

A Service of

ZBW

Leibniz-Informationszentrum Wirtschaft Leibniz Information Centre for Economics

Ku, Hyejin

# Working Paper Fair Trade in the Fields of Florida: The Impact of the Penny-Per-Pound on Tomato Pickers

CReAM Discussion Paper Series, No. 16/14

**Provided in Cooperation with:** Rockwool Foundation Berlin (RF Berlin)

*Suggested Citation:* Ku, Hyejin (2014) : Fair Trade in the Fields of Florida: The Impact of the Penny-Per-Pound on Tomato Pickers, CReAM Discussion Paper Series, No. 16/14, Centre for Research & Analysis of Migration (CReAM), Department of Economics, University College London, London

This Version is available at: https://hdl.handle.net/10419/295482

#### Standard-Nutzungsbedingungen:

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

#### Terms of use:

Documents in EconStor may be saved and copied for your personal and scholarly purposes.

You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.

If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.



# WWW.ECONSTOR.EU



# **Discussion Paper Series**

CPD 16/14

Fair Trade in the Fields of Florida: The Impact of the Penny-Per-Pound on Tomato Pickers

🕨 Hyejin Ku

Centre for Research and Analysis of Migration Department of Economics, University College London Drayton House, 30 Gordon Street, London WC1H 0AX

www.cream-migration.org

# Fair Trade in the Fields of Florida: The Impact of the Penny-Per-Pound on Tomato Pickers<sup>\*</sup>

Hyejin  $Ku^{\dagger}$ 

March 31, 2014

#### Abstract

Despite the enduring appeal of fair trade activism, little evidence exists on its effectiveness in improving producer welfare. This paper provides evidence on the direct effects of a fair trade premium on its target beneficiaries, using the case of the Penny-Per-Pound, a program that increased the piece-rate wages received by tomato pickers in Florida. It highlights that in output-constraint settings, common in agriculture, a piece-rate compensation scheme can result in externalities among workers. By inadvertently incentivizing the workers to increase their effort whereas the total output is fixed, the program amplified the externality and generated unforeseen risks for worker displacement.

JEL Codes: J88, M52, O13

Key Words: consumer activism, price premium, capacity constraint, natural ex-

periment

<sup>\*</sup>I am very grateful to the family and staff at the study farm for their support and assistance for this project. I thank Jerome Adda, David Card, Steve Coate, Christian Dustmann, Ed Lazear, Magne Mogstad, and Dmitry Ryvkin for their detailed comments and suggestions. I also thank workshop participants at the 2013 NBER Summer Institute Labor-Personnel Meeting; Bergen; PET13 Lisbon; UCL; East Anglia; and Frankfurt, for helpful discussions and comments. Julia Bonomo, Andres Chaves, Mark Flowers, and Diana Saenz have provided excellent research assistance. Financial support from the National Science Foundation grant SES-0920821 is gratefully acknowledged.

<sup>&</sup>lt;sup>†</sup>University College London. Department of Economics. Contact: 30 Gordon Street, London, WC1H 0AX, UK. Phone: +44.(0)20.7679.5852. Fax: +44.(0)20.7916.2775. E-mail: h.ku@ucl.ac.uk.

## 1 Introduction

Fair trade for products such as coffee, tea, cocoa, sugar and bananas is widespread. Although fair trade programs come in diverse packages and place varying degrees of emphasis on their non-pecuniary benefits (Moore, 2004), what forms the core of most fair trade programs is a price premium, which is essentially a *transfer* from caring consumers to producers. The magnitude of such transfers has increased dramatically over the last decade.<sup>1</sup> Despite the growing size of the fair trade industry and the enduring appeal of fair trade activism, empirical evidence on the impact of fair trade on their intended beneficiaries has been scant in the economics literature. The fact that price premiums paid by consumers often dissipate before reaching their intended recipients (Chau et al., 2009; De Janvry et al. 2014) has contributed to the difficulty in assessing the impact of a fair trade premium. In addition, while there exists work looking at the impact of fair trade on producers (e.g., Ronchi, 2002; Bacon, 2005; and Becchetti and Costantino, 2008), their lack of research design renders causal interpretation tenuous.

This paper investigates whether or not fair trade premiums lead to an improvement in the welfare of their target beneficiaries, using the case of the Penny-Per-Pound (PPP), a unique fair trade program that increased the effective earnings of piece-rate tomato pickers in Florida. To my knowledge, this is the first study that identifies the direct effect of a fair trade premium on worker earnings and welfare, based on a quasi-experimental research design. Although I focus here on a particular program affecting agricultural laborers in the U.S. and one that attracted much media attention (see, e.g., *The New York Times*, 2010 and 2011; *The Wall Street Journal*, 2010), this paper speaks to the broader issue of the efficacy and efficiency of organized consumer activism and fair trade programs in general (Brown, 2006; Baland and Duprez, 2009; Basu and Zarghamee, 2009; and Harrison and Scorse, 2010).

Being the product of a long-standing campaign organized by the Coalition of

<sup>&</sup>lt;sup>1</sup>In 2012, the price premium paid to producers via Fair Trade USA amounted to \$37 million, up from \$518,000 in 2002 (*Fair Trade USA*, 2012). In the same year, Fairtrade Foundation, a UK-based fair trade organization, generated £23 million fair trade premium through sales in the UK (*Fairtrade Foundation*, 2013).

Immokalee Workers (CIW), a grassroot labor rights group based in Immokalee, Florida, the Penny-Per-Pound program entails participating buyers (such as McDonald's and Burger King) paying one cent extra per pound of tomatoes purchased from Floridabased growers (farms), and the growers passing this fair trade premium on to the workers who harvested the tomatoes.<sup>2</sup> This paper begins by looking at the underlying incentive structure at the farm prior to the introduction of the PPP, paying particular attention to the piece rate compensation scheme and several other important features characterizing the production environment facing harvesters. Next, I analyze what impact an exogenous increase in the piece rate would have on worker incentives in such an environment. I then examine the data on whether and how workers actually responded to the PPP, and determine whether or not the program increased the welfare of the workers, as was intended by the consumers who financed the program.

This study highlights that in output-constrained settings, even a piece-rate compensation scheme, which is well known to be efficient, can give rise to externalities among workers.<sup>3</sup> When the aggregate output is fixed, one worker's higher effort and higher productivity (pieces per hour) crowds out the amount of crops (or field hours) available for all workers. Unless workers fully internalize the externality that their effort exerts on others, their competitive choices of effort may be inefficiently high from a collective standpoint.<sup>4</sup> This paper then argues that due to the capacity con-

<sup>&</sup>lt;sup>2</sup>The going piece rate for tomato pickers is 50 cents per 32-pound bucket of Round tomatoes. Therefore, if all buyers participated in the program (in other words, if 100 percent of tomatoes picked were covered by the program), the effective piece rate for workers would go up to 82 cents per bucket, a 64 percent pay increase. In 2010, the retail price of field-grown tomatoes ranged from 1.405 to 2.132 per pound (Source: U.S. Bureau of Labor Statistics). Thus, 0.01 extra per pound would have corresponded to a less than one percent increase in the price that consumers pay. While seemingly insignificant from the perspective of the consumers, therefore, the penny per pound premium can lead to a significant boost in the wages of low-income farmworkers.

<sup>&</sup>lt;sup>3</sup>It is well understood that a piece-rate incentive scheme, in which the compensation for each worker is based on his or her own output and only that, is efficient. In the absence of any complementarities in production or asymmetric information, workers' competitive choice of effort that maximizes their individual earnings, minus the costs of effort, should coincide with what will be collectively optimal for the workers as a whole (Stiglitz, 1975; Nalebuff and Stiglitz, 1983; Lazear, 1986; and Gibbons, 1987). Thus, a piece-rate scheme is often used for low-skilled repetitive tasks in which the output can be easily quantified, costs of monitoring are low, and overall costs are easy to calculate (Lazear, 1986). My key point of departure is that I focus on particular production environments in which the total amount of output is pre-determined.

<sup>&</sup>lt;sup>4</sup>This echoes the theoretical prediction in Sen (1966).

straint, the introduction of the PPP may not necessarily lead to an improvement in the welfare of workers. On the one hand, a higher piece rate means a higher reward on the same unit of output as before. Therefore, in the absence of any changes in their work effort, existing workers would gain from the wage increase. On the other hand, if each worker reacts rationally to the increased pecuniary incentive and increases his or her effort whereas the field capacity (hence the aggregate compensation) remains fixed, this widens the pre-existing gap between the competitive and the collectively optimal choices of effort. In addition, as workers become more productive (or reach the capacity in a shorter amount of time) after the introduction of the PPP, the farm might adjust downward the number of workers assigned to picking a given capacity.<sup>5</sup>

To identify the incentive effect of the PPP, I use a difference-in-differences approach exploiting the natural experiment that arises from the different sizes of tomatoes. Specifically, I compare workers' productivity in picking different varieties of tomatoes (Round vs. Grape) between seasons with and without the PPP program in place. The rationale for this identification strategy is that the PPP-related bonus was determined based solely on the relative *volume* of tomatoes each worker harvested regardless of variety, whereas there is a wide variation in the speed of harvesting different varieties due to the difference in their crop sizes. Since the piece rate that the two varieties pay differs widely (\$3.75 for Grape and \$0.50 for Round), the current distribution scheme renders the impact of the PPP bonus on Grape almost negligible vis-à-vis that on Round.<sup>6</sup> Data show that the productivity of the tomato pickers went up substantially in response to the Penny-Per-Pound program, whereas no changes in effort would have been the collectively optimal choice. In addition, with the PPP in place, fewer workers are observed to pick a given capacity than otherwise.

Due to the increased effort of workers as well as the downward adjustment in the size of the workforce, both of which were unforeseen by the well-meaning consumers

<sup>&</sup>lt;sup>5</sup>Since the total output is fixed—at least in the short-run—such adjustments imply increased chances of displacement for existing workers. Displacement should take its toll on the welfare of workers unless the workers have access to outside options that provide as much utility as what they currently obtain by working at the farm.

<sup>&</sup>lt;sup>6</sup>Output is measured in 32-pound buckets. The Penny Per Pound bonus would amount to a 8.5 percent increase in the piece rate for Grape (0.32/3.75) and a 64 percent increase for Round (0.32/0.5) if all consumers participated in the program.

who financed the program, there was some loss in welfare. My analysis shows that in the absence of any displacement effects, or *conditional* on working post-PPP, the welfare impact of the program on existing workers was positive. However, the program's impact on the *unconditional* welfare of existing workers (i.e., when the chance of displacement is taken into account), was no longer unambiguously positive. This paper thus demonstrates how, due to an unusual source of externalities underlying the piece-rate environment—namely, the capacity constraint—a well-intended policy can have unintended and even negative consequences on those who are meant to benefit from it.

