Project FORESIGHT Annual Report, 2013-2014

Forensic Science Initiative, College of Business & Economics, West Virginia University

FORESIGHT Laboratory Participant—Example Laboratory ABC (US$)

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FORESIGHT Benchmark Data 2013-2014

Project FORESIGHT is a business-guided self-evaluation of forensic science laboratories across the globe. The participating laboratories represent local, regional, state, and national agencies. Economics, accounting, finance, and forensic faculty provide assistance, guidance, and analysis. Laboratories participating in Project FORESIGHT have developed standardized definitions for metrics to evaluate work processes, linking financial information to work tasks, and functions. Laboratory managers can then assess resource allocations, efficiencies, and value of services—the mission of Project FORESIGHT is to measure, preserve what works, and change what does not.

The benchmark data for the 2013-2014 performance period includes laboratory submissions for a variety of fiscal year definitions. However, all submissions have December 31, 2013 as part of their fiscal year accounting. The majority of submissions follow a July 1, 2013 through June 30, 2014 convention. Others follow a year that begins as early as January 1, 2013 (ending December 31, 2013) while the other extreme includes laboratories with a fiscal year originating October 1, 2013 and ending September 30, 2014.

Consider the summary statistics for several of the key performance indicators. Because of outliers in several of the investigative areas, the most meaningful comparisons might best be made with respect to median as a representation of "typical" laboratory performance. To lend perspective to the spread of these metrics, each of the quartile metrics are reported along with the specific comparison to the laboratory highlighted in this report.

As of this writing, one hundred three laboratories contributed data to the project in 2013-2014. For most areas of investigation, the submitted data offers a large enough sample to elicit good statistical properties. However for Evidence Screening & Processing, and Forensic Pathology, the number of reporting laboratories in these areas is too small to draw meaningful conclusions. As such, the metrics in these two areas of investigation offer limited inference.

For more information on Project FORESIGHT, visit the Project web site at www.be.wvu.edu/forensic/foresight.htm. Questions regarding this report or other matters pertaining to Project FORESIGHT should be directed to the Principal Investigator Paul Speaker (paul.speaker@mail.wvu.edu).

Cost Metrics

Cost per Case

The **cost** includes allocations for capital, wages & salary, benefits, overtime & temporary hires, chemicals, reagents, consumables, gases, travel, quality assurance and accreditation, subcontracting, service of instruments, advertisements, non-instrument repairs and maintenance, equipment leasing, utilities, telecommunications, overhead, and other expenses.

A **case** in an investigative area refers to a request from a crime laboratory customer that includes forensic investigation in that investigative area. Note that a customer request may lead to a case in multiple investigative areas.

Table 1: Cost per Case by Investigative Area

Cost per Case	Laboratory	25th Percentile	Median	75th Percentile
Blood Alcohol	$107	$78	$132	$394
Crime Scene Investigation	$926	$750	$1,944	$7,292
Digital evidence - Audio & Video		$1,328	$2,420	$6,244
DNA Casework	$1,025	$1,150	$1,569	$2,492
DNA Database		$62	$85	$195
Document Examination		$1,670	$2,739	$4,291
Drugs - Controlled Substances	$279	$188	$326	$442
Evidence Screening & Processing	$724	$294	$542	$917
Explosives	$16,028	$2,231	$7,308	$16,954
Fingerprints	$1,185	$377	$582	$842
Fire analysis	$14,198	$980	$2,182	$3,211
Firearms and Ballistics	$2,831	$666	$1,183	$2,199
Forensic Pathology		$1,517	$2,075	$2,673
Gun Shot Residue (GSR)	$31,235	$731	$1,610	$4,910
Marks and Impressions	$7,621	$1,156	$3,114	$6,175
Serology/Biology	$612	$533	$685	$1,326
Toxicology ante mortem (excluding BAC)	$307	$382	$486	$1,488
Toxicology post mortem (excluding BAC)	$775	$414	$851	$1,708
Trace Evidence	$8,311	$2,730	$4,773	$7,790

Project FORESIGHT submissions have increased annually. Although laboratory participation is voluntary, the summary statistics have been relatively consistent across time, particularly for areas of investigation that have large numbers of submissions. To illustrate, the following table provides a comparison of the cost/case over time after

correcting for inflation. These measures are termed "real cost/case" where real refers to inflation-adjusted measures. Prior year's metrics have been converted to 2013-2014 prices.

Table 2: Real Cost per Case across Time

Real Cost* per Case	2011-2012	2012-2013	2013-2014
Blood Alcohol	$125	$121	$132
Crime Scene Investigation	$5,582	$5,360	$1,944
Digital evidence - Audio & Video	$4,978	$6,838	$2,420
DNA Casework	$1,802	$2,024	$1,569
DNA Database	$56	$66	$85
Document Examination	$4,023	$6,862	$2,739
Drugs - Controlled Substances	$193	$278	$326
Evidence Screening & Processing	$542	$1,681	$542
Explosives	$5,371	$14,322	$7,308
Fingerprints	$336	$535	$582
Fire analysis	$987	$1,389	$2,182
Firearms and Ballistics	$846	$734	$1,183
Forensic Pathology	$3,396	$2,251	$2,075
Gun Shot Residue (GSR)	$1,254	$2,293	$1,732
Marks and Impressions	$4,116	$9,568	$3,114
Serology/Biology	$610	$2,216	$685
Toxicology ante mortem (excluding BAC)	$626	$509	$486
Toxicology post mortem (excluding BAC)	$657	$653	$851
Trace Evidence	$2,934	$4,070	$4,953
* 2013-2014 = 100			

Cost per Item

Differences in case detail and differences in case complexity across laboratories (and across time) suggest that other relative cost measures may offer more meaningful comparison. FORESIGHT data collection includes measures for items, samples, and tests in each investigative area.

An **item** refers to a single object for examination submitted to the laboratory. Note that one item may be investigated and counted in several investigation areas. As noted above, the **cost** includes allocations for capital, wages & salary, benefits, overtime & temporary hires, chemicals, reagents, consumables, gases, travel, quality assurance and accreditation, subcontracting, service of instruments, advertisements, non-instrument repairs and maintenance, equipment leasing, utilities, telecommunications, overhead, and other expenses.

Table 3: Cost per Item by Investigative Area

Cost per Item	Laboratory	25th Percentile	Median	75th Percentile
Blood Alcohol	$103	$74	$127	$307
Crime Scene Investigation		$28	$282	$1,242
Digital evidence - Audio & Video		$341	$1,038	$4,187
DNA Casework	$550	$471	$674	$984
DNA Database		$60	$90	$202
Document Examination		$308	$615	$1,180
Drugs - Controlled Substances	$193	$117	$182	$263
Evidence Screening & Processing	$826	$62	$110	$605
Explosives	$1,968	$1,282	$3,424	$7,450
Fingerprints	$758	$127	$232	$433
Fire analysis	$7,517	$351	$584	$1,171
Firearms and Ballistics	$1,418	$218	$383	$835
Forensic Pathology		$1,619	$2,034	$3,019
Gun Shot Residue (GSR)	$7,809	$422	$845	$2,040
Marks and Impressions	$6,210	$305	$1,076	$2,671
Serology/Biology	$412	$110	$224	$405
Toxicology ante mortem (excluding BAC)	$307	$294	$440	$1,108
Toxicology post mortem (excluding BAC)	$556	$210	$454	$656
Trace Evidence	$260	$966	$1,609	$3,238

Cost per Sample

A **sample** refers to an item of evidence or a portion of an item of evidence that generates a reported result.

As noted above, the **cost** includes allocations for capital, wages & salary, benefits, overtime & temporary hires, chemicals, reagents, consumables, gases, travel, quality assurance and accreditation, subcontracting, service of instruments, advertisements, non-instrument repairs and maintenance, equipment leasing, utilities, telecommunications, overhead, and other expenses.

The sample offers a consistently applied metric across laboratories and suggests an average cost measure that is intuitively comparable in cross sectional commentary.

Table 4: Cost per Sample by Investigative Area

Cost per Sample	Laboratory	25th Percentile	Median	75th Percentile
Blood Alcohol	$96	$70	$96	$177
Crime Scene Investigation		$6	$71	$1,642
Digital evidence - Audio & Video		$575	$705	$2,656
DNA Casework	$255	$296	$426	$616
DNA Database		$60	$83	$171
Document Examination		$170	$566	$764
Drugs - Controlled Substances	$193	$90	$119	$196
Evidence Screening & Processing	$299	$56	$110	$310
Explosives	$1,968	$1,131	$3,143	$6,941
Fingerprints	$433	$73	$129	$319
Fire analysis	$7,517	$334	$574	$1,488
Firearms and Ballistics	$524	$230	$386	$553
Forensic Pathology		$305	$1,643	$2,113
Gun Shot Residue (GSR)	$7,809	$214	$615	$1,668
Marks and Impressions	$6,210	$245	$1,143	$2,793
Serology/Biology	$402	$85	$141	$391
Toxicology ante mortem (excluding BAC)	$302	$277	$327	$749
Toxicology post mortem (excluding BAC)	$427	$221	$344	$518
Trace Evidence	$260	$345	$1,267	$3,215

Cost per Test

A **test** refers to an analytical process, including but not limited to visual examination, instrumental analysis, presumptive evaluations, enhancement techniques, extractions, quantifications, microscopic techniques, and comparative examinations. This does not include technical or administrative reviews.

As noted above, the **cost** includes allocations for capital, wages & salary, benefits, overtime & temporary hires, chemicals, reagents, consumables, gases, travel, quality assurance and accreditation, subcontracting, service of instruments, advertisements, non-instrument repairs and maintenance, equipment leasing, utilities, telecommunications, overhead, and other expenses.

Table 5: Cost per Test by Investigative Area

Cost per Test	Laboratory	25th Percentile	Median	75th Percentile
Blood Alcohol	$48	$36	$50	$123
Crime Scene Investigation		$6	$94	$2,065
Digital evidence - Audio & Video		$143	$215	$1,525
DNA Casework	$45	$57	$123	$237
DNA Database		$46	$63	$136
Document Examination		$81	$205	$637
Drugs - Controlled Substances	$33	$27	$40	$55
Evidence Screening & Processing	$67	$13	$44	$88
Explosives	$392	$261	$674	$1,452
Fingerprints	$96	$51	$69	$89
Fire analysis	$1,865	$139	$233	$608
Firearms and Ballistics	$183	$80	$158	$296
Forensic Pathology		$163	$1,643	$2,062
Gun Shot Residue (GSR)	$2,603	$137	$247	$896
Marks and Impressions	$3,450	$127	$504	$1,010
Serology/Biology	$51	$44	$62	$96
Toxicology ante mortem (excluding BAC)	$60	$57	$119	$212
Toxicology post mortem (excluding BAC)	$79	$70	$112	$155
Trace Evidence	$108	$239	$492	$979

Metric Interpretation

The various unit cost metrics may be interpreted using the technique highlighted in The Decomposition of Return on Investment for Forensic Laboratories, *Forensic Science Policy & Management: An International Journal* Volume 1, Issue 2, 2009, Paul J. Speaker, pages 96-102. Consider the Cost/Case metric which may be decomposed into:

$$\frac{Cost}{Case} = \frac{Average\ Compensation\ x\ Testing\ Intensity}{Personnel\ Productivity\ x\ Personnel\ Expense\ Ratio}$$

From the decomposition expression for the Cost/Case, an increase in the numerator components, Average Compensation or Testing (or Sampling) Intensity, will increase the cost per case. Similarly, a decrease in denominator component will increase the cost per case. This may occur from either a drop in productivity, as measured by cases processed per FTE, or from an increase in capital investment for future productivity but financed via a drop in personnel expenses relative to total expenses.

Although the metric breakdown illustrated above offers a decomposition of the Cost/Case metric, a similar procedure may be applied to other cost metrics. Likewise, the Testing Intensity metric may be replaced by a Sampling Intensity metric (e.g., Samples/Case) or similar decomposition which offers the most meaning to the individual laboratory.

Market Metrics

A substantial portion of the cost to the laboratory comes through personal services budget for salary and benefits. (The section below on Analytical Process Metrics highlights the percentage of total costs attributable to personnel expenditures.) Laboratories across the globe and across a particular country face very different labor markets and cost of living conditions. As such, accounting for the salary and benefit pressures in each market is beyond the direct control of the individual laboratory and is subject to the market forces in a laboratory's political jurisdiction.

It may be helpful for a laboratory to replace their specific average compensation with that of the reported sample median to gain insight into how they compare to other laboratories once market forces have been neutralized.

Average Compensation

Note that **compensation** includes all personnel expenditures. This includes wages, salary, and benefits operating staff, support staff, and administrative staff. Centrally assigned compensation is apportioned to each investigative area according to the percentage of full-time equivalent employees assigned to a particular investigative area.

Note that values reported in this table and other tables with budgetary metrics have been converted to the currency of the reporting laboratory using the exchange rate for December 31 of the measured year as reported at www.xe.com.

Table 6: Average Compensation by Investigative Area

Average Compensation	Laboratory	25th Percentile	Median	75th Percentile
Blood Alcohol	$126,748	$77,264	$88,745	$111,416
Crime Scene Investigation	$102,039	$80,085	$97,819	$102,944
Digital evidence - Audio & Video		$75,598	$80,852	$98,865
DNA Casework	$120,373	$83,911	$97,160	$120,133
DNA Database		$63,515	$79,033	$85,863
Document Examination		$79,525	$88,299	$98,914
Drugs - Controlled Substances	$108,436	$81,352	$94,360	$115,853
Evidence Screening & Processing	$137,670	$44,365	$59,997	$94,863
Explosives	$115,178	$80,459	$93,034	$115,398
Fingerprints	$106,424	$78,862	$91,358	$104,038
Fire analysis	$116,601	$82,193	$93,796	$112,590
Firearms and Ballistics	$148,584	$82,693	$98,452	$119,712
Forensic Pathology		$80,075	$106,039	$121,297
Gun Shot Residue (GSR)	$116,336	$81,757	$94,363	$115,276
Marks and Impressions	$45,336	$79,235	$97,909	$110,429
Serology/Biology	$137,808	$75,717	$90,107	$114,502
Toxicology ante mortem (excluding BAC)	$117,579	$73,192	$86,972	$105,595
Toxicology post mortem (excluding BAC)	$118,013	$71,749	$86,061	$104,691
Trace Evidence	$115,508	$86,061	$95,581	$116,129

Risk Management Metrics

There are a variety of metrics that may be used in the decomposition of average cost to suggest quality and/or risk. Three of these metrics follow to highlight the level of testing, sampling, and items examined per case.

Items per Case

An **item** refers to a single object for examination submitted to the laboratory. Note that one item may be investigated and counted in several investigation areas.

A **case** in an investigative area refers to a request from a crime laboratory customer that includes forensic investigation in that investigative area. Note that a customer request may lead to a case in multiple investigative areas.

Table 7: Items per Case by Investigative Area

Items per Case	Laboratory	25th Percentile	Median	75th Percentile
Blood Alcohol	1.03	1.00	1.02	1.35
Crime Scene Investigation		1.00	12.54	34.96
Digital evidence - Audio & Video		1.41	3.08	4.70
DNA Casework	1.86	1.90	2.49	3.34
DNA Database		0.98	1.00	1.09
Document Examination		2.86	4.53	6.52
Drugs - Controlled Substances	1.44	1.40	1.69	2.17
Evidence Screening & Processing	0.88	2.09	3.70	4.60
Explosives	8.14	1.35	2.38	5.59
Fingerprints	1.56	1.52	2.41	3.89
Fire analysis	1.89	2.19	2.78	3.55
Firearms and Ballistics	2.00	1.95	2.55	5.02
Forensic Pathology		1.00	1.00	1.00
Gun Shot Residue (GSR)	4.00	1.34	2.17	3.00
Marks and Impressions	1.23	1.74	3.45	4.56
Serology/Biology	1.49	2.09	3.88	5.56
Toxicology ante mortem (excluding BAC)	1.00	1.01	1.32	1.55
Toxicology post mortem (excluding BAC)	1.39	1.52	2.31	4.21
Trace Evidence	31.94	1.94	2.16	2.31

Samples per Case

A **sample** refers to an item of evidence or a portion of an item of evidence that generates a reported result.

A **case** in an investigative area refers to a request from a crime laboratory customer that includes forensic investigation in that investigative area. Note that a customer request may lead to a case in multiple investigative areas.

Table 8: Samples per Case by Investigative Area

Samples per Case	Laboratory	25th Percentile	Median	75th Percentile
Blood Alcohol	1.11	1.03	2.00	2.04
Crime Scene Investigation		3.16	15.64	61.57
Digital evidence - Audio & Video		1.97	3.49	5.20
DNA Casework	4.02	2.53	4.02	4.70
DNA Database		1.00	1.00	1.14
Document Examination		2.47	6.21	13.27
Drugs - Controlled Substances	1.44	1.46	2.28	3.46
Evidence Screening & Processing	2.42	3.42	4.36	6.02
Explosives	8.14	1.21	3.02	9.16
Fingerprints	2.74	2.20	3.26	5.66
Fire analysis	1.89	2.22	2.93	4.22
Firearms and Ballistics	5.40	2.21	3.87	6.05
Forensic Pathology		1.00	1.07	4.20
Gun Shot Residue (GSR)	4.00	1.86	3.66	5.24
Marks and Impressions	1.23	1.41	2.97	4.59
Serology/Biology	1.52	3.59	5.40	7.65
Toxicology ante mortem (excluding BAC)	1.02	1.02	1.39	2.89
Toxicology post mortem (excluding BAC)	1.82	1.67	2.80	5.67
Trace Evidence	31.94	1.79	3.27	7.34

Tests per Case

A **test** refers to an analytical process, including but not limited to visual examination, instrumental analysis, presumptive evaluations, enhancement techniques, extractions, quantifications, microscopic techniques, and comparative examinations. This does not include technical or administrative reviews.

A **case** in an investigative area refers to a request from a crime laboratory customer that includes forensic investigation in that investigative area. Note that a customer request may lead to a case in multiple investigative areas.

