting prospective, longitudinal analyses. Financial assets did not mediate the relationship between employment and the probability of marriage, but did predict marriage. Higher car values were found to increase the probability of getting married relative to the probability of beginning to cohabit.

Beauty as a factor in courtship is also well documented. To analyze the effect of looks on earnings, Hamermesh and Biddle (1994) use household surveys for the United States and Canada taking advantage of how interviewers rated respondents' looks. They find that women's looks were unrelated to their likelihood of being married. Hamermesh and Biddle, however, give evidence that below-average-looking women are

[8] The role of women's conspicuous spending in relationships is studied in a experiment by Wang and Griskevicius (2014), who suggest that women use luxury products to signal their partners' commitment to them to deter romantic rivals.

disadvantaged in the labor market; they are also disadvantaged in the marriage market, as they get married to men with lower earnings abilities. In addition, Bereczkei et al. (1997) examine traits offered and demanded in lonely heart advertisements. With respect to the predictions derived from our model, two of their findings are particularly noteworthy. First, women who described themselves as physically attractive were more demanding, that is, more likely to require traits such as 'wealthy' and 'having private house' compared to women who did not describe themselves as physically attractive. Second, the financial and occupational status required in a new partner was increasing in the physical attractiveness the women offered. Similarly, a study of lonely heart advertisements finds that female advertisers offering physical attractiveness look for a larger number of traits in a potential partner compared to women not offering cues of physical attractiveness (Waynforth and Dunbar 1995).

With respect to age, Waynforth and Dunbar find that whereas men become more demanding with age, women become less demanding.[9] Alternatively, women may choose not to disclose their age in personal advertisements. Pawlowski and Dunbar (1999) conclude that these female advertisers try to present themselves as younger than they really are to be more demanding in what they look for in a prospective partner. Furthermore, consumption of conspicuous goods strongly decreases with age (Charles et al. 2009). An explanation suggested by our model is that women searching for a husband become less demanding as they age. Findings by Voland and Engel (1990) are in line with this argument. Using demographic data from historic parish registers to study the relationship between women's age at marriage and suitors' ownership of land, they find that the younger the women, the more likely she was to marry a well situated suitor. Voland and Engel interpret these findings as evidence that women followed an age-dependent mate selection maxim that read: "If you are young, be very choosy and marry only a high-quality mate. The older you become, the more you must reduce your standards concerning your marriage partner!" (Voland and Engel 1990, p.146).

3 Assumptions

We consider an unmarried woman who seeks a wealthy husband. We name her Brunhilde. Suppose she meets one potential partner. This candidate i would like to marry

[9] Bereczkei et al. (1997) find, however, that the proportion of women demanding traits associated with high wealth and high status does not differ across age groups.

Brunhilde. It is up to her to say yes or no. The candidate is drawn randomly from a given set of possible candidates. He has two sources of (lifetime) income. Income may be interpreted in a wide sense here and may include components that have a monetary equivalent, including aristocratic title, connectedness, a good family background, etc. Candidate i's total present value of lifetime income is

$$x_i = m_i + n_i. \tag{1}$$

The income component n_i is drawn independently from a uniform distribution on the unit interval $[0, 1]$. The income component m_i is a given non-negative number. The candidate knows both income components m_i and n_i. Brunhilde observes only one component, m_i, and knows the distribution from which the second component, n_i, is drawn. The support of $n_i \in [0, 1]$ is a normalization, and the choice of a uniform distribution allows for closed-form solutions. Conceptually, it is clear how the analysis generalizes for a more general distribution of unobservable income and for different distributions of n_i.

A candidate can spend any amount c_i of his income x_i on a conspicuous activity, which we refer to as conspicuous or status consumption. What remains after conspicuous consumption is available for genuine consumption. If i's total income is x_i, then $c_i \in [0, x_i]$ and genuine consumption is

$$g_i = x_i - c_i. \tag{2}$$

Candidates may face a liquidity constraint, which would somewhat qualify our results. In a first approach we assume that such a constraint is not binding. Before observing any characteristic or choice by a candidate, Brunhilde can offer a screening contract. This contract is denoted as a function

$$p(c_i; m_i) : [0, \infty) \times [0, \infty) \rightarrow \{0, 1\}. \tag{3}$$

It states that Brunhilde will marry the candidate with probability $p(c_i; m_i)$ if this candidate i has an observable income m_i and displays a status consumption of c_i. Brunhilde specifies such a probability as a function of c_i and m_i. Note that the acceptance probability can depend on the observable values c_i and m_i only, that m_i is exogenous, and that the the candidate chooses c_i. As seen from (3), we limit attention to deterministic screening functions: $p(c_i; m_i) \in \{0, 1\}$.[10]

[10] Brunhilde might improve on efficiency by making the acceptance probability increase smoothly with c_i. But a random acceptance choice need not be ex-post incentive compatible, and may need commitment, which is difficult to obtain in marriage markets.