Given the usual notion of efficiency associated with a piece-rate incentive scheme, the possibility of externalities among the harvesters is quite striking. However, a closer look at the nature of the problem reveals that this issue is applicable to many other settings, e.g., survey enumerators, telemarketers, or online travel agents (as in Bloom et al., 2013) who are paid on a piece-rate while the pool of potential survey respondents or the volume of customer traffic per hour is fixed. Moreover, the fact that workers' greater efforts in response to a higher piece-rate reduce their welfare gain due to a fixed total output can be related to the classic common pool resource problem, though the contexts of the two problems are entirely different (see, e.g., Hsieh and Moretti, 2003, for a particular application).<sup>7</sup>

This study is most closely related to the work of Harrison and Scorse (2004, 2010), who empirically investigate the impact of anti-sweatshop campaigns on the wages and working conditions of low-income production workers in Indonesia by exploiting

<sup>&</sup>lt;sup>7</sup>In studying the problem of the socially inefficient entry of real estate agents into the US housing market, Hsieh and Moretti (2003) argue that when there are only so many houses to be sold in a given city, the fact that the commission is fixed at 6 percent everywhere means that the total amount of commission available for a given city is pre-determined. Therefore, even if the number of houses were the same everywhere, in those cities in which houses are more expensive the reward for selling each house is greater, inducing the entry of more real estate agents and thereby lowering the productivity (houses sold per agent). The "effort" by tomato pickers in the present study is analogous to the "entry" of real estate agents in Hsieh and Moretti (2003). On tomato farms, the total amount of crops (hence the total compensation) is pre-determined. When the effective piece rate increases, each tomato picked becomes more lucrative, and thus workers put out greater effort, which is a rational thing to do from an individual perspective. However, since their higher productivity does not expand the size of the field, the workers' competitive choice of effort or work intensity per hour can be "too high" from a collective standpoint.

differences between affected and unaffected plants before and after the initiation of these campaigns. In addition, this paper also speaks to the literature on worker effort responses to changes in incentives (see, e.g., Paarsch and Shearer, 1999; Lazear, 2000; Shearer, 2004; Bandiera et al., 2005; Fehr and Goette, 2007; and Jayaraman et al., 2014). Unlike in existing work in the literature, there is no explicit change in wage contracts here. However, the introduction of the PPP works *as if* it is an exogenous increase in the piece rate received by workers, allowing me to evaluate its impact on worker effort in a natural workplace setting.

The remainder of this paper is organized as follows. The next section presents the theory. Section Three describes the data. Section Four presents the empirical results and discusses the welfare impact of the PPP. Concluding comments are in section Five.

## 2 Theory

### 2.1 Setup

This section provides a simple framework for understanding the incentive structure at the farm prior to the introduction of the PPP. It illustrates the fact that in production environments in which the aggregate output is pre-determined, even a piece-rate compensation scheme can give rise to externalities among workers. The mechanism is that when the capacity of the field is exogenously fixed and workers share common field hours, an individual worker's higher effort and higher productivity crowds out the amount of crops or field hours available to *all* workers, including himself.

#### 2.1.1 Environment

Planting decisions precede harvesting by one season. Therefore, decisions regarding the acreage and variety of crops are sunk from a harvesting standpoint. Conditional on the acreage, nature then determines the yields. At the beginning of the season, harvesters are recruited and registered. Let  $\overline{N}$  denote the number of workers registered. No prior experience is required. The harvesting task is mechanical and low-skilled labor. The size of the pool of workers,  $\overline{N}$ , varies from season to season.<sup>8</sup>

On any given day, the harvest manager decides, based on weather conditions and the maturity of crops, which field or which area within the field to pick. Therefore, the total amount to be harvested is exogenously fixed by the capacity of the field. The goal of the farm is to harvest to the capacity of the specified field. Otherwise, the unharvested crops that are mature will go to waste. Denote the capacity of a given field on a given day by  $\overline{Y} > 0$ . Let  $N \ (\leq \overline{N})$  denote the number of workers who are assigned to picking that field on that day. From an individual worker's perspective, both  $\overline{Y}$  and N are exogenous.<sup>9</sup>

Tomato bushes grow in rows. Once the field clock starts, workers spread out across different rows. Once a worker completely picks his row, he can move on to another row. Workers keep moving to different rows throughout the day. Therefore, individual workers are not "attached" to any particular row either within a day or during a season. There is no team element involved in production, and compensation is entirely based on the piece rate and the individual output.

Denote by h the total hours workers spend in the field. Once in the field, individual workers do not choose their hours. The point at which the field is completely picked to its capacity is when everyone stops. Workers, however, choose their work intensity. For a given hour, for example, each worker exerts  $e_i \ge 0$  units of effort, which determines his or her productivity (pieces per hour). Let  $f(e_i)$  be the hourly productivity of worker i with f' > 0 and f'' < 0. The total output of worker i for the field-day then is  $h \times f(e_i)$ , which I denote by  $Y_i$ . The harvest manager asks workers to stay in the field and harvest until  $\sum_j^N Y_i = \overline{Y}$ . Thus, the total field hours, h, that

<sup>&</sup>lt;sup>8</sup>According to my personal communications with the manager of the farm, apparently the farm cares little about the exact number as long as the workers can be accommodated.

<sup>&</sup>lt;sup>9</sup>The harvest manager together with crew leaders decides on N conditional on  $\overline{Y}$ , based on some heuristic. Although I do not model the manager's choice of N or discuss its optimality here, I do examine the possible changes in N (conditional on  $\overline{Y}$ ) in response to the PPP program in my empirical analysis.

workers work is determined by the following relation:

$$h = \frac{\overline{Y}}{\sum_{j}^{N} f(e_j)} \tag{1}$$

Notice that even though individual workers do not directly choose their field hours, their work intensity can indirectly affect the hours for *everyone*.<sup>10</sup>

#### 2.1.2 Worker Utility

Denote the prevailing piece-rate wage by p. Let  $C(e_i, \theta_i)$  be the cost of exerting effort of intensity  $e_i$  for a given hour, with  $C_e > 0$ ,  $C_{ee} > 0$ , and  $C_{e\theta} > 0$ . The parameter  $\theta_i$  is the inverse of workers' innate ability with  $\theta_i > 0$  for all workers. To focus on the main theoretical argument—the externality arising from the presence of a joint capacity constraint—I will consider the simplest case, in which the abilities of workers are symmetric.<sup>11</sup> Therefore, when there is no risk of confusion, I will drop the subscript *i*.

The utility for each worker then is

$$u = h\{pf(e) - C(e,\theta)\},\tag{2}$$

where h follows (1). Let B denote the per hour return on the best outside option available to the workers currently working at the tomato farm. This could be a monetized value of one hour's leisure or the utility from earning an hourly wage of  $\underline{w}$  by working at a nearby strawberry farm, etc. Then, for existing workers currently working at this farm, the following participation constraint should be satisfied by

<sup>&</sup>lt;sup>10</sup>Note that it is not possible to expand the size of the field (with mature crops) in the short run, and also that once the field is picked to its capacity, the day's harvesting ends. In the case of the tomato pickers in Florida whom I observed, once the field has been picked to its capacity, workers get on the bus by which they were brought to the field in the morning and go back to their living quarters.

<sup>&</sup>lt;sup>11</sup>The main result, the externality issue, also obtains even if workers were heterogeneous in their abilities: As long as two or more workers are subject to a joint capacity constraint, the externality problem can arise even if all workers have identical abilities. By assuming heterogenous abilities, what can be added are interesting distributional consequences related to the PPP. For simplicity, I focus here on the welfare impact of the PPP on an *average* worker and the efficiency consequences of the PPP.

revealed preferences:

$$pf(e) - C(e,\theta) \ge B. \tag{3}$$

## 2.2 The Externality Problem

Each worker's competitive choice of effort  $e_i^*$  is what satisfies

$$\left[p - \frac{pf(e_i^*) - C(e_i^*, \theta_i)}{\sum_j^N f(e_j^*)}\right] f'(e_i^*) - C_e(e_i^*, \theta_i) = 0.$$
(4)

Given  $p, \overline{Y}$ , and N, the competitive equilibrium of this model is summarized in the vector  $(e_1^*, ..., e_N^*)$ .

In (4), the second term inside the brackets shows the private cost in terms of reduced field hours (or crops available) caused by one's increased effort. However, workers do not fully internalize the cost associated with reduced field hours for *other* workers.

To maximize the joint utility of all workers, a planner will solve:

$$\max_{(e_1, e_2, \dots, e_N)} \sum_{j}^{N} u_j = p\overline{Y} - \overline{Y} \frac{\sum_{j}^{N} C(e_j, \theta_j)}{\sum_{j}^{N} f(e_j)}.$$

The choice of effort  $e_i^0$  that maximizes the joint utility is what satisfies

$$\frac{\sum_{j}^{N} C(e_{j}^{0}, \theta_{j})}{\sum_{j}^{N} f(e_{j}^{0})} f'(e_{i}^{0}) - C_{e}(e_{i}^{0}, \theta_{i}) = 0.$$
(5)

**Lemma 1** The collectively optimal choice of effort does not depend on the piece rate  $\left(\frac{\partial e^0}{\partial p}=0\right).$ 

Since the aggregate amount to be harvested is fixed at  $\overline{Y}$ , the aggregate compensation to be received from the farm is also fixed, at  $p\overline{Y}$ . Therefore, the planner's problem really boils down to the question of "at what speed" or "how intensively" each worker should labor to minimize the aggregate cost associated with harvesting  $\overline{Y}$ .

While the pay scheme is piece-rate based and there is no direct complementarity in

the productivity of workers, there is an externality problem that arises from the fact that the capacity of the field is pre-determined and that the workers share common field hours, which subjects them to a *joint* capacity constraint.

**Proposition 1** The competitive choice of effort by individual workers is higher than what will be collectively optimal  $(e^* > e^0)$ .

To see this point, re-write (5) as:

$$\left[p - \frac{\sum_{j}^{N} \{pf(e_{j}^{0}) - C(e_{j}^{0}, \theta_{j})\}}{\sum_{j}^{N} f(e_{j}^{0})}\right] f'(e_{i}^{0}) - C_{e}(e_{i}^{0}, \theta_{i}) = 0.$$
(6)

The difference between (4) and (6) is that while in the former the individual is internalizing only the private cost of reduced field hours (or crops) available due to his effort, in the latter, the individual is fully internalizing the field-hour-reducing effect of his effort on *all* workers. The cost from reduced field hours due to increased intensity of effort functions as a "tax" on the piece rate. Since this tax is greater in (6) than in (4), we can conjecture that the corresponding choice of effort in (6) should be smaller than that in (4) such that  $e^0 < e^*$ . A formal proof of this is provided in the Appendix.

## 2.3 Implications of the Penny-Per-Pound

The PPP program entails participating buyers paying an extra cent per pound of tomatoes purchased. The farm then passes on the extra money directly to the workers who harvested those tomatoes. Let s > 0 represent the penny-per-pound price premium to be transferred to harvesters. If all buyers participated in the program, the effective piece rate for the harvesters would be p+s. In reality, however, not all of the customers of this farm are participating in the program. Let  $\phi \in [0, 1]$  denote the percentage of sales covered by the program. Then, the program essentially increases the piece rate in (2) by  $s\phi$ .

#### 2.3.1 Worker Effort

The evaluation of the program boils down to the comparative statics with respect to p in (2). I first examine what impact the PPP might have on workers' choices of effort.

**A1:**  $1 < -N \cdot f \cdot f''/(f')^2$ .

**Lemma 2** If **A1**, the competitive choice of effort increases with the piece rate  $\left(\frac{\partial e^*}{\partial p} > 0\right)$ .

A proof is provided in the Appendix. A1 is a sufficient condition for worker effort to increase as the piece rate increases.<sup>12</sup>

**Proposition 2** If **A1**, the PPP widens the gap between the competitive and the collectively optimal choice of effort.

This is apparent from Lemmas 1 and 2. Since the PPP corresponds to an increase in the effective piece rate, the competitive choice of effort goes up, whereas the piece rate has no impact on the collectively optimal choice of effort. In the data, if workers' level of effort (hence productivity) changes in response to the PPP, then this will be evidence against workers fully colluding.

