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Batabyal, Amitrajeet and Beladi, Hamid

Rochester Institute of Technology, University of Texas at San Antonio

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by

AMITRAJEET A. BATABYAL[2]

and

HAMID BELADI[3]

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[2] Department of Economics, Rochester Institute of Technology, 92 Lomb Memorial Drive, Rochester, NY 14623-5604, USA. E-mail: aabgsh@rit.edu

[3] Department of Economics, University of Texas at San Antonio, One UTSA Circle, San Antonio, TX 78249-0631, USA. E-mail: Hamid.Beladi@utsa.edu

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Abstract

We focus on the interaction between a male employee and his supervisor and analyze a game-theoretic model of sexual harassment in the workplace. The male employee is accused of sexually harassing a female employee and the supervisor's task is to gather evidence and then determine whether to legally charge the male employee with sexual harassment. The evidence gathering process is random and concrete evidence is available to the supervisor with probability one-half. Our analysis of this strategic interaction leads to four results. First, we delineate the game in extensive form. Second, we specify the matrix that represents the normal form of the extensive form. Third, we show that there is no pure-strategy Nash equilibrium in the game between the male employee and his supervisor. Finally, we show that there exists a mixed-strategy Nash equilibrium in the same male employee-supervisor game.

Keywords: Evidence, Mixed-Strategy Nash Equilibrium, Sexual Harassment, Supervisor,

JEL Codes: J71, K42

1. Introduction

1.1. Overview

Sexual harassment in the workplace is now legally prohibited in almost fifty countries in the world (McCann 2005). In the United States, employment discrimination on the basis of race, color, religion, sex, or national origin is and has been illegal since the passage of Title VII of the United States Civil Rights Act of 1964. In this regard, Basu (2003) tells us that the Equal Employment Opportunity Commission (EEOC) was created in 1965 to administer and enforce this statute. The straightforward implication of this course of action is that it is illegal to engage in *any* kind of sexual harassment in the workplace in the United States. In the United Kingdom, sexual harassment has been considered to be one kind of unlawful discrimination and its proscription has been codified in section 4A of the Sex Discrimination Act of 1975 (Pina *et al.* 2009). In Australia, sexual harassment is covered by the federal Sex Discrimination Act of 1984 and by a variety of state level anti-discrimination laws (McDonald 2012).

The salience and the extent of sexual harassment in the United States was recently highlighted in a riveting article in the 5 October 2017 edition of the *New York Times* by Jodi Kantor and Megan Twohey. In this article, Ms. Kantor and Ms. Twohey pointed out that the prominent Hollywood producer Harvey Weinstein had paid off a number of women who had, over the years, accused him of sexually harassing them. This article has now led to many other stories in the print and broadcast media that have collectively made people aware of the fact that sexual harassment in the workplace is apparently rampant. With this increased awareness has come a series of resignations or firings of prominent media personalities such as Matt Lauer, formerly of NBC News, Bill O'Reilly, formerly of Fox News, Charlie Rose, formerly of the Charlie Rose show, and Tavis Smiley, formerly of the Tavis Smiley show on PBS.

Given the legal and now obvious public significance of the topic of sexual harassment in the workplace, it is of considerable interest to ascertain what economists and feminist scholars have written on this topic. Therefore, before stating the central research question that we wish to analyze in this paper, we first briefly review the extant literature in economics and in feminist discourse on sexual harassment in the workplace.

1.2. Review of literature

In a comparatively early paper, Basu (2003) first distinguishes between what he calls a single contract or a small number of contracts of a specific kind and a large number of contracts of the same kind. He then uses this distinction to develop a theoretical model to explain why society might want to intervene legislatively to control sexual harassment in the workplace. Browne (2006) takes an expansive view of the phenomenon of sexual harassment and argues that women's responses to the scourge of sexual harassment can be understood as reflections of the different evolved sexual psychologies of the sexes.

Antecol and Cobb-Clark (2006) focus on the United States military and conduct an econometric analysis of the relationship between sexual harassment and the job satisfaction and intended turnover of active duty women. They demonstrate that experiencing sexually harassing behavior is definitely linked to both diminished job satisfaction and to an increased desire to leave the military. Taking a cross-cultural perspective on the problem. Luthar and Luthar (2007) show that sexual harassment by men and the tolerance of such harassment by women vary across different nations because of basic differences in cultures and values.