To summarize the timing, first a candidate shows up. Nature chooses the candidate's characteristics m_i and n_i and the candidate observes these values. Second, Brunhilde announces the function $p(c_i, m_i)$ to him. Third, she observes the candidate's income component m_i. The candidate faces the contract $p(c_i; m_i)$ that applies to the observable income component of this candidate. Fourth, the candidate chooses c_i. Fifth, Brunhilde observes this c_i and behaves according to the screening contract she has offered. Sixth, if Brunhilde accepts the candidate, they marry and live together forever after. If Brunhilde rejects the candidate, he leaves and he and Brunhilde receive a default utility.

The cost to a candidate of conspicuous consumption c_i when his income is $x_i = m_i + n_i$ is

$$C(c_i; x_i) = \frac{c_i}{x_i}. \tag{4}$$

This cost function satisfies an important single crossing property: the cost for a given level of conspicuous consumption is higher for a person with a lower income.[11] Overall, a candidate's expected utility is

$$ap(c_i; m_i) + x_i - \frac{c_i}{x_i}.$$

Here a is the utility equivalent of the non-monetary benefit of marriage to Brunhilde.[12] This benefit occurs with probability $p(c_i; m_i)$. In turn, this probability is given by the screening contract, observable income, and conspicuous consumption. The candidate selection process is governed by Brunhilde. The candidate who is rejected can consume his income, but does not get a, thereby determining his default utility. It may, but need not, be thought of as the utility of remaining single and consuming his income on his own. Assume that the candidate under consideration has $a > 0$, ensuring that,

[11] Broom and Ruxton (2011) also assume this cost function in a signaling game in an evolutionary biology context.

[12] The non-material benefit from marriage is given, common knowledge, and identical for all candidates. It is also unaffected by their income. Experimental evidence, however, finds that men primed with a large sum of money adjust their mating strategy; that is, they increase their dating requirements — particularly for physical attractiveness (Yong and Li, 2012). Similarly, evidence from lonely heart advertisements suggests that men with more resources make higher demands about physical attractiveness (Bereczkei et al. 1997; Waynforth and Dunbar 1995). Therefore candidates who differ in income should also differ in their preference for Brunhilde. But as long as Brunhilde can freely observe a, the heterogeneity does not invalidate the analysis here. Relaxing these assumptions leads to a two-sided search and screening problem that we leave for future research.

ceteris paribus, he would benefit from marrying Brunhilde. In addition, assume that this a does not dominate all other considerations, or that

$$a \in \left(0, \frac{1}{2\gamma}\right), \tag{5}$$

where $\gamma \in (0, 1]$; the interpretation of γ and the significance of this condition are explained further below.

Turn now to Brunhilde's objective function. She wants a husband who makes a large contribution to family wealth. Several motives can drive this preference. Brunhilde may simply enjoy consumption. Another important motive that is prominent in much of the literature on marriage (see, e.g., Edlund 2006 for a review) is the desire to provide resources for raising children. Whatever the motive, Brunhilde's genuine consumption is defined as $x_i - c_i$.[13] A candidate's conspicuous consumption may also benefit Brunhilde. The utility she attributes to c_i is typically smaller than its monetary amount c_i, and we assume it is $(1 - \gamma)c_i$, where $\gamma \in (0, 1]$ is an exogenously given constant.[14] We may, for instance, think of expensive status goods given Brunhilde, who values each unit of the good only by $1 - \gamma$. Or Brunhilde may enjoy riding in the candidate's fancy sports car. Overall, Brunhilde's payoff from marrying a candidate with income x_i and conspicuous expenditure c_i is $x_i - \gamma c_i$.

Note that the screening costs affect both the candidate and Brunhilde, in contrast to the standard screening framework. A candidate always bears the screening costs imposed by conspicuous consumption described by (4). But also, Brunhilde dislikes high conspicuous consumption because it reduces what is left for joint genuine consumption or child raising.[15]

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[13] To obtain closed form solutions, we allow the cost of conspicuous consumption to enter into Brunhilde's and a candidate's payoffs asymmetrically. If, however, the very same cost function given in equation (4) also holds for Brunhilde, the comparative static results stated in Proposition 1 remain qualitatively unchanged.

[14] Our model can also capture the two extreme cases where Brunhilde also bears the full screening costs ($\gamma = 1$) and where Brunhilde bears no screening costs ($\gamma = 0$). The analysis with no screening costs is at the end of section 3.

[15] We have a successful candidate's income become the joint consumption of the married couple; one interpretation is that these resources are used to raise children and children are a pure public good for both of them. In a more general consideration, a candidate's present value of income may yield a higher or lower utility to him if he marries than if he does not marry. To assume that it has the same effect on his utility is mainly for notational convenience. This income net of conspicuous consumption also affects Brunhilde's utility, and it may do so either more strongly or less strongly. This is fully accounted for in the analysis even though the monetary amount affects Brunhilde's payoff directly, as the results do not change if Brunhilde's payoff is scaled by an arbitrary positive factor.

If Brunhilde rejects the candidate, she receives her default utility v. This utility may be determined, for instance, by the quality and frequency of future candidates, and by her rate of time preference. For the moment, assume that v is exogenously given, and we determine the optimal screening contract for this exogenous v. We will discuss in section 4 how changes in v affect Brunhilde's behavior, how one could determine v endogenously in a dynamic framework with a sequence of candidates, and how v may change in a continuing search process.

