RESOURCES, STANDARDS, AND EXPECTATIONS: WHAT CRIME LABORATORIES TELL US ABOUT PRODUCTIVITY IN PUBLIC AGENCIES

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ABSTRACT

This study examined a variety of potential correlates and influences impacting productivity at 94 government-funded American crime laboratories. The study was premised particularly on the hypotheses that variables such as work backlog, lab accreditation, and managerial expectations have an associative relationship with productivity or lack of productivity in crime laboratories. The results of this study, which relied on regression analysis, suggest that productivity indeed does have a positive relationship with lab accreditation and managerial expectations, and has a negative relationship with a climbing backlog of cases. Possible implications for crime lab management and funding (questions of public policy) and for motivation in public sector work places in general (a question of organization theory) are considered.

VARIABLE INFLUENCES ON DNA CRIME LABORATORY PRODUCTIVITY

With a quick glance at a TV Guide, one can quickly see a growing pop-cultural interest in science as a crime fighting tool and as a critical element in any modern fictional crime story. Whether one tunes into *CSI Miami*, *CSI Las Vegas*, *NCIS*, or any number of other popular crime dramas on television, the primacy of forensic evidence collected at the crime scene is quickly established as a key element leading toward the conclusion of the storyline.

The public's enamored relationship with forensic evidence as a crime fighting tool has arguably had a very real, even potent, impact on matters beyond the Nielson Ratings; the public's romance with forensic science, say some, has influenced the very dispensing of justice in the United States.

The "CSI Effect" refers to the theory that the prevalence of forensic science's exaggerated utility in crime dramas on television, the cinema, and novels, has influenced real jurors and their verdicts when they trade their living room couch for the jury box. The theory suggests that jurors who have been educated on the utility of forensic science through popular culture outlets place an unrealistic expectation on prosecutors to produce forensic evidence at trial. Many anecdotal stories have emerged from criminal justice practitioners—and particularly prosecutors—who recount occasions in which perfectly solid cases relying on eyewitness testimony, strong circumstantial evidence, and even confessions were lost because jurors wondered "Where's the DNA?".

Stevens (2009) found in a survey of over 400 prosecutors that prosecutors indeed do believe the CSI Effect is real and that it has an impact on prosecutorial decisions and strategy. In fact, the surveyed prosecutors believed that not just juries, but also judges and defense attorneys, are influenced more by CSI-type shows than they are the documented (albeit mundane) evidence of a case.

Schweitzer and Saks (2007) examined the CSI Effect through the use of mock juries and a simulated trial transcript, which included testimony from a forensic scientist. They found that *CSI* viewers were actually more skeptical of the scientific testimony than were non-*CSI* viewers. Given that the relationship was strong between ardent viewers of *CSI* and strength of conviction with their verdicts, it could be surmised that the familiarization with

forensic science due to viewership may have emboldened those jurors to be more critical of scientific testimony.

However, in other studies the CSI Effect has been shown to be negligible. Kim, Barak, and Shelton (2009) found that watching CSI type television shows had no independent effect on the verdicts juries arrived at. Further, there were no interaction effects between viewing CSI shows and individual juror characteristics—even while there were interaction effects between different types of actual evidence and juror characteristics. In other words, jurors tended to render decisions based on the evidence presented.

Whatever the actual efficacy of the CSI Effect is on jury decision making, there is little doubt that the interests of justice alone has generated a certain amount of pressure on crime labs around the country to turn around quickly the analysis and reporting on of collected physical evidence. After all, with technological advancement comes further opportunity to discover genuine truth. And discovering the truth within the context of heinous crimes is laudable, worthwhile, and just.

The push for more and better analysis from our nation's crime labs has materialized in the context of significant budget cuts across the spectrum of government services, including criminal justice services. When growing expectations of service and declining resources to deliver them intersect, a common result is that shortcuts are taken. Shortcuts in the business world may mean a shoddy product is produced. Shortcuts in accounting may result in an audit and back-taxes with penalties. Shortcuts in the crime lab result in miscarriages of justice and scandal.

