The hidden costs of the opioid crisis and the implications for financial management in the public sector

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ABSTRACT

The November 2017 release of the Council of Economic Advisers’ White House report on the opioid crisis suggests that prior consideration of expenses severely underestimated the economic costs of the opioid crisis. When corrected for these losses, the annual cost from the opioid crisis leapt nearly 600%. The cost to the criminal justice system was estimated at $8 Billion of which $270 million is borne by crime laboratories. However, laboratory budgets have not grown at a rate capable of meeting this increased demand for forensic science services. The hidden costs of the opioid crisis borne by the forensic crime laboratories comes as funds are diverted in the laboratory to meet the increased demands for services in drug chemistry and toxicology. Dramatic increases in turnaround times across other areas of investigation continue to grow as the crisis accelerates.

Prior to November 2017, the magnitude of the opioid crisis nationally was estimated to have an annual cost of nearly 0.33% of GDP. However, the release of the Council of Economic Adviser (CEA) White House report [1] on the opioid crisis suggests that prior consideration of expenses severely underestimated the economic costs of the opioid crisis by failing to include the loss in productivity from drug overdose deaths. When corrected for these losses, the annual cost from the opioid crisis leapt nearly 600% to $504 billion, and that estimated total annual cost exceeds 2% of the nation’s Gross Domestic Product (GDP) [2]. Estimates at the individual state level, some of the “crisis” states (i.e., the states with per capita overdose deaths exceeding 30 per 100,000 population) experience a cost approaching 15% of Gross State Product. The economic effects, as measured through the loss in productivity, dominate the costs in addition to previously measured explicit expenses for healthcare, including substance abuse treatment, and additional expenses for policing, courts, jails, and prisons.

The CEA report offers only a 20,000-foot view of the societal costs from opioid abuse. The costs of medical care, substance abuse treatment, and workplace productivity are based upon detailed studies with well-defended estimation procedures. The estimated cost for the criminal justice system includes an estimated cost of roughly $8 Billion [2]. However, the foundations for the criminal justice system costs are back-of-the-envelope, rough approximations of system-wide costs; they offer little advice at the jurisdictional level to manage scarce resources dealing with the crisis. Further, they provide a static view of the crisis, ignoring the dynamic growing severity of the problem.

Although the costs included in the CEA report of $504 billion are a rough estimate of the annual cost, the justice system portion is barely over 1.5% of the total and does not receive much detail in the report [1]. In the present study, we provide a more detailed examination for one aspect of the justice system effects, the forensic science analysis, detailing the direct costs and the opportunity costs elsewhere for resources diverted to the opioid crisis. Using data from the Census of Publicly Funded Forensic Crime Laboratories (hereafter, CENSUS) [3] and data from project FORESIGHT [4], we are able to provide more detail on the impact of the opioid crisis in the running of forensic laboratories. The intent is to provide policymakers with a broader view of the societal costs as decision-makers attempt to battle this crisis.

Although the costs to the justice system of $8 billion per year are small relative to the total annual cost, the detailed costs experienced by the various parts of the justice system are significant to police, laboratories, courts, jails, and prisons. We highlight the effects experienced by one aspect of the justice system, forensic...
crime laboratories. For the 2016 year highlighted in the CEA report, data on forensic crime laboratories suggests that the opioid epidemic added over $270 million in expenses to these laboratories. However, laboratory budgets did not grow at a rate capable of meeting this increased demand for forensic science services. The hidden costs of the opioid crisis borne by the forensic crime laboratories comes in the form of an opportunity cost; namely, funds are extracted from other activities in the laboratory to meet the increased demands for services in drug chemistry and toxicology. Dramatic increases in turnaround times across other areas of investigation continue to grow as the crisis accelerates.

Over the period from 2014 through 2017, the number of states1 experiencing drug deaths at a rate of thirty or more per hundred thousand population has grown from a single state (WV) to thirteen states (WV, OH, PA, DC, KY, DE, NH, MD, ME, MA, RI, CT, and NJ). These thirteen entities are termed the “crisis states” in the discussion to follow. We compare the crisis states to the other U.S. states to observe the impact of the opioid crisis on the performance of forensic crime laboratories. Recent trends demonstrate that the abuse of synthetic opioids is responsible for the most recent growth in drug overdose deaths. We expected to find that the average cost of processing forensic cases for drugs-controlled substances and toxicology would be rising in the crisis states as synthetic opioid use rose. However, we find that these average costs have been falling, likely due to economies of scale.

Although average costs declined for a period of time, total expenses for casework involving drugs-controlled substances and toxicology are growing for these crisis states. The growth rate of expenses in these areas is far outpacing the growth in budgets for the forensic laboratories. To meet this growing demand for casework in drugs-controlled substances and toxicology, laboratories appear to be shifting funds from other areas of investigation to meet expenses in these crisis areas of investigation. The result has been rapid growth in turnaround times in all areas of the laboratory and a dramatic increase in the percentage of casework in backlogs, thus delaying the administration of justice for drug-related and non-drug-related casework. In the words of William Gladstone, “justice delayed is justice denied.”