Next, we describe the choice problem of candidate i with observable income m_i for a given screening function. We consider deterministic screening functions $p(c_i; m_i) : [0, \infty) \times [0, \infty) \to \{0, 1\}$ that map different choices of conspicuous consumption for a given m_i into acceptance probabilities $p(c; m_i) \in \{0, 1\}$. The consumption choice c_i by candidate i with income x_i $(= m_i + n_i)$ determines whether the candidate is accepted by Brunhilde and receives payoff

$$x_i - \frac{c_i}{x_i} + a$$

or stays unmarried and receives

$$x_i - \frac{c_i}{x_i}.$$

Among all c_i that yield $p(c_i; m_i) = 0$, the payoff maximizing choice is $c_i = 0$. Among all c_i that yield $p(c_i; m_i) = 1$, the payoff maximizing choice for the candidate is the smallest possible c_i that yields $p(c_i; m_i) = 1$. The candidate either chooses $c_i = 0$ or else the smallest c_i that induces $p(c_i; m_i) = 1$. Denote this smallest consumption level by c. Note that, for any given $c > 0$, there is some critical total income x such that the candidate prefers $c_i = c$ compared to $c_i = 0$ if the total income x_i is at least equal to x, and prefers $c_i = 0$ otherwise. This critical $x(c)$ is

$$x(c) = \frac{c}{a}. \tag{6}$$

Brunhilde may screen the candidate using this condition. If she requires a given $c > 0$, then all candidates with $x_i \geq x$ choose c; all others choose $c_i = 0$. Such behavior separates candidates according to their x_i. Note that it follows from (4) that $x(c) = c/a$, $x'(c) = 1/a > 0$ and $x''(c) = 0$. This completes the description of candidate i's behavior.

Brunhilde can unconditionally reject the candidate (formally, she can require an impossible $c > m_i + 1$), giving her a default payoff of v. Brunhilde can also leave the option to screen unused and just marry the candidate. She then has the expected benefit $m_i + E[n_i] = m_i + \frac{1}{2}$. Lastly, if Brunhilde actively screens, the relationship

$x(c)$ as in (6) that governs the candidate's choice as a function of total income becomes relevant. Proposition 1 addresses this option.

Proposition 1 *Let condition (5) hold. If Brunhilde chooses an active deterministic screening mechanism $p(x_i; m_i)$, then she marries candidate i if he chooses*

$$c(m_i) = a\frac{v - \gamma a(m_i + 1)}{1 - 2\gamma a} \tag{7}$$

and rejects him otherwise. This strategy implies that in equilibrium she marries the candidate if and only if his full income is $x_i \geq \frac{1}{a}c(m_i)$. Within the range in which active screening occurs, the level of conspicuous consumption and the threshold level of total income that is sufficient for acceptance monotonically decrease in the observed income component m_i. And, for a given observed income m_i, conspicuous consumption increases in the default payoff v.

Proof. If Brunhilde actively screens, then she maximizes

$$w_s(x, m_i) = (x(c) - m_i)v + \int_{x(c)}^{m_i+1} (z - \gamma c)dz \tag{8}$$

by a choice of c (or, equivalently, by a choice of x). The first-order condition for a local maximum of w_s is

$$\frac{\partial w_s}{\partial x} = v - x + 2\gamma ax - \gamma am_i - \gamma a = 0. \tag{9}$$

Note further that

$$\frac{\partial^2 w_s}{(\partial x)^2} = -(1 - 2\gamma a). \tag{10}$$

Hence, the function w_s is concave for $a \leq 1/(2\gamma)$. This is where (5) is used. If $a < 1/(2\gamma)$, the optimal choice by Brunhilde is either the x solving (9) and is a screening optimum, or a corner solution, in which case no screening occurs. Solving (9) for x and using the equality $x(c(m_i)) = \frac{1}{a}c(m_i)$ by (6) yields the value in (7).

The comparative static results follow directly from (7) and by (6):

$$\frac{\partial x(c(m_i))}{\partial m_i} = -\frac{\gamma a}{1 - 2\gamma a} < 0$$

$$\frac{\partial x(c(m_i))}{\partial v} = \frac{1}{1 - 2\gamma a} > 0.$$

■

In (9) the optimal choice of $c(m_i)$ just balances the marginal disadvantage and the marginal benefit for Brunhilde. The characterization (7) implies that,

$$v > x(c(m_i)) - \gamma c(m_i). \tag{11}$$

This inequality has an interesting consequence. Brunhilde accepts a candidate who spends $c(m_i)$ on conspicuous consumption, generating a pool of candidates characterized by a range of possible incomes: any candidate with $x_i \in [x(c(m_i)), m_i + 1]$ is accepted. When choosing, she cannot observe a candidate's income. Hence, this pool of candidates who would be accepted includes candidates who provide her with a lower marriage utility than her fallback utility v from continuing the search as is shown by (11). She could avoid accepting such candidates and exclude them from the pool. She could do this by choosing a c higher than $c(m_i)$, further increasing the critical income $x(c(m_i))$, making it undesirable for a candidate with an income at $x(c(m_i))$ or slightly above it to choose the required level of conspicuous consumption that would lead to acceptance. Such a strategy, however, would not be optimal for Brunhilde. Intuitively, by admitting such inferior candidates to the pool, she lowers the required level of status consumption $c(m_i)$, admitting low-income candidates to the pool of candidates who are eventually accepted. But it also gives her some benefit, reducing her utility loss $\gamma c(m_i)$ from the wasteful conspicuous consumption made by any candidate she accepts.

