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Do workers benefit from wage transparency rules?*

Oliver Gürtler, Lennart Struth†

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Abstract

Wage transparency rules arguably enable workers better to assess their contribution to firm value, allowing them to make wage demands that more accurately reflect their value for the employing firm and to lower wage gaps in turn. This paper contains a formal analysis of transparency rules and their effects on wages. We find that these rules induce firms to behave strategically with the aim of manipulating the information workers receive. We identify a large class of rules that yield an identical equilibrium outcome. For productivity distributions with decreasing (increasing) hazard rate, transparency rules increase (potentially decrease) workers' payoff.

JEL Codes: J31, J71, K31, M51

Keywords: Wage-setting, transparency rule, payoff, strategic effect, learning effect

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1. Introduction

Wage differences between different worker groups have long been documented in the labor economics literature (e.g., Oaxaca 1973), in particular between female and male workers. The wage gaps become smaller when industry, job level and worker characteristics are controlled for, but they are still sizable even for comparable workers performing the "same job" (e.g., Blau and Kahn 2017). To lower the wage disparities within jobs, wage transparency rules have been advocated by politicians around the world and introduced in many countries.[1] The idea is that transparency rules equalize workers' perceptions of their actual contributions to firm profit, leading to more equal wage demands of workers with comparable skills and tasks.

Wage transparency rules, however, could also have some unintended consequences. The reason is that they provide information to workers about their value for their firm, with the consequence that the firm may wish to manipulate the information that workers receive to affect their wage demands. Little research has been done on the effects of wage transparency rules on wage-setting within firms, and the corresponding effects are thus not well understood. The goal of the current paper is to provide a formal analysis of (wage) transparency rules and their effects on the wage-setting in firms. Based on this analysis, we aim to understand in which situations workers benefit from these rules.

To this end, we begin by proposing a model in which a wage gap between two different groups of workers arises. There is a firm that lives for multiple periods and interacts with workers who live for one period and emanate from two different groups. In each period, the firm privately learns its productivity (i.e., the value of the output of workers) and productivity is correlated across periods. Workers privately learn their reservation values and the distribution of reservation values in one group dominates the corresponding distribution in the other group in the likelihood ratio order. At the beginning of a period, workers make

[1] One example is Germany's Pay Transparency Act, which was enacted in 2017 and which mandates firms with more than 200 employees to provide information to workers about the wages of other workers performing similar tasks. Another example is Colorado's Equal Pay for Equal Work Act, which came into force in 2021. Among other things, the act requires that all job postings disclose information about salary and benefits.

wage demands to the firm, and the firm then decides which demands to accept and which to reject. The situation is intransparent in that workers do not receive any information about past periods.

The latter assumption implies that there is no strategic linkage between periods so that, in equilibrium, the firm does not behave strategically, meaning that it accepts all wage demands below the productivity level. As a consequence, the workers from the group with the dominant distribution of reservation values receive higher wages on average and a wage gap results. The model leads to several other findings that are consistent with stylized facts. While in the model the wage gap disappears once reservation values are controlled for (e.g., Caliendo et al. 2017), it further predicts a positive correlation between firm size on the one hand, and productivity and average wages, on the other hand (e.g., Idson and Oi 1999 and Oi and Idson 1999), as well as higher self-employment rates among men than among women (e.g., OECD 2016).

Having presented our baseline model, we turn to our main research question and we analyze the effects of transparency rules. We model such a rule by allowing workers to observe some "indicator" or signal about past periods, and examples include the highest wage that a worker receives, the average or median wage, and the size of the workforce. We make three primary contributions. First, we show that all monotone and continuously differentiable indicators lead to the same equilibrium behavior, and the result can be explained as follows. Workers correctly anticipate the firm's equilibrium strategy. Given their knowledge of the model primitives and their correct anticipation of the firm's behavior, a monotone and continuously differentiable indicator allows the workers correctly to infer the firm's past productivity, regardless of the specific structure of the indicator. As an immediate consequence, equilibrium behavior is the same for all these indicators.

Second, we observe that the firm behaves strategically once a transparency rule is in place, which means that it sets the wage threshold up to which it decides to employ workers different from the productivity level. The reason is that the firm wishes to manipulate the information that the workers receive about productivity to lower their wage demands. One would conjecture that the firm wishes to signal a low productivity to trigger relatively lower wage demands. Surprisingly, we find that this is not always the case, and the firm's exact behavior depends on the hazard rate of productivity. If the hazard rate is increasing, the intuition is confirmed and the firm wishes to signal a low productivity. It does so by reducing the hiring threshold below the productivity level, repelling some workers who were profitable hires. On the contrary, if the hazard rate is decreasing, the firm wishes to signal a relatively high productivity and it therefore decides to hire some workers whose wage demands exceed their productivity, thereby suffering a loss.

Third, and most importantly, we study the impact of the transparency rule on the workers' payoff. There are two effects, which we label the strategic effect and the learning effect. The strategic effect captures the change in the workers' payoff resulting from the firm's adaptation of the hiring threshold once a transparency rule is in place. The direction of this effect depends on whether the firm lowers or raises the threshold which, as just explained, is determined by the slope of the hazard rate of productivity. When the firm lowers (raises) the threshold, the workers' payoff becomes lower (higher).

The learning effect takes into account that workers learn the firm's past productivity from the information that they receive due to the transparency rule, and that what they learn has an impact on their wage demands and, thus, on their payoff. The direction of the learning effect is unambiguously positive, meaning that the workers' payoff increases. The workers are able to tailor their wage demands to the information they receive about the firm's productivity. This allows them to make better decisions than if they stayed uninformed, leading to a relatively greater payoff. Taken together, when productivity has an increasing hazard rate, the strategic and the learning effect oppose each other, and the change in the workers' payoff depends on the dominating effect. In contrast, when the hazard rate is decreasing, the workers' payoff surely increases.

The paper is organized as follows. Section 2 summarizes the related literature, and

Section 3 contains the description of the baseline model and the equilibrium characterization. The following sections introduce a transparency rule into the baseline model. In Section 4, we start with a two-period model, which allows us to isolate the strategic effect (which works in the first period) and the learning effect (which works in the second period). In Section 5, we turn to a model with more than two periods to allow the two effects to be present at the same time. Section 6 concludes. If not stated otherwise, proofs are relegated to the Appendix.

2. Related literature

In our literature review, we focus on the theoretical approaches to understanding wage gaps and labor market discrimination.[2] In general, the literature distinguishes between taste-based and statistical discrimination. Taste-based discrimination refers to situations where firms discriminate against certain workers because they (or their "stakeholders") incur disutility when interacting with these workers (e.g., Becker 1957, Coate and Loury 1993a, Black 1995). Statistical discrimination occurs when firms lack knowledge about workers' characteristics (e.g., their ability levels) and use all the available information to estimate these characteristics. When there are differences between groups, these differences influence how firms assess the characteristics, leading to a different treatment of workers who belong to different groups, but are otherwise identical. Differences between groups can either be imposed exogenously (e.g., Phelps 1972, Aigner and Cain 1977) or emerge endogenously (e.g., Coate and Loury 1993b, Moro and Norman 2003, Fryer 2007).[3]

In our model, the firm uses an identical hiring threshold for all workers. In this sense, there is no discrimination at all. We assume, however, that the distribution of reservation values in one group dominates the corresponding distribution in the other group. Due to

[2] See Blau and Kahn (2017) for a recent survey of the corresponding empirical literature.

[3] In addition to exogenous and endogenous statistical discrimination, Bohren et al. (2020) define inaccurate statistical discrimination, which arises when firms hold incorrect beliefs about the characteristics of some worker group (see also Bohren et al. 2019).

this assumption, wage demands are relatively larger for the former than for the latter group of workers, leading to a gap between the average wages. This mechanism is reminiscent of what has been termed exogenous statistical discrimination in the literature.

A sizeable part of wage gaps can be explained by workers being employed in different industries and having different promotion prospects. The theoretical literature on discrimination has therefore focused on why some workers are discriminated against with respect to hiring (e.g., Coate and Loury 1993a, Black 1995) and promotion decisions (e.g., Milgrom and Oster 1987, Coate and Loury 1993b, Athey et al. 2000, Bjerk 2008, Gürtler and Gürtler 2019, and Bijkerk et al. 2021), and how the respective types of discrimination can be mitigated by affirmative action policies such as quotas. Less emphasis has been placed on why workers with the same observable characteristics and performing the same type of job receive different wages and, in particular, how transparency rules affect the wage-setting within firms.[4]

The most closely-related paper to ours is Cullen and Pakzad-Hurson (2021) which contains a theoretical and empirical analysis of the effects of wage transparency rules on the wage-setting within firms. In their theoretical analysis, transparency is modeled by means of a Poisson arrival process, according to which workers learn information about the wage structure within their firm with a certain probability, and where greater transparency corresponds to a process with a larger arrival rate. They find that greater transparency always leads to lower and more equalized (average) wages and also lower worker surplus. An important difference between the two models is that productivity is fixed over time in their model, whereas it changes in our model and the productivity levels in different periods are positively, but imperfectly, correlated. As a direct consequence, once the wage structure is known, the workers' wage demands are always accepted in their model, whereas the negotiations can still fail in our model. The potential failure of negotiations leads to different conclusions and a dependence of the workers' wage demands on the hazard rate of the firm's

[4]There are several experimental studies that have investigated wage transparency rules. See, e.g., Greiner et al. (2011) and Werner (2019).

productivity distribution.[5] Importantly, the results of Cullen and Pakzad-Hurson (2021) are reversed in the case of a decreasing hazard rate, where the firm sets a higher hiring threshold and, accordingly, workers always benefit from the introduction of a transparency rule.

As explained before, when a transparency rule is introduced into the model, the workers observe a signal about the firm's productivity, which the firm wishes to manipulate to trigger lower future wage demands. Accordingly, there is also a relation between the current paper and the literature on labor-market signaling (e.g., Spence 1973, Holmström 1982). The relation is particularly close to the literature on promotion signaling that originated in the work of Waldman (1984).[6] In this literature, a worker is hired by an employer who privately learns the worker's ability and then decides whether or not to promote the worker. External firms wish to hire the worker away from the current employer, and they observe the promotion decision and use it as a signal about the worker's ability, revising the ability assessment upwards in the case of a promotion. As a consequence, the employer distorts the promotion threshold, promoting the worker only in those cases where he or she is much more productive in the high-level than in the low-level job.

The promotion-signaling distortion is similar to the distortion that we observe in our model. In our model, the firm strategically changes the wage threshold up to which it hires workers to manipulate the information that future workers receive about the firm's productivity. As in the model by Waldman (1984), the goal is to lower the future wage costs. Interestingly, it is possible that the firm tries to signal a rather high productivity, whereas in the promotion-signaling model firms always want to signal that their employees have low ability.

[5]Cullen and Pakzad-Hurson (2021) consider a model extension, where productivity differs between workers and where negotiations possibly fail as well. The focus of this model variant, however, is on inducing high-productivity workers to choose the wage cutoff designed for the low-productivity workers.

[6]Further contributions to the promotion-signaling literature include Bernhardt (1995), Zábojník and Bernhardt (2001), Owan (2004), Ghosh and Waldman (2010), DeVaro and Waldman (2012), Zábojník (2012), Waldman (2013, 2016), Gürtler and Gürtler (2015, 2019), DeVaro and Kauhanen (2016), Ekinci et al. (2019), and Waldman and Zax (2020).

3. Baseline model

3.1. Model description

We consider a dynamic model in discrete time with two periods $t \in \{1, 2\}$. There is one risk-neutral firm which lives through both periods and, in each period t, there are two groups $g \in \{A, B\}$ of risk-neutral workers who live for one period. Each group consists of a continuum I_{gt} of workers of measure n_{gt}, with workers indexed by $i_{gt} \in I_{gt}$. The distribution of the workers' reservation values r_{igt} is given by the distribution function $F_{r_{gt}}$ and density $f_{r_{gt}}$ such that the distribution in group A dominates the corresponding distribution in B in the likelihood ratio order.[7] Worker productivity $V_{igt} = V_t$ is an absolutely continuous random variable with distribution function F_{V_t} and density f_{V_t}.[8] More precisely, we assume $V_2 = \lambda_1 V_1 + \lambda_2 \Theta$, where $\lambda_1, \lambda_2 > 0$ and $\Theta \sim F_\Theta$ is an absolutely continuous productivity shock that is assumed to be independent of V_1 with a hazard rate h_Θ satisfying $(h_\Theta(\theta))^2 + h'_\Theta(\theta) > 0$ for all $\theta \in supp(f_\Theta)$. All distributions are common knowledge. Supports are given by $supp(f_{V_t}) = (\underline{v}_t, \bar{v}_t)$, $supp(f_\Theta) = (\underline{\theta}, \bar{\theta})$ and $supp(f_{r_{gt}}) = (\underline{r}_{gt}, \bar{r}_{gt})$ with $\underline{v}_t, \bar{v}_t, \underline{\theta}, \bar{\theta}, \underline{r}_{gt}, \bar{r}_{gt} \in \mathbb{R} \cup \{\pm\infty\}$.

Each period proceeds in the following way. At the beginning, the firm privately learns the realization v_t of V_t, and the workers privately learn their own reservation value r_{igt}. Workers $i_{gt} \in I_{gt}$ then make wage demands w_{igt} in form of a take-it-or-leave-it (TIOLI) offer to the firm, which in general depend on the reservation value, hence $w_{igt} = w_{igt}(r_{igt})$. The firm

[7] In practice, wage transparency rules are often introduced to lower wage gaps. We thus aim to set up our baseline model such that a wage gap results. Assuming different distributions of reservation values in the two groups represents one way to achieve this goal. The assumption is based on empirical evidence (e.g., Brown et al. 2011, Caliendo et al. 2017, and Khan and Majid 2020), but we do not claim that this is the only way to generate a wage gap.
Furthermore, the existence of a wage gap is not necessary to study the effects of transparency rules on wage-setting. And as we show later, the effects are the same for the workers of all groups. This means that we do not necessarily have to distinguish between different groups of workers, and one could alternatively treat all workers as emanating from a single group.

