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# Marriage, Specialization, and the Gender Division of Labor

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## **Abstract**

A customary gender division of labor is one in which women and men are directed towards certain tasks and/or explicitly prohibited from performing others. We offer an explanation as to why the gender division of labor is so often enforced by custom, and why customary gender divisions of labor generally involve both direction and prohibition. Our model builds on the literature on the marital hold-up problem, and considers both problems in choice of specialty and human capital acquisition in a framework in which agents learn a variety of skills and then enter the marriage market. We show that wasteful behavior may emerge due to strategic incentives in career choice and human capital acquisition, and that both problems may be mitigated through the customary gender division of labor. We find, however, that a gender division of labor is not Pareto-improving; one gender is made worse off. Both the distributional effects and welfare gains of a customary gender division of labor decrease as opportunities to exchange in markets increase.

# 1 Introduction

Gary Becker's (1991) work(s) on the economics of marriage began the study of marriage and its relationship to the gender division of labor and human capital acquisition. Becker's theory began with the observation that spouses could specialize in specific tasks and then engage in trade at minimal transactions costs within a marriage. Specialization within marriage created the added benefit of allowing increasing returns to scale in human capital, as specialization allows human capital to be used more intensively.

While Becker's work provides an explanation for why a gender division of labor exists, it does not explain why we throughout history have so often observed a *customary* gender division of labor under which women and/or men are prohibited from performing certain activities by custom, and encouraged to engage in others. In Becker's model(s), there is no explicit reason for society to sanction a gender division of labor for agents, as agents should always find it in their best interests to specialize when gains to doing so are present.

So why is the gender division of labor so often dictated and rigidly enforced by custom? Why are both women and men so often prohibited from engaging in specific tasks by prevailing social norms? Hadfield (1999) explains customary gender divisions of labor as mechanisms that mitigate a coordination problem in the marriage market. As specialization requires some coordination, if agents must decide which tasks to learn without full knowledge of the characteristics of potential spouses, a well-specified gender division of labor prevents the possibility that men and women will fail to coordinate on different tasks.

In this paper we develop a complementary explanation for why a gender division of labor might occur. In addition to considering coordination problems in the marriage market, our theory also focuses on the ways in which a customary gender division of labor impacts educational decisions made prior to the search for a spouse and subsequent intra-familial bargaining over the marriage surplus. We discuss how a gender division of labor might aid in mitigating the marital hold-up problem, and also discuss distributional aspects of a customary gender division of labor.

The initial work on division of marital surplus produced the observation that treatment within marriage generally depends upon the opportunities

available outside of marriage.<sup>1</sup> Subsequent work focused on how the division of surplus arising from marriage influences spouses' prior human capital investment decisions. As spouses foresee that investments may influence the share of marital surplus obtained in bargaining, premarital educational investments generally turn out to be suboptimal. This marital hold-up problem appears to be robust to a variety of different model specifications. Konrad and Lommerud (2000) develop a model in which intra-marital time allocation decisions are made with varying degrees of cooperation, and find that educational decisions made in anticipation of marital time allocation are influenced by how cooperatively time allocation decisions are made, but are generally inefficient. Vagstad (2001) studies educational decisions in a framework in which spouses must learn how to perform both domestic and market tasks, and finds that, because of the resulting disadvantage in surplus bargaining, agents invest too heavily in learning market tasks and too little in learning domestic tasks.<sup>2</sup>

Other work has focussed on the interaction between educational decisions and marriage markets. Echevarria and Merlo (1999) present a model in which marriage partners bargain simultaneously over consumption, numbers of children, and childrens' education; while marriage market considerations impact educational decisions, decisions remain inefficient. Peters and Siow (2002) study human capital accumulation with assortative matching and non-transferable utility, and find that although educational decisions are generally inefficient, the size of the marriage market is important in assessing the degree of inefficiency.<sup>3</sup> Iyigun and Walsh (2003) study educational investments prior to entry into marriage market with assortative matching, and find that while it is possible to sustain efficient educational decisions, this possibility depends critically on the nature of the marriage market. Felli and Roberts (2002) investigate the degree to which investment inefficiencies depend on market frictions, and find both efficient and inefficient equilibria educational decisions; as competition reaches its peak and coordination failures disap-

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<sup>1</sup>See Manser and Brown (1980), McElroy and Horney (1981), and Lundberg and Pollak (1993,1994). Lundberg and Pollak (1996) reviews the literature.

<sup>2</sup>Lundberg (2002) develops a similar model in which spouses anticipate joint decisions over the allocation of familial time, and asks whether or not credible compensatory rules can be set up within marriage that encourage optimal decisions prior to marriage.

<sup>3</sup>Peters (2004) studies education and assortative matching problems more generally. See also Clark and Kanbur (2004), who delve more deeply into whether or not assortative matching in fact obtains in matching markets.

pear, investments become efficient. In a similar framework, Cole, Mailath, and Postlewaite (2001a, 2001b) describe how varying degrees of specificity impact the nature of prior investments made in anticipation of bargaining over marital surplus. They find that while there exist bargaining rules that support efficient investments, there is no guarantee that the “right” bargaining rule will be implemented. One of the chief lessons of this literature, then, is that the hold-up problem is robust to different model specifications, although its exact nature and importance depend upon marriage market characteristics, how outside-marriage options are specified, and how outside options and the marriage market interact.

In the broader literature on the hold-up problem, a variety of different solutions to hold-up problems have been explored, including shifting property rights (Williamson (1985), Hart and Moore (1990)), legal remedies for breach of contract (MacLeod and Malcomson (1993)), and wage-posting and directed search (Acemoglu and Shimer (1999)).<sup>4</sup> Our work suggests that a gender division of labor, or more generally, institutions that prohibit agents from performing certain tasks and encourage them to engage in others, may also mitigate the hold-up problem. Our theory combines elements of the standard model of education, time allocation, and surplus division (as in Konrad and Lommerud (2000) and Lommerud (1989)), with a framework in which spouses may learn multiple tasks (as in Vagstad (2001)). Agents then search for complementary partners in a marriage market, match, and bargain over marriage surplus, subject to an exogenous probability of marriage dissolution.

Our model contains some notable innovations. One innovation is the way in which we model the returns agents expect to receive outside of marriage. We allow agents limited opportunity for exchange and specialization outside of marriage. This generalizes the approach of Vagstad (2001) and Lundberg (2002), who describe tasks as “market” or “domestic” work; we allow each potential task performed to be, to varying degrees, market or domestic work. Further, our model characterizes the marriage market differently than the assortative matching frameworks employed by Iyigun and Walsh (2003), Felli and Roberts (2002), Cole, Mailath, and Postlewaite (2001a, 2001b), Peters and Siow (2002), and Peters (2004), and explicitly builds in marriage market frictions. In our model, agents engage in search for a complementary partner

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<sup>4</sup>See Williamson (1985) or Grossman and Hart (1986) for description of the general hold-up problem.

subject to frictions, where we use a matching process to characterize frictions in the marriage market, as in Diamond (1982), Mortensen (1982), and Pissarides (2000). Our method allows the difficulty or ease with which an alternative spouse may be found to enter into the determination and division of marital surplus, and also allows us to assess the interaction between marriage market factors and the incentives to acquire different types of skills.<sup>5</sup>

We describe the two types of social problems which may arise in the model as *the career choice problem* and *the jack-of-all-trades problem*; these two problems can be thought of as dimensions of the incentive problem described by Vagstad (2001) that arise when agents have to choose between learning market and domestic tasks. The career choice problem arises because agents of both genders prefer to learn tasks that are more marketable. When equipped with more marketable skills, agents command a larger share of the surplus created when married. However, this effect may lead to relative scarcity in the marriage market for those who specialize in less marketable skills, which increases their bargaining power. We show that this problem has the potential to generate fewer marriages than are socially desirable, and too many specialists in marketable tasks.