The paper is organized as follows. The next section summarizes the CEA White House report, “The Underestimated Cost of the Opioid Crisis,” and the research support upon which the report is based, including the apportionment approach which forms the foundation for the costs to the justice system. The inherent assumptions, behind the allocation of justice system expenditures, do not jibe with experience; however existing research within the justice sector can overcome these deficiencies. Following discussion of the CEA report, we provide an overview of data available to estimate costs of forensic laboratories in the justice system. The section that follows provides a brief overview of relevant work in criminal justice support systems and the cost structure, economies of scale, and other items relevant for analysis of the expected costs in updating the apportionment estimations. We show that the broad system-wide estimates may be disaggregated to the jurisdictional level to better address local and national policy. The next section provides a view of time trends nationwide in comparison to the rising costs experienced in jurisdictions most severely impacted by the opioid crisis. While the CEA report details a single year, the Council of Economic Advisers analysis takes a static view of this dynamic, growing problem. The resources required to address the opioid crisis must be aimed at a moving target, rather than a focus in the rearview mirror. That dynamic target can be estimated. The final section offers some policy implications and concluding comments.

1. The White House council of Economic Advisers report

The White House CEA report on the opioid crisis focused on the level of the crisis for the year 2015, the most recent year for which sufficient data was available [1]. The study estimated the costs from a variety of considerations including health care, addiction treatment, the justice system from investigation to incarceration, lost productivity for users—all factors considered in prior studies—and added costs from fatalities, which were not included in prior cost analyses. With these considerations and expansion to account for underreporting of opioid deaths, an estimated one-year cost of $504 billion resulted. This staggering cost for a single year represents a nearly 600% increase over prior estimates of the annual cost to society from opioid abuse.

The CEA report makes a key contribution to an understanding of the magnitude of the problem through a consideration of the societal costs from overdose deaths attributable to opioids. Using established methodologies for estimating the value of a statistical life [5] and adjusting for the age profile of opioid overdose deaths [6], the cost estimates range from a low of $221.6 billion to a high of $458.8 billion under alternative assumptions. Among the assumptions reviewed, the report argues for an age-dependent profile, which estimates the overdose death costs to be $431.7 billion.

While the report details the fatality-related cost estimations, it merely borrows prior cost estimates [2] for the associated costs for medical expenses, addiction treatment, lost productivity of abusers, and costs to the justice system for dealing with opioid abuse. Likewise, Florence, et al. [2] borrow the estimate from an earlier study by Birnbaum et al. [7,8], which categorize the methodology used to construct the estimated costs as the quantity method and the apportionment method. Healthcare, workplace, and criminal justice estimates were calculated using one of these methods or a combination of the two back-of-the-envelope methods. Inherent in the use of either method is the adoption of the assumptions regarding the underlying data. However, it is not apparent that Florence et al. [2] or The Council of Economic Advisers [1] evaluated the validity of the underlying assumptions.

Consider the apportionment method, “which begins with overall costs of drug abuse per component and apports the share associated with prescription opioid abuse based on relative prevalence of prescription opioid to overall drug abuse” ([7], p. 657). The apportionment process may sound reasonable on the surface, but the calculation of the overall costs to be apportioned is suspect. To arrive at the overall costs of drug abuse, total criminal justice expenditures are multiplied by the percentage of drug abuse cases. Not stated is an inherent assumption that all types of cases, drug-related and non-drug-related require the same average expenditure. Disaggregated data indicates otherwise. The problem is compounded in Florence et al. [2] and subsequently in The Council of Economic Advisers report [1]. “We followed an apportionment approach previously described by Birnbaum et al. [7] to update criminal justice costs...using reported criminal justice spending for drug crimes and multiplying that number by the share of drug abuse and dependence cases represented by prescription opioids” ([2], p. 903).

In the next section, we demonstrate some of the detailed knowledge regarding the cost structure for forensic laboratories. While this demonstration only addresses a portion of the justice system, it highlights the gains to the overall understanding of the societal costs of the opioid crisis to policymakers, and lends support to the allocation of resources to combat the crisis. Researchers in other justice sectors may use their expertise to highlight similar sector effects as a contribution to this overall understanding of the

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1 The reference to states includes the fifty states and the District of Columbia.
magnitude of the crisis.

2. The business of forensics

Detailed examination of forensic science laboratories as an “industry” is a relatively recent phenomenon. Four laboratories from European Union nations initiated a study, Project QUADRUPO, which examined the relationship between laboratory casework and budget allocations [9]. QUADRUPO offered some insight into the productivity of forensic laboratories through a one-year examination of four national laboratories and provided some of the earliest performance metrics by which other laboratories might gauge their own performance. In 2009, the National Institute of Justice funded a similar study for laboratories in North America called Project FORESIGHT [4]. Project FORESIGHT, however, was not limited to a single year’s view; rather it has continued to this day and offers a rich set of panel data from which to examine the forensic science laboratory portion of the justice system. Additional data is available through the Department of Justice’s periodic census of publicly funded crime laboratories [10].