[8] Note that, while our model is similar to the model of Cullen and Pakzad-Hurson (2021) in several ways, a crucial difference is that we assume productivity to vary over time while it is constant in their model.

decides which workers to accept and which to reject.[9] Workers who are accepted by the firm receive their wage demand w_{igt}, while those workers whose demand is rejected receive their reservation value r_{igt}.

The firm maximizes its total profit across both periods and discounts second-period profit by $\delta \in (0, 1]$. Workers maximize their (expected) payoff.

3.2. Equilibrium characterization

Throughout the paper, we focus on symmetric, pure-strategy Perfect Bayesian Equilibria that satisfy the following conditions. First, the firm is restricted to choose a cutoff wage $\bar{w}_t = \bar{w}_t(v_t)$ such that it accepts all workers i_{gt} whose wage demands are below $\bar{w}_t(v_t)$. Second, workers are assumed always to demand at least their reservation value. Furthermore, if worker i_{gt}'s reservation value exceeds the firm's maximal cutoff, that is, if $r_{igt} > \bar{w}_t(v_t)$ for all v_t, the worker is assumed to demand the reservation value $w_t(r_{igt}) = r_{igt}$. Third, the firm's cutoff $\bar{w}_t$ and the workers' wage demand w_t are strictly increasing and continuously differentiable almost everywhere for all $t \in \{1, 2\}$. We now proceed to characterize such equilibria in the baseline model, in which second-period workers do not receive any information about first-period decisions.

First, we consider the firm. In $t = 2$, since the second period is the last period, it is optimal for the firm to accept a worker i_{g2}'s wage demand w_{ig2} if and only if $w_{ig2} \leq v_2$. Hence, it sets the cutoff $\bar{w}_2(v_2) = v_2$. Since there is no informational linkage between the periods, the firm does not have any incentive to shade its productivity in the first period either and therefore sets the cutoff $\bar{w}_1(v_1) = v_1$.

Next, we consider the workers. In contrast to the firm, each worker only lives for one period and thus maximizes the expected payoff in that period. Denoting a period-t worker's

[9] Note that by our bargaining protocol workers have full bargaining power. In an extension (which is available upon request), we also consider an adaptation of our model in which the firm has full bargaining power. We show that, in such a model, a wage transparency rule does not affect equilibrium behavior. This is in line with Cullen and Pakzad-Hurson (2021), who show that transparency about coworkers' wages and the firm's bargaining power are substitutes. Therefore, to study the effects of transparency rules, some bargaining power for the workers is required. To simplify the analysis, we restrict attention to workers having full bargaining power.

belief about the cutoff $\bar{w}_t$ by $\hat{w}_t$, the expected payoff is given by

$$\begin{aligned} U_{igt}(w_{igt}, r_{igt}) &= \mathbb{P}[w_{igt} \leq \hat{w}_t(V_t)]w_{igt} + \mathbb{P}[w_{igt} > \hat{w}_t(V_t)]r_{igt} \\ &= (1 - F_{\hat{w}_t}(w_{igt}))\, w_{igt} + F_{\hat{w}_t}(w_{igt})r_{igt}, \end{aligned} \tag{1}$$

where $F_{\hat{w}_t}$ denotes the distribution function of the distribution of cutoffs, that is, $\hat{w}_t(V_t) \sim F_{\hat{w}_t}$, and $\mathbb{P}$ denotes a probability measure. The first-order condition with respect to w_{igt} is given by $0 = -f_{\hat{w}_t}(w_{igt})w_{igt} + (1 - F_{\hat{w}_t}(w_{igt})) + f_{\hat{w}_t}(w_{igt})r_{igt}$, which is equivalent to

$$w_{igt} = r_{igt} + \frac{1 - F_{\hat{w}_t}(w_{igt})}{f_{\hat{w}_t}(w_{igt})} = r_{igt} + \frac{1}{h_{\hat{w}_t}(w_{igt})}, \tag{2}$$

where $h_{\hat{w}_t}$ denotes the hazard rate of the distribution of the belief regarding the cutoff. When a worker marginally increases the wage demand, he or she benefits from a higher wage if the demand is accepted. At the same time, the worker faces a higher risk of rejection, in which case he or she would only receive the reservation value. The larger the hazard rate $h_{\hat{w}_t}$, the more important the latter effect becomes, and the lower is the optimal wage demand.

In equilibrium, beliefs are correct. Hence, it holds that $\hat{w}_t(v_t) = \bar{w}_t(v_t) = v_t$ for all $v_t \in supp(f_{V_t})$, and the following Proposition 1 can be stated without further proof.

Proposition 1. *In equilibrium, for all $t \in \{1, 2\}$, the firm sets $\bar{w}_t(v_t) = v_t$ and worker i_{gt} demands w_{igt} given by*

$$w_{igt} = r_{igt} + \frac{1 - F_{V_t}(w_{igt})}{f_{V_t}(w_{igt})} = r_{igt} + \frac{1}{h_{V_t}(w_{igt})}. \tag{3}$$

Before we proceed to analyze the effects of different transparency rules on equilibrium behavior, we summarize a few important findings that are implied by our baseline model and we explain that these findings are consistent with stylized facts.

3.3. Model implications

Next, we outline some implications of the model. We then argue that the implications are consistent with stylized facts. An immediate consequence of the equilibrium characterization is a positive relation between the firm's productivity v_t and the size of the workforce. This relation is obtained since the share of employed workers equals the share of wage demands not larger than the firm's productivity. The following Corollary 1 makes this precise.

Corollary 1. *Suppose the firm employs a positive fraction smaller than one of all workers. Then, the size of the workforce is strictly increasing in the firm's productivity.*

Since the firm sets a single cutoff for all workers, in particular for workers of both groups $g \in \{A, B\}$, it is immediate that the fraction of workers who are accepted by the firm is larger in the group whose distribution of reservation values is dominated.[10] Again, the following Corollary 2 states the result.

Corollary 2. *In equilibrium, for every v_t, the fraction of workers who are rejected by the firm, and therefore receive their reservation value, is larger for group A than for B.*

Next, we study the wages that the workers receive. We define the mean wage μ_{gt} of the group-g workers who are accepted by the firm as a function of the firm's productivity v_t by

$$\mu_{gt}(v_t) = \frac{1}{F_{w_{gt}}(\bar{w}_t(v_t))} \int^{\bar{w}_t(v_t)} x \, dF_{w_{gt}}(x), \tag{4}$$

where $F_{w_{gt}} = F_{r_{gt}} \circ w_t^{-1}$ denotes the distribution of group g's wage demands in period t. It is straightforward to show that the mean wage is an increasing function of the firm's productivity v_t.

Corollary 3. *Suppose the firm employs a positive fraction smaller than one of all workers. Then, the mean wage μ_{gt} is strictly increasing in the firm's productivity.*

[10] In the beginning of the section, we noted that throughout the paper we restrict attention to equilibria in which the firm sets a single cutoff for all workers. We remark that it can be shown that in the baseline model this is an assumption without loss of generality, since in every equilibrium it is optimal for the firm to set a single cutoff for all workers.

Observe that μ_{gt} is well-defined only if the productivity is sufficiently high such that a positive measure of workers is accepted by the firm, that is, if the lowest wage demand $w_t^{\min} = w_t(\underline{r}_{gt})$ is smaller than $\bar{w}_t(v_t)$ or, equivalently, $\bar{w}_t^{-1}(w_t^{\min}) < v_t$. Hence, the mean wage M_{gt} across all types of firms that employ a positive measure of workers is defined by

$$M_{gt} = \frac{1}{1 - F_{V_t}\left(\bar{w}_t^{-1}(w_t^{\min})\right)} \int_{\bar{w}_t^{-1}(w_t^{\min})}^{\bar{v}_t} \mu_{gt}(x)\, dF_{V_t}(x). \tag{5}$$

Proposition 2. *In equilibrium, $\mu_{At}(v_t) \geq \mu_{Bt}(v_t)$ for all $v_t \geq \bar{w}_t^{-1}(w_t^{\min})$ and $M_{At} \geq M_{Bt}$.*

This result is intuitive. The distribution of reservation values of group-A workers dominates the corresponding distribution of workers belonging to group B in the likelihood ratio order. Since wage demands are increasing in the reservation value, the former on average receive higher wages conditional on being employed at the firm.

Notice that the model implications, as described by the preceding corollaries and propositions, are consistent with stylized facts. An important implication is the existence of a wage gap between the different groups of workers, and such a gap is often observed in practice (e.g., when comparing male with female workers or natives with foreign-born people).[11]

In our model, the wage gap occurs due to differences in the distributions of reservation values. When we compare workers from the two different groups with identical reservation values, then these workers make the same wage demand and they receive the same wage. This result is supported by the study of Caliendo et al. (2017), who find that the wage gap disappears once reservation values are controlled for.

Corollaries 1 and 3 highlight that more productive firms are both larger and pay higher wages. Another implication from these two results is a positive correlation between firm size and mean wages. In line with these findings, empirical studies document a positive correlation between firm size, on the one hand, and productivity and wages, on the other hand (e.g., Idson and Oi 1999 and Oi and Idson 1999).

[11] See Blau and Kahn (2017) for a recent discussion of the gender wage gap.

Finally, one interpretation for receiving the reservation value would be that a person becomes self-employed. Adopting this interpretation and applying our model to male (group A) and female (group B) workers, Corollary 2 implies higher self-employment rates among men than among women. Again, there is empirical support for this finding (e.g., OECD 2016).

Example 1. This example serves to illustrate our general findings in the baseline model.[12] Let $V_1 \sim U[0,1]$ and $V_2 = V_1 + \Theta$, where $\Theta \sim U[0,1]$. Furthermore, let $n_{At} = n_{Bt} = 1/2$ for $t \in \{1,2\}$ and $f_{r_{At}}(x) = 2x \cdot \mathbb{I}_{[0,1]}(x)$, and $f_{r_{Bt}}(x) = (2-2x) \cdot \mathbb{I}_{[0,1]}(x)$ for $t \in \{1,2\}$. Note that the corresponding density function for all period-t workers, consisting of group A and B together, is then given by $f_{r_t}(x) = \mathbb{I}_{[0,1]}(x)$ for $t \in \{1,2\}$.

Equilibrium strategies can be summarized as follows. The firm sets $\bar{w}_1(v_1) = v_1$ and $\bar{w}_2(v_2) = v_2$, workers demand

$$w_1(r_{ig1}) = \frac{1}{2} + \frac{r_{ig1}}{2} \quad \text{and} \quad w_2(r_{ig2}) = \begin{cases} \frac{r_{ig2}+\sqrt{r_{ig2}^2+6}}{3}, & \text{if} \quad 0 \leq r_{ig2} \leq \frac{1}{2}, \\ \frac{2r_{ig2}+2}{3}, & \text{if} \quad \frac{1}{2} \leq r_{ig2} \leq 1. \end{cases} \tag{6}$$

Turning to the wage gap between the groups, we note that the distribution of reservation values for group A dominates the distribution of group B's reservation values in the likelihood ratio order. Figure 1 illustrates the difference $\Delta_t(v_t) = \mu_{At}(v_t) - \mu_{Bt}(v_t)$ of mean wages between both groups as a function of the workers' value v_t to the firm. In line with the results of our model, Δ_t is positive for all v_t for which the firm employs a positive measure of workers. Furthermore, for the mean wages M_{gt}, we obtain $M_{A1} = 0.667 > 0.602 = M_{B1}$, and $M_{A2} = 1.018 > 0.9165 = M_{B2}$, confirming that there is a positive gap in the groups' mean wages across all types of firms.

Finally, we calculate the workers' expected equilibrium payoff. In the first period, the

[12] All derivations regarding the examples are available from the authors upon request.

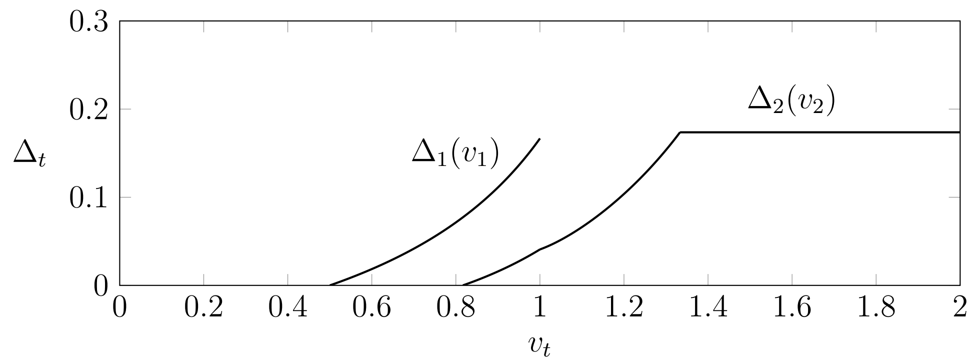

Figure 1: Difference between mean wages as a function of the firm's productivity in the corresponding period

workers' expected payoff as a function of their reservation value r_{ig1} is given by

$$U_1(w_1(r_{ig1}), r_{ig1}) = \frac{r_{ig1}^2}{4} + \frac{r_{ig1}}{2} + \frac{1}{4}. \tag{7}$$

In the second period, the workers' expected payoff, conditional on the realization v_1 of V_1, as a function of the workers' reservation value is given by

$$U_2(w_2(r_{ig2}), r_{ig2}, v_1) = \begin{cases} \frac{r_{ig2}+\sqrt{r_{ig2}^2+6}}{3}, & \text{if} \quad r_{ig2} < \frac{3v_1^2-2}{2v_1}, \\ \frac{(r_{ig2}+3v_1+3)\sqrt{r_{ig2}^2+6}+r_{ig2}^2+(3-6v_1)r_{ig2}-6}{9}, & \text{if} \quad \frac{3v_1^2-2}{2v_1} \leq r_{ig2} \leq 1/2, \\ \frac{r_{ig2}(2r_{ig2}-3v_1+4)+6v_1+2}{9}, & \text{if} \quad 1/2 \leq r_{ig2} \leq \frac{3v_1+1}{2}, \\ r_{ig2}, & \text{if} \quad \frac{3v_1+1}{2} < r_{ig2} \leq 1. \end{cases} \tag{8}$$

Note that v_1 is unknown by the workers and therefore they maximize the expected payoff with respect to the unconditional distribution F_{V_2} of $V_2 = \lambda_1 V_1 + \lambda_2 V_2$. The conditional expected payoff that we calculated here enables us to consider the effect of introducing a transparency rule on the workers' payoff in Example 4 in the next section.