Table 9: Tests per Case by Investigative Area

Tests per Case	Laboratory	25th Percentile	Median	75th Percentile
Blood Alcohol	2.23	2.02	2.16	3.83
Crime Scene Investigation				
Digital evidence - Audio & Video		6.74	9.89	17.91
DNA Casework	22.59	7.93	16.34	22.27
DNA Database		1.00	1.16	4.00
Document Examination		4.11	8.67	27.54
Drugs - Controlled Substances	8.33	5.42	8.46	12.42
Evidence Screening & Processing	10.78	8.62	12.73	29.75
Explosives	40.86	5.89	10.63	19.98
Fingerprints	12.29	4.25	8.77	12.34
Fire analysis	7.61	3.80	6.22	12.63
Firearms and Ballistics	15.51	3.60	7.43	17.56
Forensic Pathology		1.00	1.07	7.65
Gun Shot Residue (GSR)	12.00	4.05	5.90	10.04
Marks and Impressions	2.21	3.69	7.52	18.75
Serology/Biology	11.93	9.65	12.61	19.72
Toxicology ante mortem (excluding BAC)	5.09	3.70	5.03	11.11
Toxicology post mortem (excluding BAC)	9.81	4.80	9.93	14.24
Trace Evidence	76.88	7.97	12.16	20.83

Tests per Sample

A **test** refers to an analytical process, including but not limited to visual examination, instrumental analysis, presumptive evaluations, enhancement techniques, extractions, quantifications, microscopic techniques, and comparative examinations. This does not include technical or administrative reviews.

A **sample** refers to an item of evidence or a portion of an item of evidence that generates a reported result.

Table 10: Tests per Sample by Investigative Area

Tests per Sample	Laboratory	25th Percentile	Median	75th Percentile
Blood Alcohol	2.00	1.06	1.50	2.02
Crime Scene Investigation				
Digital evidence - Audio & Video		1.36	3.99	4.38
DNA Casework	5.62	3.28	4.00	5.02
DNA Database		1.00	1.36	4.00
Document Examination		1.05	2.00	3.00
Drugs - Controlled Substances	5.78	2.32	3.00	4.00
Evidence Screening & Processing	4.45	2.71	3.75	4.64
Explosives	5.02	2.16	5.00	7.00
Fingerprints	4.49	1.26	1.99	4.49
Fire analysis	4.03	1.09	2.00	4.00
Firearms and Ballistics	2.87	1.20	2.26	3.00
Forensic Pathology		1.00	1.00	2.00
Gun Shot Residue (GSR)	3.00	1.00	1.97	3.00
Marks and Impressions	1.80	2.00	3.00	5.00
Serology/Biology	7.82	1.68	2.67	4.42
Toxicology ante mortem (excluding BAC)	5.01	1.65	3.17	4.90
Toxicology post mortem (excluding BAC)	5.40	1.70	2.86	4.42
Trace Evidence	2.41	2.40	4.04	6.00

Productivity Metrics

Return to the decomposition measure for the cost/case. The denominator terms have the opposite effect on average cost. That is, as ***labor productivity*** or the ***labor expense ratio*** increase, average costs will fall. This confirms that, as a representative scientist is able to process more cases per year, then the effect will be a decrease in the average

cost as fixed expenditures are averaged over a higher volume of processed cases. Similarly, if a greater portion of the budget is devoted to personnel expenditures (as opposed to capital investment) *ceteris paribus*, more cases will be processed for the same expenditure at the opportunity cost of delaying investment in capital equipment for future returns.

The next five tables contain the LabRAT summary statistics for alternative personnel productivity ratio measures.

Cases per FTE

This measure is simply the number of Cases completed for each full-time equivalent (FTE) employee (the work input of a full-time employee working for one full year) retained by the laboratory. It gives an indication of the level of productivity within the average laboratory by investigative area.

Table 11: Cases per FTE by Investigative Area

Cases per FTE	Laboratory	25th Percentile	Median	75th Percentile
Blood Alcohol	1,473.66	270.72	832.29	1,557.67
Crime Scene Investigation	137.43	19.05	46.26	153.95
Digital evidence - Audio & Video		21.33	45.70	76.25
DNA Casework	142.12	57.91	88.53	137.63
DNA Database		899.52	2,068.38	2,544.29
Document Examination		25.52	43.91	82.31
Drugs - Controlled Substances	479.79	337.06	446.76	590.96
Evidence Screening & Processing	224.89	63.93	147.25	169.54
Explosives	8.75	10.78	26.79	54.51
Fingerprints	115.90	134.83	221.12	326.33
Fire analysis	10.00	43.56	69.08	112.96
Firearms and Ballistics	61.36	61.74	95.10	175.24
Forensic Pathology		53.72	58.81	84.52
Gun Shot Residue (GSR)	4.55	24.56	58.53	176.96
Marks and Impressions	9.28	19.11	29.00	85.49
Serology/Biology	266.24	94.25	155.50	210.92
Toxicology ante mortem (excluding BAC)	465.22	75.93	206.08	359.20
Toxicology post mortem (excluding BAC)	184.86	68.74	140.30	247.24
Trace Evidence	16.92	19.77	28.28	50.46

Items per FTE

This measure is the number of Items examined internally for each full-time equivalent (FTE) employee (the work input of a full-time employee working for one full year) retained by the laboratory. It gives an indication of the level of productivity within the average laboratory by investigative area.

Table 12: Items examined per FTE by Investigative Area

Items per FTE	Laboratory	25th Percentile	Median	75th Percentile
Blood Alcohol	1,524	349	940	1,602
Crime Scene Investigation		184	904	3,948
Digital evidence - Audio & Video		33	71	237
DNA Casework	265	138	213	333
DNA Database		324	1,153	2,287
Document Examination		117	190	467
Drugs - Controlled Substances	691	544	706	1,081
Evidence Screening & Processing	197	208	366	619
Explosives	71	25	55	129
Fingerprints	181	243	574	1,007
Fire analysis	19	108	206	333
Firearms and Ballistics	123	184	304	438
Forensic Pathology		54	58	80
Gun Shot Residue (GSR)	18	61	174	231
Marks and Impressions	11	39	107	301
Serology/Biology	396	334	473	947
Toxicology ante mortem (excluding BAC)	465	127	274	433
Toxicology post mortem (excluding BAC)	258	171	297	531
Trace Evidence	541	50	83	137

Samples per FTE

This measure is the number of samples from Items examined internally for each full-time equivalent (FTE) employee (the work input of a full-time employee working for one full year) retained by the laboratory. It gives an indication of the level of productivity within the average laboratory by investigative area.

Table 13: Samples per FTE by Investigative Area

Samples per FTE	Laboratory	25th Percentile	Median	75th Percentile
Blood Alcohol	1,640	581	1,521	2,172
Crime Scene Investigation		60	2,007	5,457
Digital evidence - Audio & Video		49	114	175
DNA Casework	571	188	349	516
DNA Database		626	1,623	2,344
Document Examination		148	208	778
Drugs - Controlled Substances	691	733	1,012	1,671
Evidence Screening & Processing	545	286	571	1,001
Explosives	71	27	53	158
Fingerprints	317	407	822	1,415
Fire analysis	19	98	212	369
Firearms and Ballistics	332	237	341	436
Forensic Pathology		58	83	462
Gun Shot Residue (GSR)	18	89	208	541
Marks and Impressions	11	38	98	333
Serology/Biology	406	398	754	1,287
Toxicology ante mortem (excluding BAC)	473	175	362	479
Toxicology post mortem (excluding BAC)	336	230	371	529
Trace Evidence	541	53	97	333

Tests per FTE

This measure is the number of tests performed on samples for each full-time equivalent (FTE) employee (the work input of a full-time employee working for one full year) retained by the laboratory. It gives an indication of the level of productivity within the average laboratory by investigative area.

Table 14: Tests per FTE by Investigative Area

Tests per FTE	Laboratory	25th Percentile	Median	75th Percentile
Blood Alcohol	3,281	1,173	1,969	3,224
Crime Scene Investigation				
Digital evidence - Audio & Video		111	420	697
DNA Casework	3,210	582	1,181	2,726
DNA Database		953	2,360	3,431
Document Examination		243	623	1,243
Drugs - Controlled Substances	3,996	2,468	3,076	4,518
Evidence Screening & Processing	2,425	964	2,138	4,145
Explosives	358	123	235	481
Fingerprints	1,425	1,258	1,779	2,426
Fire analysis	76	213	566	772
Firearms and Ballistics	952	434	809	1,329
Forensic Pathology		59	83	830
Gun Shot Residue (GSR)	55	129	521	906
Marks and Impressions	21	95	269	834
Serology/Biology	3,176	1,168	2,335	3,266
Toxicology ante mortem (excluding BAC)	2,369	627	1,055	2,380
Toxicology post mortem (excluding BAC)	1,814	725	1,141	2,008
Trace Evidence	1,301	218	303	606

Reports per FTE

This measure is the number of reports filed per full-time equivalent (FTE) employees (the work input of a full-time employee working for one full year) retained by the laboratory. It gives an indication of the level of productivity within the average laboratory by investigative area.

Table 15: Reports per FTE by Investigative Area

Reports per FTE	Laboratory	25th Percentile	Median	75th Percentile
Blood Alcohol	1,800	261	802	1,580
Crime Scene Investigation	180	16	44	180
Digital evidence - Audio & Video		11	35	56
DNA Casework	152	58	87	138
DNA Database		101	2,024	3,344
Document Examination		24	43	89
Drugs - Controlled Substances	479	334	501	658
Evidence Screening & Processing		73	153	174
Explosives	9	10	30	53
Fingerprints	188	123	190	323
Fire analysis	10	46	71	121
Firearms and Ballistics	72	64	94	140
Forensic Pathology		51	61	83
Gun Shot Residue (GSR)	5	25	69	186
Marks and Impressions	17	17	28	86
Serology/Biology		84	138	201
Toxicology ante mortem (excluding BAC)	498	74	215	361
Toxicology post mortem (excluding BAC)	195	72	139	267
Trace Evidence	17	17	26	50

Analytical Process Metrics

The next decomposition measure, **Personnel Expense/Total Expense**, serves as a proxy for the level of analytical technology chosen. This measure has a significant negative correlation with **Capital Expense/Total Expense** and serves as simpler decomposition term for the return on investment.

Below, the cost structure is detailed with a breakdown of expenses in capital, labor, consumables, versus other costs. Investigative areas that are highly automated, such as evidenced by the DNA database processing line, should show a lower Personnel Expense/Total Expense.

Personnel Expense as a proportion of Total Expense

Note that **compensation** includes all personnel expenditures. This includes wages, salary, and benefits operating staff, support staff, and administrative staff. Centrally assigned compensation is apportioned to each investigative area according to the percentage of full-time equivalent employees assigned to a particular investigative area.

Table 16: Personnel Expenditures/Total Expenditures by Investigative Area

Personnel Expenditures/Total Expenditures	Laboratory	25th Percentile	Median	75th Percentile
Blood Alcohol	80.73%	62.27%	75.44%	80.66%
Crime Scene Investigation	80.19%	71.74%	80.76%	87.31%
Digital evidence - Audio & Video		72.91%	76.42%	81.81%
DNA Casework	82.66%	56.27%	66.31%	74.38%
DNA Database		37.64%	50.19%	65.69%
Document Examination		68.25%	81.07%	87.65%
Drugs - Controlled Substances	81.12%	70.45%	77.38%	85.13%
Evidence Screening & Processing	84.51%	75.51%	84.70%	90.29%
Explosives	82.13%	52.18%	70.54%	86.84%
Fingerprints	77.49%	77.91%	85.72%	90.46%
Fire analysis	82.12%	69.32%	77.03%	85.77%
Firearms and Ballistics	85.52%	71.61%	83.64%	88.91%
Forensic Pathology		70.15%	84.18%	89.43%
Gun Shot Residue (GSR)	81.94%	68.35%	79.92%	83.75%
Marks and Impressions	64.09%	69.10%	81.78%	89.44%
Serology/Biology	84.51%	74.51%	81.41%	85.23%
Toxicology ante mortem (excluding BAC)	82.35%	63.48%	72.20%	81.94%
Toxicology post mortem (excluding BAC)	82.36%	63.09%	76.26%	82.59%
Trace Evidence	82.12%	58.34%	75.08%	82.53%

Capital Expense as a proportion of Total Expense

Capital expenditures reference those purchases by the laboratory for assets whose use extends across time periods. Since depreciation classifications place laboratory equipment into a five year depreciation class, the capital expenditures over a five year period are averaged in the determination of this portion of a laboratory's expenditures.

Table 17: Capital Expenditures/Total Expenditures by Investigative Area

Capital Expenditures/Total Expenditures	Laboratory	25th Percentile	Median	75th Percentile
Blood Alcohol	8.32%	4.92%	7.79%	14.72%
Crime Scene Investigation	8.56%	1.75%	4.76%	7.79%
Digital evidence - Audio & Video		7.94%	11.31%	19.89%
DNA Casework	7.49%	4.64%	8.08%	13.59%
DNA Database		2.63%	5.47%	7.08%
Document Examination		1.38%	3.69%	7.97%
Drugs - Controlled Substances	8.15%	4.75%	6.55%	11.71%
Evidence Screening & Processing	6.69%	1.14%	4.69%	6.52%
Explosives	7.72%	4.63%	11.97%	35.73%
Fingerprints	9.72%	1.80%	4.24%	6.55%
Fire analysis	7.72%	3.74%	6.01%	11.11%
Firearms and Ballistics	6.25%	2.03%	4.66%	7.89%
Forensic Pathology		1.77%	2.94%	7.62%
Gun Shot Residue (GSR)	7.70%	4.52%	6.62%	15.73%
Marks and Impressions	15.51%	1.84%	4.64%	12.00%
Serology/Biology	6.69%	1.21%	3.05%	5.93%
Toxicology ante mortem (excluding BAC)	7.61%	5.60%	8.31%	12.96%
Toxicology post mortem (excluding BAC)	7.62%	4.97%	7.71%	11.70%
Trace Evidence	7.72%	5.11%	9.61%	14.35%

Consumables Expense as a proportion of Total Expense

This category includes a variety of variable cost components including chemicals, reagents, consumables, and gases.

Table 18: Consumables Expenditures/Total Expenditures by Investigative Area

Consumables Expenditures/Total Expenditures	Laboratory	25th Percentile	Median	75th Percentile
Blood Alcohol	8.26%	4.91%	7.15%	9.99%
Crime Scene Investigation				
Digital evidence - Audio & Video		1.97%	5.06%	10.39%
DNA Casework	7.43%	7.10%	10.88%	14.34%
DNA Database		7.89%	18.10%	39.38%
Document Examination		1.40%	2.87%	4.58%
Drugs - Controlled Substances	8.09%	2.43%	4.73%	6.51%
Evidence Screening & Processing	6.64%	1.08%	2.12%	4.87%
Explosives	7.66%	2.54%	3.86%	5.03%
Fingerprints	9.64%	1.01%	2.18%	5.81%
Fire analysis	7.66%	1.83%	3.12%	5.43%
Firearms and Ballistics	6.21%	0.66%	2.10%	3.81%
Forensic Pathology		2.33%	2.43%	2.90%
Gun Shot Residue (GSR)	7.64%	1.56%	3.05%	4.55%
Marks and Impressions	15.39%	1.49%	2.82%	9.01%
Serology/Biology	6.64%	3.09%	5.72%	8.08%
Toxicology ante mortem (excluding BAC)	7.56%	5.07%	6.55%	8.89%
Toxicology post mortem (excluding BAC)	7.56%	4.99%	6.45%	8.64%
Trace Evidence	7.66%	1.56%	2.80%	5.76%

Turn-around Time

Note that turn-around time is offered in two forms. The first is a measure that begins when the last item of evidence in an investigative area has been submitted to the laboratory. The second measure begins the turn-around time count with the submission of the first piece of evidence in an investigative area. Because most laboratories only record one or the other of these measures, there is some seeming inconsistency which is attributed to the limited sample. The metric has been slightly altered from previous years to correspond to recommendations from Project FORESIGHT participants. The change in the metric reflects the time from each request for analysis to issuance of a report. As such, a case in one investigative area may have multiple turn-around times that correspond to separate requests.

Median Turn-around Time (Timed in days from **last** submission of evidence to Report submission)

Table 19: Turnaround Time from Last Item Received by Investigative Area

Turnaround Time from Last Item Received	Laboratory	25th Percentile	Median	75th Percentile
Blood Alcohol	8	5	18	40
Crime Scene Investigation	9	9	26	112
Digital evidence - Audio & Video		43	123	256
DNA Casework	9	53	67	128
DNA Database		15	51	99
Document Examination		27	49	66
Drugs - Controlled Substances	11	10	30	67
Evidence Screening & Processing		24	34	36
Explosives	5	15	31	105
Fingerprints	7	19	35	69
Fire analysis	10	21	41	57
Firearms and Ballistics	7	18	58	132
Forensic Pathology		79	86	172
Gun Shot Residue (GSR)	2	14	41	59
Marks and Impressions	48	28	54	109
Serology/Biology		25	45	68
Toxicology ante mortem (excluding BAC)	26	24	44	74
Toxicology post mortem (excluding BAC)	21	24	40	50
Trace Evidence	6	42	67	104

Median Turn-around Time (Timed in days from **first** submission of evidence to Report submission)

Table 20: Turnaround Time from First Item Received by Investigative Area

Turnaround Time from First Item Received	Laboratory	25th Percentile	Median	75th Percentile
Blood Alcohol	8	4	8	35
Crime Scene Investigation	12	7	18	100
Digital evidence - Audio & Video		44	138	303
DNA Casework	20	39	90	163
DNA Database		11	51	239
Document Examination		31	59	105
Drugs - Controlled Substances	11	12	35	73
Evidence Screening & Processing		24	34	48
Explosives	5	26	77	118
Fingerprints	12	16	36	81
Fire analysis	10	18	45	112
Firearms and Ballistics	8	21	83	137
Forensic Pathology		41	96	172
Gun Shot Residue (GSR)	14	13	35	92
Marks and Impressions	66	25	67	159
Serology/Biology		23	58	100
Toxicology ante mortem (excluding BAC)	38	25	39	64
Toxicology post mortem (excluding BAC)	37	30	37	55
Trace Evidence	9	38	74	152

Backlog

Another area of concern involves the increased demand for laboratory services and the level of backlog. For data collection purposes, the definition of backlog has been defined as open cases at the end of the fiscal year that have been open for more than thirty days. As a relative comparative measure, the ratio of open cases to total cases for the year is presented in the following table.