The jack-of-all-trades problem is the standard hold-up problem captured by much of the literature on education and bargaining within marriage, and is similar to the basic incentive problems discussed by Konrad and Lommerud (2000), Vagstad (2001), and Lundberg (2002). It is the result of what can be called an under-specialization incentive. In our model, agents learn a variety of tasks to ensure a reasonable living when not married, but also face a strategic incentive to learn a variety of tasks. To the extent that one is better off when not married if one is self-sufficient, this affects the bargaining within marriage over surplus, and self-sufficient agents are able to command a larger share of the marriage surplus. We show that this problem may generate less productive marriages which a gender division of labor may alleviate at cost: those agents who are not married and currently searching for partners are less able to subsist. The formalization of this tradeoff allows one to assess the circumstances under which a gender division of labor increases societal welfare.

One usefulness of bargaining models of marital surplus division is the in-

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<sup>5</sup>In some respects, our work carries out an agenda outlined by Vagstad (2001), who notes the need for careful consideration of the impact of the functioning of the marriage market on the incentives spouses have to learn market and domestic tasks.

sight they lend into the forces behind the relative treatment of spouses within marriage. This body of theory, is, for example, able to explain the observed negative correlation between the treatment of women within marriage and womens' opportunities outside of marriage. This relationship has borne itself out in a variety of settings, as described in Bahr (1972), Blood and Wolfe (1960), Buric and Zelevic (1967), Heer (1958, 1963), Rodman (1967), Saflios-Rothschild (1967), Scanzoni (1972) and Saltzman-Chafetz (1995). The negative correlation between treatment within marriage and ability to function outside of it also applies in less developed countries (Blumberg (1988)), and emerges across cultures of very different levels of sophistication (Rodman (1967)).

In practice, it seems that throughout history the gender division of labor is somewhat arbitrary. Consider table 1, from Jacobsen (1998: 217) using data from Murdock (1967). The table uses data from 863 past and present societies to create a simple breakdown for 11 activity groups by whether only or mostly men, both genders equally, or only or mostly women perform chores in the activity group. While some tasks, such as hunting, are almost exclusively men's activities, many tasks are not consistently allocated to one gender or the other, even though in a majority of cases, only one gender performs the task; agriculture, appearing at the bottom of the table, is perhaps the best example of this phenomenon.<sup>6</sup> This is in contrast to Becker's assertion that the gender division of labor is driven by biological differences between men and women and therefore should be relatively consistent across societies.<sup>7</sup> In consideration of this evidence, Hadfield (1999) notes that the basic coordination problem in skill acquisition does not imply that particular tasks need be done by either men or women, just that some gender division of labor be specified. Our theory has similar implications; the important thing about task segregation is not which tasks are allocated to which gender, but instead that some task segregation be specified to coordinate in the marriage

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<sup>6</sup>In a more detailed array of 46 sub-activities compiled for a set of 224 nonindustrial societies, Murdock (1937) finds these same general patterns, namely the prevalence of assignment to one or the other gender rather than non-gender-typing of activities, and the variation across societies for most activities regarding which gender actually performs the task. See Jacobsen (1998: 218) for a reprinting of these data.

<sup>7</sup>This patterning also contrasts to another biological-difference-based theory of the gender division of labor posited by Galor and Weil (1996), who suggest that men have comparative advantage in physical tasks and women in mental tasks; thus gendered labor divisions would be comparable for societies at the same level of development.



market and restrict strategic investment problems.

We show that a customary gender division of labor may mitigate both the jack-of-all-trades problem as well as the career choice problem by forcing one segment of the population to learn specific tasks.<sup>8</sup> We also show that such rules have distributional consequences: the relative position of one spouse within marriage may be worsened, resulting in poorer treatment both within marriage and outside of it. Thus, a gender division of labor may increase welfare, but this increase in overall welfare may not be Pareto-improving for both genders. These arguments together are suggestive as to why customary gender divisions of labor have proven to be so enduring, even when seemingly anachronistic. Our results indicate that a customary gender division of labor might have social value in some circumstances, but, to some degree, occurs at the expense of the disadvantaged gender and may harm the ability of individuals to function outside of marriage. Further, one gender may have a vested interest in maintaining the customary gender division of labor because of the distributional consequences of the rule.

## 2 The Model

### 2.1 Basic framework

Becker (1991: Chapter 2) models human capital acquisition, marriage, and time devoted to production as a simultaneous choice. Matching and bargaining models of marriage typically modify this framework so that decisions are made sequentially, in which educational investments are made first, then matching in the marriage market occurs, marriage terms are negotiated, and time allocation decisions are made. We follow this conventional sequence of events.

The population consists of type  $m$  and type  $f$  agents; the number of each type of agent is normalized to one.<sup>9</sup> All agents gain utility from consuming

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<sup>8</sup>In this sense, our theory, like Lundberg (2002), focuses on ways in which marital hold-up and coordination problems might be solved, rather than discussing the details of the problem. Lundberg's focus is primarily on family policy, while ours is on the role of custom.

<sup>9</sup>Like most models of marriage, our model posits only two types of agents. Interestingly, a number of societies feature what is, in effect, a third gender role. These roles have been found in a number of societies, including a number of American Indian tribes, where such roles appear to be inextricably tied to homosexual behavior, as well as the *xanith* in Oman,

two consumption goods,  $a$  and  $b$ , according to a utility function:

$$u = u(a, b).$$

The utility function has the standard shape:  $u_a > 0, u_b > 0, u_{aa} < 0, u_{bb} < 0$ , and both goods are essential:  $u(0, b) = u(a, 0) = 0$ .

Agents have one unit of labor time to allocate to production of either good. The amount of time devoted to production of good  $a$  is  $t$ , so the amount of time devoted to production of good  $b$  is  $1 - t$ .

The total amount of output that an agent can produce depends on his/her skill set. As is also typical in the literature, we assume that production occurs according to a linear technology. The amount of good  $a$  an agent can produce is given by

$$a = \alpha t,$$

where  $t$  is the time allocated to production of good  $a$ , and the total amount of good  $b$  that an agent is capable of producing is:

$$b = \beta(1 - t).$$

Agents' skill sets are captured by the parameters  $\alpha$  and  $\beta$ . Agents are not endowed with skills naturally, but must engage in costly learning to acquire skills. We follow Rosen (1983) in specifying the costs of acquiring skills. These costs are:

$$c_i = c_i(\alpha, \beta); \quad i = f, m.$$

The cost function has the standard shape:  $c_\alpha > 0, c_\beta > 0, c_{\alpha\alpha} > 0, c_{\beta\beta} > 0, c_{\alpha\beta} \geq 0$ . The subscripts on the costs-of-learning function allow for potential differences in the costs of learning across genders, but do not preclude the possibility that women and men are identical in their capacity to learn tasks. In fact, we focus primarily on the case in which  $c_f = c_m$ ; thus, we posit that there are no biological differences in the capacity to learn different tasks. However, by allowing for cost functions to vary, one could study the impact

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the *mahu* of Tahiti, and the *hijra* in India (Jacobsen 1998: 401). There is some debate over whether these third-gender persons took on cross-gender roles or truly filled a third position within societies with different associated tasks. This second possibility posits an interesting additional modelling problem for future research.

of biological differences between men and women on the gender division of labor.

