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"Matching with Moral Hazard:
Assigning Attorneys to Indigent Defendants"

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Matching with Moral Hazard: Assigning Attorneys to Indigent Defendants

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Abstract

Each year, over a hundred thousand defendants who are too poor to pay for a lawyer are assigned counsel. Existing procedures for making such assignments are essentially random and have been criticized for giving indigent defendants no say in choosing the counsel they are assigned to. In this paper, we model the problem of assigning counsel to indigent defendants as a matching problem. A novel aspect of this matching problem is the moral hazard component on the part of counsel. Within the model, we show that holding the total expenditure for counsel fixed and changing the matching procedure to accommodate defendants' and attorneys' preferences will make defendants worse off. More precisely, if we switch from random matching to stable matching, defendants become worse off because stable matching exacerbates the moral hazard problem on the part of counsel. In addition, we find conditions on reservation wages of attorneys under which random matching is the efficient way to allocate defendants to counsel.

Keywords: Matching, Moral Hazard, Contract, Indigent Defense

JEL classification: D47, D86, C78

1 Introduction

Each year, more than a hundred thousand individuals in the U.S. who are too poor to pay for counsel are subject to criminal prosecution.[1] The Sixth Amendment to the U.S. Constitution guarantees defendants the right to counsel in federal criminal prosecutions

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[1]Langton and Farole (2010) report, "In 2007, 957 public defender offices across the nation received more than 5.5 million indigent defense cases."

but does not specify how this right is to be exercised. The U.S. Supreme Court expanded these rights in a series of cases decided in the 1960s and 1970s. The most celebrated of these being *Gideon v. Wainwright* (1963), in which the court held that a defendant charged with a felony, including state crimes, had the right to government-provided counsel.

At present, the government provides counsel for indigent defendants using three different defender systems. The first is the practice of hiring defense attorneys from public defender organizations, in which salaried staff attorneys render criminal indigent defense services through a public or private nonprofit organization or as direct government employees (Cohen (2012)). The second is contract defense programs. In this system, contracts to represent indigent defendants are awarded through an "auction." The dollar value of the contract and its duration are specified before the auction. Private attorneys, bar associations, or law firms indicate their willingness to accept the specified contract. Then the government awards the contract to a subset of participants based on their quality. The duration of each contract is one year, and the dollar value is set in terms of a flat fee per criminal case or hourly rate with a cap, which turns into a flat fee per case if the attorney's work report exceeds the cap. The third system is to use assigned counsel programs, in which a judge assigns an attorney to the case, and the attorney accepts out of professional courtesy.

The common feature of all three systems is that the indigent defendant is not permitted to choose his/her attorney. Schulhofer and Friedman (1993) summarize this state of affairs as follows:

> Most citizens would consider it shockingly unethical for an attorney representing one side in a lawsuit to be selected or paid, even indirectly, by the opposing party. Yet such principles are violated routinely in this country on a massive scale. In criminal cases, the great majority of defense attorneys are paid directly or indirectly by the prosecuting party, the state.

Drumgo v. Superior Court (1973) is an extreme example of the denial of choice. Fleeta Drumgo and five others were each charged with five counts of murder, one count of conspiracy, and one count of assault while serving a state prison sentence. Four features made Drumgo's case special: A private attorney had to be appointed because the public defender's office was unable to serve. Richard Hodge, the attorney requested by Drumgo was *qualified* and *willing* to represent Drumgo. Drumgo's request for representation by Hodge *preceded* the appointment of a different private attorney by the trial judge. The trial judge denied Drumgo's request to be represented by Hodge. Subsequently, the court of appeals ordered the trial judge to replace Drumgo's court chosen counsel with Hodge. This decision was overturned by the California Supreme Court on the grounds that the trial judge had the discretionary power to appoint counsel for an indigent defendant (Tague (1974)).

In this paper, we take up the question of how counsel should be matched to indigent defendants and analyze the effect of allowing indigent defendants a choice. In our model, the government moves first by announcing a contract. This is followed by an entry decision by attorneys, and then using the announced selection process, the government selects which attorneys to hire. Then there is a matching stage in which defendants are matched to hired attorneys. Subsequently, each attorney decides whether to exert effort for his/her assigned

client or shirk the responsibility. Because the government has to provide funding for this system, the government is responsible for designing the contract using a selection process, a matching process, and a wage contract. To put it differently, a contract specifies a selection process, a matching process, and a wage contract.

What distinguishes this problem from other matching problems considered in the literature is the moral hazard component. The government that is charged with matching defendants to attorneys must ensure that sufficient incentives exist for each attorney to exert effort on behalf of his/her assigned defendant.

There is much evidence of a moral hazard problem in the representation of indigent defendants, especially under private contractor systems. Furthermore, shirking can be grounds for appeal (see *Strickland v. Washington* (1984)). One vivid instance of moral hazard comes from McDuffie County, Georgia. In an effort to cut costs on indigent defense, a contract was awarded to Bill Wheeler, who offered to perform *all* the county's indigent defense work for $25,000, almost $20,000 lower than the other two bids and $21,000 lower than the previous year's cost. As part of his contract, Wheeler continued to maintain a private practice as well. As Lemos (2000) reports, "most of Wheeler's indigent clients met him for the first time in court. After a brief, whispered conversation, Wheeler would recommend a guilty plea." Between 1993 and 1998, Wheeler filed only seven motions and tried only 14 cases in court, of which only two were jury trials.

The first part of this paper justifies the denial of choice in the indigent defense system. We compare the indigent defense system under three different matching rules. The first rule assigns indigent defendants uniformly at random to counsel. We view this as representative of how defendants are currently matched with counsel (Schulhofer and Friedman (1993) and Cohen (2012)). We then consider a setting in which defendants are permitted to choose a counsel from the same group of attorneys as before. Indeed, Tague (1974) and Schulhofer and Friedman (1993) have all argued for giving defendants a greater say in the choice of counsel. Schulhofer and Friedman (1993), in particular, suggest the use of vouchers. We model the outcome of such a voucher system as a stable matching; however, under the voucher system, the group of attorneys who are assigned to indigent defendants may be different. We show that holding the government's budget fixed, changing the matching from random to stable, i.e., accommodating defendants' and attorneys' preferences, makes defendants worse off. Moreover, we show that using a voucher system, i.e., using a stable matching *and* changing the set of hired attorneys, makes the indigent defendants worse off. There are two main reasons why permitting defendants a choice makes them worse off. First, institutional restrictions require that wage contracts be nondiscriminatory, i.e., the government cannot give different wages to different attorneys for different cases.[2] Under this restriction, if the government changes the matching rule from uniform random to stable, then there will be an attorney who knows that he/she will get the worst case after signing the contract. Hence, this attorney's participation constraint is violated under the previous wage contract. To satisfy this attorney's participation constraint, the government raises every attorney's wage contract. As a result, given a fixed budget, the government can't hire enough attorneys and incentivize them to exert effort.

The second reason is risk aversion on the part of the attorneys. The government has

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[2]We discuss reasons for restriction to nondiscriminatory wage contracts in section 5.

to compensate for the disutility of exerting effort for each attorney by providing a wage contract. Under the uniform random matching, the government has to compensate all attorneys for the expected disutility of exerting effort. However, under stable matching, each attorney is assigned to a specific indigent defendant, and the government has to compensate attorneys for different costs of exerting high effort. Consider a case in which hired attorneys have the same reservation wage and attorneys are risk averse, i.e., their utility function for money is concave. The cheapest way for the government to compensate all of them is to give them a uniform lottery over all indigent defendants and the same wage contract because their utility function for money is concave. In section 5, we formally show that after relaxing the institutional restriction to only nondiscriminatory wage contracts, if a condition on reservation wages of a subset of attorneys and a condition on cost function are satisfied, the government will optimally choose a nondiscriminatory contract and the uniform random matching.

The second part of this paper explores an optimal allocation and an optimal contract. We characterize the optimal allocation of attorneys to indigent defendants, in which an allocation is a lottery over different matchings. We show that if the reservation wage of all hired attorneys is the same, the uniform random matching is optimal. In addition, if the cost function is separable, then the status quo indigent defense system is using *the optimal contract*, even if the government is allowed to use any discriminatory wage contract and any allocation of attorneys to indigent defendants.