Cases Open over 30 Days/Annual Caseload

Table 21: Backlog Cases as a Percent of Total Cases by Investigative Area

Backlog Cases/Annual Caseload	Laboratory	25th Percentile	Median	75th Percentile
Blood Alcohol	0.03%	0.28%	0.83%	5.14%
Crime Scene Investigation	0.04%	0.54%	8.89%	27.33%
Digital evidence - Audio & Video		8.45%	35.80%	132.35%
DNA Casework	3.90%	6.42%	17.17%	32.74%
DNA Database		0.54%	14.02%	38.76%
Document Examination		7.24%	20.54%	31.90%
Drugs - Controlled Substances	5.79%	2.14%	6.46%	21.01%
Evidence Screening & Processing		4.92%	16.75%	28.67%
Explosives		11.11%	25.81%	44.83%
Fingerprints	6.59%	4.07%	8.82%	32.61%
Fire analysis		2.72%	7.74%	13.99%
Firearms and Ballistics	22.22%	6.82%	22.22%	69.86%
Forensic Pathology		5.12%	11.15%	38.97%
Gun Shot Residue (GSR)		4.75%	13.35%	41.64%
Marks and Impressions	81.82%	18.51%	42.56%	76.70%
Serology/Biology		3.84%	17.22%	36.80%
Toxicology ante mortem (excluding BAC)	6.57%	2.22%	6.19%	11.54%
Toxicology post mortem (excluding BAC)	6.54%	3.71%	5.77%	9.75%
Trace Evidence	21.21%	14.17%	25.25%	43.09%

Time in Casework

The next table presents the percentage of time that is dedicated to casework. Alternatives to time spent in casework include testimony (including preparation and wait time), research & development activities, teaching to the profession, teaching for customers, taking continuing education/training sessions, participating in international and/or interagency cooperative efforts, and developing materials for publication.

Percentage of Time in Casework

Table 22: Percentage of Time in Casework by Investigative Area

Percent time in Casework	Laboratory	25th Percentile	Median	75th Percentile
Blood Alcohol	43.67%	34.81%	44.78%	63.65%
Crime Scene Investigation	58.79%	30.62%	48.48%	59.37%
Digital evidence - Audio & Video		32.82%	36.78%	197.40%
DNA Casework	58.28%	41.06%	48.85%	66.52%
DNA Database		21.47%	41.65%	45.17%
Document Examination		37.98%	48.21%	59.34%
Drugs - Controlled Substances	41.52%	36.92%	43.62%	55.00%
Evidence Screening & Processing		45.69%	54.40%	61.21%
Explosives	22.66%	27.61%	36.35%	46.24%
Fingerprints	33.08%	35.23%	42.72%	70.54%
Fire analysis	22.73%	26.16%	41.44%	61.60%
Firearms and Ballistics	32.85%	28.13%	40.11%	58.14%
Forensic Pathology		48.88%	51.35%	58.31%
Gun Shot Residue (GSR)	22.51%	32.18%	43.46%	56.95%
Marks and Impressions		19.82%	41.29%	69.72%
Serology/Biology		36.47%	47.85%	63.22%
Toxicology ante mortem (excluding BAC)	39.09%	41.94%	50.32%	70.38%
Toxicology post mortem (excluding BAC)	39.17%	43.40%	51.47%	66.27%
Trace Evidence	22.63%	22.40%	36.31%	63.06%

Efficiency and Cost Effectiveness of Forensic Science Services—FORESIGHT 2013-2014 Benchmark Data

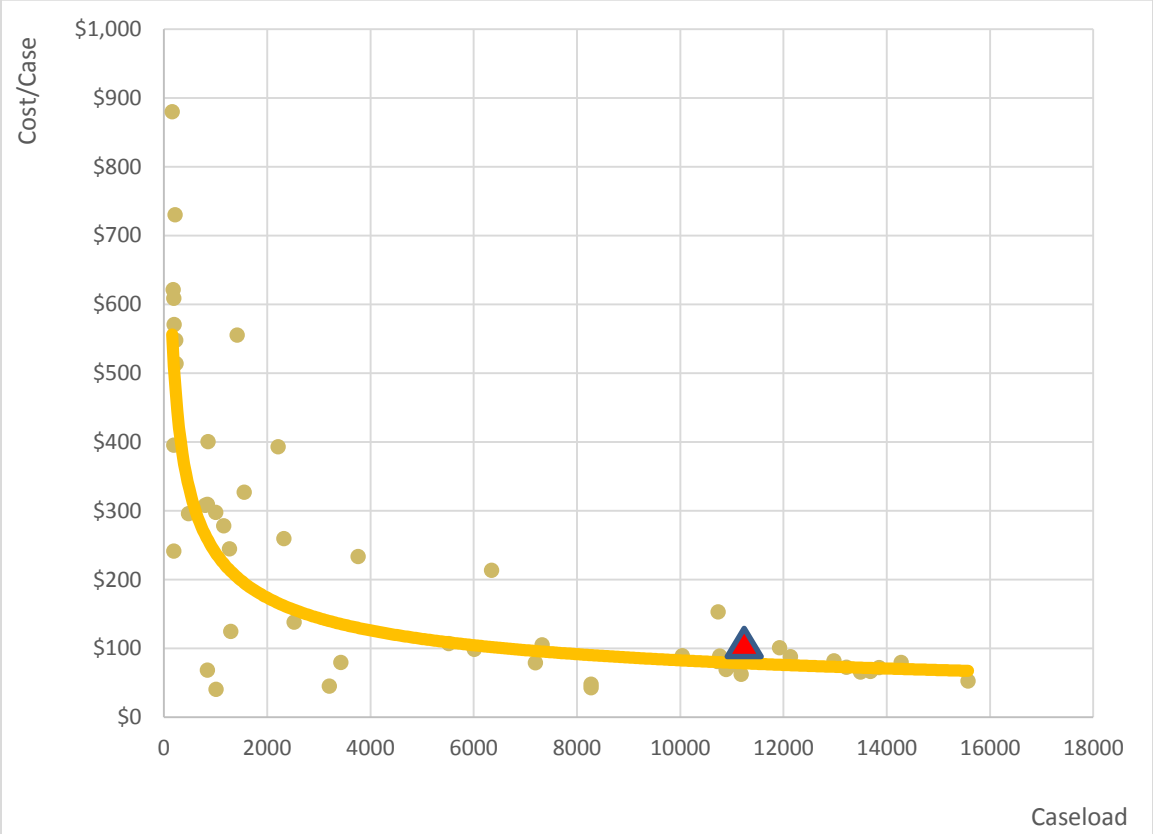
The summary statistics offer a one-dimensional view of performance. In this section, that view is expanded through a consideration of cost effectiveness and efficiency. Economic theory indicates that any industry, including forensic science laboratories, will have average costs (Cost/Case) that decline as caseload is increased until reaching a point of perfect economies of scale. Thereafter, diseconomies of scale will be realized and average costs will rise as caseload increases. This behavior is exemplified via U-shaped average cost curves.

For each investigative area, the industry average total cost curve has been estimated by a series of non-linear regressions. When a laboratory performs on or near the curve, it is an indication of efficiency for the corresponding caseload. For an efficient performance that is near the bottom of the U-shaped curve, the laboratory exhibits cost effective performance as it approaches perfect economies of scale.

In addition to this cross–sectional comparison, average cost and productivity are illustrated for all past FORESIGHT submissions. The term "real" indicates that costs have been adjusted for inflation and converted to the most recent year's price index.

Blood Alcohol Analysis

Figure 1: Blood Alcohol Analysis Average Total Cost



Foresight Project 2013-2014, West Virginia University, Morgantown, WV, USA

LABORATORY ABC Performance (Relative Efficiency Deviation 20% - 25%)

Figure 2: Laboratory ABC Blood Alcohol "Real" Cost per Case (2013.12=100)

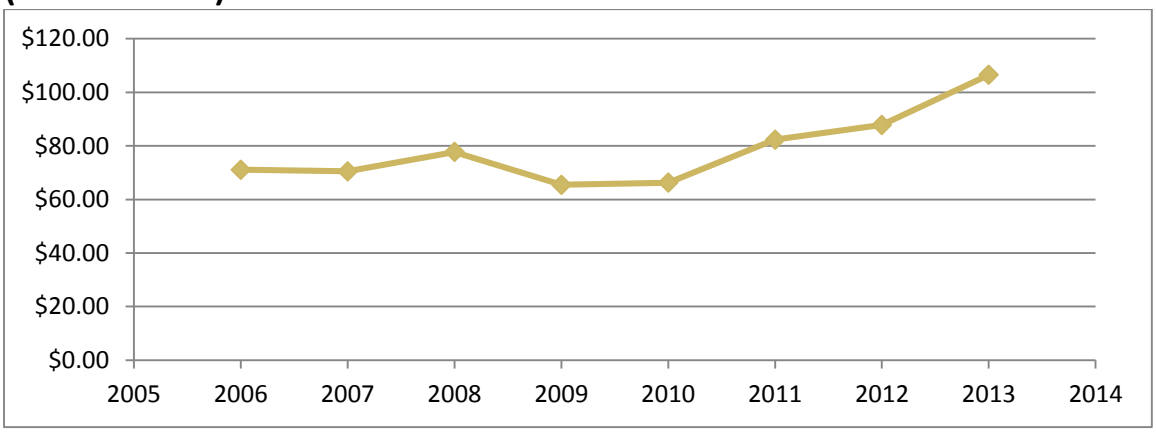


Figure 3: Laboratory ABC Blood Alcohol Cases per FTE

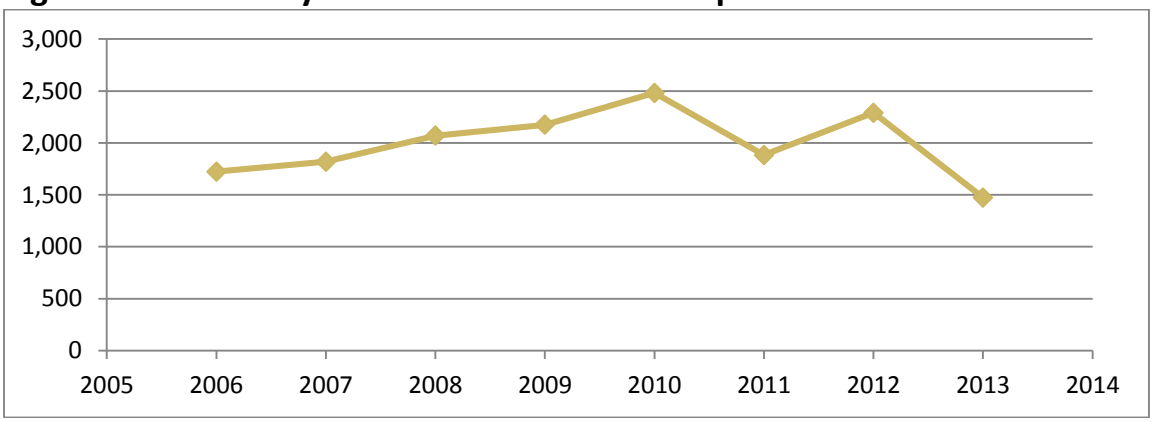
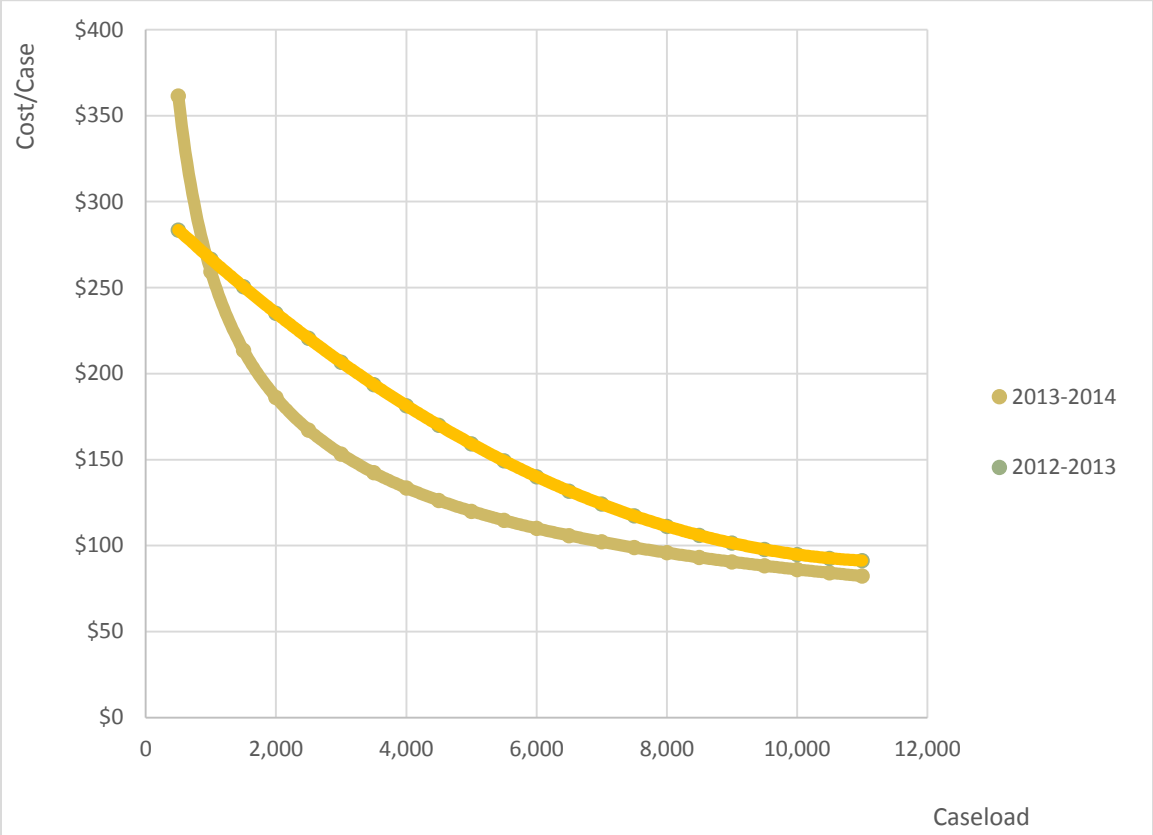


Figure 4: Blood Alcohol Efficient Frontier over Time

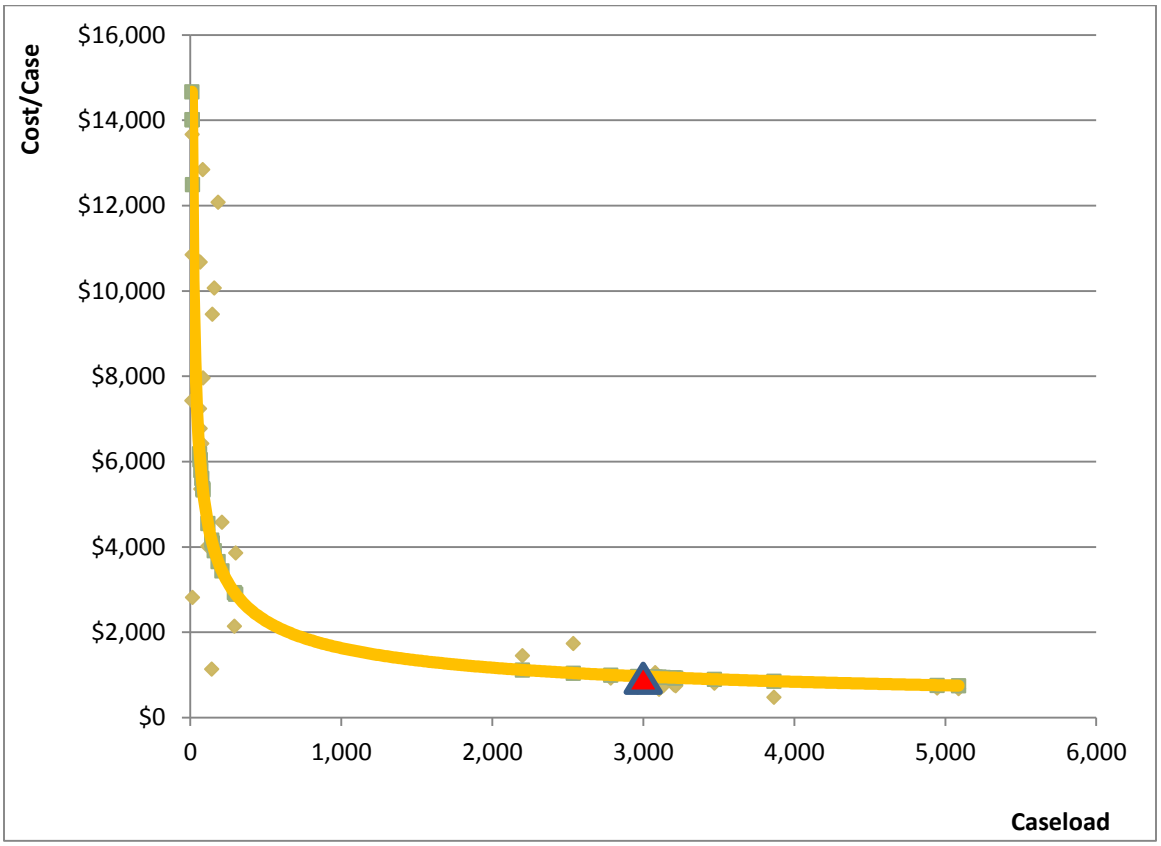


The estimated cost efficient performance across time is fairly consistent. The figure above highlights the estimate from the 2012-2013 FORESIGHT submissions with the 2013-2014 FORESIGHT submissions. The estimated efficient frontier across years is nearly identical when laboratories operate near perfect economies of scale. Discrepancies across time are greater at more extreme caseloads.

Crime Scene Investigation

For the first time, we received enough submissions in the area of crime scene investigation to estimate the efficient relationship between caseload and cost per case.