Hersch (2011) points out that even though sexual harassment in the workplace is illegal in the United States, many workers report that they have been harassed in this way. In addition, relative to male workers, female workers face a far higher risk of being harassed sexually. Farhang

et al. (2015) study opinion assignment and authorship on the United States Courts of Appeals. They show that female and more liberal judges are substantially more likely to write opinions in sexual harassment cases. This happens not because of some policy driven behavior by "female and liberal assigners" but instead because of an institutional environment in which judges seek out the opinions they wish to write.

Mackinnon (2016) looks at sexual harassment in schools in the United States and Title IX's guarantee of equal educational outcomes on the basis of sex. She contends that if the institutional liability standard of deliberate indifference for damages in private suits was replaced with an international human rights liability standard then power would be shifted into the hands of the survivors of sexual harassment and there would be positive change toward sex equality in education. Hersch (2018) computes what she calls a "value of statistical harassment (VSH)" and maintains that if the maximum damages awarded under federal law were increased to equal the so called VSH then this would create the right economic incentives for organizations to deter sexual harassment. Finally, the survey-based study of Goldberg *et al.* (2019) documents the ways in which an organization's tolerance of sexual harassment influences the effectiveness of the sexual harassment investigative training that is imparted to human resource managers.

Moving on to the writings of feminist scholars, many have noted that the sexual harassment phenomenon "arises from men's economic power over women, which enables them to exploit and coerce women sexually…" (McDonald 2012, p. 6). In this regard, Samuels (2003) contends that, from a feminist perspective, power is not a direct or primary force. Instead, in contemporary society, the balance of power lies with men and hence even when women are in more senior positions relative to men, they are made more vulnerable by virtue of the fact that they are women.

Feminist scholars have also pointed out that the causes and the outcomes of sexual harassment can frequently be understood in terms of three features of a workplace (Welsh 1999, McDonald 2012). These three features include workplace culture, the gendered nature of an individual's work group, and the differential power of workers. So, *inter alia*, these three features help explain why, in the face of covert or overt sexual harassment, women often stay silent in the workplace. In this regard, Cairns (1997) contends that because of patriarchal socialization in the workplace, women are often disempowered and take on the position of the "Other" relative to a male norm. As a result, women tend to accommodate notions of femininity defined by male norms. As a result of the logic in the preceding two sentences, women may either believe that their experiences are not real or that it is they who are in the wrong. In either of these two cases, the result often is the use of silence by women to either resist or to hold back and refuse to participate in the workplace.

Finally and in contrast to the perspective of Cairns (1997) that we have just discussed, Hunter (2002) and Wear *et al.* (2007) have proposed an alternate explanation for why women often stay silent in the face of sexual harassment. According to these researchers, many younger women have grown up in an age in which feminists and feminism have been delineated negatively in the media. As such, these younger women either seek to distance themselves from such negative media characterizations or think of themselves as "non-gendered subjects," in the process, disavowing both their femininity and any disadvantages flowing from this femininity.

The studies by economists and feminist scholars discussed in this section have certainly advanced our understanding of the many facets of sexual harassment in the workplace. Even so, we would now like to emphasize three points. First, consistent with an observation made in McDonald (2012), existing studies of sexual harassment in the workplace are mainly empirical or

case study based and they *rarely employ* mathematical modeling of any kind. Second and once again consistent with a suggestion in McDonald (2012), there is a need for *methodological research* on the topic of sexual harassment in the workplace. Finally, to the best of our knowledge, there is no research in either feminist economics or in feminist discourse more generally that analyzes the *game-theoretic* aspects of sexual harassment in the workplace. Given this lacuna in the literature, the principal research question that we study is the strategic interaction between a male employee who is accused of sexual harassment and his supervisor who must determine whether to legally charge this male employee with sexual harassment.[4] We undertake this exercise and in so doing, contribute to the literature by providing what we believe is the *first* formal analysis of a game-theoretic model of sexual harassment in the workplace.