Proposition 2 shows that unless workers fully collude, the overpicking problem stated in Proposition 1 should become more pronounced with the PPP in place than before, creating some welfare loss.<sup>13</sup>

## 2.3.2 Welfare

Having discussed the possibility that the workers may not extract the maximum possible surplus from the PPP, I next turn to the question of whether the workers are

<sup>&</sup>lt;sup>12</sup>Consider  $f(e) = Ae^b$  where A > 0 and  $b \in (0, 1)$  as an example. Then the condition **A1** becomes: b < N/(N+1). When the size of the workforce, N, is larger, the required degree of concavity, b, to induce a positive effort response becomes less stringent. Since the collectively optimal response in the present context is no change in effort, a larger group size renders workers' competitive choices of effort more likely to deviate from the collectively optimal choices, which is intuitive.

<sup>&</sup>lt;sup>13</sup>However, this does not imply that the PPP necessarily makes the workers worse off. Rather, it means that while workers may still be better off with the PPP than without—recall that the PPP raises the effective piece rates—the welfare gain in the competitive equilibrium is not as large as it could have been had the workers implemented the collectively optimal strategy.

better off with the program than without. From the perspective of individual workers, the capacity,  $\overline{Y}$ , and the size of the workforce assigned to picking that capacity, N, are exogenous. Recall that their competitive choice of effort was summarized in the vector  $(e_1^*, ..., e_N^*)$ . Denote the utility that each worker enjoys in a competitive equilibrium by

$$g(p,\overline{Y},N) \equiv \frac{\overline{Y}}{\sum_{j}^{N} f(e_{j}^{*})} \{ pf(e_{i}^{*}) - C(e_{i}^{*},\theta_{i}) \}.$$

$$\tag{7}$$

Also, denote the field hours that each worker spends by

$$h(p,\overline{Y},N) \equiv \frac{\overline{Y}}{\sum_{j}^{N} f(e_{j}^{*})}.$$
(8)

Holding constant N, the evaluation of the impact of the PPP on the welfare of workers then boils down to determining the sign of the derivative of the indirect utility in (7) with respect to the piece rate, p, i.e., whether  $\partial g(p, \overline{Y}, N))/\partial p$  is positive or not.

Denote by  $\sigma_f$  the elasticity of productivity with respect to the piece rate such that  $\sigma_f \equiv \frac{df/f}{dp/p}$ .

**Proposition 3** If  $\sigma_f < 1$ , then existing workers are better off with the program than without  $\left(\frac{\partial g(p,\overline{Y},N)}{\partial p} > 0\right)$ .

A proof is provided in the Appendix. This is a sufficient condition for the program to increase the welfare of workers in the absence of any displacement effects. The condition says that unless the effort (hence productivity) response of workers is not too large, the program leads to an increase in the welfare of existing workers.

So far, I have treated the size of the workforce picking a given capacity as constant. However, if the workers become more productive (or reach the capacity in a shorter amount of time) after the introduction of the PPP, the farm might adjust downward the number of workers, N, assigned to picking a given capacity,  $\overline{Y}$ , in order to keep the daily field hours relatively stable (or for any other reason).<sup>14</sup> Suppose that with the PPP in place, the number of workers went down to  $N' (\leq N)$ . This means that

<sup>&</sup>lt;sup>14</sup>Since the farm pays by the pieces, not by the hour, there is no obvious reason for why the farm might want to adjust the number of workers. Whether they do adjust it or not is thus an empirical question.

the existing workers, while receiving a higher piece rate than before, are also facing some probability of displacement. Let  $\pi$  denote the probability of displacement with respect to the PPP such that

$$\pi \equiv 1 - \frac{N'}{N}.$$

Prior to the PPP, N' = N, hence  $\pi = 0$ .

Taking into account the possible displacement effect, the expected utility of a worker can be expressed as follows:

$$\Omega \equiv (1 - \pi)g(p, \overline{Y}, N) + \pi Bh(p, \overline{Y}, N),$$

where *B* represents the hourly *utility* obtainable from the best outside option (see Section 2.1.2). With probability  $1 - \pi$ , the worker is retained and he or she obtains the utility from harvesting. With probability  $\pi$ , the worker is displaced from this farm and obtains hourly utility *B* multiplied by the number of hours that the worker *would have spent* at the farm if he or she was retained.<sup>15</sup>

The derivative of  $\Omega$  with respect to the piece rate p, evaluated in the pre-PPP situation  $(N' = N, \pi = 0)$ , is:

$$\frac{\partial\Omega}{\partial p}\Big|_{N'=N,\ \pi=0} = \frac{\partial g(p,\overline{Y},N)}{\partial p} + \sigma_N \left[\frac{g(p,\overline{Y},N)}{p} - \frac{Bh(p,\overline{Y},N)}{p}\right],\tag{9}$$

where  $\sigma_N \equiv -\partial \pi / (\partial p/p) = (\partial N/N) / (\partial p/p)$ , the elasticity of the size of the workforce assigned to picking a given capacity with respect to the piece rate.

**Proposition 4** If  $\sigma_f - \sigma_N < 1$ , then the PPP increases the welfare of existing workers.

A proof is provided in the Appendix. Proposition 4 states a sufficient condition for the welfare impact of the PPP to be positive. If  $\sigma_N = 0$  (i.e., no adjustment in the picking group size), this corresponds to the situation in Proposition 3. In contrast, if there is a non-zero probability of displacement from the farm following the PPP such

 $<sup>^{15}</sup>$ I am assuming here *ex ante* equal chance of displacement for all existing workers, consistent with the earlier assumption of symmetric abilities between workers.

that  $\sigma_N < 0$ , then the combined effects of  $\sigma_f$  and  $|\sigma_N|$  will have to be sufficiently small to ensure that the welfare impact of the PPP for the workers is positive.

Essentially, Proposition 3 is concerned with the welfare impact of the PPP conditional on working at the farm post-PPP whereas Proposition 4 considers the welfare impact unconditionally and considering possible displacement effects. Below, I will quantify  $\sigma_f$  and  $\sigma_N$  in the data in order to determine the impact of the PPP on the welfare of workers.

#### 2.3.3 Earnings

Welfare is a more complex issue than earnings, and the assumptions underlying the welfare approach may not be agreeable to everyone. Therefore, I also consider the impact of the PPP on worker earnings, setting aside the issue of utility. The relevant question here is the impact on worker earnings (in piece-rate equivalence), for each dollar of the PPP money transferred to workers. The expected earnings of each of the N existing workers can be expressed as:

$$\omega \equiv (1 - \pi) \{ h(p, \overline{Y}, N) p f(e) \} + \pi \{ h(p, \overline{Y}, N) \underline{w} \},\$$

where  $\underline{w}$  represents the hourly *earnings* from the best outside option available to workers (see Section 2.1.2). To express the earnings in piece-rate equivalence, divide it through by the output,  $h(p, \overline{Y}, N)f(e_i)$ . Then, we obtain

$$\widehat{\omega} \equiv (1-\pi)p + \pi \frac{w}{f(e)}.$$

The derivative of  $\hat{\omega}$  with respect to the piece rate, evaluated in the pre-PPP situation  $(N' = N, \pi = 0)$ , is:

$$\left. \frac{\partial \widehat{\omega}}{\partial p} \right|_{N'=N,\pi=0,} = 1 + \sigma_N \{ 1 - \frac{\underline{w}}{pf(e^*)} \},\tag{10}$$

where  $\sigma_N = -\partial \pi / (\partial p/p) = (\partial N/N) / (\partial p/p)$  as before. The first term is the direct effect of a piece rate increase by \$1. If  $\sigma_N = 0$  and there is no risk of displacement, then

the per-dollar impact of the PPP money on workers would be exactly \$1. However, if  $\sigma_N < 0$  and the ratio,  $\frac{w}{pf(e^*)}$ , is strictly less than unity (i.e., the outside option does not pay as much as what the workers can make per hour at this farm), then the per-dollar impact of the PPP money on workers would be diluted in proportion to the magnitude of  $\sigma_N$ .

## 3 Setting and Data

My analysis is based on data collected at a large tomato farm in Florida that hires hundreds of tomato pickers who hand-pick tomatoes in the field. The farm is the first of its kind to implement the PPP program, before its expansion across the state in subsequent years.<sup>16</sup> The main dataset is obtained from the firm's payroll records and it covers three harvesting seasons spanning two years prior to the program (spring 2008 and 2009) and the year in which the program was in place (spring 2010). For simplicity, I will from here on refer to these three harvesting seasons as Year 1, Year 2, and Year 3, respectively. The records show detailed harvesting activities at the worker/field/variety levels for each day of the duration of each season. I have also obtained rudimentary demographic information on the harvesters, including their ages, genders, and the dates on which they were hired.<sup>17</sup> In parts of my analysis, I use climatic data for the relevant harvesting and growing periods. The data come from the Global Surface Summary of Day Data produced by the National Climatic Data Center (NCDC) and the Florida Climate Center, based at Florida State University.<sup>18</sup>

A harvesting season lasts for about two months; naturally, this varies from year to year depending on the weather conditions and the field life-cycle. The farm grows several different varieties of tomatoes. My analysis will focus on the two core varieties

<sup>&</sup>lt;sup>16</sup>Although the PPP program was expanded to other farms in Florida in subsequent years, during the period covered in the present paper the study farm was the first of its kind to actually implement the program, leaving little room for general equilibrium effects to take effect. Moreover, throughout the operation of the program, a third party auditor tightly monitored and ensured that the PPP premium was indeed passed on to its intended recipients, the harvesters, and that there was no compromise in the existing wage structures.

<sup>&</sup>lt;sup>17</sup>Hire date is the point at which a worker first registered with this farm. However, this does not mean that the worker has been continuously working with this farm since the point of hiring. <sup>18</sup>http://www.ncdc.noaa.gov/ and http://climatecenter.fsu.edu/.



Figure 1: Piece Rates, Pieces, and Earnings

at the farm, Round and Grape. These two varieties together represent over 70 percent of the total field hours worked. My sample includes all workers who harvested either Round or Grape tomatoes.

Output is measured in units of 32-pound buckets. The piece rate per 32-pound bucket of Round (bigger) tomatoes is 50 cents, and the piece rate for Grape (smaller) tomatoes is \$3.75. Figure 1 shows the pre-program characteristics of the two core crops. On average, workers pick 21.73 buckets of Round tomatoes per hour and 2.51 buckets of Grape tomatoes. Clearly, it is much easier to fill up a 32-pound bucket with the big tomatoes than with small tomatoes. However, in terms of earnings per hour, the two varieties more or less equalize as the higher piece rate for Grape compensates for its slower production. On average, a worker can make \$10.87 per hour on Round and \$9.42 per hour on Grape.

Some background statistics at the farm- and worker-levels are provided in Table A.1. Panel A shows that a typical harvester during each season is approximately 29 years of age, is male, and joined the farm in that season or the year before (tenure is computed as harvest year minus "hire year," the year when the worker registered with this farm for the first time). Panel B shows that, on average, 236 to 334 workers harvest either Round or Grape tomatoes each day. In Year 1, for instance, 167

harvesters pick Round, and 154 harvesters pick Grape each day. The size of the daily workforce varies depending on the harvesting requirements for each day. There are 780, 1133, and 735 unique workers registered in Years 1, 2, and 3, respectively; these figures represent the total number of workers who *ever* harvested during each season, while the size of the daily workforce is much smaller, as mentioned above.

