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Home production, market production and the gender wage gap: Incentives and expectations ☆

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ABSTRACT

We study the joint determination of gender differences in labor earnings and time devoted to home production in an economy where informational frictions give rise to incentive problems in the labor market. Our model generates novel predictions on the relation between earnings, home hours and the incidence of performance pay, which we confront with the data. The empirical evidence broadly supports our hypothesis.

1. Introduction

One important fact about women in the labor market is the substantial and persistent gender earnings gap. O'Neill (2003) shows that the male–female gap in median earnings was 24% in 2000 and 42% of this differential could not be accounted for by gender differences in schooling, experience and job characteristics. Moreover, there is a substantial gender difference in home hours. PSID data for the period 1976–2001 show that husbands' home hours are roughly one third of wives' and that this difference is stable over time.[1]

What can explain these gender differences in labor earnings and time devoted to home production? We study this question and propose that incentive problems in the labor market play a crucial role. Our model generates novel predictions on the relation between earnings, home hours and the incidence of performance pay, which we confront with the data. Evidence from the Census and the PSID broadly supports our hypothesis.

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[1] Authors' calculation based on the Michigan Panel Study of Income Dynamics (PSID).

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Our theory is based on a simple model in which agents are involved in individual work decisions on the labor market and in joint household decisions on consumption and home production. We make two critical assumptions. The utility cost of work effort is increasing in home hours, and effort and home hours are private information. This leads to moral hazard and adverse selection problems in market work, since it is harder to provide incentives to workers with high home hours. Firms offer incentive compatible labor contracts that are constrained-efficient. Household decisions are also efficient. The feedback between individual labor market outcomes and joint household decisions generates a potentially self-fulfilling mechanism that allows for gendered equilibria, even with no fundamental differences in productivity or preferences across genders. If, for example, firms believe that home hours are higher for women, they will offer them labor contracts with lower earnings, performance pay and effort. Then, the opportunity cost of home hours is lower for women and wives will allocate more time to home production, thus confirming firms' beliefs. The incentive problems in the labor market amplify gender earnings differentials due to differences in home hours, while earnings differentials across genders reinforce the division of labor within the household.

The model delivers a number of predictions on the relation between home hours, earnings and the use of performance pay by gender. Specifically, workers' earnings, the fraction of performance pay in total compensation and effort are inversely related to home hours. Thus, gender differences in earnings and the fraction of performance pay are positively related to the gender differences in home hours. In equilibria in which women's home hours are greater than men's, women will be offered contracts that specify a lower level of effort, leading to lower earnings and lower fraction of performance pay relative to men. For given gender differences in home hours, the gender differentials in earnings and performance pay are greater when incentive problems are more severe, that is when the correlation between observable measures of performance and effort is low.

Our empirical analysis confronts these predictions with the data. Specifically, we maintain that the severity of the incentive problem varies by occupation, and examine the evidence on gender differentials in earnings and performance pay across occupations exploiting a variety of data sources. Using Census data for year 2000, we study aggregate gender earnings differentials by marital status for three broad occupational categories: management, sales and production. Evidence on occupational characteristics and the structure of compensation suggests that incentive problems are more severe in management and sales.[2] For managers, their wide range of responsibilities implies that many factors contribute to influence the observable measures of performance related to their activity. The resulting weak statistical link between effort and performance exacerbates the incentive problem. Similarly, sales volumes depend to a large degree on variables that are not directly related to sales personnel's effort. These considerations are less important for production workers.

We find that gender differentials in earnings are greatest in management and sales occupations relative to production occupations for married workers. This is consistent with the prediction that gender earnings differentials are positively related to the severity of the incentive problem. In addition, we find that while gender differentials in earnings are significantly greater for married workers than for single workers for management and sales occupations, controlling for age and education, the differential by marital status is much smaller for production workers. Since gender differences in home hours are much greater for married than for single workers in the data, this result is consistent with the prediction that the effect of gender differences in home hours on gender earnings differentials is amplified when incentive problems are more severe.

Since the Census does not include information on performance pay, we also use PSID data from the late 1990s that reports information on bonuses and commissions. We find a negative and significant correlation between the male/female difference in the fraction of performance pay and the female/male earnings ratio. Based on our estimates, the differences in performance pay account for 10 to 21% of the gender earnings differential for management occupations, and 6% for sales occupations. These results confirm the Census analysis and provide support for the mechanism linking gender differentials in earnings and home hours in our model. In a cross-section of married couples from the PSID, we also find a negative correlation between the wife/husband ratio of home hours and the wife/husband ratio of earnings, and a positive correlation between the hours ratio and the husband–wife difference in the fraction of performance pay. This pattern also parallels the predictions of our model.

Our analysis bridges the literature on the sexual division of labor (Becker, 1985) with the one on incentive contracts and job design (Holmstrom and Milgrom, 1991) and the theory of statistical discrimination (Coate and Loury, 1993). The idea that the gender earnings gap can arise from a self-fulfilling mechanism based on the household dates back to Francois (1998). Our original contribution is to identify the source of statistical discrimination with the incentive problem in the labor market. The general constrained-efficient contracting framework that we propose generates a series of novel predictions on gender differences in the structure, as well as the level, of compensation that provide a new lens for the empirical analysis of gender earnings gaps. These predictions are not sensitive to the details of the contracting environment and find strong support in the data.

Our results can also be used to understand the evolution of the gender earnings differentials. Golan and Levy-Gayle (2007) find that a decline in statistical discrimination can account for approximately 13% of the sizeable decline in the gender earnings gap between the late 1970's and the late 1980's. On the other hand, Blau and Kahn (2004) document the decline in gender earnings differentials slows considerably starting in the 1990s.[3] They show that the slowing convergence

[2] See Milgrom and Roberts (1992) and MacLeod and Parent (2003).

[3] Based on O'Neill (2003), the female/male ratio in hourly earnings rose from 66 to 80% between 1975 and 1990 and remained constant at that level until 2000.

can mostly be accounted for by an increase in the "unexplained gap," which is linked to labor market discrimination. The positive relation between gender earnings differences and performance pay predicted by our model provides a potential explanation for this pattern. Lemieux et al. (2007) document a rise in the fraction of U.S. jobs explicitly linking pay to performance, while Hall and Murphy (2003) discuss the rise in equity based performance pay programs for employees at all levels since the early 1990s. The rise in performance pay can explain the slowing convergence in gender earnings differentials, based on our analysis. These findings also suggest that if the incidence of performance pay continues to grow, the progress in women's relative earnings may be significantly stifled.

The paper is organized as follows. Section 2 presents the model and discusses the results of numerical simulations. Section 3 reports evidence supporting the model's predictions. Finally, Section 4 concludes.

2. The model

The economy is populated by a continuum of adult agents, ex ante identical except for gender, and a continuum of identical firms. The agents are equally divided by gender, they are all married and belong to a household. All households are made up of two agents of different gender.[4]

There are two types of goods in this economy—a market good and a home good. Firms produce the market good using labor as the only input. All agents are employed in market work. Households combine the market good and home hours of each spouse to produce the home good, which is household specific.

Individual utility is increasing in consumption of market and home goods and decreasing in the number of hours worked at home and in the effort applied to market work. Specifically, preferences are represented by:

$$U(c,h,e) = -\exp\bigl(-\sigma\bigl[c - v(h,e)\bigr]\bigr) + \theta \log G, \tag{1}$$

where $c \geqslant 0$ is individual consumption of the market good, $h \in [0, \bar{h}]$ for $\bar{h} > 0$ denotes home hours, $e \geqslant 0$ denotes effort applied to market work, and $G \geqslant 0$ is consumption of the home good. The parameter $\sigma > 0$ corresponds to the constant coefficient of absolute risk aversion, while $\theta > 0$ represents the weight on the home good. The function $v(\cdot)$ corresponds to the disutility of market and home work. The function v is increasing in both its arguments, twice continuously differentiable and convex.

We make the following key assumption on preferences:

$$v_{he} > 0. \tag{2}$$

This assumption implies that an agent's marginal utility cost of effort is increasing in home hours. The rationale for this restriction, following Becker (1985), is simply that when an agent is engaged in more than one task, in this case home production and market work, the marginal utility cost of each activity will rise.

Since all agents belong to a household and are employed in market work, they are each involved in individual decisions on the labor market and in joint decisions within their household. On the labor market, agents negotiate with their employer over labor contracts, which specify earnings and effort. Within the household, spouses pool labor income and efficiently choose consumption of the home good and the allocation of home hours.

We now describe the labor contracting problem and household optimization, and then present our definition of equilibrium.

2.1. Labor contracts

All agents are employed by a firm and each firm hires a continuum of workers. Since all firms are identical, we consider the problem of a representative firm. A worker's output is a function of her effort:

$$y = f(e) + \omega, \tag{3}$$

where the function $f(e)$ denotes expected output, and f is strictly increasing, twice continuously differentiable and weakly concave. The random variable ω is distributed normally with zero mean and variance $\Sigma^2 > 0$.

We make the following informational assumptions:

A1. Effort, e, and home hours, h, are *private information*.
A2. Output, y, is *observable*.

The unobservability of effort gives rise to *moral hazard* and the assumption that home hours are private determines an additional *adverse selection* problem.

The primary rationale for assuming that workers' home hours are not observed by firms is that it is conceivably hard for firms to monitor employees outside the workplace. Surely, it is easier for an employer to observe effort on the job than

[4] Since the purpose of this paper is to study the joint determination of gender differentials in labor market outcomes and in the household division of labor, we abstract from modelling marriage decisions and concentrate on married couples.

workers' home activities. However, given that home hours may influence their effectiveness, firms will have an interest in screening workers in this dimension. Most importantly, unobservable home hours are essential to the equilibrium properties of the model, as we discuss in detail in Section 2.3.

Given these informational assumptions, we model the firm–worker relationship as a principal-agent problem. The firm chooses labor contracts to maximize the surplus from the employment relationship. Home hours do not influence agents' output directly, so they can be interpreted as an agent's *type* from a firm's standpoint. Earnings will depend on output. This property is required to implement strictly positive effort, given the moral hazard problem. Thus, the optimal contract will specify an earnings function, $w(y)$, and effort to be implemented for each type of agent, h, in the population.

The CARA assumption on preferences implies that individual wealth is irrelevant for the agents' choice of effort and therefore for incentives. As will become clear in Section 2.2, individual wealth depends on household wealth in this model. This in turn is a function of home hours and earnings of both spouses. The CARA assumption ensures that firms do not need to condition contracts on any household variables.

The menu of contracts offered by firms depends on their beliefs on the distribution of home hours in the population. We denote the fraction of agents with home hours given by $h \in H$ with $\pi(h)$, where $\pi(h) > 0$, $\sum_{h\in H} \pi(h) = 1$ and H is support of π. This distribution is taken as given by firms but will be endogenously determined in equilibrium. The optimal labor contract can be represented as a mapping, $\mathcal{C}(\pi)$, that specifies a couple $\{w(y), e\}$ for each $h \in H$, as a function of π. Assumption (2) plays the role of a single crossing condition in this context. It ensures that, given that contracts are incentive compatible, agents with home hours h will self-select into the appropriate contract in the menu implied by $\mathcal{C}(\pi)$. Since the contract space is *unrestricted*, the optimal labor contract will be constrained-efficient.

To isolate the role of moral hazard and adverse selection on the properties of the optimal labor contracts, we first consider the firm's problem when home hours are observable and then also introduce private information on home hours.[5]

If home hours are public information, firms face a moral hazard problem. Labor contracts solve:

$$\text{(Problem F1)} \quad \max_{\{w(y),e\},\, e\in[0,1]} S(e;h)$$

subject to

$$e = \arg\max_{e\in[0,1]} E\big[U(c,h,e)\big], \tag{4}$$

where the objective function is the expected surplus from the employment relationship, and (4) is the incentive compatibility constraint associated with moral hazard.

As shown in Holmstrom and Milgrom (1991), the CARA form of the utility function $U(\cdot)$ implies that, without loss of generality, we can restrict attention to earnings functions of the form: $w(y) = \bar{w} + \tilde{w}y$. We refer to $\bar{w}$ and $\tilde{w}y$ as salary and performance pay, respectively. Then, the certainty equivalent of the expected surplus from the employment relationship can be written as:

$$S(e;h) = f(e) - v(h,e) - \frac{\sigma \Sigma^2 (\tilde{w})^2}{2}. \tag{5}$$

The first term is expected output, the second term is the agent's utility cost, given home hours h. The last term corresponds to the reduction in the agents' utility due to variability in earnings induced by their dependence on output. The incentive compatibility constraint can be restated in the following simple form:

$$e = \arg\max_{e\geqslant 0} \tilde{w} f(e) - v(h,e). \tag{6}$$

Using the first order approach, we can replace (6) with:

$$\tilde{w} f'(e) = v_e(h,e), \tag{7}$$

$$\tilde{w} f''(e) - v_{ee}(h,e) \leqslant 0. \tag{8}$$

Since we assume f is concave and v is convex, (8) will automatically be satisfied. The CARA assumption on preferences also implies that the salary component of earnings does not influence workers' incentives to exert effort. Imposing a zero profit condition on firms implies: $\bar{w} = y(1 - \tilde{w})$ and $w = y$.

To obtain analytical solutions, we will restrict attention to the following functional forms:

$$f(e) = e, \tag{9}$$

$$v(h,e) = (\psi + h)\frac{e^2}{2}. \tag{10}$$

The parameter $\psi \geqslant 0$ can be interpreted as a fixed cost of working on the market. The qualitative properties of the optimal contracts holds more generally.

[5] Consumption of the home good is irrelevant for incentive compatibility given that utility is separable between market and home goods. Hence, we can ignore it for Problems F1 and F2 below.

Proposition 1. *The optimal labor contract with observed home hours satisfies*:

$$e^*(h) = \frac{1}{(\psi + h)(1 + \sigma \Sigma^2(\psi + h))}, \tag{11}$$

$$\tilde{w}^*(h) = \frac{1}{1 + \sigma \Sigma^2(\psi + h)}. \tag{12}$$

In addition, expected earnings are given by $Ew^*(h) = f(e^*(h))$, *with* $Ew^{*\prime}(h) < 0$ *and* $Ew^{*\prime\prime}(h) > 0$.

Proof. In Appendix A. □

The main properties of the optimal contract are that effort, e, the fraction of performance pay, $\tilde{w}$, and expected total earnings, w, are *decreasing* in home hours, h. This follows from assumption (2) that implies that the marginal utility cost of effort is increasing in home hours and, therefore, it is more costly for firms to incentivize workers with high home hours. Effort and the fraction of performance pay also decrease with the parameter Σ. High values of Σ reduce the ability of output to serve as a signal for high effort, making the moral hazard problem more severe. By a similar logic, effort and the fraction of performance pay also fall with risk aversion, σ.