In a standard screening framework Brunhilde would bear none of the costs of the signal; that is, she would get x_i, rather than $x_i - \gamma c(m_i)$ from a candidate who produces the signal and whom she accepts. But because Brunhilde bears some of the cost of conspicuous consumption, $x(c(m_i))$ differs from the reservation utility v.

Note that Brunhilde's strategy to choose according to (11) is time consistent. Up to the time when Brunhilde and the successful candidate marry, Brunhilde behaves optimally using all information available to her.[16] She could have chosen a smaller pool of acceptable candidates, simply by increasing c above $c(m_i)$, but such an increase would not maximize her utility. Note also that the deviation (11) does not result from risk aversion by Brunhilde, as her payoff has consciously been chosen to be linear in income, but it is an outcome of conspicuous consumption being costly for Brunhilde.

Figure 1 illustrates the problem for a given v and a given m_i. For a given cut-off level x, Brunhilde's payoff consists of the sum of the two shaded areas, ABCF of area

[16] We rule out divorce as an option here. If true income were revealed immediately after marriage and Brunhilde could costlessly divorce from a husband who turns out to have low income, divorce would, in this extreme case, resolve the information problem and lead to different outcomes.

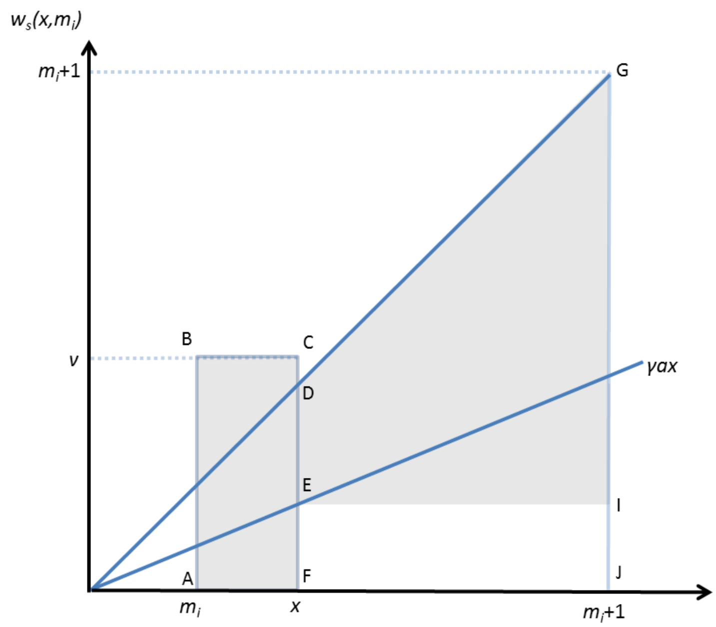

Figure 1: Brunhilde's payoff for a given v and m_i

$v(x-m_i)$, and EDGI, which equals the integral in (8). It is equal to the expected income of the candidate for $x_i > x$, net of the area EIJF, or $[(m_i+1)-x]\gamma a$. This area measures the cost to Brunhilde of the candidate's spending on conspicuous consumption. It is this area that makes Brunhilde's problem differ from a standard screening problem in which she would simply choose a cut-off of $x = v$. The solution here converges to this solution for $\gamma a \to 0$. Figure 1 can also illustrate the effect of a marginal change in x. An increase in x by one marginal unit increases the cost to Brunhilde of the candidate's conspicuous consumption by $\gamma a[(m_i + 1) - x]dx$. Brunhilde's gain from this increase in x is measured by $[(v - x)+ \gamma ax]dx$. Equating the marginal cost and the marginal benefit yields the first-order condition (9).

Proposition 1 characterizes conspicuous consumption if Brunhilde actively screens. The level of conspicuous consumption she requires declines with the candidate's observable income. This pattern is consistent with the notion described in the introduction about 'old money.' If the candidate has a rich family background, an aristocratic title, or other observable characteristics that have a positive monetary equivalent, the candidate needs less conspicuous consumption to make Brunhilde marry him. Further, 'old money' candidates need less wealth on average in the equilibrium to be acceptable to Brunhilde. The threshold level of total income that is acceptable for her in the equilibrium is lower for 'old money' than for the 'nouveaux riches.' So, in comparison, the 'nouveaux riches' face two disadvantages in the marriage market. They have to spend more on conspicuous consumption to provide the right signal, and they need to be richer on average to be successful, compared to 'old money' candidates.