To this end, in what follows, section 2 describes the game model with two distinctive features. Our motivation for using this particular model stems from our belief that the model captures the most common features of the underlying dispute resolution process in a straightforward manner. First, a male employee is accused of sexually harassing a female co-worker and the supervisor's task is to gather evidence and to then determine whether to legally charge the male employee with sexual harassment in the workplace. Second, the process of gathering evidence is *not* deterministic but probabilistic. Specifically, what this second feature means is that evidence is available to the supervisor *not* with certainty but with probability one-half. Section 3 delineates the game we study in extensive form. Section 4 specifies the matrix that represents the normal form of the extensive form described in section 3. Section 5 points out that there is no pure-strategy Nash equilibrium in the strategic interaction or game between the accused

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McDonald (2012, p. 11) notes that "[e]vidence also indicates that [sexual harassment] continues to be experienced mainly by women…" This provides the impetus for supposing that the employee who is charged with sexual harassment in our model is male. That said, we acknowledge that it is certainly possible for the person charged with sexual harassment to be female.

male employee and his supervisor. Section 6 demonstrates that there exists a mixed-strategy Nash equilibrium in the same male employee-supervisor game. Finally, section 7 concludes and then discusses an extension of our model in which the payoffs in the game under study are not zero-sum.

2. The Game Model

Consider a workplace in which a particular female employee accuses a fellow male employee of sexual harassment. The male employee's supervisor (player 1) suspects the male employee (player 2) and begins the process of gathering evidence to determine whether he will formally charge the male employee with breaking the law and engaging in sexual harassment.[5] As noted in section 1 and to keep the problem interesting, we suppose that the evidence gathering process is *probabilistic*. As such, concrete evidence will be available to the supervisor only with probability $1/2$.[6]

The accused male employee knows that his supervisor is in the midst of gathering evidence but he does *not* know whether this supervisor has gathered concrete evidence or not. The game between the supervisor and the accused male employee proceeds as follows: The supervisor realizes whether or not he has evidence, i.e., the state of the world, and on the basis of this realization he selects his action. He can either legally charge the accused male employee with sexual harassment in the workplace (Charge) or drop the charge and absolve this employee of the sexual harassment accusation (Drop).

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5 The work of Berdahl and Moore (2007) and McCabe and Hardman (2005) tells us that women are generally less accepting than men of sexual harassment in the workplace. Therefore, even though from a modeling standpoint, thinking of the supervisor as male is without loss of generality, in any given practical instance, the gender of the supervisor may affect the vigor with which a charge of sexual harassment is pursued by this supervisor.

6 If, instead of $1/2$, we picked a different numerical value, then the values of some of the payoffs to the two players being studied would change but our analysis would not change substantively. That said, in the Appendix, we discuss one way in which this particular aspect of our model might be generalized.

Once legally charged by the supervisor, the male employee has two possible actions. He can either confess to breaking the law and to sexually harassing the female employee (Confess) or he can deny the charge and maintain his innocence (Deny). As a result of this strategic interaction between the supervisor and the accused male employee, the payoffs to the two players are as follows: If the supervisor drops the sexual harassment charge and effectively frees the accused male employee then both players get 0. If the supervisor legally charges the male employee and this employee confesses to the charge then the supervisor gets $a > 0$ and the male employee gets $-a$. If the supervisor charges the male employee and this employee denies the charge and maintains his innocence then the payoffs to the two players depend on the gathered evidence. If the supervisor does *not* have concrete evidence then the accused employee is vindicated and he gets $b > 0$ but the supervisor is embarrassed and hence this supervisor gets $-b$. On the other hand, if the supervisor does have concrete evidence then he is vindicated and gets $b > 0$ and the accused male employee is fired and hence gets $-b$. Our subsequent mathematical analysis makes sense only when $b > a$ and hence we assume that this is the case in the remainder of this paper.

The reader should note the "zero-sum" nature of the payoffs arising from the strategic interaction between the supervisor and the accused male employee. What this means is that player $i's$ gain is equal to player $j's$ loss, $i \neq j$, and therefore these two payoffs always sum to zero.[7] With this background in place, our next task is to draw the game tree that represents the extensive form of the game that we have just described.