If home hours are unobserved, firms also face an adverse selection problem. The optimal menu of contracts will consist of a couple $\{w(y), e\}$ for each value of home hours in the population. Incentive compatibility constraints associated with the adverse selection problem will induce workers to self-select an earnings-effort pair appropriate to their type. The workers for whom the adverse selection incentive compatibility constraint is binding will extract a rent, which also reduces the surplus from the employment relation.

Firms take the distribution of home hours as given, but in equilibrium this distribution will be jointly determined from the optimal response of households to labor contracts chosen by firms. We discuss the equilibrium determination of the home hours distribution in Section 2.3. Here, we describe the optimal contracting problem for a given distribution on home hours. We restrict attention to the case in which there are two values of home hours in the population, $h \in \{h_L, h_H\}$ with $h_L < h_H$, respectively, with distribution $\pi(h_j)$ for $j = L, H$. This is the only case that can occur in equilibrium, as we prove in Section 2.3.

The optimal labor contracts with unobserved home hours solve the following problem:

(Problem F2) $$\max_{\{e_j, \tilde{w}_j\}_{j=L,H}, T_L, T_H} \sum_j \pi(h_j)\left(f(e_j) - v(h_j, e_j) - \sigma \Sigma^2 \frac{\tilde{w}_j^2}{2} - T_j\right)$$

subject to

$$\tilde{w}_j f'(e_j) = v_e(h_j, e_j), \tag{13}$$

$$f(\hat{e}_i)\tilde{w}_i - v(h_j, \hat{e}_i) - \sigma \Sigma^2 \frac{\tilde{w}_i^2}{2} + T_i \leqslant f(e_j)\tilde{w}_j - v(h_j, e_j) - \sigma \Sigma^2 \frac{\tilde{w}_j^2}{2} + T_j, \tag{14}$$

$$f'(\hat{e}_i)\tilde{w}_i = v_e(h_j, \hat{e}_i), \tag{15}$$

for $j = L, H$, where $\hat{e}_i$ denotes the level of effort chosen by an agent of type j when she cheats and reports to be of type i, and T_j, $j = L, H$, denotes the informational rent. If the distribution of home hours is degenerate so that $\pi(h_L) = 1$ or $\pi(h_H) = 1$, then this problem collapses to Problem F1.

Proposition 2 summarizes the relevant properties of the optimal labor contracts.

Proposition 2. *For* $j = L, H$, $\tilde{w}_j^*$ *and* e_j^* *are decreasing in* h_j. *If in addition*:

$$\sigma \Sigma^2 \leqslant \frac{1}{\psi + \bar{h}}, \tag{16}$$

the adverse selection incentive compatibility constraint (14) *is only binding for workers with* high *home hours,* $T_H > 0$ *and*:

$$e_H^* = \frac{0.5}{\sigma \Sigma^2(\psi + h_H)^2}, \tag{17}$$

$$\tilde{w}_H^* = \frac{0.5}{\sigma \Sigma^2(\psi + h_H)}, \tag{18}$$

$$e_L^* = \frac{0.5(\psi + h_H)}{(\psi + h_L)(\psi + 0.5(h_H + h_L))}, \tag{19}$$

$$\tilde{w}_L^* = \frac{0.5(\psi + h_H)}{(\psi + 0.5(h_H + h_L))}. \tag{20}$$

Proof. In Appendix A. □

The fraction of performance pay and effort for each type are decreasing in their home hours for any configuration of binding adverse selection incentive compatibility constraints, as in the case with observable hours. This property of optimal contracts is an implication of the moral hazard problem. The dispersion of earnings and effort across types depends on the pattern of binding adverse selection incentive compatibility constraints. Assumption (16) ensures that only workers with high home hours will have an incentive to mimic those with low home hours who absent adverse selection receive higher earnings. This assumption captures the notion that firms want to discriminate between workers whose cost of effort is low and are thus easy to incentivize from workers whose cost of effort is high and are more likely to shirk.[6] Eqs. (17)–(20) clearly imply that effort and performance pay for agents with high home hours are decreasing with risk aversion, σ, and the volatility of output for given effort. Thus, the differences in performance pay across types will increase with these parameters, as in the case with observable home hours.

The labor contracting environment described above parsimoniously embeds elements of job design and of optimal compensation policy. As discussed in Milgrom and Roberts (1992), the variable y should be interpreted as an observable measure of performance. Then, the performance pay component in earnings is consistent with a variety of widely used compensation schemes. For example, for sales workers, y would correspond to the volume of sales and $\tilde{w}$ to the commission rate. For management positions, y may stand for profits for the unit under a manager's supervision with $\tilde{w}$ representing the bonus rate. For production workers, y would correspond to units of output and $\tilde{w}$ to the piece-rate. A menu of contracts in which one specifies high effort and one specifies low effort can also be interpreted as two different jobs or positions within a firm.[7]

A very important property of this labor contracting framework is that there are *no restrictions* on the contract space. This has a very important implications for gender differentials in earnings. Since gender is observable, firms can offer different contracts to female and male workers. However, they will find it optimal to do so *if and only if* they believe that the distribution of home hours differs by gender. In this case, we denote the optimal menu of labor contracts with $C_i(\pi_i)$, $i = f, m$, where f, m stand for female and male. If the distribution of home hours is the same across genders, male and female workers will be offered the same menu of contracts. The equilibrium implications of this feature of the model will further be discussed in Section 2.3.

2.2. Households

The representative household takes as given the mapping between individual home hours, earnings and effort, conditional on gender, implied by the labor contracts offered by firms, $\mathcal{C}_i(\pi_i)$ for $i = f, m$. The fact that labor contracts are incentive compatible jointly imply that *individual* optimality of effort for given home hours is satisfied for each spouse for given h_i and a consumption level $c_i \geqslant 0$ under the optimal contracts. We can then define the following individual indirect utility function:

$$V_i(c_i, h_i; \mathcal{C}) = EU\big(c_i, h_i, e_i^*(h_i)\big), \tag{21}$$

for $i = f, m$, where effort satisfies Problem F2.

The production function for the home good is

$$G = g(h_f, h_m, k), \tag{22}$$

where k is the amount of market good used in home production and g is strictly increasing in all its arguments and concave.

The representative household's problem is to choose G, k, h_i and c_i to maximize:

(Problem H) $\displaystyle\sum_{i=f,m} \lambda_i V_i(c_i, h_i; \mathcal{C}) + \theta \log(G)$

subject to (22),

$$h_i, c_i \geqslant 0 \quad \text{for } i = f, m, \tag{23}$$

$$k = a + \sum_i w_i^*(h_i), \tag{24}$$

where a denotes exogenous household wealth. The parameters, λ_i, for $i = f, m$, represent the weight of each spouse in household decisions.[8]

[6] The qualitative properties of optimal labor contracts with adverse selection do not depend on which incentive compatibility constraint is binding. If the adverse selection incentive compatibility constraint is binding for workers with low home hours, the effort and incentive pay by type display similar properties to (17)–(20) with H and L reversed. Thus, condition (16) simply isolates the most interesting case.

[7] For this interpretation, see Lommerud and Vagstad (2007).

[8] Problem H implies that household decisions are Pareto efficient, as in Chiappori's (1997) "collective labor supply" approach. This framework is consistent with a variety of "household bargaining" models, as in McElroy and Horney (1981) and Manser and Brown (1980). See also Bergstrom (1997) for a review.

2.2.1. Choice of home hours

The optimal allocation of home hours depends on the spouses' relative opportunity cost of home hours, which is a function of prevailing labor contracts. In particular, the spouse with lower earning potential in market work will devote more time to home production. We interpret the intra-household allocation of home hours as a long term arrangement of the spouses, that may be costly to reverse in the short run.

We posit the following functional form for home good, G, production:

$$g(h_f, h_m, k) = H(h_f, h_m)^{\delta} k^{1-\delta}, \tag{25}$$

$$H(h_f, h_m) = \left[h_m^{\zeta} + h_f^{\zeta}\right]^{1/\zeta}, \tag{26}$$

with $\delta, \zeta \in (0, 1)$. The function $H(\cdot)$ aggregates the contribution of home hours and the parameter δ denotes the contribution of market goods to the production of the home good. The parameter $1/\zeta$ represents the elasticity of substitution between the wife's and husband's home hours.

The optimal choice of h_f, h_m, k and G can be analyzed as a sequence of cost minimization problems and is independent of the Pareto weights λ_i. The optimal values of h_f and h_m for given H solve:

$$\text{(Problem H1)} \quad C^H(\bar{H}; \mathcal{C}) = \min_{h_f, h_m \geqslant 0} Ew_f(h_f) + Ew_m(h_m)$$

$$\text{subject to} \quad \left[h_m^{\zeta} + h_f^{\zeta}\right]^{1/\zeta} \geqslant \bar{H},$$

for given $\bar{H} > 0$ and given $\mathcal{C}_j(\pi_i)$ for $j = f, m$. Here, expectations are taken with respect to the random variable ω.

The first order necessary conditions are:

$$\left(\frac{h_f}{h_m}\right)^{1-\zeta} = \frac{E[w'_m(h_m)]}{E[w'_f(h_f)]}, \tag{27}$$

$$\bar{H} = h_m\left[\left(\frac{h_f}{h_m}\right)^{\zeta} + 1\right]^{1/\zeta}, \tag{28}$$

where $w'(h)$ denotes the derivative of total earnings with respect to home hours. The sufficient condition for optimality of the home hours allocation is:

$$h_f \gtreqless h_m \quad \Leftrightarrow \quad Ew_f(h_f) \lesseqgtr Ew_m(h_m). \tag{29}$$

The terms $E[w'_j(h_j)]$ for $j = f, m$ correspond to the opportunity cost of home hours for each spouse and depend on labor contracts. Eq. (27) implies that the spouse with lower opportunity cost, will devote more time to home production. The difference in spousal home hours for given labor contracts depends on the elasticity of substitution in H. If $w_f(h) = w_m(h)$ for all $h \geqslant 0$, that is the same menu of labor contracts is being offered to workers of different gender, households are indifferent over the allocation of home hours across spouses and they will randomize.

We describe the problems for the choice of H, k and G in Appendix A. The solution to the household problem can be represented by the policy functions $c_i(a; \mathcal{C})$, $h_i(a; \mathcal{C})$, $k(a; \mathcal{C})$, and $G(a; \mathcal{C})$ for $i = f, m$.

2.3. Equilibrium

We now provide a formal definition of equilibrium for our economy.

Definition 3. An equilibrium is given by beliefs on the distribution of home hours $\pi_i(h)$ for $i = f, m$, labor contracts $\mathcal{C}_i(\pi_i)$ for $i = f, m$, and policy functions for the household $\{G, k, h_f, h_m, c_f, c_m\}(a, \mathcal{C})$, such that:

(i) Labor contracts solve Problem F2, given $\pi_i(h)$ for $i = f, m$;
(ii) Household policy functions solve the household problem, given $\mathcal{C}_i(\pi_i)$ for $i = f, m$;
(iii) The resulting distribution of home hours in the population is $\pi_i(h)$ for $i = f, m$.

This definition clarifies that the equilibrium distribution of home hours is the outcome of a self-fulfilling mechanism. Firms' beliefs over this distribution shape the trade-off faced by households in the allocation of home hours, since they determine the spouses' relative earning potential. The representative household takes labor contracts as given and chooses home hours based on this trade-off. This, in turn, determines the effective distribution of home hours in the population. Given that all agents are ex ante identical, the equilibrium distribution of home hours across genders only depends on firms' self-fulfilling beliefs.

We say that an equilibrium is *gendered* when firms believe that the distribution of home hours is different for female and male workers. We say that it is *ungendered* otherwise. In ungendered equilibria, the same menu of labor contracts will

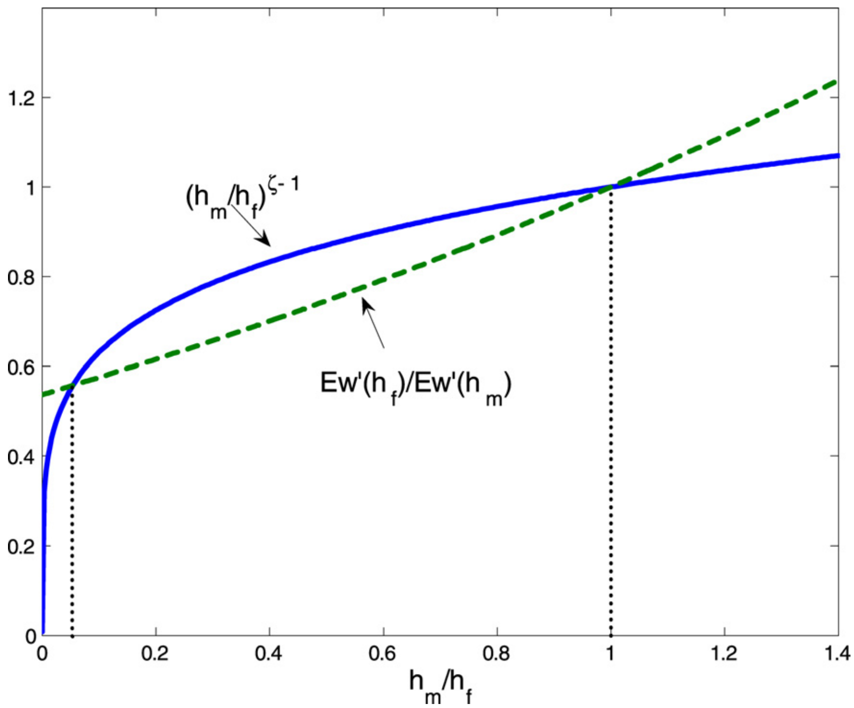

Fig. 1. Solutions to Eq. (27).

be offered to female and male workers. The household will be indifferent over which spouse should be assigned high home hours and they will randomize.

We focus on *symmetric* equilibria, in which identical agents take the same actions. This is a natural restriction, given our representative agent/firm assumption. The following proposition characterizes the set of symmetric equilibria.

Proposition 4. *In any symmetric equilibrium, there will at most be two values of home hours in the population,* $\{h_L, h_H\}$, *with* $0 < h_L \leqslant h_H$. *The set of equilibria uniquely includes*:

(i) *Two* gendered equilibria *with degenerate distribution of home hours,* $\pi_i(h_H) = 1$ *and* $\pi_j(h_L) = 1$ *for* $i, j = f, m$ *and* $i \neq j$;
(ii) *One* ungendered equilibrium *with degenerate distribution of home hours,* $\pi_f(\tilde{h}) = \pi_m(\tilde{h}) = 1$ *for some* $\tilde{h} > 0$;
(iii) *A family of* ungendered equilibria *with non-degenerate distribution of home hours,* $\pi_f(h_j) = \pi_m(h_j) \in (0, 1)$ *for* $j = L, H$.

