The High Quality of Piece-Rate Compensation

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Abstract

Using a unique database from the energy-related home services industry, we measure differences in quantity and quality outcomes between full time employees who are paid a daily rate and contractors who are paid by the number of jobs completed. The assignment of calls to technicians is independent of their employment status, hence overcoming issues of endogeneity that have afflicted previous studies in this area. We are therefore able to more precisely estimate the impact of incentives on performance. We find significant evidence supporting the prediction that piece-rate workers indeed work faster and complete more jobs. We find mixed evidence on the quality consequences of incentive compensation – although piece-rate workers yield comparable quality for low-creativity tasks, their quality is significantly lower for high-creativity tasks.

I. Introduction

A large literature explores the impact of different compensation systems on output (Lazear & Oyer 2012, Shearer 2004, Freeman and Kleiner 2005). A common finding is that piece-rate compensation elicits higher volumes of output from employees than time-based compensation, presumably by eliciting effort to work more rapidly. However, a more challenging question remains unanswered: how does piece-rate compensation affect the quality of the output?

Theoretical models predict that if quantity is monitored but quality is not (or is monitored less effectively than is quantity), then piece-rate compensation should lead workers to emphasize quantity over quality; quality of piece-rate-based output should be lower than that of output from time-based compensation (Gibbons 1987).[1] It is therefore not clear whether piece-rate compensation will yield higher quality-adjusted productivity than time-based compensation.

Although a growing body of empirical work has found evidence consistent with the predicted effect of piece-rate compensation on output quantity (Courty & Marschke 2004; Freeman & Kleiner 2005; Bandiera et al 2007), the empirical research has been largely silent on the issue of output quality. Thus far, it has been difficult to address this issue because, unlike quantity, the quality of output has been difficult to measure in non-experimental settings (an exception is Fernie & Metcalf's 1999 study of jockeys under varying payment schemes, which does not have sufficient data to support large-scale regression estimation).

In this paper, we use a novel data set to overcome constraints that have afflicted prior research. Our setting is the energy-related home services industry. A large North American firm has agreed to provide confidential access to detailed data on every service call in a specific state/province over two 12-month periods, totaling over 500,000 visits to residences. We call this firm EnergyServCo and the state/province BigState.[2]

These data are well suited to testing theories as they relate to quality and quantity. The company uses a mixture of employees who are paid a daily wage and contractors who are paid by the number of jobs completed. We are able to measure almost every aspect of the job including the nature of the job, the time each job takes to complete, as well as whether the customer subsequently calls the company back for follow up service, thus allowing us to capture quality of work.

One of the major challenges with such studies relates to endogeneity, namely the allocation of jobs or tasks to piece-rate workers and employees is not random, thus limiting the ability to compare performance across jobs. This challenge is overcome in the current paper as the allocation of service calls to technicians is based on who is next in the queue and who is in proximity to the address, thus mitigating issues of endogeneity. As such, we are able to more precisely measure the impact of incentives on work effort.

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[1] Quality-shading is one variant of the general problem of the "gaming" of incentive systems by agents. Another example of gaming relates to the timing of effort, e.g. manipulating sales to exploit quarterly targets (Larkin 2007).
[2] The firm wishes to retain confidentiality. As a result, we occasionally resort to inelegant language such as "BigState" to avoid naming the particular state or province from which the data come.

Our results are consistent with prior research that finds that piece-rate workers work faster, and as a result complete more tasks, than time-rate employees. We find that piece-rate contractors drive more quickly between jobs, are more likely to find customers at home and complete jobs more quickly than employees, speaking directly to the underlying incentives – contractors only get paid if the job is completed, whereas employees are paid hourly. Contractors are incented to work as fast as possible so as to complete as many jobs as possible in any given shift. Employees, being paid by the hour, have less of an incentive to do so, and these predictions are borne out in the data.

We also explore the quality of work by measuring the likelihood that the same customer calls the company for subsequent service within given periods of time. We can determine whether subsequent calls are for the same problem, another problem with the same piece of equipment (e.g., furnace or air conditioner), or a problem with another piece of equipment. This feature of the data therefore allows us to measure quality differences between services rendered by employees and technicians.

We find mixed evidence on quality. Notably the incentive structures have differential impacts on quality depending upon the nature of the job in question. When tasks are routine (specifically, maintenance jobs), piece-rate workers and employees generate qualitatively identical rates of call-backs. However, when tasks are less routine (specifically, repair jobs), piece-rate workers generate higher rates of call-backs, which we interpret as lower quality. These results help to clarify the conflicting results from previous studies that have focused on a single type of task. For example, studies that look at low-variability tasks such as tree planters (Shearer (2004)), windshield installers (Lazear (2000)) or letter writers Dickinson (1999) have found relatively small decreases in quality from piece-rate compensation. In sharp contrast, recent studies of environments that require exploration and creativity have found that high-powered incentive structures can undermine performance (Ederer and Manso (2013)).

The paper proceeds as follows. In Section II we provide information about our subject firm, EnergyServCo. In particular, we describe its employment arrangements and detail how service calls are scheduled and accomplished. Section III presents model specification the data and Section IV provides estimation results. In Section V we provide a discussion and conclusions.