In March of 2008, the chief of the state crime lab in Washington resigned after judges in three different counties criticized the work performed in the labs under his purview. In particular, the judges criticized poor procedure and

perjuring certifications relating to Driving Under the Influence (DUI) intoxilyzer tests (Hunter, 2008).

Similarly, the crime lab belonging to the Houston (Texas) Police Department was found in 2007 to be chronically unreliable in its serology and DNA analysis after a 3-year investigation. In total, the convictions of 180 incarcerated offenders were called into question (Criminal Justice Newsletter, 2007). Many of these offenders, convicted for rape and murder, were given a new rationale for appeal and a chance at freedom despite their guilt. Others incarcerated may not have been involved in their alleged crimes at all.

The federal government took notice of the growing utility of, and reliance upon, forensic science by law enforcement. In 2003, the U.S. Department of Justice launched the *DNA Initiative: Advancing Justice through DNA Technology*. This program, administered by the National Institute of Justice, was backed by a 5-year $1 billion commitment to award grants to state and local governments for the purpose of establishing or bolstering crime labs. A particular focus of the initiative was to reduce or eliminate casework in the labs through advances in technology, and to reduce laboratory backlogs. By January of 2007, over $125 million had been awarded in grants to laboratories around the country for precisely this purpose (Law & Order, 2007).

Backlogs are a perennial problem in crime labs around the country—particularly for DNA analysis. For example, in Maryland, the state had a backlog of untested and uncollected samples from felons (who are subject to DNA collection for database purposes) of 24,000 in January of 2007. Likewise, in 2005, the crime lab operated by the Georgia Bureau of Investigation faced a backlog of 30,000 cases needing analysis to be conducted.

MOTIVATION

There is plenty of evidence to suggest that people get into government service, including criminal justice careers, because they have a public service orientation. Houston (2006) indicated that people who are in government are more likely than employees in the private sector to be motivated by service to the public (i.e. Public Service Motivation, or PSM). They were also more likely to volunteer for charitable causes. Frank and Lewis (2004) found that public sector employees are more inclined to be motivated by opportunities to serve and help others than are private sector employees.

Many crime lab employees may indeed have entered the field, or remain in it, because they are serving and making a difference for the public—and more specifically, victims of crime. However, it would certainly be understandable if lab technicians, facing seemingly insurmountable backlogs in the crime lab work environment, found themselves discouraged due feelings of futility for lack of making a dent. And were this to be true, it would not be unreasonable to predict that performance and productivity might somehow be impacted.

Frederick Herzberg's Motivation-Hygiene Theory (or Two Factor Theory) goes a long way to set a foundation for this notion. Herzberg noted that the workplace can offer workers both intrinsic and extrinsic benefits. These two factors, the intrinsic and extrinsic, combine to impact job satisfaction, and by extension, motivation and productivity. According to Herzberg, extrinsic benefits (such as salary, fringe benefits, shift hours, job security, etc) are important to worker satisfaction in so far as their absence would result in dissatisfaction. However, extrinsic benefits alone do not produce satisfaction or happiness. For that, there must be intrinsic benefit felt by the employee. Intrinsic benefits include things such as a sense

of accomplishment and achievement, a belief in one's work as important, a sense of responsibility, receiving recognition, etc).

While working conditions, including the existence of an overwhelming backlog of job responsibilities, as well as organizational and even judicial pressure to get the job done, may diminish the reservoir of extrinsic benefit for the employee, the nature and importance of the work as a matter of public service arguably contributes to the intrinsic rewards accruing to the lab employee. A number of studies in public administration have considered Public Service Motivation's (PSM) contribution to job satisfaction and productivity.

Alonso and Lewis (2001) examined survey results of over 35,000 federal employees and found at least some evidence that PSM was positively related to performance. Wright and Pandey (2008) found in their own study of PSM that job satisfaction was shaped by PSM at least in occasions where employees perceived that their own values were aligned with the values of the organization they worked for. Put another way, they believed in what they were doing.