2 Model

There is a finite set of indigent defendants J, and $|J| = N$. The difficulty of each indigent defendant $j \in J$'s case is exogenously given and denoted by $d_j \in D$.[3] Index indigent defendants according to their case difficulty, i.e., $d_j \leq d_{j+1} \forall j \in J$. There is a finite set of available attorneys I^a, and the number of available attorneys exceeds the number of indigent defendants, i.e., $|I^a| > |J|$. Each attorney $i \in I^a$ has an exogenous quality $q_i \in Q$.[4] Index attorneys in I^a according to their quality, $q_i \leq q_{i+1} \quad \forall i \in I^a$. Each indigent defendant is in need of an attorney. By law, the government has to provide each indigent defendant with one attorney. Furthermore, the government has to ensure that each indigent defendant receives representation that satisfies the "effective assistance of counsel" criterion, which we discuss later.

The game begins with the government announcing a contract. A contract specifies a selection rule, an allocation rule, and a wage contract, all of which we define later. Attorneys decide to participate given the announced contract. Denote the set of attorneys who participate by $I^p \subseteq I^a$.

The government hires a subset of participating attorneys based on the announced selection rule. The set of hired attorneys is denoted by $I \subseteq I^p$. The government has to hire N attorneys to ensure that each indigent defendant has an attorney. If $|I| < N$, then the

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[3] One can interpret the difficulty of a case by the type of indigent defendant or the type of case assigned to the indigent defendant.

[4] One can determine the quality of an attorney by the amount of experience he/she has and the law school from which he/she graduated (Iyengar (2007)).

constitutional right of at least one indigent defendant is violated; hence, we require that $|I| = N$ for an indigent defense system. Based on the announced allocation rule, attorneys are assigned to a defendant. Subsequently, each attorney decides to exert high effort or low effort, denoted by $e \in \{e_l, e_h\}$, on behalf of his/her assigned client.

A wage contract (w_1, w_2) specifies payments to hired attorneys based on a noisy signal of the attorney's effort level. The effort is not observable by the government; therefore, it's not contactable. Based on the announced wage contract, each attorney is paid a contingent wage, i.e., w_1 if the signal is s_1 and w_2 if the signal is s_2. The signal $s \in \{s_1, s_2\}$ follows the distribution $p_l = Pr(s_2|e_l)$, $p_h = Pr(s_2|e_h)$. s_2 is more likely if the attorney exerts a high effort rather than a low effort, i.e., $p_h > p_l$. To put it differently, s_2 is good news about the attorney's effort being high, and s_1 is a bad news about the attorney's effort being high. The signal can be the number of visits before the trial that the attorney had with his client, the number of motions that the attorney filed, and other indicators of the attorney's effort. The government cannot rely on an indigent defendant's report about the attorney's effort, because every convicted indigent defendant will use his/her own report as grounds for appealing the court's decision.

An attorney with quality q_i has an outside option $r(q_i)$. If attorney i gets hired, his/her payoff is $u(w) - c(e, d)$, which is determined by wage, effort, and difficulty of the assigned case.

The government wants to minimize the sum of the expected payments to hired attorneys, i.e., $\sum_{i \in I} p_h w_2 + (1 - p_h) w_1$, subject to providing every indigent defendant with one attorney who satisfies the minimum effort condition. Each attorney must choose high effort e_h in compliance with the effective assistance standard specified in the *Strickland v. Washington* (1984) ruling. In *Strickland v. Washington* (1984), the court announced the standard for evaluating postconviction claims of ineffective assistance.

Assumption 1 *(i) $u(w)$ is strictly increasing, continuous, and strictly concave in w.*

(ii) High effort costs more than low effort, i.e., $c(e_h, d_j) > c(e_l, d_j)$ for any $d_j \in D$.

(iii) $r(q_i)$ is nondecreasing in q_i.

(iv) $c(e_h, d)$ is nondecreasing in d and $c(e_h, d_1) \neq c(e_h, d_N)$.

(v) $c(e_h, d) - c(e_l, d)$ is nondecreasing in d.

Assumptions 1-i and 1-ii on the utility function and the cost function are standard in moral hazard literature; strict concavity of $u(w)$ follows from risk aversion of attorneys. The main result of the paper holds for risk-neutral attorneys as well. Assumption 1-iii about the reservation wage is plausible because the quality of an attorney is a qualitative measure, which represents demand for an attorney. More demand corresponds to a higher reservation wage. The first part of Assumption 1-iv is without loss of generality because we determined the order of the indigent defendants based on the difficulty of their case; however, the order of these difficulties are not specified. To put it differently, we can define a new difficulty measure for each case such that $c(e_h, d)$ is nondecreasing in d. The second part of Assumption 1-iv is satisfied if at least two indigent defendants have cases with

different costs of exerting high effort. Assumption 1-v (increasing differences assumption) states that if the cost of exerting high effort for case j is higher than that for case j', then the difference between the cost of exerting high effort and low effort for case j should be higher than the difference between the cost of exerting high effort and low effort for case j'. We assume that all attorneys in I^p have a weak incentive to participate, and all other attorneys have a strict incentive not to participate in the indigent defense system.

The government selects a subset of attorneys to represent indigent defendants from the set of participating attorneys. A *selection rule* is a mapping from the power set of I^a into the power set of I^a, such that $\Gamma(\tilde{I}) \subseteq \tilde{I} \quad \forall \tilde{I} \subseteq I^a$. To put it differently, there is a set of available attorneys I^a, a subset of this set will participate I^p, and then the government uses the specified selection rule Γ to hire a subset of this set $I = \Gamma(I^p)$.

Given a set of hired attorneys I, a *matching* is a one-to-one mapping $\mu : J \rightarrow I$. Denote the set of all matchings by $\mathcal{M}(I)$. An *allocation* $\lambda(I) = (\lambda_\mu(I))_{\mu \in \mathcal{M}(I)}$ is a probability distribution over the set of all matchings. An allocation determines how to (randomly) assign a given set of attorneys to a set of indigent defendants. For each matching $\mu \in \mathcal{M}(I)$, $0 \leq \lambda_\mu(I) \leq 1$ and $\sum_{\mu \in \mathcal{M}(I)} \lambda_\mu(I) = 1$. Denote the set of all $\lambda(I)$ by $\Delta \mathcal{M}(I)$. Given an allocation $\lambda(I)$, define $\phi_\lambda(I)(i,j)$ as the probability that attorney $i \in I$ matches with indigent $j \in J$. Define Φ_λ as $N \times N$ matrix, where element (i,j) is $\phi_\lambda(i,j)$. Note that Φ_λ is a doubly stochastic matrix. A *random allocation*, $\lambda(I)$, is an allocation such that $\exists i \in I, \exists j \in J : 0 < \phi_\lambda(i,j) < 1$. Under a random allocation, at least one attorney does not know his assigned case when he/she signs the contract.

The government needs to announce an allocation for each set of hired attorneys. The government can announce the same rule for all sets of hired attorneys or the government can use different allocations for different sets of hired attorneys. In sections 3 and 4, the government uses the same allocation no matter which attorneys are defending the indigent defendants. However, in section 5, we specify an optimal allocation for each set of hired attorneys.

Define $\Omega(I^a)$ to be the set of all subsets of I^a of size N, i.e., $\Omega(I^a) = \{\tilde{I} | \tilde{I} \subseteq I^a, |\tilde{I}| = N\}$. An *allocation rule* Λ is a mapping from $\Omega(I^a)$ to $\Delta \mathcal{M}(I)$, $\Lambda : \Omega(I^a) \rightarrow \Delta \mathcal{M}(I)$, i.e., Λ specifies a probability distribution λ over matchings for any subset of size N of I^a.

3 Alternative Indigent Defense Systems

We compare the current indigent defense system (status quo) with two alternatives: an indigent defense system that uses a stable matching (stable matching system) and an indigent defense system that uses vouchers (a voucher system). First, we solve for an optimal wage contract for a given allocation λ and a selection rule Γ. Using this wage contract, we analyze the status quo indigent defense system, an indigent defense system under a stable matching, and an indigent defense system that uses vouchers.

An indigent defense system under a stable matching gives indigent defendants and attorneys the right to choose each other. However, the attorneys are select by the government before the matching stage. Under a stable matching, an indigent defendant chooses an attorney from the set of attorneys selected by the government. If the attorney accepts, then

he/she is matched to the defendant.

A voucher indigent defense system allows indigent defendants to select any attorney from the set of available attorneys. Under a voucher indigent defense system, the government does not select attorneys before the matching stage. In other words, the set of hired attorneys under a voucher indigent defense system is different from the set of hired attorneys under the status quo indigent defense system. The outcome of a voucher system is a stable matching.