We prove Proposition 4 in Appendix A. Here, we describe the argument heuristically, since it clarifies the feedback mechanism between labor contracts and the household's problem.

We concentrate on the gendered equilibrium in which women have higher home hours. For such an equilibrium to exist, Eq. (27) must have a solution with $h_m/h_f < 1$. Eq. (27) is represented in Fig. 1 for a given value of h_f. The solid line represents the left-hand side of the equation while the dashed line represents the right-hand side. Generically, there are two values of the ratio h_m/h_f that solve this equation for given h_f. The first is $h_m/h_f = 1$, the second is strictly greater than zero and strictly smaller than 1. For $\max E w_f(h) < \max E w_m(h)$, the solution to Problem H1 is the one with higher female home hours. This pins down the equilibrium ratio of home hours and establishes that the distribution $\pi_f(h_H) = 1$ and $\pi_m(h_L) = 1$ is an equilibrium. The equilibrium value of h_f can then be derived by solving the rest of the household problem. Since Problem H1 has a unique solution, the resulting equilibrium is unique in its class. A similar reasoning can be used to construct an equilibrium in which men have higher home hours and the ungendered equilibrium with $h_m/h_f = 1$.

The fact that we restrict attention to symmetric equilibria and that all agents are identical, except for gender, implies that there can only be two values of home hours in any equilibrium. It follows that, if firms believe that the distribution of home hours is different across genders, then such a distribution will be degenerate and explains result (i) in Proposition 4. The second implication is that any equilibrium with non-degenerate distribution of home hours must be ungendered. A non-degenerate distribution of home hours in a symmetric equilibrium requires household to randomize over the allocation of home hours across spouses, so that they must be indifferent over this allocation. This outcome can occur only if firms believe such a distribution to be identical across genders. This explains results (ii) and (iii) in the proposition.

If the distribution of home hours is degenerate, there is no adverse selection in equilibrium. However, the assumption that home hours are private information is essential to the analysis. Since we allow the contract space to be unrestricted, firms will find it optimal to offer different contracts to female and male workers *if and only if* they believe that the distribution of home hours differs by gender. Hence, if home hours were observed, firms would offer each individual a contract that is optimal given their home hours and gendered equilibria would not arise. The only way to obtain a gendered equilibrium with observable home hours and no gender differences in tastes or productivities would be to introduce gains from an asymmetric allocation of home hours in the production function for the home good. For example, an incentive to accumulate home specific skills or other forms of non-convexities in home production.

It may be possible to construct equilibria with female discrimination and observable home hours, even without ex ante gender differences, by restricting the contract space. This reduces the firms' ability to screen workers via the menu of contracts, making it optimal to rely on observable characteristics that are correlated with the relevant unobserved trait. Gendered equilibria in such a setting would typically feature low and high earnings contracts, with the low earnings contract offered to women irrespective of their home hours, and the high earning contract offered to men.[9] The fact that we allow for an unrestricted contract space minimizes the potential for statistical discrimination in our model.

2.3.1. Ex ante differences

Proposition 4 identifies the set of possible equilibria with no ex ante differences across genders. Only one of these equilibria reproduces the arrangement prevailing in most societies, whereby men specialize in market production and women in home production leading to lower relative earnings for women. This pattern has often been justified on the basis of biological differences leading to a comparative advantage for women in home production, resulting from their ability to bear children.

To explore this argument, we allow women to be more productive in home work. Specifically, we posit that:

$$H(h_f, h_m) = \left[h_m^{\zeta} + (1+\varepsilon)h_f^{\zeta}\right]^{1/\zeta}, \tag{30}$$

where $\varepsilon > 0$ represents women's higher relative productivity in home production. We maintain the assumption that female and male workers are equally productive in market work. There are two possible interpretations for the parameter ε connected to biological differences. If children are viewed as a component of the home good, ε captures women's greater relative contribution in its production due to their ability to give birth and breast feed children. Alternatively, ε can capture the negative effects on their relative market productivity of women during and after pregnancy.

The following result holds.

Proposition 5. *There exists a unique value of ε, $\bar{\varepsilon}$, such that*:

(i) *For $0 < \varepsilon \leqslant \bar{\varepsilon}$, there are two equilibria, one of with $h_f/h_m < 1$ and distribution of home hours $\pi_f(h_H) = 0$ and $\pi_m(h_L) = 0$, and one with $h_f/h_m > 1$ and distribution of home hours $\pi_f(h_H) = 1$ and $\pi_m(h_L) = 1$;*
(ii) *For $\varepsilon > \bar{\varepsilon}$, there is one equilibrium with $h_f/h_m > 1$ and distribution of home hours $\pi_f(h_H) = 1$ and $\pi_m(h_L) = 1$.*

The proof is in Appendix A. The argument is similar to the proof of Proposition 4.

Proposition 5 has several interesting implications. The first is that there are no ungendered equilibria with ex ante differences across genders. Interpreting ε as a perturbation to relative productivities across genders, this result implies that the ungendered equilibrium with $h_f = h_m$, described in Proposition 4, is unstable. The second implication is that there always exists an equilibrium in which wives devote more time to home production. In this equilibrium, h_f/h_m is increasing in ε. The third implication is perhaps the most surprising. If relative productivity differences are small enough, an additional equilibrium exists in which wives' home hours are *lower* than husbands'. The region of multiple equilibria is delimitated by the threshold $\bar{\varepsilon}$.

The existence of this counterintuitive equilibrium is rooted in the incentive problem on the labor market. If firms believe that women's home hours are lower than men's, the optimal labor contracts will specify higher effort and higher performance pay for women. The resulting differences earnings, amplified by the incentive problem, will offset their comparative advantage in home production. Households will consequently find it optimal for wives to devote less time to home work than husbands. Such an equilibrium is more likely to exist, if the degree of complementarity in spouses' home hours in home production is high, which corresponds to low values of the parameter ζ in the aggregator $H(h_f, h_m)$. A greater degree of complementarity reduces the incentives to specialize within the household. The threshold $\bar{\varepsilon}$ also negatively depends on the utility cost of market work ψ.

Taken together, these results suggest a potential explanation for both the prevailing pattern of gender specialization and the persistence of gender wage differentials. Lack of medical knowledge and poor obstetric practices, as well as the absence of alternatives to breast feeding, imply that ε was historically high, leading to an equilibrium in which women are mostly devoted to home production and men specialize in market work. Advances in medical technologies leading to a reduction in health problems associated with pregnancy and childbirth and the development of infant formula starting from the 1930s would have led to a sharp decline in the value of ε, giving rise to the possibility of ungendered equilibria. Albanesi and Olivetti (2007) explore the impact of medical progress related to motherhood in a model without statistical discrimination

[9] See Francois (1998) for an example.

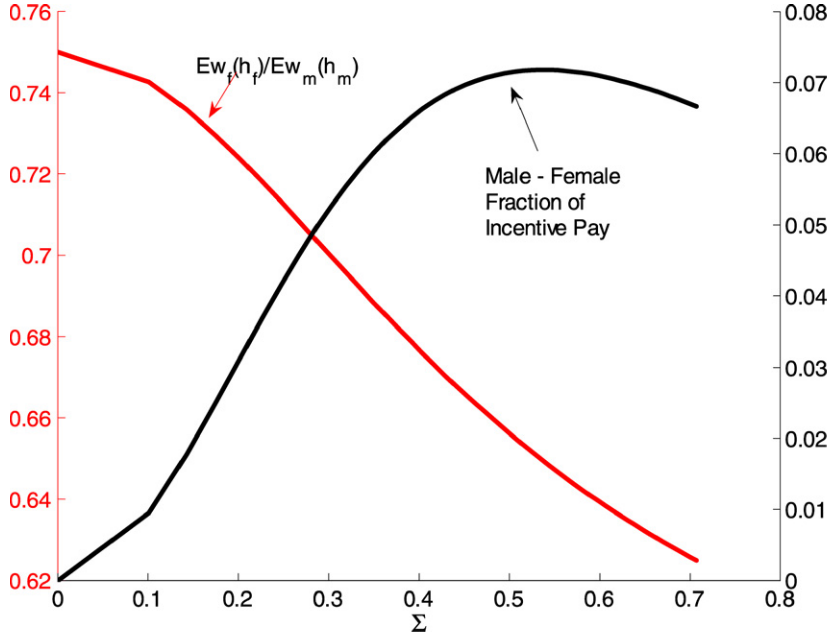

Fig. 2. Properties of optimal labor contracts for $h_f = 0.3$ and $h_m = 0.1$.

and find that it has a quantitatively large positive impact on women's participation and relative earnings and it induces a significant reduction in their home hours relative to men. However, the self-fulfilling nature of the distribution of home hours when there is a potential for statistical discrimination implies that a decline in women's comparative advantage in home production need not lead to a substantial decline in women's share of home hours or the gender earnings differential.

2.4. The feedback between home hours and labor market outcomes

To explore the relation between home hours and earnings predicted by our model, we now conduct several comparative statics exercises. We restrict attention to gendered equilibria where women have higher home hours, so that labor contracts satisfy Proposition 1.

We first study the role of the parameter Σ, which corresponds to the standard deviation of output for given effort. An increase in this parameter makes it harder to infer effort from observable measures of performance and exacerbates the incentive problem. Eq. (11) makes clear that effort is decreasing in the value of this parameter, and that this effect is greater for higher levels of home hours. Given that higher Σ reduces the optimal level of effort to be implemented, the fraction of performance pay will also be declining in Σ. By Eq. (12), this effect will be stronger at higher home hours, since the marginal cost of effort for the worker is increasing in home hours.

Taken together, these properties of labor contracts imply that if women's home hours are higher than men's, the female/male earnings ratio will be declining in Σ, while the male–female difference in the fraction of performance pay will be increasing in Σ. This property is illustrated in Fig. 2 for a numerical example. The female/male earnings ratio corresponds to the red line (left axis) and the difference in the fraction of performance pay between male and female workers corresponds to the black line (right axis). Σ ranges between 0 and 70% of worker potential output. Home hours are set to $h_f = 0.3$ and $h_m = 0.1$, which corresponds to the average ratio of wives to husbands home hours observed in the PSID for the 1990's.[10]

For $\Sigma = 0$, effort is equal to output, there is no moral hazard, and the fraction of performance pay is zero for both female and male workers. However, since women have higher home hours, firms will offer them a labor contract in which they exert lower effort. Hence, earnings will be lower for female workers. In this example, the earnings ratio is 75%. Positive values of Σ exacerbate gender differentials in earnings for given differences in home hours. As Σ increases, the earnings ratio drops quite rapidly, while the male–female fraction of performance pay increases. For Σ equal to 50%, the earnings ratio is equal to 60%, while male workers' fraction of performance pay is 8 percentage points greater than for female workers.

In Fig. 3, we reproduce this graph for smaller differences in home hours across genders, specifically $h_f = 0.15$ and $h_m = 0.10$. The ratio of female to male home hours in this example corresponds to the average female/male ratio of home hours for never married workers in the PSID. The pattern of variation in relation to Σ is analogous to that in Fig. 2. However,

[10] Other parameter values are $\psi = 0.1$ and $\sigma = 1$.

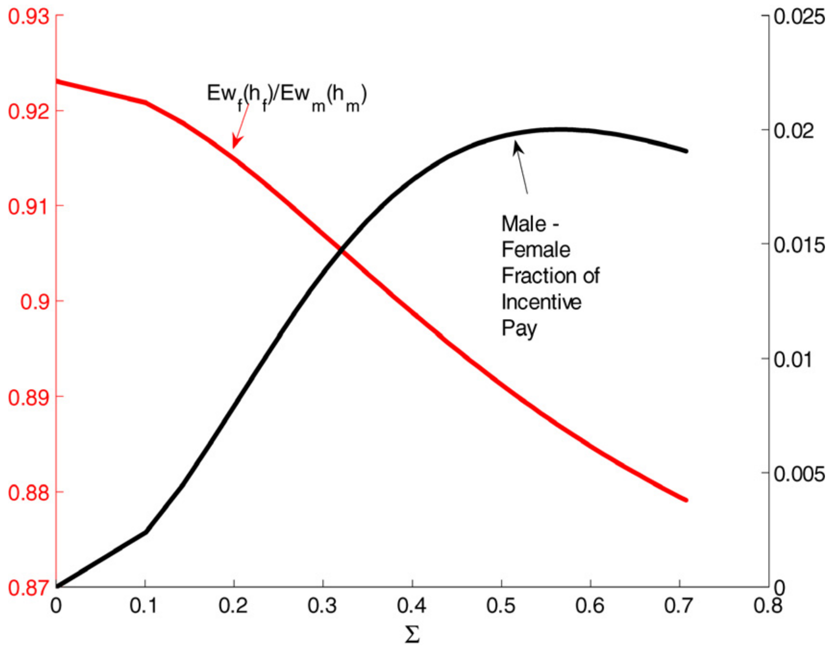

Fig. 3. Properties of optimal labor contracts for $h_f = 0.15$ and $h_m = 0.1$.

the earnings ratio is significantly higher, equal to 93% for $\Sigma = 0$ and dropping to 89% for $\Sigma = 50\%$. The difference in the fraction of performance pay across male and female workers only reaches 2% for $\Sigma = 50\%$.

These findings translate into the following predictions:

1. The female/male earnings ratio should be lower when the incentive problem is more severe and the difference in the fraction of performance pay across male and female workers should be negatively related to the female/male earnings ratio.
2. These effects are stronger when the differences in home hours between women and men is greater.

The dependence of labor market outcomes on home hours delivers additional predictions concerning the relation between earnings ratios, performance pay and home hours across spouses. Specifically:

3. The wife/husband ratio of home hours should display a negative correlation with the wife/husband earnings ratio.
4. The wife/husband ratio of home hours should display a positive correlation with the husband/wife difference in the fraction of performance pay.

Prediction 3 is a direct implication of Problem H1, the households' optimal choice of home hours across spouses. This property is common to other efficient models of intra-household allocation. Prediction 4 stems from the specific feedback mechanism between home hours and the incentive problem in the labor market that we highlight in our model.

We illustrate these predictions in Fig. 4. The red line corresponds to the wife/husband earnings ratio (left axis) and the black line to the husband/wife difference in the fraction of performance pay (right axis). They are plotted against h_f/h_m for $\Sigma = 0.31$. Clearly, the earnings ratio is smaller than 1 only if the wife's home hours are greater than the husband's. Moreover, this ratio is decreasing in the difference in home hours across spouses, while the opposite is true for the fraction of performance pay. For $h_f/h_m = 3$, the wife/husband earnings ratio is equal to 70% in this example, while men's fraction of performance pay is 5 percentage points greater than women's.