The notion that management plays a role in motivation, job satisfaction, and performance is not only intuitive, but also well-established in public administration literature. Moynihan and Pandey (2007) found in their study of state health and human service agency managers that job satisfaction of employees is shaped by the actions and approaches of managers. Likewise, Ritz (2009) reported that managerial techniques significantly contribute to employee perceptions and attitudes when those techniques are integrated with an appreciation for employees' commitment to the public interest and public service.

Dnika (2006) studied correlates of both intrinsic and extrinsic job satisfaction factors in over 220 human service

employees. He found that extrinsic and intrinsic job satisfaction were interrelated to each other. He noted that despite the public service orientation of the workers, which was quite real, there was a need to feel empowered by management to do their jobs, and to be extrinsically rewarded as well as recognized for their work to be properly motivated. In other words, management and extrinsic variables mattered even while possessing a service orientation consistent with PSM.

The Dnika study is one of hundreds of studies over time that have re-affirmed the findings of the now classic Hawthorne Studies which began in 1924. In essence, then and now, the actions of management matter to the motivation and performance of employees. The attention paid to employees by management matters. The expectations of management as perceived by the employees matter.

The present study seeks to explore further what extrinsic factors may contribute to workplace productivity, and through inference, the motivation that precedes it, by examining public crime labs. Extrinsic factors such as working conditions, represented by case backlogs and managerial expectations, as well as salary, information management systems in place, the size of the labs and laboratory accreditation status, are examined against the productivity measure of DNA analyses conducted in a single calendar year.

METHODS AND RESULTS

Data and Measures

Using data from the *Census of Publicly Funded Forensic Crime Laboratories: 2005* collected by the U.S. Department of Justice Bureau of Labor Statistics (U.S. Department of Justice 2008), we analyzed the data using a robust linear regression. This cross-sectional study contacted all 389 publicly funded crime labs in the United

States (210 state-funded labs, 84 county-funded labs, 62 municipal-funded labs, and 33 federal-funded labs), and received 291 responses (response rate = 75%). We excluded crime labs from our analysis that either did not do DNA testing, or had missing observations in any of the variables in our model (see Table 1 for an explanation of model variables). This brought the final number of crime labs in our analysis down to ninety four (n = 94).

The set of hypotheses to be tested are:

- ***H1:*** *As the percentage of backlogged cases increases, individual DNA analyst productivity will decrease.*
- ***H2:*** *Crime labs that are accredited by a professional organization (such as the American Society of Crime Laboratory Directors) will have higher individual DNA analyst productivity than crime labs that are not accredited.*
- ***H3:*** *As managerial expectations on individual DNA analysts increase, individual DNA analyst productivity will also increase.*

Table 1 provides detailed descriptions of the independent and dependent variables. The units of analysis are individual crime labs. As such the dependent variable is constructed by calculating the average number of DNA analyses (or cases) completed in 2005 by DNA analysts at each specific crime lab. The three key variables that correspond to the three stated hypotheses are Backlog, Accreditation and Expectation variables. The Backlog variable, operationalized as the percentage of total DNA analysis requests in 2005 (which is the entire 2005 caseload plus all backlogged 2004 cases) that were backlogged (not completed) at the 2005 year end. The Backlog variable is a measure of how efficiently the crime lab is able to manage its DNA caseload. The Accreditation variable is a dichotomous variable (1 = accredited) designed to highlight the difference between professionally accredited and non-accredited DNA crime labs. The Expectation variable is