In the first phase of the game, agents learn skills. We find it convenient to characterize learning as choice taking place over two dimensions: choice of a specialty, which is akin to choosing a comparative advantage, and then choice of  $\alpha$  and  $\beta$ , the degree to which each task is learned.<sup>10</sup> An agent applies his or her specialty skill when the possibility of specialization presents itself, but is free to apply his or her secondary skill as needed, when the option to specialize is not available. After agents have simultaneously decided on specialties and learning, the second stage of the game commences.

In the second phase of the game, agents enter a marriage market in which they match with a complementary partner of the opposite gender and specialty. Those women who have elected to specialize in producing good  $a$  enter a marriage market in which they search for men who have specialized in producing good  $b$ , and vice versa. The marriage market is assumed to be segmented, so that type  $f$  agents who have specialized in production of good  $a$  face no possibility of encountering a type  $m$  agent who is also specialized in production of good  $a$ . There are potentially two marriage markets, one in which type  $f$  agents specializing in  $a$  production are matched with type  $m$  agents specializing in production of  $b$ , and one in which type  $f$  agents specialized in production of good  $b$  are matched with type  $m$  agents specializing in production of good  $a$ . Within each market, agents randomly encounter complementary agents of the opposite type.<sup>11</sup> Our results are robust to the case in which matching occurs randomly across opposite-gender agents of all specialty, but the analysis is a bit more complicated in the more general case. In the limiting case in which all women, for example, specialize in the same task, there is only one market segment.

As in other models of marriage and production, marriage generates returns to its participants by creating a low-transactions costs environment within which two agents with complementary skills can engage in specialization, production, and exchange. A clear statement of the value created by the marriage environment requires description of the returns agents can achieve outside of marriage. Thus, we first describe agents' autarkic, "outside

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<sup>10</sup>In this regard, our model is similar to Lundberg (2002) and Vagstad (2001), who also model multidimensional educational choices.

<sup>11</sup>This is a model of segmented market search; see Acemoglu (1997). In most other ways, our model closely mirrors the classic search and matching model due to Diamond (1982), Mortensen (1982), and Pissarides (2000).

marriage” returns.

## 2.2 Autarkic utilities and potential for exchange

Autarkic utility forms an important part of an agent’s leverage in bargaining over the gains to marriage, and also describes the well-being of agents when they are not married, engaged in search for a complementary partner. For these two reasons, autarkic returns occupy an important place in our model and warrant a detailed discussion.

We begin by noting that if an agent is not matched with a marriage partner and has no other opportunities for exchange, he or she must allocate time to production of both goods. That is, the agent earns returns:

$$h(\alpha, \beta) = u(\alpha t^*, \beta(1 - t^*)), \quad (1)$$

where  $t^*$ , the agent’s optimal allocation of effort between the two tasks, lies strictly between zero and one. Marriage is one such opportunity for specialization and exchange, but generally speaking, agents may have some opportunity for specialization and exchange even if not married, for instance, through access to labor and goods markets or some alternative institution. For utmost simplicity, we imagine that the relative price of good  $a$  is one, thus, if an agent were able to find such an exchange opportunity, the agent could earn utility:

$$e(\alpha) = u(\alpha(1 - x^*), \alpha x^*). \quad (2)$$

Expression (2) is similar to (1) with one notable exception. As stressed by our notation, the function  $e(\alpha)$  depends only on the agent’s ability to perform his or her specialty task, while  $h$  depends upon the agent’s ability to perform both tasks. The possibility of exchange allows the agent to replace his or her autarkic opportunity cost trade-off with that in the market, as in any model of comparative advantage.

To reflect the idea that the agent may not always have an exchange and specialization opportunity, we adopt a simplistic framework in which the agent encounters an exchange opportunity with some exogenous probability  $p$ . Thus, an agent who has specialized in production of good  $a$  earns expected utility:

$$u^a = (1 - p^a)h^a(\alpha, \beta) + p^a e^a(\alpha). \quad (3)$$

The same chain of logic applies to an agent who has specialized in production of good  $b$ :

$$u^b = (1 - p^b)h^b(\alpha, \beta) + p^b e^b(\beta). \quad (4)$$

The probabilities  $p^a$  and  $p^b$  are natural, if simplistic, measures of the degree to which exchange opportunities exist outside of marriage. The inclusion of the probability of encountering an exchange opportunity outside of marriage is our way of measuring the specificity of investments, which emerges as a crucial factor in analyzing investment decisions in different, yet related models such as Cole, Mailath, and Postlewaite (2001a,b). Further, this modelling technique generalizes the approach of other work that focuses on the distribution of effort among spouses between “market” work and “domestic” work, as in Konrad and Lommerud (2000), Vagstad (2001), and Lundberg (2002).<sup>12</sup> In our model, each task is potentially domestic and/or market work, depending on the probability of encountering an outside exchange opportunity. This will allow us to see how the potential role for a gender division of labor changes as tasks vary in the degree to which they are domestic or market work. A final point worth establishing is that, as long as an agent is not equally gifted at the two tasks, autarkic utility is strictly increasing in the degree to which an outside exchange opportunity is present.

### 2.3 Marriage returns and marriage surplus

Following Becker (1991), in our model the gains to marriage stem from the fact that marriage is a zero transactions costs environment, and agents can therefore specialize and exchange within marriage to maximum joint advantage.<sup>13</sup> If marriage partners are able to produce some amounts  $a_w$  and  $b_w$  of goods  $a$  and  $b$ , they may costlessly negotiate agreements which result in a Pareto-optimal distribution of these quantities within the marriage. Since agents are assumed to have identical preferences, a Pareto-optimal distribution of goods within marriage gives each agent an equal consumption bundle.

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<sup>12</sup>While our approach generalizes that taken in previous literature, we still have avoided explicitly modelling outside marriage exchange institutions, though we shall discuss some related issues at further length below.

<sup>13</sup>This framework is similar to Becker’s original formulation, and is also similar to that employed in Hatfield (1999). Contrast this with “public goods” models of marriage, in which marital surplus arises through provision of public goods within marriage, as in Lommerud (1989), Vagstad (2001), and Lundberg (2002).

Then, assuming  $u$  to be homogenous of degree one in its arguments, the total utility generated by marriage in this case can be written as:

$$W(a_w, b_w) = 2u\left(\frac{1}{2}a_w, \frac{1}{2}b_w\right) = u(a_w, b_w). \quad (5)$$

If the couple must produce all goods itself, and neither marriage partner has any opportunity for exchange outside of marriage, time allocations are chosen to maximize (5) given the skills of the spouses. In what follows, we focus on the case in which the type  $f$  agent is an  $\alpha$  specialist, while the type  $m$  agent is a  $\beta$  specialist. Substituting production functions into (5) gives:

$$W = u(\alpha_f t_f + \alpha_m t_m, \beta_f(1 - t_f) + \beta_m(1 - t_m)). \quad (6)$$

In this context Becker (1991: 33) shows that it is optimal for at least one agent to specialize completely in production of one good. Like Hadfield (1999), we also find it easier to work with a stronger case of Becker's result, and assume that full specialization is optimal, so that within marriage each agent fully allocates all of his or her time to his or her specialty.<sup>14</sup> Thus, in the event that there is no potential to enter into exchange agreements outside of marriage, we may write total marriage returns as:

$$H = H(\alpha_f, \beta_m).$$

So far, we have assumed that married agents have no potential to engage in exchange outside of marriage in a labor market. What if the couple had an opportunity to trade  $a$  for  $b$ ? In this case the married couple achieves utility:

$$E^a = u(\alpha_f(1 - x_f^*), x_f^* \alpha_f + \beta_m),$$

where  $x_f^*$  is the optimal quantity of good  $a$  that the couple exchanges in the market at the assumed 1:1 trade ratio. We might also consider the case in which the type  $m$  agent is able to exchange  $b$  for  $a$ :

$$E^b = u(\alpha_f + (1 - x_m^*)\beta_m, x_m^* \beta_m).$$

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<sup>14</sup>We thus sidestep some of the complexities involved in choosing marital allocations of time for reasons of tractability. Our chief purpose is describing in simple fashion gains to specialization. The time allocation has been studied extensively in, for example, Lommerud (1989) and Konrad and Lommerud (2000). Still, in the present paper, agents do spend some amount of their lifetime executing both tasks as a result of search frictions.