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[7] Our game-theoretic model with a zero-sum payoff structure can be used to describe many economic problems---like the sexual harassment problem---that share the following structure: a higher-ranking individual (our supervisor) must decide whether or not to formally charge a lower-ranking individual (our male employee) who has been accused of some kind of wrongdoing (sexual harassment in our case). That said, note that this "wrongdoing" can refer to many things such as embezzlement of funds, computer hacking, and spreading false and/or malicious information. Given a particular kind of wrongdoing, in principle, what will differ from model to model are the actual numerical payoffs, the probabilities with which the different states of the word arise, and the probabilities with which the different players play their strategies in a mixed-strategy Nash equilibrium.

3. The Extensive Form

In the language of game theory---see Tadelis (2013, pp. 136-137)---the game we have described in section 2 is a game of imperfect information. As is standard in the analysis of such games, we introduce a third player named "Nature" who does not receive any payoff but who moves first and randomly selects the state of the world, i.e., whether concrete evidence does or does not exist. This is shown in the topmost or first level of the game tree in Figure 1 below. We

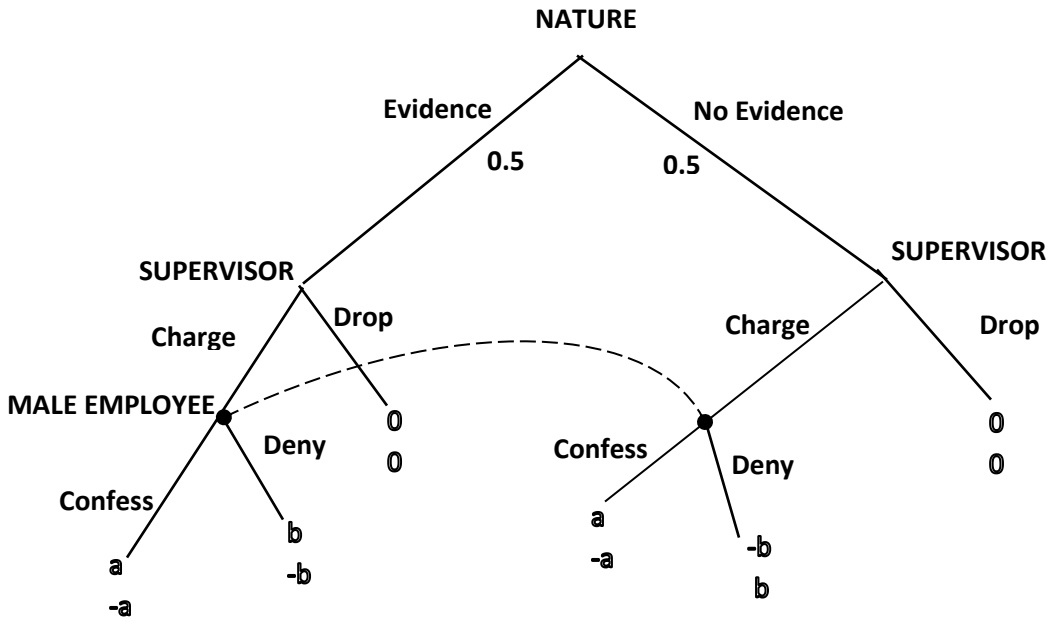

Figure 1: Extensive form of the supervisor-male employee game

notice that concrete evidence exists with probability $1/2$ and that it does not with complementary probability $1/2$. Once Nature has moved, the supervisor moves, deciding either to legally charge the male employee or to drop the charge against him. This is shown in the second level of the game tree in figure 1. Once the supervisor has moved, the accused male employee moves, acting either to confess to or to deny the legal charge made against him. This is shown in the third and lowest

level of the game tree in figure 1. The payoffs received by the two players are indicated at the bottom of the branches depicting the different contingencies that might arise in this game.

Two points about this game are now worth emphasizing. First, observe that even though the accused male employee observes the supervisor's move, he does *not* observe Nature's move. Second, as shown with the dashed line in figure 1, the male employee's information set cuts across the "branches" of the game tree. Therefore, in the game under study, there are *no* proper subgames other than the entire game itself. We now proceed to specify the matrix that represents the normal form of the extensive form that we have just described in this section.