Figure 5: Crime Scene Investigation Average Total Cost



Foresight Project 2013-2014, West Virginia University, Morgantown, WV, USA

LABORATORY ABC Performance (Relative Efficiency Deviation 0%)

Figure 6: Laboratory ABC Crime Scene Investigation "Real" Cost per Case (2013.12 = 100)

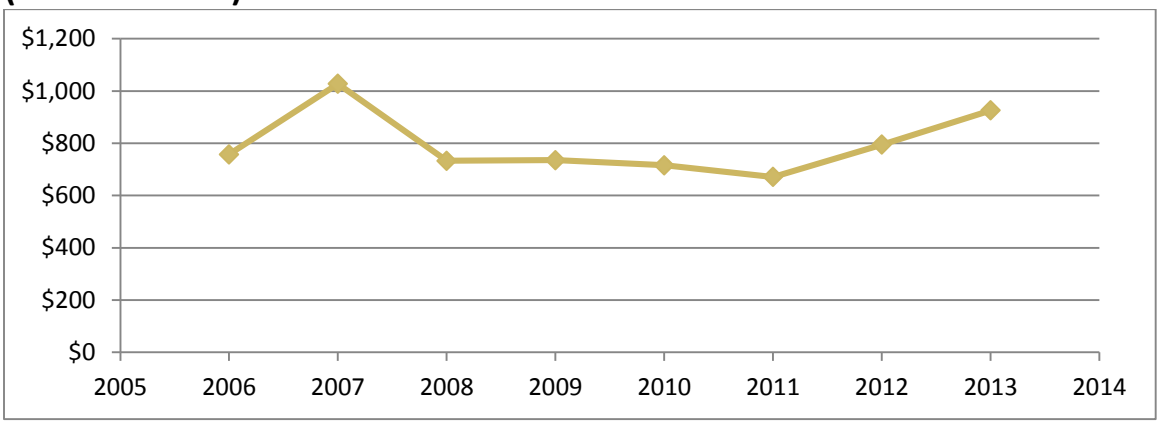
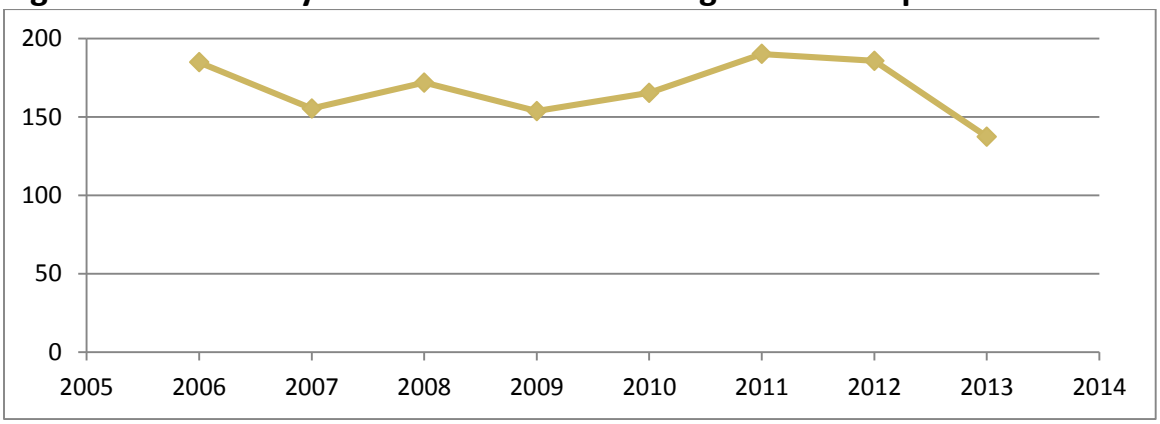


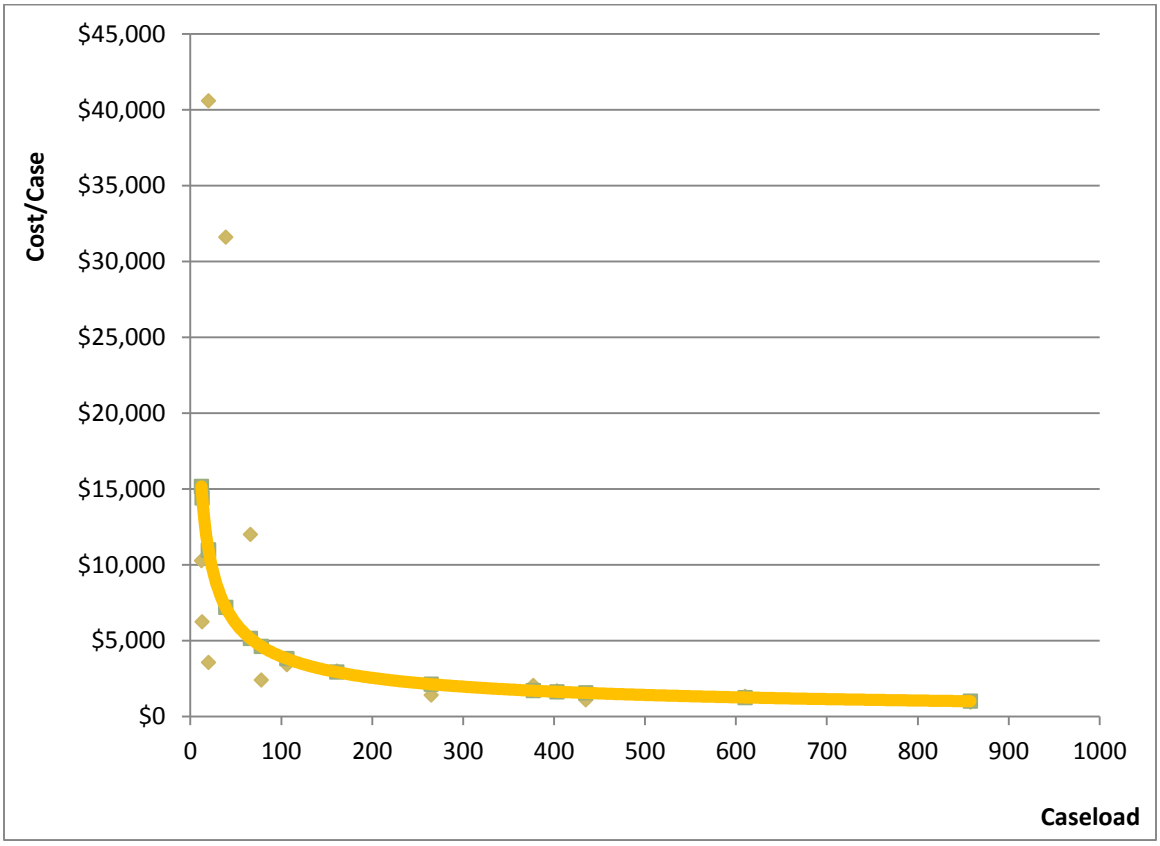
Figure 7: Laboratory ABC Crime Scene Investigation Cases per FTE



Digital Evidence

For the first time, we received enough submissions in the area of digital evidence to estimate the efficient relationship between caseload and cost per case.

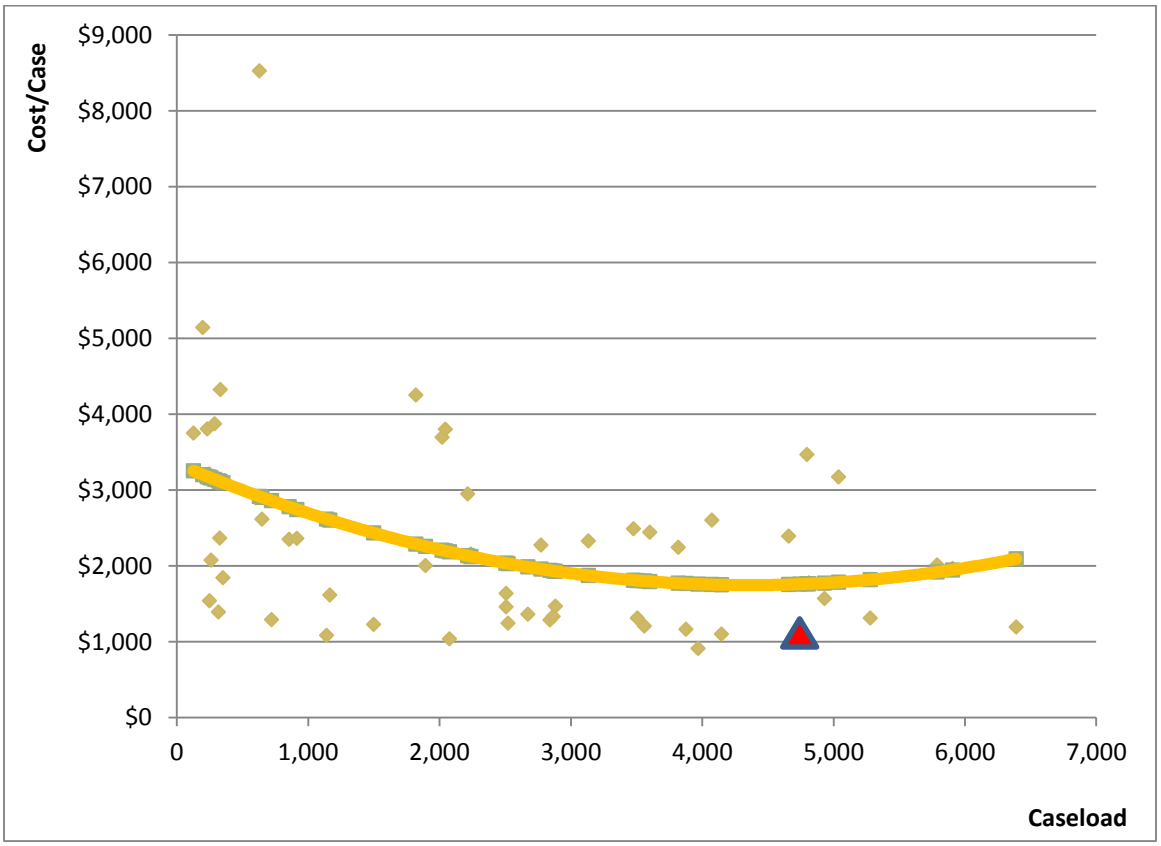
Figure 8: Digital Evidence Analysis Average Total Cost



Foresight Project 2013-2014, West Virginia University, Morgantown, WV, USA

DNA Casework Analysis

Figure 9: DNA Casework Average Total Cost



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LABORATORY ABC Performance (Relative Efficiency Deviation 0%)

Figure 10: Laboratory ABC DNA Casework "Real" Cost per Case (2013.12 = 100)

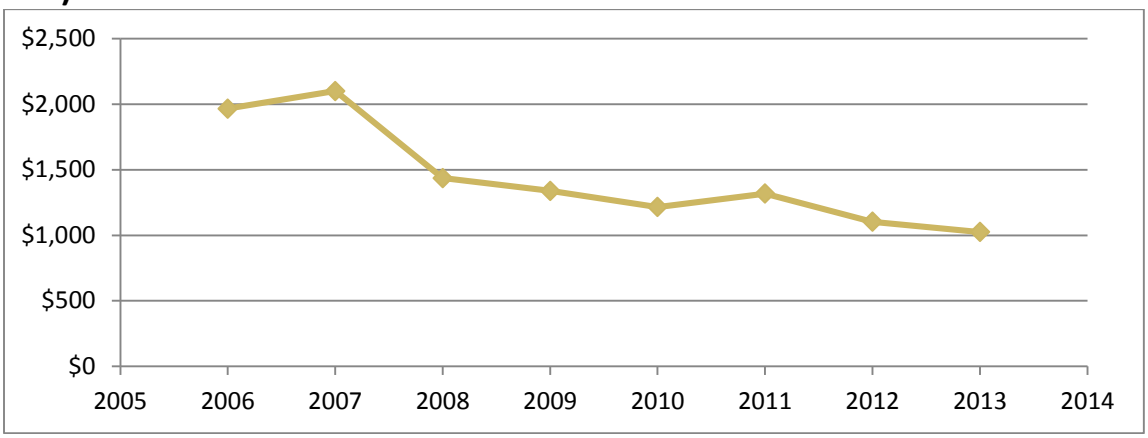


Figure 11: Laboratory ABC DNA Casework Cases per FTE

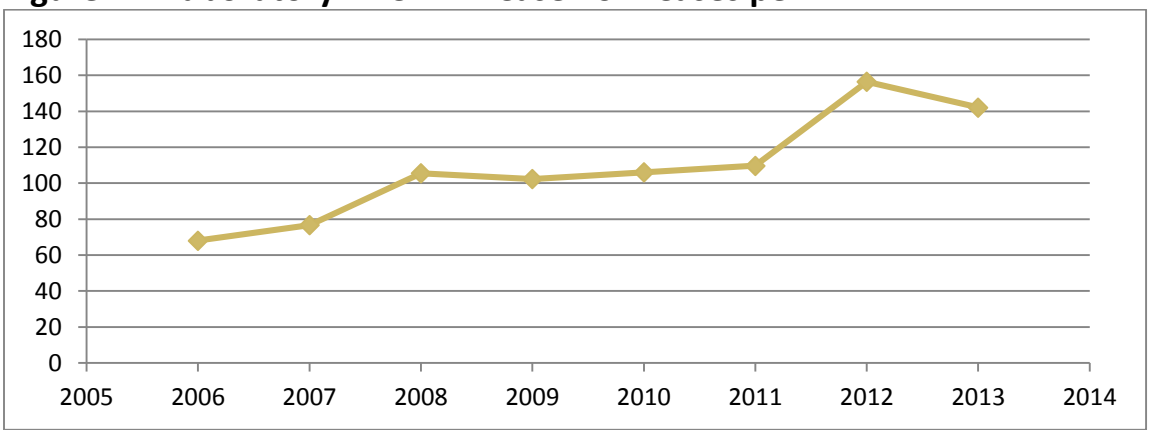
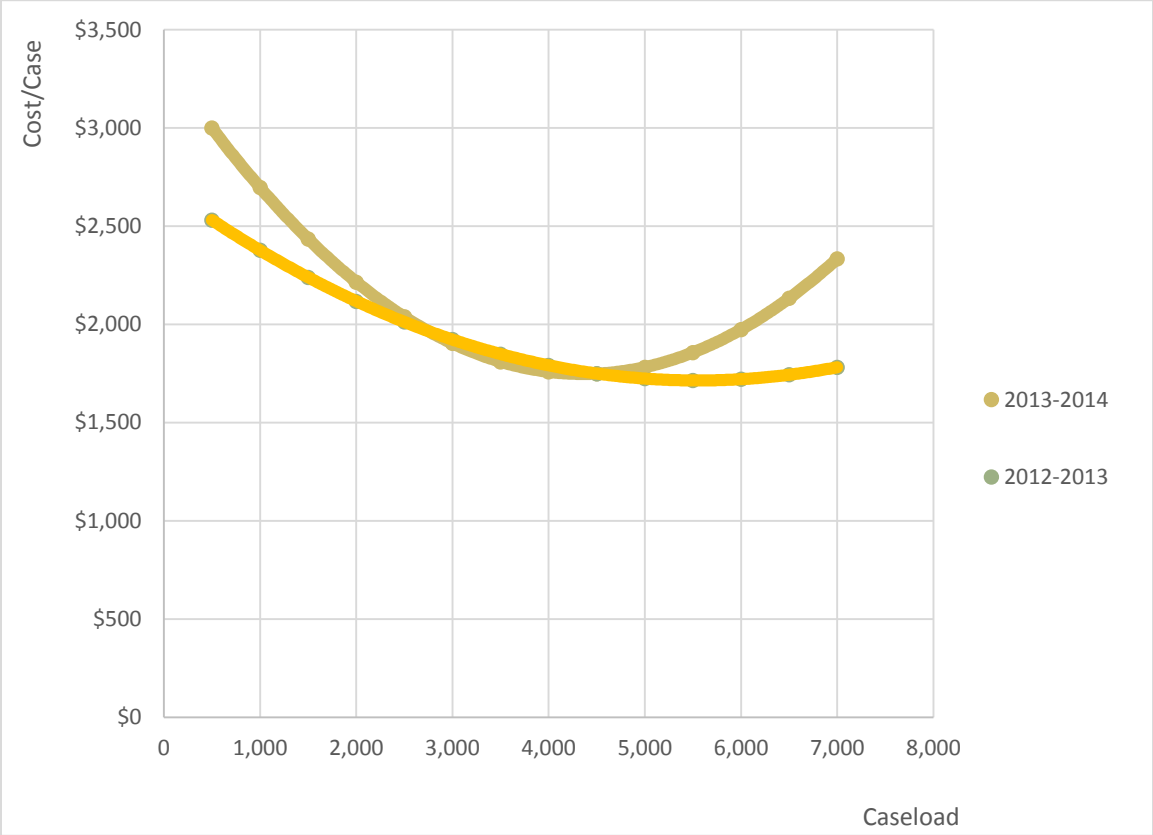


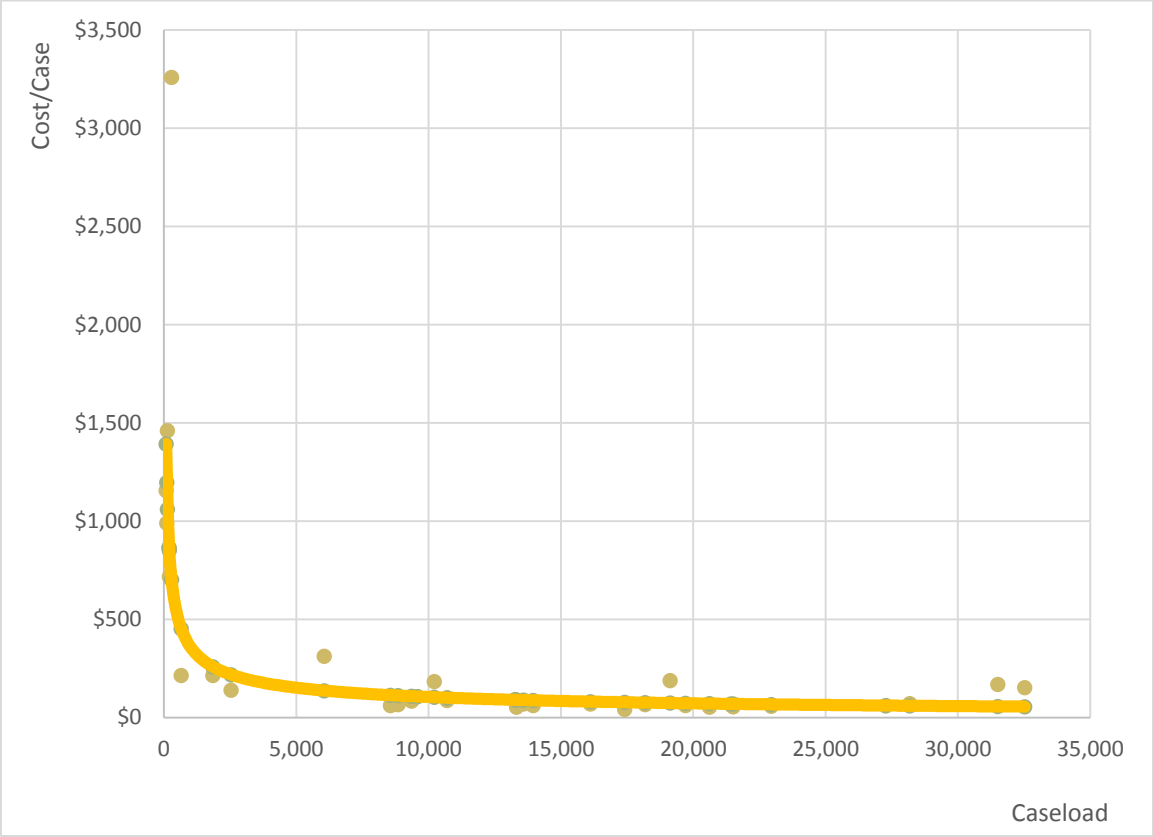
Figure 12: DNA Casework Efficient Frontier over Time



The estimated cost efficient performance across time is fairly consistent. The figure above highlights the estimate from the 2012-2013 FORESIGHT submissions with the 2013-2014 FORESIGHT submissions. The estimated efficient frontier across years is nearly identical when laboratories operate near perfect economies of scale. Discrepancies across time are greater at more extreme caseloads.