4. Transparency rules

We now introduce a wage transparency rule into the model and study its effects on employment decisions and wage structures. In this section, we begin our analysis by considering a broad class of transparency rules that are shown to be equivalent and thus yield the same equilibrium behavior.

4.1. Indicator

We model a transparency rule by supposing that, at the beginning of the second period, workers now observe an **indicator** $X_{F_{w_1}}(\bar{w}_1)$, where the function $X_{F_{w_1}} : \mathbb{R} \to \mathbb{R}$, $\bar{w}_1 \mapsto X_{F_{w_1}}(\bar{w}_1)$ is assumed to be strictly monotone and differentiable in the firm's cutoff for all wage demand functions w_1. Note that, in addition to standard examples such as the first period's mean wage, our notion of an indicator also includes transparency rules in which workers do not receive any direct information about the period-1 wage structure, but rather about the fraction of accepted workers. Before discussing specific examples in more detail, we state our equivalence result precisely.

Proposition 3. *Let the second-period workers observe an indicator $X_{F_{w_1}}(\bar{w}_1)$, that is, the value of a strictly monotone and differentiable function $X_{F_{w_1}}$ of the firm's period-1 wage cutoff $\bar{w}_1$. Then, in equilibrium, second-period workers infer the first-period productivity v_1 correctly, that is, their belief $\tilde{V}_1$ about the productivity is a deterministic function of the firm's cutoff decision given by $\tilde{V}_1 = \tilde{v}_1 = v_1$, and it holds that*

$$\tilde{v}_1'(\bar{w}_1) = \frac{1}{\bar{w}_1'(v_1)}. \tag{9}$$

The result is intuitive. Recall our assumption that the distribution of reservation values is common knowledge among workers. Thus, given strictly increasing beliefs about first-period wage demands and the firm's hiring cutoff, any transparency rule in the above sense provides the second-period workers with information which is a one-to-one correspondence with the firm's cutoff decision. Hence, second-period workers' belief about first-period productivity is a deterministic function of the cutoff. Therefore, in equilibrium, when beliefs are confirmed, second-period workers are able to infer the first-period productivity correctly.

Furthermore, the meaning of the condition $\tilde{v}_1'(\bar{w}_1) = \frac{1}{\bar{w}_1'(v_1)}$ is that the firm can affect workers' belief regarding the first-period productivity by deviating from the equilibrium cutoff, but that the effect of a marginal change in the cutoff on the belief is the same for all indicators. As we will see once we have introduced the equilibrium conditions in Section 4.2, an immediate consequence of this result is that equilibrium behavior is the same for all of the above transparency rules. In the following, we present examples of corresponding (wage) transparency rules.

Example 2 (Transparency about wages)**.** We consider three common examples of wage transparency rules. First, suppose that second-period workers observe the mean wage

$$\mu_{w_1} = \frac{1}{F_{w_1}(\bar{w}_1)} \int^{\bar{w}_1} x \, dF_{w_1}(x) \tag{10}$$

of all workers who are accepted by the firm in the first period. If the firm sets a cutoff between the minimum and maximum wage demand, that is, if $w_1^{\min} = w_1(\underline{r}_{g1}) < \bar{w}_1 < w_1(\bar{r}_{g1}) = w_1^{\max}$, the mean wage μ_{w_1} of all accepted workers is strictly increasing in the firm's cutoff and hence $X_{F_{w_1}} = \mu_{w_1}$ is an indicator, as defined above.[13] Thus, by Proposition 3, we have $\tilde{v}_1 = v_1$ and $\tilde{v}_1'(\bar{w}_1) = 1/\bar{w}_1'(v_1)$ in equilibrium.

Second, assume that second-period workers are provided with the median wage $\mathrm{m}_{w_1}(\bar{w}_1)$ of all workers who are accepted by the firm in the first period, which is given by the equation

$$\int_{w_1^{\min}}^{\mathrm{m}_{w_1}} dF_{w_1}(x) = \int_{\mathrm{m}_{w_1}}^{\bar{w}_1} dF_{w_1}(x). \tag{11}$$

[13] Note that if the cutoff is below the lowest wage demand in the first period, no workers are accepted by the firm and the mean wage is not defined. If the cutoff is above the highest wage demand, all first-period workers are employed and thus the second-period workers cannot perfectly infer the first-period workers' value v_1 to the firm anymore. Instead, in equilibrium, they infer that $w_1^{\max} \leq \bar{w}_1(\tilde{V}_1)$, which yields a lower bound on the possible values of v_1, and hence the updated belief is a random variable with a distribution given by the truncation of F_{V_1}. Similar arguments apply for the other transparency rules.

Again, it can be shown that for all $w_1^{\min} < \bar{w}_1 < w_1^{\max}$ the median wage $X_{F_{w_1}} = \mathrm{m}_{w_1}$ is an indicator such that Proposition 3 applies.

Third, suppose that the workers observe the maximum wage paid by the firm in the first period. If the cutoff does not exceed the maximum wage demand in that period, the highest wage paid coincides with the firm's cutoff and hence also serves as an indicator in the above sense.

In Example 2, we considered transparency rules that contain information about the firm's wage structure. In the following Example 3, we show that information about the firm size can also serve as an indicator and therefore yield the same equilibrium outcome.

Example 3 (Transparency about firm size)**.** Assume that, at the beginning of the second period, workers observe the measure $m_1 = n_1 F_{w_1}(\bar{w}_1)$ of workers who are accepted y the firm in the first period. It is immediate that, if $w_1^{\min} < \bar{w}_1 < w_1^{\max}$, the measure of accepted workers is strictly increasing in the firm's cutoff $\bar{w}_1$. Hence, $X_{F_{w_1}} : \bar{w}_1 \mapsto n_1 F_{w_1}(\bar{w}_1)$ is an indicator, as defined before, and Proposition 3 can be applied.

So far, we have only considered examples of indicators that are increasing in the firm's cutoff. However, Proposition 3 also includes indicators that are strictly decreasing in $\bar{w}_1$. As an example, suppose that, at the beginning of the second period, workers observe the measure $n_1 - m_1 = n_1 \cdot (1 - F_{w_1}(\bar{w}_1))$ of workers who are rejected by the firm in the first period. Obviously, this indicator is strictly monotone in the relevant range, and thus Proposition 3 is applicable.

4.2. Equilibrium characterization

In the following, we derive necessary equilibrium conditions. First, we consider the workers. Again, denote the period-t workers' beliefs about the firm's cutoff by $\hat{w}_t$ and the corresponding distribution of cutoffs by $F_{\hat{w}_t} = F_{\tilde{V}_t} \circ \hat{w}_t^{-1}$, where the random variable $\tilde{V}_t$ denotes the period-t workers' belief about the firm's productivity in period t. Then, the workers' objective function is the same as in the baseline model. They maximize their expected payoff

$$\begin{aligned} U_{igt}(w_{igt}, r_{igt}) &= \mathbb{P}[w_{igt} \le \hat{w}_t(\tilde{V}_t)]w_{igt} + \mathbb{P}[w_{igt} > \hat{w}_t(\tilde{V}_t)]r_{igt} \\ &= (1 - F_{\hat{w}_t}(w_{igt}))\, w_{igt} + F_{\hat{w}_t}(w_{igt}) r_{igt}. \end{aligned} \tag{12}$$

In the first period, workers do not have any additional information about the productivity, hence $\tilde{V}_1 = V_1 \sim F_{V_1}$. Second-period workers now observe an indicator at the beginning of the period. We have shown in Proposition 3 that any indicator leads to a deterministic belief $\tilde{v}_1$ about the first-period productivity. Since $V_2 = \lambda_1 V_1 + \lambda_2 \Theta$, the workers' updated belief about their value to the firm is therefore given by $\tilde{V}_2 = \lambda_1 \tilde{v}_1 + \lambda_2 \Theta \sim F_{\tilde{V}_2}$.

Next, we consider the firm. In the second period, it is again optimal for the firm to accept a worker i_{g2}'s wage demand w_{ig2} if and only if $w_{ig2} \le v_2$. Since the second period is the last period, there are no informational spillovers affecting future workers, and therefore the firm has no incentive to reject any profitable wage demands. In the first period, this no longer holds true. Denoting the firm's belief about the workers' wage demands by $\tilde{w}_t$ and its period-t profit by π_t, in the first period after receiving the wage demands w_1, its total (expected) profit Π is given by

$$\begin{aligned} \Pi(\bar{w}_1, v_1) &= \pi_1(\bar{w}_1, v_1) + \delta \mathbb{E}\left[\pi_2(\bar{w}_2, V_2) \middle| V_1 = v_1\right] \\ &= n_1 \int^{w_1^{-1}(\bar{w}_1)} v_1 - w_1(r)\, dF_{r_1}(r) \\ &\quad + \delta \mathbb{E}\left[n_2 \int^{\tilde{w}_2^{-1}(\bar{w}_2)} \lambda_1 v_1 + \lambda_2 \Theta - \tilde{w}_2(r)\, dF_{r_2}(r) \right]. \end{aligned} \tag{13}$$

Note that, although second-period profit π_2 does not explicitly depend on the first-period cutoff $\bar{w}_1$, it does so implicitly, since the second-period wage demand will depend on the realization of the indicator and therefore on first-period decisions.

The following Proposition 4 characterizes equilibrium in the model with a transparency rule.

Proposition 4. *Suppose the second-period workers observe an indicator. Then, in equilib-*

rium, the workers' period-1 wage demand w_1 and the firm's first-period cutoff $\bar{w}_1$ satisfy the respective first-order conditions

$$\begin{aligned} &(w_1(r_{ig1}) - r_{ig1})\, f_{\bar{w}_1}(w_1(r_{ig1})) = 1 - F_{\bar{w}_1}(w_1(r_{ig1})) \quad \textit{and} \\ &n_1\left(v_1 - \bar{w}_1(v_1)\right) f_{w_1}(\bar{w}_1(v_1)) = \frac{\delta n_2}{\bar{w}_1'(v_1)} \int\int^{w_2^{-1}(\lambda_1 v_1 + \lambda_2 \theta)} \left.\frac{\partial w_2}{\partial \tilde{v}_1}\right|_{\tilde{v}_1 = v_1} (r) dF_{r_2}(r) dF_\Theta(\theta). \end{aligned} \tag{14}$$

In the second period, the workers' wage demand w_2 and the firm's cutoff $\bar{w}_2$ fulfill

$$\begin{aligned} (w_2(r_{ig2}) - r_{ig2})\, f_\Theta\left(\frac{w_2(r_{ig2}) - \lambda_1 v_1}{\lambda_2}\right) = \lambda_2 \left(1 - F_\Theta\left(\frac{w_2(r_{ig2}) - \lambda_1 v_1}{\lambda_2}\right)\right) \quad \textit{and} \\ \bar{w}_2(v_2) = v_2. \end{aligned} \tag{15}$$

4.3. Effects of transparency rules

We now proceed to study the effects of transparency rules on equilibrium behavior in more detail. From the firm's first-order condition in equation (14), it can immediately be seen that its cutoff is determined differently than in the baseline model. The reason is that now the firm has to take into account the effect of its first-period decisions on the next period. In the following, we further characterize the firm's period-1 decision depending on the properties of the random shock Θ.

Definition 1 (Strategic behavior by the firm)**.** We say that the firm **behaves strategically** in period $t \in \{1, 2\}$, if it sets a cutoff different from the workers' value to the firm, that is, if there is a $v_t \in supp(f_{V_t})$ such that $\bar{w}_t(v_t) \neq v_t$.

Proposition 5 shows that the firm behaves strategically.[14]

[14] The assumption in the first sentence of the proposition is required for the following reason. If there exists no $\theta \in supp(f_\Theta)$ such that $w_2^{\min} < \lambda_1 v_1 + \lambda_2 \theta < w_2^{\max}$, then, for all realizations of the second-period productivity shock, it must hold that $\lambda_1 v_1 + \lambda_2 \theta \leq w_2^{\min}$ or $w_2^{\max} \leq \lambda_1 v_1 + \lambda_2 \theta$. This means that, for all realizations $\theta \in supp(f_\Theta)$, the firm rejects or accepts (almost) all workers in the second period, respectively, and the random shock has no effect on the firm's employment decisions in the second period. Therefore, in either case, the firm does not influence the second-period profit by marginally changing the period-1 cutoff and thus has no incentive to behave strategically in the first period.

Proposition 5. *Suppose there is a realization $\theta \in supp(f_\Theta)$ of the random shock such that $w_2^{\min} < \lambda_1 v_1 + \lambda_2 \theta < w_2^{\max}$. Then, if the hazard rate h_Θ is not constant, the firm behaves strategically in the first period.*

The proposition shows that the firm sets a cutoff different from the workers' value to manipulate the second-period workers' belief about its productivity to trigger lower wage demands in the second period. In equilibrium, the workers are not fooled by the firm and infer the true productivity.[15]

To understand the firm's behavior better, we first need to understand how the second-period workers' wage demands depend on their belief $\tilde{v}_1$ about the productivity. The following Lemma 1 considers this question.