3. Connecting the model with the evidence

To empirically evaluate the link between incentives and gender differentials in home hours, earnings and performance pay, we posit that the severity of the incentive problem varies across occupations. Thus, we can interpret the comparative statics results in Section 2.4 as predictions on gender differentials in earnings and the structure of compensation across occupations. This extrapolation is based on the result that effort, the fraction of performance pay and total earnings are inversely related to home hours. Hence, in any equilibrium in which women have higher home hours, gender differentials in these variables should be positively related at all levels of aggregation, that is positions within a firm, jobs, occupations, industry, etc.

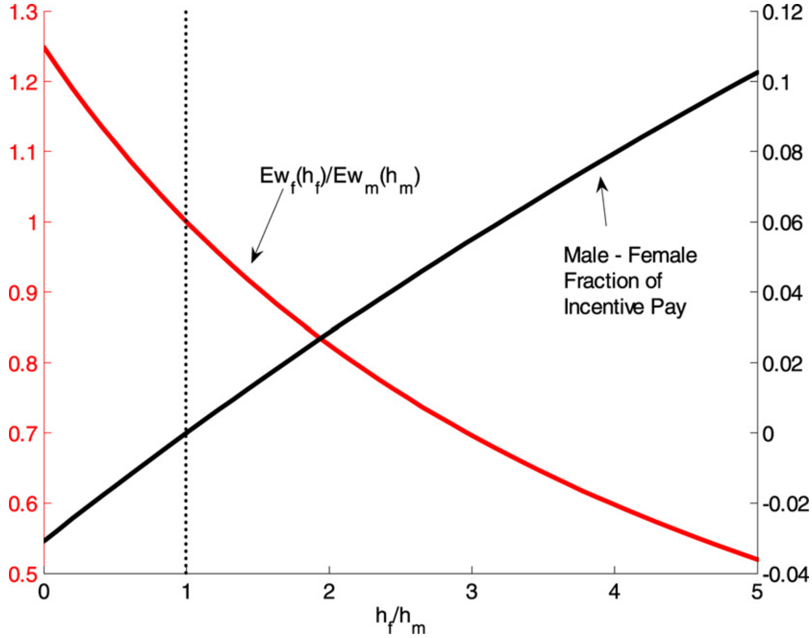

Fig. 4. Properties of optimal labor contracts for $\Sigma = 0.31$.

We also exploit the smaller gender differences in home hours for never married than for married individuals, a well-known fact. Extrapolating from our model, gender differentials in earnings and performance pay should be smaller for never marrieds within occupations and the variation by marital status of these differences should be greatest in those occupations where the incentive problem is more severe.[11]

Predictions 1 and 2 can then be restated as follows:

1. Gender earning differentials should be higher in occupations in which the incentive problem is more severe. Differences in performance pay between male and female workers should be inversely related to the gender differential in earnings.
2. These effects should be stronger for married than for never married workers.

How do we measure the severity of the incentive problem? In our model, it is related to the variance of output conditional on effort, that is the parameter Σ. Intuitively, the uncertainty associated with a worker's effort conditional on output should increase with the complexity of the job. This suggests that it should be higher for management occupations, since for managers profits or revenues depend on a variety of factors, many of which are outside the managers control. For sales occupations, sales volumes depend to a large degree on variables that are not directly related to a sales personnel's effort and may be uncertain.[12] These considerations are less important for production workers.

The natural ranking across these occupations suggested by this intuition is supported by evidence on job characteristics by occupation reported in MacLeod and Parent (2003). Using the Quality of Employment Survey and the National Longitudinal Survey of Youth, they find that management and sales occupations are characterized by greater workers' autonomy and larger variety of tasks, characteristics that exacerbate incentive problems. They also find that in those occupations, performance pay is used more. This is also consistent with the fact that incentive problems are more severe in these occupations. Based on these results, we consider three broad occupational categories: management, sales and production,[13] based on the notion that incentive problems are more severe in management and sales than in production occupations.

We draw on two data sources to evaluate these predictions. We use data from the one-percent Integrated Public Use Microsample (IPUMS) of the decennial Census for the year 2000 to study aggregate gender earnings differentials by marital status across industries and occupations. Since the Census does not include information on the structure of earnings, we use PSID data from the late 1990s to document the negative relation between the male/female difference in the fraction of

[11] In a model with both singles and married individuals, firms would optimally condition on marriage status only if the distribution of home hours is different for these groups. If singles were included in our model, in equilibria in which married women have higher home hours than married men, home hours of married women would be greater than for single women, while the opposite would be true for men, since households have an incentive to specialize.

[12] For example, sales workers are typically assigned to specific territories or products. Hence, sales volumes will fluctuate with shocks to local demand. See Catalyst (1995) for a description of the sales occupation, especially in relation to gender.

[13] In this exercise, we are implicitly assuming that unobserved differences in Σ across occupations are uncorrelated with other unobserved factors affecting the endogenous variables of interest.

performance pay and the female/male earnings ratio. We also consider a cross-section of married couples from the PSID, in order to evaluate predictions 3 and 4.

The predictions of the model are broadly supported by the empirical findings.

3.1. Evidence from the Census

Our Census sample includes all white individuals between 25 and 54 years of age, who are not in school, do not reside on a farm or live in group quarters. We also exclude the armed forces and restrict attention to those individuals who worked at least 50 weeks in the previous year and who usually work at least 30 hours per week. We consider three occupational categories: sales, management and production in 16 industries. We analyze separately married and never married workers.[14]

In order to make a meaningful comparison of gender earnings differentials, we need to take into account systematic differences in observable characteristics such as age and education by marital status and across occupations/industries. For example, never married individuals tend, on average, to be younger than married individuals. Since gender gaps in earnings increase by age this could bias the comparison in our favor. In order to control for these systematic differences we compute the gender gap in earnings for married and never married workers by running median regressions that control for a gender dummy, as well as for human capital variables—age and its square term and three education dummies.[15] We estimate this measure of *residual* gender earnings differentials separately for each industry and for each of the three broad occupational categories. Thus, we are effectively controlling for systematic differences by gender, age, education and marital status in the distribution of workers across occupations/industries.

The dependent variable in the regressions for each industry/occupation cell is the log of annual earnings. In our analysis we use total labor earnings because this is the data counterpart of the measure of total labor compensation in our model. However, one could argue that this is not the appropriate measure of labor compensation, since women tend to work fewer hours than men. This concern is attenuated by the fact that we only consider individuals that work at least 30 hours per week and who were employed for at least 50 weeks. This sample selection criterion considerably reduces the variation in market hours but does not eliminate the concern since high earnings jobs tend to be associated with higher hours.

To control for the robustness of our results to this observation, we conducted our analysis using the log of hourly earnings as a dependent variable. Our findings, reported in Table B.2 in Appendix B, are consistent with those for annual earnings. We also ran the annual earnings regressions with the addition of a cubic in hours worked in the set of controls. The results of this analysis are identical to those reported in Table 1 and we omit them for brevity.[16]

Table 1 reports the *residual* female/male ratio of median earnings for full-time year-round workers for the three occupational categories by industry and by marital status.[17] The first column refers to management occupations, the second to sales occupations and the third to production occupations. In each column, we report the statistics separately for married workers and for never married workers. The first row of the table, displays the average female/male ratio of median earnings across all industries for each occupational category. The residual gender earning ratios are estimated very precisely within each occupation/industry cell. All estimates are statistically significant at the 1% level and for ease of exposition, we do not report them in the table.

We find a considerable variation in the female/male earnings ratio across industries, and across the three occupational categories within each industry, even after controlling for gender difference in human capital characteristics. Moreover, the patterns of variation differ substantially by marital status. We can summarize our findings as follows:

1. There is a large variation in residual female/male median earnings ratios across industries conditional on marital status, yet in all industries and occupations the female/male earnings ratio is lower for married than for never married workers.
2. For married workers, the female/male earnings ratio is lowest in management and sales occupations. The median married woman in sales earns, just 69 percent of what the median married man earns on average across all industries, while in management occupations she earns 72 percent of the median married man's total earnings. The highest value of the gender earnings ratio for married workers is in production occupations, where the median woman earns 80 percent of median male earnings.

[14] See the Data appendix, Table B.1, for variable definitions and for summary statistics for our sample.

[15] The three dummies correspond to the following categories: high school completed, some college and college completed. The omitted dummy variable corresponds to individuals who completed less than twelve years of schooling.

[16] We also performed the analysis for the sample of workers with children. The pattern of ranking of the gender earnings ratios by marital status across occupational categories and industries is identical to the one reported in the paper for the overall sample. These results are reported in the Data appendix, Table B.3.

We have also experimented with different sample inclusion rules by considering all racial groups and by expanding the sample to include all individuals aged 16 to 64. In all the cases the results of our analysis are quantitatively similar to the ones reported in the paper.

[17] Entries in the table are in percentage points. They are obtained by taking the exponential of the estimated regression coefficient for the female dummy expressed in log points.

Table 1
Female/male median earnings ratios across industries, occupations, and marital status (full-time, year-round workers, entries in %)

	Management		Sales		Production	
	Married	Single	Married	Single	Married	Single
Average across all industries	72	94	69	92	80	83
Accommodation and food	71	95	55	99	80	84
Administrative, support, waste mgmt	76	90	68	86	81	85
Arts, entertainment & recreation	77	104	78	87	83	87
Construction	67	75	75	77	83	87
Educational services	81	93	82	95	83	87
Finance and insurance	65	88	64	87	83	87
Health care & social assistance	70	91	57	70	77	80
Information	73	91	83	102	82	86
Manufacturing	76	90	71	93	66	67
Other services (no public adm.)	72	101	64	78	76	79
Profess, scientific & tech. services	72	90	70	90	83	86
Public administration	80	103	81	129	83	87
Real estate and rental/leasing	66	103	64	113	83	87
Retail trade	65	101	56	83	72	74
Transportation and warehousing	71	94	64	85	83	87
Wholesale trade	70	101	75	92	79	83

3. For never married workers, the ranking of earnings ratios across occupations is reversed and gender differentials are smallest for management and sales, and highest in production. The median single woman earns 92 percent in sales and 94 percent in management of the total labor compensation earned by the median man in the corresponding occupation. Production occupations display the lowest ratio, equal to 83 percent.

As a result, the difference in gender earnings ratio of married relative to never married workers is substantial in sales and management occupations, approximately 20 percentage points. By contrast, gender earnings ratios do not vary significantly by marital status for production workers. These patterns suggest that across all industries married women are subject to the largest earnings penalty in those occupations where the incentive problem is most severe and that gender earnings differentials are positively related to gender differentials in home hours. We have conducted robustness checks by replicating the analysis for a finer set of occupation categories. The findings are largely confirmed. We discuss this exercise in Appendix B and report the results in Table B.4.

3.2. Evidence from the PSID

We document the negative relation between male/female difference in the fraction of performance pay and the female/male earnings ratio across occupations predicted by our model using PSID data for the late 1990s. As we did with the Census data, we select our sample to include all white men and women between 25 and 54 years of age who are not in school, who are not in the armed forces, and who worked at least 30 hours per week and 50 weeks per year. As in the previous section, gender earnings ratios correspond to the estimated coefficients for a female dummy in log-earnings regressions that also control for age and its square term and three education dummies.

We concentrate on gender earnings ratios at the occupation/industry level. The PSID coding of occupations differs from the one available from the Census 2000, but we construct occupational categories that are similar to the ones used for our Census analysis. This level of disaggregation requires a larger sample size than the one available in each wave of the PSID. Hence, we do not exploit the panel dimension of the data but simply pool together all the individuals in the 1994 to 2001 waves. The resulting statistics can be interpreted as medium run averages of the relevant variables.[18] Our measure of the fraction of performance pay is the ratio of bonuses and commissions to labor income, defined as wages and salaries, plus bonuses and commissions. Since the PSID only reports information on bonuses and commissions for household heads, that are predominantly married males or single women, we cannot condition on marital status.[19] Summary statistics for this sample are reported in the Appendix B, Table B.5.

We find a strong negative correlation between the female/male earnings ratio and the male/female difference in the fraction of performance pay. The correlation coefficient is −0.65 and it is significant at the one percent level. This correlation (as well as all the subsequent ones we report) takes into account the relative weight of each occupation in aggregate employment. Fig. 5 displays a scatter plot of these two variables. Consistent with our Census findings, sales and management

[18] In the PSID, data on hours worked, total labor earnings, bonuses and commission income, are reported for the previous calendar year. Hence, our data covers the time period 1993–2000. In 1997 the PSID started collecting information bi-annually. Hence, our sample includes 6 waves of PSID data.

[19] Information on bonuses and commission is only available for 27% women in the sample. Of these, only 13 are married. Information on incentive pay is available for 99% of the men in the sample, of which 80% are married.