Panel C summarizes the transaction-level records. A transaction is the record of when the field clock for each worker starts to when it stops. A worker can have multiple transactions per day; e.g., a worker can work for 5 hours in the field, take a lunch break, and work for another 4 hours in the afternoon. In this case, the worker has two recorded transactions in the production data. On average, each transaction lasts for 4-5 hours, during which time a worker picks 112-135 buckets of Round tomatoes or 11-14 buckets of Grape tomatoes.

Beginning in Year 3, the PPP program was in place at the farm. The PPPrelated bonus was determined based on the relative volume of tomatoes each worker harvested regardless of variety.<sup>19</sup> Figure A.1 plots the PPP earnings for Year 3 of individual workers against the total pieces that each worker harvested, based on data from weeks in which there were positive PPP payments. Clearly, these variables are closely correlated with each other, consistent with the distribution scheme described above. The two variables are not completely aligned because in each week, the amount of sales to participating buyers and the types of tomatoes sold differ, and not all workers pick the same variety each week.

Table A.2 presents the magnitude of the PPP bonus that each worker received in relation to his or her output and regular earnings. In Year 3, 735 unique workers were counted. During the season, workers received, on average, \$110 in PPP bonus. Since each worker harvested, on average, 1720 buckets of tomatoes (across all varieties), the piece-rate equivalence would amount to \$0.07. This piece-rate equivalence is what I computed *ex post*, based on the season-total PPP payment and season-total pieces harvested. The workers themselves would not have had this information during

<sup>&</sup>lt;sup>19</sup>That is, from the perspective of computing the PPP bonus, one 32-pound bucket of Round tomatoes was counted as equivalent to one 32-pound bucket of Grape tomatoes.

the season. There were some weeks in which no sales to participating buyers took place, thus generating no PPP payment. If I focus on those weeks in which there were positive PPP payments, workers who happened to harvest during those weeks earned, on average, \$116 in PPP bonus, which amounts to about \$0.10 in piece rate equivalence or 10 percent of their earnings.

## 4 Empirical Analysis

Based on the theoretical results, my empirical analysis will proceed as follows. First, I will examine the data to establish that the production setting at the farm is indeed characterized by capacity constraints as argued in the theory. Second, I will examine whether and how the workers responded to the PPP program. Lemmas 1 and 2 have testable implications: If the level of effort changes in response to the PPP, then this is evidence against workers fully colluding. Third, I will estimate the impact of the PPP on the productivity of workers and on the size of the workforce picking a given capacity. Based on the estimates, I will quantify  $\sigma_f$  and  $\sigma_N$ , the elasticities, and discuss the implications of the PPP program for worker earnings and welfare.

## 4.1 Capacity Constraints

In the theory (Section 2),  $\overline{Y}$  represented the daily capacity of the farm, a quantity that is exogenously determined and is independent of the actual productivity of workers. In the data, I only observe the actual output, which depends on the productivity of workers, and not the hypothetical output or the capacity  $\overline{Y}$ . Therefore, I first construct the empirical counterpart of  $\overline{Y}$  based on factors exogenous to the actual effort of workers.

Suppose that on day t, the farm harvested  $Y_{vft}$  amount of tomatoes of variety  $v \in \{R(ound), G(rape)\}$  in field f, where  $f \in \{1, ..., F\}$ . For each variety separately, consider predicting the field-day level output based on two factors: daily climatic

conditions  $(\mathbf{C}_t)$  and field fixed effects  $(\psi_f)$ :

$$Y_{vft} = a_0 + a_1 \mathbf{C}_t + \psi_f + \varepsilon_{vft},\tag{11}$$

where the vector  $\mathbf{C}_t$  includes a comprehensive list of climatic variables that could affect the yield in a given field, including average temperature, maximum temperature, minimum temperature, dew point, precipitation, visibility, wind speed, cumulative lagged sunshine, and cumulative lagged rainfall. The cumulative lagged sunshine is proxied by the sum of the average temperature on all days between day t - 30 and t. The cumulative rainfall is the sum of the daily precipitation on all days between day t - 30 and t. The rationale for using the cumulative lagged climate conditions is that generally there is a one-month gap between the end of the planting season and the beginning of the harvesting season, during which time the crops are maturing. The field fixed effects  $\psi_f$  are intended to capture all characteristics inherent to the field such as acreage, soil quality, etc. Denote the predicted value of  $Y_{vft}$  by  $\hat{Y}_{vft}$ . Then, the farm's daily predicted output (in Round equivalence) across all fields it operates is

$$\sum_{f=1}^{F} (\widehat{Y}_{Rft} + 8.66 \widehat{Y}_{Gft}) \equiv \widehat{Y}_t, \qquad (12)$$

where the quantity for Grape is multipled by 8.66 (21.73/2.51 from Figure 1) to express it in Round equivalence. The predicted capacity  $\hat{Y}_t$  in (12), which is exogenous to the actual choice of effort by workers, will serve as an empirical counterpart to the farm's daily capacity  $\overline{Y}$  in the theory.

Based on data from the pre-program period, Figure 2 plots the daily total field hours at the farm-level against the predicted capacity. Obviously, if there are more tomatoes to be harvested on that day, more field hours are needed to pick to the capacity. There are two methods by which the farm can meet its need for more field hours: increase the number of workers and/or increase the field hours that each worker spends. Data show that both of these margins are operative.

Figure 3 shows that the size of the workforce on a given day,  $N_t$ , increases with the predicted capacity. Moreover, Figure 4 shows that the average field hours that



Figure 2: Aggregate field hours vs. Predicted Capacity

each worker spends also increases with the predicted capacity. This means that while the farm adjusts the picking group size  $N_t$  depending on the daily capacity (Figure 3), that margin of adjustment does not fully exhaust the farm's need for extra labor hours. Therefore, workers get more field hours than otherwise when the daily capacity goes up exogenously.

Figures 2 through 4 together are consistent with the idea that workers harvest until their aggregate output reaches the capacity such as equation (1) in Section 2. Suppose instead that the workers are not subject to the joint capacity constraint and that each worker stops harvesting after fulfilling his or her desired field hours. If that was true, then one wouldn't find the relationship in Figure 4, as in that case the field capacity shouldn't dictate how many field hours individual workers actually spend each day.<sup>20</sup>

The correlations shown in Figures 2, 3, and 4 are presented in a regression framework in Table A.3. As we saw in the figures, the predicted daily capacity is positively

<sup>&</sup>lt;sup>20</sup>Based on my interviews with workers, their usual concern is not with working for "too long." Given their limited outside options, workers often said that they would like "more" hours, not fewer. As they are paid on a piece rate rather than a fixed wage, it is not surprising that they desire more hours: more field hours translate into more earnings. In addition, the fact that the size of the worker pool,  $\overline{N}$ , is larger than the number of workers who actually get to work each day,  $N_t$  also validates their concern since the farm always has access to more workers (i.e., more field hours) than are needed on a typical day.



Figure 3: Number of workers vs. Predicted Capacity



Figure 4: Field hours per worker vs. Predicted Capacity

associated with the aggregate field hours at the farm-level as well as with the total number of workers who harvest on that day. In addition, the average field hours that each worker spends (conditional on working) are also positively associated with the predicted capacity. All coefficients are statistically significant.

## 4.2 The Incentive Effect of the Penny-Per-Pound

Given that the tomato pickers are working in an environment characterized by capacity constraints, the theory predicts no change in effort as the collectively optimal response to the PPP. If worker productivity increases after the introduction of the PPP, this will be evidence against workers implementing the collectively optimal strategy (Lemma 1), implying some efficiency losses for the workers as a whole. In this section, I examine whether and to what extent the workers responded to the rise in effective piece rates induced by the PPP. The estimated productivity responses will serve as a basis for my welfare analysis in Section 4.4.

To identify the causal impact of the PPP program on worker effort, I compare workers' productivity in different varieties of tomatoes (Round vs. Grape) between seasons with and without the program in place. The rationale for this identification strategy is that (for administrative convenience) the PPP-related bonus was determined based solely on the relative *volume* of tomatoes each worker harvested regardless of variety, although there is a wide variation in the speed of harvesting the two types of tomatoes. Since the piece rate that each variety pays differs so widely (\$3.75 for Grape and \$0.50 for Round), the current distribution scheme renders the impact of the PPP bonus on Grape almost negligible vis-à-vis that on Round. Specifically, the PPP-related bonus would amount to a 8.5 percent increase in the piece rate for Grape (0.32/3.75) and a 64 percent increase for Round (0.32/0.5) if all consumers participated in the program. Essentially, I use Grape as the control variety and Round as the treatment variety with respect to the PPP, with the identifying assumption that absent the PPP, season-specific shocks would not have differential effects on the two types of tomatoes. That is, if a season is a bad crop year for Grape, then it should be a bad crop year for Round as well, in the absence of the PPP program.

The advantage of this strategy is that I can effectively control for common shocks affecting the productivity of both varieties, e.g., a generally good or bad crop year, more pleasant harvesting conditions, etc. In a regression framework this translates into:

$$y_{ivft} = c + \alpha_t + \beta T_v + \gamma (Post_t \times T_v) + \delta \mathbf{Z}_{vft} + \psi_f + \theta (\mathbf{C}_t \times T_v) + \phi_i + u_{ivft}, \quad (13)$$

in which  $y_{ivft}$  is the log of productivity (pieces/hour) of worker *i* for variety *v*, field f, on day t; *c* is a constant;  $\alpha_t$  is the day fixed-effect;  $T_v$  is a dummy indicating whether variety *v* is Round (vs. Grape); and  $Post_t$  is a dummy indicating whether day *t* belongs to the post-program period. Notice that the  $Post_t$  dummy is subsumed in the day fixed-effects  $\alpha_t$ . The vector  $\mathbf{Z}_{vft}$  includes variety-field specific life-cycle  $(LC_{vft})$  and its squared, to account for the fact that, depending on how many days have been picked, the density of the crops available for picking may be different. Following Bandiera et al. (2005), I measure  $LC_{vft}$  as the number of calendar days the field has been picked for that variety at any moment in time, divided by the total number of days the variety is picked in that field over the season.<sup>21</sup> Also,  $\psi_f$  denotes the field fixed effects that capture time-invariant field characteristics such as acreage, soil quality, geographic location of the field, etc. My main coefficient of interest is  $\gamma$ .

One obvious concern about the identification strategy above is that some omitted covariates of  $Post_t$  may have a *differential* impact on the productivity of the two varieties. Suppose, for instance, that Round tomatoes are more resistant to freeze shocks than Grape, and that the farm was hit by a freeze shock in the season with the PPP. In this situation, the estimate of  $\gamma$  may pick up the differential impact of the freeze shock, which I could falsely attribute to the incentive effect of the PPP program. To address this issue, I include  $\mathbf{C}_t \times T_v$  in equation (13) and allow for a comprehensive list of climatic variables that could have *differential* impacts on the two varieties ( $\mathbf{C}_t$  is the vector of daily climatic conditions as described in Section 4.1).

<sup>&</sup>lt;sup>21</sup>Since multiple varieties are grown in the same "field," I measure the field life-cycle for each variety separately.

Notice that the "level" effect of  $\mathbf{C}_t$  is subsumed in the day fixed-effects  $\alpha_t$ , and that therefore the effect of any common shocks affecting the productivity of both varieties is already accounted for.