Examination of any public sector service is often made difficult because of inconsistencies with the data. Those inconsistencies arise from fiscal year differences, jurisdictional idiosyncrasies, wide ranging language and definitions of services, and a general lack of centralization in the data collection. The QUADRUPO study offered a unified language for crime laboratory services and offered a detailed breakdown of expenditures across areas of investigation within laboratories.

The FORESIGHT study adopted the standards of QUADRUPO with respect to definitions for data collection from casework, personnel, and budgets. Further, FORESIGHT collects the data annually with data submissions from the 2005–2006 fiscal year to the present. FORESIGHT offers a sample of laboratories that has been growing in size to the most recent submission of 163 laboratories for the 2017–2018 period. Laboratory service areas are divided into nineteen analytical services (Blood & Breath Alcohol; Crime Scene Investigation; Digital Evidence—computer, audio, & video; DNA Casework; DNA Database; Document Examination; Drugs—Controlled Substances; Evidence Screening & Processing; Explosives; Fingerprints; Fire Analysis; Firearms & Ballistics; Forensic Pathology; Gunshot Residue; Marks & Impressions; Serology/Biology; Toxicology ante mortem; Toxicology post mortem; and Trace Evidence). Within each analytical service casework detail is collected on the number of cases submitted, items submitted, items outsourced and items examined internally, number of samples examined internally, number of tests on those samples, and number of reports written. Additionally, two metrics are collected on turnaround time for cases and unprocessed cases, including a categorization for those unprocessed cases that are more than thirty days old (backlog).

FORESIGHT also collects budget and personnel data. On the personnel side, the number of full-time equivalent employees (FTE) is collected for both analytical staff and support staff and the allocation of time to casework investigation versus non-casework activity is registered. Expenditures are detailed for capital, labor, consumables, and other costs to break down a full description of the cost structure by investigative area. Included in the expenditure data are the direct expenditures of the laboratory and any indirect costs that are borne by the parent agency.

The CENSUS collects data on requests for services by investigative area, backlog, and limited budget information for the years 2002, 2005, 2009, and 2014. Budget totals are provided at an aggregated level for the entire laboratory, but not the allocation across analytical areas. Personnel allocations are limited to the number of full-time and part-time employees, but not the allocation across analytical areas, nor a translation of part-time personnel to a full time equivalent. Much of the casework detail is consistent with the detail in FORESIGHT from requests in an analytical area to completions and the number of cases unprocessed and the number outstanding for more than thirty days. The categories for analytical processes is more compressed than FORESIGHT to include Biological Services, Controlled Substances, Crime Scene Investigation, Digital Media, Firearms, Impressions, Latents, Questioned Documents, Toxicology, and Trace Evidence.

The CENSUS has an advantage with responses from 360 of the 409 publicly funded forensic crime laboratories in the United States, while FORESIGHT relies upon voluntary participation with 163 submissions in the most recent year and 139 submissions in the 2015–2016 period. To assess the impact from the opioid crisis on this portion of the justice system, details from the CENSUS on the volume of activity across analytical areas is applied to lessons from analysis of FORESIGHT data to provide a jurisdictionally-based measure of the costs from the crisis.

3. Observations from project FORESIGHT

The CEA report allocated justice system expenditures equally across all types of criminal investigation and prosecution and allocated total expenditures by the percentage of drug-related crime. While that may have been a reasonable assertion for a national view from a broad perspective, analysis of the FORESIGHT data has shown that the costs differ widely across analytical processes. Consider the data in Table 1 from project FORESIGHT [11].

Table 1 highlights the wide range in cost per case both within and across the various areas of investigation. The apportionment method employed in the CEA report does not distinguish these differences. The CEA report treats all forensic crime laboratory analysis from a macro viewpoint and apportions an equal cost foundation to all activity.

Beyond the comparisons across areas of investigation is the wide range of average costs within each area of investigation. Maguire et al. [12] examine the importance of the widely varying cost behavior as a well-known economic phenomenon, economies of scale. In the provision of any good or service, there is a “right
size," where average costs are minimized. This optimal provision of the good or service is referenced as perfect economies of scale. Because forensic crime laboratory services are most often provided at the jurisdictional level, and not market determined, perfect economies of scale are rarely observed.

To illustrate, consider the scatter plot in Fig. 1 of the 2015–2016 FORESIGHT data for Drugs—Controlled substances with average costs mapped against the caseload of each jurisdiction.

Microeconomic theory indicates that we should expect to see average costs decline as output increases, up to a point, perfect economies of scale are observed. Beyond that level of output, average costs should begin to increase as diseconomies of scale are experienced. This general economic behavior is important to the explanation of effects from the opioid crisis. In particular, each jurisdiction that faces an increase in demand for services will affect forensic crime laboratories differently, depending upon their initial caseload with respect to perfect economies of scale.

Project FORESIGHT data enable us to have some predictive capacity with respect to expected costs for a given caseload [13,14]. Fig. 2 illustrates the theoretical average cost curve suggested by the data for Drugs-Controlled substances in the scatter plot of Fig. 1. (Note that the suggested average cost curve is for illustrative purposes and is hand drawn and not the result of an econometric estimation.)