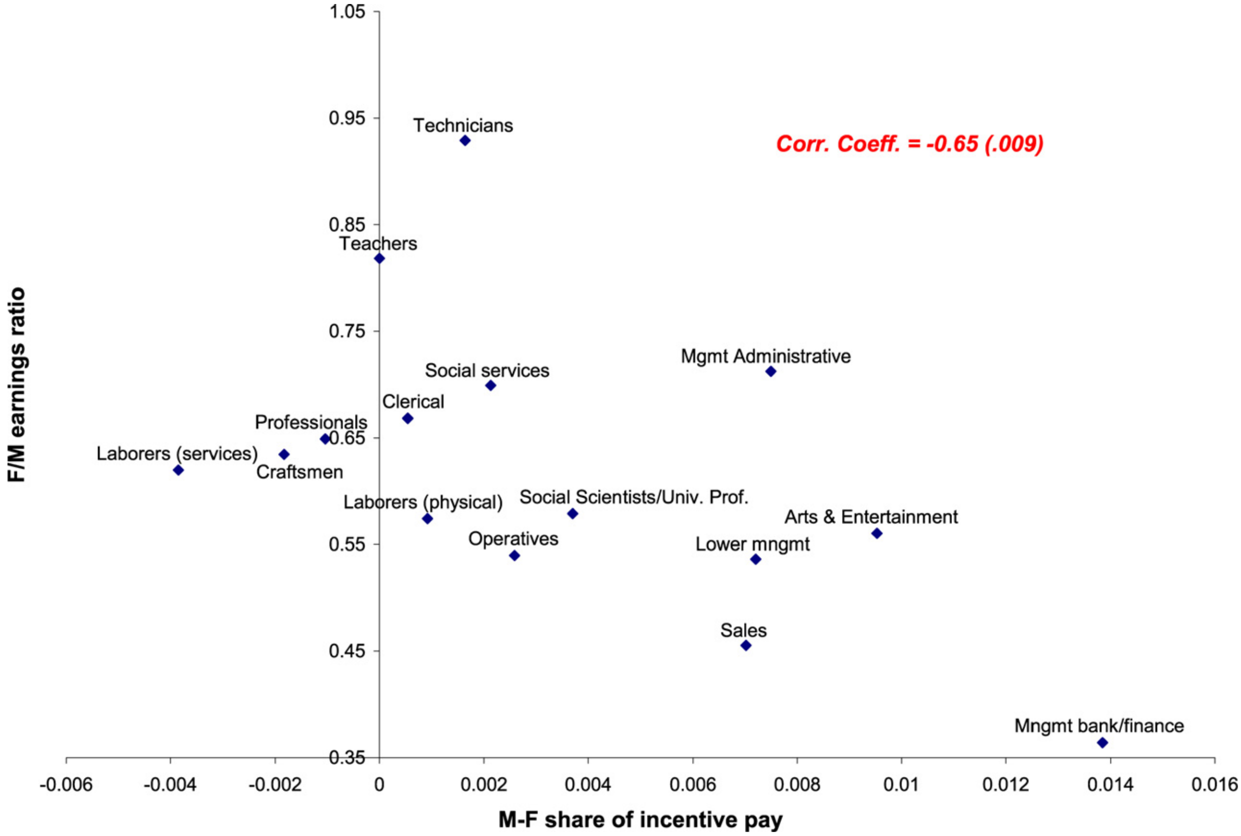

Fig. 5. Correlation between the F/M earnings ratio and the M–F fraction of incentive pay.

occupations in banking, finance and in the clerical sector are characterized by the lowest female/male earnings ratio and the highest male/female difference in the fraction of performance pay.[20]

We also use the PSID data on bonuses and commissions to corroborate our findings on the severity of the incentive problem and gender earnings differentials discussed in Section 3.1. Fig. 6 reports a scatter plot of the aggregate fraction of performance pay, which we interpret as a proxy for the general strength of incentives in an occupation, and the female/male earnings ratio across occupations. The correlation between these two variables is -0.57, significant at the five percent level. Consistent with MacLeod and Parent (2003), the occupations with job characteristics that imply a more severe incentive problem exhibit a higher fraction of performance pay. These same occupations also have low female/male earnings ratios. The fraction of performance pay varies between 0 (for teachers) and 3.2% (for sales). These performance pay shares are averages over the entire sample. If we restrict attention to those respondents that report positive bonuses or commissions, which comprise approximately 10% of the sample,[21] the fraction of performance pay varies from 1.7% for laborers to 23% for sales, as reported in Fig. 7. The correlation between the fraction of performance pay and the female/male earnings ratio in this case is -0.65, significant at the one percent level.

Since our female sample is disproportionately composed of single women, the average female shares of performance pay by occupation are likely to provide an upper bound on the actual statistics for the entire female population. As a consequence, the male–female differences in performance pay shares we report may underestimate the actual difference observed in the data, especially so for sales and management occupations, where the incentive problem is most severe.

The analysis above highlights gender differences in performance pay *shares* across occupations. Although this statistic is informative it does not provide a correct measure of the role of performance pay in explaining gender differentials because it does not take into account of differences in the levels of total compensation across genders/occupations. For instance, if the male–female difference in total compensation is larger in occupations where the incentive problem is most severe and these

[20] To account for the role of differences in hours worked in determining gender earnings differentials, we also conduct this analysis for hourly wages. We find that the correlation between the female/male difference in log hourly wages and the male/female difference in the fraction of incentive pay is -0.54 and significant at the five percent level.

[21] MacLeod and Parent (2003) find that the percentage of workers reporting positive incentive pay is 17% in the 1993 wave of the PSID and 20% in the NLSY. For the PSID, this discrepancy may be due to the fact that they include older and part-time workers in their sample.

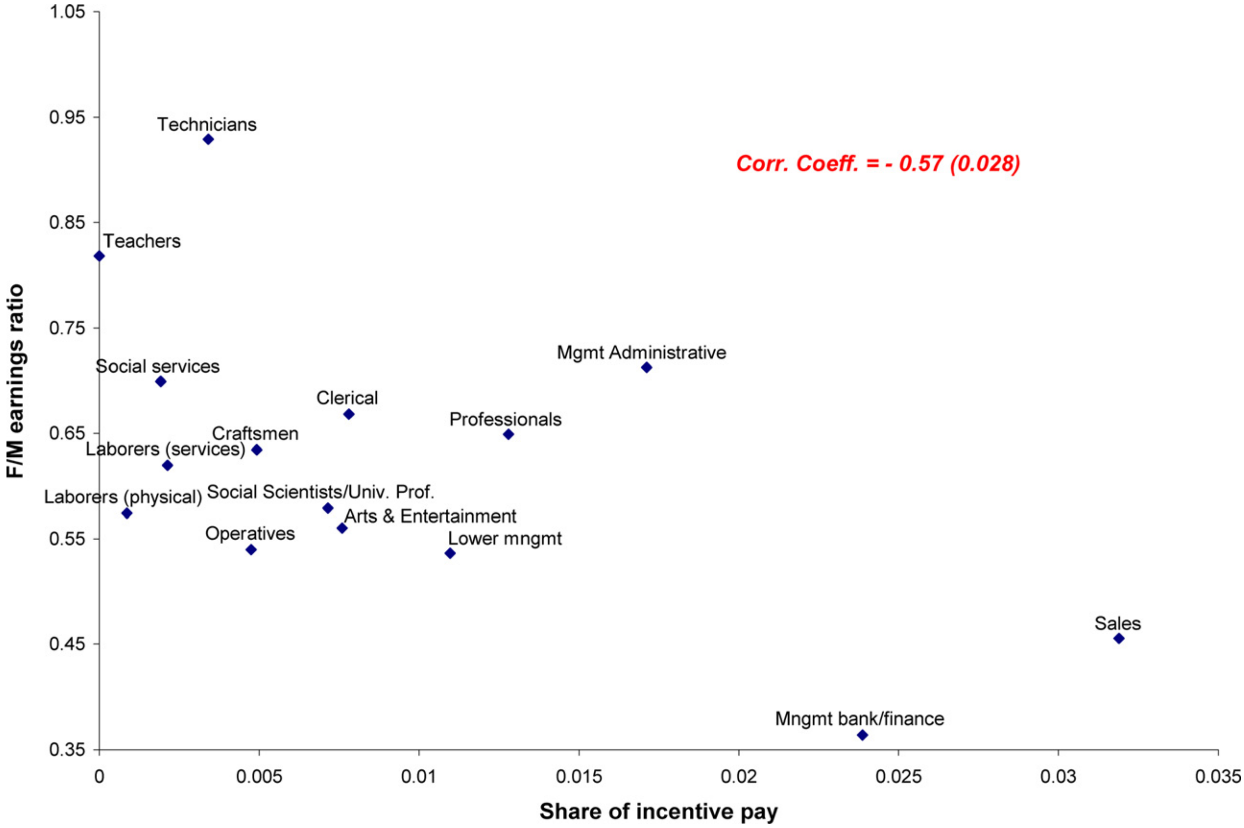

Fig. 6. Correlation between the F/M earnings ratio and the aggregate fraction of incentive pay.

occupations are also characterized by the highest levels of total compensation, then a small percentage points difference in performance pay share across genders will translate into a relatively larger gender difference in total compensation.

In order to quantitatively assess the role of performance pay in explaining gender differentials, we estimate the fraction of male–female differences in total compensation that can be attributed to male–female differences in performance-based pay. Suppose that i_j is the monetary value of performance pay and w_j is total earnings for a worker of sex $j = f, m$, then the average value of $\frac{i_m - i_f}{w_m - w_f}$, by occupation and overall, represents the fraction of the gender differential in earnings explained by gender differences in performance pay. We compute this statistic both for the entire sample and for just those workers who report positive performance pay.

The results are reported in Table 2. The first two columns of the table report the fraction of the gender earnings differential that can be attributed to differences in performance pay respectively for the overall sample and for the sample that excludes workers who did not report any performance pay. The last two columns of the table display the fraction of workers reporting positive performance pay. We report the statistics for the four broad occupation/industry categories characterized by the largest incidence of performance pay and for all the occupations. If we average over the entire sample, we find that for management, banking and finance the gender differences in performance pay account for respectively 10 and 21% of the differences in total earnings. For lower management and sales, they account for 6%. If we restrict our sample to those workers who report positive performance pay, for management, banking and finance the fraction increases to 24 and 31%, respectively. For lower management and sales, it reaches 22 and 28%, respectively. Note moreover, that the fraction of females and males that report performance pay is very similar for each occupation, which indicates there is no gender bias in reporting performance pay. This analysis suggests that differences in performance pay are quite important in accounting for differences in earnings in those occupations where incentives play a role. These results confirm our Census analysis.

Interestingly, the large variation in the female/male earnings ratio across the occupations considered is not systematically related to the fraction of females working in a given occupation. As shown in Fig. 8, there is no clear relation between these two variables and their correlation is not significantly different from zero.[22] This evidence casts doubts on explanations of gender earnings differentials based solely on occupational sorting by gender. Although it would be interesting to study the differential role of occupational sorting and incentive problems within each occupation in accounting for gender

[22] The same is true for the difference in log hourly wages and for the Census 2000 sample. This is also consistent with evidence from the National Committee on Pay Equity, based on the 2000 Household Data Annual Averages from the Bureau of Labor Statistics.

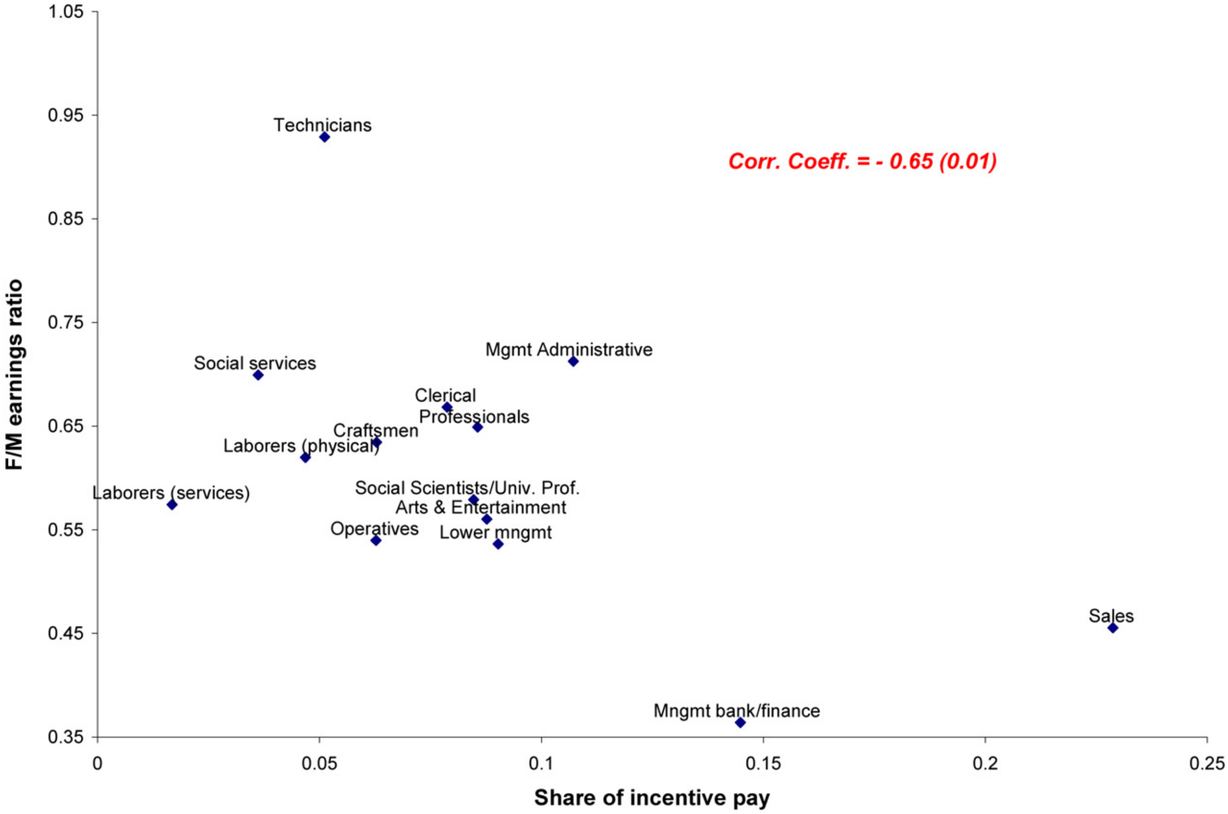

Fig. 7. Correlation between the F/M earnings ratio and the aggregate fraction of incentive pay for workers with positive incentive pay.

Table 2
Share of gender earnings differential explained by gender differences in performance pay (entries in %)

	Overall sample	Sample with performance pay	% with positive performance pay	
			Males	Females
Management	10	24	19	24
Mngmt, banking, finance	21	31	26	20
Lower management	6	22	13	14
Sales	6	28	17	14
Overall*	5	24	11	14

Based on PSID data for 1994 to 2001. See text for sample selection rules.
* Overall refers to the weighted average of each statistics across all occupations.

earnings differentials, this analysis is beyond the scope of this paper since our representative household/representative firm environment does not generate predictions on occupational sorting.

Finally, we tackle predictions 3 and 4 in Section 2.4, which in a cross-section of married couples translate into:

3. The correlation between the wife/husband ratio of home hours and the wife/husband ratio of earnings should be negative.
4. The correlation between the wife/husband ratio of home hours and the husband–wife difference in the fraction of performance pay should be positive.