3.1 Optimal wage contract for a given allocation and selection rule

We find the optimal wage contract from the government's point of view subject to two sets of constraints. First, the government wants to hire attorneys in the set $I = \{k', \ldots, k+N-1\}$. Second, the government wants every attorney who is hired to exert high effort no matter which case the attorney is assigned to. The objective of the government is to minimize the expected cost of providing counsel to indigent defendants.

Define $u_1 = u(w_1)$, $u_2 = u(w_2)$. Hence a wage contract (w_1, w_2) in the utility measure is (u_1, u_2). Define $h(.) = u^{-1}(.)$. Under Assumption 1, $h(.)$ is strictly convex. [5]

The following optimization problem identifies the optimal wage contract (u_1^*, u_2^*) for a given λ, such that any attorney $i \in I$ is willing to participate and exert high effort:

$$\min_{u_1, u_2} \sum_{i \in I} p_h h(u_2) + (1 - p_h) h(u_1)$$

s.t.

$$(p_h - p_l)(u_2 - u_1) \geq c(e_h, d) - c(e_l, d) \quad \forall d \in D \quad \text{(IC)},$$
$$u_1 + p_h(u_2 - u_1) \geq r(q_i) + E_\lambda^i(c(e_h, d)) \quad \forall i \in I \quad \text{(IR)},$$

where:

$$E_\lambda^i(c(e_h, d)) = \sum_{j \in J} \phi_\lambda(i, j) c(e_h, d_j),$$

is the expected cost of exerting high effort under the allocation λ for attorney i. Observe that because of restriction to nondiscriminatory wage contracts, the objective function can be simplified to:

$$\sum_{i \in I} p_h h(u_2) + (1 - p_h) h(u_1) = N(p_h h(u_2) + (1 - p_h) h(u_1)).$$

Note that the only place that allocation enters the government's problem for determining an optimal wage contract is in the right-hand side of individual rationality (IR) constraints.

Incentive compatibility (IC) constraints hold for $\forall d \in D$ and $\forall i \in I$ because the government wants all attorneys to exert high effort for every case. Observe that (IC) is the same for $\forall i \in I$. Therefore, we need to consider (IC) $\forall d \in D$. (IR) is satisfied only in expectation because attorneys are committed to accept any case assigned to them under λ.

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[5]Such notations make the problem of finding the optimal way of implementing an action a convex programming problem (see Grossman and Hart (1983)).

We solve the government's problem for selecting an optimal wage contract, an optimal allocation rule, and an optimal selection rule in two steps. First, for any given allocation rule and selection rule, find the optimal wage contract u_1^*, u_2^*. Then using the optimal wage contract, in the second step, find an optimal allocation rule and an optimal selection rule. Lemma 1 specifies the optimal wage contract w_1^*, w_2^* or equivalently u_1^*, u_2^* for a given allocation rule and selection rule.

Lemma 1 *Given Assumption 1, for a fixed allocation λ and a fixed set of hired attorneys I, the optimal wage contract is:*

$$u_1^* = R_\lambda - p_h \big(\tfrac{c(e_h, d_N) - c(e_l, d_N)}{p_h - p_l} \big), \tag{1}$$

$$u_2^* = R_\lambda + (1 - p_h) \big(\tfrac{c(e_h, d_N) - c(e_l, d_N)}{p_h - p_l} \big), \tag{2}$$

where R_λ is:

$$R_\lambda = max\{r(q_i) + E_\lambda^i(c(e_h, d))\}_{i \in I}.$$

Proof: See the appendix.

3.2 Status quo

The *uniform random allocation*, $\lambda_u(I)$, selects each element of $\mathcal{M}(I)$ with equal probability, i.e., it selects a matching from $\mathcal{M}(I)$ uniformly at random. Observe that under the uniform random allocation, any element of I has the same uniform probability of matching to any element of J, i.e., for any $i \in I$ and any $j \in J$, $\phi_{\lambda_u}(i, j) = \frac{1}{N}$. The *uniform random allocation rule* Λ_u, specifies the uniform random allocation for any set $I \in \Omega(I^a)$.

The status quo system for assigning counsel to defendants does not rely on the preferences of defendants and attorneys. The status quo allocation rule that the government uses is the uniform random allocation rule (Cohen (2012) and Schulhofer and Friedman (1993)). Furthermore, under the status quo system, the government selects the N highest quality attorneys from set I^p (Schulhofer and Friedman (1993)). We call this selection rule the *merit-based selection rule*.

In our model, under the uniform random allocation, the government is indifferent between selecting which N attorneys from set I^p to hire because fixing a nondiscriminatory wage contract the cost of hiring any attorney from the set of participating attorneys is the same. Hence, the government is behaving optimally when it uses the merit-based selection rule. We denote the index of the highest element of this set by $k + N - 1$, i.e., $q_{k+N-1} \geq q_i \forall i \in I^p$ and $k + N - 1 \in I^p$. Hence the set of hired attorneys under the merit-based selection rule is $\{k, k+1, ..., k+N-1\}$. To put it differently, given λ_u and a (w_1, w_2), the government is indifferent between different selection rules Γ as long as $|\Gamma(I^p)| = N$. One such selection rule is the merit-based selection rule. To model the status quo indigent defense system, we use the merit-based selection rule that the government currently uses (Schulhofer and Friedman (1993)). Under the uniform random allocation, R_λ depends on $r(q_{K+N-1})$ only, i.e., given the set I^p, which depends on u_1^*, u_2^*, the government's cost does not depend on other elements of I. Hence, the government hires the highest-quality attorneys from set I^p, i.e., the government uses the merit-based selection rule. Note that

$r(q_i)$ is a nondecreasing function, not a strictly increasing function; therefore, it may be the case that $|I^p| > N$. In this case, because the cost of a contract with each attorney in I^p is the same for the government, the government is indifferent, so the government selects the highest-quality attorneys.

The optimal wage contract under uniform random allocation is:

$$u_1^* = r(q_{k+N-1}) + E_d(c(e_h, d)) - p_h\left(\tfrac{c(e_h,d_N)-c(e_l,d_N)}{p_h-p_l}\right), \tag{3}$$

$$u_2^* = r(q_{k+N-1}) + E_d(c(e_h, d)) + (1 - p_h)\left(\tfrac{c(e_h,d_N)-c(e_l,d_N)}{p_h-p_l}\right), \tag{4}$$

where $E_d(c(e_h, d)) = \frac{1}{N}\sum_{j=1}^{N} c(e_h, d_j)$.

The cost of this indigent defense system for the government is:

$$\mathcal{C}_u = N\left((1 - p_h)h\left(r(q_{k+N-1}) + E_d(c(e_h, d)) - p_h\left(\frac{c(e_h, d_N) - c(e_l, d_N)}{p_h - p_l}\right)\right) + p_h h\left(r(q_{k+N-1}) + E_d(c(e_h, d)) + (1 - p_h)\left(\frac{c(e_h, d_N) - c(e_l, d_N)}{p_h - p_l}\right)\right)\right).$$

We view the *status quo contract* as the merit-based selection rule, the uniform random allocation rule, and the wage contract specified in equations (3) and (4). We view $\mathcal{C}_u$ as the budget of the status quo indigent defense system.

The following lemma characterizes the set of attorneys who would participate under the specified optimal wage contract, the uniform random allocation rule, and the merit selection rule. Recall that the index of the highest-quality attorney who participates is $k + N - 1$ and any attorney with an index above $k + N - 1$ does not participate.

Although the government is using the merit-based selection rule, hired attorneys are not the highest-quality attorneys available. The government uses the wage contract to incentivize attorneys to participate in the indigent defense system. If the wage contract is designed for the N lowest quality attorneys, then attorneys with reservation wages higher than $r(q_N)$ will not participate. Lemma 2 shows that, even under merit-based selection rule, any hired attorney has a reservation wage of at most $r(q_N)$. If we consider the reservation wage as a signal for an attorney's quality, we can conclude that the government is hiring attorneys with quality close to N lowest-quality attorneys.