How does the presence of exchange opportunities influence marriage returns? Since we assumed the two goods entered into the utility function in the same way, the marginal gains from engaging in market exchange for one good can be studied by differentiating the utility function with respect to  $x_f$  or  $x_m$ , and evaluating the result at  $x_f = 0$  or  $x_m = 0$ . For example:

$$\left. \frac{\partial E^a}{\partial x_f} \right|_{x_f=0} = -\frac{\partial u(\alpha_f, \beta_m)}{\partial a} + \frac{\partial u(\alpha_f, \beta_m)}{\partial b}.$$

The above expression may be either positive or negative, and depends on the marginal utilities of the two goods at the productivity levels/output levels  $\alpha_f, \beta_m$ . Since the two goods enter the utility function in exactly the same fashion, we have the following:

$$\begin{aligned} \frac{\partial E^a}{\partial x_f} < 0 & \quad \text{if} \quad \alpha_f < \beta_m, \\ \frac{\partial E^a}{\partial x_f} = 0 & \quad \text{if} \quad \alpha_f = \beta_m, \\ \frac{\partial E^a}{\partial x_f} > 0 & \quad \text{if} \quad \alpha_f > \beta_m. \end{aligned}$$

This indicates that there are gains to engaging in an exchange opportunity only if, for example, the type  $f$  agent has an *absolute* advantage in producing good  $a$  so that  $\alpha_f > \beta_m$ . A similar argument would illustrate that this is also true when an opportunity to exchange good  $b$  presents itself. We thus have the following form of marriage returns, taking into the account the probabilities with which exchange opportunities present themselves:

$$\begin{aligned} W(\alpha_f, \beta_m) = & \quad H(1 - p^a) + p^a E^a, \quad \alpha_f > \beta_m, \\ & \quad H, \quad \alpha_f = \beta_m, \\ & \quad H(1 - p^b) + p^b E^b, \quad \alpha_f < \beta_m. \end{aligned} \tag{7}$$

A similar function  $W(\beta_f, \alpha_m)$  can be developed for the case in which the agents have chosen alternative specialties. As in the case of individual agents' returns, note further that *marriage returns never depend on either agents' ability to perform their non-specialty task*. If married, agents fully specialize, regardless of whether or not an outside exchange opportunity presents itself.

## 2.4 Matching and the search for a marriage partner

Once agents have made skill acquisition decisions, agents enter a matching game in which they may be matched to an agent with a complementary skill set, by which we mean an agent of the opposite type who has a comparative advantage in production of the other good. When matched with a complementary partner, agents of opposite types and skill sets immediately strike a Nash bargain over division of the marriage surplus, and then engage in joint production and distribution. If agents are not matched, they produce alone for a period and then reenter the matching process in the next period. With positive probability at the beginning of every period, those agents that were married are separated from their spouses by exogenous forces at the rate  $s$ . When separation occurs, agents produce alone one period and then reenter the matching game the following period.<sup>15</sup>

There are potentially four types of agents in the model: type  $f$  agents who specialize in production of good  $a$ , type  $f$  agents who specialize in production of good  $b$ , type  $m$  agents who specialize in production of good  $a$ , and type  $m$  agents who specialize in production of good  $b$ . Since we have normalized the size of each population of agents to be of measure 1, we can denote the population frequency of each type of agent as  $f^a$ ,  $f^b$ ,  $m^a$ , and  $m^b$ , respectively. We shall also use this notation to refer to each type of agent.

We denote the percentage of agents of each type that are unmarried by including a “ $U$ ” subscript, so the fraction of unmarried  $f^a$  is  $f_U^a$ . The matching technology describing the process by which unmarried  $f^i$  agents are matched with unmarried  $m^j$  agents is given by, at any time  $t$ :

$$w^{ij} = w^{ij}(f_U^i, m_U^j).$$

where either  $ij = ab$ , denoting the case in which type  $f$  agents specializing in production of good  $a$  are matched to type  $m$  agents with specialty  $b$ , or  $ij = ba$ , denoting the opposite case. We assume that  $w$  is continuous and homogenous of degree one.

Using the matching technology, we can explicitly describe the solution for lifetime utilities, matching probabilities, and the fraction of the lifetime the typical agent spends married. The matching technology can be used to describe the flow of agents into and out of marriage. For example, the

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<sup>15</sup>We assume that there is an exogenous separation rate for largely technical reasons. We do, however, expound on the role of the separation rate in ensuing sections. A good discussion of time allocation under the threat of divorce is Lommerud (1989).



fraction of  $f^i$  agents and  $m^j$  agents who are unmarried at any given time obey the following laws of motion:

$$\begin{aligned} \dot{f}_U^i &= -w^{ij}(f_U^i, m_U^j) + s(f^i - f_U^i), \\ \dot{m}_U^j &= -w^{ij}(f_U^i, m_U^j) + s(m^j - m_U^j). \end{aligned} \quad (8)$$

The first expression on the right-hand side of each of the equations in (8) describes the number of unmarried agents who match, marry, and thus exit the unmarried state, while the second term on the right hand side of the two equations in (8) describes the number of married agents who are separated from their current match, and thus enter into the pool of unmatched agents; in writing these expressions, we have exploited the fact that  $f^i = f_M^i + f_U^i$ . This simply means that the fraction of married and unmarried agents must add up to the total number of type  $f$  agents specialized in production of good  $i$ .

In steady state equilibrium, it must be the case that  $\dot{f}_U^i = 0$  and  $\dot{m}_U^j = 0$ . This relationship implies that in a steady-state the following must be true:

$$s(f^i - \bar{f}_U^i) = w^{ij}(f_U^i, m_U^j) = s(m^j - \bar{m}_U^j) \quad (9)$$

The equalities in (9) mean that the flow of unmarried  $f^i$  agents who match in the marriage market must equal the flow of  $m^j$  agents who match in the marriage market. Equation (9) implies that:

$$\bar{f}_U^i = f^i - m^j + \bar{m}_U^j. \quad (10)$$

Equation (10) indicates that the number of unmatched agents on one side of the market is generally equal to the number of unmatched agents on the other side of the marriage market only when the number of participants on each side of the market is equal. If it should be the case, for example, that there are more  $f^i$  agents than  $m^j$  agents, the result would be that there are, at any given time, more unmatched  $f^i$  agents than  $m^j$  agents. This has important ramifications for the probability that any type of agent finds a match when searching for a marriage partner, and also impacts bargaining over marriage surplus. The steady-state probability that an unmarried type  $f^i$  agent finds a match (a type  $m^j$  agent) at any particular time as:

$$\bar{q}_f^i = \frac{w^{ij}(\bar{f}_U^i, \bar{m}_U^j)}{\bar{f}_U^i}, \quad (11)$$

while the probability that an unmarried  $m^j$  agent finds an  $f^i$  agent is:

$$\bar{q}_m^j = \frac{w^{ij}(\bar{f}_U^i, \bar{m}_U^j)}{\bar{m}_U^j}. \quad (12)$$

Note that the equilibrium match probability (11) for a type  $f^i$  agent is increasing the number of  $m^j$  agents in the market, and decreasing in the number of  $f^i$  agents in the market. Equation (10) indicates that  $\bar{q}_f^i$  and  $\bar{q}_m^j$  will only be equal when there are equal numbers of  $f^i$  agents and  $m^j$  agents in the marriage market.