So far, we characterized the optimal active screening mechanism under the condition that it is optimal for Brunhilde to set a positive, but not prohibitive, threshold. Next, we explore alternatives to her active screening mechanism. If Brunhilde has a very high default utility v and observes the candidate's m_i, any screening may be a hopeless exercise. A sufficient, but not a necessary condition for no screening is that $v > m_i + \max\{n_i\} = m_i + 1$, as the condition implies that the default payoff is higher than the payoff from marrying the best possible type of candidate. Also, if v is very small and m_i is sufficiently large, for instance, $m_i > v$, then it becomes a dominant strategy to accept the candidate and ask for $c = 0$, to minimize the conspicuous consumption cost. Again, this condition is only sufficient. In general, which of the three strategies (active screening, outright rejection, and outright acceptance) is best depends on the parameters of the model.

Here we provide some characterization. Recall that Brunhilde has three potentially optimal options: outright reject, outright accept with $c = 0$, and actively screen with $c(m_i)$. The maximal payoffs for these three choices are given by

$$\begin{aligned} w_r(v, m_i) &= v, \\ w_a(v, m_i) &= m_i + (1/2), \\ w_s(v, m_i) &= \max_x \left[(x - m_i)v + \int_x^{m_i+1} (z - \gamma x a) dz \right]. \end{aligned}$$

We can now study Brunhilde's optimal choice as a function of m_i and v. The optimal choices for different regions are identified in Figure 2.

H1: outright rejection versus active screening: Rejecting the candidate with observed income component m_i independent of his conspicuous consumption is (weakly) superior to active screening if

$$v \geq (x - m_i)v + \int_x^{m_i+1} (z - \gamma x a) dz, \tag{12}$$

for all possible cutoffs $x < m_i + 1$. This condition can be rewritten after rearranging, integrating, and dividing by $(m + 1 - x)$ as

$$v \geq \frac{m_i + 1 + x}{2} - \gamma a x. \tag{13}$$

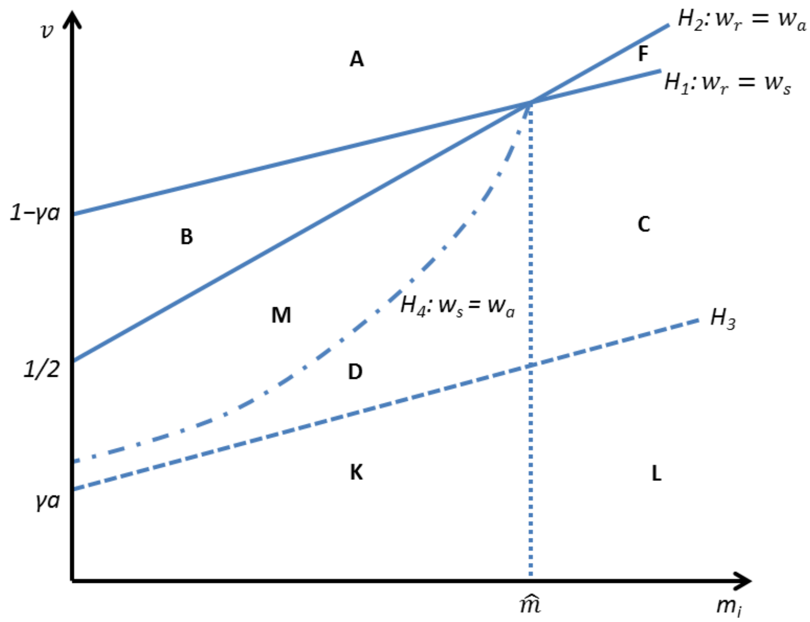

Figure 2: Brunhilde's strategy for a given m_i

Making use of $\gamma a < 1/2$ by (5), the right-hand side in (13) strictly increases in x and attains a maximum at $x = m_i + 1$. Hence, for (12) to be satisfied for all possible x, v must be greater than $(m_i+1)(1-\gamma a)$. This defines a hyperplane H_1 in the $v-m_i$-space for which the payoff-maximizing active-screening mechanism yields the same payoff as outright rejection of the candidate:

$$H_1: \ v = (m_i + 1)(1 - \gamma a).$$

It shows that the critical level of m_i increases with Brunhilde's default utility v, and also increases with the cost of conspicuous consumption, which in turn increases with γ and/or a. Also, the line divides the $v-m_i$-space into a range with $w_r > w_s$ (upper-left) and with $w_r < w_s$ (lower-right).

H_2: outright rejection versus outright acceptance: A second hyperplane is drawn in Figure 2. It shows the combinations (v, m_i) for which $w_a = w_r$, or

$$H_2: \ v = m_i + (1/2).$$

This hyperplane separates all combinations (v, m_i) for which $w_r > w_a$ (upper-left) from those with $w_r < w_a$ (lower-right). The two hyperplanes H_1 and H_2 intersect for

$$m_i = \frac{1 - 2\gamma a}{2\gamma a} > 0,$$

and this value $m_i \equiv \hat{m}$ may, but need not, be smaller than 1. At the intersection, Brunhilde is indifferent among all three alternatives: $w_s(v(\hat{m}), \hat{m}) = w_r(v(\hat{m}), \hat{m}) = w_a(v(\hat{m}), \hat{m})$ holds.