The estimation of this relationship in public sector provision of goods or services is well-documented [15–17]. Knapp [15] uses data from British crematoria to estimate the efficient frontier using a second-degree polynomial relationship between the average cost

| Area of Investigation               | 25th percentile | Median  | 75th percentile |
|-------------------------------------|-----------------|---------|-----------------|
| Blood Alcohol                       | $226            | $313    | $424            |
| Crime Scene Investigation           | $2,010          | $3,053  | $4,315          |
| Digital evidence - Audio & Video    | $2,575          | $3,988  | $6,441          |
| DNA Casework                        | $2,13           | $3,451  | $6,441          |
| Evidence Screening & Processing     | $3,13           | $5,817  | $3,628          |
| Explosives                          | $3,35           | $1,684  | $3,628          |
| Forensic Pathology                  | $3,75           | $6,243  | $8,907          |
| Firearms and Ballistics             | $485            | $1,178  | $424            |
| Fingerprints                        | $514            | $678    | $933            |
| Fire analysis                        | $920            | $1,755  | $3,066          |
| Fire analysis                        | $920            | $1,755  | $3,066          |
| Forensic Pathology                  | $1,602          | $2,010  | $3,053          |
| Gun Shot Residue (CSR)              | $1,567          | $3,188  | $5,851          |
| Marks and Impressions               | $1,567          | $3,188  | $5,851          |
| Serology/Biology                    | $810            | $1,479  | $2,315          |
| Toxicology ante mortem (excluding BAC)| $465        | $571    | $825            |
| Toxicology post mortem (excluding BAC)| $514        | $678    | $933            |
| Trace Evidence                       | $2,213          | $3,451  | $6,441          |

Fig. 1. Drugs-Controlled Substances Cost/Case relative to Caseload.

**Table 1**
Cost per case by investigative area.
of a cremation and the scale of operations of the crematorium. Hammond [16] refines the estimation after correcting for error normality assumptions and focuses on the lower boundary from the resulting efficient frontier. Christoffersen et al. [17] use data on the cleaning contracts for Danish schools to estimate the efficient frontier. They use this frontier to compare public and private provision of the service.

We follow similar techniques for an estimation of the efficient frontier for Drugs-Controlled Substances analysis. Fig. 3 illustrates the estimated relationship we obtain following the technique for estimation of a quadratic relationship. Further, this average cost behavior is not unique to this analytical area. A similar cross-laboratory depiction occurs in every analytical area [13].

The quadratic regression estimate in Fig. 3 provides the expected average cost curve shape as described in theory. However, it does not appear to provide a particularly good fit over the entire range of the data. Data at the extremes, particularly low caseload laboratories, do not seem to fit the estimate curve as well as the fit for the more central caseloads. While a quadratic provides the expected shape as suggested by economic theory, it may not be the best description of the relationship between average cost and level of activity. There are other potential relationships that may be appropriate for estimation for the entire relationship, or perhaps a portion of the relationship. That is, the average cost to level of activity may follow a variety of functional forms over the range of potential outputs.

Fig. 4 illustrates one such possibility where a double logarithmic estimation is conducted. This specification offers a better fit to the lower end of the spectrum, the seemingly downward sloped portion of a U-shaped average cost curve. However, it does not appear to perform as well for higher caseload prediction with a growing underestimation as caseload increases. A combination of functional forms over various ranges of caseload has been shown to reduce squared deviations, provide a better fit to the data, and eliminate systematic error [14].

The CEA report [1] adopts the Florence et al. [2] apportionment of costs to include drug crime and other crime that is drug-influenced. This suggests that expenditures for forensic analytical areas of investigation for Drugs-Controlled Substances, Toxicology ante mortem, and Toxicology post mortem, as well as a portion of expenditures in all other analytical areas should be attributed to drugs, and from that drug and drug-influenced crime expenditures are divided into opioid and non-opioid categories.

As such, the efficient average cost frontier in each area of investigation is needed to assign costs to the opioid epidemic. The efficient frontiers have been estimated previously using FORESIGHT data [14]. These estimated curves are presented in the Appendix in Table 5. Using the efficient frontier estimates from FORESIGHT, we can obtain a jurisdictionally-based estimate of the opioid costs by applying these estimates to the casework data in the CENSUS. The CENSUS data offers the casework activity level across areas of investigation for approximately 80% of U.S. crime laboratories, while FORESIGHT represents less than half of the eligible crime laboratories. Using the FORESIGHT estimated efficient frontier relationship for the caseloads of the CENSUS data; a cost estimate for 80% of U.S. laboratories may be obtained. To make this extended estimate, however, a correction must be made for the breadth of activities covered in the CENSUS data relative to the FORESIGHT data. For example, project FORESIGHT collects Toxicological data separately for Blood/Breath Alcohol, Toxicology ante mortem, and Toxicology post mortem, while the CENSUS collects data for Toxicology to include the three separate categories. To overcome the different data collection regimens, new estimates for the efficient frontier of CENSUS defined areas of investigation are provided in the Appendix in Table 6.

Fig. 2. Drugs-Controlled Substances Cost/Case relative to Caseload with Efficient Frontier Approximated.