II. EnergyServCo

EnergyServCo is among the largest retailers of energy services in North America, with several million customers across many jurisdictions in the United States or Canada. As part of its operations, EnergyServCo offers maintenance and repair services. These include installation, maintenance, and service of heating, ventilation, and air conditioning (HVAC) equipment, water heaters, plumbing, and other electrical equipment. EnergyServCo's service unit in BigState is divided into more than 20 geographically based sub-units, mostly conforming to large towns or counties. Each sub-unit has its own dedicated technicians, and is responsible for maintaining staffing levels and for ensuring quality of technical service.[3]

[3] EnergyServCo has outsourced management of service (as well as many other activities) to franchise organizations in a handful of geographic sub-units. In this study, we exclude consideration of franchised sub-units.

EnergyServCo is a subsidiary of a large electric utility, which acquired EnergyServCo shortly after the electricity industry was deregulated in the late 1990s. In turn, EnergyServCo's parent is owned by a large multinational firm. Neither the direct parent nor the ultimate parent is actively involved in EnergyServCo's operations.

The study focuses on EnergyServCo's maintenance and service activities in a large state or province that we shall call BigState. In BigState, EnergyServCo has traditionally rented water heaters to customers. Under terms of the rental agreement, maintenance and service remain the responsibility of EnergyServCo. In addition, homeowners who own their heating equipment frequently purchase annual service contracts from EnergyServCo. It is also possible for a homeowner who owns the equipment and who does not have a service contract to call EnergyServCo for maintenance and service on a fee-per-service basis. EnergyServCo has roughly one million household customers in BigState, roughly 300,000 of which purchase annual servicing contracts.

As a vast majority of service calls are covered by rental agreements or service contracts, EnergyServCo's chief economic goal is to perform projects at as low a cost as possible. The installation of new parts and the devotion of large amounts of technician time (at least in the case of employee-technicians) impose costs on EnergyServCo with no direct recompense from customers. The exception to this is when a technician persuades a customer to buy a new piece of equipment or service from EnergyServCo.

EnergyServCo may dispatch technicians to a home for one of two types of calls: service or maintenance. Maintenance calls are fairly routine and are regularly scheduled as part of annual contract with customers: technicians show up at the home and inspect the equipment in question, such as a furnace, air conditioner or water heater. These calls are not associated with the homeowner having a problem with the equipment. In sharp contrast, service calls involve the homeowner experiencing a problem with the piece of equipment, and hence call EnergyServCo for service. Unlike the case of maintenance, a service call involves an inspection process and the need to diagnose the problem and develop the appropriate solution. As such, the nature of the two types of calls is quite different.

Technician Characteristics

EnergyServCo relies on a mix of company employees and independent contractors to handle maintenance and repair calls. Of particular note for this study, company employees are unionized and, per successive union-EnergyServCo contracts dating back more than 15 years, are paid on a day-rate basis. In contrast, independent contractors are paid per completed job.

EnergyServCo's technicians are expected to be able to resolve a wide range of problems associated with heating, ventilation and air conditioning (HVAC) equipment. All of EnergyServCo's technicians are licensed by BigState. All of EnergyServCo's technicians carry personal liability insurance; EnergyServCo pays for this for all of its employees and for virtually all of its independent contractors. In addition, BigState certifies technicians as being qualified for particular types of work, such as servicing of air conditioners (which require knowledge of both cooling systems and electrical systems).

Aside from the difference in compensation scheme, there are three other differences between EnergyServCo employees and EnergyServCo contractors. First, EnergyServCo employees are fully employed by EnergyServCo. In contrast, many contractors work only part-time for EnergyServCo – in some cases working full days but only on weekends, in other cases working only during peak seasons. Second EnergyServCo employees are likely to get "better" shifts, such as normal daytime hours rather than evening/nighttime shifts. Third, EnergyServCo employees drive EnergyServCo vans and carry EnergyServCo-mandated inventory on board, while contractors drive their own (or their companies') vans. The contractors who are fully utilized by EnergyServCo have decals on their vans with the EnergyServCo logo. All but the most casually used contractors have EnergyServCo dashboard computers. For those that do not, data must be captured using pen and paper.

Assigning Technicians to Jobs

When a customer has a problem with her HVAC, or other equipment, she reports the problem by calling the customer service line at EnergyServCo. The customer service representative collects information including the home address and the nature of the problem – for example, "the heat isn't coming on" or "the air conditioner is making excessive noise." The representative enters this information into EnergyServCo's computer system, including the "problem" code that categorizes the type of problem described by the customer.

The computer system, which keeps track of all scheduled home visits and of available technician-hours in an area, generates a range of possible four-hour time blocks during which a service technician will be able to visit the customer's house to address the problem. The customer and representative converge on a preferred time block that will fit the customer's schedule, and the representative enters this into the computer system. A typical time block might be between 1pm and 5pm on the day of the customer's phone call.

On the day of the home visit, the homeowner's call is one of several in her geographic region attached to a particular time block. EnergyServCo's dispatching computer system assigns calls to technicians throughout the day. For the first call of each technician's shift, the computer assigns a call that is close to the technician's home. After that, the computer assigns jobs to technicians in real-time as jobs get completed. At any one time, the computer assigns two jobs to a technician – the job he is currently working on and the job that will follow immediately afterward.

Of particular interest for this study is that EnergyServCo's system works much like a taxi dispatching system in that it assigns jobs to technicians based on geographic proximity. In other words, as the homeowner's job nears the top of the queue, EnergyServCo's dispatching system assigns it to the closest technician who is expected to finish his previous job in time to arrive at the home within the promised time block. It must be emphasized that the EnergyServCo dispatching system does not assign technicians based on their status as employee or contractor, but rather simply on their availability and closeness to the particular job site. Thus these assignments are not subject to concerns about endogeneity that frequently afflict studies of mode choice and performance, and as such allows for a clean identification of differences in performance between employees and contractors based on compensation scheme.