measured as the number of DNA requests per year that management expects each DNA analyst to complete. The other independent variables are included in the model as control variables. The Workforce variable is operationalized to control for the "emphasis" of the crime lab. Since many crime labs perform a variety of law-enforcement related analyses (fingerprints, ballistics, etc), the Workforce variable—operationalized as the percent of the total crime lab workforce who are DNA analysts—is a means of determining the emphasis on DNA analysis at any given crime laboratory. The Salary variable is operationalized as the maximum salary that can be earned by a DNA analyst salary range minus a DNA analysts' minimum salary. This variable provides some insight into the construction of the crime lab's pay scale, with the assumption that crime labs with a greater difference between the maximum and minimum salaries for DNA analysts have more salary latitude, potentially greater inequality in pay, and more opportunity for DNA analysts to earn more as their performance and/or seniority increases. The LIMS variable is a dichotomous variable indicating that the crime lab has a lab information management system (1 = LIMS present). Crime labs that have LIMS are at an advantage in that these types of systems often do work-flow analysis, present quality control data and reports, provide data management, promote enterprise-level collaboration and help to maintain regulatory compliance. The two remaining variables, Large (1 = 50 or more DNA analysts) and Small (1 = 10 or fewer DNA analysts), are dichotomous variables designed to account for the size of the crime labs.

Table 1
Variable Specifications

Variable Name	Specification
Dependent Variable	
Analyses	The number of DNA analyses conducted per analyst in 2005 calendar year.
Independent Variables	
Backlog	The percentage of 2005 DNA analysis requests (2004 backlog and 2005 calendar year requests) that were backlogged at 2005 year end.
Accredited	Dichotomous variable indicating that the lab is accredited by a professional organization (1 = Accredited).
Expectation	The number of DNA requests per year that management expected each DNA analyst to complete.
Workforce	The percent of the crime lab workforce who are DNA analysts.
Salary	DNA analyst salary range (maximum salary – minimum salary).
LIMS	Dichotomous variable indicating that the lab has a lab information management system (LIMS) (1 = yes).
Large	A dummy variable indicating that the lab has 50 or more DNA analysts employed there full-time (1 = large lab).
Small	A dummy variable indicating that the lab has 10 or fewer DNA analysts employed there full-time (1 = small lab).

Table 2 presents the means and standard deviations for the dependent variable and all independent variables. Notice that 94% of the crime labs have been accredited and 95% of all crime labs have LIMS, yet despite these two high percentages, the correlation coefficient between these two variables was only $r = 0.326$. Also note that average managerial expectations (mean for Expectation = 84.83) differed quite significantly from the actual average number of cases done by DNA analysts (mean for Analyses = 18.88). Also worthy of mention is the mean of the Backlog variable, which indicates that roughly 39% of all DNA analysis cases were backlogged at the year end of 2005.

Table 2
Descriptive Statistics

Variable Name	Mean	Standard Deviation
Analyses	18.88	16.58
Backlog	0.39	0.25
Accredited	0.94	0.25
Expectation	84.83	58.92
Workforce	0.63	0.13
Salary	30195	9957.5
LIMS	0.95	0.23
Large	0.16	0.37
Small	0.28	0.45

Multivariate Analysis

Using robust regression with a Bisquare weight function (see Neter et al 1996 for a primer on robust regression), it is possible to create a linear model similar to an ordinary least squares (OLS) regression model but with greater correction for heteroscedasticity and influential observations. This approach errs on the side of artificially reducing Type I error (the error of rejecting a null hypothesis when it is actually true), which for the purposes of hypothesis testing in linear models means that p-values are slightly larger than they are if OLS is used for parameter estimation. The robust regression parameter estimates in this instance were comparable to the OLS regression parameter estimates. The linear model estimated is as follows (see Table 1 for variable specification):

$$\text{Analyses} = b_0 + b_1\,\text{Backlog} + b_2\,\text{Accredited} + b_3\,\text{Expectation} + b_4\,\text{Workforce} + b_5\,\text{Salary} + b_6\,\text{LIMS} + b_7\,\text{Large} + b_8 + \text{Small} + e_i$$

Table 3 presents the parameter estimates of the above linear model reported by MATLAB. The statistically significant F (F = 79.93) indicates the overall significance of the model, which is consistent with the moderately high R-squared (R-squared = 0.48) reported. Three of the independent variable coefficients (Backlog, Accredited and Expectation) were statistically significant.