Let  $V$  denote the (steady state) lifetime utility of a married agent,  $R$  denote the lifetime utility of an unmarried agent, and  $S$  the share of marriage surplus obtained by the agent. In a steady state, the lifetime utility of a type  $k = f, m$  agent specializing in production of good  $i = a, b$  is described by:

$$rV_k^i = S_k^i + s(R_k^i - V_k^i), \quad (13)$$

while the steady state lifetime utility of a type  $k$  agent specializing in  $i$  production who is unmarried is:

$$rR_k^i = u_k^i + \bar{q}_k^i(V_k^i - R_k^i). \quad (14)$$

Solving equations (13) and (14) gives the following equations:

$$V_k^i = \frac{su_k^i + (\bar{q}_k^i + r)S_k^i}{r(r + s + \bar{q}_k^i)}, \quad (15)$$

$$R_k^i = \frac{(r + s)u_k^i + \bar{q}_k^i S_k^i}{r(r + s + \bar{q}_k^i)}. \quad (16)$$

Describing the division of the marriage surplus closes the model. We follow convention and suppose that surplus is divided according to an instantaneous symmetric Nash bargain. Surplus shares  $S_f^i$  and  $S_m^j$  are determined by the solution to:

$$V_m^i - R_m^i = V_f^j - R_f^j. \quad (17)$$

Applying (15) and (16) to (17) we have:

$$S_k^i = \Delta_k^i W - \Delta_k^i u_l^j + \Delta_l^j u_k^i. \quad (18)$$

The share coefficients  $\Delta_k^i$  are given by:

$$\Delta_k^i = \frac{r + s + \bar{q}_k^i}{2r + 2s + \bar{q}_k^i + \bar{q}_l^j}. \quad (19)$$

To aid in keeping the subscripts and superscripts straight, if we chose  $k = m, l = f$  we could take  $i = a$  or  $j = b$  to examine the case in which type  $m$  agents specialize in production of  $a$  and type  $f$  agents specialize in production of  $b$ , for example.

The shares in (19) reflect the idea that bargaining power depends on the proportion of each type of agent in the population. Note that the share equations described by (19) imply that  $\Delta = \frac{1}{2}$  when there are equal proportions of type  $f$  and type  $m$  agents participating in a marriage market, as in this case, the equilibrium matching probabilities (11) and (12) are equal (recall further the discussion of steady state fractions of each type of agent searching for a marriage partner at equations (9) and (10)). If there are not equal proportions of complementary agents in the marriage market, the relatively scarce side of the marriage market enjoys a bargaining advantage which is reflected by a larger value of  $\Delta$ . This is because the scarcer side of the market matches more easily as reflected by a larger value of  $q$ , which in turn implies a larger value of  $\Delta$ .

Since agents move in and out of marriage according to a two-state Markov process in equilibrium, in the long run, an agent of any type and specialty spends the following fraction of time married (omitting subscripts for brevity):

$$\frac{\bar{q}}{s + \bar{q}},$$

and a fraction of time:

$$\frac{s}{s + \bar{q}},$$

unmarried. Weighting each value function by the fraction of time spent in marriage and the the fraction of time spent away from marriage admits the following representation of lifetime utilities:

$$U = \frac{\bar{q}S + su}{r(\bar{q} + s)}. \quad (20)$$

Lifetime utility depends on the fraction of time spent married, the division of the marriage returns, and the fraction of time that each agent spends in each state. Our primary instrument in analyzing specialty selection and human capital acquisition, any resulting impacts on the relative welfare of the sexes, and optimal decisions with and without a customary gender division of labor is  $U$  in (20), coupled with the shares of surplus described in (19).

## 2.5 Strategic specialty choice

There are two potential types of social problems that occur in our model, both of which may be mitigated by a customary gender division of labor. The first problem, which is the focus of this section, blends elements of a coordination problem with strategic choice of specialty. One might describe this section of the paper as developing the marriage market ramifications of the results described in Vagstad (2001) and Lundberg (2002) pertaining to agents' choices in learning market and domestic work. As Vagstad showed, agents prefer to learn market tasks because of the leverage gained in marital surplus bargaining. The exposition of our model in this subsection develops some of the nuances of this picture, and also supplements understanding of the coordination model of Hadfield (1999).

We begin by describing career choice in the absence of a customary gender division of labor. To isolate the career choice aspect of the problem, suppose that there is no inherent difference between type  $f$  agents and type  $m$  agents and that the costs of learning to produce good  $a$  or good  $b$  as a specialty are equal. Further, suppose that career choice is discrete, so an individual chooses a career at a fixed cost  $c$ , and thereby gains a bundle of skills, denoted by  $(\alpha^a, \beta^a)$  for an agent specializing in  $a$  production, and  $(\alpha^b, \beta^b)$  for an agent specializing in  $b$  production. To reiterate, we assume that:

$$c^a(\alpha^a, \beta^a) = c^b(\alpha^b, \beta^b) = c,$$

and also that

$$\alpha^a = \beta^b, \alpha^b = \beta^a; \alpha^a > \alpha^b$$

These assumptions imply that the acquired skill bundles are mirror images of one another. Since agents are identical, there is no difference in the aggregate returns created by either type of marriage (i. e., either an  $a$  to  $b$  type marriage or a  $b$  to  $a$  marriage), so regardless of which gender performs which task

in marriage, we write returns achieved by a married couple as  $W$ , where  $W = 2u(\frac{\alpha^a}{2}, \frac{\beta^b}{2})$ . The neglect of whether or not an exchange opportunity for either good is present is made possible by our assumptions that neither agent has an absolute advantage in production, and that the goods receive equal weight in the utility function, as described in section 2.3, equation (7).

The specialty choice game has an easily-characterizable set of equilibria. There are two pure strategy equilibria in which all agents of each type specialize in production of the same good, and a mixed strategy equilibrium in which positive fractions of agents specialize in both tasks. The two pure strategy equilibria cannot in general be Pareto ranked, as they both generate equal social welfare. However, each gender strictly prefers the equilibrium in which he or she is more specialized in the relatively more marketable task.

To be more explicit, consider the pure strategy equilibrium in which all type  $f$  agents specialize in production of good  $a$ , while all type  $m$  agents specialize in production of good  $b$ . In this case, the probability of finding a mate when unmarried is equal for both types of agent (indeed, the measure of participants in the only existing side of the marriage market is one), and collapses to  $q_k^i = q_l^j = \bar{q}$ . The lifetime utilities described by (20) and the surplus division equations (18) and (19) simplify to:

$$U_{f,ps}^a = \frac{1}{2} \frac{\bar{q}(W + u_f^a - u_m^b) + 2su_f^a}{r(\bar{q} + s)}$$

and

$$U_{m,ps}^b = \frac{1}{2} \frac{\bar{q}(W + u_m^b - u_f^a) + 2su_m^b}{r(\bar{q} + s)}. \quad (21)$$

In this case, recall that the shares of the surplus described by (19) reduce to  $\frac{1}{2}$ .

Social welfare is the sum of utility obtained by both types, weighted by the fraction of the population of each type (which is in this case unity):

$$SW = \frac{\bar{q}W + su_f^a + su_m^b}{r(\bar{q} + s)}. \quad (22)$$

Suppose now that there is a difference in the returns individuals earn due to differences in the likelihood agents of different specialties are able to find outside exchange opportunities. In particular, suppose that  $p^a < p^b$ , from

which it follows that  $u_f^a < u_m^b$  (see equations (3) and (4)). Thus, *ceteris paribus*, agents prefer the equilibrium in which they specialize in the task for which there are more exchange opportunities outside of marriage; note how the difference  $u_m^b - u_f^a$  enters into the utility functions in (21).