From the technician's point of view, the day goes as follows. The technician leaves his home and gets into his van, which he drives home after work each day. He punches the "job" button on his dashboard computer in order to get the details on his first destination of the day. The dashboard computer then provides the name of the customer, the address of the call, and a code that indicates the general nature of the problem. The technician then drives to the address. When he arrives and is about to leave his vehicle to knock on the customer's door, he pushes the "arrived" button on the dashboard computer. The computer then provides the address for his subsequent call, so that he knows where he will be going after his call is completed. The technician then approaches the home and, if he is able to gain entry, does the job required. In the case of maintenance, this is usually routine and typically requires a fairly straightforward inspection. In contrast, in the case of a service call, the technician must first diagnose and then fix the problem that led to his customer's service call.

Service/Maintenance Call Outcomes

A service call can end in one of three ways. First, the customer may not answer the door. In this case, the technician returns to his vehicle and enters the "customer didn't answer" code on the dashboard computer. Later, an EnergyServCo representative will call the customer to reschedule the appointment. Second, the technician fixes the problem. In this case, he returns to his vehicle and enters the "successfully completed" code on his computer. Third, the technician diagnoses the problem but finds that he does not have the requisite part(s) to fix it in his 250-part inventory that he carries in his van. In this case, he returns to his vehicle and enters the "need part X" code into his dashboard computer. Later, an EnergyServCo operations person will arrange for part X to be delivered to the customer's home in conjunction with another technician who will fix the problem. EnergyServCo's managers have a strong preference for successful resolution, both because customers prefer this outcome and because it is costly for EnergyServCo to provide another visit.[4]

Whatever the outcome, the technician enters the appropriate completion code into his dashboard computer upon returning to the vehicle. This enables him to get additional information about the next call he will be making. The EnergyServCo communication system provides information on future jobs to technicians only as they complete existing tasks. This provides the technician with a strong incentive to enter codes indicating progress upon completion of each task (driving to a home; arriving at the home; completing the job). Thus we are confident that the data regarding time spent on each job is accurate.

Of course, a technician might declare victory over a problem prematurely. Sometimes, a technician visits and appears to have resolved a problem, but afterward the customer continues to have trouble. The customer than calls EnergyServCo's customer service line again, and the cycle

[4] EnergyServCo may also be interested in other measures of performance such as customer satisfaction measures or upselling activity by the technicians. Given such data are not available, these dimensions remain outside the scope of this paper.

repeats anew. This feature of the data allows us to identify the quality of the work undertaken by the technician, and test whether there are systematic differences between employees and contractors. We are able to identify whether there is a follow up call to the same address for the same problem, for another problem on the same piece of equipment, or a problem on another piece of equipment at the same home. While the focus on those call backs for exactly the same problem on the same piece of equipment would allow for a very precise measure of quality, there may also be significant information in these broader measures of quality as well. For example, to the extent that company employees of EnergyServCo spend more time at the home relative to contractors, perhaps addressing or looking for other potential problems in in the home, the likelihood of being called back to the home will fall, and will be captured by fewer call-backs to the same address. This allows us to address a much richer measure of quality of work undertaken.

III. Data and Specification of the Model

As described above, EnergyServCo records a large amount of information about each call that its energy services division handles. We obtained from EnergyServCo the records associated will calls handled in BigState during the years 2009 and 2012. These comprise over 500,000 service and maintenance calls across 22 geographic sub-units. Table 1 provides a summary of the data available for each call. Using the fields described in Table 1, we construct several variables that we use to undertake our analysis, which are reported in Table 2.

******* Insert Table 1 *******

******* Insert Table 2 *******

<u>Conceptualizing the Process</u>

In undertaking our analysis, we focus on each of the four distinct phases in the call process. The first involves driving to the address where the job is to be completed. This variable is called “Drive Time.” Second, once arrived, the technician must gain entry to the home by knocking on the door or ringing the doorbell. This variable is defined as “Gained Entry,” and will be 1 if entry in the home is gained, 0 otherwise. Third, once entry is gained, the technician does the job. If he is able to compete the job successfully, then he chooses the completion code “Job Completed.” This allows us to measure how long it took to do the job, a variable we call “Job Time.” It is also possible that the technician does not have the required part, hence the completion code “Parts Ordered” is chosen by the technician. Fourth, from the data we are able to also measure whether there is another call from the same address at specific points in the future. We define three separate defect variables: Exact indicates a call back for the same problem; Equipment indicates a call back for a different problem but on the same piece of equipment; and Site indicates a call back for a problem on another piece of equipment but at the same address. These are therefore used as three measures of quality. We construct these call-back measures for 15-, 30-, 60- and 90-day windows following the initial call.

IV. Data Description

In 2009, EnergyServCo's had 274 company employees and 128 independent contractors in BigState in 2009, and 286 and 188 in 2012, respectively. In the case of employees, 89% worked more than 100 days in a given year, and 95% work more than 30 days. In contrast, 48% of contractors worked more than 100 days, and 65% worked more than 30 days. This reflects EnergyServCo's reliance on contractors to manage peak demand at certain times of the year. For the bulk of our results, we focus on the "core" set of technicians who work for EnergyServCo more than 30 days per year. The results are the qualitatively the same when we restrict the sample to technicians with more than 100 days of work, or when we include all technicians regardless of how many days/year they work for EnergyServCo.