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3 The quadratic regression estimate in Fig. 3 has not been corrected for the error normality assumption as highlighted by Hammond [16]. Fig. 3 is merely illustrative of the relationship in the data.
estimation procedures may be undertaken to provide the national cost from opioids. Each of the missing crime laboratories are identified in the CENSUS data. Using population data for the political jurisdictions of these missing crime laboratories, along with the FBI Uniform Crime Report, FORESIGHT and CENSUS estimated costs, and other relevant data, estimates may be made for the remaining laboratories [18].

4. Updated estimate of opioid costs to crime laboratories

To arrive at the jurisdictional costs, we begin with project FORESIGHT laboratories and then add non-FORESIGHT labs in the
CENSUS and calculate the efficient frontier cost for the corresponding caseload. This should represent a minimum cost for the given caseload. For the remaining laboratories, we estimate their caseload, based upon data in the CENSUS and the relationship between caseloads, population, and the crime rate for each area of investigation. National estimates represent the sum of the jurisdictional estimates (Table 2).

5. The dynamic trends in opioid costs

While the prior sections offer an ability to measure the annual costs of the opioid crisis to the crime laboratory, we do not examine the effects on all sectors of the justice system. If desired, research across other sectors of the justice system, including policing, incarceration, and the courts, may apply similar techniques to refine the rough estimates in the CEA report [1].

To highlight the dynamic effects, we begin with a separation of the states according to rates of drug overdose deaths [19]. Table 3 illustrates the annual number of deaths per 100,000 population over the 2014–2018.

While only a single state, West Virginia, experienced overdose deaths at a rate of thirty per 100,000 population in 2014, the total number of states with such a high overdose death rate rose to 13 jurisdictions by 2018. Hedegaard et al. [20,21] provide detail on the nature of this growth since 1999 for the entire country. They show that nationally, drug overdose deaths have grown from 6.1 per 100,000 population to 21.7 deaths per 100,000 in 2017. Fig. 5 illustrates these trends. Hedegaard et al. [21] detailed analysis indicates that the overdose death rate over the period highlighted in Table 3 is largely attributed to synthetic opioids. For example, the rate of drug overdose deaths attributed to natural and synthetic opioids increased by roughly 3% per year over this period; the death rate from heroin overdoses did not grow in the most recent year shown. However, overdose deaths from synthetic opioids, such as fentanyl, increased by 71% over the period highlighted in Table 3.

We use the split between the “Crisis States” and other states to examine the costs of the opioid crisis. Anecdotal comments from laboratories have pointed to some of the complications surrounding synthetics. Because of these ad hoc comments, we used the FORESIGHT data for U.S. laboratories to see what was happening over time to laboratories in the crisis states versus other jurisdictions. For example, laboratories reported that the different

### Table 2
Estimated expenditures by crime laboratories from opioid-related crime.

|                      | Drugs-Controlled Substances | Toxicology     | Other Areas of Investigation | Total Opioid Expenditures |
|----------------------|-----------------------------|----------------|-----------------------------|--------------------------|
| FORESIGHT Laboratories| $25,276,113                 | $28,096,584    | $39,839,340                 | $91,212,037              |
| CENSUS Laboratories   | $38,829,971                 | $43,162,867    | $61,202,464                 | $143,195,302             |
| Other Laboratories    | $9,185,486                  | $10,210,461    | $14,477,847                 | $33,873,794              |
| TOTAL                | $73,291,569                 | $81,469,912    | $115,519,652                | $270,281,133             |

### Table 3
Overdose deaths per 100,000 Population.

| State | 2014 | 2015 | 2016 | 2017 |
|-------|------|------|------|------|
| WV    | 35.5 | 41.5 | 52.0 | 57.8 |
| OH    | 24.6 | 29.9 | 39.1 | 46.3 |
| PA    | 21.9 | 26.3 | 37.9 | 44.3 |
| DC    | 14.2 | 18.6 | 38.8 | 44.0 |
| KY    | 24.7 | 29.9 | 31.5 | 37.2 |
| DE    | 20.9 | 22.0 | 30.8 | 37.0 |
| NH    | 26.2 | 34.3 | 39.0 | 37.0 |
| MD    | 17.4 | 20.9 | 33.2 | 36.3 |
| ME    | 16.8 | 21.2 | 28.7 | 34.4 |
| MA    | 19.0 | 25.7 | 33.0 | 31.8 |
| RI    | 23.4 | 28.2 | 30.8 | 31.0 |
| CT    | 17.6 | 22.1 | 27.4 | 30.9 |
| NJ    | 14.0 | 16.3 | 23.2 | 30.0 |