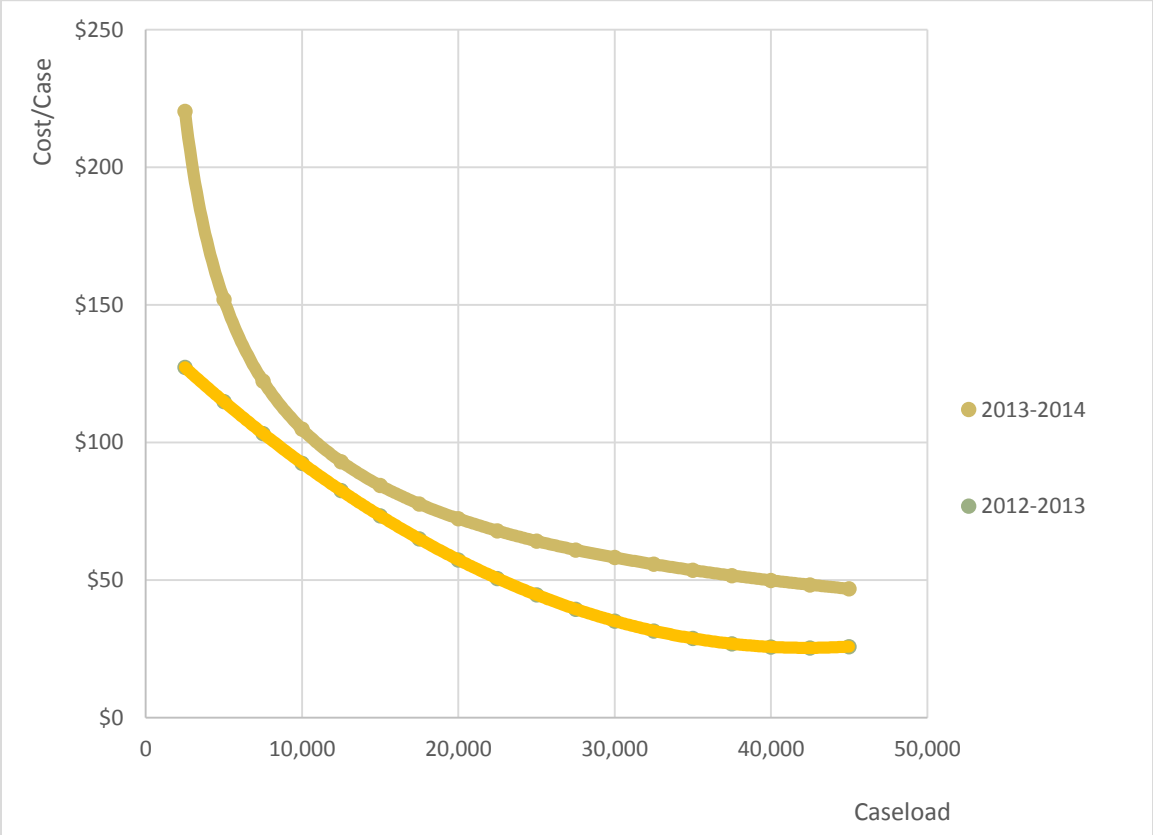
DNA Database

Figure 13: DNA Database Average Total Cost



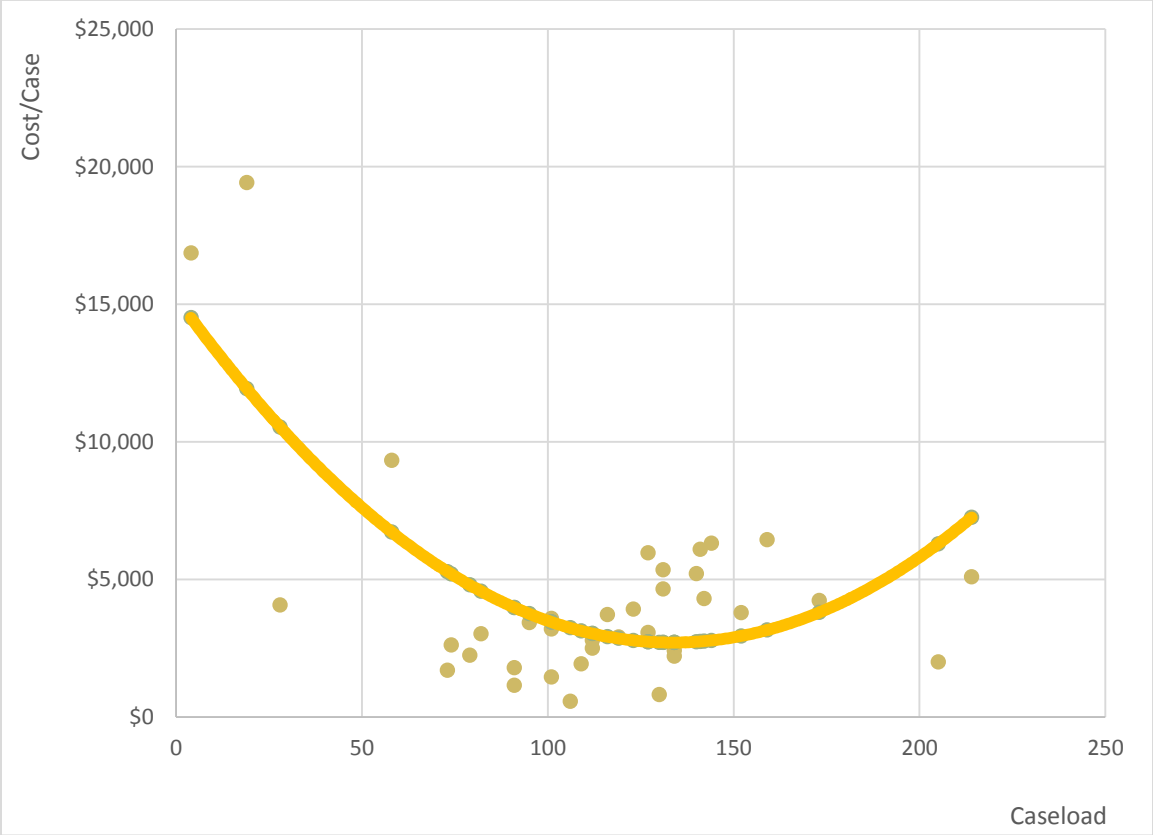
Foresight Project 2013-2014, West Virginia University, Morgantown, WV, USA

Figure 14: DNA Database Efficient Frontier over Time



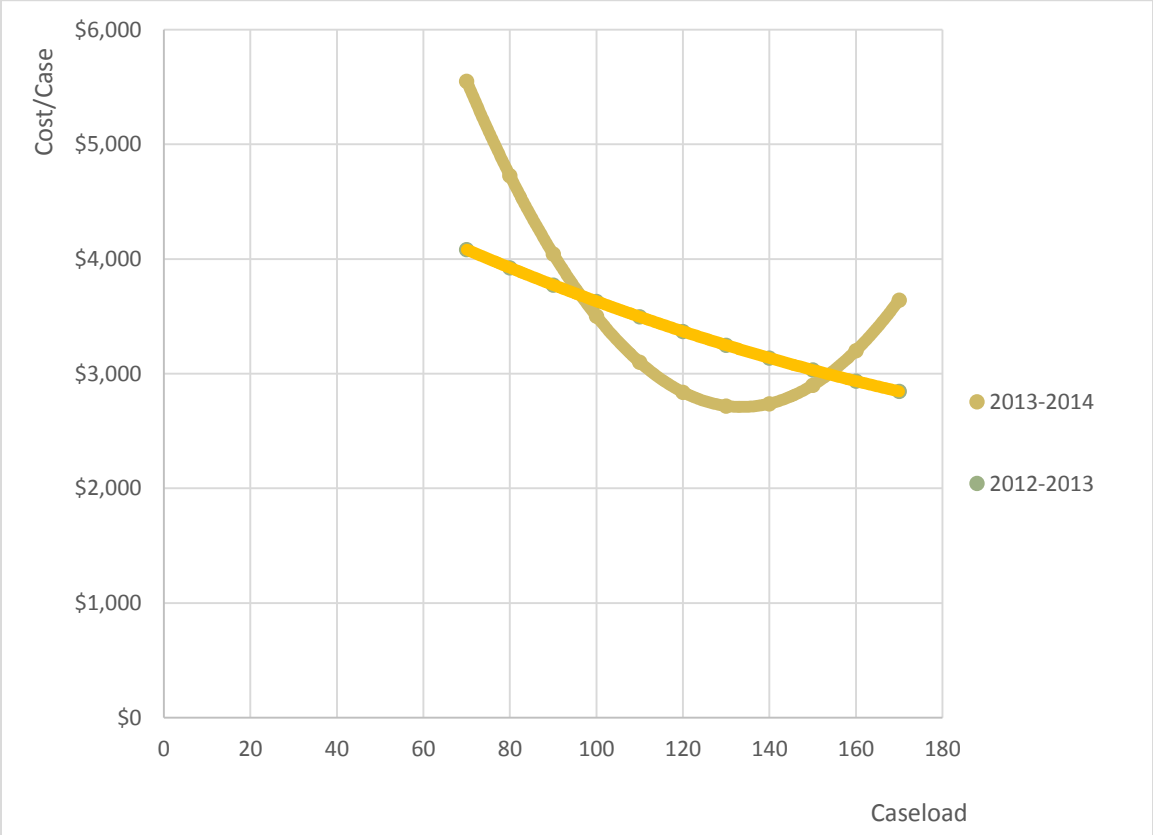
Document Examination

Figure 15: Document Examination Average Total Cost



Foresight Project 2013-2014, West Virginia University, Morgantown, WV, USA

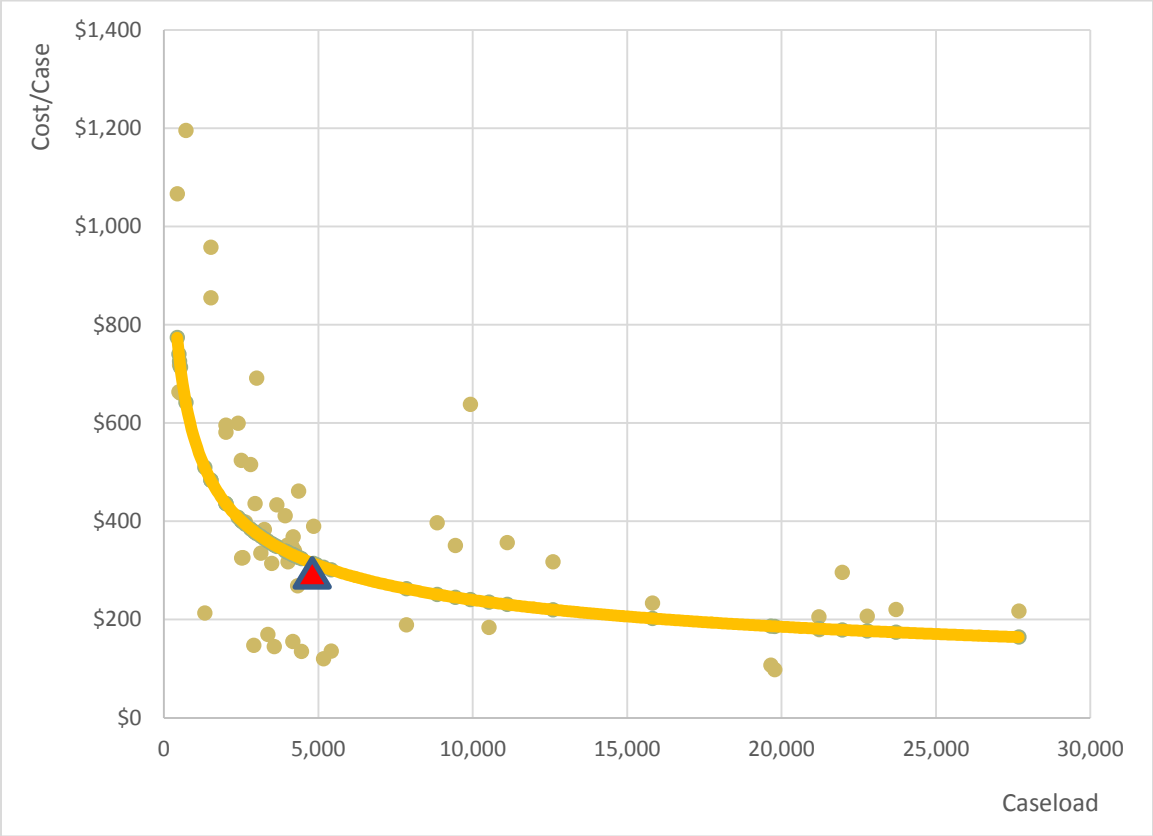
Figure 16: Document Examination Efficient Frontier over Time



The estimated cost efficient performance across time is fairly consistent over the range where the vast majority of submissions appear. The figure above highlights the estimate from the 2012-2013 FORESIGHT submissions with the 2013-2014 FORESIGHT submissions. The estimated efficient frontier across years is nearly identical when laboratories operate near perfect economies of scale. Discrepancies across time are greater at more extreme caseloads.

Drugs—Controlled Substance Analysis

Figure 17: Drugs-Controlled Substances Average Total Cost



Foresight Project 2013-2014, West Virginia University, Morgantown, WV, USA

▲ LABORATORY ABC Performance (Relative Efficiency Deviation 0%)

Figure 18: Laboratory ABC Drugs-Controlled Substances "Real" Cost per Case (2013.12 = 100)