In 2009, there were 254,796 calls, of which 167,058 were for service and 87,738 for maintenance. The total number of calls in 2012 was 264,769, of which 147,658 were for service and 117,112 for maintenance.

Company employees handled 77% of the service jobs and 63% of the maintenance jobs in 2009. In general, independent contractors were more likely to work overnight shifts and weekends, and some contractors work during the peak service season of October-November (when homeowners typically discover problems with their heating systems) and May-June (when air conditioner problems are revealed).

EnergyServCo technician calls span 54 different job types. Each job type identifies a specific piece of equipment and a specific problem or task. Examples include "air conditioner making excessive noise," "furnace not working," and "water from water heater not hot enough." The twelve most frequent job types account for nearly 90% of all calls.

V. Empirical Analysis

In this section, we measure whether there are systematic differences in the behavior and outcomes of contractors and employees. We hypothesize that contractors, who are paid by the number of jobs completed, will work faster and complete more jobs than employees. We will also address whether there are systematic quality differences between these two groups of technicians.

To test these hypotheses, we estimate the following model:

$$\begin{aligned} Outcome_i \;=\; & \alpha + \beta(Contractor_i) + \Sigma_m\, \gamma_i^m(month_i) + \Sigma_d \gamma_i^d(day_i) + \Sigma_h \gamma_i^h(hour_i) \\ & + \Sigma_c \gamma_i^c(city_i) + \Sigma_j \gamma_i^j(JobType_i) + \varepsilon_i \end{aligned} \tag{1}$$

where *Contractor*$_i$ is a dummy variable equal to 1 if the technician on the particular call is a contractor, and 0 if he is an employee, γ_i^m captures month fixed effects, γ_i^d day fixed effects, γ_i^h hour fixed effects, γ_i^c city fixed effects, and γ_i^j are job type fixed effects for the 12 most common job types in the sample. The coefficient of interest is β which captures the difference in the outcome measure for contractors and employees, after controlling for the fixed effects noted above. The outcome variables to be considered are Drive Time, Gain Access, Job Time, Parts Ordered, and the three Defect variables, namely exact, equipment and site. We consider these in turn.

<u>Who Drives Faster?</u>

Given that contractors are paid per job, they have an incentive to drive faster so they can complete more jobs in any particular day, thus earning a higher income. In sharp contrast, employees are not compensated by the number of jobs completed, but rather a flat rate for the day. As such, they have less of an incentive relative to contractors to drive quickly. We therefore hypothesize that controlling for month, day, hour, city and the job type, contractors will drive more quickly between jobs relative to employees. That is, we expect that the coefficient estimate on the contractor variable (β) will be negative.

Regression results for equation (1) with Drive Time as the dependent variable are presented in Table 4. The results are consistent with the predictions of theory. For both 2009 and for 2012, with and without fixed effects, for all calls, or whether we focus on service calls or maintenance calls, the coefficient on contractor variables is systematically negative and statistically significant. This is our first piece of evidence to indicate that indeed contractors work faster, or in this case, drive faster between jobs.

******* Insert Table 4 *******

<u>Who finds people at home most?</u>

Once a technician arrives at the site where the work is to be completed, he knocks on the door or rings the doorbell in order to gain entry. In the event there is no one home, the technician returns to the vehicle and enters the “customer not home” code into the dashboard computer. One would expect there to be little difference in the true incidence of people not being at home for contractors or for employees.

The regression results using Gained Access as the dependent variable are reported in Table 5. The results indicate systematically that contractors are more likely to gain access to the home. Or stated differently, contractors are less likely than employees to find that the customer is not home. These results hold in the absence and in the presence of fixed effects. Thus, for the same month, day of the week, time of the day, jurisdiction and job type, contractors are more likely to gain access to the home relative to company employees.

As in the case of drive times, these results are consistent with predictions of the theory. The incomes of employees are not directly impacted by finding the customer being home. In sharp contrast, the contractor only gets paid when he is able to gain entry and complete the job. As such, the incentives are stronger for the contractor to gain entry relative to those of the employee, and this is borne out in the data.

******* Insert Table 5 *******

Who is most likely to indicate they don't have the part?

Once a technician begins the job there is a possibility that he will not have the requisite part to complete the job. As the regression results in Table 6 demonstrate, contractors are more likely to indicate they needed a part in the case of service jobs, but less likely in the case of maintenance jobs. What might cause this?

Maintenance jobs tend to be far more predictable than service jobs, with a more predictable requirement for specific replacement parts. On average, EnergyServCo contractors carry less inventory than employees. Anecdotal evidence indicates that this inventory is skewed toward the more commonly needed replacement parts. We speculate that contractors are less likely to be at an "inventory disadvantage" for maintenance jobs than for service jobs; hence their low level of "need parts" outcomes for maintenance vs. service jobs.[5]

******* Insert Table 6 *******

Who finishes the job faster?

A key hypothesis being tested in this paper relates to whether contractors who are paid by the job result in their working faster than employees, controlling for all other factors. As noted above, the dispatching system of EnergyServCo allocates call to employees and contractors in such a way that any effects of endogeneity are mitigated. It must be stressed here again that the jobs undertaken by employees and contractors are the same: the allocation of jobs is based solely on who is next in the queue and also closest to the site location. Any systematic differences in the time it takes to complete jobs should therefore be attributed to differences in incentives.