Lemma 1. *Suppose that the hazard rate h_Θ of the random shock is increasing (constant, decreasing).*[16] *Then, in equilibrium, whenever $w_{ig2} > r_{ig2}$, we have $\frac{\partial w_{ig2}}{\partial \tilde{v}_1} > (=, <)\, 0$.*

To understand the intuition behind the lemma, notice that the first-order condition determining the workers' period-2 wage demand can be rewritten as

$$w_{ig2} = r_{ig2} + \frac{\lambda_2}{h_\Theta\left(\frac{w_{ig2} - \lambda_1 \tilde{v}_1}{\lambda_2}\right)}. \tag{16}$$

Similar to our argumentation in the baseline model, by marginally increasing the wage demand, workers benefit from a higher wage if they get hired, but at the same time increase the probability of being rejected. The larger the hazard rate h_Θ, the more important is the latter effect and the lower is the optimal wage demand. Now notice that the hazard rate is evaluated at $\frac{w_{ig2} - \lambda_1 \tilde{v}_1}{\lambda_2}$, which is decreasing in $\tilde{v}_1$, and the reason is that workers already anticipate being hired at a low θ when they believe that v_1 is large. Now, if h_Θ is increasing,

[15] The latter is a standard result in signal-jamming models and was pointed out by Holmström (1982).

[16] Note that we assume the hazard rate to be globally monotone across the full support of the distribution. While this is not a necessary condition and the result should also hold under weaker conditions, even the stronger requirements are met by standard distributions such as the uniform distribution (with an increasing hazard rate) or the Weibull distribution (with a decreasing hazard rate).

then $h_\Theta\left(\frac{w_{ig2}-\lambda_1\tilde{v}_1}{\lambda_2}\right)$ is decreasing in $\tilde{v}_1$, and the wage demands get larger as $\tilde{v}_1$ increases. Similar arguments apply when h_Θ is constant or decreasing.

As the sign of $dw_{ig2}/d\tilde{v}_1$ depends on the hazard rate of Θ, one would expect the direction of the firm's incentive to shade its productivity in the first period also to depend on h_Θ, since the expected profit in the second period is decreasing in the workers' wage demands. The following Proposition 6 confirms this intuition.

Proposition 6. *Suppose there is a realization $\theta \in supp(f_\Theta)$ of the random shock such that $w_2^{\min} < \lambda_1 v_1 + \lambda_2\theta < w_2^{\max}$. Then, the following holds: If the hazard rate h_Θ is increasing, the firm sets $\bar{w}_1(v_1) \leq v_1$ for all $v_1 \in supp(f_{V_1})$ with strict inequality for some v_1. If h_Θ is constant, the firm sets $\bar{w}_1(v_1) = v_1$, and if the hazard rate is decreasing, it sets $\bar{w}_1(v_1) \geq v_1$ for all $v_1 \in supp(f_{V_1})$ with strict inequality for some v_1.*

So far, we have considered the effects of transparency rules on equilibrium behavior. We now proceed to our main research question, and we analyze the effect of transparency rules on the workers' payoff.

In Proposition 6, we have shown that, depending on the hazard rate of the second-period productivity shock, the firm's reaction to a transparency rule is to behave strategically and set a cutoff that is different from the workers' value in the first period. Therefore, the first-period workers' expected payoff when applying at the firm is affected by the transparency rule. We denote this as the *strategic effect* of the transparency rule on the workers' payoff.

Proposition 7. *Suppose that the hazard rate h_Θ is increasing (decreasing). Then, the expected payoff of all first-period workers who demand a wage that is strictly larger than their reservation value decreases (increases).*

When h_Θ is increasing, the firm reacts to the introduction of the transparency rule by decreasing the hiring threshold, as explained before. This means that the workers find it more difficult to get hired and to receive a wage rather than their reservation value. Whenever their wage demand exceeds the reservation wage, their payoff thus declines. The intuition is analogous when h_Θ is decreasing. Here, the workers find it easier to get hired, since the firm sets a higher hiring threshold, leading to a greater payoff for the workers.

Since the second period is the last period, the firm accepts all workers whose wage demands do not exceed the productivity. This holds true for the baseline model as well as in the model with a transparency rule. Therefore, transparency does not affect the second-period workers' payoff through a change in the firm's behavior. The transparency rule, however, allows the workers to infer the period-1 productivity, providing them with more accurate information about their own value for the firm. This enables workers to tailor their wage demands to the information that they receive, leading to better decisions and, thus, higher expected payoffs. We denote this as the *learning effect* of the transparency rule.

Proposition 8. *For every first-period productivity, the expected payoff of all second-period workers increases due to the transparency rule. Furthermore, the average (across all types of firms) expected payoff of every second-period worker increases, compared to the baseline model.*

Observe that the strategic effect of the transparency rule has an impact on the first-period workers, whereas the learning effect affects the second-period workers. That is, there are no workers for whom both effects play a role. This is an artefact of the restriction to two periods. In Section 5, we thus extend the model to more than two periods, where workers are impacted by both the strategic and the learning effect.

Before we do so, we revisit Example 1 to illustrate our general findings on the introduction of a transparency rule into the model.

Example 4 (Equilibrium behavior with a transparency rule)**.** To be able to compare the results between the models with and without a transparency rule, we impose the same parameters and distributional assumptions as in Example 1. Let $V_1 \sim U[0,1]$ and $V_2 = V_1 + \Theta$, where $\Theta \sim U[0,1]$ (and note that the hazard rate h_Θ is increasing). Furthermore, let $n_{At} = n_{Bt} = 1/2$ for $t \in \{1,2\}$ and $f_{r_{At}}(x) = 2x \cdot \mathbb{I}_{[0,1]}(x)$, and $f_{r_{Bt}}(x) = (2-2x) \cdot \mathbb{I}_{[0,1]}(x)$ for $t \in \{1,2\}$.

Since there is now an informational linkage between the periods, the firm still accepts all workers with wage demands less than or equal to the productivity in the second period, but it behaves strategically in the first period. Thus, the first-period workers' strategies also adapt. Furthermore, second-period workers now learn the first-period productivity and, since productivity is correlated across periods, have a different belief about their value to the firm than in the baseline model. Equilibrium strategies can be summarized as follows. In period $t = 1$, it holds that

$$\begin{aligned} w_1(r_{ig1}) &= \begin{cases} \frac{2+3\sqrt{2}}{16} + \frac{1}{2}r_{ig1}, & \text{if} \quad r_{ig1} \in \left[0, \frac{2+3\sqrt{2}}{8}\right], \\ r_{ig1}, & \text{if} \quad r_{ig1} \in \left[\frac{2+3\sqrt{3}}{8}, 1\right], \end{cases} \\ \bar{w}_1(v_1) &= \frac{\sqrt{2}-2}{8} + \frac{\sqrt{2}+2}{4}v_1, \end{aligned} \tag{17}$$

while in the second period

$$w_2(r_{ig2}) = \frac{v_1+1}{2} + \frac{1}{2}r_{ig2} \quad \text{and} \quad \bar{w}_2(v_2) = v_2. \tag{18}$$

For the mean wage M_{gt}^{tr} across all types of firms, we obtain $M_{A1}^{tr} = 0.520 > 0.476 = M_{B1}^{tr}$, and $M_{A2}^{tr} = 0.968 > 0.872 = M_{B2}^{tr}$.

Recall that in the baseline model we had $M_{A1} = 0.667 > 0.602 = M_{B1}$ and $M_{A2} = 1.018 > 0.9165 = M_{B2}$. Therefore, it holds that $M_{gt}^{tr} < M_{gt}$ and $M_{At}^{tr} - M_{Bt}^{tr} < M_{At} - M_{Bt}$ for all $g \in \{A, B\}$ and $t \in \{1, 2\}$, that is, in this example transparency leads to lower and more equal average wages, so that we observe something akin to an equity-efficiency tradeoff.

We again calculate the workers' expected equilibrium payoff. In the first period, the workers' expected payoff U_1^{tr} as a function of their reservation value r_{ig1} is given by

$$U_1^{tr}(w_1(r_{ig1}), r_{ig1}) = \begin{cases} \frac{r_{ig1}\left(32r_{ig1}+2^{\frac{7}{2}}+48\right)+3\cdot 2^{\frac{3}{2}}+11}{32\left(\sqrt{2}+2\right)}, & \text{if} \quad r_{ig1} \in \left[0, \frac{2+3\sqrt{2}}{8}\right], \\ r_{ig1}, & \text{if} \quad r_{ig1} \in \left[\frac{2+3\sqrt{2}}{8}, 1\right]. \end{cases} \tag{19}$$

The left panel of Figure 2 shows the workers' expected payoff U_1 in the baseline model, given in equation (7), as well as the expected payoff U_1^{tr} in the model with a transparency rule, given in equation (19), as functions of the reservation value in the first period. As h_Θ is increasing in the case of the uniform distribution, the transparency rule has a negative strategic effect on the workers' payoff. Accordingly, the workers receive a lower payoff irrespectively of their reservation value.

In the second period, the workers' expected payoff as a function of their reservation value r_{ig2} is given by

$$U_2^{tr}(w_2(r_{ig2}), r_{ig2}, v_1) = \frac{r_{ig2}^2}{4} + \frac{r_{ig2}}{2} - \frac{r_{ig2}v_1}{2} + \frac{v_1^2}{4} + \frac{v_1}{2} + \frac{1}{4}. \tag{20}$$

The right panel of Figure 2 shows the expected second-period payoff U_2 in the baseline model, given in equation (8), and the expected payoff U_2^{tr} in the model with a transparency rule, given in equation (20), conditional on $V_1 = v_1 = 0.75$, as a function of the workers' reservation value. Due to the positive learning effect, for all reservation values r_{ig2} the workers' payoff is relatively larger when the transparency rule is in place.

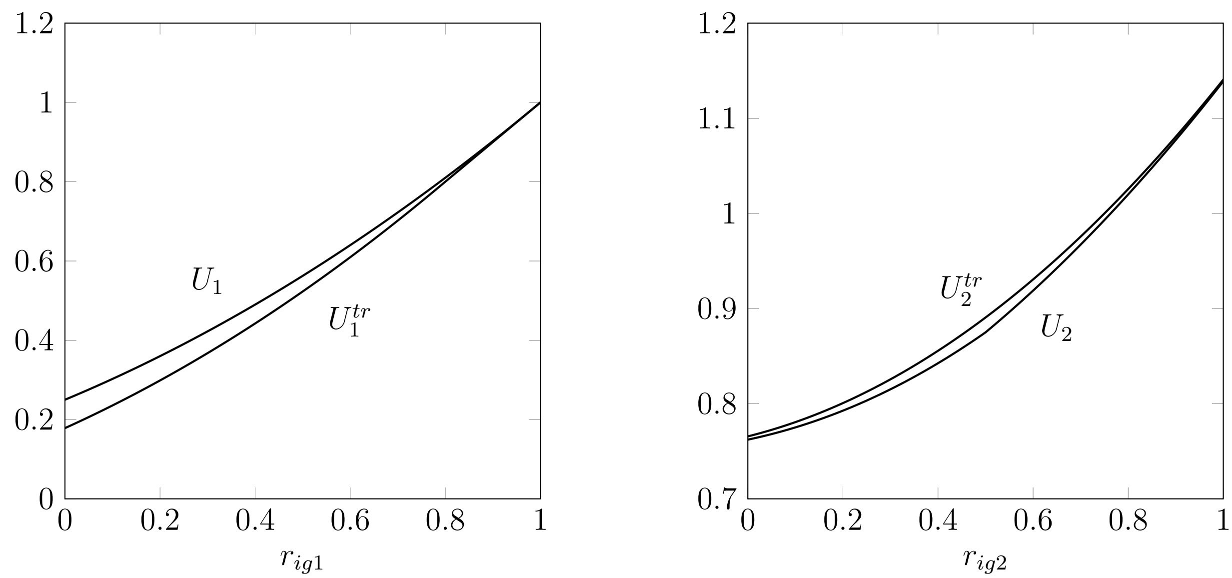

Figure 2: Expected payoff as a function of the workers' reservation values

5. Multi-period model

In this extension, we consider a model with $T > 2$ periods. We determine the equilibrium in the model without a transparency rule for a general number of periods, and we also allow for a general number of periods when stating the workers' and the firm's objectives in the model with a transparency rule. When we determine the equilibrium in that model, however, we restrict attention to the case $T = 3$. This is mainly for expositional convenience, and it would be relatively easy to go beyond three periods.

With a general number of periods, the workers' value to the firm in period $t \in \{1, ..., T\}$ is recursively defined by $V_1 = \Theta_1$ and $V_t = V_{t-1} + \lambda_t \Theta_t \sim F_{V_t}$ for $t \geq 2$, where Θ_t are iid random variables with $\Theta_t \sim F_\Theta$ and $\lambda_t \geq 0$, for all $t \in \{1, ..., T\}$.[17]

5.1. Baseline model

Note that, in the baseline model without a transparency rule, the addition of periods does not change equilibrium behavior. By analogous arguments as in Section 3, equilibrium behavior can be summarized as follows:

Proposition 9. *In equilibrium, for all $t \in \{1, 2, .., T\}$, the firm sets $\bar{w}_t(v_t) = v_t$ and worker i_{gt} demands w_{igt} given by*

$$w_{igt} = r_{igt} + \frac{1 - F_{V_t}(w_{igt})}{f_{V_t}(w_{igt})} = r_{igt} + \frac{1}{h_{V_t}(w_{igt})}. \tag{21}$$

5.2. Transparency rule

In the two-period version of the model, we imposed the assumption that the introduction of a transparency rule allows the second-period workers to observe an indicator or signal about the first-period decisions. We extend this assumption to the case of more than two

[17] The productivity process differs slightly from the process in the two-period model, in that the weight of the previous productivity V_{t-1} in the definition of V_t is normalized to 1. We make this assumption for notational convenience; the results do not change qualitatively.

periods by assuming that the period-t workers observe an indicator about each previous period $1, ..., t-2, t-1$.