We study these correlations across a sample of married couples using the PSID. The ideal data set for this exercise would include information on home hours, market hours, labor earnings and the structure of compensation for both spouses for an ample cross-section of married couples. While being far from ideal, the PSID is one of the few data sets that allows us to move in this direction. In particular, we have information on home hours, market hours and earnings of both spouses.[23]

[23] The variable that reports home hours in the PSID poses a measurement problem. The survey respondent is asked to provide a measure of weekly hours worked at home by him- or herself and by the spouse (if married). No time diaries are used. This could be problematic if respondents tend to overestimate

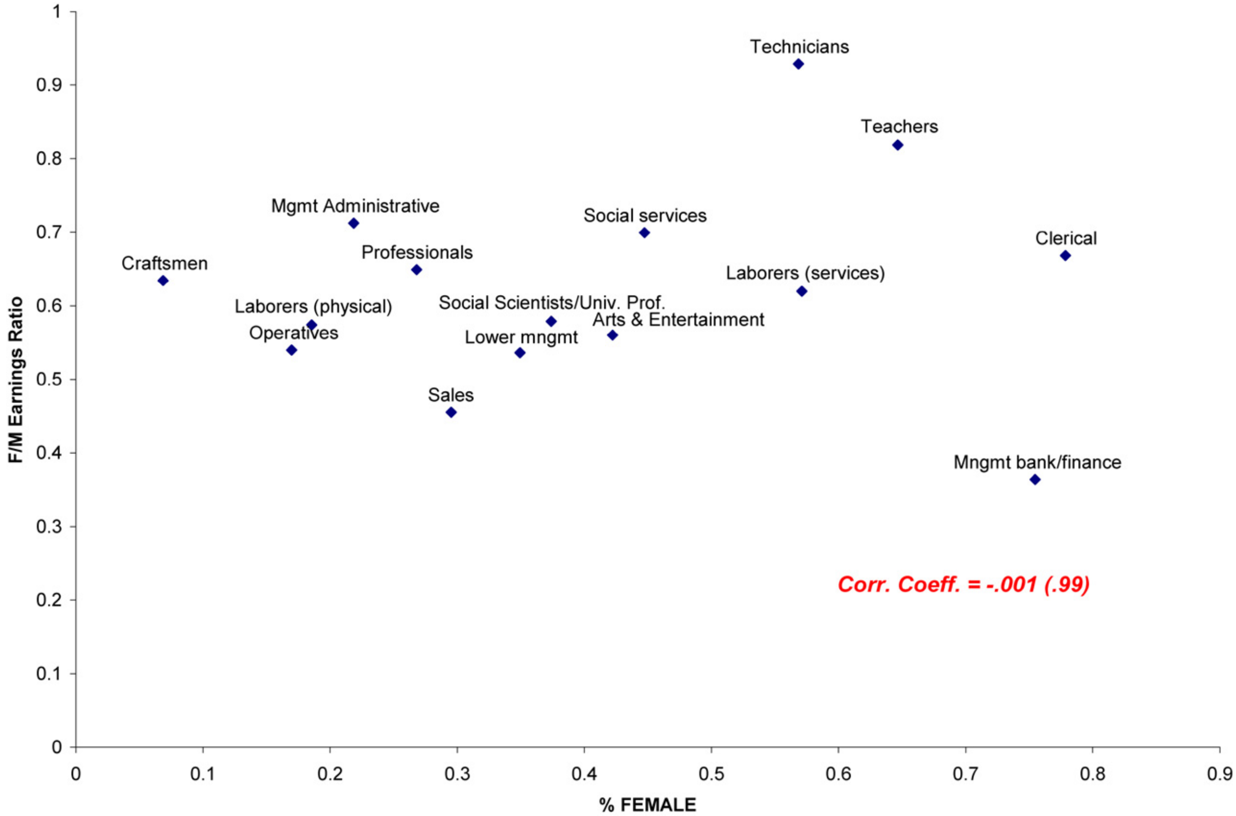

Fig. 8. Correlation between the percentage of female workers and the F/M earnings ratio.

However, we only have information on bonuses and commissions for household heads. In order to recover the information for spouses, we use the available information on occupation jointly with the gender-specific average shares of performance pay by occupational categories. We impute a value of $\tilde{w}$ that is equal to the fraction of performance pay received by the average worker of the same gender in the same occupation. We then compute $\tilde{w}_m - \tilde{w}_f$ for each couple as the difference of the reported performance pay shares of husband and of the imputed performance pay share of the wife.

To minimize the impact of additional factors, such as race, cohort and wife's labor market attachment, that could be driving the cross-sectional correlations we are interested in exploring, we aim to build a sample that is homogeneous with respect to age, presence of young children in the household, and labor market attachment of both spouses, while maintaining a reasonable sample size. We include male-headed married couples where both husband and wife are white, the head of the household is between 25 and 44 years old and both spouses are full-time year-round workers (they both work at least 30 hours per week and at least 50 weeks per year). Moreover, we only consider couples that report all the relevant variables for both partners. Summary statistics for this sample are presented in Appendix B, Table B.6. We report the results of our analysis in Table 3.

Entries in column 1 refer to the sample of married couples. Column 2 reports correlation coefficients for the sample of married couples with children less than 13 years old. Our sample consists of 300 couples of which 167 have children. The data confirms prediction 3 that wife/husband earnings and home hours ratios are negatively correlated across all households. This is true irrespective of the presence of children. The correlation coefficient is −0.27 and significant at the one percent level in both samples. On the other hand, the validity of prediction 4 depends on the presence of children. We find that for the overall sample there is a positive but small and not significant correlation between the difference in performance pay shares across spouses and the wife/husband ratio of home hours, whereas for the sample of married couples with children, the correlation coefficient is equal to 0.21 and it is significant at the one percent level.

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their own home hours and to underestimate their spouses' home hours. In particular, if respondents are disproportionately women we would tend to overestimate the wife/husband ratio of home hours. Evidence from time-use surveys for the late-1990s confirms the PSID evidence that wives spend, on average, at least twice as much time than their husbands in home production activities irrespective of their labor market status.

The first wave of the American Time-Use data set (ATUS), made available by the Bureau of Labor Statistics in January 2005, could provide an alternative to the PSID. The ATUS data, however, also has a serious drawback for married households. Only one spouse is selected at random and asked to fill the time-use questionnaire. Consequently, time-use information is not available for both husbands and wives for the CPS sample. This makes it impossible to analyze patterns of relative home hours and earnings across married couples.

Table 3
Home hours, earnings and performance pay across a sample of married couples

	All	With kids
$\text{corr}(\frac{w_f}{w_m}, \frac{h_f}{h_m})$	$-\mathbf{0.27}$	$-\mathbf{0.27}$
	(0.0003)	(0.000)
$\text{corr}(\tilde{w}_m - \tilde{w}_f, \frac{h_f}{h_m})$	0.03	**0.21**
	(0.582)	(0.007)
Number of couples	300	167

p-values in parentheses.

4. Concluding remarks

This paper lays out a simple framework that endogenizes gender differentials in earnings and home hours. Incentive problems in the labor market play an essential role and lead to novel predictions on the link between gender differences in the structure of compensation and home hours that are broadly supported in the data. Our analysis sheds light on the link between biological differences and gender differentials in labor market outcomes. We show that equilibria in which women have higher home hours and consequently lower earnings are possible even without ex ante gender differences. On the other hand, even if women have a comparative advantage in home production, equilibria in which men have higher home hours and lower earnings are also possible. The existence of these equilibria is rooted in the incentive problem on the labor market. Taken together these results lead to the conclusion that biological differences are neither a necessary or a sufficient condition for women's lower earnings.

We abstract for selection of women and men into different occupations or industries by assuming that all agents are ex ante identical except for gender and there is only one production technology.[24] This assumption also implies that there are no efficiency losses associated with gender discrimination. An extension of the model that allows for a non-degenerate distribution of individual productivities, symmetric across genders, could address in part both these issues. In a gendered equilibrium, female workers with high productivity may be induced to sort into low skill occupations. This would generate misallocation costs associated with gender discrimination.[25]

Our empirical results provide suggestive evidence in support of the theoretical mechanism, but data limitations prevent us from directly testing our model. Specifically, the Census does not report home hours or the fraction of performance pay. This information is available in the PSID, which does not report incentive of pay for *both* husbands and wives. Moreover, the PSID data does not include any equity based measures of performance pay. The ideal data set would include observations on the structure of earnings at the individual level for a broad class of sectors and jobs, as well as detailed household level information. To the best of our knowledge, such a data set is not available for the U.S. Albanesi and Olivetti (2008) concentrate on top executives, a group of workers for which high quality data on different components of pay is available. They find that female top executives receive lower performance pay as a fraction of total compensation and that hours devoted to home production, including childcare, are greater for female executives than for male, consistently with the pattern for the broad population of workers. They also consider gender differences in preferences and barriers to career advancement, and conclude that the gender differences in the structure of pay for top executives are inefficient.

Appendix A

A.1. Labor contracts

Proof of Proposition 1. The first order necessary conditions for Problem 1 at an interior solution are:

$$f'(e) - v_e(h,e) + \mu\big(\tilde{w} f''(e) - v_{ee}(h,e)\big) = 0, \tag{A.1}$$

$$-\sigma \Sigma^2 \tilde{w} + \mu f'(e) = 0. \tag{A.2}$$

To solve for effort, substitute $\mu = \frac{\sigma \Sigma^2 \tilde{w}}{f'(e)}$ and $\tilde{w} = \frac{v_e(h,e)}{f'(e)}$, into (A.1) to obtain an equation in e:

$$f'(e) - v_e(h,e) + \frac{\sigma \Sigma^2 \frac{v_e(h,e)}{f'(e)}}{f'(e)} \left(\frac{v_e(h,e)}{f'(e)} f''(e) - v_{ee}(h,e) \right) = 0. \tag{A.3}$$

Assuming (9)–(10), (A.3) simplifies to:

$$1 - (\psi + h)e - \sigma \Sigma^2 (\psi + h)^2 e = 0,$$

[24] Goldin's (1986) pioneering study links supervisory and monitoring costs to occupational segregation by gender.

[25] The innefficiencies associated with gender discrimination may also depend on the nature of the household bargaining process. See Ishida (2003).

which implies (11) and (12). Imposing zero profits on firms, delivers $Ew^*(h) = f(e^*(h))$. Then:

$$Ew^{*\prime}(h) = \frac{-(1+2\sigma\Sigma^2(\psi+h))}{((\psi+h)+\sigma\Sigma^2(\psi+h)^2)^2} < 0,$$
$$Ew^{*\prime\prime}(h) = 2\frac{1+3\sigma\Sigma^2(\psi+h)+3[\sigma\Sigma^2(\psi+h)]^2}{((\psi+h)+\sigma\Sigma^2(\psi+h)^2)^3} > 0. \qquad \square$$

Proof of Proposition 2. The Lagrangian for Problem F2 is:

$$\max_{\{e_j,\tilde{w}_j\}_{j=L,H},T_L,T_H} 0.5\sum_j\left(f(e_j)-v(h_j,e_j)-\sigma\Sigma^2\frac{\tilde{w}_j^2}{2}-T_j\right)-\sum_j\mu_j\big(\tilde{w}_jf'(e_j)-v_e(h_j,e_j)\big)$$
$$-\sum_{j,i\neq j}\lambda_j\left[f(\hat{e}_i)\tilde{w}_i-v(h_j,\hat{e}_i)-\sigma\Sigma^2\frac{\tilde{w}_i^2}{2}+T_i-f(e_j)\tilde{w}_j+v(h_j,e_j)+\sigma\Sigma^2\frac{\tilde{w}_j^2}{2}-T_j\right]$$
$$-\sum_{j,i\neq j}\xi_j\big(f'(\hat{e}_i)\tilde{w}_i-v_e(h_j,\hat{e}_i)\big). \tag{A.4}$$

After substituting in functional forms, the first order necessary conditions for this problem are:

$$0.5\big(1-(\psi+h_j)e_j\big)+\mu_j(\psi+h_j)-\lambda_j\big(-\tilde{w}_j+(\psi+h_j)e_j\big)=0, \tag{A.5}$$
$$-0.5\sigma\Sigma^2\tilde{w}_j-\mu_j-\lambda_j\big(-e_j+\sigma\Sigma^2\tilde{w}_j\big)-\lambda_i\big(\hat{e}_j-\sigma\Sigma^2\tilde{w}_j\big)=0, \tag{A.6}$$
$$-\lambda_j\big(\tilde{w}_i-(\psi+h_j)\hat{e}_i\big)+\xi_j(\psi+h_j)=0, \tag{A.7}$$
$$-0.5+\lambda_j-\lambda_i\leqslant 0, \quad \text{with equality for } T_j>0, \tag{A.8}$$
$$\tilde{w}_j-(\psi+h_j)e_j=0, \tag{A.9}$$
$$\hat{e}_i\tilde{w}_i-(\psi+h_j)\frac{\hat{e}_i^2}{2}-\sigma\Sigma^2\frac{\tilde{w}_i^2}{2}+T_i-e_j\tilde{w}_j+(\psi+h_j)\frac{e_j^2}{2}+\sigma\Sigma^2\frac{\tilde{w}_j^2}{2}-T_j\leqslant 0, \tag{A.10}$$
$$\lambda_j\left[\hat{e}_i\tilde{w}_i-(\psi+h_j)\frac{\hat{e}_i^2}{2}-\sigma\Sigma^2\frac{\tilde{w}_i^2}{2}+T_i-e_j\tilde{w}_j+(\psi+h_j)\frac{e_j^2}{2}+\sigma\Sigma^2\frac{\tilde{w}_j^2}{2}-T_j\right]=0, \quad \lambda_j\geqslant 0, \tag{A.11}$$
$$\tilde{w}_i-(\psi+h_j)\hat{e}_i=0, \tag{A.12}$$

for $j=L,H$ and $i\neq j$. (A.9) implies $\xi_j=0$ for L,H and (A.8) implies that only one adverse selection incentive compatibility constraint can bind. Condition (16) guarantees that only the constraint for h_H is binding. To see that $T_H>0$ is a solution under (16), assume that $T_H>0$. Then, $\lambda_H>0$ and $T_L=\lambda_L=0$ and Eqs. (A.5)–(A.12) imply (17)–(20). By (18) and (20):

$$\tilde{w}_L-\tilde{w}_H=\frac{0.5(\psi+h_H)}{\psi+0.5(h_H+h_L)}-\frac{0.5}{\sigma\Sigma^2(\psi+h_H)}$$
$$=\frac{2\sigma\Sigma^2(\psi+h_H)-\frac{2\psi+h_H+h_L}{(\psi+h_H)}}{(2\psi+h_H+h_L)2\sigma\Sigma^2}>0,$$

if and only if

$$\frac{1}{(\psi+h_H)}>\sigma\Sigma^2>\frac{1}{(\psi+h_H)}\frac{\psi+(h_H+h_L)/2}{(\psi+h_H)}. \tag{A.13}$$

The first inequality holds by (16), while the second inequality holds for any $h_L<h_H$. Then, by (A.10), $T_H>0$. Now, we prove that no other solutions exist under (16). Consider the case $\lambda_L>0$, $T_L>0$, $T_H=0$ and $\lambda_H=0$. Then, $\lambda_L=0.5$ and:

$$e_L=\frac{0.5}{\sigma\Sigma^2}\frac{1}{(\psi+h_L)^2}, \tag{A.14}$$
$$\tilde{w}_L=\frac{0.5}{\sigma\Sigma^2}\frac{1}{(\psi+h_L)}, \tag{A.15}$$
$$e_H=\frac{0.5(\psi+h_L)}{(\psi+h_H)(\psi+0.5(h_L+h_H))}, \tag{A.16}$$
$$\tilde{w}_H=\frac{0.5(\psi+h_L)}{(\psi+0.5(h_L+h_H))}. \tag{A.17}$$

This is a solution, we check that T_L is indeed strictly positive. Substituting into (A.10):

$$\begin{aligned}\tilde{w}_H - \tilde{w}_L &= \frac{(\psi + h_L)}{(2\psi + h_H + h_L)} - \frac{1}{(\psi + h_L)2\sigma\Sigma^2} \\ &= \frac{2\sigma\Sigma^2(\psi + h_L) - \frac{(\psi+h_H)}{(\psi+h_L)} - 1}{(2\psi + h_H + h_L)2\sigma\Sigma^2} > 0.\end{aligned}$$