The Backlog variable is a measure of the "busyness" of the lab. An interpretation of the Backlog variable coefficient (b_1 = -16.42) indicates that for every 10% of the year's cases that are unfinished and thus backlogged, analyst output declines by 1.6 cases on average. In a substantive sense, this is significant since the average DNA analyst completes about 19 cases per year (Analyst variable mean = 18.88). Crime labs which are able to better manage their workload (through additional hires, more efficient processes, etc) are likely to have

higher levels of productivity from their DNA analysts. This significant result validates the first hypothesis (H1).

Table 3
Robust Regression Parameter Estimates[1]

Variable Name	Coefficients	Standard Errors
Backlog	-16.42**	5.00
Accredited	12.95*	5.84
Expectation	0.10**	0.02
Workforce	1.15	10.23
Salary	-0.00+	0.00+
LIMS	-3.70	5.74
Large	-4.81	3.26
Small	2.87	2.92
Constant	9.10	9.11
N	86	
R-squared	0.48	
F	79.93*	

*p-value < 0.05
**p-value < 0.01
[1]Analyses as dependent variable

The second hypothesis that was tested was the hypothesis that crime labs which have been accredited by at least one professional organization (such as American Society of Crime Laboratory Directors) will have increased DNA analyst productivity. The b_2 coefficient, which corresponds to the Accredited variable was statistically significant. The magnitude and direction of b_2 validated the second hypothesis. Since the Accredited variable is a dummy variable, the interpretation of $b_2 = 12.95$ is straightforward. If a crime lab is accredited, individual DNA analysts at that lab are able to complete, on average, nearly thirteen more DNA analyses per year. This is largely because the requirements for accreditation require

certain standards for equipment, training, education and internal processes—all of which have the effect of improving analyst efficiency. In 2005, roughly 94% of crime labs that conduct DNA analyses are accredited (Mean of Accredited variable = 0.94).

The Expectation variable provides the test of the third hypothesis. The positive slope coefficient $b_3 = 0.10$ is statistically significant and in the hypothesized direction. In practical terms, an increase of ten additional completed cases in managerial expectations yields roughly one additional completed DNA analysis per DNA analyst. This would seem to be a relatively cost-free method of increasing productivity in crime labs, but as shown from Table 2, a disconnect between managerial expectations and actual DNA analyses completed exists—the mean of the Expectation variable is 84.83 and the mean of the Analyses variable is 18.88. Both variables have high standard deviations relative to the magnitude of the means, so there is quite a bit of variability amongst the crime labs in this study.

A worthwhile question is whether or not there is a diminishing return on managerial expectations. In other words, if the true nature of the relationship between Expectation and Analyses is non-linear, then there may be a point whereby managerial expectations matter less in the day-to-day productivity of DNA analysts. Figure 1 shows both a robust (bisquare weighting) linear regression line (solid line) and a robust (bisquare weighting) quadratic polynomial regression (dashed line) with Expectation as the independent variable and Analyses as the dependent variable. As one can see, the two regression lines are nearly identical—indicating that there does not appear to be a diminishing return on managerial expectations.