We begin by considering the workers and we continue to denote the period-t workers' belief about the firm's cutoff by $\hat{w}_t$ and the corresponding distribution of cutoffs by $F_{\hat{w}_t} = F_{\tilde{V}_t} \circ \hat{w}_t^{-1}$, where the random variable $\tilde{V}_t$ denotes the period-t workers' belief about the firm's productivity in period t. The workers' objective function is then the same as in the baseline model. They maximize their expected payoff

$$\begin{aligned} U_{igt}(w_{igt}, r_{igt}) &= \mathbb{P}[w_{igt} \leq \hat{w}_t(\tilde{V}_t)] w_{igt} + \mathbb{P}[w_{igt} > \hat{w}_t(\tilde{V}_t)] r_{igt} \\ &= \left(1 - F_{\hat{w}_t}(w_{igt})\right) w_{igt} + F_{\hat{w}_t}(w_{igt}) r_{igt}. \end{aligned} \tag{22}$$

In the first period, workers do not have any additional information about the productivity, hence $\tilde{V}_1 = V_1 \sim F_{V_1}$. Second-period workers now observe an indicator at the beginning of the period. We have shown in Proposition 3 that any indicator leads to a deterministic belief $\tilde{v}_1$ about the first-period productivity, and the same holds here. Since $V_2 = V_1 + \lambda_2 \Theta_2$, the workers' updated belief about their value to the firm is therefore given by $\tilde{V}_2 = \tilde{v}_1 + \lambda_2 \Theta_2 \sim F_{\tilde{V}_2}$. Turning to $t \in \{3, ..., T\}$, recall that workers observe an indicator about each previous period. With arguments analogous to those in the proof of Proposition 3, one can then show that period-t workers have a deterministic belief $\tilde{v}_{t-1}$ about the productivity in the previous period. Since $V_t = V_{t-1} + \lambda_t \Theta_t$, the workers' updated belief about their value to the firm is therefore given by $\tilde{V}_t = \tilde{v}_{t-1} + \lambda_t \Theta_t \sim F_{\tilde{V}_t}$.

Next consider the firm. In the T'th period, it is again optimal for the firm to accept a worker i_{gT}'s wage demand w_{igT} if and only if $w_{igT} \leq v_T$. Since the T'th period is the last period, there are no informational spillovers affecting future workers, and therefore the firm has no incentive to reject any profitable wage demands. In the $(T-1)$'th period, this no longer holds true. Since workers in the following period receive information in form of the indicator, the firm takes this into account in the decision on the optimal cutoff in period $T-1$. More precisely, denoting the firm's belief about the workers' wage demands by $\tilde{w}_t$

and its period-t profit by π_t, in the second-to-last period after receiving the wage demands w_{T-1}, its total (expected) future profit Π_{T-1} is given by

$$\begin{aligned}
\Pi_{T-1}(\bar{w}_{T-1}, v_{T-1}) &= \pi_{T-1}(\bar{w}_{T-1}, v_{T-1}) + \delta\mathbb{E}\left[\pi_T(\bar{w}_T, V_T)|V_{T-1} = v_{T-1}\right] \\
&= n_{T-1}\int^{w_{T-1}^{-1}(\bar{w}_{T-1})} v_{T-1} - w_{T-1}(r)\, dF_{r_{T-1}}(r) \\
&\quad + \delta\mathbb{E}\left[n_T\int^{\tilde{w}_T^{-1}(\bar{w}_T)} v_{T-1} + \lambda_T\Theta_T - \tilde{w}_T(r)\, dF_{r_T}(r)\right].
\end{aligned} \tag{23}$$

Note that, although period-T profit π_T does not explicitly depend on the previous period cut-off $\bar{w}_{T-1}$, it does so implicitly, since the period-T wage demand will depend on the realization of the indicator and therefore on previous decisions. For a general period $t \in \{1, ..., T-1\}$, the total expected future profit Π_t is analogously given by

$$\begin{aligned}
\Pi_t(\bar{w}_t, v_t) &= \pi_t(\bar{w}_t, v_t) + \sum_{k=t+1}^{T} \delta^{k-t}\mathbb{E}\left[\pi_k(\bar{w}_k, V_k)|V_t = v_t\right] \\
&= n_t\int^{w_t^{-1}(\bar{w}_t)} v_t - w_t(r)\, dF_{r_t}(r) \\
&\quad + \sum_{k=t+1}^{T} \delta^{k-t}\mathbb{E}\left[n_k\int^{\tilde{w}_k^{-1}(\bar{w}_k)} V_k - \tilde{w}_k(r)\, dF_{r_k}(r)\,\middle|\, V_t = v_t\right].
\end{aligned} \tag{24}$$

The following Proposition 10 characterizes the equilibrium in case of three periods.

Proposition 10. *Let $T = 3$. Suppose the period-t workers observe an indicator about all previous periods. Then, in equilibrium, the workers' period-1 wage demand w_1 and the firm's* *first-period cutoff $\bar{w}_1$ satisfy the respective first-order conditions*

$$\begin{aligned}
&(w_1(r_{ig1}) - r_{ig1})\, f_{\bar{w}_1}(w_1(r_{ig1})) \\
&\quad = 1 - F_{\bar{w}_1}(w_1(r_{ig1})) \quad \textit{and} \\
&n_1\,(v_1 - \bar{w}_1(v_1))\, f_{w_1}(\bar{w}_1(v_1)) \\
&\quad = -\delta n_2 \int \frac{\partial w_2^{-1}}{\partial \tilde{v}_1}(\bar{w}_2)\tilde{v}_1'(\bar{w}_1)\Big|_{\tilde{v}_1 = v_1} (v_1 + \lambda_2\theta_2 - \bar{w}_2)\, f_{r_2}(w_2^{-1}(\bar{w}_2))\, dF_\Theta(\theta_2) \\
&\quad + \delta n_2 \int \int^{w_2^{-1}(\bar{w}_2)} \frac{\partial w_2}{\partial \tilde{v}_1}(r)\tilde{v}_1'(\bar{w}_1)\Big|_{\tilde{v}_1 = v_1} f_{r_2}(r) dr\, dF_\Theta(\theta_2) \\
&\quad + \delta^2 n_3 \int \int \int^{w_3^{-1}(v_1 + \lambda_2\theta_2 + \lambda_3\theta_3)} \frac{\partial w_3}{\partial \tilde{v}_2}(r)\tilde{v}_2'(\bar{w}_1)\Big|_{\tilde{v}_1 = v_1} f_{r_3}(r) dr\, dF_\Theta(\theta_2)\, dF_\Theta(\theta_3).
\end{aligned} \tag{25}$$

In the second period, the workers' wage demand w_2 and the firm's cutoff $\bar{w}_2$ fulfill

$$\begin{aligned}
(w_2(r_{ig2}) - r_{ig2})\, f_{\bar{w}_2}(w_2(r_{ig2})) &= 1 - F_{\bar{w}_2}(w_2(r_{ig2})) \quad \textit{and} \\
n_2\,(v_2 - \bar{w}_2(v_2))\, f_{w_2}(\bar{w}_2(v_2)) &= \delta n_3 \int \int^{w_3^{-1}(v_2 + \lambda_3\theta_3)} \frac{\partial w_3}{\partial \tilde{v}_2}\tilde{v}_2'(\bar{w}_2)\Big|_{\tilde{v}_2 = v_2} (r) dF_{r_3}(r) dF_\Theta(\theta_3).
\end{aligned} \tag{26}$$

In the third period, the workers' wage demand w_3 and the firm's cutoff $\bar{w}_3$ fulfill

$$\begin{aligned}
(w_3(r_{ig3}) - r_{ig3})\, f_\Theta\left(\frac{w_3(r_{ig3}) - v_2}{\lambda_3}\right) = \lambda_3\left(1 - F_\Theta\left(\frac{w_3(r_{ig3}) - v_2}{\lambda_3}\right)\right) \quad \textit{and} \\
\bar{w}_3(v_3) = v_3.
\end{aligned} \tag{27}$$

We focus on period 2 and note that the equilibrium conditions for that period have the exact same form as those for the first period in the two-period model (as specified in Proposition 4). This means that the strategic effect on the workers' payoff in the second period of the three-period model acts in the same way as that in the first period of the two-period model, allowing us to apply our previous results on this effect in the three-period model.

Furthermore, the second-period workers learn the true first-period productivity v_1, just as they did in the two-period model. This means that the learning effect that we identified in the two-period model continues to hold in the second period, again allowing us to apply our preceding results. Summing up, the payoff of the second-period workers is now impacted on by both the strategic and the learning effect. It follows that, if Θ_3 has a decreasing hazard rate, then the two effects act into the same direction and workers are clearly better off after the introduction of the transparency rule. In contrast, if Θ_3 has an increasing hazard rate, then the effects are countervailing, and whether or not workers benefit from the introduction of the transparency rule depends on which effect dominates. One may conjecture that, as the λ_t's get large, the relative importance of the learning effect declines since the correlation of productivity across time becomes weaker. At the same time, however, the firm's incentive to manipulate the information that the workers receive declines as well, diminishing the importance of the strategic effect. Accordingly, a ranking of the two effects is likely to depend on the specifics of the model (even if we fix the λ_t's at certain values).

6. Conclusion

The goal of the current paper has been to study the effects of transparency rules on the wage-setting in firms. To this end, we have started by developing a model of wage negotiations, in which workers are uncertain about their contribution to the firm value when making wage demands to the firm. Since the workers' wage demands are increasing in the reservation value and the distributions of reservation values differs across groups, a wage gap between groups results. The model has delivered several other empirical implications that are consistent with stylized facts. In a second step, we have introduced a transparency rule into the model, and we have identified a class of equivalent rules that lead to an identical equilibrium outcome. We have found that the introduction of a transparency rule induces the firm to behave strategically with the aim of manipulating the information workers receive. We have shown that the effect of the rule on payoffs crucially depends on the hazard rate of the productivity distribution. For distributions with a decreasing hazard rate, transparency rules increase the workers' payoffs, while for distributions with an increasing hazard rate, the opposite could happen.

Throughout the model, we have imposed the assumption that productivity is the same for all workers, and a next possible step in the analysis would be to consider workers with different productivity. While a detailed analysis of such a model is beyond the scope of this paper, our conjecture is that the qualitative results would not change strongly, while the firm's strategic behavior would be muted. The reason is that the additional worker heterogeneity would dilute the signal that workers observe about the firm's productivity (e.g., since a high wage could now be paid either because of the firm's high productivity or because of a worker's outstanding ability), reducing the firm's incentive to manipulate the information that workers receive.

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7. Appendix

7.1. Omitted proofs

Proof of Corollary 1. The measure of workers who are employed by the firm in period t is given by $n_t F_{w_t}(\bar{w}_t(v_t))$. Since $\bar{w}_t$ is strictly increasing in the firm's productivity and F_{w_t} is a cumulative distribution function, this fraction is increasing in the firm's productivity. Furthermore, by the assumption that the support of the workers' reservation values is convex, it follows that $F_{w_t} \circ \bar{w}_t$ is strictly increasing in v_t if $F_{w_t}(\bar{w}_t(v_t)) \in (0, 1)$, that is, if some, but not all, workers are accepted by the firm. □

Proof of Corollary 2. The fraction of group g workers who are rejected by the firm in period t is given by $1 - F_{r_{gt}}(w_t^{-1}(\bar{w}_t(v_t)))$. Since the distribution of reservation values in group A dominates the corresponding distribution of group B in the likelihood ratio order, by Theorem 1.C.1 in Shaked and Shanthikumar (2007) it follows that $F_{r_{At}}$ also dominates $F_{r_{Bt}}$ in the usual stochastic order. Hence, since $\bar{w}_t$ and w_t are strictly increasing, it follows that $F_{r_{At}}(w_t^{-1}(\bar{w}_t(v_t))) \leq F_{r_{Bt}}(w_t^{-1}(\bar{w}_t(v_t)))$ for all v_t. The result is obtained. □

Proof of Corollary 3. Since $\bar{w}_t = v_t$, when the firm employs a positive fraction of all workers smaller than one, the mean wage μ_{gt} can be written as

$$\mu_{gt}(v_t) = \frac{1}{F_{w_{gt}}(v_t)} \int^{v_t} x \, dF_{w_{gt}}(x). \tag{28}$$

Differentiating with respect to v_t and simplifying, we obtain

$$\mu'_{gt}(v_t) = \frac{f_{w_{gt}}(v_t)}{F_{w_{gt}}(v_t)}(v_t - \frac{1}{F_{w_{gt}}(v_t)} \int^{v_t} x \, dF_{w_{gt}}(x)), \tag{29}$$

which is positive.