H_3: outright acceptance better than any active screening contract: To limit further the area of possible active screening, note that active screening is strictly dominated by outright acceptance for all (v, m_i) for which $x(c(m_i)) \leq m_i$. This condition yields a further hyperplane H_3, which determines the combinations v and m_i for which $x(c(m_i)) = m_i$:

$$H_3 : v = m_i(1 - \gamma a) + \gamma a.$$

For all combinations below this line active screening is inferior to outright acceptance. Unlike H_1 and H_2, however, this line only provides a sufficient condition. Active screening does not dominate outright acceptance for all points above this line.

Hyperplanes H_1, H_2, H_3 and the vertical line through $(v(\hat{m}), \hat{m})$ span seven regions A, B, C, D, F, K, and L, for which the following partial order is established. For A Brunhilde chooses outright rejection, as this dominates active screening and outright acceptance. For F Brunhilde chooses outright acceptance, as $w_s < w_r$ and $w_r < w_a$ in this region. For regions B, C, D, K and L Brunhilde will not choose outright rejection. Whether active screening or outright acceptance yields a higher payoff needs to be considered more closely. A necessary condition for active screening not to be dominated by outright acceptance with $c = 0$ is that (v, m_i) lies to the upper-left of H_3. Accordingly, outright acceptance with $c = 0$ occurs in regions K and L.

So we turn to regions B, C, and D. Consider some $\widetilde{m}_i > \hat{m}$ and start at the point $(H_1(\widetilde{m}_i), \widetilde{m}_i)$ vertically above $\widetilde{m}_i$ on H_1. A reduction in v leaves w_a unchanged. But it reduces w_s, as

$$\frac{dw_s}{dv} = x - m_i > 0, \tag{14}$$

where $\frac{\partial w_s}{\partial x}\frac{\partial x}{\partial v} = 0$ holds due to the envelope theorem. The inequality $x - m_i > 0$ always holds in an active screening equilibrium above H_3. The condition (14) shows that if v is decreasing between H_1 and H_3, then w_s is strictly monotonically decreasing. For $m_i > \hat{m}$, consider the point $(H_1(\widetilde{m}_i), \widetilde{m}_i)$ vertically above $\widetilde{m}_i$ on H_1. Consider a decrease in v starting from this point. At this point, $w_s = H_1(\widetilde{m}_i) = w_r < w_a$. A decrease in v further reduces w_s, but keeps w_a constant. Accordingly, $w_s < w_a$ for all combinations $(v, m_i) \in C$, establishing that Brunhilde chooses outright acceptance with $c = 0$ for combinations of (v, m_i) in C. For $m_i \in [0, \hat{m})$, consider again the point $(H_1(\widetilde{m}_i), \widetilde{m}_i)$ vertically above $\widetilde{m}_i$ on H_1. Consider a decrease in v starting from this point. At this point, $w_s = w_r = H_1(\widetilde{m}_i) > w_a$. A decrease in v decreases w_s, but keeps w_a constant.

A decrease in v reduces $w_s - w_a$. Once we reach $H_2(\widetilde{m}_i)$, we know that $w_s > w_r$ at this point (we are below H_1). Moreover, we know that $w_r = w_a$ at this point (which lies on H_2). Accordingly, $w_s > w_a$, implying that Brunhilde will use active screening for all combinations $(v, m_i) \in B$. If, for given m_i, v is further decreased below $H_2(m_1)$, then w_s decreases further and eventually falls below w_a. For instance, for $v = H_3(\widetilde{m}_i)$ Brunhilde has a dominant strategy of accepting with $c = 0$. By monotonicity and the intermediate-value theorem, there is exactly one v such that $w_s = w_a$. By this principle, we can construct a critical level of v for every $m_i \in [0, \hat{m})$. These critical levels yield a fourth hyperplane H_4. All points between H_1 and H_4 describe combinations of (v, m_i) for which Brunhilde uses active screening; for all combinations below H_4 she chooses outright acceptance with $c = 0$.

Lastly, we can show that H_4, which separates the range $w_s > w_a$ from $w_s < w_a$, has a positive slope. Note that w_a is invariant for changes in v, but increases with m_i. As H_4 is an indifference surface with $w_a = w_s$, for a proof that its slope is indeed positive we consider the slope of this locus. Using the envelope theorem again and solving $(x - m_i)dv + (-v + m_i + 1 - \gamma ax - 1)\, dm_i = 0$ for this slope yields

$$\frac{dv}{dm_i} = -\frac{m_i - \gamma ax - v}{x - m_i}. \tag{15}$$

As $x(c(m_i))$ must be greater than m_i for active screening not to be strictly dominated by outright acceptance, the denominator is positive. Further, $m_i - \gamma ax - v < x - \gamma ax - v < 0$ as it was shown earlier that $v > x - \gamma c\,(m_i)$. Hence, the slope (15) is positive for all m_i in the relevant range.