4. The Normal Form

The supervisor acts at two information sets following Nature's choice of "Evidence" or "No Evidence." Observe that we can think of "Evidence" and "No Evidence" as the two possible states of the world. Now, in each case, this supervisor has two actions "Charge" or "Drop." This means that he has four pure-strategies. Let $xy \in \{CC, CD, DC, DD\}$ denote the strategy of player 1 (supervisor) where x follows "Evidence" and y follows "No Evidence." In contrast to player 1, player 2 (male employee) acts at only one information set and hence his strategies are simply $\{Confess, Deny\}$.

For each strategy profile, we can compute the respective payoffs as the *expected* or *mean* payoffs each player gets on the assumption that Nature is mixing half-and-half. This process gives us the following matrix

	Player 2: Male Employee		
		Confess	*Deny*
Player 1: Supervisor	CC	$a, -a$	$0, 0$
	CD	$a/2,\ -a/2$	$b/2,\ -b/2$
	DC	$a/2,\ -a/2$	$-b/2,\ b/2$
	DD	$0, 0$	$0, 0$

Table 1: The game in normal form

We now use this normal form representation to discuss whether pure-strategy Nash equilibria exist in the game that we are studying.

5. Pure-Strategy Nash Equilibria

Inspecting Table 1 carefully, we see that the supervisor has two strictly dominated strategies. In particular, DC is dominated by CC and DD is dominated by CD. Therefore, we can eliminate these two strategies and focus on the reduced game represented by the following matrix

	Player 2: Male Employee		
		$Confess$	$Deny$
Player 1: Supervisor	CC	$a, -a$	$0, 0$
	CD	$a/2,\ -a/2$	$b/2,\ -b/2$

Table 2: The reduced game in normal form

Inspecting the various strategies and the payoffs in Table 2 carefully, it is straightforward to verify that this reduced game does *not* have any pure-strategy Nash equilibria. This notwithstanding, we

now demonstrate that there exists a mixed-strategy Nash equilibrium in this supervisor-male employee game.

6. Mixed-Strategy Nash Equilibrium

Let the supervisor (player 1) choose CC (CD) with probability p $(1-p)$. Similarly, let the male employee (player 2) choose $Confess$ $(Deny)$ with probability q $(1-q)$. Now, for the male employee to be indifferent between his two pure-strategies, we must have

$$p(-a) + (1-p)(-a/2) = p(0) + (1-p)(-b/2) \quad (1)$$

Solving equation (1) for the probability p, we get

$$p = (b-a)/(a+b). \quad (2)$$

Now, for the supervisor to be indifferent between his two pure-strategies, we need

$$q(a) + (1-q)(0) = q(a/2) + (1-q)(b/2). \quad (3)$$

Solving equation (3) for the probability q, we obtain

$$q = b/(a+b). \quad (4)$$

Given the values of the two probabilities in equations (2) and (4), we deduce that a unique mixed-strategy Nash equilibrium in the supervisor-male employee game exists. In this equilibrium, the supervisor (male employee) plays his optimal strategy S_1 (S_2) and we have

$$S_1 = \left(\frac{b-a}{a+b}\right) CC + \left(\frac{2a}{a+b}\right) CD, S_2 = \left(\frac{b}{a+b}\right) Confess + \left(\frac{a}{a+b}\right) Deny. \quad (5)$$

Equation (5) tells us that when he has evidence, the only Nash equilibrium of this game is for the supervisor to legally charge the male employee $(b-a)/(a+b)$ proportion of the time and to drop the charge $2a/(a+b)$ proportion of the time. For the male employee, it is optimal to confess $b/(a+b)$ proportion of the time when he is charged.

The interpretation of equation (5) can be simplified considerably by focusing on the special case where $b = 2a$. In this case, straightforward computations show that $p = 1/3$ and that $q = 2/3$. So, in this special case, the only Nash equilibrium of this game is for the supervisor to legally charge the male employee one-third of the time and to drop the charge two-thirds of the time. For the male employee, it is optimal to confess two-thirds of the time when he is legally charged. That said, observe that because the only proper subgame is the entire game itself, the only Nash equilibrium is also a subgame perfect Nash equilibrium. Put differently, it is *not* possible to find a Nash equilibrium that is not a subgame perfect Nash equilibrium.

We now conclude this section with two observations about our analysis thus far in this paper. First, it is true that in our game-theoretic model, the structure of the payoffs to the two players arising from their strategic interaction is zero-sum. However, this feature in and of itself does *not* allow us to conclude that the only equilibria must be in mixed strategies. As shown by the work of Duersch *et al.* (2012), it is certainly possible for a finite, two-player, and zero-sum game to possess Nash equilibria in pure strategies.