□

Proof of Proposition 2. Note that

$$\mu_{gt}(v_t) = \frac{1}{F_{w_{gt}}(\bar{w}_t(v_t))} \int_{w_t^{\min}}^{\bar{w}_t(v_t)} x \, dF_{w_{gt}}(x) = \frac{1}{F_{r_{gt}}(w_t^{-1}(\bar{w}_t(v_t)))} \int^{w_t^{-1}(\bar{w}_t(v_t))} w_t(r) \, dF_{r_{gt}}(r).$$

Since the distribution of reservation values $F_{r_{At}}$ in group A dominates the corresponding distribution in group B in the likelihood ratio order, by theorem 1.C.5 in Shaked and Shanthikumar (2007), it holds that any truncation of the distribution of reservation values in group A dominates the corresponding truncation of the distribution in group B in the usual stochastic order. Denoting the truncation from above at $w_t^{-1}(\bar{w}_t(v_t)))$ by

$$G_{r_{gt}}(r) = \frac{F_{r_{gt}}(r)}{F_{r_{gt}}(w_t^{-1}(\bar{w}_t(v_t)))},$$

we therefore obtain

$$\mu_{gt}(v_t) = \int w_t(r) \, dG_{r_{gt}}(r)$$

and, since w_t is strictly increasing, $\mu_{At}(v_t) \geq \mu_{Bt}(v_t)$ for all $v_t \geq \bar{w}_t^{-1}(w_t^{\min})$. Furthermore, since

$$M_{gt} = \frac{1}{1 - F_{V_t}\left(\bar{w}_t^{-1}(w_t^{\min})\right)} \int_{\bar{w}_t^{-1}(w_t^{\min})}^{\bar{v}_t} \mu_{gt}(x) \, dF_{V_t}(x),$$

it follows $M_{At} \geq M_{Bt}$. □

Proof of Proposition 3. Denote the (strictly increasing) second-period workers' belief about w_1 and $\bar{w}_1$ by $\tilde{w}_1$, and $\hat{w}_1$, respectively. Then, the second-period workers' belief $\tilde{V}_1$ about the first-period productivity v_1 is formed via the condition

$$X_{F_{w_1}}(\bar{w}_1) = X_{F_{\tilde{w}_1}}(\hat{w}_1(\tilde{V}_1))$$

or, equivalently, $X_{F_{w_1}}(\bar{w}_1) - X_{F_{\tilde{w}_1}}(\hat{w}_1(\tilde{V}_1)) = 0$. Since $\hat{w}_1$ is strictly increasing and $X_{F_{\tilde{w}_1}}$ is strictly monotone, $\tilde{V}_1 = \tilde{v}_1$ is a deterministic function of $\bar{w}_1$, and we obtain

$$\tilde{v}_1'(\bar{w}_1) = \frac{\partial X_{F_{w_1}}(\bar{w}_1)/\partial \bar{w}_1}{\partial X_{F_{\tilde{w}_1}}(\hat{w}_1(\tilde{v}_1))/\partial \hat{w}_1 \cdot \hat{w}_1'(\tilde{v}_1)}.$$

In equilibrium, beliefs are correct, that is, $\tilde{w}_1 = w_1$ and $\hat{w}_1 = \bar{w}_1$. Hence, we obtain $X_{F_{w_1}}(\bar{w}_1(v_1)) = X_{F_{w_1}}(\bar{w}_1(\tilde{v}_1))$, and therefore $\tilde{v}_1 = v_1$ and $\tilde{v}_1'(\bar{w}_1) = 1/\bar{w}_1'(v_1)$. □

Proof of Proposition 4. First, consider the second period. Since the second period is the last period, the firm has no incentive to shade its productivity and accepts all workers with a wage demand not greater than their value to the firm. Thus, the firm sets $\bar{w}_2(v_2) = v_2 = \lambda_1 v_1 + \lambda_2 \theta$.

Second-period workers maximize, given their belief $\hat{w}_2$ about the period-2 cutoff, the expected payoff $(1 - F_{\hat{w}_2}(w_{ig2}))\, w_{ig2} + F_{\hat{w}_2}(w_{ig2}) r_{ig2}$. Hence, the first-order condition with respect to w_{ig2} is given by

$$0 = -f_{\hat{w}_2}(w_{ig2}) w_{ig2} + 1 - F_{\hat{w}_2}(w_{ig2}) + f_{\hat{w}_2}(w_{ig2}) r_{ig2}$$

which is equivalent to $(w_{ig2} - r_{ig2})\, f_{\hat{w}_2}(w_{ig2}) = 1 - F_{\hat{w}_2}(w_{ig2})$. It holds that $F_{\hat{w}_2} = F_{\tilde{V}_2} \circ \hat{w}_2^{-1}$ and $\tilde{V}_2 = \lambda_1 \tilde{v}_1 + \lambda_2 \Theta$. Hence, we obtain $F_{\hat{w}_2}(x) = F_\Theta\left(\frac{\hat{w}_2^{-1}(x) - \lambda_1 \tilde{v}_1}{\lambda_2}\right)$ and $f_{\hat{w}_2}(x) = f_\Theta\left(\frac{\hat{w}_2^{-1}(x) - \lambda_1 \tilde{v}_1}{\lambda_2}\right) \frac{1}{\lambda_2 \hat{w}_2'(\hat{w}_2^{-1}(x))}$. The first-order condition is then given by

$$(w_{ig2} - r_{ig2})\, f_\Theta\left(\frac{\hat{w}_2^{-1}(w_{ig2}) - \lambda_1 \tilde{v}_1}{\lambda_2}\right) \frac{1}{\lambda_2 \hat{w}_2'(\hat{w}_2^{-1}(w_{ig2}))} = 1 - F_\Theta\left(\frac{\hat{w}_2^{-1}(w_{ig2}) - \lambda_1 \tilde{v}_1}{\lambda_2}\right).$$

In the first period, the firm chooses the cutoff $\bar{w}_1$ to maximize its total (expected) profit

Π across both periods. Hence, its objective function is

$$\begin{aligned}\Pi(\bar{w}_1, v_1) &= \pi_1(\bar{w}_1, v_1) + \delta\mathbb{E}[\pi_2(\bar{w}_2, \lambda_1 v_1 + \lambda_2\Theta)] \\ &= n_1 \int^{w_1^{-1}(\bar{w}_1)} v_1 - w_1(r)\, dF_{r_1}(r) + \delta\mathbb{E}\left[n_2 \int^{\tilde{w}_2^{-1}(\bar{w}_2)} \lambda_1 v_1 + \lambda_2\Theta - \tilde{w}_2(r)\, dF_{r_2}(r)\right] \\ &= n_1 \int^{w_1^{-1}(\bar{w}_1)} v_1 - w_1(r)\, dF_{r_1}(r) \\ &\quad + \delta \int n_2 \int^{\tilde{w}_2^{-1}(\bar{w}_2)} \lambda_1 v_1 + \lambda_2\theta - \tilde{w}_2(r)\, dF_{r_2}(r)\, dF_\Theta(\theta).\end{aligned}$$

Note that, since π_2 depends on the firm's belief about $\tilde{w}_2$, the second-period workers' wage demand, it also implicitly depends on those workers' beliefs $\tilde{v}_1$ about the first-period productivity which is influenced by the firm's choice of $\bar{w}_1$. Hence, the first-order condition with respect to $\bar{w}_1$ is given by

$$\begin{aligned}0 &= n_1 \frac{d}{d\bar{w}_1} w_1^{-1}(\bar{w}_1)\left(v_1 - w_1(w_1^{-1}(\bar{w}_1))\right) f_{r_1}(w_1^{-1}(\bar{w}_1)) \\ &\quad + \delta n_2 \int \frac{d}{d\bar{w}_1} \tilde{w}_2^{-1}(\bar{w}_2)\left(\lambda_1 v_1 + \lambda_2\theta - \tilde{w}_2(\tilde{w}_2^{-1}(\bar{w}_2))\right) f_{r_2}(\tilde{w}_2^{-1}(\bar{w}_2))\, dF_\Theta(\theta) \\ &\quad + \delta n_2 \int \int^{\tilde{w}_2^{-1}(\bar{w}_2)} -\frac{d}{d\bar{w}_1}\tilde{w}_2(r) f_{r_2}(r) dr\, dF_\Theta(\theta) \\ &= \frac{n_1}{w_1'(w_1^{-1}(\bar{w}_1))}\left(v_1 - \bar{w}_1\right) f_{r_1}(w_1^{-1}(\bar{w}_1)) \\ &\quad + \delta n_2 \int \frac{\partial}{\partial \tilde{v}_1} \tilde{w}_2^{-1}(\bar{w}_2) \tilde{v}_1'(\bar{w}_1)\left(\lambda_1 v_1 + \lambda_2\theta - \bar{w}_2\right) f_{r_2}(\tilde{w}_2^{-1}(\bar{w}_2))\, dF_\Theta(\theta) \\ &\quad - \delta n_2 \int \int^{\tilde{w}_2^{-1}(\bar{w}_2)} \frac{\partial \tilde{w}_2}{\partial \tilde{v}_1}(r) \tilde{v}_1'(\bar{w}_1) f_{r_2}(r) dr\, dF_\Theta(\theta).\end{aligned}$$

Observe that, since $\bar{w}_2(v_2) = v_2 = \lambda_1 v_1 + \lambda_2\theta$, the second term vanishes, and thus, after some rearrangement, the first-order condition reduces to

$$n_1\left(v_1 - \bar{w}_1\right) \frac{f_{r_1}(w_1^{-1}(\bar{w}_1))}{w_1'(w_1^{-1}(\bar{w}_1))} = \delta n_2 \tilde{v}_1'(\bar{w}_1) \int \int^{\tilde{w}_2^{-1}(\bar{w}_2)} \frac{\partial \tilde{w}_2}{\partial \tilde{v}_1}(r) f_{r_2}(r) dr\, dF_\Theta(\theta).$$

Since $f_{w_1}(x) = F'_{w_1}(x) = f_{r_1}(w_1^{-1}(x))/w_1'(w_1^{-1}(x))$, this can be rewritten as

$$n_1 (v_1 - \bar{w}_1) f_{w_1}(\bar{w}_1) = \delta n_2 \tilde{v}_1'(\bar{w}_1) \int \int^{\tilde{w}_2^{-1}(\bar{w}_2)} \frac{\partial \tilde{w}_2}{\partial \tilde{v}_1}(r) f_{r_2}(r) dr \, dF_\Theta(\theta).$$

First-period workers maximize their expected payoff $(1 - F_{\hat{w}_1}(w_{ig1})) w_{ig1} + F_{\hat{w}_1}(w_{ig1}) r_{ig1}$. Hence, the first-order condition with respect to w_{ig1} is given by

$$0 = -f_{\hat{w}_1}(w_{ig1}) w_{ig1} + 1 - F_{\hat{w}_1}(w_{ig1}) + f_{\hat{w}_1}(w_{ig1}) r_{ig1}$$

which is equivalent to $(w_{ig1} - r_{ig1}) f_{\hat{w}_1}(w_{ig1}) = 1 - F_{\hat{w}_1}(w_{ig1})$.

In equilibrium, beliefs are correct. Thus, for all $t \in \{1, 2\}$, it holds $\hat{w}_t = \bar{w}_t$ and $\tilde{w}_t = w_t$. The result then follows by invoking Proposition 3. □

Proof of Proposition 5. In Proposition 4, we have shown that for any equilibrium cutoff $\bar{w}_1$ it holds that

$$n_1 (v_1 - \bar{w}_1(v_1)) f_{w_1}(\bar{w}_1(v_1)) = \frac{\delta n_2}{\bar{w}_1'(v_1)} \int \int^{w_2^{-1}(\lambda_1 v_1 + \lambda_2 \theta)} \left. \frac{\partial w_2}{\partial \tilde{v}_1} \right|_{\tilde{v}_1 = v_1} (r) dF_{r_2}(r) dF_\Theta(\theta). \quad (30)$$

By Lemma 1, since the hazard rate h_Θ is non-constant, the right-hand side of equation (30) is non-zero if the intersection $\{w_2^{-1}(\lambda_1 v_1 + \lambda_2 \theta) : \theta \in supp(f_\Theta)\} \cap supp(f_{r_2})$ is of positive (Lebesgue) measure. This is ensured by noting that

$$w_2(\underline{r}_2) = w_2^{\min} < \lambda_1 v_1 + \lambda_2 \theta < w_2^{\max} = w_2(\bar{r}_2)$$

is equivalent to $\underline{r}_2 < w_2^{-1}(\lambda_1 v_1 + \lambda_2 \theta) < \bar{r}_2$. Furthermore, by the assumption that the second-period workers observe an indicator, it holds that $f_{w_1} \circ \bar{w}_1 > 0$, and thus the left-hand side is non-zero if and only if $\bar{w}_1(v_1) \neq v_1$. The result follows by the observation that the right-hand side of equation (30) is continuous in the first-period productivity. □

Proof of Lemma 1. In period 2, workers form a belief regarding v_1, denoted by $\tilde{v}_1$. Hence, their belief about V_2 is given by $\tilde{V}_2 = \lambda_1 \tilde{v}_1 + \lambda_2 \Theta$. As shown in the proof of Proposition 4, the first-order condition to the second-period workers' maximization problem can be stated as

$$w_{ig2} = r_{ig2} + \lambda_2 \frac{1 - F_\Theta\left(\frac{w_{ig2} - \lambda_1 \tilde{v}_1}{\lambda_2}\right)}{f_\Theta\left(\frac{w_{ig2} - \lambda_1 \tilde{v}_1}{\lambda_2}\right)} = r_{ig2} + \frac{\lambda_2}{h_\Theta\left(\frac{w_{ig2} - \lambda_1 \tilde{v}_1}{\lambda_2}\right)},$$

where h_Θ denotes the hazard rate corresponding to Θ. Applying the implicit function theorem yields

$$\frac{\partial w_{ig2}}{\partial \tilde{v}_1} = -\frac{\frac{\lambda_2 h'_\Theta\left(\frac{w_{ig2} - \lambda_1 \tilde{v}_1}{\lambda_2}\right)\left(-\frac{\lambda_1}{\lambda_2}\right)}{\left(h_\Theta\left(\frac{w_{ig2} - \lambda_1 \tilde{v}_1}{\lambda_2}\right)\right)^2}}{1 + \frac{\lambda_2 h'_\Theta\left(\frac{w_{ig2} - \lambda_1 \tilde{v}_1}{\lambda_2}\right)\frac{1}{\lambda_2}}{\left(h_\Theta\left(\frac{w_{ig2} - \lambda_1 \tilde{v}_1}{\lambda_2}\right)\right)^2}} = \frac{\lambda_1 h'_\Theta\left(\frac{w_{ig2} - \lambda_1 \tilde{v}_1}{\lambda_2}\right)}{\left(h_\Theta\left(\frac{w_{ig2} - \lambda_1 \tilde{v}_1}{\lambda_2}\right)\right)^2 + h'_\Theta\left(\frac{w_{ig2} - \lambda_1 \tilde{v}_1}{\lambda_2}\right)}.$$