Figure 1
Robust Linear and Non-linear Models for Expectation vs. Analyses

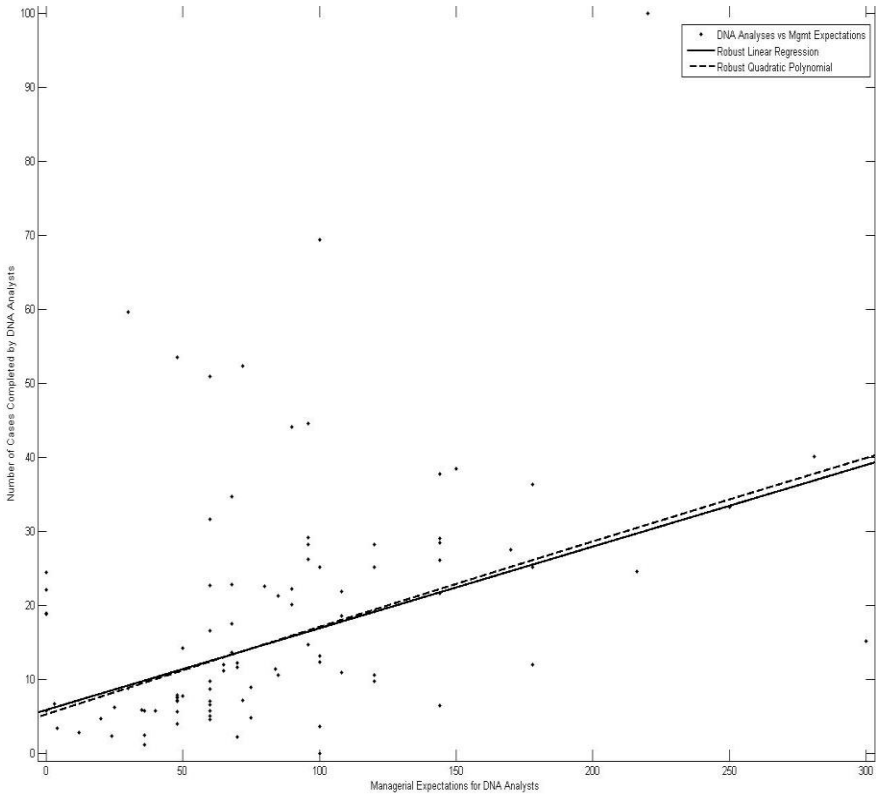
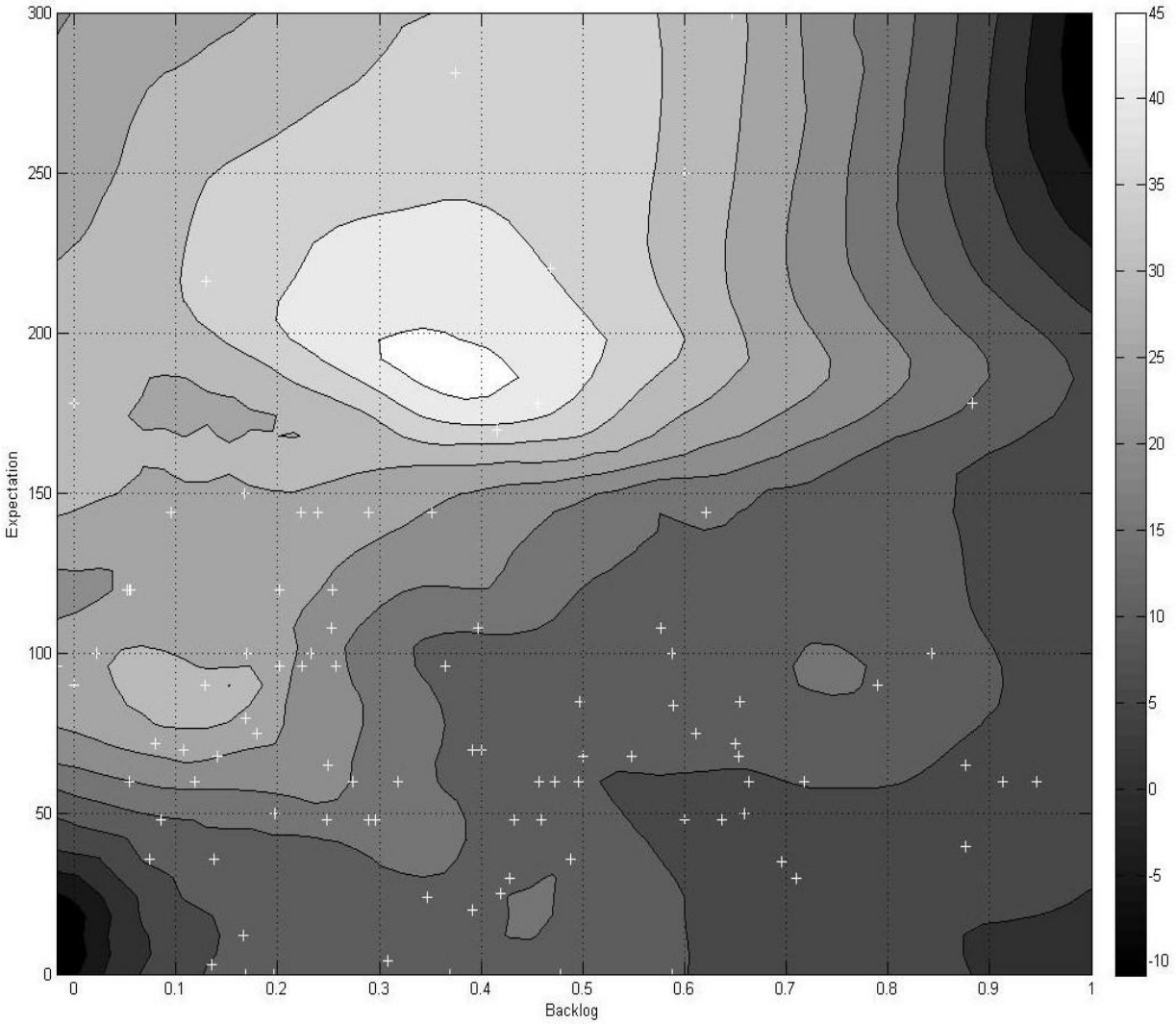