As noted above, contractors have a significantly stronger incentive to complete jobs more quickly relative to employees as they are paid by the job. The more quickly a contractor completes a job, the sooner he can move on to the next job and hence increase his compensation. In sharp contrast, the employee is not compensated extra for finishing a job more quickly – he is simply paid by the hour. As such we expect the contractors to finish jobs more quickly.

[5] This raises two questions. First, why doesn't EnergyServCo require contractors to carry a specified distribution of inventory on their trucks? North American laws restrict the extent to which an organization can specify such details for independent contractors, thus precluding this option. Second, if both contractors and employees have similar levels of the requisite parts for maintenance jobs, then why would employees generate "need part" outcomes more than contractors? Incentive theory would predict that a piece-rate technician will be more highly motivated to successfully complete a job than a day-rate technician, such that a tired employee would be more likely (on the margin) to give up and claim the need for a part than a contractor would. In a companion study (Suppressed for anonymity, 2015), we find that "need parts" outcomes do not occur randomly, but in fact occur more frequently at the end of a technician's shift and on days with highly anticipated professional sporting events – and these effects are more prevalent among employees than contractors.

Regression results with Job Time as the dependent variable are provided in Table 7. They indicate that with or without fixed effects, contractors finish jobs more quickly relative to employees. Even though contractors are faster with respect to both service and maintenance jobs, contractors are relatively quicker for maintenance jobs than is the case for service jobs. This may relate to the fact that maintenance jobs tend to be routine, and incentive compensation has been shown to work well in routine environments. In contrast, such compensation tends to not work as well for tasks that require exploration. These results are consistent with those previous results. That is, it is entirely possible that nature of the tasks involved drive the relatively fast contractor performance in maintenance jobs.

******* Insert Table 7 *******

<u>Addressing alternative explanations: Employees resemble contractors on "short days"</u>

Thus far we have found that contractors drive faster and complete jobs faster than employees, as well as finding customers home more readily. We have attributed these differences to the effect of piece-rate incentive compensation for the contractors.

However, one could imagine that employees and contractors differ on unobserved dimensions that drive these results. For example, if employees are on average older, then they may drive more prudently and work at a more steady, measured rate than their immature contractor counterparts. More generally, there might be an employee "trait" that generates these differences between employees and contractors, with incentive compensation merely spuriously correlated with the differences.

An ideal experiment would assign the same technician to jobs under different compensation systems, sometimes as a piece-rate technician and sometimes as a day-rate technician. EnergyServCo does not do this. However, we are able to exploit one source of variation in employee incentives that allows us to approximate this experiment. Specifically, we can identify an environment in which there are increased incentives for employees to work quickly.

A few times during the year, EnergyServCo experiences "short days." On short days, there are too few jobs to keep an employee occupied for the entirety of his shift. On such days, the employee remains on call throughout his shift but is allowed to go wherever he wants during the downtime. Most employees choose to either spend time at home or at coffee shops (usually with other employees). Put differently, on a short day an employee who finishes his work will be able to relax at home or with friends. This results in an incentive for the employees to work faster relative to days when there are sufficient jobs to keep them busy through the end of their shift. This of course would not apply to contractors as they are paid only by the number of jobs. If there are not sufficient jobs to keep the contractor busy, he is dismissed for the rest of the day and hence does not get any further compensation.

The regression specification is expanded to include a Short Day variable and an interaction term between the contractor and short day.

$$Outcome_i = \alpha + \beta^{c}(Contractor_i) + \beta^{SD}(Shortday_i) + \beta^{c,SD}(Contractor_i * Shortday_i) + \Sigma_m \gamma_i^m(month_i) + \Sigma_d \gamma_i^d(day_i) + \Sigma_h \gamma_i^h(hour_i) + \Sigma_c \gamma_i^c(city_i) + \Sigma_j \gamma_i^j(JobType_i) + \varepsilon_i \quad (2)$$

Regression results are provided in Table 8. As the regression results indicate, even in the presence of a contractor dummy and the contractor dummy interacted with the short day variable, the short-day variable alone is negative and highly significant. That is, there is a strong effect on how quickly employees work on short days: employees work much faster on short days relative to normal days – in some cases up to 12 minutes faster. These are effects are strongly significant and very large. Overall, employees reduce their driving and job-completion time overages (relative to contractors) by more than half on short days. It is difficult to accommodate this in any explanation that rests on an employee "trait" rather than on the influence of incentive compensation.

******* Insert Table 8 *******

Measuring Quality Differences between Contractors and Employees

Why is it the case that employees take a longer time to complete jobs than contractors? While it is quite likely that the incentive hypothesis discussed above is driving these outcomes, there may be an alternative hypothesis as well. Even though we have controlled for job type, the equipment being repaired, and time of day, day of week and month of the year, it may still be possible that employees are spending more time in the home for other reasons. It is possible that employees devote more effort than contractors to ensuring the their work is done properly, or spend additional time identifying other potential problems at the customer's site, or spend more time "chatting" with customers to enhance the company's brand (something that contractors have less of an incentive to do). Although we can not easily examine the "chatting" possibility, we now turn to considering whether employees do higher quality work than contractors.