These results imply that each gender prefers the pure-strategy equilibrium in which they are specialized in the relatively more marketable task. How might one measure the gains which accrue to society from this effect more generally? As a benchmark for the no-coordination case, consider the mixed-strategy equilibrium in which some fraction of agents of both types specialize in both tasks.<sup>16</sup> In the mixed-strategy equilibrium, agents of both types must receive equal utility from either career choice:

$$U_f^a = U_f^b; \quad U_m^b = U_m^a.$$

Since  $p^a < p^b$ , it follows that  $u^a < u^b$  (see equations (3) and (4)). This leads to the implication that at the mixed-strategy equilibrium, unequal numbers of each type of agent in the market. Specifically,  $f^b > f^a$ , and  $m^b > m^a$ , so that more agents of each gender specialize in the relatively more marketable task. This is because, when  $u^a < u^b$ , when there are equal numbers of each type of agent in the marriage market,  $U^a < U^b$ , indicating that some agents specializing in production of  $a$  could switch to  $b$  production and earn strictly greater utility.

This argument renders clear how utilities are equilibrated across specialties. As agents move towards more marketable tasks, those that are specialized in unmarketable tasks grow scarcer. Because they are relatively scarce in the marriage market, they are able to obtain a share of surplus in marriage bargaining that offsets the disadvantage due to specialization in the nonmarketable task. One may employ these results to show that, even though one of the pure strategy equilibria increases social welfare, it may not necessary generate a Pareto improvement for each type of agent. Consider the utility of  $f$  agents specialized in  $a$  at the pure strategy equilibrium; this utility is given by the second part of (21). At the mixed-strategy equilibrium, this

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<sup>16</sup>There remains the difficult conceptual question as to whether or not the mixed-strategy equilibrium is the appropriate baseline for describing outcomes in a completely uncoordinated environment. In this game, there is no natural focal point, and neither pure strategy equilibrium is a natural choice over the other, so the mixed strategy equilibrium is a reasonable yardstick for the case in which coordination is absent.

agent earns instead:

$$U_{f,ms}^a = \frac{\bar{q}_f^a S_f^a + s u^a}{r(\bar{q}_f^a + s)}, \quad (23)$$

Where  $S_f^a$  is to be determined. Let  $\bar{\Delta}_f^a$  and  $\bar{\Delta}_m^b$  denote the equilibrium share of surplus obtained at the mixed strategy equilibrium. Since  $f^a < m^b$  at the mixed strategy equilibrium, we have  $\bar{q}_f^a > \bar{q} > \bar{q}_m^b$ , which in turn implies that  $\bar{\Delta}_f^a > \frac{1}{2} > \bar{\Delta}_m^b$ . Lifetime utility (23) at the mixed strategy equilibrium can now be written as:

$$U_{f,ms}^a = \frac{\bar{q}_f^a(\bar{\Delta}_f^a(W - u_m^b) + \bar{\Delta}_m^b u_f^a) + s u_f^a}{r(\bar{q}_f^a + s)}. \quad (24)$$

For utility at the pure strategy equilibrium to be greater than utility at the mixed strategy equilibrium, the following inequality must hold, using (21) and (24) to form  $U_{ps,f}^a > U_{ms,f}^a$ :

$$\mu_f(W - u_m^b) + \mu_m u_f^a < s(\bar{q}_f^a - \bar{q})u_f^a; \quad (25)$$

The weights  $\mu_m$  and  $\mu_f$  are defined by the following expressions:

$$\begin{aligned} \mu_f &= (\bar{q}_f^a \bar{q} (\bar{\Delta}_f^a - \frac{1}{2}) + s(\bar{q}_f^a \bar{\Delta}_f^a - \frac{1}{2} \bar{q})), \\ \mu_m &= (\bar{q}_f^a \bar{q} (\bar{\Delta}_m^b - \frac{1}{2}) + s(\bar{q}_f^a \bar{\Delta}_m^b - \frac{1}{2} \bar{q})). \end{aligned} \quad (26)$$

The sign of (25) is ambiguous. The term on the right-hand side of the inequality in (25) is positive, as  $\bar{q}_f^a > \bar{q}$ , meaning that those specialized in non-marketable tasks are more likely to find matches at the mixed-strategy equilibrium relative to the pure-strategy equilibrium. Since  $\bar{\Delta}_f^a > \frac{1}{2}$ ,  $\mu_f$  is greater than zero, and since  $\bar{\Delta}_m^b < \frac{1}{2}$ ,  $\mu_m$  is less than zero. Thus, one may conclude that a switch from a mixed-strategy equilibrium, in which both genders perform both tasks, to a pure strategy equilibrium, in which each gender performs a specific task, produces ambiguous results on the utility of the gender which is forced to specialize in the less marketable task. Consider inequality (25) as the term  $u_f^a$  gets very small; this may happen, for example, because an individual specialized in production of good  $a$  cannot produce  $b$  well, and/or has almost no opportunity to engage in exchange outside of

marriage; in short, this agent's skills are relatively specific to marriage. As the  $u_f^a$  term goes to zero, the inequality in (25) cannot be satisfied, as the right-hand side goes to zero while the left-hand side remains strictly positive. This happens because at the coordinated equilibrium, agents specialized in the relatively marriage-specific task no longer have the twin advantages gained through relative scarcity: easier matching, and the resulting increase in bargaining power.

Thus, in the circumstance in which one gender learns a highly marriage-specific task, the gender division of labor may be welfare-improving but not Pareto-improving. This result reinforces explanations for several features of a customary gender division of labor. For example, the fact that the gender division of labor might be welfare-increasing in circumstances in which there are limited opportunities to engage in exchange and specialization outside of marriage, and when agents do not or must not spend a large fraction of their lives unmarried, makes strong intuitive sense. Further, the idea that a customary gender division of labor puts the party with relatively less marketable skills at a disadvantage in bargaining over the marriage surplus, and therefore leaves this party with a smaller share of the marriage surplus and in some sense, treated relatively less well within marriage, also coincides with empirical observation.

The flip side of the result that the gender division of labor reduces the utility of one party relative to the mixed strategy equilibrium is that it increases the utility of the other relative to the mixed strategy equilibrium. Thus, a motive for the party in relative power to maintain the gender division of labor even after it has outlived its welfare-enhancing properties is suggested by this work.

## 2.6 Customary gender division of labor and the hold-up problem

We begin this section by illustrating the incentive problem that occurs when there is no customary gender division of labor, but now focus on reasons why one agent type may be explicitly prohibited, possibly by social sanction, from performing one task or the other. We show that relative to the social optimum, agents invest too much in learning tasks that they do not perform when married, and invest too little in tasks that they do. This investment strategy renders agents less reliant on marriage, and thus better-positioned



to bargain over marriage terms. In some circumstances, a customary gender division of labor, by prohibiting agents from engaging in certain tasks, may reduce agents' incentives to learn tasks they will not specialize in marriage. Not surprisingly, the rule has distributional consequences that may cause a reduction in lifetime utility for one party relative to a regime in which there is no customary gender division of labor, though this effect may be neutralized if both groups are restricted in the tasks that they may perform. This latter possibility amounts to a case in which the gender division of labor forces both parties to marriage away from a noncooperative investment equilibrium and closer to a cooperative one, though a two-sided gender division of labor is an imperfect means of accomplishing this.