Another plausible concern regards possible interaction between  $Post_t$  and  $T_v$ through unobserved changes in worker characteristics. First, in the post-PPP season, workers who were more productive may have been assigned disproportionately to picking Round tomatoes. Second, in the post-PPP season, workers who were more productive or more highly motivated may have been disproportionately hired/retained. To address both types of concerns, I also include worker fixed-effects  $\phi_i$  in some of my specifications. I compare the *same* worker's productivity between the two varieties by exploiting the fact that during a given season, depending on the harvesting schedule of the farm, workers are assigned to different varieties, and most of them pick both varieties during the season. In this strategy, if workers who joined the farm post-program are more or less "able" than before, this does not bias my results unless it is the case that (i) workers are asymmetrically talented in picking different varieties and that (ii) workers who are better in picking Round tomatoes were hired disproportionately during the season with the program. However, as a rule, workers are not pre-screened based on ability at the time of hiring. Moreover, data show that, if anything, worker productivity in both varieties go hand in hand (see Figure A.2). Therefore, it is highly unlikely that conditions (i) and (ii) would be simultaneously satisfied. On the other hand, conditional on a worker's ability, the possibility that the same worker exerted more effort in Round than in Grape is precisely what my argument is positing.<sup>22</sup>

<sup>&</sup>lt;sup>22</sup>While the empirical analysis exploits the two varieties for a causal identification of the impact of the PPP on productivity, my theoretical model currently has nothing to say about between-variety substitution of effort for the same worker. However, one could come up with a model in which a worker's daily energy is fixed, and workers choose the optimal rate of effort substitution between the two varieties because they had different piece rates preceding the PPP program (I do not build such a model as the substitution between varieties is not the main point of the paper and would be simply distracting). In such an environment, when the effective piece rate of Round goes up relative to Grape, the optimal relative effort in Round should also go up. This is certainly an interesting area of workers' adjustment behavior to explore, and it does not refute the identification strategy above: Note that the empirical strategy allows for the identification of the incentive effect in relative terms only (Round vs. Grape), and that I do not make any causal interpretation about productivity changes in the reference variety, namely Grape.



Figure 5: Worker-level productivity: Round

#### 4.2.1 Productivity in Round and Grape: Overview

Figure A.3 shows the *farm-level* productivity (aggregate pieces/aggregate hours) for Round and Grape (the latter is multiplied by 8.66 so as to be comparable with the scale for Round) before and after the introduction of the PPP program. In the year the farm implemented the program, the farm-level productivity for Round went up while that for Grape went down slightly.<sup>23</sup> Figures 5 and 6 show, for each variety, the kernel density estimates of *worker-level* productivity during the seasons with and without the program. With the PPP program in place, the distribution of workerlevel productivity for Round shifted to the right whereas that for Grape remained virtually the same.

In Table 1, I present a series of regressions comparing the difference in worker productivity before and after the PPP, separately for Round and Grape tomatoes. The results for Round are in Columns 1 through 4 and those for Grape are in Columns 5 through 8. Column 1 shows the baseline regression, controlling for field fixed-effects only. It shows that with the PPP in place, the productivity in Round went up by 0.145 log points or 15.6 percent. Column 2 includes a comprehensive list of climatic

 $<sup>^{23}</sup>$ The p-values corresponding to the t-test for equality of means between the pre- and post-PPP periods are 0.0006 for Round and 0.0250 for Grape, respectively.



Figure 6: Worker-level productivity: Grape

controls including average temperature, maximum temperature, minimum temperature, dew point, precipitation, visibility, wind speed, cumulative lagged sunshine, and cumulative lagged rainfall.<sup>24</sup> The coefficient on  $Post_t$  goes up to 0.192. Column 3 includes field-specific life-cycle (LC) and its squared. Lastly, Column 4 includes worker demographic characteristics: age, age squared, female dummy, and tenure at the farm (in years). The number of observations drops due to missing demographic data for some individuals, but the coefficient on  $Post_t$  remains positive and highly significant.

Columns 5 through 8 in Table 1 show that in the case of Grape tomatoes, worker productivity, if anything, went down slightly in the season with the PPP in place although none of the coefficients are statistically significantly different from zero. This is consistent with the fact that for Grape tomatoes, a 32 cent bonus translates into a mere 8.5 percent increase in effective piece rates (as opposed to 64 percent in the case of Round tomatoes). While the results in Table 1 are suggestive, the observed change in productivity in Round may not be causal. Thus, I next turn to the difference-in-differences estimates, to better isolate the impact of the PPP from the omitted covariates of  $Post_t$ .

<sup>&</sup>lt;sup>24</sup>The number of observations drops slightly due to missing climatic data for some dates.

	L .	Table 1: PF	P and Wo	rker product	ivity			
		Dep	endent var.	: Log Produ	ictivity (Pi	eces/Hou	r)	
		Roi	und			Gr	ape	
	(1)	(2)	(3)	(4)	(5)	(9)	(2)	(8)
Post	$0.145^{***}$	$0.192^{***}$	$0.201^{***}$	$0.183^{***}$	-0.018	-0.063	-0.064	-0.096
	(0.044)	(0.049)	(0.050)	(0.049)	(0.085)	(0.072)	(0.074)	(0.076)
Observations	27,874	27,071	27,071	21,366	28,224	27,161	27,161	21,212
R-squared	0.060	0.089	0.104	0.159	0.070	0.107	0.113	0.139
Field FE	Yes	$\mathbf{Yes}$	Yes	$\mathbf{Yes}$	$\mathbf{Yes}$	$\mathbf{Yes}$	$\mathbf{Yes}$	$\mathbf{Yes}$
Climate		$\mathbf{Yes}$	$\mathbf{Yes}$	$\mathbf{Yes}$		Yes	$\mathbf{Yes}$	$\mathbf{Yes}$
Field life-cycle			$\mathbf{Yes}$	$\mathbf{Yes}$			$\mathbf{Yes}$	$\mathbf{Yes}$
Worker characteristics				$\mathbf{Y}_{\mathbf{es}}$				$\mathbf{Yes}$
Notes: Robust standard e	rrors clustered	by day in pa	arentheses					

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Climate includes daily average temperature, max temperature, min temperature, dew point, precipitation, visibility, wind speed, cumulative lagged sunshine, and cumulative lagged rainfall.

Field life-cycle includes number of calendar days the field has been picked for that variety at any moment in time divided by the total number of days the field is picked for that variety over the season (LC) and LC squared.

Worker characteristics includes worker age, age squared, female dummy, and worker tenure at the farm.

#### 4.2.2 Estimates of Productivity Responses

Table 2 presents the estimates of (13). Column 1 shows the baseline diff-in-diff estimates, controlling for field fixed-effects. The positive coefficient on Round indicates that due to the size difference between types, the baseline productivity (pieces/hour) for Round is much higher than that for Grape. The coefficient on *Post* is negative but is not statistically significantly different from zero, which is reassuring in that no trend exists between pre- and post-program seasons in the absence of the PPP program. My main coefficient of interest is  $Post \times Round$ . The result shows that if I take Grape as the reference variety, the productivity in Round went up, which is consistent with the argument that the PPP program boosted the productivity of workers. Column 2 controls for day fixed-effects (which subsumes the impact of *Post*), and the coefficient here goes up to 0.340. In Column 3, I control for the field-variety life-cycle (LC), and its squared. The coefficient remains stable. Column 4 controls for the possible *differential* effects of the concurrent and cumulative lagged weather conditions on the two varieties (The effect of any common shocks affecting the productivity of both varieties is already accounted for by the day fixed-effects). The coefficient on  $Post \times Round$  goes down slightly but is still highly statistically significant and the sign remains positive.<sup>25</sup>

To put the magnitude of the effort response of workers into context, how should we interpret the coefficient? What is the implied elasticity? The answer to these questions depends on what we assume the workers are responding to. Did they believe that the PPP program covered 100 percent of all sales? Or did they have adaptive expectations such that after each paycheck, they mentally updated the amount of the PPP bonus for the following week? I don't know the definitive answer, but if I assume that workers thought that the program coverage was 100 percent, this gives me the lower bound of the elasticity of productivity with respect to the piece rate.

Suppose that the workers believed that the PPP program coverage was 100 per-

<sup>&</sup>lt;sup>25</sup>The number of observations drops slightly due to missing climatic data. The estimates in Columns 1 through 3 are not sensitive when I restrict the sample to those observations with full climatic data (i.e., same as in Column 4).

p	P			
		Depende	ent var.:	
	Log F	Productivity	y (Pieces/H	Iours)
	(1)	(2)	(3)	(4)
Post×Round	0.216***	0.340***	0.335***	0.283***
	(0.075)	(0.077)	(0.079)	(0.075)
Post	-0.036			
	(0.077)			
Round	$2.158^{***}$	2.131***	$2.146^{***}$	$3.255^{***}$
	(0.030)	(0.033)	(0.031)	(0.763)
Field FE	Yes	Yes	Yes	Yes
Day FE		Yes	Yes	Yes
Field life-cycle (LC) and LC-squared			Yes	Yes
Crew FE				Yes
Climate×Round				Yes
Observations	56,098	56,098	56,098	54,232
R-squared	0.900	0.920	0.920	0.920

Table 2: Impact of the PPP on worker productivity: Diff-in-diff estimates

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Post is subsumed in Day FE for Columns 2 through 4.

cent, raising the effective piece rates by 32 cents. Then, the implied elasticity of productivity with respect to piece rates,  $\sigma_f$ , ranges from 0.523 to 0.823.<sup>26</sup> The estimated elasticity is comparable to estimates in the existing studies. Paarsch and Shearer (1999) estimate the elasticity of productivity with respect to piece rates among tree planters to be 0.77 to 2.14; in a similar study, Haley (2003) estimates elasticities between 0.41 and 1.51.

#### 4.2.3 Robustness Checks

In Table 3, I examine whether the main results in Table 2 (column 4) are robust to the inclusion of worker fixed-effects and to various sample restrictions. Column 1 shows that when I include worker fixed-effects the coefficient becomes slightly smaller but remains positive and highly statistically significant. This suggests that the results in Table 2 are not driven by more productive workers selecting themselves into picking

<sup>&</sup>lt;sup>26</sup>The diff-in-diff estimate of (log) of productivity is between 0.216 and 0.340. The corresponding diff-in-diff in (log) of piece rate is  $0.413 \ (= \{\ln(0.32 + 0.5)) - \ln(0.5)\} - \{\ln(0.32 + 3.75) - \ln(3.75)\})$ . Then, the elasticity is between 0.523 and  $0.823 \ (0.216/0.413 \ \text{and} \ 0.340/0.413)$ .

			0		
	Depend	lent var.: L	og Product	tivity (Pieces,	/Hours)
	All	Male	Age < 40	Fresh hires	Panel
	(1)	(2)	(3)	(4)	(5)
Post×Round	0.306***	0.321***	0.339***	$0.325^{***}$	0.342***
	(0.086)	(0.086)	(0.086)	(0.090)	(0.084)
Worker FE	Yes	Yes	Yes	Yes	Yes
Observations	$54,\!232$	39,141	$38,\!542$	$15,\!860$	$11,\!053$
R-squared	0.944	0.945	0.944	0.945	0.946

Table 3: Robustness: Controlling for worker characteristics

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

All regressions include the full set of controls (Col 4 of Table 2).

Column 2 restricts the sample to male workers only.

Column 3 restricts the sample to workers under age 40.