A direct measure of quality would be reflected in the likelihood there is another call from the same address for the exact same problem, while a broader measure would be captured by whether there are calls back to home for other problems in the home. To the extent employees are spending more time identifying additional problems in the home may result in fewer call backs to the same home for other problems – that is other than the exact same problem the technician was there to fix. That is, are employees being proactive in looking for other potential problems?

We track whether there is a subsequent call to the same address at any point after an initial call. We assess three measures of quality. The most direct measure of quality relates to whether a customer calls back within 15, 30, 60 or 90 days for the exact same problem on the same piece of equipment. To the extent there are systematic differences in call back rates between contractors and employees will speak to how well the work was done – this would be the most precise measure of quality considered.

We also consider two broader measures of quality. We measure whether there is a call back to the home for a "different" problem on the same piece of equipment and a most broad measure of quality is captured by whether there is a call back to the same address for a problem on a different piece of equipment.   Table 9 reports the coefficients on the contractor variable for the different measures of quality.

******* Insert Table 9 *******

In the case of Service calls, homes that were served by contractors are more likely to have call backs for the exact same problem, but not for the broader measures of quality. In the case of maintenance, there is no measured difference in the call back rate. As noted above, maintenance calls are far more repetitive and standard relative to service calls. Consistent with previous evidence for these routine tasks, incentive contracts result in higher output but no measured difference in quality. In sharp contrast, in the case of service, which requires a certain extent of exploration, piece rate does indeed result in higher quantity of work but not quality.

<u>What could explain the higher defect rates related to contractor work?</u>

In order to consider differences in defect rates between contractors and employees, we take into account the time involved. More specifically, we create a variable which is equal to 1 to identify calls where the time involved is above average. That is, we measure whether this is a systematic relationship between those jobs that are taking longer and defect rates, and how this effect differs between employees and contractors. It is hypothesized that the longer the call is taking will have less of an impact on employees as they have less of an incentive to hurry. In contrast, once a contractor realizes the call is taken longer than average, he may be incented to hurry and hence be less careful and diligent in his work. The regression is expanded as follows to take into account the above average time variable:

$$\begin{aligned} Outcome_i \; = \; & \alpha + \beta^{c}\,(Contractor_i) + \beta^{AAT}\,(\,Above\ Average\ Time_i) \\ & + \beta^{c,AAT}(Contractor_i * Above\ Average\ Time_i) \\ & + \Sigma_m\,\gamma_i^m(month_i) + \Sigma_d\gamma_i^d(day_i) + \Sigma_h\gamma_i^h(hour_i) + \Sigma_c\gamma_i^c(city_i) \\ & + \Sigma_j\gamma_i^j(JobType_i) + \varepsilon_i \end{aligned} \qquad (3)$$

***** Insert Table 10 *****

As Table 10 shows, there are significant differences in these results between service and maintenance calls. In the case of service calls, there is no impact for calls taking a longer than average time on the likelihood of there being a defect, that is, a call back.   In sharp contrast, for maintenance calls taking more than an average amount of time, contractor jobs are more likely to result in a call back.

One interpretation is that contractors, paid by piece-rate, may become impatient as a job extends beyond its expected duration, and consequently declare victory over a job prematurely.

Conclusions

Using a unique data set, we have been able to contribute to the literature on incentive compensation. We find that piece-rate technicians complete jobs faster, drive between jobs faster, and are more likely to find customers at home than are daily-rate technicians, consistent with incentive theory. We find that these behaviors are particularly stark for maintenance jobs, which tend to be routine, as compared to service jobs, which are characterized by higher variability and creativity. We also find that piece-rate technicians generate comparable levels of quality in their work for routine maintenance jobs, but offer lower levels of quality for non-routine service jobs. This result links prior empirical studies that have focused on either routine or non-routine tasks, and suggests situations in which piece-rate compensation may be particularly suitable or particularly unsuitable.

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Table 1. Variables in the EnergyServCo data	
Field	Description
District ID	Unique identifier for specific geographic district within BigState
Site ID	Unique identifier for location where maintenance/repair call is made
Technician ID	A unique code associated with each technician making the call; the last digit indicates whether he is an employee or a contractor
Order Code	Code denoting the type of equipment that is the subject of the call and the type of problem that it is being reported
Activity	Categorical variable denoting either maintenance call or repair (service) call
Creation Time	Date/time that the work order was created
Required data	Date/time that customer is told to expect the technician (4-hour time-slot)
Enroute time	Date/time that technician begins to drive to the site for the call
Arrival time	Date/time that technician arrives at the site of the call
Completion time	Date/time that technician completes the call
Completion code	Code denoting one of three results: 1) Homeowner (or tenant) not home 2) Need additional part to fix the problem 3) Call successfully resolved
Needed-part code	Code denoting the type of part needed to fix the problem (if applicable)
Revenue	What the company would charge for this service to a customer who owns her equipment and who does not have a service plan. This is an internal charge to another division for customers who have rented equipment or who have service plans.
Cost	Cost incurred by the company to complete the call. This includes both Labor cost and Parts costs.
Labor cost	Labor cost incurred by the company to complete the call. (Hourly wage)*(length of call) for employee technicians; Piece rate for the relevant Order Code for independent contractor technicians.
Parts cost	Actual cost of parts used.