To keep things simple, we focus on one pure strategy equilibrium: one in which all type  $f$  agents specialize in production of good  $a$  when married, and all type  $m$  agents specialize in production of good  $b$  when married. This isolates our study of incentives from our investigation of specialty choice in the previous section. It also allows us to illustrate clearly an additional motive as to why a society might wish to prohibit members of one group from engaging in certain tasks, beyond simply directing them towards a certain specialty.

Consider the human capital investment decision of one type  $f$  agent,  $\hat{f}$ , given the behavior of all other type  $f$  agents and all type  $m$  agents (Indeed, throughout this section we shall treat the decisions of type  $m$  agents as fixed). Whenever matched with a type  $m$  agent (adopting the convention that all variables pertaining to  $\hat{f}$  are marked with a hat),  $\hat{f}$  receives a share of the marriage surplus determined by:

$$\hat{V}_m^b - R_m^b = \hat{V}_f^a - \hat{R}_f^a \quad (27)$$

Equation (27) indicates that the division of the surplus  $\hat{f}$  receives depends on the population characteristics of agents of both types. If any type  $m$  agent were to refuse marriage with  $\hat{f}$ , in the next period he would be matched with the "typical" type  $f$  agent, as the probability of seeing  $\hat{f}$  again is zero. If we first solve for the standard division of the surplus described by (17), substitute the result into (27), and solve for  $\hat{S}_f^a$ , we get:

$$\hat{S}_f^a = \frac{(\bar{q} + r)\hat{W} + r(\hat{u}_a^f - u_b^m) - \bar{q}\frac{1}{2}(W - u_a^f + u_b^m)}{(2r + \bar{q})}. \quad (28)$$

Substituting  $\hat{S}_f^a$  from (28) into (20) yields:

$$\hat{U}_f^a = \frac{\bar{q}((\bar{q} + r)\hat{W} + r(\hat{u}_a^f - u_b^m) - \bar{q}\frac{1}{2}(W - u_a^f + u_b^m))}{r(2r + \bar{q})(\bar{q} + s)} + \frac{s\hat{u}_a^f}{r(\bar{q} + s)}. \quad (29)$$

Social welfare can be written in the same form as previously described in (22):

$$SW = \frac{\bar{q}W + su_f^a + su_m^b}{r(\bar{q} + s)}. \quad (30)$$

Consider now the individual type  $\hat{f}^a$  agent's incentive to invest in learning the two tasks. The agent's first order conditions for maximizing (29) are:

$$\frac{\partial U_f^a}{\partial \alpha} = \frac{\bar{q}}{r(2r + \bar{q})(\bar{q} + s)} \left[ (\bar{q} + r) \frac{\partial W}{\partial \alpha} + r \frac{\partial u_a}{\partial \alpha} \right] + \frac{s}{r(\bar{q} + s)} \frac{\partial u_a}{\partial \alpha} - \frac{\partial c}{\partial \alpha} = 0, \quad (31)$$

and

$$\frac{\partial U_f^a}{\partial \beta} = \frac{\bar{q}}{(2r + \bar{q})(\bar{q} + s)} \frac{\partial u_a}{\partial \beta} + \frac{s}{r(\bar{q} + s)} \frac{\partial u_a}{\partial \beta} - \frac{\partial c}{\partial \beta} = 0. \quad (32)$$

By contrast, maximization of social welfare with respect to the type  $f$  agents choices of  $\alpha$  and  $\beta$  yields the following two first order conditions:

$$\frac{\partial SW}{\partial \alpha} = \frac{1}{r(\bar{q} + s)} \left[ \bar{q} \frac{\partial W}{\partial \alpha} + s \frac{\partial u_a}{\partial \alpha} \right] - \frac{\partial c}{\partial \alpha} = 0, \quad (33)$$

and

$$\frac{\partial SW}{\partial \beta} = \frac{s}{\bar{q}(r + s)} \frac{\partial u_a}{\partial \beta} - \frac{\partial c}{\partial \beta} = 0. \quad (34)$$

Comparing social welfare and individual returns allows one to see the sources of the incentive problem in human capital acquisition decisions. Agents excessively weight outside-marriage returns, and weight too little within-marriage returns as evidenced by the presence of additional  $\frac{\partial u_a}{\partial \alpha}$  and  $\frac{\partial u_a}{\partial \beta}$  terms in expressions (31) and (32) relative to (33) and (34).<sup>17</sup> The basic

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<sup>17</sup>There is in fact another incentive problem at work, which emerges because agents do not consider the impact of human capital investments on the bargaining opportunities of others. We do not discuss this externality here: see Acemoglu (1997).

incentive problem is essentially that described by Vagstad (2001). Agents maximize the share of the surplus they are able to obtain through bargaining, and not the surplus itself. From the perspective of society, this agent invests too little in learning the task that will be performed in marriage, and too much in learning the task that will not be performed in marriage. However, note that the socially optimal investment in the non-specialty task described by (34) does imply that the agent should invest in some effort in learning task how to produce good  $b$ . If it is hard to find a match in the marriage market, or if the rate of separation is high, equation (34) implies that the marginal social benefits from  $f^a$  agents learning how to produce  $b$  increase. This is because under these circumstances, they are likely to spend a sizeable fraction of their lifetimes unmarried, and may need to be able to perform task  $b$  to subsist.

A customary gender division of labor may under some circumstances mitigate the incentive problem, but, in light of (34), it may go too far. A gender division of labor takes the form of a restriction on the set of activities that a type  $f$  agent may perform. If the agent is prohibited from performing task  $b$ , for example, the result is the agent simply chooses  $b = 0$ ; there is no reason to learn how to do something that the agent will never be allowed to do. If  $b$  is restricted to be zero, the result may either increase or decrease social welfare; welfare increases because strategic investment incentives are eliminated, but welfare decreases because type  $f^a$  agents are now more helpless when not married.

Consider the following discrete-choice example, in which type  $f$  agents specialize in production of good  $a$ , but must decide whether or not to learn to perform task  $b$ . In the event that an agent has learned the task, we normalize their skill level to 1, so  $\alpha = 1$ . The agent must decide whether or not to choose  $\beta = 1$ . Take the utility function to be  $u = a^{1/2}b^{1/2}$ . It then follows that the agent will choose  $t^* = 1/2$  if no market is available, and  $x^* = 1/2$  if a market is available. Then, from (1) and (2), we obtain the following expression for autarkic utility when the agent has chosen to learn how to produce good  $b$  ( $\beta = 1$ ):

$$u_f^a(\beta = 1) = \frac{1}{2}(1 - p_a) + \frac{1}{2}p_a.$$

If the agent chooses not to learn how to produce good  $b$ , the agent earns

autarkic utility:

$$u_f^a(\beta = 0) = \frac{1}{2}p_a. \quad (35)$$

Expression (35) reflects the fact that the agent is not self-sufficient if there is no potential for accessing outside markets. Using (29), we can compute the change in lifetime utility due to learning how to produce  $b$  as:

$$\Delta U_f^a = \frac{1}{2} \frac{(1 - p_a) \left[ \frac{\bar{q}r}{2r + \bar{q}} + s \right]}{r(\bar{q} + s)} - c_b.$$

By applying (30), we can compute the gain in social welfare due due to the agent learning how to produce  $b$  as:

$$\Delta SW = \frac{1}{2} \frac{(1 - p_a)s}{r(\bar{q} + s)} - c_b.$$

Figure 1 graphs  $\Delta U_f^a$  and  $\Delta SW$  as functions of  $p_a$ , the probability that the individual is able to access a labor market. The social returns to learning the task are generally less than the private returns, as social returns do not consider the distributional impact of learning additional tasks. On figure 1, the gap between the two causes a social problem only in the region between the dashed lines, when  $p_a$  is of moderate size. Why does this happen? When  $p_a$  is very small, it may both be socially and individually desirable for type  $f$  agents to learn how to produce good  $b$ , as there is little chance of self-sufficiency outside of marriage if agents are completely specialized. On the other hand, when  $p_a$  is very large, it is both socially and individually desirable that agents not learn how to produce  $b$ . This is because the high  $p_a$  implies ample specialization opportunities outside of marriage, and the agent is more often than not able to rely on her primary skill, and thus do not need task  $b$ . In between the dashed lines on the figure, the private gains to learning how to produce good  $b$  are positive, while the social gains are negative. In this region, society would be better off if  $f$  agents did not learn how to produce good  $b$ , but type  $f$  agents would choose to learn it. In this environment, prohibiting type  $f$  agents from performing task  $b$  may be socially desirable, even though it has a negative impact on type  $f$  agents' utility.