Fig. 5. Drug deaths per 100,000 population.
Fig. 6. Average Cost over Time for Opioid Crisis States v. Other States.
chemical composition of the synthetics, as compared to experience,
added expenses as the synthetic drugs chemical makeups were
identified. This suggested that we would see increased average
costs in the thirteen opioid crisis states when compared to the
other jurisdictions. However, Fig. 6 illustrates that this did not
occur. The average costs for the crisis states declined for a time in
each of the areas of investigation, Drugs-Controlled Substances,
Toxicology ante mortem, and Toxicology post mortem.
The behavior illustrated in Fig. 6 does not meet initial expecta-
tions. However, when reconsidered in light of the work of Maguire
et al. [12] and noting the populations of the crisis states, the initial
drop in the average costs for the crisis states may be explained. The
drop in average costs may simply reflect economies of scale. That is,
there may be some higher costs to identify the synthetics, the
higher volume of activity may override these costs and result in the
drop in average costs. Fig. 7 offers support for this interpretation.
For each of the three areas of investigation, the total expenditures
are growing at an annual rate that far exceeds those of the other
states.
Given these rates of increase in expenditures, it raises the
question as to how the opioid states are budgeting for the crisis. An
examination of the total forensic crime laboratory budget in the
12 crisis states and the other states shows that budgets for each group
grew at an annual rate of approximately 3%. Fig. 7 suggests that the
budgets for the other states roughly matched the growth in total
laboratory expenditures with drugs-controlled substances growing
1.1%, below the 3%; toxicology ante-mortem growing at 4.7%, above
3%; and toxicology post mortem growing near the 3% level at 3.25%.
For the crisis states, the growth rate in each area was well above the
growth in the total laboratory budget: 7.65% for drugs-controlled
substances; 11.12% for toxicology ante mortem; and 6.94% for
toxicology post mortem.
However, even with these increased expenditures, it has been
difficult for laboratories to keep up with the demand for services.
Fig. 8 illustrates the growth in turnaround time (TAT) that crisis
states and the other states experienced over this 2011–2018 period.
The TAT impact is notable over the past three years for the crisis
states. While other factors may well explain part of this behavior,
the separation of the crisis states from the TAT in the other states is
consistent with the time period for the rise in synthetic opioids
[21].
If expenditures in the crisis states are rising at a pace not met by
funding, then those increased expenditures must come from else-
where in the laboratory. Consider the impact that a higher turn-
around time has for all of the areas of investigation within the
laboratory for the crisis states. To illustrate, consider the percentage
of backlogged cases, with backlog defined as cases open for over
thirty days. Table 4 shows the percentage of cases submitted within
the year that are open for more than thirty days.
While the opioid crisis alone might not account for the all of
delay in analysis, the dramatic rise in backlog for all areas of
investigation suggests that forensic crime laboratory funding is
falling short of that needed to meet the demand for services. Certainly,
the opioid crisis, particularly the growing problem from
synthetic opioids, contributes to the funding shortfall. The hidden
cost comes through the diversion of laboratory funding from other
areas to meet the heightened demands from opioids.

6. Concluding remarks
The Council of Economic Advisers White House report [1] on the
severity of the opioid crisis highlighted the economic incentive to
act. While health concerns already provided a strong incentive to
act, the economic costs offered a supporting argument for treat-
ment to forestall the other societal costs, especially the loss of life.
We add to that economic support by highlighting the effects on one
expenditure area in the justice system, expenditures of the forensic
crime laboratory. These expenditures are down-the-road costs
from the absence of successful treatment leading to criminal
prosecution or interpretation of death. The trends identified high-
light the annual costs and the growth in those costs. These suggest
some policy implications.
The immediate implication deals with the current problem of
the growth in forensic crime laboratory expenditures from the rise
in opioid use. In the short-term, funding for forensic crime labo-
ratories must grow at a pace to keep up with the demand for ser-
vices. It isn’t just the opioid-related cases that are floundering, it is
all types of cases that are delayed as internal resources must be
Fig. 8. Crisis states turnaround time.
extracted from other analyses to support the opioid-related cases. For example, several recent papers [22–24] have highlighted the enormous costs of additional crime in non-drug cases, when the administration of justice is delayed.

The long-term solution to the opioid problem requires an understanding of the massive costs when addictions are not successfully treated. As highlighted by the CEA report and supplemented with the present analysis, the costs of treatment may appear to be high, but the alternatives make those costs pale in comparison. The present study is meant to offer some additional insight into the economic consequences that may be hidden, but foretell another serious funding problem if left unaddressed.

Declaration of interest
None.

Appendix

### Table 4
Percentage of backlog cases.

| Area of Investigation                  | Median 2014-15 | Median 2017-18 |
|----------------------------------------|----------------|----------------|
| Blood Alcohol                          | 0.42%          | 9%             |
| Digital evidence — Audio & Video       | 10%            | 82%            |
| DNA Casework                           | 10%            | 59%            |
| Document Examination                   | 15%            | 73%            |
| Drugs/Controlled Substances            | 4%             | 51%            |
| Explosives                             | 20%            | 78%            |
| Fingerprints                           | 7%             | 56%            |
| Fire analysis                          | 7%             | 68%            |
| Firearms and Ballistics                | 16%            | 66%            |
| Gun Shot Residue (CSR)                 | 5%             | 66%            |
| Marks and Impressions                  | 35%            | 69%            |
| Serology/Biology                       | 7%             | 51%            |
| Toxicology ante mortem (excluding BAC) | 5%             | 59%            |
| Toxicology post mortem (excluding BAC) | 6%             | 60%            |
| Trace Evidence                         | 22%            | 93%            |