Lemma 2 *Under the status quo contract the reservation wage of highest-quality attorney who participates is strictly lower than the reservation wages of attorneys who abstain, i.e., $r(q_{k+N-1}) < r(q_{k+N})$. Furthermore, if $k > 1$, then reservation wages $r(q_i)$ for all $i = N, N + 1, \ldots, k + N - 1$ are the same.*

Proof: The expected utility of attorney $k + N$ from participating in the indigent defense system is strictly less than his/her outside option $r(q_{k+N})$, otherwise he/she would participate in the indigent defense system. Moreover, the expected utility of attorney $k + N - 1$ from participating in the indigent defense system is at least $r(q_{k+N-1})$. Under the uniform random allocation rule, the expected utility of attorney $k + N$ from participating in the indigent defense system is equal to the expected utility of attorney $k + N - 1$ from partic-

ipating in the indigent defense system. Hence, their outside options can not be equal, i.e., $r(q_{k+N-1}) \neq r(q_{k+N})$.

Suppose there exists attorney i' such that $N \leq i' < N + k - 1$ and $r(q_{N+k-1}) > r(q_{i'})$. By hiring attorneys $i' - N + 1, ..., i'$, the government satisfies all the equilibrium constraints, and the expected cost is lower than hiring attorneys $k, ..., N + k - 1$ because $\mathcal{C}_u$ is a strictly increasing function of $r(q_{k+N-1})$, a contradiction. ∎

3.3 An indigent's right to an attorney of his/her choice

In this section, we study two indigent defense systems that permit defendants and attorneys to choose each other. A stable matching characterizes the outcome of incorporating the preferences of indigent defendants and attorneys. There are many arguments in favor of defendants' and attorneys' right to choose.

Tague (1974) and Schulhofer and Friedman (1993) have argued for giving defendants a greater say in their choice of counsel. There is a natural conflict of interest between the indigent's attorney and the prosecution side, hence giving the power of selecting and funding of both sides to one office will result in a conflict of interest. Moreover, other government funded systems, such as health care and the education system, incorporate the preferences of two sides of the market; one such instance is vouchers in education systems. The outcome of a system that gives indigent defendants and attorneys a choice is a stable matching. Gale and Shapley (1962) define a stable matching: A matching is stable if no matched agent prefers to be single and no pair of agents prefers each other to their assigned partner in the matching.

Schulhofer and Friedman (1993) suggest a voucher system for an indigent defense system. The outcome of a voucher system is a stable matching. However, under a voucher system, the set of attorneys who get hired is different than the set of attorneys who get hired under the status quo indigent defense system of assigning attorneys to indigent defendants. We consider a different set of hired attorneys under the voucher system when we compare the outcome of status quo indigent defense system with a voucher system.

3.3.1 Stable matching

First, we define a stable matching and a positive assortative matching. We show that all stable matchings are positive assortative matchings. Hence, we can restrict our attention to positive assortative matchings. At the end, we discuss the optimal wage contract under a stable matching.

To define a stable matching, we specify preferences for indigent defendants and attorneys. For a fixed wage contract, each indigent defendant j has a *preference* over attorneys denoted by $\prec_j$. If two attorneys exert the same amount of effort, all indigent defendants prefer the attorney with the higher quality to the attorney with the lower quality, i.e., if $q_i < q_{i'}$ then $i \prec_j i', \forall j \in J$. Moreover, if $q_i = q_{i'}$, then every indigent defendant is indifferent between attorney i and attorney i'. Given a wage contract, each attorney $i \in I^a$ has a preference over cases denoted by $\prec_i$. Each attorney prefers a case that gives him/her a higher utility to a case that gives him a lower utility under the specified wage contract.

Furthermore, if an attorney is not committed to accepting at least one case and a case that gives him/her a strictly lower utility than his/her outside option, then he/she prefers his/her outside option.

Under a nondiscriminatory wage contract, all attorneys prefer cases with lower disutility of high effort, i.e., if $c(e_h, d_j) < c(e_h, d_{j'})$ then $j' \prec_i j, \forall i \in I^a$. Moreover, if $c(e_h, d_j) = c(e_h, d_{j'})$, then every attorney is indifferent between case j and case j'. Using the preferences of both sides of this market, we can define stable matching and a positive assortative matching for a fixed wage contract and find their relationship.

For a fixed wage contract, a matching μ is *stable* if:

1. Every attorney prefers his/her match to his/her outside option, i.e., $\gamma_i \prec_i \mu^{-1}(i), \forall i \in I$, where γ_i is the attorney's outside option. Note that any indigent defendant prefers any attorney to his/her outside option.

2. There is no blocking pair. A blocking pair is (i, j) such that $\mu(j) \neq i$, $\mu^{-1}(i) \prec_i j$ and $\mu(j) \prec_j i$.

For a fixed wage contract, a *positive assortative matching* is a matching such that:

1. For any $i, i' \in I$ if $q_i < q_{i'}$ then $\mu^{-1}(i) \prec_{i'} \mu^{-1}(i')$.

2. For any $j, j' \in J$ if $c(e_h, d_j) > c(e_h, d_{j'})$ then $\mu(j) \prec_{j'} \mu(j')$.

Lemma 3 specifies the relationship between stable matching and a positive assortative matching.

Lemma 3 *Under any nondiscriminatory wage contract, if all attorneys have an incentive to exert high effort, any stable matching is a positive assortative matching.*

Proof: Suppose there exists a stable matching μ that is not a positive assortative matching, i.e., there exist i, i' and j, j' such that $\mu(j) = i$, $\mu(j') = i'$, $q_i < q_{i'}$ and $c(e_h, d_j) < c(e_h, d_{j'})$. Then (i', j) is a blocking pair, because $j' \prec_{i'} j$ and $i \prec_j i'$. Therefore, the matching μ is not stable, a contradiction. ∎

Consider an indigent defense system that uses a positive assortative matching. Each attorney at the ex-ante stage of the game, i.e., deciding to participate in the system or abstain, knows exactly which case difficulty he will face. Under a positive assortative matching, if there exist an attorney i and case j such that $0 < \phi(i, j) < 1$, then $c(e_h, d_j) = c(e_h, d_{j'})$ for any other case $j' \in J$ with $0 < \phi(i, j') < 1$.

The following optimization solves for the optimal wage contract for hiring attorneys from the set $I = \{k, ..., k + N - 1\}$, under a positive assortative matching λ_s, when they have incentive to exert high effort:

$$\min_{u_1, u_2} \sum_{i=k}^{k+N-1} p_h h(u_2) + (1 - p_h) h(u_1)$$

s.t.

$$(p_h - p_l)(u_2 - u_1) \geq c(e_h, d) - c(e_l, d) \forall d \in D,$$
$$u_1 + p_h(u_2 - u_1) \geq r(q_i) + (c(e_h, d_{k+N-i})) \forall i \in I.$$

We can show that the incentive constraint for the highest d binds.[6] The matching is a positive assortative, so we need to find $q_{\tilde{i}}$ such that $r(q_{\tilde{i}}) + (c(e_h, d_{k+N-i}))$ is maximized. We can relax this problem and only consider the (IR) for q_k. Attorney k will get case N. We can find a lower bound on an optimal wage contract, denote this by (u_1^{**}, u_2^{**}), by relaxing the problem and only considering (IR) for the attorney with the lowest quality, i.e., attorney k:[7]

$$u_1^{**} \geq r(q_k) + c(e_h, d_N) - p_h\left(\tfrac{c(e_h, d_N) - c(e_l, d_N)}{p_h - p_l}\right), \tag{5}$$

$$u_2^{**} \geq r(q_k) + c(e_h, d_N) + (1 - p_h)\left(\tfrac{c(e_h, d_N) - c(e_l, d_N)}{p_h - p_l}\right). \tag{6}$$

3.3.2 Voucher system

Critics of the status quo indigent defense system have proposed the use of a voucher indigent defense system because this system gives indigent defendants the right to choose their attorneys. In a voucher indigent defense system, the government gives each indigent defendant a voucher that specifies a wage contract for the attorney who accepts the defendant's case.

Given that every indigent defendant has the same voucher, all indigent defendants will go to their most preferred attorney in the first round, i.e., they will go to $i^* \in I^a$, where $i \prec_j i^* \forall i \in I^a, \forall j \in J$. Then i^* will either accept his/her most preferred case, i.e., j^* where $j \prec_{i^*} j^*, \forall j \in J$, in this case (i^*, j^*) are matched, or i^* will reject all indigent defendants' proposals. The same process happens for the remaining indigent defendants and attorneys until every indigent defendant is matched with one attorney or there are no remaining attorneys. At the end, if every indigent defendant has an attorney, the allocation is a positive assortative matching.