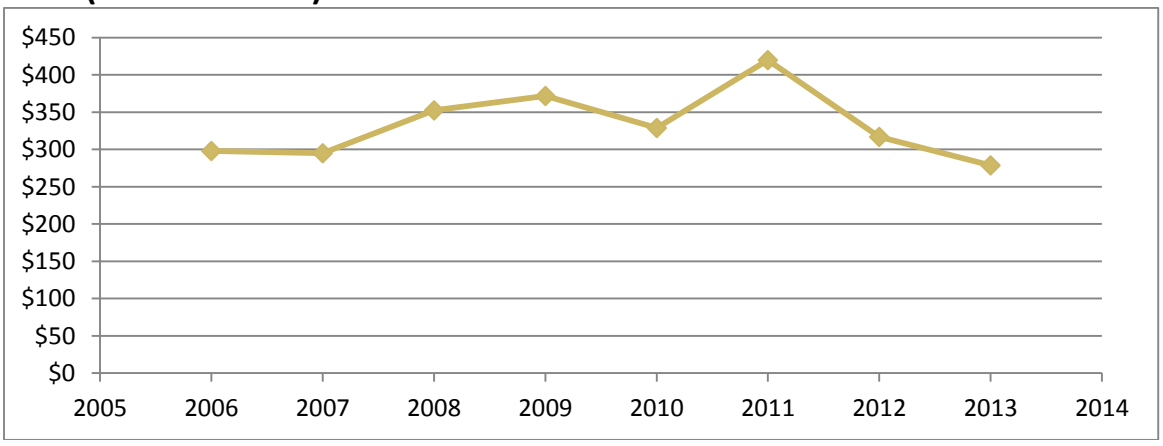


Figure 19: Laboratory ABC Drugs-Controlled Substances Cases per FTE

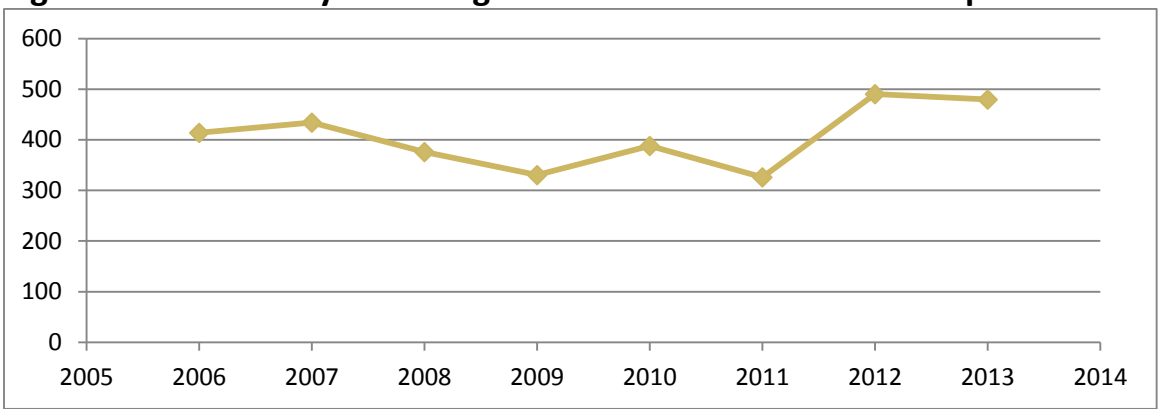
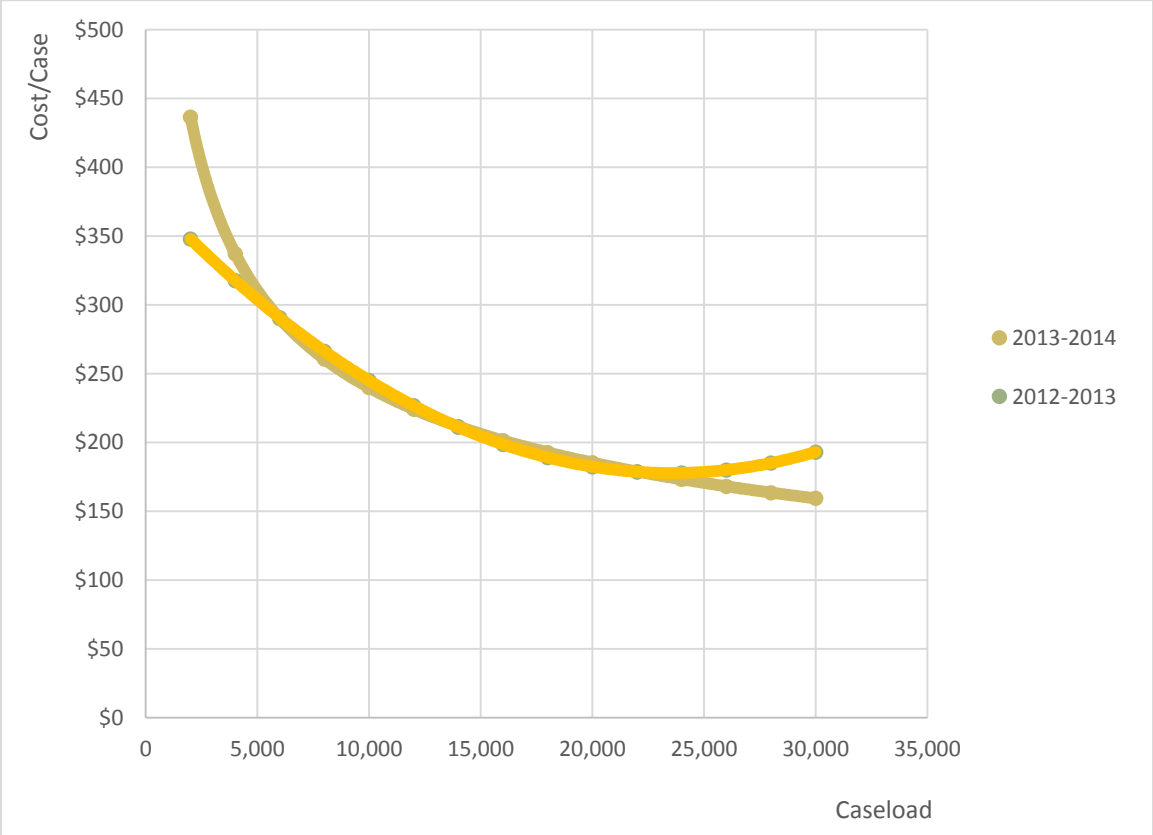


Figure 20: Drugs-Controlled Substances Efficient Frontier over Time



The estimated cost efficient performance across time is fairly consistent. The figure above highlights the estimate from the 2012-2013 FORESIGHT submissions with the 2013-2014 FORESIGHT submissions. The estimated efficient frontier across years is nearly identical when laboratories operate near perfect economies of scale. Discrepancies across time are greater at more extreme caseloads.

Evidence Screening & Processing

There is insufficient data to estimate the average total cost curve for this area of investigation.

Figure 21: Laboratory ABC Evidence Screening & Processing "Real" Cost per Case (2013.12=100)

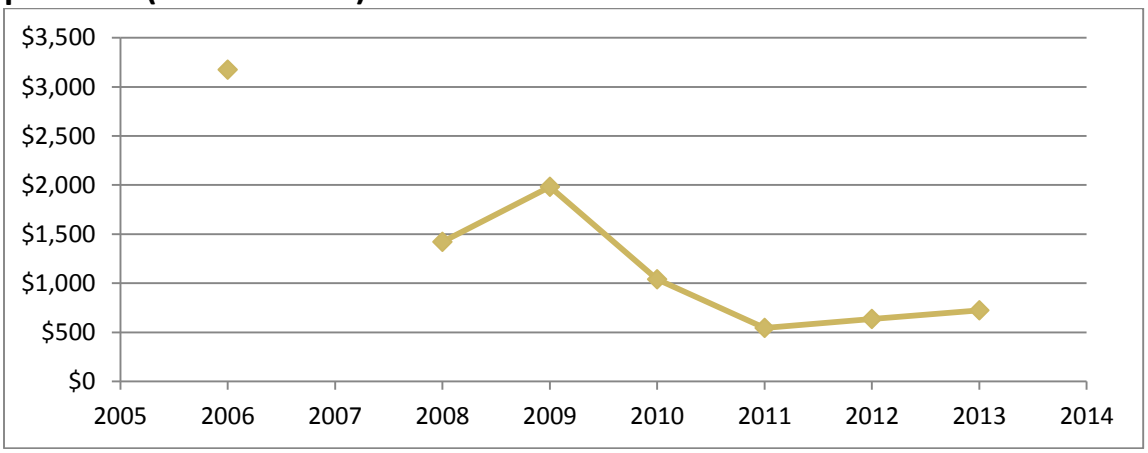
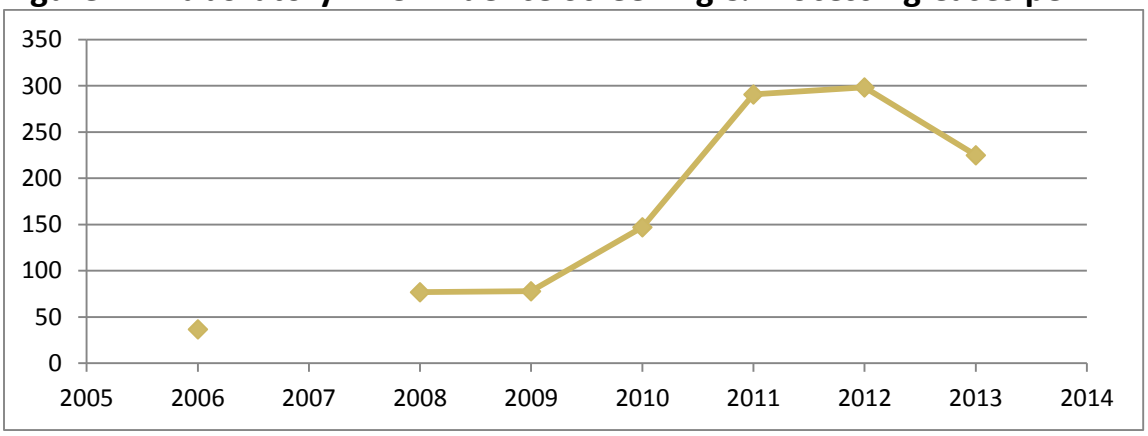
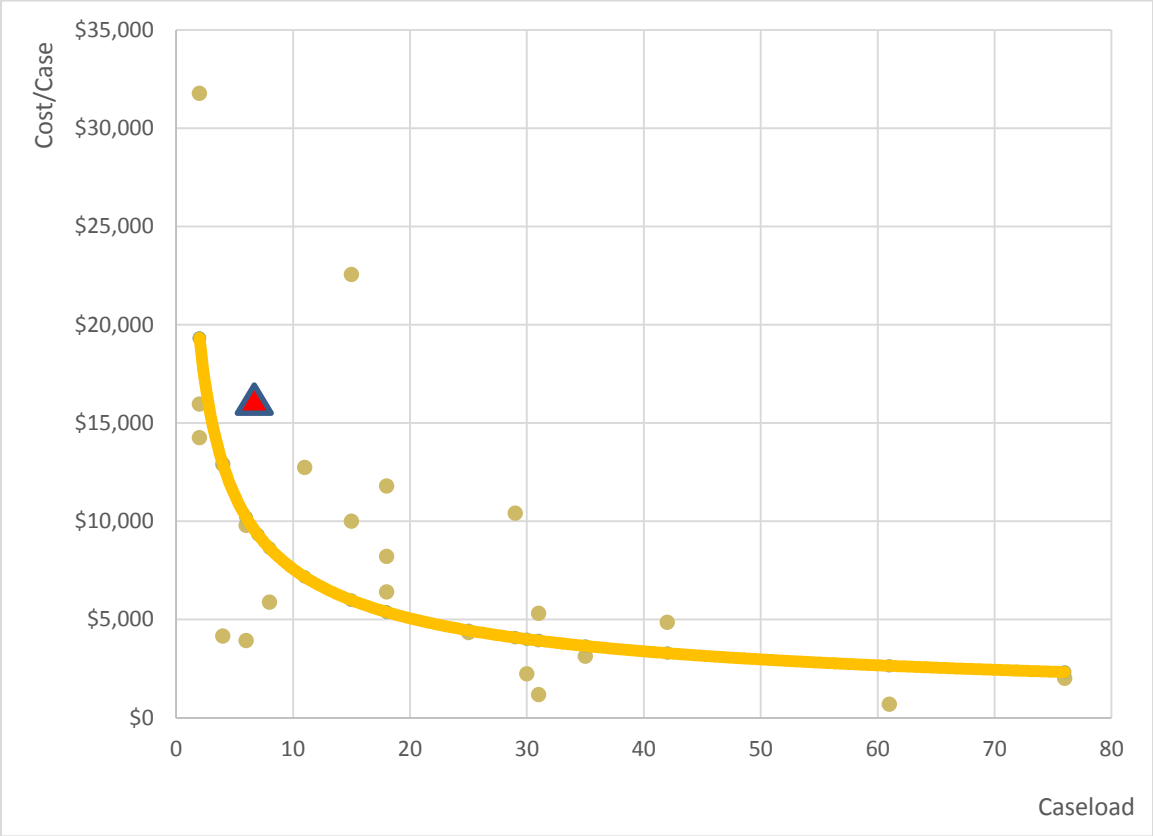


Figure 22: Laboratory ABC Evidence Screening & Processing Cases per FTE



Explosives Analysis

Figure 23: Explosives Analysis Average Total Cost



Foresight Project 2013-2014, West Virginia University, Morgantown, WV, USA

LABORATORY ABC Performance (Relative Efficiency Deviation 65% - 70%)

Figure 24: Laboratory ABC Explosives Analysis "Real" Cost per Case (2013.12 = 100)

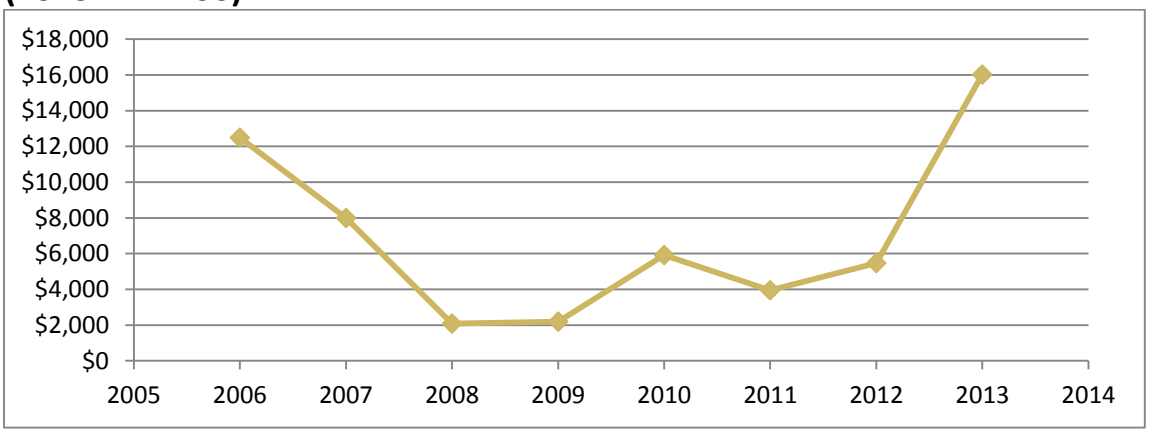


Figure 25: Laboratory ABC Explosives Analysis Cases per FTE

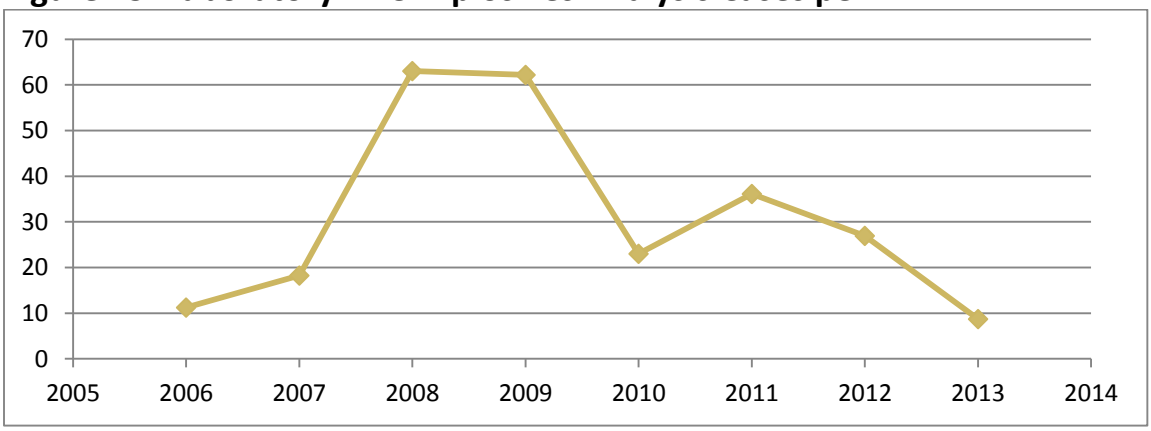
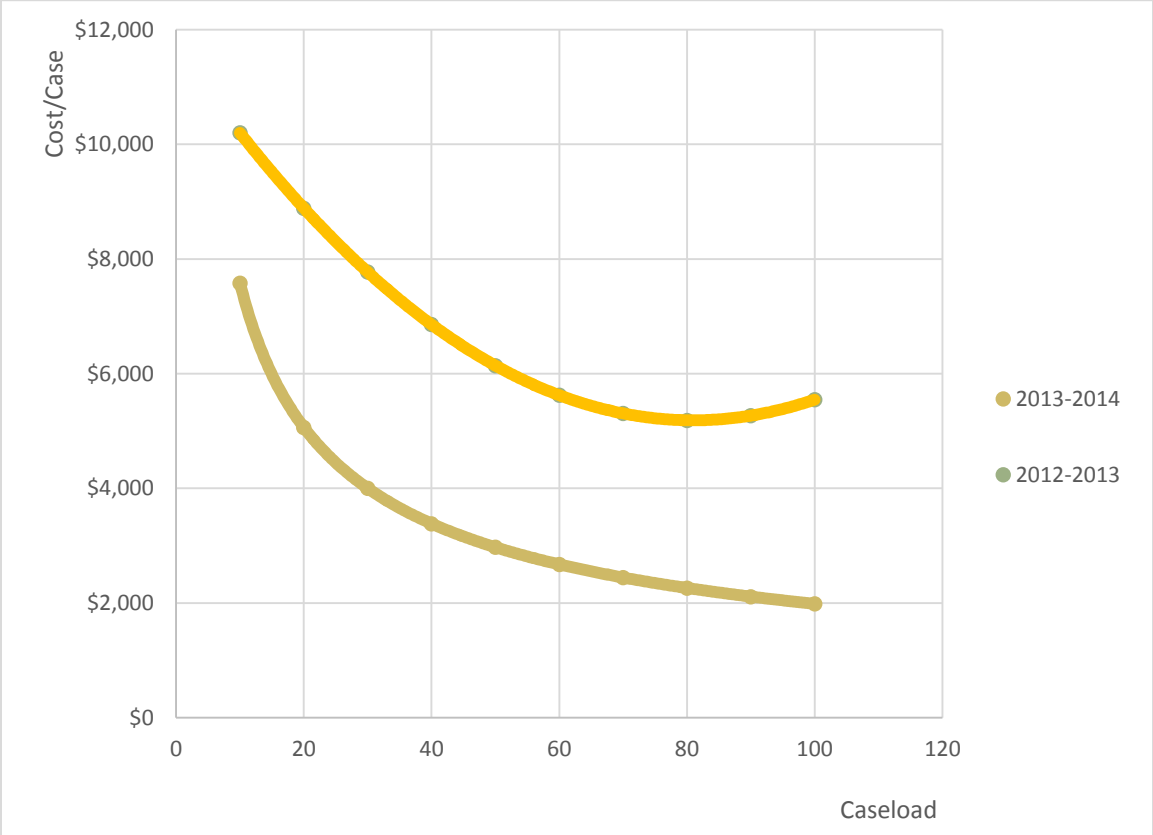


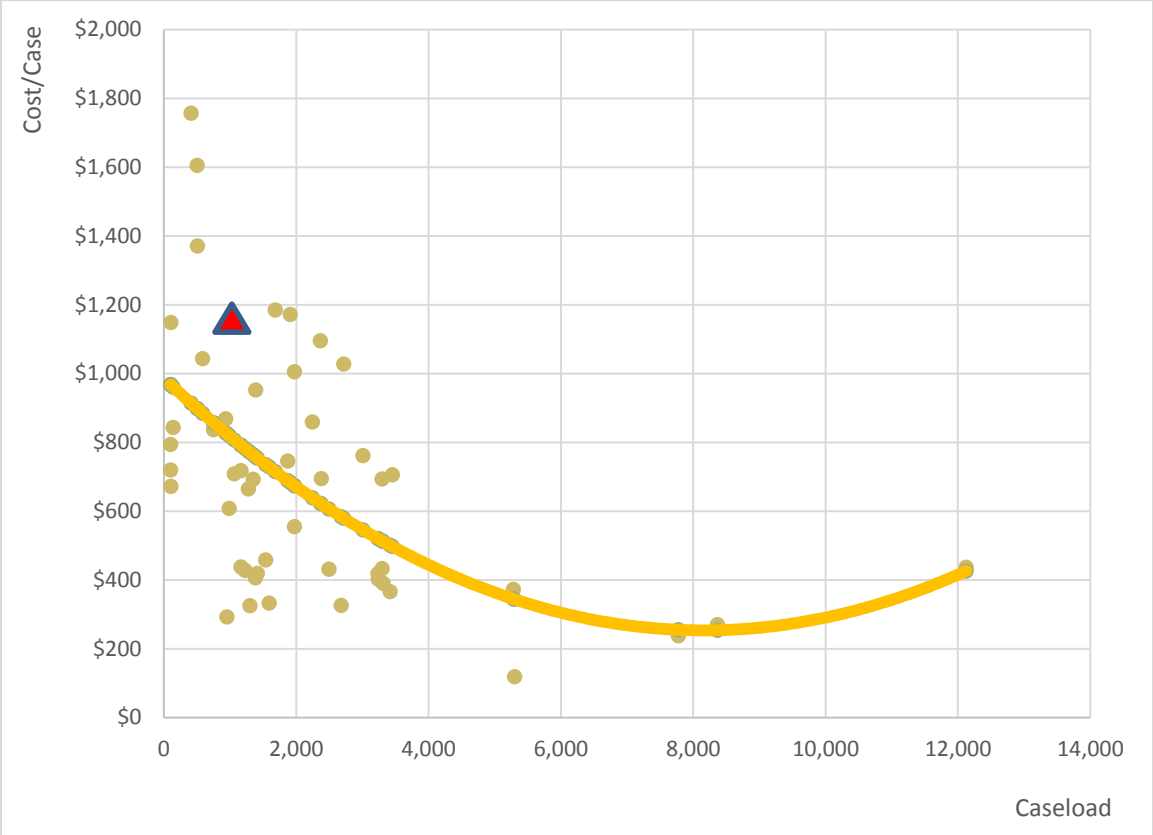
Figure 26: Explosives Analysis Efficient Frontier over Time



The estimated cost efficient performance across time exhibits the expected shape, but the effect of the small sample shows that the efficient frontier would benefit from a more representative sample. The figure above highlights the estimate from the 2012-2013 FORESIGHT submissions with the 2013-2014 FORESIGHT submissions.