### Table 5
Efficient Frontier Equations across FORESIGHT Areas of Investigation

| Area of Investigation                  | Dependent Variable | Obs. | Constant | Cases | Cases² | LN (Cases) | F-statistic |
|----------------------------------------|--------------------|------|----------|-------|--------|------------|-------------|
| Blood Alcohol Analysis                 | LN(Cost/Case)      | 95   | 8.0769   | (0.3689) | -0.3730 | (0.0446)   | 69.8472     |
| Crime Scene Investigation              | LN(Cost/Case)      | 37   | 10.6801  | (0.5574) | -0.5080 | (0.0895)   | 32.2088     |
| DNA Casework                           | Cost/Case          | 55   | 1330.9474 (355.6750) | -0.1428 | (0.1150) | 1.41E-05 | (7.78E-06) |
| DNA Database                           | LN(Cost/Case)      | 64   | 9.8396   | (0.3611) | -0.3402 | (0.0532)   | 40.8246     |
| Document Examination                   | Cost/Case          | 51   | 9.8857   | (0.3531) | -0.5833 | (0.0393)   | 220.4712    |
| Drugs–Controlled Substances            | LN(Cost/Case)      | 95   | 7.7252   | (0.3161) | 9.65E-01 | (7.78E-06) | 8.9251      |
| Explosives                             | LN(Cost/Case)      | 56   | 9.8518   | (0.2138) | -0.2575 | (0.0826)   | 9.7032      |
| Fire Analysis                          | Cost/Case          | 37   | 10.6801  | (0.5574) | -0.5080 | (0.0895)   | 32.2088     |
| Fire Analysis                          | LN(Cost/Case)      | 46   | 9.3391   | (0.4726) | -0.3762 | (0.1173)   | 10.2914     |
| Firearms & Ballistics Analysis         | LN(Cost/Case)      | 82   | 10.5126  | (0.22546) | -0.4604 | (0.0569) | 193.9070    |
| Gunshot Residue Analysis                | Cost/Case          | 50   | 10.6801  | (0.5574) | -0.5080 | (0.0895) | 32.2088     |
| Gunshot Residue Analysis                | LN(Cost/Case)      | 20   | 9.5960   | (0.2189) | -0.3847 | (0.0699)   | 39.9181     |
| Marks & Impressions Analysis           | LN(Cost/Case)      | 82   | 10.3337  | (0.2977) | -0.5236 | (0.0821) | 40.6461     |
| Serology/Biology Analysis              | Cost/Case          | 14   | 1644.869 | (122.7290) | -0.2567 | (0.0331) | 193.9070    |
| Toxicology ante mortem Analysis        | Cost/Case          | 70   | 778.962  | (78.5504) | -0.5989 | (0.1477)   | 16.4359     |
| Trace Evidence Analysis                 | Cost/Case          | 70   | 5305.6021 | 338.3597 | -0.4954 | (0.10224) | 23.5105     |
| Trace Evidence Analysis                 | LN(Cost/Case)      | 25   | 10.6627  | (0.3439) | -0.4954 | (0.10224) | 23.5105     |

Note: Standard errors are shown in parentheses.
Table 6

Efficient Frontier Equations across Census Areas of Investigation

| Area of Investigation | Dependent Variable | Obs. | Constant | Cases | Cases² | LN (Cases) | F-statistic |
|-----------------------|--------------------|------|----------|-------|--------|------------|-------------|
| Crime Scene Investigation | LN(Cost/Case) | 37   | 10.6801  | 0.5574 | -1.4675 | 10.6132    | 32.2088     |
| DNA Database          | LN(Cost/Case) | 51   | 9.8857   | 0.3331 | -0.5833 | 220.4712   | 20.7217     |
| Document Examination  | Cost/Case         | 67   | 11700.4971 | 2219.4849 | -1.4675 | 10.6132    | 32.2088     |
| Drugs–Controlled Substances | LN(Cost/Case) | 95   | 7.7252   | 0.3161 | -0.2268 | 38.9251    | 13.1753     |
| Fingerprint Identification | Cost/Case | 50   | 8.5142   | 0.5424 | -0.2575 | 9.7032     |             |
| Firearms & Ballistics Analysis | LN(Cost/Case) | 37   | 10.5126  | 0.22546 | -0.4604 | 193.9070   |             |
| Marks & Impressions Analysis | LN(Cost/Case) | 82   | 10.3357  | 0.2997 | 0.0311  | 40.6461    |             |
| Forensic Biology Analysis (includes serology/biology & DNA Casework) | Cost/Case | 126  | 1350.2609 | 188.0350 | -0.6707 | 5.31E-05   | 26.6964     |
| Toxicology Analysis   | LN(Cost/Case) | 76   | 9.6498   | 0.2800 | -0.4158 | 179.8395   |             |
| Trace Evidence Analysis (includes explosives & GSR) | LN(Cost/Case) | 103  | 10.3423  | 0.2108 | -0.3887 | 105.3046   |             |

Note: Standard errors are shown in parentheses.