4 Comparison of Alternative Indigent Defense Systems

In this section, we compare the status quo with two alternative indigent defense systems: a stable matching system and a voucher system. First, we define the measure for these comparisons. Second, we specify the assumption that we need for these comparisons.

If the cost of providing the same N attorneys who exert high effort is lower under the one contract compared with another contract, then we say that the first contract is *superior* to the second contract. Consider two indigent defense systems with different contracts. Suppose the first contract is superior to the second contract. Moreover, the budget of the second indigent defense system is set equal to the budget of the first system. Then an indigent defense system that uses the second contract will result in one of the following:

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[6]See the proof of Lemma 1.

[7]Note that this is a lower bound on an optimal wage contract for any indigent defense system that uses a matching with the following property: Attorney k', where $k' \geq k$, is assigned to case N with probability 1, i.e., $\exists k' \geq k$ such that $\phi(k', N) = 1$. Negative assortative matching is one example. All the results in section 4 hold for this type of indigent defense system as well.

Either effective representation requirement for at least one indigent defendant is violated, i.e., at least one attorney is choosing e_l. Or the quality of the lowest-quality attorney under this contract is strictly lower than the quality of lowest-quality attorney under the superior contract.

Assumption 2 $r(q_N) - r(q_1) < c(e_h, d_N) - E_d(c(e_h, d))$.

Intuitively, the match-specific part of the utility function varies more than the reservation wage of the N lowest-quality attorneys. Assumption 2 states that the difference between the reservation wages of the N lowest-quality attorneys in the set I^a is less than the difference between the cost of exerting high effort when matched with the highest cost case and the expected cost of exerting high effort when matched uniformly at random. The N lowest-quality available attorneys have a very similar outside option. Therefore, their reservation wages are close to each other.

Theorem 1 *Under Assumptions 1 and 2, the status quo contract is superior to any contract that uses a positive assortative matching.*

Proof: We show that the cost of the government under a positive assortative matching for hiring $I = \{k, ..., k + N - 1\}$ is strictly greater than the cost of the government under random allocation for hiring all attorneys in I. Recall that under the uniform random allocation rule $r(q_N) = r(q_{k+N-1})$, so:
$$r(q_{k+N-1}) + E_d(c(e_h, d)) = r(q_N) + E_d(c(e_h, d)) < r(q_1) + c(e_h, d_N) \leq r(q_k) + c(e_h, d_N),$$
which implies that:
$$u_1^* < u_1^{**}, u_2^* < u_2^{**}.$$
Because $h(.)$ is a strictly increasing function, we have:

$$h(u_1^*) < h(u_1^{**}), h(u_2^*) < h(u_2^{**})$$

$$\Rightarrow \sum_{i=k}^{k+N-1} p_h h(u_2^*) + (1 - p_h)h(u_1^*) < \sum_{i=k}^{k+N-1} p_h h(u_2^{**}) + (1 - p_h)h(u_1^{**}).$$

■

Theorem 1 states that under the status quo system budget, using a positive assortative matching instead of the uniform random allocation, and using the same set of attorneys, the government cannot induce every attorney to exert high effort. Theorem 1 shows that permitting indigent defendants and attorneys to choose each other, given the same budget that the status quo indigent defense system has, will result in a worse indigent defense system from the indigent defendants' point of view.

Lemma 3 states that any stable matching is a positive assortative matching. Theorem 1 implies the following statement about the comparison between status quo and a stable matching system.

COROLLARY 1 *Under Assumptions 1 and 2, the status quo contract that uses the uniform random allocation is superior to any contract that uses any stable matching.*

There are two reasons that Theorem 1 and corollary 1 hold: restriction of using only nondiscriminatory wage contracts and the risk aversion of attorneys.

The first reason is the restriction of using only nondiscriminatory wage contracts. Under any positive assortative matching, the lowest-quality attorney in set I is matched to the most difficult case. Consider the participation constraint of this attorney under the status quo contract and under any contract that uses a positive assortative matching. The reservation wage of this attorney is the same under these two contracts. However, the expected disutility of effort is strictly larger under a positive assortative matching. Therefore, the government has to increase the wage contract for this attorney to satisfy his participation constraint. The wage contract is nondiscriminatory; therefore, increasing a wage contract for one attorney implies that wage contracts are increased for every hired attorney. The cost of the government is strictly increasing in u_1 and u_2; hence, an increase in the wage contract of every attorney increases the cost of the indigent defense system for the government. Note that this argument doesn't depend on the risk aversion of attorneys.

The second reason is the risk aversion on the part of attorneys. Consider an example with two cases and two attorneys with the same reservation wages. In this example, suppose the government can pay the attorneys different wages. The government has to compensate the attorneys' expected disutility of effort and their forgone reservation wage. Under a positive assortative matching, the low-quality attorney is matched to the difficult case and the high-quality attorney is matched to the easy case. Recall that $u(w)$ is strictly concave. Therefore, it is cheaper for the government to pay equal wages to both attorneys and use the uniform random allocation, instead of paying a very high wage to the low-quality attorney and a low wage to the high-quality attorney. The role of risk aversion is discussed in more detail in section 5.

The following lemma shows that risk aversion is not essential for this result and that without risk aversion the same conclusion is true.

Lemma 4 *If the attorneys are risk neutral, i.e., $u(w) = w$, Theorem 1 holds, i.e., the status quo contract is superior to any contract that uses a positive assortative matching.*

Proof: Given the set I and λ, the minimum cost for the government to hire all attorneys in I and induce every $i \in I$ to exert high effort is $\mathcal{C}$:

$$\mathcal{C} = \quad \min_{u_1, u_2} \sum_{i=k}^{k+N-1} p_h w_2 + (1 - p_h) w_1$$
$$s.t.$$
$$(p_h - p_l)(w_2 - w_1) \geq c(e_h, d) - c(e_l, d),$$
$$\forall d \in D, \quad \forall i \in I,$$
$$w_1 + p_h(w_2 - w_1) \geq r(q_i) + E_\lambda^i(c(e_h, d)),$$
$$\forall i \in I.$$

Note that the left-hand side of (IR) is equal to $\frac{1}{N}$ of $\mathcal{C}$. In order to find $\mathcal{C}$, we need to find which (IR) binds. Hence, the cost of the government given the set I is:

$$\mathcal{C} = N \times R_\lambda.$$

Under the uniform random allocation, the cost of the government is:

$$\mathcal{C}_u = N \times (r(q_{k+N-1}) + E_d c(e_h, d)).$$

Under a positive assortative matching, the cost of the government is:

$$\mathcal{C}_s = N \times R_\lambda \geq N \times (r(q_k) + c(e_h, d_N)).$$

The inequality follows from the definition of R_λ. Hence, under Assumption 2, $\mathcal{C}_u < \mathcal{C}_s$, i.e., given the same budget that the status quo system has, the outcome of the indigent defense system under any stable matching is worse than the outcome of the indigent defense system under the uniform random allocation. ∎

Next, we compare the outcome of the status quo indigent defense system with the outcome of a voucher system. Under a voucher system, indigent defendants and attorneys have the right to choose each other; hence, the allocation λ is not a choice of the government. Moreover, the indigent defendants can choose the set of hired attorneys, i.e., selection rule Γ is not under the government's control. These two features make a voucher indigent defense system an interesting alternative system at first glance. However, the following theorem shows that the status quo contract is superior to any contract that uses a voucher system.

In order to do this comparison, we find a lower bound on the cost of the optimal wage contract from the government's point of view, under a positive assortative matching as the allocation rule. Recall that the allocation under a voucher system is a positive assortative matching. Under a voucher system, we consider any set of hired attorneys with size N, where attorneys' qualities are at least q_k. One possible set of hired attorneys under a voucher system is $\{k, ..., k + N - 1\}$. We require the wage optimal contract to give the hired attorneys incentive to exert high effort under a voucher system.