Fingerprint ID

Figure 27: Fingerprint Identification Average Total Cost



Foresight Project 2013-2014, West Virginia University, Morgantown, WV, USA

LABORATORY ABC Performance (Relative Efficiency Deviation 65% - 70%)

Figure 28: Laboratory ABC Fingerprint Identification "Real" Cost per Case (2013.12 = 100)

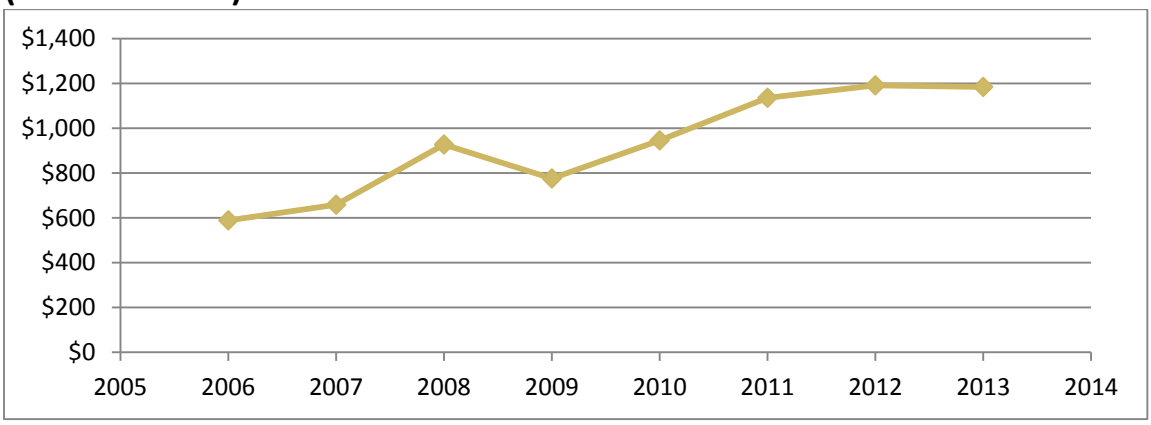


Figure 29: Laboratory ABC Fingerprint Identification Cases per FTE

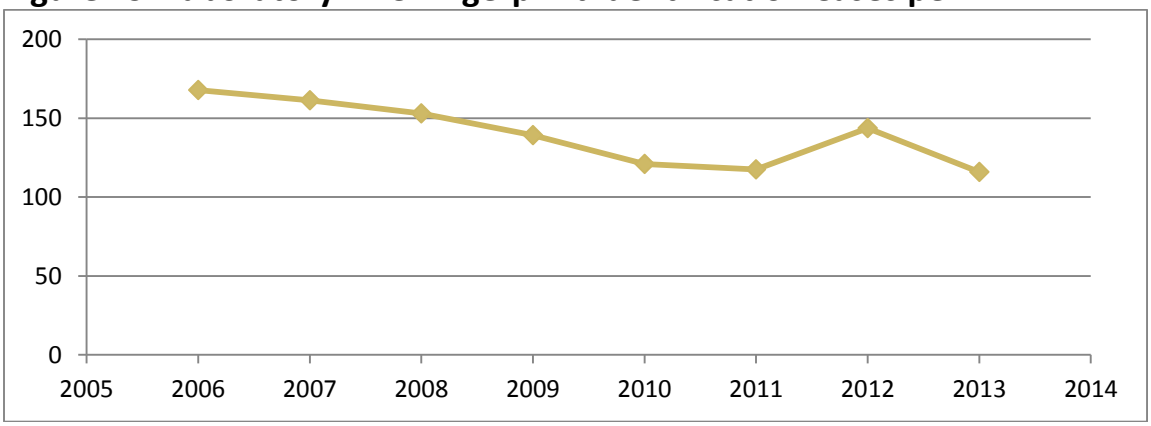
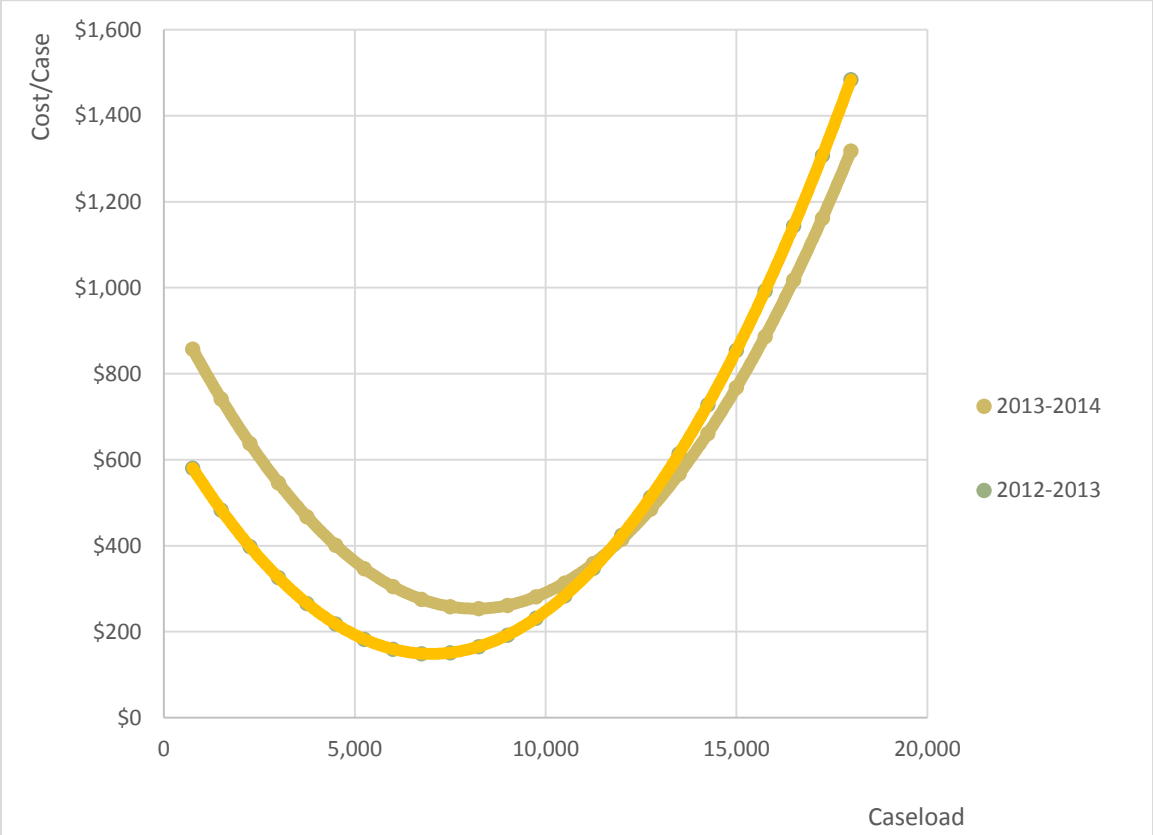


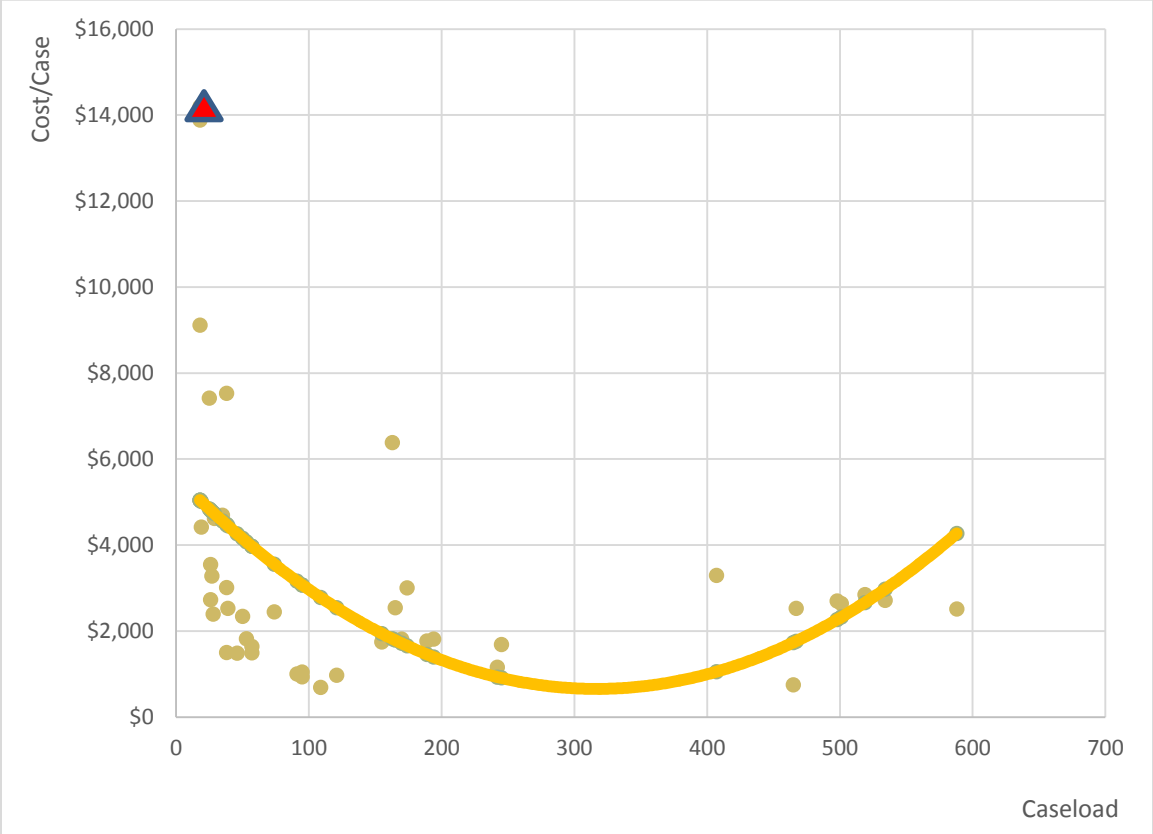
Figure 30: Fingerprint Identification Efficient Frontier over Time



The estimated cost efficient performance across time is fairly consistent. The figure above highlights the estimate from the 2012-2013 FORESIGHT submissions with the 2013-2014 FORESIGHT submissions. The estimated efficient frontier across years is nearly identical when laboratories operate near perfect economies of scale. Discrepancies across time are greater at more extreme caseloads.

Fire Analysis

Figure 31: Fire Analysis Average Total Cost



Foresight Project 2013-2014, West Virginia University, Morgantown, WV, USA

LABORATORY ABC Performance (Relative Efficiency Deviation exceeds 100%)

Figure 32: Laboratory ABC Fire Analysis "Real" Cost per Case (2013.12 = 100)

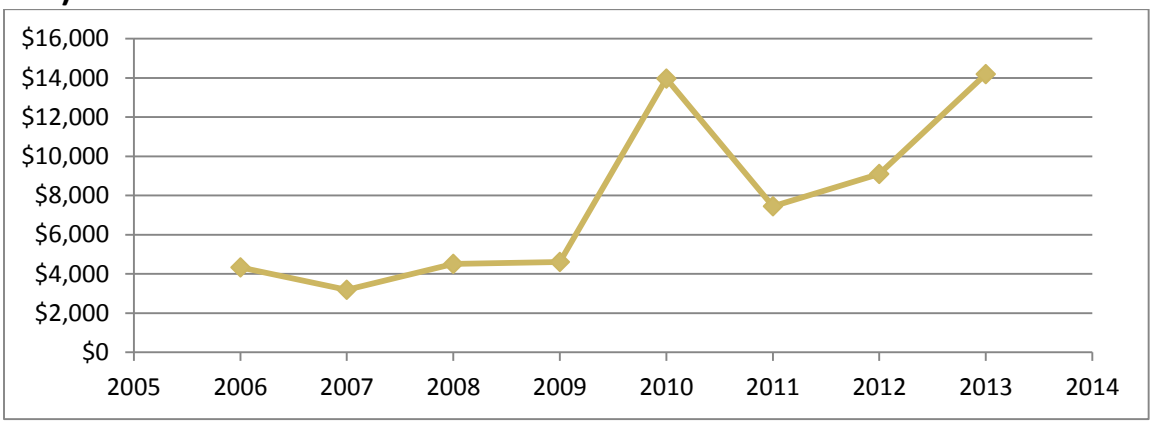


Figure 33: Laboratory ABC Fire Analysis Cases per FTE

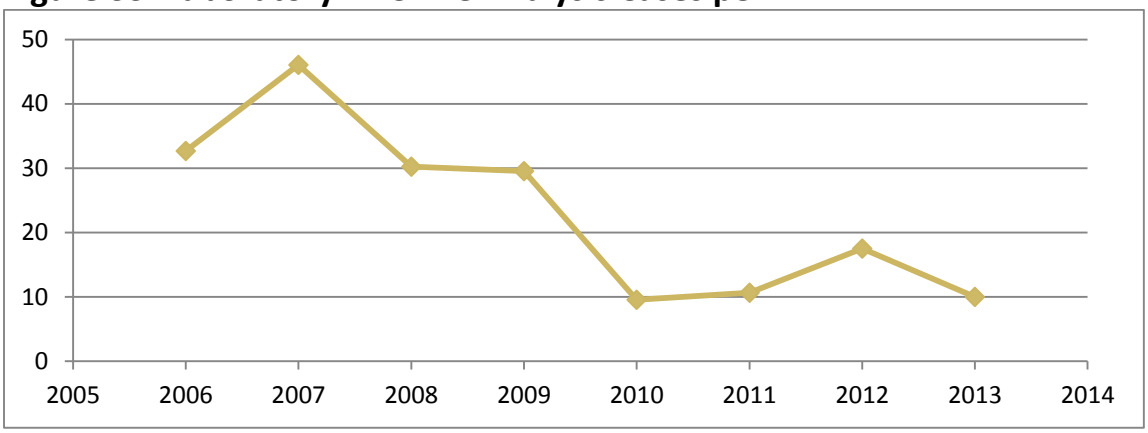
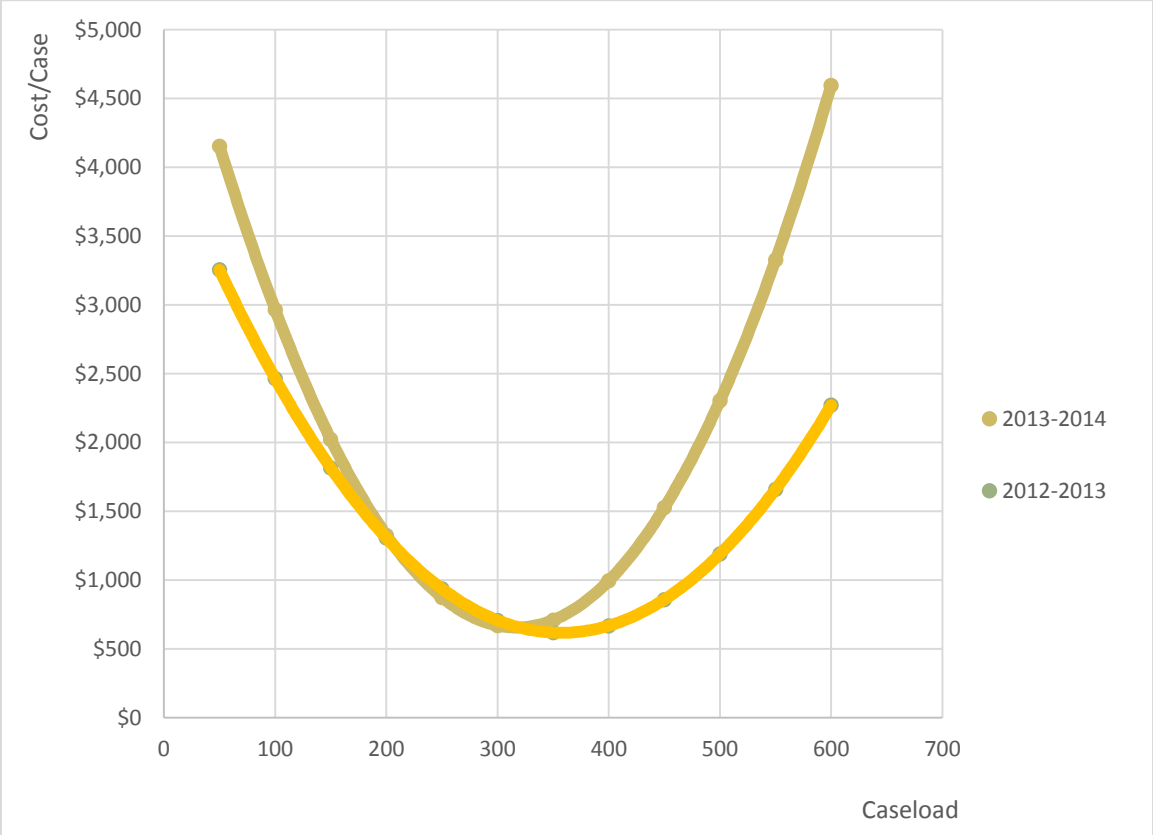