Second, the insights that our game-theoretic analysis brings to the actual problem of sexual harassment in the workplace are fourfold. Specifically, our model captures (i) the fact that an accused male employee's supervisor plays a prominent role in determining whether or not to bring legal charges against the accused employee, (ii) the point that the evidence gathering process typically does not lead to the accumulation of foolproof evidence, (iii) the notion that there are strategic aspects to the optimal actions that are taken by both the supervisor and the accused male employee, and (iv) the idea that it makes sense for each of the two players to keep his rival guessing about his true intentions in the dispute resolution process. These findings are broadly consistent

with the observation in McDonald (2012, p. 8) that "the extent to which [sexual harassment] occurs is impacted by organizational characteristics…"

Finally, the preceding two points notwithstanding, our analysis in this paper does have some limitations and therefore can be improved upon. In this regard, we could (i) analyze a game model that allows for repeated interactions between the accused male employee and his supervisor as more and presumably better information becomes available, (ii) formally model the learning that occurs on the parts of both players over time about the actual events that have taken place, and (iii) alter the numerical payoffs so that they are not always zero-sum but take on other values. We now demonstrate in the last two paragraphs of section 7 below how, for example, this third point can be addressed by discussing an extension of the model that we have been analyzing thus far.

7. Conclusions

In this paper, we concentrated on the interaction between a male employee and his supervisor and analyzed a game-theoretic model of sexual harassment in the workplace. The male employee was accused of sexually harassing a female employee and the supervisor's task was to gather evidence and to then determine whether to legally charge the male employee with sexual harassment. The evidence gathering process was random and concrete evidence was available to the supervisor with probability one-half. Our analysis of this strategic interaction led to four findings. First, we delineated the game in extensive form. Second, we specified the normal form of the extensive form. Third, we pointed out that there was no pure-strategy Nash equilibrium in the game between the male employee and his supervisor. Finally, we demonstrated that there existed a mixed-strategy Nash equilibrium in the same male employee-supervisor game.

In the Appendix, we describe a general theoretical framework that can be used to shed light on many questions that are related to the issues we have discussed in this paper. Game-theoretic

studies of sexual harassment in the workplace that analyze this kind of an extended model will provide additional insights into an odious phenomenon that has important economic, psychological, and social ramifications for many individuals in contemporary society.

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Appendix

Consider the following game-theoretic model that delineates the strategic interaction between the male employee and his supervisor and in which the payoffs to the two players are *not* zero-sum. The male employee chooses whether or not to sexually harass a female co-worker. The supervisor determines how much effort (e) to exert in gathering evidence about the male employee's potential harassment of his female co-worker. This effort $e \in [0, 1]$. Exerting effort to gather evidence is costly and hence when the supervisor exerts effort e to gather evidence, this costs him $c(e) = 100e^2$. If it turns out that the male employee has not harassed his female co-worker then he receives a payoff of 0, his supervisor pays the evidence gathering cost without any benefit from this evidence gathering process, yielding a payoff to him of $-100e^2$. If the male employee has harassed his female co-worker then his payoff depends on whether or not he is legally charged by his supervisor. If he is charged then his payoff is -100 and his supervisor's payoff is $100 - 100e^2$. In contrast, if the male employee is not charged by his supervisor then his payoff is 50 and his supervisor's payoff is $-100e^2$. Finally, if the male employee harasses his female co-worker and his supervisor exerts effort e to gather evidence then the male employee is charged by his supervisor with probability e and is not charged with complementary probability $(1 - e)$.

The above modeling framework can be used to shed light on several questions pertaining to the strategic interaction between the male employee and his supervisor that we have not analyzed in this paper. Here are three examples of such questions. First, if the supervisor believes that the male employee *has* harassed his female co-worker for sure then what is the optimal value of the effort exertion level e? Second, if the supervisor believes that the male employee has *not* harassed his female co-worker for sure then what is the optimal value of e? Finally, does this game

between the male employee and his supervisor have a pure-strategy Nash equilibrium or must we focus on a mixed-strategy Nash equilibrium once again?