Theorem 2 *Given Assumptions 1 and 2, under the status quo system's budget, switching from the status quo contract to any contract that uses a voucher system results in one of the following:*

1. *At least one indigent defendant doesn't have an attorney.*

2. *At least one hired attorney doesn't have sufficient incentive to exert high effort.*

3. *The quality and the reservation wage of the lowest-quality attorney among hired attorneys is strictly lower than the quality and the reservation wage of the lowest-quality attorney among hired attorneys under the status quo contract.*

Proof: From equations 5 and 6, we know that the cost of the government under any stable matching, such that the quality of each attorney is at least q_k, is at least $N(p_h h(u_2^{**}) + (1-p_h)h(u_1^{**}))$, because $h(.)$ is strictly increasing in u_1^{**} and u_2^{**}, $N(p_h h(u_2^{**}) + (1-p_h)h(u_1^{**}))$ is a lower bound on the cost of the government under a positive assortative matching, too. If we show that the cost of the government under a voucher system for hiring the set I is greater than the cost of the government under the uniform random allocation rule for

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hiring I, then we can conclude that the cost of the government for hiring N attorneys using a voucher system such that the quality of each attorney is at least q_k is greater than the cost of the government under the uniform random allocation for hiring I. We proved this in Theorem 1, so no matter which set of attorneys from set I^a are recruited under the voucher system, as long as their quality is above q_k given the same budget, the outcome of the system under the uniform random allocation is superior to the outcome under the voucher system. We do not consider the situation in which a voucher system results in some unmatched indigent defendants, or some indigent defendants are matched with attorneys with quality lower than q_k, because in these situations it is clear that the status quo contract is superior to the contract that uses a voucher system. ∎

5 Optimal Allocation

The status quo allocation rule that the government uses in the indigent defense system is the uniform random allocation rule, i.e., $\Lambda_u = \lambda_u(I) \quad \forall I$.

In this section, first, for any set of hired attorneys I, we characterize the optimal allocation. Second, for a fixed set of hired attorneys I, we specify the conditions on reservation wages of hired attorneys such that the uniform random allocation is optimal. At the end, we specify a set of conditions on reservation wages of attorneys $1, ..., N$ and the cost function such that the status quo contract is the optimal contract.

The government wants to minimize the cost, subject to hiring N attorneys and incentivizes them to exert high effort. The government can choose a selection rule, an allocation rule, and a wage contract. We showed that the merit-based selection rule is optimal under the uniform random allocation rule, and we specified the optimal wage contract in Lemma 1. In this section, we define and characterize the optimal allocation.

Given a set I, an allocation λ^* is *optimal* if the cost of the government under the contract that uses λ^* and the optimal wage contract given λ^*, which is specified in Lemma 1, is lower than the cost of the government under any other contract.

Theorem 3 *The following linear program identifies an optimal allocation for a given set* I:

$$
\begin{aligned}
&\text{(LP*)} && \min_{y, \{\phi(i,j)\}_{i \in I, j \in J}} \quad y \\
&\quad s.t. \\
&&& r(q_i) + \sum_{j \in J} \phi(i,j) c(e_h, d_j) \leq y \quad \forall i \in I, \\
&&& \sum_{j \in J} \phi(i,j) = 1 \quad \forall i \in I, \\
&&& \sum_{i \in I} \phi(i,j) = 1 \quad \forall j \in J, \\
&&& \phi(i,j) \geq 0 \quad \forall i \in I, j \in J.
\end{aligned}
$$

Proof: See the appendix. ∎

The solution of linear program (LP*) specifies a doubly stochastic matrix $[\phi^*(i,j)]$ and

y^*, using the Birkhoff-von Neumann decomposition algorithm, we can find the optimal allocation λ^*.

If the reservation wages of all hired attorneys are equal, the optimal allocation can be characterized easily from the solution of the linear program (LP*). Lemma 5 shows that the uniform random allocation is optimal under this condition. Therefore, the status quo allocation that the government uses is indeed optimal if reservation wages of all hired attorneys are equal. On the other hand, if under the status quo contract reservation wages of all hired attorneys are not equal, then we can improve the status quo indigent defense system by using a different allocation rule.

Lemma 5 *For a fixed set of hired attorneys I, the uniform random allocation is the optimal allocation if and only if $r(q_i)$ is the same for all $i \in I$.*

Proof: See the appendix.   ∎

COROLLARY 2 *If the reservation wages of at least two hired attorneys under the status quo contract are not equal, then there exists a superior contract that hires the same set of hired attorneys.*

Define a separable cost function as $c(e, d) = c(e) - g(d)$. This special cost function represents the following cost structure: The utility of an attorney is the utility from wage minus disutility of effort plus nonpecuniary utility that depends on the type of his/her match, i.e., $u(w) + g(d) - c(e)$. The separable cost function represents a situation in which there is no complementarity between case difficulty and effort level.

For the rest of the paper, we relax the restriction to the nondiscriminatory wage contracts. A discriminatory wage contract specifies a contingent wage for each possible assignment of attorneys and indigents, i.e., $\{u_1(i, j), u_2(i, j)\}_{i \in I, j \in J}$. An *optimal contract* is a contract that minimizes the cost of the government. Note that the government can choose any selection rule, any allocation rule, and any discriminatory wage contract to minimize the cost. Recall that the merit-based selection rule is optimal under the uniform random allocation rule, and based on Lemma 5, the uniform random allocation rule is optimal if $r(q_i) = r \quad \forall i \in I$. Currently, the government is using nondiscriminatory wage contracts. There are several reasons that the government should in fact use nondiscriminatory wage contracts. First, the government is prosecuting the defendant. At the same time, the prosecution and attorney are involved in the plea bargaining process. Using discriminatory contracts signals the government's perception of the likelihood of winning or losing the case. This signal affects the plea bargaining process. Second, the right to counsel is a constitutional right. Paying different wages for different cases based on any criteria other than the case type may seem as discrimination among the indigent defendants. Third, it may be the case that the government does not have the same information as the counsel about the difficulty of each case. In addition to those reasons, we identify a condition such that nondiscriminatory wage contracts are optimal even when discriminatory wage contracts are available. The following theorem identifies conditions on reservation wages of a subset of available attorneys and cost function such that the status quo contract is optimal among a

very broad class of contracts, such as discriminatory wage contracts; stable, deterministic allocation rules; random allocation rules; and any selection rule that doesn't violate the constitutional rights of indigent defendants.

Theorem 4 *Under Assumptions 1 and 2, separable cost function, and $r(q_i) = r$ for all $i \in \{1, \ldots, N\}$, the status quo contract is* **the optimal contract***.*

Proof: See the appendix.

One can use Theorem 4 for comparison and show that Theorem 1 holds because of two different forces; first, institutional restrictions to nondiscriminatory wage contracts, and second, the risk aversion of attorneys.

COROLLARY 3 *Under Assumptions 1 and 2, a separable cost function, and $r(q_i) = r$ for all $i \in \{1, \ldots, N\}$, even if the government can announce discriminatory wage contracts, the status quo contract is superior to any contract that uses a positive assortative matching and any contract that uses a stable matching.*

Corollary 3 shows that without restriction to nondiscriminatory wage contracts, the status quo contract is superior to any contract that uses a stable matching. This result is due to the fact that attorneys are strictly risk averse. Note that under discriminatory wage contracts, there may exist a stable matching that is not a positive assortative matching.

6   Conclusion

We model the assignment of indigent defendants to attorneys as a matching with a moral hazard component. Using this model, we show that the matching process is a part of the contract and that changing the matching process will affect the incentives of attorneys. Specifically, accommodating defendants' and attorneys' preferences encourages some attorneys who are hired under status quo to either exit the indigent defense system or to put in less effort making defendants worse off. Furthermore, using a voucher system makes defendants worse off.

We characterize an optimal allocation. Using this characterization, we show that the uniform random matching is optimal if and only if the reservation wage of all hired attorneys is the same. Hence, if under the status quo contract at least two hired attorneys have different reservation wages, then there exists a superior contract. The superior contract is the merit-based selection rule, an optimal allocation, and the optimal wage contract, all of which we characterize in this article. Under this superior contract, the government can hire the same set of attorneys and give them sufficient incentive to exert high effort with a strictly lower expenditure. Finally, we show that if the cost function is separable and the reservation wage of all hired attorneys is the same, then the status quo indigent defense system is using the optimal contract.

Appendix A   Proofs of Results

Proof of Lemma 1.   We find an optimal wage contract by finding binding constraints. Consider an optimal solution to the minimization problem. The minimization problem is a standard convex problem. The existence of an optimal solution is guaranteed (see Grossman and Hart (1983)). Denote the optimal solution by (u_1^*, u_2^*). We characterize the necessary conditions for (u_1^*, u_2^*) to be an optimal solution by finding which constraint is binding.

Given (u_1^*, u_2^*), find an attorney i such that:

$$r(q_i) + E_\lambda^i(c(e_2, d_j)) = R_\lambda.$$

At least one attorney with this property exists. Denote an attorney with this property by i^*.