Since, by assumption, $\left(h_\Theta\left(\frac{w_{ig2} - \lambda_1 \tilde{v}_1}{\lambda_2}\right)\right)^2 + h'_\Theta\left(\frac{w_{ig2} - \lambda_1 \tilde{v}_1}{\lambda_2}\right) > 0$, the sign of $\frac{dw_{ig2}}{d\tilde{v}_1}$ thus equals the sign of the numerator $\lambda_1 h'_\Theta\left(\frac{w_{ig2} - \lambda_1 \tilde{v}_1}{\lambda_2}\right)$. □

Proof of Proposition 6. The proof goes by similar arguments to the proof of Proposition 5. Again, note that in Proposition 4 we have shown that for any equilibrium cutoff $\bar{w}_1$ it holds that

$$n_1\left(v_1 - \bar{w}_1(v_1)\right) f_{w_1}(\bar{w}_1(v_1)) = \frac{\delta n_2}{\bar{w}'_1(v_1)} \int \int^{w_2^{-1}(\lambda_1 v_1 + \lambda_2 \theta)} \left.\frac{\partial w_2}{\partial \tilde{v}_1}\right|_{\tilde{v}_1 = v_1} (r) dF_{r_2}(r) dF_\Theta(\theta). \quad (31)$$

If the hazard rate h_Θ is increasing (decreasing), by Lemma 1, the right-hand side of equation (31) then is positive (negative) if the intersection $\{w_2^{-1}(\lambda_1 v_1 + \lambda_2 \theta) : \theta \in supp(f_\Theta)\} \cap supp(f_{r_2})$ is of positive (Lebesgue) measure. This is ensured by noting that

$$w_2(\underline{r}_2) = w_2^{\min} < \lambda_1 v_1 + \lambda_2 \theta < w_2^{\max} = w_2(\bar{r}_2)$$

is equivalent to $\underline{r}_2 < w_2^{-1}(\lambda_1 v_1 + \lambda_2 \theta) < \bar{r}_2$. Furthermore, by the assumption that the second-period workers observe an indicator, it holds that $f_{w_1} \circ \bar{w}_1 > 0$, and thus the left-hand-side of equation (31) is positive (negative) if and only if $\bar{w}_1(v_1) < (>) v_1$. If the hazard rate h_Θ is constant, by Lemma 1, the right-hand side of equation (31) vanishes, and since $f_{w_1} \circ \bar{w}_1 > 0$, almost everywhere we obtain $\bar{w}_1(v_1) = v_1$. $\square$

Proof of Proposition 7. Recall that the expected equilibrium payoff of worker i_{gt} is given by

$$\begin{aligned} U_{igt}(w_{igt}, r_{igt}) &= \mathbb{P}[w_{igt} \leq \bar{w}_t(V_t)] w_{igt} + \mathbb{P}[w_{igt} > \bar{w}_t(V_t)] r_{igt} \\ &= \left(1 - F_{\bar{w}_t}(w_{igt})\right) w_{igt} + F_{\bar{w}_t}(w_{igt}) r_{igt}. \end{aligned}$$

Denote the expected payoff in the model with and without the indicator by U_{igt}^{tr} and U_{igt}, respectively. By Proposition 1, in the baseline model it holds that $\bar{w}_1(v_1) = v_1$, and therefore

$$\begin{aligned} & U_{ig1}^{tr}(w_{ig1}, r_{ig1}) - U_{ig1}(w_{ig1}, r_{ig1}) \\ & = \left(1 - F_{\bar{w}_1}(w_{ig1})\right) w_{ig1} + F_{\bar{w}_1}(w_{ig1}) r_{ig1} - \left(\left(1 - F_{V_1}(w_{ig1})\right) w_{ig1} + F_{V_1}(w_{ig1}) r_{ig1}\right) \\ & = \left(F_{V_1}(w_{ig1}) - F_{\bar{w}_1}(w_{ig1})\right)\left(w_{ig1} - r_{ig1}\right) \end{aligned}$$

is negative (positive) for all $w_{ig1} > r_{ig1}$ if and only if $F_{V_1}(w_{ig1}) - F_{\bar{w}_1}(w_{ig1})$ is negative (positive). By Proposition 6, we have $\bar{w}_1(v_1) \leq v_1$ and $\bar{w}_1(v_1) \geq v_1$ for all v_1 with strict inequality for some v_1 if the hazard rate h_Θ is increasing and decreasing, respectively. By Theorem 1.A.17 in Shaked and Shanthikumar (2007), it follows that V_1 dominates (is dominated by) $\bar{w}_1(V_1)$ in the usual stochastic order, and therefore $F_{V_1}(w_{ig1}) - F_{\bar{w}_1}(w_{ig1})$ is negative (positive) for all $w_{ig1} > r_{ig1}$ if h_Θ is increasing (decreasing).

For some r_{ig1} denote by w_{ig1} and w_{ig1}^{tr} the optimal wage demand in the baseline model and the model with a transparency rule, respectively. Then, it must hold that $U_{ig1}(w_{ig1}, r_{ig1}) \geq U_{ig1}(w_{ig1}^{tr}, r_{ig1})$ and $U_{ig1}^{tr}(w_{ig1}^{tr}, r_{ig1}) \geq U_{ig1}^{tr}(w_{ig1}, r_{ig1})$. If $w_{ig1}, w_{ig1}^{tr} > r_{ig1}$ and the hazard rate h_Θ is increasing, we thus obtain $U_{ig1}(w_{ig1}, r_{ig1}) \geq U_{ig1}(w_{ig1}^{tr}, r_{ig1}) \geq U_{ig1}^{tr}(w_{ig1}^{tr}, r_{ig1})$ and, if the hazard rate is decreasing, we obtain $U_{ig1}^{tr}(w_{ig1}^{tr}, r_{ig1}) \geq U_{ig1}^{tr}(w_{ig1}, r_{ig1}) \geq U_{ig1}(w_{ig1}, r_{ig1})$. This concludes the proof. $\square$

Proof of Proposition 8. Denote the second-period workers' belief about the period-2 productivity by $\tilde{V}_2$ and $\tilde{V}_2^{tr}$ in case of the baseline model and the model with a transparency rule, respectively. Further, denote the corresponding equilibrium wage demands by w_{ig2} and w^{tr}. Then, since in equilibrium $\bar{w}_2(v_2) = v_2$, for all r_{ig2} it holds that

$$\begin{aligned} w_{ig2} &\in \operatorname{argmax}_{w_{ig2}} \left\{ \mathbb{P}[w_{ig2} \leq \tilde{V}_2] w_{igt} + \mathbb{P}[w_{ig2} > \tilde{V}_2] r_{ig2} \right\} \\ w_{ig2}^{tr} &\in \operatorname{argmax}_{w_{ig2}^{tr}} \left\{ \mathbb{P}[w_{ig2}^{tr} \leq \tilde{V}_2^{tr}] w_{igt}^{tr} + \mathbb{P}[w_{ig2}^{tr} > \tilde{V}_2^{tr}] r_{ig2} \right\}. \end{aligned} \tag{32}$$

Suppose now that $V_1 = v_1$. Then the second-period workers' payoff in the baseline model is given by

$$U_2(w_{ig2}, r_{ig2}, v_1) = \left(1 - F_{V_2|V_1=v_1}(w_{ig2})\right) w_{ig2} + F_{V_2|V_1=v_1}(w_{ig2}) r_{ig2},$$

while in the model with transparency it is given by

$$U_2(w_{ig2}^{tr}, r_{ig2}, v_1) = \left(1 - F_{V_2|V_1=v_1}(w_{ig2}^{tr})\right) w_{ig2}^{tr} + F_{V_2|V_1=v_1}(w_{ig2}^{tr}) r_{ig2}.$$

Since in the model with a transparency rule second-period workers learn the first-period productivity perfectly, it holds that $\tilde{V}_2 = V_2 = \lambda_1 V_1 + \lambda_2 V_2 \sim F_{V_2}$ and $\tilde{V}_2^{tr} = (V_2 | V_1 = v_1) = \lambda_1 v_1 + \lambda_2 \Theta \sim F_{V_2|V_1=v_1}$. By (32), it therefore follows that $U_2(w_{ig2}, r_{ig2}, v_1) \leq U_2(w_{ig2}^{tr}, r_{ig2}, v_1)$ for all $r_{ig1} \in supp(f_{r_{ig1}})$. Hence, for all $v_1 \in supp(f_{V_1})$, the expected payoff of every second-period worker increases due to the transparency rule.

Furthermore, it can immediately be seen that the average expected payoff (across all types of firms) also increases due to the transparency rule, that is, it holds that

$$\int U_2(w_{ig2}, r_{ig2}, v_1) dF_{V_1}(v_1) \leq \int U_2(w_{ig2}^{tr}, r_{ig2}, v_1) dF_{V_1}(v_1).$$

This concludes the proof. □

Proof of Proposition 10. First, consider the third period. Since the third period is the last period, the firm has no incentive to shade its productivity and accepts all workers with a wage demand not greater than their value to the firm. Thus, the firm sets $\bar{w}_3(v_3) = v_3 = v_2 + \lambda_3\theta_3$.

Period-3 workers maximize, given their belief $\hat{w}_3$ about the period-3 cutoff, the expected payoff $(1 - F_{\hat{w}_3}(w_{ig3}))\, w_{ig3} + F_{\hat{w}_3}(w_{ig3}) r_{ig3}$. Hence, the first-order condition with respect to w_{ig3} is given by

$$0 = -f_{\hat{w}_3}(w_{ig3}) w_{ig3} + 1 - F_{\hat{w}_3}(w_{ig3}) + f_{\hat{w}_3}(w_{ig3}) r_{ig3}$$

which is equivalent to $(w_{ig3} - r_{ig3})\, f_{\hat{w}_3}(w_{ig3}) = 1 - F_{\hat{w}_3}(w_{ig3})$. It holds that $F_{\hat{w}_3} = F_{\tilde{V}_3} \circ \hat{w}_3^{-1}$ and $\tilde{V}_3 = \tilde{v}_2 + \lambda_3\Theta_3$. Hence, we obtain

$$F_{\hat{w}_3}(x) = F_\Theta\left(\frac{\hat{w}_3^{-1}(x) - \tilde{v}_2}{\lambda_3}\right)$$

and

$$f_{\hat{w}_3}(x) = f_\Theta\left(\frac{\hat{w}_3^{-1}(x) - \tilde{v}_2}{\lambda_3}\right)\frac{1}{\lambda_3 \hat{w}_3'(\hat{w}_3^{-1}(x))}.$$

The first-order condition is then given by

$$(w_{ig3} - r_{ig3})\, f_\Theta\left(\frac{\hat{w}_3^{-1}(w_{ig3}) - \tilde{v}_2}{\lambda_3}\right)\frac{1}{\lambda_3 \hat{w}_3'(\hat{w}_3^{-1}(w_{ig3}))} = 1 - F_\Theta\left(\frac{\hat{w}_3^{-1}(w_{ig3}) - \tilde{v}_2}{\lambda_3}\right).$$

In the second period, the firm chooses the cutoff $\bar{w}_2$ to maximize its total (expected) profit Π_2 across the current and all future periods, that is, across periods 2 and 3. Hence, its objective function is

$$\begin{aligned}
\Pi_2(\bar{w}_2, v_2) &= \pi_2(\bar{w}_2, v_2) + \delta\mathbb{E}[\pi_3(\bar{w}_3, v_2 + \lambda_3\Theta_3)] \\
&= n_2 \int^{w_2^{-1}(\bar{w}_2)} v_2 - w_2(r)\, dF_{r_2}(r) + \delta\mathbb{E}\left[n_3 \int^{\tilde{w}_3^{-1}(\bar{w}_3)} v_2 + \lambda_3\Theta_3 - \tilde{w}_3(r)\, dF_{r_3}(r)\right] \\
&= n_2 \int^{w_2^{-1}(\bar{w}_2)} v_2 - w_2(r)\, dF_{r_2}(r) \\
&\quad + \delta \int n_3 \int^{\tilde{w}_3^{-1}(\bar{w}_3)} v_2 + \lambda_3\theta_3 - \tilde{w}_3(r)\, dF_{r_3}(r)\, dF_\Theta(\theta_3).
\end{aligned}$$

Note that, since π_3 depends on the firm's belief about w_3, the third-period workers' wage demand, it also implicitly depends on those workers' beliefs $\tilde{v}_2$ about the second-period productivity which is influenced by the firm's choice of $\bar{w}_2$. Hence, the first-order condition with respect to $\bar{w}_2$ is given by

$$\begin{aligned}
0 &= n_2 \frac{d}{d\bar{w}_2} w_2^{-1}(\bar{w}_2) \left(v_2 - w_2(w_2^{-1}(\bar{w}_2)\right) f_{r_2}(w_2^{-1}(\bar{w}_2)) \\
&\quad + \delta n_3 \int \frac{d}{d\bar{w}_2} \tilde{w}_3^{-1}(\bar{w}_3) \left(v_2 + \lambda_3\theta_3 - \tilde{w}_3(\tilde{w}_3^{-1}(\bar{w}_3))\right) f_{r_3}(\tilde{w}_3^{-1}(\bar{w}_3))\, dF_\Theta(\theta_3) \\
&\quad + \delta \int n_3 \int^{\tilde{w}_3^{-1}(\bar{w}_3)} -\frac{d}{d\bar{w}_2} \tilde{w}_3(r) f_{r_3}(r) dr\, dF_\Theta(\theta_3) \\
&= \frac{n_2}{w_2'(w_2^{-1}(\bar{w}_2))} \left(v_2 - \bar{w}_2\right) f_{r_2}(w_2^{-1}(\bar{w}_2)) \\
&\quad + \delta n_3 \int \frac{\partial \tilde{w}_3^{-1}}{\partial \tilde{v}_2}(\bar{w}_3) \tilde{v}_2'(\bar{w}_2) \left(v_2 + \lambda_3\theta_3 - \bar{w}_3\right) f_{r_3}(\tilde{w}_3^{-1}(\bar{w}_3))\, dF_\Theta(\theta_3) \\
&\quad - \delta \int n_3 \int^{\tilde{w}_3^{-1}(\bar{w}_3)} \frac{\partial \tilde{w}_3}{\partial \tilde{v}_2}(r) \tilde{v}_2'(\bar{w}_2) f_{r_3}(r) dr\, dF_\Theta(\theta_3).
\end{aligned}$$