Table 2. Variables constructed from the EnergyServCo data	
Drive Time	Arrival Time – Enroute time (measured in minutes)
Gained Access	0 if Completion code = 1; 1 otherwise
Job Time	Completion time – Arrival time (measured in minutes)
Total Call Time	Completion time (current call) – Completion time (previous call)
Parts Ordered	1 if Completion code = 2; 0 otherwise.
Contractor	1 if technician is a contractor; 0 if technician is an employee
JobCode	Categorical variables denoting the type of equipment to be serviced and problem reported: e.g., furnace not turning on; air conditioner making excessive noise, water heater not heating water; etc.
Problem Code	Dummy variables for type of problem ie. not turning on, making noise
Defect--Exact	1 if technician reports problem fixed and then homeowner calls back with same problem within N days. Dummy variables are created for each of 15, 30, 60, or 90 days
Defect--Equipment	1 if technician reports problem fixed and then homeowner calls back with a different problem on the same piece of equipment within N days. Dummy variables are created for each of 15, 30, 60, or 90 days
Defect--Site	1 if technician reports problem fixed and then homeowner calls back with a problem on a different piece of equipment within N days. Dummy variables are created for each of 15, 30, 60, or 90 days.
Longjob	1 if a job takes longer to complete than the average job of its type; else 0.

Table 4
OLS estimation: Drive Time as a function of compensation type

	2009				2012			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
	All Calls	All Calls	Service	Maintenance	All Calls	All Calls	Service	Maintenance
Contractor	-4.684*** (0.0585)	-3.863*** (0.0630)	-5.23*** (0.0851)	-2.097*** (0.0935)	-3.513*** (0.0595)	-2.186*** (0.0632)	-3.686*** (0.0938)	-0.949*** (0.0896)
Month FE	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Day FE	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Hour FE	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Metro area FE	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Job type FE	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Constant	15.43*** (0.0307)	26.83*** (2.057)	17.55*** (3.134)	33.39*** (2.756)	15.76*** (0.0347)	29.10*** (3.098)	32.50*** (3.704)	11.39 (6.804)
Observations	254,796	254,796	167,058	87,738	264,769	264,769	147,657	117,112
Adjusted R-squared	0.025	0.105	0.105	0.118	0.013	0.076	0.081	0.078
F	6414.2	292.5	208.2	166.9	3487.0	222.9	141.8	143.8

Standard errors in parentheses
* p<0.05; ** p<0.01; *** p<0.001

Table 5
Logit estimation: "Customer Not Home" as function of compensation type

	Year = 2009				Year = 2012			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
	Service	Service	Maint.	Maint.	Service	Service	Maint.	Maint.
Contractor	-0.026*** (0.001)	-0.024*** (0.001)	-0.071*** (0.001)	-0.075*** (0.002)	-0.023*** (0.001)	-0.022*** (0.001)	-0.051*** (0.001)	-0.051*** (0.001)
Month FE	No	Yes	No	Yes	No	Yes	No	Yes
Day FE	No	Yes	No	Yes	No	Yes	No	Yes
Hour FE	No	Yes	No	Yes	No	Yes	No	Yes
Metro area FE	No	Yes	No	Yes	No	Yes	No	Yes
Job type FE	No	Yes	No	Yes	No	Yes	No	Yes
Constant	0.034*** (0.001)	-0.023 (0.037)	0.073*** (0.001)	0.070 (0.044)	0.028*** (0.001)	0.017 (0.036)	0.057*** (0.001)	0.009 (0.077)
No. Obs	180,267	180,267	103,370	103,370	158,029	158,029	138,021	138,021
Adj. R-sq	0.004	0.008	0.026	0.032	0.005	0.008	0.019	0.021
F	781.5	17.17	2723.3	49.30	752.1	14.49	2621.5	43.93

Standard errors in parentheses
* p<0.05; ** p<0.01; *** p<0.001

Table 6 Logit estimation: "Need a part" as function of compensation type								
	2009				2012			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
	Service	Service	Maint.	Maint.	Service	Service	Maint.	Maint.
Contractor	0.052*** (0.002)	0.033*** (0.002)	-0.004*** (0.001)	-0.005*** (0.001)	0.026*** (0.002)	0.017*** (0.002)	-0.002*** (0.000)	-0.002*** (0.000)
Month FE	No	Yes	No	Yes	No	Yes	No	Yes
Day FE	No	Yes	No	Yes	No	Yes	No	Yes
Hour FE	No	Yes	No	Yes	No	Yes	No	Yes
Metro area FE	No	Yes	No	Yes	No	Yes	No	Yes
Job type FE	No	Yes	No	Yes	No	Yes	No	Yes
Constant	0.129*** (0.001)	0.257*** (0.075)	0.005*** (0.000)	-0.004 (0.013)	0.112*** (0.001)	0.244** (0.078)	0.002*** (0.000)	0.008 (0.016)
Observations	180,267	180,267	103,370	103,370	158,029	158,029	138,021	138,021
Adjusted R-squared	0.004	0.059	0.001	0.006	0.001	0.050	0.000	0.002
F	708.0	121.0	122.7	9.192	205.4	89.33	51.45	5.466

Standard errors in parentheses
* p<0.05; ** p<0.01; *** p<0.001"

Table 7
OLS estimation: Job Time (job duration) as a function of compensation type