Hence, $T_L > 0$ iff $1 < \sigma\Sigma^2(\psi + h_L) < (\frac{(\psi+h_H)}{(\psi+h_L)} + 1)0.5$, which is ruled out by (16). Finally, consider $\lambda_L = \lambda_H = 0$ and $T_L = T_H = 0$. The first order conditions imply:

$$\tilde{w}_j = \frac{1}{1 + (\psi + h_j)\sigma\Sigma^2}, \qquad e_j = \frac{1}{\psi + h_j + (\psi + h_j)^2\sigma\Sigma^2},$$

for $j = H, L$. Substituting these expressions into (10), we have that $T_L = T_H = 0$ iff:

$$\left[\frac{1}{(\psi + h_H)} - \sigma\Sigma^2\right]\left(\tilde{w}_L^2 - \tilde{w}_H^2\right) \leqslant 0,$$
$$\left[(\tilde{w}_H)^2 - (\tilde{w}_L)^2\right]\left(\frac{1}{(\psi + h_L)} - \sigma\Sigma^2\right) \leqslant 0.$$

Since $\tilde{w}_L > \tilde{w}_H$, the two inequalities are satisfied for $\frac{1}{(\psi+h_H)} - \sigma\Sigma^2 \leqslant 0$ and $\frac{1}{(\psi+h_L)} - \sigma\Sigma^2 \geqslant 0$, which violate (16). □

A.2. Household problem

Let $MC^H(\mathcal{C}) = \partial C^H(H;\mathcal{C})/\partial H$ be the marginal cost of H, which is independent of H given that $H(\cdot)$ is homogeneous of degree 1. Specifically, by (27)–(28):

$$MC^H(\mathcal{C}) = \left[(1+\varepsilon)\left(\frac{Ew'(h_f)}{(1+\varepsilon)}\right)^{\zeta/(\zeta-1)} + \left(Ew'(h_m)\right)^{\zeta/(\zeta-1)}\right]^{(\zeta-1)/\zeta}.$$

The second cost minimization problem for the household can be written as:

$$\text{(Problem H2)} \quad C^G(\bar{G};\mathcal{C}) = \min_{k,H \geqslant 0} k + MC^H(\mathcal{C})H \quad \text{subject to} \quad H^\delta k^{1-\delta} \geqslant \bar{G},$$

for $\bar{G} > 0$. The first order necessary conditions for this problem imply:

$$k = \left(\frac{1}{MC^H(\mathcal{C})}\frac{\delta}{1-\delta}\right)^{-\delta} G,$$
$$\frac{H}{k} = \left(\frac{1}{MC^H(\mathcal{C})}\frac{\delta}{1-\delta}\right).$$

These equations define k and H as a function of G. We can then define $MC^G(\mathcal{C}) = \partial C^G(G;\mathcal{C})/\partial G$, with:

$$MC^G(\mathcal{C}) = (1-\delta)^{-(1-\delta)}\left(\frac{\delta}{MC^H(\mathcal{C})}\right)^{-\delta}.$$

Problems H1 and H2 are convex minimization problems. Hence, first order necessary conditions are sufficient and the optima will be attained by the respective policy functions. Combining the solutions to Problems H1 and H2, we can define the functions $\hat{h}_f(G;\mathcal{C})$, $\hat{h}_m(G;\mathcal{C})$ that express the optimal intra-household allocation of home hours as a function of the level of public home consumption. The last step of the household problem is to optimize (10) by choice of G, c_f and c_m subject to $c_f + c_m + MC^G(\mathcal{C})G \leqslant a + \sum_i w_i^*(\hat{h}_i(G;\mathcal{C}))$. The solution to this problem gives rise to the policy functions: $c_i(a;\mathcal{C})$, and $G(a;\mathcal{C})$, and recursively to $h_i(a;\mathcal{C}) = \hat{h}_m(G(a;\mathcal{C});\mathcal{C})$ for $i = f, m$.

A.3. Equilibrium

We prove the proposition in two steps. We first establish that any symmetric equilibrium there are at most two values of home hours in the population and that any such equilibrium with non-degenerate distribution of home hours must be ungendered. Then, we show the set of equilibria with degenerate distribution of home hours.

Lemma A.1. *If the distribution of home hours in the population is non-degenerate, that is $\pi_f(h_j) \in (0,1)$ and $\pi_m(h_j) \in (0,1)$ for $j = H, L$ with $h_L < h_H$, then the equilibrium is ungendered and $\pi_f(h_j) = \pi_m(h_j)$ for $j = L, H$.*

Proof. To prove the first result, note that given that there is a representative household, in a gendered equilibrium, home hours will be constant across wives and husbands, leading to two values of home hours in the population with $0 < h_L < h_H$. In an ungendered equilibrium, households are indifferent over the distribution of home hours across spouses and they randomize. The randomization strategy will be the same across all households leading to at most two values of home hours in the population. To prove the second result, note that a non-degenerate distribution of home hours occurs when households are indifferent over the allocation of home hours across spouses. Suppose that the distribution of home hours is non-degenerate and the equilibrium is gendered, so that $\pi_m(h_j) \neq \pi_f(h_j)$ for $j = L, M$ for some $0 < h_L < h_H$. Then, wives and husbands will not be facing the same menu of labor contracts and randomization will not be optimal and the distribution of home hours will be degenerate. Contradiction. Hence, if the distribution of home hours is non-degenerate, the equilibrium is ungendered. □

Proof of Proposition 4. If firms' beliefs satisfy $\Pr(h_f < h_m) = 1$, then $\max Ew_f(h) > \max Ew_m(h)$. If such an equilibrium exists, $h_f < h_m$ and the distribution of home hours will be given by $\pi_f(h_H) = 0$ and $\pi_m(h_L) = 0$, by Lemma A.1. Hence, equilibrium labor contracts will satisfy Proposition 1. Such an equilibrium exists, if Problem H1 has a solution with $h_f/h_m < 1$. Such an equilibrium is unique, if this is the unique solution to Problem H1. Note that (27) and (28) can be rewritten as:

$$(x)^{1-\zeta} = \frac{Ew'(h_m)}{Ew'(xh_m)}, \tag{A.18}$$

$$\frac{H}{h_m} = \left[x^{\zeta} + 1\right]^{1/\zeta}, \tag{A.19}$$

where $x = h_f/h_m$. Eq. (A.18) implicitly defines x as a function of h_m, while (A.19) defines h_m as a function of H. The following lemma characterizes the solutions to (A.18).

Lemma A.2. *If labor contracts satisfy Proposition* 1*, Eq.* (A.18) *generically has two solutions, $x_1(h_m) = 1$ and $x_2(h_m) < 1$, with $\lim_{h_m \to 0} x_2(h_m) = 1$ and $\lim_{h_m \to \infty} x_2(h_m) = 0$. Moreover, Eq.* (A.19) *has a unique finite solution h_m^i for each branch $x_i(h_m)$ for $i = 1, 2$, with $h_m^1 > h_m^2$ for given H.*

Proof. The left-hand side of Eq. (A.18) is increasing and concave in x and crosses the forty-five degree line at $x = 0$ and $x = 1$. Given that firms' beliefs over the distribution of home hours in the population are degenerate, the contracts offered to female and male workers are described by Proposition 1. It follows that $\frac{Ew'(h_m)}{Ew'(h_m)} = 1$, so that one solution to (A.18) is $x_1(h_m) = 1$. Since, $E'w^{*\prime}(h) < 0$ and $Ew^{*\prime\prime}(h) > 0$, for all $0 < x < 1$, $\frac{Ew'(h_m)}{Ew'(xh_m)} < 1$. Moreover, the right-hand side of (A.18) is continuous and increasing in x, since the slope of this expression as a function of x, given by $h_m \frac{Ew'(h_m)}{Ew'(xh_m)} \frac{-Ew''(xh_m)}{Ew'(xh_m)}$, is positive. Since by (12) and (11), $\lim_{x \to 0} Ew'(xh_m) < 0$ and $Ew'(h_m)/\lim_{x \to 0} Ew'(xh_m) < 1$, there must be another crossing at $x_2(h_m) < 1$. The convexity of $Ew'(h)$, implies that $x_2(h_m)$ is decreasing in h_m. In addition, Proposition 1 implies $w^{*\prime}(0)$ is finite and $\lim_{h_m \to \infty} Ew'(h) = 0$. Then, $\lim_{h_m \to 0} x_2(h_m) = 1$ and $\lim_{h_m \to \infty} x_2(h_m) = 0$ follows. By (A.19), $h_m^1(H) = H2^{-1/\zeta}$. Since $x_2(h_m)$ is decreasing in h_m, $\lim_{h_m \to 0} x_2(h_m) = 1$ and $\lim_{h_m \to \infty} x_2(h_m) = 0$, the right-hand side of Eq. (A.19) evaluated at $x_2(h_m)$ is bounded below 1, and bounded above by $2^{-1/\zeta}$. Since $\lim_{h_m \to 0} H/h_m = \infty$ and $\lim_{h_m \to \infty} H/h_m = 0$, (A.18) has a unique finite solution when evaluated at $x_2(h_m)$, $h_m^2(H) > 0$. □

By Lemma A.2, generically there exist two zeros for Eq. (A.18), $x_1 = 1$ and $x_2 \in (0, 1)$. However, under $\max Ew_f(h) < \max Ew_m(h)$, $x_1 = 1$ is not optimal for Problem H1. Hence, the unique solution to Problem H1 is $0 < h_L = h_f = x_2 h_m = x_2 h_H$ for h_m that solves (28) and H that solves Problem H2. This solution is constant for all households. Hence, the resulting distribution of home hours is $\pi_f(h_H) = 0$ and $\pi_m(h_L) = 0$, consistent with firms' beliefs.

If firms' beliefs satisfy $\Pr(h_f > h_m) = 0$, then $\max Ew_f(h) < \max Ew_m(h)$. If such an equilibrium exists, $h_f > h_m$ and the distribution of home hours will be given by $\pi_f(h_H) = 1$ and $\pi_m(h_L) = 1$. By (27) and (28), we can write:

$$(y)^{1-\zeta} = \frac{Ew'(h_f)}{Ew'(yh_f)}, \tag{A.20}$$

$$\frac{H}{h_f} = \left[1 + y^{\zeta}\right]^{1/\zeta}, \tag{A.21}$$

where $y = h_m/h_f$. Applying Lemma A.2 to (A.20)–(A.21) implies that there are two zeros for (A.20): $y_1 = 1$ and $y_2(h_f) < 1$. But under $\max Ew_f(h) < \max Ew_m(h)$, $y_1 = 1$ is not optimal for Problem H1. Hence, the unique solution to Problem H1 is $0 < h_L = h_m = y_2 h_f = y_2 h_H$ for all households, resulting in the distribution of home hours $\pi_m(h_H) = 0$ and $\pi_f(h_L) = 0$, consistent with firms' beliefs. This proves result (i) in Proposition 4. Note that $y_2(h) = x_2(h)$ and $h_m^2(H) = h_f^2(H)$.

If firms' beliefs satisfy $\Pr(h_f = h_m) = 1$, then $Ew_f(h) = Ew_m(h)$ for all possible values of h. By Lemma A.2, $x_1 = 1$ is a zero for Eq. (A.18). Moreover, under $Ew_f(h) = Ew_m(h)$, the ratio $h_f/h_m = 1$ solves Problem H1 and induces distribution of home hours $\pi_i(\bar{h}) = 1$ for $i = f, m$ with $\bar{h} = H2^{-1/\zeta}$, by (A.19), consistent with firms' beliefs. By contrast the zero $x_2 < 1$ for Eq. (A.18) would induce a distribution of home hours inconsistent with firms' beliefs. Since there is a unique value of $\bar{h}$ which solves Problem H1, this equilibrium is unique. This proves result (ii) in Proposition 4. □

A.4. Ex ante differences

Proof of Proposition 5. Assume that firms believe that female home hours are smaller than male home hours, so that $\max Ew_f(h) > \max Ew_m(h)$. To see if $h_f/h_m < 1$ is optimal for the household, we need verify whether the system:

$$(x)^{1-\zeta} = \frac{E[w'_m(h_m)]}{E[w'_f(xh_m)]/(1+\varepsilon)}, \tag{A.22}$$

$$\frac{H}{h_m} = \left[(1+\varepsilon)x^{\zeta} + 1\right]^{1/\zeta}, \tag{A.23}$$

has a solution with $x < 1$ when, by Lemma A.1, labor contracts solve Problem F1. By Lemma A.2, for $\varepsilon > 0$ (A.22) has two zeros, with $0 < x_2 < x_1 < 1$. By $\max Ew_f(h) > \max Ew_m(h)$ and since $Ew(h)$ is decreasing and convex in h by Proposition 1, x_1 will not be optimal for Problem H1. Hence, households will choose $h_L = h_f = x_2 h_m = h_H$ and the resulting distribution of home hours will be $\pi_f(h_H) = 0$ and $\pi_m(h_L) = 0$, consistent with firms' beliefs. If ε is high enough, however, Eq. (A.22) fails to have a solution so that this equilibrium fails to exist.

If firms believe female home hours are greater than male home hours, $\max Ew_f(h) < \max Ew_m(h)$. This outcome can be an equilibrium if $h_m/h_f > 1$ solves Problem H1. To verify this, consider the system of equations:

$$(y)^{1-\zeta} = \frac{E[w'_f(h_f)]}{E[w'_m(yh_f)](1+\varepsilon)}, \tag{A.24}$$

$$\frac{H}{h_f} = \left[(1+\varepsilon) + y^{\zeta}\right]^{1/\zeta}. \tag{A.25}$$

By Lemma A.2, for $\varepsilon > 0$, generically, there are two zeros for Eq. (A.24), $0 < y_1 < 1 < y_2$. However, y_2 is not optimal for Problem H1 under $\max Ew_f(h) < \max Ew_m(h)$. Hence, the unique solution to Problem H1 is $y_2 > 1$. Then, the equilibrium distribution of home hours will satisfy $\pi_f(h_H) = 1$ and $\pi_m(h_L) = 1$, with $0 < h_L = h_m = y_2 h_f = h_H$, consistent with firm beliefs. □

Appendix B. Data appendix

B.1. Census analysis

The Census sample includes 25–54 year old white men and women, who are not in school, not in the armed forces, do not reside on a farm or live in group quarters. We include individuals who worked at least 50 weeks in the previous year and who usually work at least 30 hours per week.