Figure 2
Contour Plot: Backlog (x-axis), Expectation (y-axis) and Analyses (z-axis)



One may also surmise that there may be an inter-relationship between Backlog, Expectation, and Analyses. Figure 2 provides a contour plot (using loess smoothing) of

Backlog (x-axis), Expectation (y-axis) and Analyses (z-axis, which is indicated by dark and light shading as indicated by the color legend on the right). The lighter shaded regions of Figure 2 indicated the regions corresponding to Backlog and Expectation where DNA analyst productivity was relatively high. Conversely, the darker shaded regions indicate regions of low DNA analyst productivity. From this analysis, it seems that variation in the Backlog variable has an impact on the effect of Expectation on Analyses. Suppose management expected 200 completed analyses per DNA analyst. If Backlog = 0.3, then analysts are likely to respond by increasing productivity. However, if Backlog = 0.9, analysts will be much less productive on average. Indeed, it would seem that there is an ideal target region for maximum DNA analyst productivity: Expectations between 150 and 250, and Backlog roughly between 0.2 and 0.5.

Implications

Many public-sector employees (including DNA analysts) are motivated by a desire to serve the society and the public (Frank and Lewis 2004; Houston 2006). For DNA analysts, this desire can be fueled by feelings of justice for victims and families. Indeed each case that comes to a DNA crime laboratory has a real-world story with real victims and suspects. However, these findings suggest that increased case backlog in crime laboratories does not always translate into increased productivity. Indeed, it seems a tipping point exists where the backlog of cases begins to have a negative impact on DNA analyst productivity. The implication for public-sector management more broadly is that even dedicated employees with a strong desire to serve the public good can be overwhelmed by what seems to be insurmountable workloads. Managers need to be mindful of employee

workloads and need to take appropriate steps to keep the workload from becoming overwhelming.

These findings also suggest that managers may also be able to increase employee performance through organizational accreditation (or by taking other steps which mandate certain standards and levels of productivity). Our findings show that crime lab accreditation has a significant positive impact on DNA analyst performance. We believe this finding will likely hold true for other professional, public-sector employees.

Several managerial studies going back to the famous Hawthorne Experiments have found that managerial expectations have an impact on employee productivity. This study found that increased managerial expectations of employee productivity had a significant impact on improving employee productivity. This essentially amounts to a "free" way in which managers can increase employee productivity. Furthermore, we found no tipping point or upper-limit to these expectations within our analysis. We caution that in practice, such tipping points may exist in certain situations and managers may want to try to find optimum productivity by manipulating the inter-relationship between managerial expectations and employee workloads.

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