If the (IR) constraint for i^* is satisfied, then all individual rationality constraints are satisfied. Because the left-hand side of (IR) is the same for all $i \in I$, the right-hand side is maximized for attorney i^*.

We claim that (IR) for i^* binds. Suppose (IR) does not bind for i^*. Then we can reduce u_1^* and u_2^* uniformly to $u_1^* - \epsilon, u_2^* - \epsilon$ such that (IR) is still satisfied for all $i \in I$. Note that this process does not affect (IC) constraints. Therefore, we can reduce the objective function, i.e., we can reduce the cost of the government, a contradiction with optimality of (u_1^*, u_2^*).

If (IC) for the highest d is satisfied, then all incentive constraints are satisfied. Because the left-hand side of the (IC) constraint is the same for all $d \in D$, the right-hand side is maximized at d_N, the largest element in D.

Finally, we claim that (IC) for the highest d binds. However, suppose (IC) for the highest d does not bind. Consider the following relaxed problem:

$$\min_{u_1, u_2} \sum_{i \in I} p_h h(u_2) + (1 - p_h) h(u_1)$$

$$s.t.$$

$$u_1 + p_h(u_2 - u_1) \geq R_\lambda.$$

After simplifying the constraint, we get:

$$\min_{u_1, u_2} \sum_{i \in I} p_h h(u_2) + (1 - p_h) h(u_1)$$

$$s.t.$$

$$(1 - p_h)u_1 + p_h u_2 \geq R_\lambda.$$

Suppose $(\tilde{u}_1, \tilde{u}_2)$ is a solution to this relaxed problem, define $u_1^\dagger = \tilde{u}_1 - \frac{\epsilon}{1 - p_h}$ and $u_2^\dagger = \tilde{u}_2 + \frac{\epsilon}{p_h}$. Because the constraint is satisfied at $(\tilde{u}_1, \tilde{u}_2)$, it is also satisfied at $(u_1^\dagger, u_2^\dagger)$. $(\tilde{u}_1, \tilde{u}_2)$ is an optimal solution to this relaxed problem; therefore, the following problem must be optimized at $\epsilon = 0$:

$$\min_\epsilon \sum_{i \in I} p_h h(\tilde{u}_2 + \tfrac{\epsilon}{p_h}) + (1 - p_h)h(\tilde{u}_1 - \tfrac{\epsilon}{1-p_h})$$

s.t.

$$(1 - p_h)\tilde{u}_1 + p_h \tilde{u}_2 \geq R_\lambda.$$

Taking first-order condition with respect to ϵ and evaluating it at $\epsilon = 0$, we get:

$$\sum_{i \in I} p_h(\tfrac{1}{p_h})h'(\tilde{u}_2) - \tfrac{1-p_h}{1-p_h}h'(\tilde{u}_1) = 0$$
$$\Rightarrow h'(\tilde{u}_2) = h'(\tilde{u}_1)$$
$$\Rightarrow \tilde{u}_1 = \tilde{u}_2.$$

Consider the (IC) in the original problem. At $\tilde{u}_1 = \tilde{u}_2$ left-hand side of (IC) is zero. Under Assumption 1, high effort costs more than low effort; hence, the right-hand side of (IC) is strictly positive. Thus, at $(\tilde{u}_1, \tilde{u}_2)$, (IC) is violated. Therefore, (IC) constraints bind in the original problem.

Using this binding constraint, we can find an optimal wage contract. There is only one wage contract that satisfies all these necessary conditions. The optimal wage contract is:

$$u_1^* = R_\lambda - p_h\Big(\tfrac{c(e_h,d_N)-c(e_l,d_N)}{p_h-p_l}\Big),$$
$$u_2^* = R_\lambda + (1 - p_h)\Big(\tfrac{c(e_h,d_N)-c(e_l,d_N)}{p_h-p_l}\Big).$$

∎

Proof of Theorem 3. Given an allocation λ and a set of hired attorneys I, from Lemma 1 the optimal wage contract is:

$$u_1^* = R_\lambda - p_h\Big(\tfrac{c(e_h,d_N)-c(e_l,d_N)}{p_h-p_l}\Big),$$
$$u_2^* = R_\lambda + (1 - p_h)\Big(\tfrac{c(e_h,d_N)-c(e_l,d_N)}{p_h-p_l}\Big).$$

Hence, the government's problem for finding the optimal allocation is:

$$\min_\lambda \sum_{i \in I} p_h h(u_2^*) + (1 - p_h)h(u_1^*),$$

or simply:

$$\min_\lambda p_h h(u_2^*) + (1 - p_h)h(u_1^*).$$

The objective function depends on λ only through R_λ, and it is strictly increasing in R_λ. Therefore, the government's problem is:

$$\min_\lambda R_\lambda.$$

Thus, the optimal allocation given the set I solves:

$$\min_\lambda \left[\max \left\{ r(q_i) + \sum_{j \in J} \phi_\lambda(i,j)(c(e_h, d_j)) \right\}_{i \in I} \right],$$

which is equivalent to the linear program (LP*). Given the solution to this program, $\{\phi^*(i,j)\}_{i \in I, j \in J}$, we can use the Birkhoff-von Neumann decomposition algorithm to find the optimal allocation λ. ∎

Proof of Lemma 5. (If direction:) Suppose $r(q_i) = r$ for all $i \in I$, and the uniform random allocation is not optimal. Then there exists λ' such that:

$$\max \left\{ r + E_{\lambda'}(c(e_h, d)) \right\}_{i \in I} < \max \left\{ r + E_{\lambda_u}(c(e_h, d)) \right\}_{i \in I}.$$

$r + E_{\lambda_u}(c(e_h, d))$ is constant for all $i \in I$ and equal to $r + \frac{\sum_{j \in J}(c(e_h, d_j))}{N}$. Hence,

$$\max \left\{ r + E_{\lambda'}(c(e_h, d)) \right\}_{i \in I} < r + \frac{\sum_{j \in J}(c(e_h, d_j))}{N}.$$

Then under λ' we have:

$$r + \sum_{j \in J} \phi_{\lambda'}(i,j)c(e_h, d_j) < r + \frac{\sum_{j \in J}(c(e_h, d_j))}{N} \forall i \in I$$
$$\Rightarrow \quad \sum_{i \in I} \left(r + \sum_{j \in J} \phi_{\lambda'}(i,j)c(e_h, d_j) \right) < \sum_{i \in I} \left(r + \frac{\sum_{j \in J}(c(e_h, d_j))}{N} \right)$$
$$\Rightarrow \quad \sum_{i \in I} \sum_{j \in J} \phi_{\lambda'}(i,j)c(e_h, d_j) < \sum_{i \in I} \frac{\sum_{j \in J}(c(e_h, d_j))}{N}$$
$$\Rightarrow \quad \sum_{j \in J} \sum_{i \in I} \phi_{\lambda'}(i,j)c(e_h, d_j) < \sum_{j \in J} \frac{\sum_{i \in I}(c(e_h, d_j))}{N}$$
$$\Rightarrow \quad \sum_{j \in J} c(e_h, d_j) < \sum_{j \in J}(c(e_h, d_j)),$$

a contradiction.

(Only if direction:) If $r(q_i)$ is not constant, there exist $i', i'' \in I$ such that $r(q_{i'}) < r(q_{i''})$. Hence, under the uniform random allocation:

$$r(q_{i'}) + E_{\lambda_u}(c(e_h, d)) < R_{\lambda_u},$$

and:

$$r(q_{i'}) + E_{\lambda_u}(c(e_h, d)) < r(q_{i''}) + E_{\lambda_u}(c(e_h, d)).$$

Fix an arbitrary small $\epsilon > 0$ and construct a new allocation $\bar{\lambda}$ such that:

$$\phi_{\bar{\lambda}}(i', 1) = \frac{1-\epsilon}{N},$$
$$\phi_{\bar{\lambda}}(i', N) = \frac{1+\epsilon}{N},$$
$$\phi_{\bar{\lambda}}(i, 1) = \frac{1}{N} + \frac{\epsilon}{(N-1)N} \quad \forall i \in I, i \neq i',$$
$$\phi_{\bar{\lambda}}(i, N) = \frac{1}{N} - \frac{\epsilon}{(N-1)N} \quad \forall i \in I, i \neq i',$$
$$\phi_{\bar{\lambda}}(i, j) = \frac{1}{N} \quad \forall i \in I, j \in J, j \neq 1, N.$$

Intuitively, the new allocation rule is constructed from the uniform random allocation with a few changes. i' gets the easiest case with lower probability under $\bar{\lambda}$. Everyone else gets the easiest case with higher probability under $\bar{\lambda}$. However, i' gets the hardest case with higher probability under $\bar{\lambda}$. Everyone else gets the hardest case with lower probability under $\bar{\lambda}$.