We use the following Census variables in our analysis. INCWAGE for total annual wages and salaries, WKSWORK1 for weeks worked and UHRSWORK for usual hours worked per week. These three variables report information for the year preceding the Census survey. For educational attainment we use the variable EDUCREC to group individuals according to four broad educational categories: less than high school, high school completed, some college and college completed. We construct four education dummies based on this categorization. The first dummy is equal to one if an individual has completed less than twelve years of schooling and is equal to zero otherwise. The second dummy variable is equal to one if he or she has completed twelve years of schooling, and is equal to zero otherwise. The third dummy variable equals one if the individual has completed between twelve and fifteen years of schooling and it is equal to zero otherwise. Finally, the fourth dummy variable is equal to one if an individual has completed at least sixteen years of education and it equals zero otherwise. The omitted dummy variable in the regressions corresponds to individuals who completed less than twelve years of schooling. For industry, we use the variable INDNAICS that reports the type of establishment in which a person worked in terms of the good or service produced. Industries are coded according to the North American Industrial Classification System developed in 1997. We have excluded from our sample workers in agriculture, forestry, fishing, and hunting, mining and utilities. This is because for these three industries we are unable to compute adjusted gender earnings ratios for the sample of never married workers in sales and management occupations. That is, once we control for age and education in each of the occupation/industry cells there is not enough variation left to estimate the coefficient on the female dummy. We use the variable OCCSOC for occupation. OCCSOC classifies occupations according to the 1998 Standard Occupational Classification (SOC) system. The Census also provides an aggregation of all the occupations in 23 broader categories that include the three categories considered in the analysis. The definition of production occupations also includes construction and extraction workers.

Table B.1
Summary statistics for the Census sample

	Males		Females	
	Mean	St. dev.	Mean	St. dev.
Age	40.03	8.06	40.14	8.19
Less than HS	0.07	0.25	0.04	0.20
HS	0.30	0.46	0.30	0.46
Some college	0.30	0.46	0.35	0.48
College+	0.33	0.47	0.30	0.46
Married spouse present	0.70	0.46	0.62	0.49
Married spouse absent	0.01	0.10	0.01	0.09
Separated	0.02	0.12	0.03	0.16
Divorced	0.11	0.31	0.17	0.38
Widowed	0.00	0.06	0.02	0.12
Never married	0.16	0.37	0.16	0.36
Number of children	1.09	1.20	0.94	1.08
Salary (annual)	49,552	49,929	33,240	29,358
Market hours (annual)	2405	477	2185	387
Log hourly earnings	2.86	0.65	2.59	0.58
Management	0.07	0.25	0.05	0.22
Business and financial operations	0.04	0.21	0.07	0.25
Computer and math	0.04	0.19	0.02	0.15
Architecture and engineering	0.04	0.20	0.01	0.09
Life, physical, and social science	0.01	0.11	0.01	0.10
Community and social services	0.01	0.10	0.02	0.14
Legal occupations	0.01	0.12	0.02	0.13
Education, training and library	0.02	0.13	0.05	0.22
Arts, design, ent, sports and media	0.02	0.14	0.02	0.14
Healthcare practitioner and techn.	0.03	0.16	0.09	0.28
Healthcare support	0.00	0.05	0.03	0.17
Protective services	0.03	0.18	0.01	0.09
Food preparation and serving	0.02	0.12	0.03	0.17
Building, ground cleaning/maintenance	0.03	0.16	0.02	0.13
Personal care services	0.01	0.08	0.03	0.18
Sales	0.11	0.32	0.11	0.31
Office and administrative support	0.06	0.24	0.27	0.45
Farming, fishing and forestry	0.01	0.08	0.00	0.04
Construction and extraction	0.10	0.30	0.00	0.06
Installation, maintenance and repair	0.08	0.27	0.01	0.07
Production	0.11	0.32	0.06	0.24
Transportation and material moving	0.08	0.28	0.02	0.13
Agriculture, forestry, fishing, hunting	0.01	0.11	0.00	0.06
Mining	0.01	0.09	0.00	0.04
Utilities	0.02	0.13	0.01	0.08
Construction	0.12	0.32	0.02	0.14
Manufacturing	0.21	0.41	0.12	0.32
Wholesale trade	0.06	0.23	0.03	0.17
Retail trade	0.10	0.30	0.11	0.32
Transportation and warehousing	0.06	0.24	0.03	0.16
Information	0.03	0.18	0.04	0.19
Finance and insurance	0.04	0.20	0.09	0.28
Real estate and rental and leasing	0.02	0.13	0.02	0.14
Professional, scientific, and technical	0.07	0.26	0.07	0.26
Administrative and support and waste man	0.03	0.16	0.03	0.16
Educational services	0.04	0.18	0.08	0.27
Health care and social assistance	0.04	0.20	0.20	0.40
Arts, entertainment and recreation	0.01	0.12	0.01	0.12
Accomodation and food services	0.03	0.16	0.04	0.20
Other services (exclude public administration)	0.04	0.20	0.04	0.20
Public administration	0.06	0.24	0.06	0.23
Number of observations	31,489,615		21,461,034	

B.1.1. Robustness

We have conducted robustness checks by performing our analysis for a finer set of, 1-digit, occupation categories (professionals, managers, sales, clerical, craftsmen, operatives, laborers and services).

A recent study by Lemieux et al. (2007) provides information on the fraction of jobs, within each 1-digit occupation, associated with pay for performance. They find that the fraction of workers in performance pay jobs is more prevalent in managerial and sales occupations. The fraction is lowest for laborers, operatives and craftsmen (that is, production workers). We use their findings to 'rank' 1-digit occupational categories according to the severity of the incentive problem (again,

Table B.2
Gender differences in earnings across industries, occupation, and marital status (full-time, year-round workers, % female/male median *hourly* earnings ratios)

	Management		Sales		Production	
	Married	Single	Married	Single	Married	Single
Average across all industries	79	96	78	100	82	86
Accommodation and food	80	96	80	102	82	85
Administrative, support, waste mgmt	84	87	89	93	83	87
Arts, entertainment & recreation	83	98	86	87	85	90
Construction	76	80	69	84	85	89
Educational services	86	95	76	108	85	89
Finance and insurance	71	91	71	90	85	89
Health care & social assistance	74	93	73	107	81	84
Information	79	91	76	93	84	88
Manufacturing	80	93	78	95	69	70
Other services (no public adm.)	83	103	78	110	78	81
Profess, scientific & tech. services	77	94	77	93	85	89
Public administration	85	105	84	123	86	90
Real estate and rental/leasing	71	105	80	123	86	90
Retail trade	72	96	73	89	75	77
Transportation and warehousing	80	97	83	105	85	90
Wholesale trade	78	107	72	103	82	85

Table B.3
Gender differences in earnings across industries, occupation, and marital status. Sample with children in the household (full-time, year-round workers, % female/male median earnings ratios)

	Management		Sales		Production	
	Married	Single	Married	Single	Married	Single
Average across all industries	69	92	64	97	76	77
Accommodation and food	69	74	47	156	77	78
Administrative, support, waste mgmt	73	155	–	–	77	78
Arts, entertainment & recreation	72	37	–	–	79	82
Construction	64	75	–	–	79	81
Educational services	77	137	–	–	78	80
Finance and insurance	65	60	64	156	79	81
Health care & social assistance	69	100	–	–	73	74
Information	68	71	85	79	78	80
Manufacturing	74	134	69	89	63	64
Other services (no public adm.)	71	99	59	40	71	71
Profess, scientific & tech. services	69	83	–	–	77	79
Public administration	79	77	67	100	79	81
Real estate and rental/leasing	64	116	62	156	79	83
Retail trade	63	79	54	67	68	68
Transportation and warehousing	67	109	59	43	79	80
Wholesale trade	66	70	72	88	75	76

Note: Gender earnings ratios are missing for administrative, support and waste management, arts, entertainment and recreation, construction, educational services, finance and insurance, and professional, scientific and technical services. For these industries we are unable to compute adjusted gender earnings gaps for the sample of never married workers in sales occupations. This is because there is not enough variation left in each occupation/industry/marital status cell once we control for differences in age and education across workers.

Table B.4
Gender differences in earnings across occupation, and marital status (full-time, year-round workers, % female/male median earnings ratios)

	% receiving pay for performance	F/M residual earnings ratios		
		Married	Never married	Difference
Sales	54	65	93	28
Managers	22	67	93	25
Professionals	11	75	96	21
Services	9	69	90	21
Clerical	9	73	91	18
Craftsmen	9	70	87	17
Operatives	10	63	80	17
Laborers	8	68	85	17

Table B.5
Summary statistics for the PSID sample

	Males		Females	
	Mean	St. dev.	Mean	St. dev.
Age	37.88	7.94	38.10	8.09
Years of education	13.13	2.92	12.91	3.88
Married	0.80	0.40	0.69	0.46
Never married	0.09	0.29	0.10	0.31
Widowed	0.00	0.05	0.01	0.12
Divorced	0.09	0.28	0.16	0.37
Separated	0.02	0.13	0.03	0.17
Number of children	1.11	1.14	0.90	1.04
Salary (annual)	45,601	40,303	28,104	20,889
Log hourly earnings	2.74	0.62	2.40	0.57
Market hours (annual)	2453	513	2159	410
Weekly hours worked	46.47	8.70	41.39	7.18
Weeks worked	50.82	0.75	50.72	0.73
Arts & entertainment	0.01	0.12	0.02	0.14
Clerical	0.05	0.21	0.29	0.46
Social services	0.01	0.11	0.02	0.13
Craftsmen	0.25	0.43	0.03	0.18
Laborers (physical)	0.04	0.19	0.02	0.12
Laborers (services)	0.06	0.23	0.14	0.34
Lower mngmt	0.06	0.24	0.06	0.24
Mgmt administrative	0.13	0.33	0.06	0.24
Mngmt bank/finance	0.01	0.08	0.04	0.19
Operatives	0.16	0.37	0.06	0.23
Professionals	0.10	0.30	0.06	0.24
Sales	0.07	0.25	0.05	0.22
Social scientists/univ. prof.	0.01	0.11	0.01	0.12
Teachers	0.02	0.13	0.06	0.23
Technicians	0.03	0.18	0.08	0.27
Number of observations	5452		3046	
Sample with non-missing incentive pay	5428		826	
Average incentive pay share	0.01	0.05	0.01	0.04
Sample with positive incentive pay	564		88	
Average incentive pay share	0.10	0.13	0.07	0.11
Share with positive incentive pay, by occupation				
Arts & entertainment	0.02	0.13	0.00	0.00
Clerical	0.04	0.20	0.31	0.46
Social services	0.01	0.08	0.00	0.00
Craftsmen	0.20	0.40	0.05	0.21
Laborers (physical)	0.02	0.14	0.00	0.00
Laborers (services)	0.02	0.16	0.08	0.27
Lower mngmt	0.08	0.27	0.08	0.27
Mgmt administrative	0.21	0.40	0.11	0.32
Mngmt bank/finance	0.01	0.10	0.08	0.27
Operatives	0.12	0.33	0.03	0.18
Professionals	0.15	0.35	0.11	0.32
Sales	0.10	0.30	0.07	0.25
Social scientists/univ. prof.	0.01	0.10	0.02	0.15
Teachers	0.00	0.00	0.00	0.00
Technicians	0.02	0.15	0.06	0.23

assuming that the incidence of incentive pay jobs measures the severity of the incentive problem in that occupation). These categories can be easily obtained by using the Census variable OCC1950, which applies the 1950 Census Bureau occupational classification system to occupational data. Note that this set of occupations is also broadly consistent with the ones used in our PSID analysis.

Table B.4 reports the results of this analysis. The statistics on the fraction of incentive pay by occupation reported in column one are from Lemieux et al. (2007, Table 2) based on the PSID. We report residual gender earnings ratios (controlling for education, age and industry) by marital status in columns 2 and 3. Column 4 reports the difference in gender ratios by marital status. Once again, differences by marital status in gender earnings gaps tend to be highest in sale occupations where the severity of the incentive problem is most severe. The results confirm those reported in Table 1.

Table B.6
Summary statistics for the PSID sample of married couples

	Mean	St. dev.
Age of husband	34.15	5.87
Age of wife	32.46	6.30
Weekly home hours of husband	8.26	9.73
Weekly home hours of wife	16.15	10.49
Weeks worked, husband	50.74	0.73
Weeks worked, wife	50.70	0.71
Weekly market hours of husband	45.87	7.98
Weekly market hours of wife	41.60	9.83
Labor income of husband	39,615	28,083
Labor income of wife	25,224	21,040
Wife/husband ratio of home hours	2.32	2.62
Wife/husband earnings ratio	0.63	0.49
Husband/wife difference incentive share	−0.002	0.01
Number of children	1.03	1.13
Number of observations	300	

B.2. PSID analysis

Our PSID sample pools together all the individuals in the 1994 to 2001 waves. Hence, the summary statistics can be interpreted as medium run averages of the relevant variables. The sample includes all white men and women between 25 and 54 years of age who are not in school, who are not in the armed forces, and who worked at least 30 hours per week and 50 weeks per year. We exclude workers with real weekly earnings below $67 in 1982 dollars from the sample. We deflate nominal variables using the CPI with base year 2000. The information on the demographic variable is from the Family and Individual files. The information on hours worked, income, bonus, and commission is from the Income Plus files. Information on bonuses and commission is only available for 824 women out of approximately 3000 women in the sample. Of these, 270 are never married, 426 are divorced and only 13 are married. Information on incentive pay is available for most of the men in the sample (5427 out of 5452 observations of which 4349 are married). We consider the following occupational categories: management positions in administration, management positions in banking, finance and in the clerical sector, lower level management occupations, professional occupations (engineers, architects, lawyers, and medical doctors), technical occupations (in the health sector, engineering, and social sciences), occupations in community/social services, social scientists and university professors, teachers other than college professors, occupations in arts and entertainment, design, sports and the media, sales occupations, clerical occupations, craftsmen, operatives, physical laborers, in services excluding private households. We exclude from the analysis the category of laborers working in private households because no male reports to be employed in this occupation.

The sample of married couples refer to male-headed households where the head of the household is 25–44, both spouses are white and they both work full-time year-round. There is a substantial variation in the number of repeated observations for each couple in our sample across waves of the PSID (for example only a third of the married couples that we observe in 1994 are still in the sample in 1995). This entry/exit behavior can be due to a variety of reasons: divorce, attrition from the overall PSID sample, a change in the employment status of one of the two partners or lack of information on one of the variables of interest for our analysis. Hence, it is not meaningful to either pool together all the waves of the PSID or to take averages over the set of repeated observations across waves. Each cross-section of data that satisfies the sample selection criteria only includes a small number of observations in each wave. In order to maximize the size of the cross-section, we include one data point for each married couple, corresponding to the first year in which the couple satisfies our sample selection criteria for waves 1994–2001. We experimented with different sample selection criteria. For example, we considered all the observations in one wave, say 1999, and then added married couples from adjacent waves. The results obtained for these alternative samples are consistent with the ones reported in the paper.

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