	2009				2012			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
	All Jobs	All Jobs	Service	Maintenance	All Jobs	All Jobs	Service	Maintenance
Contractor	-7.923*** (0.151)	-4.463*** (0.154)	-3.548*** (0.213)	-6.170*** (0.217)	-14.62*** (0.139)	-9.493*** (0.138)	-7.993*** (0.226)	-10.41*** (0.164)
Month FE	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Day FE	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Hour FE	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Metro area FE	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Job type FE	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Constant	52.43*** (0.079)	83.34*** (5.036)	81.87*** (7.837)	75.77*** (6.401)	54.36*** (0.0814)	59.20*** (6.766)	43.82*** (8.931)	67.12*** (12.49)
No. Obs	254,796	254,796	167,058	87,738	264,769	264,769	147,657	117,112
Adj. R-sq	0.011	0.179	0.207	0.078	0.040	0.220	0.244	0.094
F	2770.9	539.1	461.2	106.2	10984.8	761.8	514.3	177.8

Standard errors in parentheses
* p<0.05; ** p<0.01; *** p<0.001

Table 8 OLS estimation: Drive time and Job time as functions of compensation type and "short days"								
	Drivetime, 2012 data				Jobtime, 2012 data			
	(3)	(6)	(9)	(12)	(3)	(6)	(9)	(12)
	All Jobs	All Jobs	Service	Maintenance	All Jobs	All Jobs	Service	Maintenance
Contractor	-4.759*** (0.0615)	-3.887*** (0.0656)	-5.143*** (0.0876)	-2.150*** (0.0985)	-7.906*** (0.158)	-4.363*** (0.160)	-3.258*** (0.219)	-6.488*** (0.228)
ShortDay	-2.336*** (0.130)	-1.828*** (0.129)	-1.070*** (0.173)	-2.767*** (0.187)	-10.85*** (0.333)	-8.652*** (0.315)	-6.119*** (0.432)	-11.88*** (0.433)
Contractor* ShortDay	1.746*** (0.206)	1.237*** (0.200)	-0.602 (0.308)	1.936*** (0.261)	4.755*** (0.528)	3.915*** (0.490)	-0.522 (0.770)	8.900*** (0.605)
Month FE	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Day FE	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Hour FE	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Metro area FE	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Job type FE	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Constant	15.57*** (0.0317)	27.47*** (2.057)	17.90*** (3.134)	34.56*** (2.753)	53.08*** (0.0813)	86.38*** (5.029)	83.77*** (7.831)	80.80*** (6.375)
Observations	254,796	254,796	167,058	87,738	254,796	254,796	167,058	87,738
Adjusted R-squared	0.026	0.106	0.106	0.121	0.016	0.182	0.209	0.087
F	2253.8	289.2	204.8	166.1	1356.2	539.4	455.7	115.2

Standard errors in parentheses
* p<0.05; ** p<0.01; *** p<0.001

Table 9 – Defects by compensation type, for service and for maintenance jobs, for different time windows in which a defect can occur

Probit: Coefficient on Contractor variable, model includes all fixed effects – Service, 2012				
	15 days	30 days	60 days	90 days
Exact: same problem	0.04409**	0.03778**	0.04612***	0.04362***
Equipment: difft problem, same piece of equipment, excl. Exact	-0.00463	-0.00411	-0.00432	-0.00603
Site: different problem, same site, excl. Exact and Eqpmt	0.04968*	0.03199	0.01377	0.01872

Probit: Coefficient on Contractor variable, model includes all fixed effects – Maintenance, 2012				
	15 days	30 days	60 days	90 days
Exact: same problem	0.03054	0.00946	-0.01593	-0.04191
Equipment: difft problem, same piece of equipment, excl. Exact	0.24142**	0.20009**	0.17592**	0.16683**
Site: different problem, same site, excl. Exact and Eqpmt	0.00847	-0.00404	-0.01163	-0.01936

* p<0.05; ** p<0.01; *** p<0.001

Table 10 – Defects by compensation type and by whether the job takes an above-median amount of time to complete, for service and for maintenance jobs, 30-day defect window

	(1)	(2)	(3)	(4)	(5)	(6)
	Defect-Exact-30 days	Defect-Exact-30 days	Defect-Eqpmt-30 days	Defect-Eqpmt-30 days	Defect-Site-30 days	Defect-Site-30 days
	Service	Maintenance	Service	Maintenance	Service	Maintenance
Contractor	0.006** (0.002)	-0.002** (0.001)	0.004 (0.003)	-0.008*** (0.001)	0.002 (0.003)	-0.011*** (0.002)
Contractor* Longjob	0.003 (0.003)	0.002* (0.001)	0.009* (0.004)	0.021*** (0.002)	0.010* (0.005)	0.022*** (0.002)
Longjob	-0.001 (0.001)	-0.003*** (0.001)	-0.003 (0.002)	-0.011*** (0.001)	-0.005 (0.003)	-0.014*** (0.002)
Month FE	Yes	Yes	Yes	Yes	Yes	Yes
Day FE	Yes	Yes	Yes	Yes	Yes	Yes
Hour FE	Yes	Yes	Yes	Yes	Yes	Yes
Metro area FE	Yes	Yes	Yes	Yes	Yes	Yes
Job type FE	Yes	Yes	Yes	Yes	Yes	Yes
Constant	-0.053 (0.079)	-0.009 (0.039)	-0.116 (0.10)	-0.002 (0.093)	-0.021 (0.117)	-0.021 (0.112)
Observations	116,904	128,046	116904	128046	116904	128046
Adjusted R-squared	0.020	0.002	0.025	0.008	0.020	0.008
F	25.59	4.705	32.05	15.07	26.15	15.53

Standard errors in parentheses
* p<0.05; ** p<0.01; *** p<0.001