These considerations are summarized by

Proposition 2 *Brunhilde outrightly rejects candidates in region A. She accepts any candidate and requires $c = 0$ in regions F,C,D,K,L. She applies the optimal active screening contract in regions B and M.*

Figure 2 illustrates Brunhilde's trade-offs based on the parametric version of her problem. We used this parametric form to allow for some analytic solutions, but the comparative static results indicate what would happen in a more abstract framework. More generally, Brunhilde's behavior depends on how much the candidate desires to marry her (captured by a), the nature of conspicuous consumption (captured by the candidate's cost of conspicuous consumption and by γ), and on factors determining the candidate's and Brunhilde's default utilities. Brunhilde's optimal choice also depends on the distribution of n_i in comparison to the size of m_i. The characterization of the equilibrium solutions for the parametric case in Propositions 1 and 2 is indicative, however, of more general cases. Whether m_i is sufficiently large for outright marriage, or whether Brunhilde outrightly rejects the candidate, will depend on a comparison between her default utility and the upward potential, i.e., the range of n_i, and on the screening costs in an equilibrium with active screening. The screening costs very much depend on the size of γa. Also, for a sufficiently large m_i and a sufficiently narrow range for the distribution of n_i, it is likely that Brunhilde prefers a contract that accepts the candidate if the candidate chooses $c_i = 0$.

We can also consider Brunhilde's strategy for a sufficiently small and for a sufficiently large marriage premium a. Several factors may affect the size of a. On the macro-level, the shares of males and females in the population may be unbalanced.[17] On the micro-level the value attributed to marrying Brunhilde may depend on her beauty or character. When $a \to 0$, Brunhilde offers a screening contract to all candidates regardless of their observable income, as screening becomes costless. The universal screening has a counterintuitive implication.

Corollary 1: *Women who are particularly sought after are disadvantaged: active screening is more costly for them than for others.*

Departing from (5), let $a \geq 1/(2\gamma)$ so that Brunhilde does not use a screening contract. Instead, she requests that candidates choose $c_i = 0$ and rates a candidate who complies with this request on the basis of his observable income component only. For a very low m_i she rejects, for a very high observable income she accepts. The threshold is

$$\widetilde{m} + \frac{1}{2} = v \tag{16}$$

[17] China's one-child policy is considered to be responsible for a smaller share of women in the population (Hesketh 2009). Moreover, out-migration from regions that lack economic opportunities is often different for men and women, causing gender imbalances: Kröhnert and Vollmer (2012) report that in 2005 the sex ratio for 18 to 29-year-olds was 89 women per 100 men due to disproportionate migration of women from East Germany to West Germany. As studied by Griskevicius et al. (2012), a male-biased sex ratio affects decision making on saving, borrowing, and spending consistent with evolutionary biological theory predicting the effects on the intensity of competition for mates. When the sex ratio was male-biased, men (but not women) were found to choose more immediate rewards and to discount the future more strongly, to plan to save less, and to be more willing to increase their credit card debt. In addition, when women were scarce, participants — regardless of their sex — expected men to spend more money during courtship, e.g., to buy a more expensive engagement ring.

Proposition 3 *For $a \geq 1/(2\gamma)$ and for all levels of m_i and of v, Brunhilde's payoff under active screening is less than* $\max\{w_r(v, m_i), w_a(v, m_i)\}$.

Proof. For $a \geq 1/(2\gamma)$ the objective function (8) is convex. There exists no interior solution for the critical income level x. The two possible corner solutions are $w_r(v, m_i)$ and $w_a(v, m_i)$. ■

Our last comparative study is on the role of screening costs. Our framework departs from the standard approach as Brunhilde bears a share, γ, of the cost of the signal which is produced by the successful candidate. As discussed after Proposition 1, if Brunhilde does not bear any screening costs, i.e., $\gamma = 0$, she sets the critical income threshold equal to her reservation utility (formally, $x = v$). Screening is then costless for Brunhilde but costly to the candidate. As long as screening does not affect the quality, number, or frequency of candidates showing up, for $\gamma = 0$ Brunhilde would always offer an active screening contract to all candidates, irrespective of their observable income. She would never leave this option unused. A candidate with a high observable income may have a very low additional unobservable income. Using her screening strategy, Brunhilde prefers to identify such a candidate to be able to reject him if screening is costless for her.

4 Dynamic implications

We so far solved for Brunhilde's optimal local strategy if she interacts with one single candidate who wants to marry her, with her and the candidate having exogenously given default utilities. We determined the optimal mechanism design for her. Her problem may be embedded in a dynamic context, for instance, a sequence of marriage decisions, which continue until she marries. Such a framework typically has a Markov property: Brunhilde's payoff from marrying a given candidate depends only on this candidate's conspicuous consumption c_i and actual income x_i, but typically does not depend on the sequence of rejections that occurred previously. It is this independence which allows us to consider single marriage decisions in isolation, as we did in section 3, and where the behavior characterizes local strategies as a function of the current candidate's observed income component m_i and the candidate's conspicuous consumption.

In a dynamic framework a few further aspects need to be specified. One aspect is the distribution from which the observable income component of subsequent candidates is drawn, how this distribution changes over time, and the frequency with which new candidates show up if Brunhilde rejects the current candidate. Also, the utility as single and how she discounts the future needs to be described.