While our model is not a model of the evolution of the gender division of labor, it is suggestive as to why a gender division of labor originally arose, and its impact on the relative well-being of men and women once adopted. Our

model also suggests a link between the declining importance of the gender division of labor over the past century in modern economies. The literature relating family economics, fertility, and growth, draws an explicit link from the opportunities for market participation provided by growth to changes in family structure. For example, Greenwood and Seshadri (2002) describe how industrialization reduces the need for children, as goods traditionally provided by children may be more cheaply purchased in the market. Hazan and Maoz (2002), who consider explicitly the potential dynamics of formal labor force participation over time, predict a nonlinear (S-curve) path in which changing social norms, which are affected by a change in women's formal labor force participation, reinforce the rise in women's labor force participation that is precipitated by the rising value of women's labor outside the home. This would tend to counteract the tendency of the gender with the distributional advantage to resist change. Galor and Weil (1996) argue that higher wages for women raise the costs of children relatively more than they raise household income. Our model suggests that one aspect of this transition is that it may decrease the importance of having a specialist in what was traditionally viewed as non-market work in the family. Thus, as market opportunities increase, gender roles break down, fertility declines, and the relative treatment of women within marriage improves.

### 3 Conclusions

We have developed a theoretical model of the gender division of labor which relies upon the importance of the ultimate distribution of marriage surplus for human capital acquisition. The role of a gender division of labor is to limit possibilities for strategic acquisition of human capital; human capital accumulated for the purposes of gaining better treatment within marriage. Our model is capable of explaining several phenomena which typically coexist with the gender division of labor, such as:

1. The gender with the distributional advantage tends to have the more marketable form of labor or the form of labor that provides the more easily-traded output (outside of marriage).
2. The gender with the distributional advantage would more strongly resist changes in labor markets that would make labor of the other gender more marketable.

3. The gender with the distributional advantage would more strongly resist changes in marriage patterns that would increase the probability of separation, such as less stringent standards for receiving a divorce.
4. The more restricted gender is treated more poorly within marriage.

More broadly construed, our work offers an explanation for the customary gender division of labor that matches well aspects of the institutional evolution of societies as they move through different phases of development. It also suggests why a customary gender division of labor is most conspicuous at those stages of development in which labor markets are somewhat, but not completely developed. One might also add that our theory suggests that in societies with low levels of technological sophistication, such as hunter gatherers, and modern societies, there is little need for a gender division of labor.<sup>18</sup> In the former case, this is because human capital acquisition is not as important, and there is greater need for individuals to be self-sufficient. In the latter case, individuals, even when highly specialized in certain tasks, may sustain themselves through market exchange. Thus, they face little incentive to strategically acquire skills they will not use.

While this paper provides several reasons for why the gender division of labor might exist, it has not presented an explicitly dynamic theory which explains the interplay between human capital accumulation, the development and decline of customs, task segregation, and economic growth. Constructing such a model and studying its correspondence with changes over time for a broad sample of societies constitutes an interesting avenue for further research.

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<sup>18</sup>This nonlinear progression is in partial contrast to that suggested by Galor and Weil (1996), whose theory predicts that the degree of specialization would decline over time as the reward to physical labor declines during the process of development.

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Activity	Only/mostly men	Both	Only/mostly women	Societies
Hunting	100	0	0	738
Metal working	100	0	0	360
Boat building	96	3	1	215
Fishing	79	15	6	562
House building	75	10	15	457
Animal husbandry	64	22	14	412
Leather working	46	5	49	280
Weaving	30	12	58	265
Pottery making	9	5	86	328
Gathering	8	14	78	396
Agriculture	32	32	36	639

Table 1: Distribution of tasks across 863 non-industrial societies. From Jacobsen(1998, p. 217), adapted from Murdock (1967).

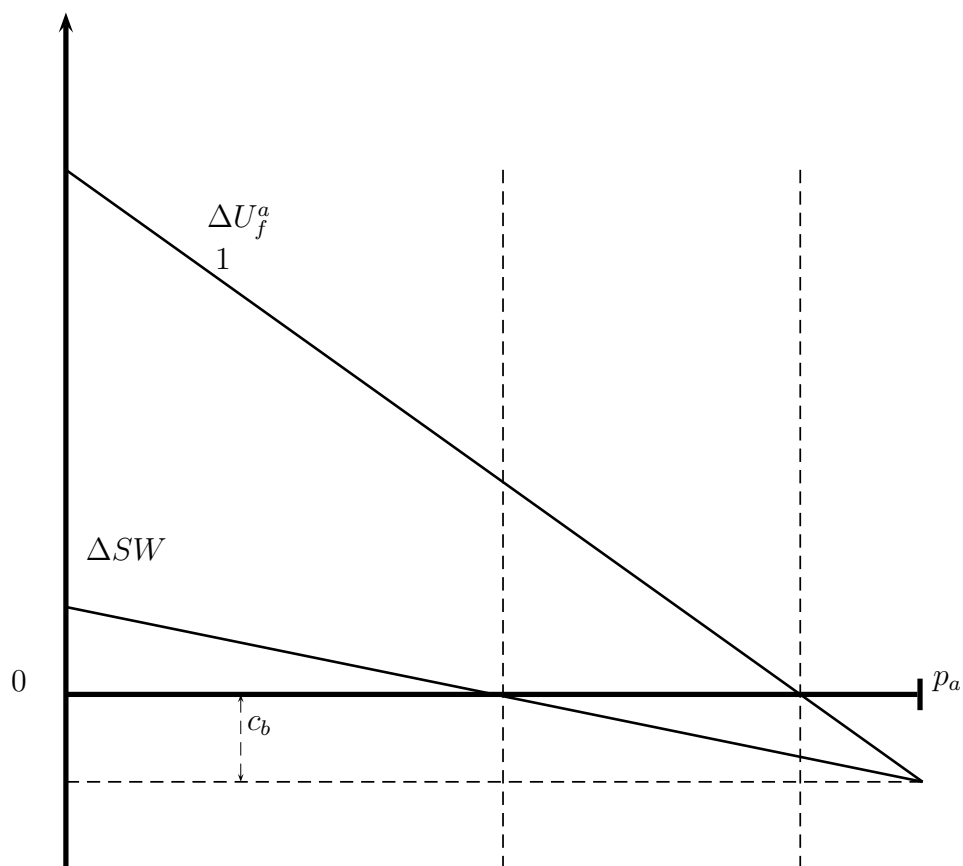


Figure 1: The marginal private and marginal social gains to learning a non-specialty task as functions of  $p_a$ . The region between the two vertical dashed lines is the region in which a customary gender division of labor increases welfare.