Column 4 restricts the sample to workers who were hired within the past one year from the harvesting season at hand.

Column 5 includes workers who worked in both pre- and post-PPP seasons.

Round tomatoes in the year with the PPP program. Columns 2 and 3 restrict the sample to male workers and workers under 40 years of age, respectively. In these homogenous samples, the results remain stable. In Column 4, I focus on workers who were hired within the past year from the point of the harvesting season at hand. Column 5 is based on the panel of workers who appear in both the pre- and post-PPP seasons. Column 5 essentially compares the same worker's productivity between varieties and between seasons, and is the most restrictive specification considered so far. This is intended to address concerns such as: "What if workers who are more 'clever' join the farm post-program, i.e., workers who may not be more talented in picking Round, but have an intention to pick harder in Round?". As Columns 4 and 5 show, the productivity response I observe is not driven by changes in worker composition between seasons, or between varieties within the farm. Overall, my main results are robust to various types of sample restrictions and do not seem to be driven by workers' selection into the Round variety in the post-program year.

In Table 4, I examine whether the positive productivity response is indeed due to the PPP program rather than representing a secular trend. Column 1 is the result of my preferred specification, Column 1 of Table 3, except that  $Post \times Round$  is now

	<u>E RODUSTIE</u>	ess: Enects of	<u>Placebo treati</u>	nent
	Depende	nt var.: Log P	roductivity (P	ieces/Hours)
	All	Years 1 & 2	Years 1 & 3	Years 2 & 3
	(1)	(2)	(3)	(4)
Year 2×Round	0.043	0.050		
	(0.092)	(0.093)		
Year $3 \times \text{Round}$	$0.330^{***}$		$0.289^{**}$	$0.343^{***}$
	(0.097)		(0.116)	(0.121)
Observations	$54,\!232$	41,194	33,757	$33,\!513$
R-squared	0.944	0.940	0.949	0.947

	Table 4:	Robustness:	Effects of	of Placebo	treatment
--	----------	-------------	------------	------------	-----------

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

All regressions include the full set of controls as in Column 1 of Table 3.

Year 2 and Year 3 are subsumed in Day FE.

Column 1 uses the full sample and uses Year 1 as a baseline.

Column 2 includes Years 1 and 2 only using Year 1 as a baseline.

Column 3 includes Years 1 and 3 only using Year 1 as a baseline.

Column 4 includes Years 2 and 3 only using Year 2 as a baseline.

replaced by Year  $2 \times Round$  and Year  $3 \times Round$  (the reference year is Year 1). As expected, there is no productivity response in Year 2, and a positive effect is present only in Year 3 (the year with the PPP program in place). Column 2 uses Year 1 as the base year and checks whether there is any positive productivity effect in Year 2. Clearly, there is no effect in Year 2. Column 3 uses data from Year 1 and Year 3 only, using Year 1 as the base year: The effect for Year 3 still obtains. In Column 4, I use data from Year 2 and Year 3 only, using Year 2 as the base year: The effect for Year 3 still obtains. The findings in Table 4 are reassuring in that I do find a positive productivity response in Year 3 but not in the other years.

#### 4.2.4Comments

The diff-in-diff estimates show that there was a differential increase in the productivity of Round post-PPP, which I attribute to the incentive effect of the program. Relating to my theory, the fact that worker effort and productivity went up after the introduction of the program is evidence against workers implementing the collectively optimal strategy.

An interesting question that arises, given prior research findings on the presence of social preferences among agricultural workers (Bandiera et al., 2005), is why the tomato pickers studied here responded the way they did when no increase in productivity would have been the collectively optimal response to the PPP. Notice that Bandiera et al. (2005) compares worker productivity under *two explicitly different* compensation schemes, namely relative pay vs. piece rate. Under a relative pay scheme, there are clear and direct benefits to collusion among workers. The authors show that workers' productivity is indeed reduced under a *relative pay* regime (as compared to the piece rate regime), consistent with workers' exhibiting social preferences.

In the present paper, however, the compensation scheme in use is *piece rate and remains so throughout*. The capacity constraint as a potential source of inefficiency, as my theory points out, is so subtle that it is possible that the existence of such problems never occurred to the tomato pickers, hence providing no motive for collusion on their part. Alternately, it may well be that workers were fully aware of the nature of the problem, but that the work environment they are in was simply not conducive to (full) collusion. First, the number of workers in a given field is quite large, typically over 150, a group size substantially higher than that which will facilitate cooperation (Isaac et al., 1988). Second, tomato bushes are quite thick and tall and that precludes both active monitoring and mutual enforcement of collusion among workers (cf. Bandiera et al., 2005 and 2010).<sup>27</sup>

<sup>&</sup>lt;sup>27</sup>Given the observed productivity increase as a result of the PPP, another question that might arise is why the farm was not paying a higher piece rate already (i.e., irrespective of the PPP). Notice, however, that the PPP is financed by the consumers and not by the employer. Therefore, the implications of a given productivity increase for the farm will be quite different depending on who finance the piece-rate increase. More importantly, notice that when the total output is predetermined, maximizing the productivity (pieces per hour) of individual workers is not in the best interest of the farm. Since the farm does not pay workers a set amount per hour, but instead pays per bucket or per piece, this in effect pre-determines the total wage based on the constraint of field size and the amount of ripe tomatoes. In such production environments, the farm has little incentive to want to increase a worker's productivity. The pre-existing piece rate, which is also the going market rate, was therefore not set to maximize worker effort and productivity, but rather to ensure that enough workers showed up every morning at the farm rather than going to work somewhere else. Of course, in settings in which the production capacity is not fixed, a firm's optimal choice of piece-rate wages will look quite different from what I observe here.

## 4.3 Intensive and Extensive Margins of Labor Hours

Holding constant the capacity of the farm  $(\overline{Y})$ , the PPP effect can manifest itself in two different ways. First, now that workers are more productive (or reach the capacity in a shorter amount of time), the farm might adjust downward the number of workers, N, assigned to picking a given capacity,  $\overline{Y}$ , in order to keep the daily field hours relatively stable (or for any other reason). Second, the farm may keep the size of the workforce (normalized by the field capacity) constant, but due to the PPP effect, the workers get fewer field hours *than otherwise* because of everyone's increased productivity.

So far, I have focused on the second aspect of the PPP effect (although the capacity is not constant in reality, the field-hour reducing effect is *implied* by the increased productivity), but the first aspect is clearly possible. Since the farm pays by the pieces, not by the hour, and the capacity is fixed, there is no obvious reason for why the farm might want to adjust the number of workers. Whether they do adjust it or not is thus an empirical question. To examine this issue, I estimate a variant of equation (13) using the number of workers picking a given capacity, as the dependent variable. Specifically, I estimate at the variety-field-day level:

$$\ln \frac{N_{vft}}{\widehat{Y}_{vft}} = c_1 + \alpha_{1t} + \beta_1 T_v + \gamma_1 (Post_t \times T_v) + \delta_1 \mathbf{Z}_{vft} + \psi_f + u_{vft}, \qquad (14)$$

where  $N_{vft}$  is the number of workers who picked variety v in field f on day t, which I normalize by the predicted capacity of that field on that day for that variety,  $\hat{Y}_{vft}$ (which comes from (11);  $c_1$  is a constant;  $\alpha_{1t}$  is day fixed effects;  $T_v$  is a dummy indicating whether variety v is Round (vs. Grape);  $Post_t$  is a dummy indicating whether day t belongs to the post-program period;  $\mathbf{Z}_{vft}$  includes variety-field specific life-cycle ( $LC_{vft}$ ) and its squared; and  $\psi_f$  is the field fixed-effects. My coefficient of interest is  $\gamma_1$ .

Table 5 presents the estimates of (14). Column 1 shows the baseline diff-in-diff estimate with field fixed-effects. The negative coefficient indicates that with the PPP in place, the number of workers (normalized by field capacity) decreased by 0.266 log

rasie of impact of the fift e		i the worme	100
	D	ependent va	r.:
	Log (Size o	of Workforce	e/Capacity)
	(1)	(2)	(3)
Post×Round	-0.266**	-0.257*	-0.201
	(0.109)	(0.145)	(0.139)
Post	-0.093		
	(0.106)		
Round	-2.259***	-2.257***	-2.299***
	(0.064)	(0.081)	(0.086)
Field FE	Yes	Yes	Yes
Day FE		Yes	Yes
Field life-cycle (LC) and LC-squared			Yes
Observations	1,212	1,212	1,212
R-squared	0.747	0.835	0.843

 Table 5: Impact of the PPP on the size of the workforce

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

In Columns 2 and 3, Post is subsumed in Day FE.

points or 23.3 percent. This is consistent with the view that due to the increased productivity of workers post-PPP, fewer workers were assigned to picking a given capacity than otherwise. Column 2 controls for day fixed-effects (which subsumes the impact of *Post*). In Column 3, I additionally control for field life-cycle and its square. The coefficient on  $\gamma_1$  remains negative though it is no longer statistically significant.

While not always precisely estimated, I find some evidence for a decrease in the number of workers picking a given capacity with the PPP program in place. The magnitude of  $\gamma_1$  ranges between -0.201 and -0.266 log points. Suppose that the PPP program coverage was 100 percent, thus raising the piece rates by 32 cents. Then, the implied elasticity of the size of workforce with respect to piece rates,  $\sigma_N$ , will be between -0.486 and -0.644.<sup>28</sup> In the next section, I explore the implications of my empirical findings for the earnings and welfare of workers.

<sup>&</sup>lt;sup>28</sup>The diff-in-diff estimate of (log) of the size of workforce is between -0.201 and -0.266. The corresponding diff-in-diff in (log) of piece rate is 0.413 (= {ln(0.32+0.5))-ln(0.5)}-{ln(0.32+3.75)-ln(3.75)}). Then, the elasticity is between -0.486 and -0.644 (-0.201/0.413 and -0.266/0.413).

1 0 1			V	
		Outside o	option pays	
	75%	50%	0% (unemployed)	
Displacement rate $(\sigma_N)$		of current earnings		
Same as elasticity of productivity $(\sigma_f)$	\$0.79	\$0.58	0.17	
Half as fast as $\sigma_f$	\$0.89	0.79	0.58	
No adjustment in workforce	\$1.00	\$1.00	\$1.00	

Table 6: Impact on existing workers per-dollar of the PPP money transferred

Note: This example is based on  $\sigma_f = 0.823$ .

## 4.4 Discussion

## 4.4.1 The Impact of the PPP on the Earnings of Workers

My empirical estimate of  $\sigma_N$  ranged between -0.486 and -0.644 when the estimate of  $\sigma_f$  ranged between 0.523 and 0.823, under similar assumptions. One of the reasons why the absolute magnitude of  $\sigma_N$  is smaller than the magnitude of  $\sigma_f$  may be because this was the first year in which the program was in place, and the farm may not yet have fully reacted to the increased productivity of workers. Suppose that the rate of response  $\sigma_N$  is in proportion to  $\sigma_f$ . Based on the actual estimate of  $\sigma_f$ , which I argue is more reliable than the estimate of  $\sigma_N$  (since the adjustment in N is a secondary effect induced by the productivity response), in Table 6, I tabulate the per-dollar impact based on different assumptions about the displacement rate and outside options (see Section 2.3.3 for details). I use  $\sigma_f = 0.823$  to construct this example.