Note that $\bar{\lambda}$ is indeed an allocation because each row and column of Φ adds up to 1. For an arbitrary small $\epsilon > 0$ we have:

$$r(q_{i'}) + E_{\bar{\lambda}}(c(e_h, d)) < r(q_{i''}) + E_{\bar{\lambda}}(c(e_h, d)).$$

For any $i \neq i'$:
$$r(q_i) + E_{\bar{\lambda}}(c(e_h, d)) < r(q_i) + E_{\lambda_u}(c(e_h, d)),$$

one such i is $i = i''$:

$$r(q_i'') + E_{\bar{\lambda}}(c(e_h, d)) < r(q_i'') + E_{\lambda_u}(c(e_h, d)) \leq R_{\lambda_u}.$$

However, for i':

$$r(q_{i'}) + E_{\bar{\lambda}}(c(e_h, d)) > r(q_{i'}) + E_{\lambda_u}(c(e_h, d)).$$

Therefore:

$$r(q_{i'}) + E_{\lambda_u}(c(e_h, d)) < r(q_{i''}) + E_{\bar{\lambda}}(c(e_h, d)) \leq R_{\lambda_u}.$$

We can conclude that

$$R_{\bar{\lambda}} < R_{\lambda_u}.$$

This is a contradiction with optimality of the uniform random allocation. ∎

Proof of Theorem 4. From Lemma 5 we know that the uniform random allocation is the optimal allocation. We need to show that a nondiscriminatory wage contract is optimal even if the government can use discriminatory wage contracts.

Consider a selection rule, an allocation rule Λ, and an optimal discriminatory wage contract $\{u_1^\dagger(i, j), u_2^\dagger(i, j)\}_{i \in I^a, j \in J}$. We need to show that the cost of government under this contract is higher than the cost of the government under the status quo contract. We restrict our attention to optimal discriminatory wage contracts only because if this claim is true for any contract that uses an optimal discriminatory wage contract then it is true for any other contract, too.

Denote the set of hired attorneys under this contract by I, the allocation by λ, and

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the optimal discriminatory wage contract by $\{u_1^\dagger(i,j), u_2^\dagger(i,j)\}_{i \in I, j \in J}$. After the contract is signed, attorneys and indigent defendants are matched based on λ. Note that each attorney is assigned to one indigent defendant, and denote this realized matching by μ. The cost of government if μ is realized is:

$$C_\mu = \sum_{i \in I} (p_2 h(u_2^*(i, \mu^{-1}(i))) + (1 - p_2) h(u_1^*(i, \mu^{-1}(i)))),$$

where:

$$u_1^\dagger(i, \mu^{-1}(i)) = r(q_i) + c(e_h, d_{\mu^{-1}(i)}) - p_h\left(\tfrac{c(e_h) - c(e_l)}{p_h - p_l}\right),$$
$$u_2^\dagger(i, \mu^{-1}(i)) = r(q_i) + c(e_h, d_{\mu^{-1}(i)}) + (1 - p_h)\left(\tfrac{c(e_h) - c(e_l)}{p_h - p_l}\right).$$

Finding an optimal discriminatory wage contract is simple. For each possible match $\mu(\tilde{j}) = \tilde{i}$, there are two binding constraints, an incentive compatibility constraint for $\tilde{i}$ when he/she is matched to indigent defendant $\tilde{j}$, and an individual rationality constraint for $\tilde{i}$ when he/she is matched to indigent defendant $\tilde{j}$. One can show these constraints bind at optimality. Hence, the optimal wage contract $u_1^\dagger(i, j), u_2^\dagger(i, j)$ is derived by solving each possible match under the allocation λ. Note that $c(e, d_j) = c(e) - g(d_j)$ implies $c(e_h, d_j) - c(e_l, d_j) = c(e_h) - c(e_l)$.

For any set of hired attorneys I, we know that $r(q_i) > r(q_1) = r \forall i \in I$. Therefore:

$$u_1^*(i, \mu^{-1}(i)) \geq r + c(e_h, d_{\mu^{-1}(i)}) - p_h\left(\tfrac{c(e_h) - c(e_l)}{p_h - p_l}\right),$$
$$u_2^*(i, \mu^{-1}(i)) \geq r + c(e_h, d_{\mu^{-1}(i)}) + (1 - p_h)\left(\tfrac{c(e_h) - c(e_l)}{p_h - p_l}\right).$$

Define

$$\xi = r - p_h\left(\tfrac{c(e_h) - c(e_l)}{p_h - p_l}\right),$$
$$\zeta = r + (1 - p_h)\left(\tfrac{c(e_h) - c(e_l)}{p_h - p_l}\right).$$

Hence,

$$u_1^*(i, \mu^{-1}(i)) \geq c(e_h, d_{\mu^{-1}(i)}) + \xi, \tag{7}$$
$$u_2^*(i, \mu^{-1}(i)) \geq c(e_h, d_{\mu^{-1}(i)}) + \zeta. \tag{8}$$

The cost of the government under the uniform random allocation with nondiscriminatory wage contract is

$$C_u = \sum_{i \in I} (p_2 h(u_2^\dagger) + (1 - p_2) h(u_1^\dagger)),$$

where:

$$u_1^\dagger = r + E_d(c(e_h, d)) - p_h\left(\tfrac{c(e_h) - c(e_l)}{p_h - p_l}\right) = E_d(c(e_h, d)) + \xi,$$
$$u_2^\dagger = r + E_d(c(e_h, d)) + (1 - p_h)\left(\tfrac{c(e_h) - c(e_l)}{p_h - p_l}\right) = E_d(c(e_h, d)) + \zeta.$$

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Suppose there exists $i' \in I$ such that $u_2^*(i', \mu^{-1}(i')) \neq \frac{\sum_{i \in I} u_2^*(i, \mu^{-1}(i))}{N}$, i.e., at least two attorneys are getting different wages under the high signal. Under Assumption 1, $h(.)$ is a strictly convex function. By Jensen's inequality, we have:

$$h\left(\frac{\sum_{i \in I} u_2^*(i, \mu^{-1}(i))}{N}\right) < \frac{\sum_{i \in I} h(u_2^*(i, \mu^{-1}(i)))}{N}. \tag{9}$$

From equation (8) we have:

$$\frac{\sum_{i \in I} u_2^*(i, \mu^{-1}(i))}{N} \geq \frac{\sum_{i \in I} (c(e_h, d_{\mu^{-1}(i)}) + \zeta)}{N} \tag{10}$$

$$= \zeta + \frac{\sum_{i \in I} c(e_h, d_{\mu^{-1}(i)})}{N} = \zeta + \frac{\sum_{j \in J} c(e_h, d_j)}{N} = \zeta + E_d(c(e_h, d)) = u_2^\dagger. \tag{11}$$

Under Assumption 1, $h(.)$ is a strictly increasing function; therefore:

$$h(u_2^\dagger) \leq h\left(\frac{\sum_{i \in I} u_2^*(i, \mu^{-1}(i))}{N}\right). \tag{12}$$

Observe that that if there does not exist $i' \in I$ such that $u_2^*(i', \mu^{-1}(i')) \neq \frac{\sum_{i \in I} u_2^*(i, \mu^{-1}(i))}{N}$, then for at least one attorney $i \in I$ we must have that $r(q_i) > r$. In this case, the Jensen's inequality is a weak inequality; however, inequity (11) is a strict inequality. Therefore, inequality (12) holds with strict inequality.

By comparing inequality (9) and inequality (12), we get:

$$\sum_{i \in I} h(u_2^\dagger) < \sum_{i \in I} h(u_2^*(i, \mu^{-1}(i))).$$

Similarly:

$$\sum_{i \in I} h(u_1^\dagger) < \sum_{i \in I} h(u_1^*(i, \mu^{-1}(i))).$$

Therefore:

$$\mathcal{C}_u < \mathcal{C}_\mu.$$

We can conclude that the status quo system, i.e., the merit-based selection rule, the uniform random allocation rule, and nondiscriminatory wage contracts, is the optimal contract even among discriminatory wage contracts. ∎

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