Conflict of Interest

Authors declare there is no conflict of interest.

References

[1] The Council of Economic Advisers, The Underestimated Cost of the Opioid Crisis, November 22, 2017. Retrieved from whitehouse.gov, https://www.whitehouse.gov/sites/whitehousegov/files/images/The%20Underestimated%20Cost%20of%20the%20Opioid%20Crisis.pdf.
[2] M. Houck, P. Speaker, Efficiency and the cost effective delivery of forensic science services: in-sourcing, out-sourcing, and privatization, Forensic Sci. Policy Manag.: Int. J. 3 (2) (2012) 62–69.
[3] P.J. Speaker, The Jurisdictional Return on Investment from Processing the Backlog of Untested Sexual Assault Kits, Forensic Sci. Int.: Synergy 1 (1) (2019) 227–238.
[4] P.J. Speaker, Process improvement and the efficient frontier: forecasting the limits to strategic change across crime laboratory areas of investigation, Forensic Sci. Policy Manag.: Int. J. 8 (3–4) (2017) 109–127.
[5] C.J. Hammond, Estimating the statistical cost curve: an application of the stochastic frontier technique, Appl. Econ. 18 (9) (1986) 971–984.
[6] C. Florence, C. Zhou, F. Luo, L. Xu, The economic burden of prescription opioid overdose, abuse, and dependence in the United States, 2013, Med. Care 54 (10) (2016) 901–906.
[7] Bureau of Justice Statistics, Publicly Funded Forensic Crime Laboratories: Resources and Services, 2014, NQJ 250151, www.bjs.gov, 2014.
[8] M.M. Houck, R.A. Riley, P.J. Speaker, FORESIGHT: a business approach to improving forensic science services, Forensic Sci. Policy Manag.: Int. J. 1 (2) (2009) 85–95.
[9] W.K. Viscusi, J.E. Aldy, The Value of a Statistical Life: A Critical Review of Market Estimates throughout the World, National Bureau of Economic Research (NBER), Cambridge, MA, 2003. Working Paper 9487.
[10] J.E. Aldy, W.K. Viscusi, Adjusting the value of a statistical life for age and cohort effects, Rev. Econ. Stat. 90 (3) (2008) 573–581.
[11] B. Birnbaum, A. White, M. Schiller, T. Waldman, J. Cleveland, C. Roland, Societal costs of prescription opioid abuse, dependence, and misuse in the United States, Pain Med. 12 (2011) 657–667.
[12] European Network of Forensic Science Institutes, QUADRUPOL–DEVELOPMENT OF A BENCHMARKING MODEL FOR FORENSIC LABORATORIES, Commission of the European Union, 2003.
[13] M.M. Houck, R.A. Riley, P.J. Speaker, FORESIGHT: a business approach to improving forensic science services, Forensic Sci. Policy Manag.: Int. J. 1 (2) (2009) 85–95.
[14] Bureau of Justice Statistics, Office of Justice Programs, Data Collection: Census of Publicly Funded Forensic Crime Laboratories, Retrieved from Bureau of Justice Statistics: https://www.bjs.gov/index.cfm?ty=dcdetail&uid=244, 2017, December 4.
[15] Centers for Disease Control and Prevention, Drug Overdose Deaths, Opioid Overdose, 2018, https://www.cdc.gov/drugoverdose/data/statedeaths.html. (Accessed 15 February 2019).
[16] U.S. Department of Justice, Federal Bureau of Investigation, Criminal Justice Information Services Division, FBI Uniform Crime Report 2014, 2017, December 3. Retrieved from Department of Justice, Federal Bureau of Investigation, Criminal Justice Information Services Division, https://ucr.fbi.gov/crime-in-the-u.s/2014/crime-in-the-u.s.-2014.
[17] C. Maguire, M. Houck, P. Williams, P. Speaker, Efficiency and the cost effective delivery of forensic science services: in-sourcing, out-sourcing, and privatization, Forensic Sci. Policy Manag.: Int. J. 3 (2) (2012) 62–69.
[18] P.J. Speaker, Financial management of forensic science laboratories: lessons from project FORESIGHT 2011–2012, Forensic Sci. Policy Manag.: Int. J. 6 (1–2) (2015) 7–29.
[19] P.J. Speaker, Process improvement and the efficient frontier: forecasting the limits to strategic change across crime laboratory areas of investigation, Forensic Sci. Policy Manag.: Int. J. 8 (3–4) (2017) 109–127.
[20] M. Knapp, Economies of scale in local public services: the case of British crematoria, Appl. Econ. 14 (2) (1982) 447–453.
[21] H. Christoffersen, M. Paldam, A. Wurtz, Public versus private production and economies of scale, Public Choice 130 (2007) 311–328.
[22] J. Doleac, The effects of DNA databases on crime, Am. Econ. J. Appl. Econ. 9 (1) (2017) 165–201.
[23] C. Wang, L.M. Wein, Analyzing Approaches to the Backlog of Untested Sexual Assault Kits in the U.S.A, J. Forensic Sci. (2018) 1–8.