The per-dollar impact is positive in all cases. As the last row of Table 6 shows, if there is no risk of displacement and all of the existing workers will be retained at the farm post-program, then the per-dollar effect of the PPP money on workers will be exactly \$1, which is probably what the NGO and the participating consumers had in mind. However, empirical analysis showed that some downward adjustments in the size of the workforce (normalized by the capacity) accompanied the increased productivity of workers, both of which were unforeseen by the consumers. Therefore, the effective benefits accruing to workers were most likely less than the whole dollar amount considering the realistic outside options available to the workers.

#### 4.4.2 The Impact of the PPP on the Welfare of Workers

My estimate of  $\sigma_f$  ranged between 0.523 and 0.823 based on the assumption that the workers believed that the PPP program coverage was 100 percent, raising the effective piece rates by 32 cents. Since  $\sigma_f < 1$  in this case, the sufficient condition in Proposition 3 is satisfied. This means that for those workers who continue to work at the farm post-PPP, the impact of the PPP on the *conditional* welfare was positive.

However, when it comes to the *unconditional* welfare (i.e., when the chance of displacement is taken into account), the impact of the PPP is no longer unambiguously positive. Under the same assumption regarding worker beliefs, my estimate of  $\sigma_N$  ranged between -0.486 and -0.644. Then, the magnitude of  $\sigma_f - \sigma_N$  ranges between 1.009 and 1.468. Even with the very conservative estimates of  $\sigma_f$  and  $\sigma_N$ , the magnitude of  $\sigma_f - \sigma_N$  exceeds 1. Moreover, if the observed workers' productivity response was in fact to a lower level of perceived program coverage than 100 percent, e.g., workers thought that the effective piece rate rose by less than the full 32 cents, then my estimated worker productivity increase will translate into a larger value of  $\sigma_f$  (and  $|\sigma_N|$ ), making it even more difficult to satisfy the condition in Proposition 4. Since what is stated in Proposition 4 is a sufficient condition, failure to satisfy the condition does not imply that the workers are necessarily worse off with the program than without. However, it does indicate that there was some loss in welfare due to the effort response of workers, for the welfare gain from the PPP would have been the largest and unambiguously positive had the workers implemented the collectively optimal strategy and not increased their effort at all.

## 5 Concluding Comments

This paper highlights that in situations in which the aggregate output is predetermined, even a piece-rate compensation scheme, which is well known to be efficient, can give rise to externalities among workers. This shows that when capacity constraints are important (at least in the short-run, e.g., due to large fixed costs of expanding production capacity), the welfare gain from an exogenous increase in the piece rate may become smaller to the extent that the effort of workers responds to the changed incentives.

These considerations should be particularly important for programs such as the Penny-Per-Pound, which is targeted at low-income laborers whose choices of effort may be especially responsive to changes in the piece rate. Data show that the tomato pickers indeed responded to the piece-rate increases and that their productivity rose substantially, amplifying the pre-existing externality problem. In addition, with the PPP in place, fewer workers are observed to pick a given capacity than otherwise. Due to the increased effort of workers as well as the downward adjustment in the size of the workforce, both of which were unforeseen by the well-meaning consumers who financed the program, there was some loss in welfare. This shows how a well-intended policy can have unintended and even negative consequences on those who are meant to benefit from it.

Despite the findings regarding welfare loss caused by the effort response of workers, the conclusion of this paper is not that consumers should stop paying the PPP. The welfare loss associated with the PPP is really due to the fact that currently the PPP bonus is tied to the piece rate, which inadvertently incentivizes the workers to increase their effort whereas the field capacity (hence the total compensation) is fixed and is invariant to the productivity of workers. While the PPP, thanks to its intuitiveness and simplicity, was a powerful campaign to attract the attention of well-meaning consumers, in terms of implementation, it might be better to keep the financial transfer as a pure transfer rather than to tie it to production activity or to piece rates.

With the increasing popularity of fair trade programs in the U.S. and globally, the findings of this paper are likely to affect a broader set of workers than those studied here. There are several directions for future research. In assessing the welfare impact of the program, I focus here on the efficiency consequences of the program on workers at large—or on an average worker—while remaining agnostic about distributional consequences. However, to the extent that consumers who finance the program care about the distributional impact of the program on workers, different approaches could be adopted for the policy's evaluation. Another problem that is of interest (independently from the PPP program) is the optimal choice of picking group size. As discussed before, when the total output is fixed and the workers are paid for pieces rather than for hours, the firm is indifferent regarding larger or smaller number of workers picking the same capacity. However, the picking group's size can influence the welfare of workers through its interaction with the capacity constraint. In this respect, the interests of the firm and the workers do not seem well aligned, and as long as there are no negative consequences for their profits, the firm may be open to the idea of optimal staffing.

## References

- Bacon, Christopher, 2005. "Confronting the Coffee Crisis: Can Fair Trade, Organic, and Specialty Coffees Reduce Small-Scale Farmer Vulnerability in Northern Nicaragua?," World Development, 33(3): 497-511.
- [2] Baland, Jean-Marie and Cedric Duprez, 2009. "Are Labels Effective Against Child Labor?," *Journal of Public Economics*, 93(11-12): 1125-1130.
- [3] Bandiera, Oriana, Iwan Barankay, and Imran Rasul, 2005. "Social Preferences and the Response to Incentives: Evidence from Personnel Data," *Quarterly Journal of Economics*, 120(3): 917-962.
- [4] Bandiera, Oriana, Iwan Barankay, and Imran Rasul, 2010. "Social Incentives in the Workplace," *Review of Economic Studies*, 77(2): 417-458.
- [5] Basu, Kaushik, and Homa Zarghamee, 2009. "Is Product Boycott a Good Idea for Controlling Child Labor? A Theoretical Investigation," *Journal of Development Economics*, 88(2): 217-220.
- [6] Bechetti, Leonardo and Marco Costantino 2007. "The Effects of FairTrade on Affiliated Producers: An Impact Analysis on Kenyan Farmers," World Development, 36(5): 823–842.

- Bloom, Nicholas, James Liang, John Roberts, and Zhichun Jenny Ying, 2013.
   "Does Working from Home Work? Evidence from a Chinese Experiment," NBER Working Paper, No. 18871.
- [8] Brown, Drusilla K., 2006. "Consumer Product Labels, Child Labor and Educational Attainment," The B.E. Journal of Economic Analysis and Policy, 5(1): 1-29.
- [9] Chau, Nancy H., Hideaki Goto, and Ravi Kanbur, 2009. "Middlemen, Non-Profits, and Poverty," working paper, Cornell University.
- [10] De Janvry, Alain, Craig McIntosh, and Elisabeth Sadoulet, 2014. "Fair Trade and Free Entry: Can a Disequilibrium Market Serve as a Development Tool?," working paper, UC San Diego.
- [11] Fair Trade USA, 2012. "Fair Trade USA Alamanac 2012," Oakland, CA, http://fairtradeusa.org/resources/impact-reports,
- [12] Fairtrade Foundation, 2013. "Fairtrade Foundation Annual Review 2012/2013," London, UK, http://www.fairtrade.org.uk/what\_is\_fairtrade/annual\_reports.aspx.
- [13] Gibbons, Robert, 1987. "Piece-rate Incentive Schemes," Journal of Labor Economics, 5(4): 413-429.
- [14] Haley, M. Ryan, 2003. "The Response of Worker Effort to Piece Rates: Evidence from the Midwest Logging Industry," *Journal of Human Resources*, 38(4): 881-890.
- [15] Harrison, Ann, and Jason Scorse, 2004. "Moving Up or Moving Out? Anti-Sweatshop Activists and Labor Market Outcomes," NBER Working Paper 10492.
- [16] Harrison, Ann, and Jason Scorse, 2010. "Multinationals and Anti-sweatshop Activism," American Economic Review, 100(1): 247-73.

- [17] Hsieh, Chang-Tai, and Enrico Moretti, 2003. "Can Free Entry Be Inefficient? Fixed Commissions and Social Waste in the Real Estate Industry," *Journal of Political Economy*, 111(5): 1076-1122.
- [18] Isaac, R. Mark and James M. Walker, 1988. "Group Size Effects in Public Goods Provision: The Voluntary Contributions Mechanism," *Quarterly Journal of Economics*, 103(1): 179-199.
- [19] Jayaraman, Rajshri, Debraj Ray, and Francis de Vericourt, 2014. "Productivity Response to a Contract Change," NBER working paper, No. 19849.
- [20] Lazear, Edward P., 1986. "Salaries and Piece Rates," Journal of Business, 1986: 405-431.
- [21] Lazear, Edward P., 2000. "Performance Pay and Productivity," American Economic Review, 90(5): 1346-1361.
- [22] Moore, Geoff, 2004. "The Fair Trade Movement: Parameters, Issues and Future Research," *Journal of Business Ethics*, 53(1-2): 73-86.
- [23] Nalebuff, Barry J., and Joseph E. Stiglitz, 1983. "Prizes and Incentives: Towards a General Theory of Compensation and Competition," *Bell Journal of Economics*, 21-43.
- [24] Paarsch, Harry J. and Bruce S. Shearer, 1999. "The Response of Worker Effort to Piece Rates: Evidence from the British Columbia Tree-Planting Industry," *Journal of Human Resources*, 34(5): 643-667.
- [25] Ronchi, Loraine, 2002. "The Impact of Fair Trade on Producers and Their Organizations: A Case Study with CooCafe in Costa Rica," working paper, University of Sussex.
- [26] Sen, Amartya, 1966. "Labour Allocation in a Cooperative Enterprise," *Review of Economic Studies*, 33(4): 361-371.

- [27] Shearer, Bruce, 2004. "Piece Rates, Fixed Wages and Incentives: Evidence from a Field Experiment," *Review of Economic Studies*, 71(1): 513-534.
- [28] Stiglitz, Joseph E., 1975. "Incentives, Risk, and Information: Notes towards a Theory of Hierarchy," *Bell Journal of Economics*, 552-579.
- [29] The New York Times, 2010. "One Penny More a Pound," December 3, 2010.
- [30] The New York Times, 2011. "After Long Fight, Farmworkers in Florida Win an Increase in Pay," January 18, 2011.
- [31] The Wall Street Journal, 2010. "Major Growers to Join Wage Plan," October 13, 2010.