If the time horizon is long and Brunhilde anticipates a long series of possible candidates following each rejection, all drawn from the same distribution of candidates, then the dynamic problem may be reasonably well described as a stationary problem. The decision problem in section 3 can then be seen as the period decision in a dynamic framework with an infinite number of periods, with one candidate showing up in each period until Brunhilde finally marries. A possible extension of our framework is to solve for the perfect Bayesian equilibrium in stationary Markov strategies. A formal analysis would require some notation, but conceptually it is clear how the continuation value v is endogenously determined in such a framework and is the discounted value of the expected payoff which Brunhilde has if she does not marry in a given period but rather waits for future options.

Stationarity need not be an appropriate description. Brunhilde naturally grows older, future candidates may reassess their benefits of marrying her, and the flow of further candidates may be finite and may change its characteristics over time. This changes her default utility of staying single from one marriage decision to the next. She may feel her biological clock ticking; being older, she may feel a greater urge to find a supporting husband soon. For the decision problem analyzed in section 3, these aspects find their counterparts mostly in a change in v over time. The effect of such a change for $a < 1/(2\gamma)$ in the range of equilibrium with active screening is

$$\frac{\partial x(m_i)}{\partial v} = \frac{1}{a}\frac{\partial c(m_i)}{\partial v} = \frac{1}{1-2\gamma a} > 0.$$

If her default utility decreases, and if she actively screens, Brunhilde will be willing to marry a candidate with a lower total income, and she will require less status consumption as proof of a candidate's unobservable income. Also, a reduction in v may result in a change of the equilibrium regime. As seen in Figure 2, a reduction in v may cause either of several transitions. For some values of observed income, she changes her behavior from active screening to outright acceptance. For some values of observed income, she changes her behavior from outright rejection to active screening. For some observed income she changes her behavior from outright rejection to outright acceptance.

The number of future marriage options may narrow over time, thereby reducing v. The pool of candidates may change over time. Candidates will also be older. As argued by Bergstrom and Bagnoli (1993), the information asymmetry regarding men's lifetime income unravels over time. An increase in candidates' age typically causes a shift in which part of income or ability is observable and which part is unobservable. If Brunhilde can observe a larger proportion of potential income, her information problem is simplified. The first round effect of improved information is an increase in default utility v over the lifetime. In addition, young male candidates with a high earnings potential in comparison to what is observable tend to wait, such that older candidates are a positive self-selected sample. This effect should also increase v. Candidates with a high earnings potential may wait because they expect delay to improve their attractiveness, which in turn changes their aspirations. This may reduce a, the parameter measuring the candidates' desire to marry a specific Brunhilde. It remains an intricate research question to study the interaction between Brunhilde's information extraction problem and the candidate's means to change the distribution of observable and unobservable income components over time.

Overall, aging has several effects in this framework, but many of these point at a reduction of v over the lifetime and to a better informed Brunhilde at the time of decision making. The empirical counterpart (and testable hypothesis) for this result is a relationship between age and courtship expenditure. Ceteris paribus, the intensity of status consumption during courtship should decrease with age, perhaps explaining the finding by Charles et al. (2009) that age reduces the propensity to buy conspicuous goods. Though a standard explanation for such a pattern may be 'lost ambitions,' or 'illusions lost' and a 'more realistic attitude toward life,' our theory would explain the pattern as an equilibrium phenomenon among people who are fully rational when they are young and when they are old.

5 Discussion and conclusions

We studied screening in marriage matching. Conspicuous consumption provides information about a possible partner's wealth or prospects. We show that a potential bride can use a simple mechanism: a menu of contracts to sort candidates and thereby induce but also curb conspicuous spending during courtship. This screening device reveals whether a candidate's total income exceeds an optimally chosen threshold. Candidates with income below the threshold give up. Worthy candidates spend a given threshold amount. This threshold does not depend on their total income, but only on the part of their income that is directly observable. Candidates with the same total income but with a larger share of directly observable income need spend less on conspicuous consumption.

In an important departure from standard screening models, in our model screening is costly not only for the prospective husband, but also for the potential bride. She cares about the income that is available for joint family expenditure and for raising children. A candidate who spends much of his income on conspicuous consumption during courtship will reduce the very income that is available for joint family consumption. Both she and the candidate suffer from this reduction in family income. Selecting a worthy candidate by his spending on conspicuous consumption is therefore a mixed pleasure: a higher signal, aimed at signaling higher quality, directly reduces the candidate's quality as a husband. In some instances the cost of the signal can be so high even to her that she may abstain and not use such a mechanism: she may be better-off by making an outright decision about acceptance or rejection of a candidate and base this decision on the part of the candidate's income that is directly observable. Her default utility, the amount of a candidate's directly observable part of income ('old money'), the welfare cost of conspicuous consumption, and how she shares in this cost are all crucial for her choice of a mechanism.

The formal analysis makes several predictions that fit with casual or anecdotal evidence. In particular, it can explain that conspicuous consumption is discouraged or is very low for candidates with a rich family background or other visible indications of high wealth ('old money'), whereas it is more prominent among the 'new rich.' It also offers a rational choice explanation for lower conspicuous consumption and less extensive gift giving of status goods in the context of courting among older cohorts.

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