Observe that, since $\bar{w}_3(v_3) = v_3 = v_2 + \lambda_3\theta_3$, the second term vanishes, and thus, after some rearrangement, the first-order condition reduces to

$$n_2 \left(v_2 - \bar{w}_2\right) \frac{f_{r_2}(w_2^{-1}(\bar{w}_2))}{w_2'(w_2^{-1}(\bar{w}_2))} = \delta n_3 \tilde{v}_2'(\bar{w}_2) \int \int^{\tilde{w}_3^{-1}(\bar{w}_3)} \frac{\partial \tilde{w}_3}{\partial \tilde{v}_2}(r) f_{r_3}(r) dr\, dF_\Theta(\theta_3).$$

Since $f_{w_2}(x) = F_{w_2}'(x) = f_{r_2}(w_2^{-1}(x))/w_2'(w_2^{-1}(x))$, this can be rewritten as

$$n_2 \left(v_2 - \bar{w}_2\right) f_{w_2}(\bar{w}_2) = \delta n_3 \tilde{v}_2'(\bar{w}_2) \int \int^{\tilde{w}_3^{-1}(\bar{w}_3)} \frac{\partial \tilde{w}_3}{\partial \tilde{v}_2}(r) f_{r_3}(r) dr\, dF_\Theta(\theta_3).$$

Second-period workers maximize their expected payoff $\left(1 - F_{\hat{w}_2}(w_{ig2})\right) w_{ig2} + F_{\hat{w}_2}(w_{ig2}) r_{ig2}$. Hence, the first-order condition with respect to w_{ig2} is given by

$$0 = -f_{\hat{w}_2}(w_{ig2}) w_{ig2} + 1 - F_{\hat{w}_2}(w_{ig2}) + f_{\hat{w}_2}(w_{ig2}) r_{ig2}$$

which is equivalent to $\left(w_{ig2} - r_{ig2}\right) f_{\hat{w}_2}(w_{ig2}) = 1 - F_{\hat{w}_2}(w_{ig2})$.

In the first period, the firm chooses the cutoff $\bar{w}_1$ to maximize its total (expected) profit Π_1 across the current and all future periods, that is, across periods 1, 2, and 3. Hence, its objective function is

$$\begin{aligned}
\Pi_1(\bar{w}_1, v_1) &= \pi_1(\bar{w}_1, v_1) + \delta\mathbb{E}[\pi_2(\bar{w}_2, v_1 + \lambda_2\Theta_2)] + \delta^2\mathbb{E}[\pi_3(\bar{w}_3, V_2 + \lambda_3\Theta_3)|V_1 = v_1] \\
&= n_1 \int^{w_1^{-1}(\bar{w}_1)} v_1 - w_1(r)\, dF_{r_1}(r) \\
&\quad + \delta\mathbb{E}\left[n_2 \int^{\tilde{w}_2^{-1}(\bar{w}_2)} v_1 + \lambda_2\Theta_2 - \tilde{w}_2(r)\, dF_{r_2}(r)\right] \\
&\quad + \delta^2\mathbb{E}\left[n_3 \int^{\tilde{w}_3^{-1}(\bar{w}_3)} V_2 + \lambda_3\Theta_3 - \tilde{w}_3(r)\, dF_{r_3}(r) \,\middle|\, V_1 = v_1\right] \\
&= n_1 \int^{w_1^{-1}(\bar{w}_1)} v_1 - w_1(r)\, dF_{r_1}(r) \\
&\quad + \delta \int n_2 \int^{\tilde{w}_2^{-1}(\bar{w}_2)} v_1 + \lambda_2\theta_2 - \tilde{w}_2(r)\, dF_{r_2}(r)\, dF_\Theta(\theta_2) \\
&\quad + \delta^2 \int\int n_3 \int^{\tilde{w}_3^{-1}(\bar{w}_3)} (v_1 + \lambda_2\theta_2 + \lambda_3\theta_3 - \tilde{w}_3(r))\, dF_{r_3}(r)\, dF_\Theta(\theta_2)\, dF_\Theta(\theta_3).
\end{aligned}$$

Again, since π_2 depends on the firm's belief about w_2, the second-period workers' wage demand, it also implicitly depends on those workers' beliefs $\tilde{v}_1$ about the first-period productivity which is influenced by the firm's choice of $\bar{w}_1$. Additionally, π_3 depends on the firm's belief about w_3 and therefore also on the period-3 workers' beliefs $\tilde{v}_1$ about the first-period productivity. Hence, the first-order condition with respect to $\bar{w}_1$ is given by

$$
\begin{aligned}
0 &= n_1 \frac{d}{d\bar{w}_1} w_1^{-1}(\bar{w}_1) \left(v_1 - w_1(w_1^{-1}(\bar{w}_1)\right) f_{r_1}(w_1^{-1}(\bar{w}_1)) \\
&+ \delta n_2 \int \frac{d}{d\bar{w}_1} \tilde{w}_2^{-1}(\bar{w}_2) \left(v_1 + \lambda_2\theta_2 - \tilde{w}_2(\tilde{w}_2^{-1}(\bar{w}_2))\right) f_{r_2}(\tilde{w}_2^{-1}(\bar{w}_2))\, dF_\Theta(\theta_2) \\
&+ \delta n_2 \int \int^{\tilde{w}_2^{-1}(\bar{w}_2)} -\frac{d}{d\bar{w}_1} \tilde{w}_2(r) f_{r_2}(r) dr\, dF_\Theta(\theta_2) \\
&+ \delta^2 n_3 \int \int \frac{d}{d\bar{w}_1} \tilde{w}_3^{-1}(\bar{w}_3) \left(v_1 + \lambda_2\theta_2 + \lambda_3\theta_3 - \tilde{w}_3(\tilde{w}_3^{-1}(\bar{w}_3))\right) f_{r_3}(\tilde{w}_3^{-1}(\bar{w}_3))\, dF_\Theta(\theta_2)\, dF_\Theta(\theta_3) \\
&+ \delta^2 n_3 \int \int \int^{\tilde{w}_3^{-1}(\bar{w}_3)} -\frac{d}{d\bar{w}_1} \tilde{w}_3(r) f_{r_3}(r) dr\, dF_\Theta(\theta_2)\, dF_\Theta(\theta_3) \\
&= \frac{n_1}{w_1'(w_1^{-1}(\bar{w}_1))} (v_1 - \bar{w}_1)\, f_{r_1}(w_1^{-1}(\bar{w}_1)) \\
&+ \delta n_2 \int \frac{\partial \tilde{w}_2^{-1}}{\partial \tilde{v}_1}(\bar{w}_2) \tilde{v}_1'(\bar{w}_1)\, (v_1 + \lambda_2\theta_2 - \bar{w}_2)\, f_{r_2}(\tilde{w}_2^{-1}(\bar{w}_2))\, dF_\Theta(\theta_2) \\
&- \delta n_2 \int \int^{\tilde{w}_2^{-1}(\bar{w}_2)} \frac{\partial \tilde{w}_2}{\partial \tilde{v}_1}(r) \tilde{v}_1'(\bar{w}_1) f_{r_2}(r) dr\, dF_\Theta(\theta_2) \\
&+ \delta^2 n_3 \int \int \frac{\partial \tilde{w}_3^{-1}}{\partial \tilde{v}_2}(\bar{w}_3) \tilde{v}_2'(\bar{w}_1)\, (v_1 + \lambda_2\theta_2 + \lambda_3\theta_3 - \bar{w}_3))\, f_{r_3}(\tilde{w}_3^{-1}(\bar{w}_3))\, dF_\Theta(\theta_2)\, dF_\Theta(\theta_3) \\
&- \delta^2 n_3 \int \int \int^{\tilde{w}_3^{-1}(\bar{w}_3)} \frac{\partial \tilde{w}_3}{\partial \tilde{v}_2}(r) \tilde{v}_2'(\bar{w}_1) f_{r_3}(r) dr\, dF_\Theta(\theta_2)\, dF_\Theta(\theta_3)
\end{aligned}
$$

Note that, since $\bar{w}_3(v_3) = v_3 = v_2 + \lambda_3\theta_3$, the second-to-last term vanishes, and thus, after some rearrangement, the first-order condition becomes

$$
\begin{aligned}
& n_1 (\bar{w}_1 - v_1) \frac{f_{r_1}(w_1^{-1}(\bar{w}_1))}{w_1'(w_1^{-1}(\bar{w}_1))} \\
&\quad = \delta n_2 \int \frac{\partial \tilde{w}_2^{-1}}{\partial \tilde{v}_1}(\bar{w}_2) \tilde{v}_1'(\bar{w}_1)\, (v_1 + \lambda_2\theta_2 - \bar{w}_2)\, f_{r_2}(\tilde{w}_2^{-1}(\bar{w}_2))\, dF_\Theta(\theta_2) \\
&\qquad - \delta n_2 \int \int^{\tilde{w}_2^{-1}(\bar{w}_2)} \frac{\partial \tilde{w}_2}{\partial \tilde{v}_1}(r) \tilde{v}_1'(\bar{w}_1) f_{r_2}(r) dr\, dF_\Theta(\theta_2) \\
&\qquad - \delta^2 n_3 \int \int \int^{\tilde{w}_3^{-1}(\bar{w}_3)} \frac{\partial \tilde{w}_3}{\partial \tilde{v}_2}(r) \tilde{v}_2'(\bar{w}_1) f_{r_3}(r) dr\, dF_\Theta(\theta_2)\, dF_\Theta(\theta_3).
\end{aligned}
$$

Analogously to the second period, it holds that $f_{w_1}(x) = F_{w_1}'(x) = f_{r_1}(w_1^{-1}(x))/w_1'(w_1^{-1}(x))$.

First-period workers maximize their expected payoff $(1 - F_{\hat{w}_1}(w_{ig1}))\, w_{ig1} + F_{\hat{w}_1}(w_{ig1}) r_{ig1}$.

Hence, the first-order condition with respect to w_{ig1} is given by

$$0 = -f_{\hat{w}_1}(w_{ig1})w_{ig1} + 1 - F_{\hat{w}_1}(w_{ig1}) + f_{\hat{w}_1}(w_{ig1})r_{ig1}$$

which is equivalent to $(w_{ig1} - r_{ig1})\, f_{\hat{w}_1}(w_{ig1}) = 1 - F_{\hat{w}_1}(w_{ig1})$.

In equilibrium, beliefs are correct. Thus, for all $t \in \{1, 2, 3\}$, it holds that $\hat{w}_t = \bar{w}_t$ and $\tilde{w}_t = w_t$. □

7.2. Examples of indicators

7.2.1. Transparency rules regarding wages

First, suppose that, at the beginning of the second period, the workers observe the mean wage

$$\mu_{w_1}(\bar{w}_1) = \frac{1}{F_{w_1}(\bar{w}_1)} \int_{w_1^{\min}}^{\bar{w}_1} x \, dF_{w_1}(x)$$

of all workers who are accepted by the firm in the first period. If $\bar{w}_1 \in (w_1^{\min}, w_1^{\max})$, it holds that

$$\mu'_{w_1}(\bar{w}_1) = -\frac{f_{w_1}(\bar{w}_1)}{F^2_{w_1}(\bar{w}_1)} \int_{w_1^{\min}}^{\bar{w}_1} x \, dF_{w_1}(x) + \frac{f_{w_1}(\bar{w}_1)}{F_{w_1}(\bar{w}_1)} \bar{w}_1 = \frac{f_{w_1}(\bar{w}_1)}{F_{w_1}(\bar{w}_1)} \left(\bar{w}_1 - \mu_{w_1}\right) > 0.$$

Hence, $X_{F_{w_1}} = \mu_{w_1}$ is strictly increasing and therefore an indicator in the sense of Proposition 3.

Second, suppose that, at the beginning of the second period, workers observe the median wage m_{w_1} of all workers who are accepted by the firm in the first period, which is given by the equation

$$\int_{w_1^{\min}}^{\mathrm{m}_{w_1}} dF_{w_1}(x) = \int_{\mathrm{m}_{w_1}}^{\bar{w}_1} dF_{w_1}(x).$$

If $\bar{w}_1 \in (w_1^{\min}, w_1^{\max})$, it holds that

$$\mathrm{m}'_{w_1}(\bar{w}_1) = \frac{f_{w_1}(\bar{w}_1)}{2 f_{w_1}(m_{w_1})}.$$

Hence, $X_{F_{w_1}} = \mathrm{m}_{w_1}$ is strictly increasing and therefore an indicator in the sense of Proposition 3.

Third, suppose that, at the beginning of the second period, the workers observe the maximum wage that is paid by the firm in the first period, which, if $\bar{w}_1 \in (w_1^{\min}, w_1^{\max})$ is simply given by the cutoff $\bar{w}_1$ and therefore $X_{F_{w_1}} = \mathrm{id}$ which is strictly increasing.

7.2.2. Transparency rules regarding firm size

Suppose that, at the beginning of the second period, the workers observe the measure m_1 of the workers who are accepted by the firm in the first period, that is, the indicator is given by $X_{F_{w_1}}(\bar{w}_1) = m_1 = n_1 \cdot F_{w_1}(\bar{w}_1)$. Since by assumption F_{r_1} and w_1 are strictly increasing, $F_{w_1} = F_{r_1} \circ w_1^{-1}$ is also strictly increasing. It is then immediate that $X_{F_{w_1}}(\bar{w}_1) = m_1$ is an indicator in the sense of Proposition 3. In case the second-period workers observe the measure of rejected workers in the first period, the result is obtained by analogous arguments.