A Online Appendix: Additional Figures and Tables



Figure A.1: Penny-Per-Pound vs. Pieces



Figure A.2: Worker productivity in Grape vs. Round



Figure A.3: Farm-level productivity

1			
Year 1	Year 2	Year 3	
A: Wor	ker demog	graphics	
28.15	29.74	29.81	
(7.640)	(8.626)	(8.459)	
642	953	621	
0.125	0.117	0.109	
(0.331)	(0.321)	(0.312)	
649	959	625	
0.751	0.606	1.242	
(0.723)	(0.815)	(1.114)	
634	951	621	
B: Size of workforce			
236.5	332.7	334.8	
(125.2)	(142.5)	(129.7)	
167.2	267.6	288.4	
(104.4)	(124.6)	(91.22)	
154.3	224.5	251.7	
(111.2)	(137.3)	(109.2)	
780	1133	735	
C:	Transacti	ons	
112.9	113.5	135.3	
(59.39)	(64.93)	(54.40)	
5.182	4.690	5.275	
(2.044)	(2.097)	(1.585)	
10317	10597	6942	
14.09	11.56	12.57	
(9.444)	(8.512)	(9.742)	
5.277	4.223	4.847	
(2.823)	(2.386)	(2.410)	
10505	9845	7859	
	$\begin{array}{r} \hline \text{Year 1} \\ \hline \text{A: Wor.} \\ 28.15 \\ (7.640) \\ 642 \\ 0.125 \\ (0.331) \\ 649 \\ 0.751 \\ (0.723) \\ 634 \\ \hline \text{B: Si} \\ 236.5 \\ (125.2) \\ 167.2 \\ (104.4) \\ 154.3 \\ (111.2) \\ \hline 780 \\ \hline \text{C:} \\ 112.9 \\ (59.39) \\ 5.182 \\ (2.044) \\ 10317 \\ \hline 14.09 \\ (9.444) \\ 5.277 \\ (2.823) \\ 10505 \\ \end{array}$	Year 1Year 2A: Worker demog $28.15$ $29.74$ $(7.640)$ $(8.626)$ $642$ $953$ $0.125$ $0.117$ $(0.331)$ $(0.321)$ $649$ $959$ $0.751$ $0.606$ $(0.723)$ $(0.815)$ $634$ $951$ B: Size of worl $236.5$ $332.7$ $(125.2)$ $(142.5)$ $167.2$ $267.6$ $(104.4)$ $(124.6)$ $154.3$ $224.5$ $(111.2)$ $(137.3)$ 780 $1133$ C: Transacti $112.9$ $113.5$ $(59.39)$ $(64.93)$ $5.182$ $4.690$ $(2.044)$ $(2.097)$ $10317$ $10597$ $14.09$ $11.56$ $(9.444)$ $(8.512)$ $5.277$ $4.223$ $(2.823)$ $(2.386)$ $10505$ $9845$	

Table A.1: Descriptive statistics

Note: Mean with standard deviations in parentheses.

All	PPP	No PPP		
110.8	116.4	NA		
(74.69)	(72.20)			
1500 5	1000 5	<b>F</b> 10 1		
1720.7	1263.5	716.1		
(1138.7)	(762.9)	(399.4)		
1510 5	884.00	607.2		
1019.0	884.00	007.5		
(853.1)	(589.7)	(261.4)		
0.0734	0 0969	NA		
(0.0500)	(0.0455)	1111		
(0.0509)	(0.0455)			
0.0743	0.104	NA		
(0.0567)	(0.0577)			
(0.0007)	(0.0011)			
735	703	599		
	$\begin{array}{c} \text{All} \\ 110.8 \\ (74.69) \\ 1720.7 \\ (1138.7) \\ 1519.5 \\ (853.1) \\ 0.0734 \\ (0.0509) \\ 0.0743 \\ (0.0567) \\ 735 \end{array}$	$\begin{array}{c c c c c c c c c c c c c c c c c c c $		

Table A.2: Penny-Per-Pound and Worker Earnings

Note: Mean with standard deviations in parentheses.

Data from Year 3 (the post-PPP season).

Column All covers the entire season.

Column PPP covers weeks in which PPP-relevant sales occurred.

Column No PPP covers weeks in which no PPP-relevant sales occurred.

	De	ependent var.:	
	Aggregate field hours	Number of workers	Field hours
	at farm-level	at farm-level	per worker
	(1)	(2)	(3)
Predicted capacity	37.886***	$5.523^{***}$	0.017**
	(2.507)	(0.325)	(0.008)
Constant	239.226**	$59.101^{***}$	$5.397^{***}$
	(105.961)	(14.197)	(0.414)
Observations	92	92	92
R-squared	0.700	0.782	0.067

Table A.3: Daily predicted capacity, field hours worked, and number of workers

Notes: Robust standard errors in parentheses; \*\*\* p<0.01, \*\* p<0.05, \* p<0.1The coefficient on Predicted capacity is multiplied by 1000.

## **B** Online Appendix: Proofs

## **Proof of Proposition 1**

The first order condition (4) for worker *i* can be re-written as

$$Q(e_i^*; e_{-i}^*) \equiv \frac{\sum_j^N C(e_j^*, \theta_j)}{\sum_j^N f(e_j^*)} f'(e_i^*) - C_e(e_i^*, \theta_i) + \frac{\sum_{j \neq i}^N C(e_j^*, \theta_j)}{\sum_j^N f(e_j^*)} f'(e_i^*) = 0.$$

Know from (5) and from the symmetry between workers that

$$\begin{aligned} Q(e_i^0; e_{-i}^0) &= \frac{\sum_j^N C(e_j^0, \theta_j)}{\sum_j^N f(e_j^0)} f'(e_i^0) - C_e(e_i^0, \theta_i) + \frac{\sum_{j \neq i}^N C(e_j^0, \theta_j)}{\sum_j^N f(e_j^0)} f'(e_i^0) \\ &= \frac{(N-1)C(e^0, \theta)f'(e^0)}{Nf(e^0)} > 0. \end{aligned}$$

However, from f'' < 0 and  $C_{ee} > 0$ , know that  $\frac{\partial Q}{\partial e_i} \equiv \frac{\partial^2 u}{\partial e_i^2} < 0$ . That is, Q is a decreasing function of  $e_i$ . The fact that  $Q(e_i^*; e_{-i}^*) = 0$  and  $Q(e_i^0; e_{-i}^0) > 0$  thus implies that

 $e^0 < e^*$ .

## Proof of Lemma 2

The first order condition for each *i*'s utility maximization problem is (4) or u' = 0, where  $u' \equiv \frac{\partial u}{\partial e_i}$ . Taking the derivative of the FOC with respect to *p*, we obtain

$$\frac{\partial u'}{\partial p} + u'' \frac{\partial e_i^*}{\partial p} + \sum_{j \neq i}^N \frac{\partial u'}{\partial e_j} \frac{\partial e_j^*}{\partial p} = 0,$$

where  $u'' \equiv \frac{\partial^2 u}{\partial e_i^2}$ . By symmetry of  $\theta_i$  for all *i*'s,

$$\frac{\partial u'}{\partial p} = -\{u'' + (N-1)\frac{\partial u'}{\partial e_j}\}\frac{\partial e_i^*}{\partial p}.$$

Then,

$$\frac{\partial e_i^*}{\partial p} = \frac{\frac{\partial u'}{\partial p}}{(-u'') - (N-1)\frac{\partial u'}{\partial e_j}} = \frac{(+)}{(+) - (+)}$$
(15)

since

$$\frac{\partial u^{'}}{\partial p} = (1 - \frac{1}{N})f^{'} > 0,$$

$$u'' = \{p - \frac{pf(e) - C(e,\theta)}{Nf(e)}\}f''(e) - C_{ee} = \{p - u\}f''(e) - C_{ee} < 0,$$
(16)

and

$$\frac{\partial u'}{\partial e_j} = \left\{\frac{pf(e) - C(e,\theta)}{Nf(e)}\right\} \frac{\{f'(e)\}^2}{Nf(e)} = u \frac{\{f'(e)\}^2}{Nf(e)} > 0.$$
(17)

For  $\frac{\partial e_i^*}{\partial p} > 0$  in (15) to be true, we require  $-u'' > (N-1)\frac{\partial u'}{\partial e_j}$ , which can be written as

$$-\{(p - \frac{pf(e) - C(e, \theta)}{Nf(e)})f''(e) - C_{ee}\} > (N - 1)\{\frac{pf(e) - C(e, \theta)}{Nf(e)}\}\frac{\{f'(e)\}^2}{Nf(e)},$$
 (18)

using (16) and (17). Factoring out p and re-arranging the terms, re-write the condition (18) as:

$$p[\frac{\{f'(e)\}^2}{Nf(e)} + f''(e)] < \frac{N}{N-1} \{-\frac{C(e,\theta)}{Nf(e)}f''(e) + C_{ee} + \frac{N-1}{\{Nf(e)\}^2}C(e,\theta)\{f'(e)\}^2\}.$$
 (19)

In (19), the right-hand side is positive because f'' < 0 and  $C_{ee} > 0$ . The inequality in (19) will hold if

$$\frac{(f')^2}{Nf} + f'' < 0,$$

which is the condition stated in A1.

## **Proof of Proposition 3**

When N is fixed, for the PPP to increase the welfare of existing workers, we require  $\frac{\partial g(p,\overline{Y},N)}{\partial p} > 0$  when evaluated at the initial situation. From (7), know that

$$\begin{aligned} \frac{\partial g(p,\overline{Y},N)}{\partial p} &= \frac{\overline{Y}}{\sum_{j}^{N} f(e_{j}^{*})} f(e_{i}^{*}) + \frac{\partial g(p,\overline{Y},N)}{\partial e_{i}} \frac{\partial e_{i}^{*}}{\partial p} + \sum_{j\neq i}^{N} \frac{\partial g(p,\overline{Y},N)}{\partial e_{j}} \frac{\partial e_{j}^{*}}{\partial p}, \\ &= \frac{\overline{Y}}{N} \{1 - (\frac{N-1}{N}) \frac{pf(e^{*}) - C(e^{*},\theta)}{pf(e^{*})} \sigma_{f}\}, \end{aligned}$$

using symmetry between N workers; the fact that and that  $\frac{\partial g(p,\overline{Y},N)}{\partial e_i} = 0$  from the FOC in (4), and that  $\sigma_f \equiv \frac{df/f}{dp/p}$ . For  $\frac{\partial g(p,\overline{Y},N)}{\partial p} > 0$ , we require

$$\sigma_f < \frac{N}{N-1} \frac{pf(e^*)}{pf(e^*) - C(e^*, \theta)}.$$
(20)

A sufficient condition for (20) to hold is

 $\sigma_f < 1$ 

because

$$1 < \frac{N}{N-1} \frac{pf(e^*)}{pf(e^*) - C(e^*, \theta)}$$
(21)

from  $\frac{N}{N-1}>1$  and  $pf(e^*)>pf(e^*)-C(e^*,\theta).$ 

## **Proof of Proposition 4**

For the PPP to increase the welfare of existing workers, we require the derivative of  $\Omega$  evaluated in the pre-PPP situation in (9) to be positive. Since  $\sigma_N \leq 0$  and  $\frac{Bh(p,\overline{Y},N)}{p} \geq 0$ , a sufficient condition for  $\frac{\partial\Omega}{\partial p} > 0$  is

$$\frac{\partial g(p, \overline{Y}, N)}{\partial p} + \sigma_N \frac{g(p, \overline{Y}, N)}{p} > 0.$$
(22)

Know that

$$\frac{\partial g(p,\overline{Y},N)}{\partial p} = \frac{\overline{Y}}{N} [1 - (\frac{N-1}{N}) \frac{pf(e^*) - C(e^*)}{pf(e^*)} \sigma_f].$$
(23)

In addition, from  $g(p, \overline{Y}, N) > \frac{\overline{Y}}{\sum_{j}^{N} f(e_{j}^{*})} pf(e_{i}^{*})$ , we also know that

$$\frac{g(p,\overline{Y},N)}{p} > \frac{\overline{Y}}{N}.$$
(24)

Applying (23) and (24) and based on the fact that  $\sigma_N \leq 0$ , we can re-write the sufficient condition in (22) as follows:

$$\frac{\overline{Y}}{N}\left[1-\left(\frac{N-1}{N}\right)\frac{pf(e^*)-C(e^*)}{pf(e^*)}\sigma_f+\sigma_N\right]>0,$$

or

$$1 - \left(\frac{N-1}{N}\right) \frac{pf(e^*) - C(e^*)}{pf(e^*)} \sigma_f + \sigma_N > 0.$$
(25)

A sufficient condition for (25) to hold is

 $\sigma_f - \sigma_N < 1$ 

because of (21).