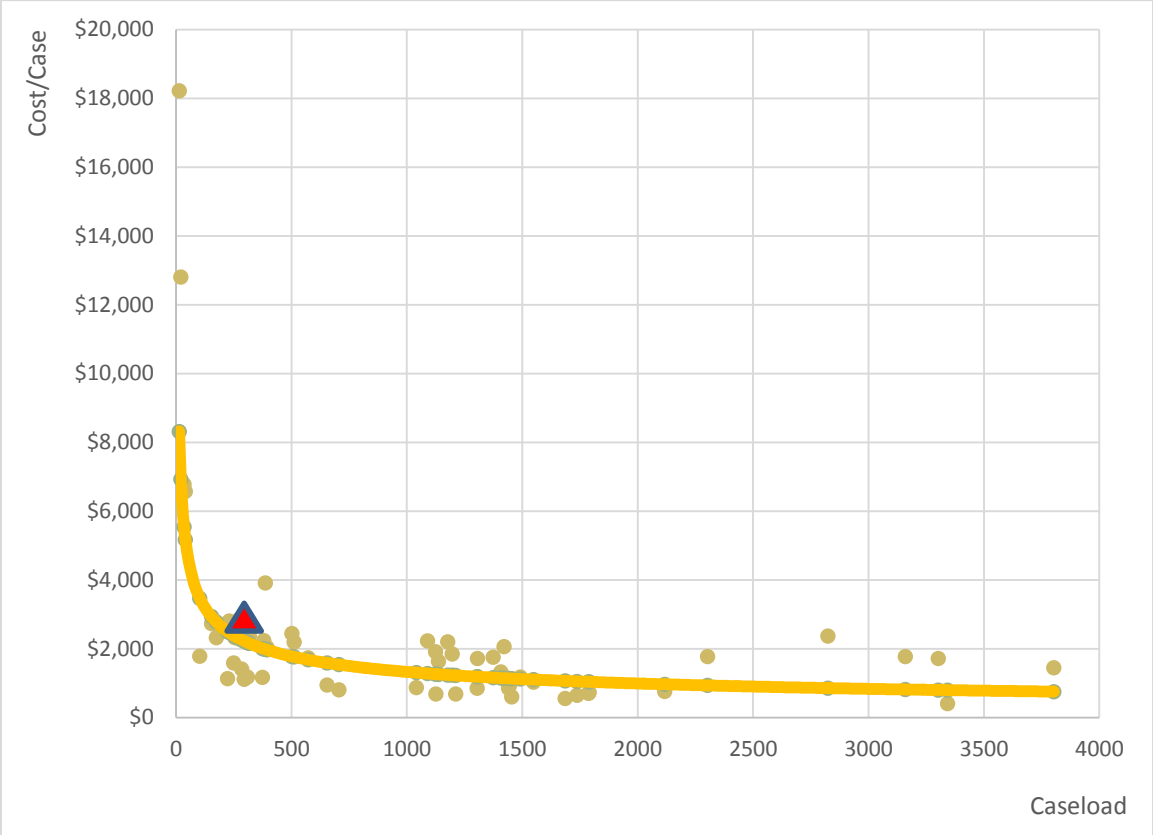
Figure 34: Fire Analysis Efficient Frontier over Time



The estimated cost efficient performance across time is fairly consistent. The figure above highlights the estimate from the 2012-2013 FORESIGHT submissions with the 2013-2014 FORESIGHT submissions. The estimated efficient frontier across years is nearly identical when laboratories operate near perfect economies of scale. Discrepancies across time are greater at more extreme caseloads.

Firearms & Ballistics Analysis

Figure 35: Firearms & Ballistics Average Total Cost



Foresight Project 2013-2014, West Virginia University, Morgantown, WV, USA

LABORATORY ABC Performance (Relative Efficiency Deviation 20% - 25%)

Figure 36: Laboratory ABC Firearms & Ballistics "Real" Cost per Case (2013.12 = 100)

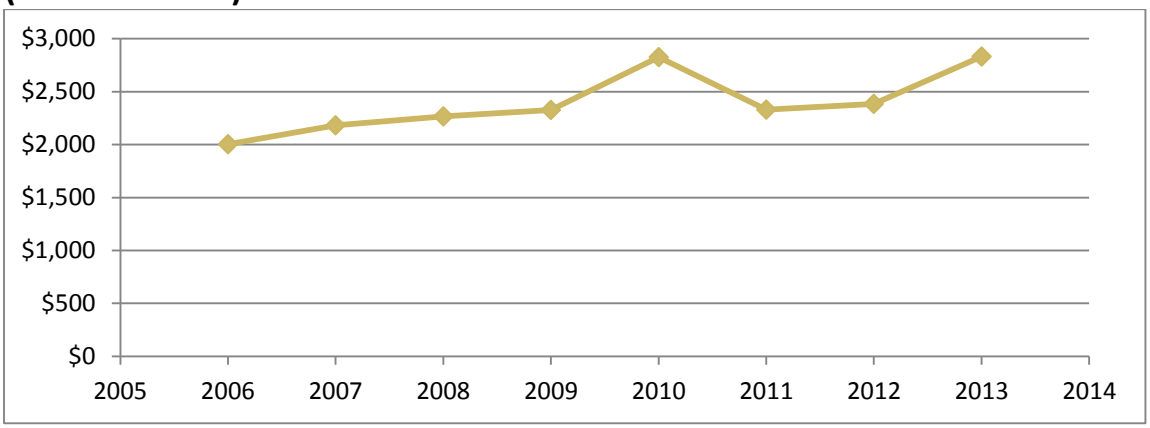


Figure 37: Laboratory ABC Firearms & Ballistics Cases per FTE

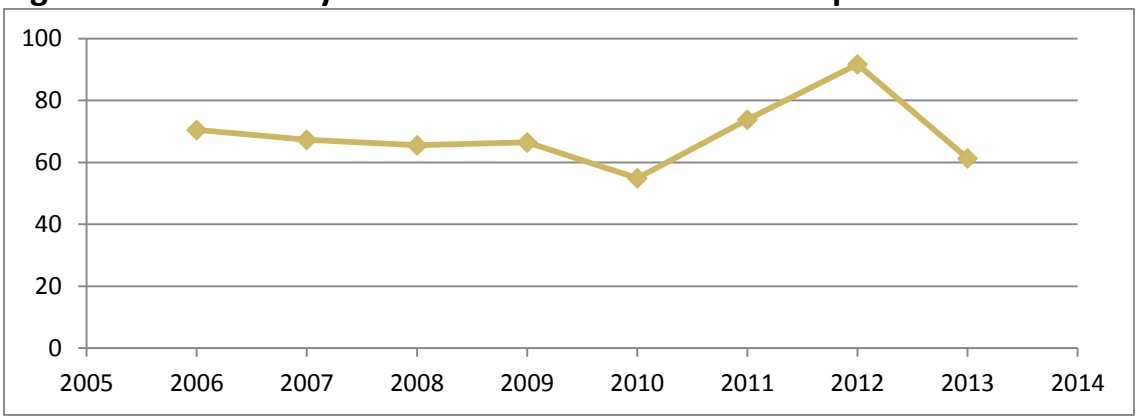
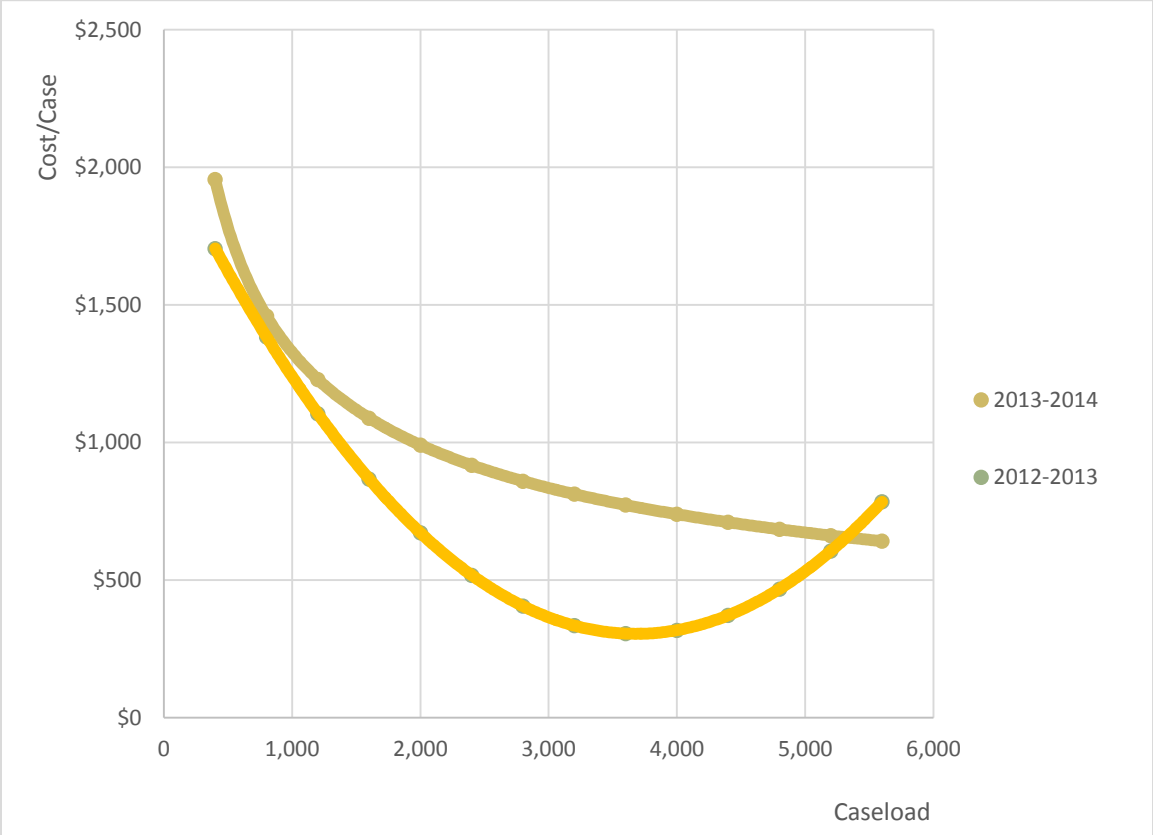


Figure 38: Firearms & Ballistics Efficient Frontier over Time



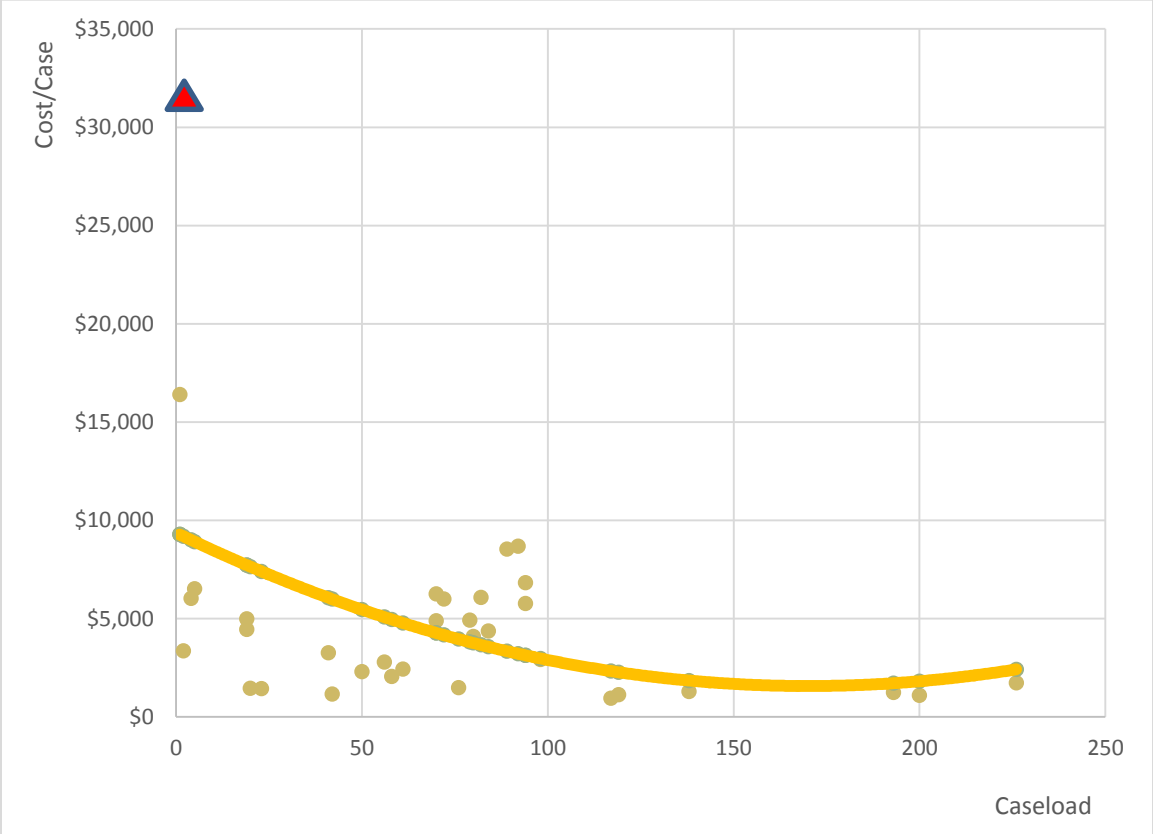
The estimated cost efficient performance across time is fairly consistent. The figure above highlights the estimate from the 2012-2013 FORESIGHT submissions with the 2013-2014 FORESIGHT submissions. The estimated efficient frontier across years is nearly identical when laboratories operate near perfect economies of scale. Discrepancies across time are greater at more extreme caseloads.

Forensic Pathology

There is insufficient data to estimate the average total cost curve for this area of investigation.

Gun Shot Residue Analysis

Figure 39: Gun Shot Residue Average Total Cost



Foresight Project 2013-2014, West Virginia University, Morgantown, WV, USA

LABORATORY ABC Performance (Relative Efficiency Deviation exceeds 100%)

Figure 40: Laboratory ABC Gun Shot Residue "Real" Cost per Case (2013.12 = 100)

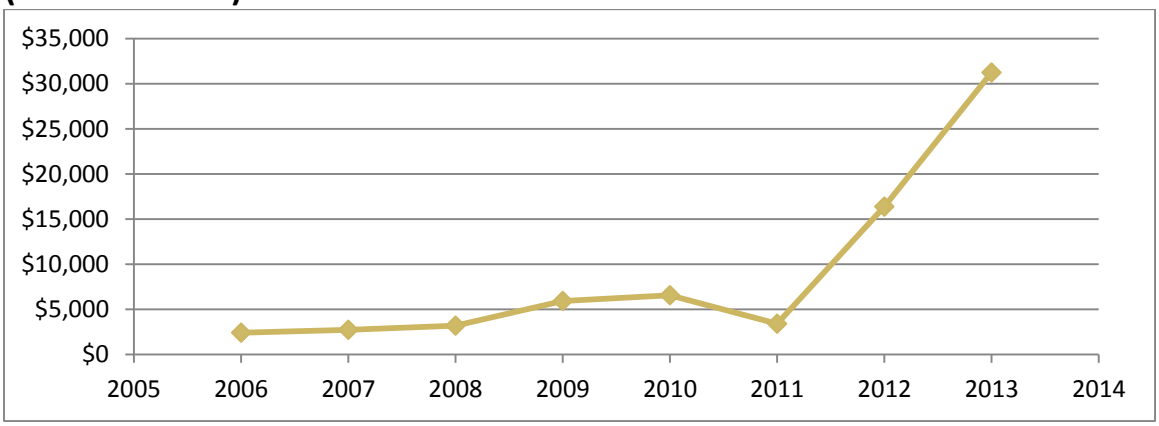


Figure 41: Laboratory ABC Gun Shot Residue Cases per FTE

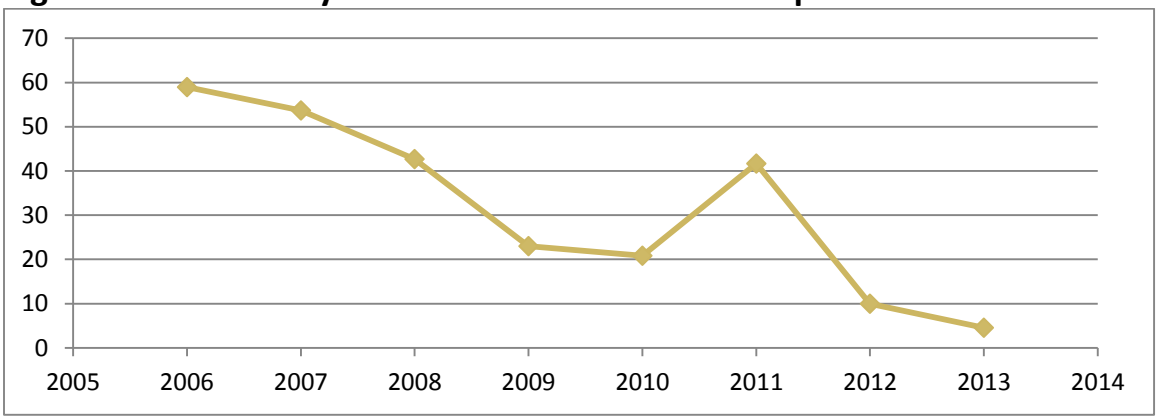
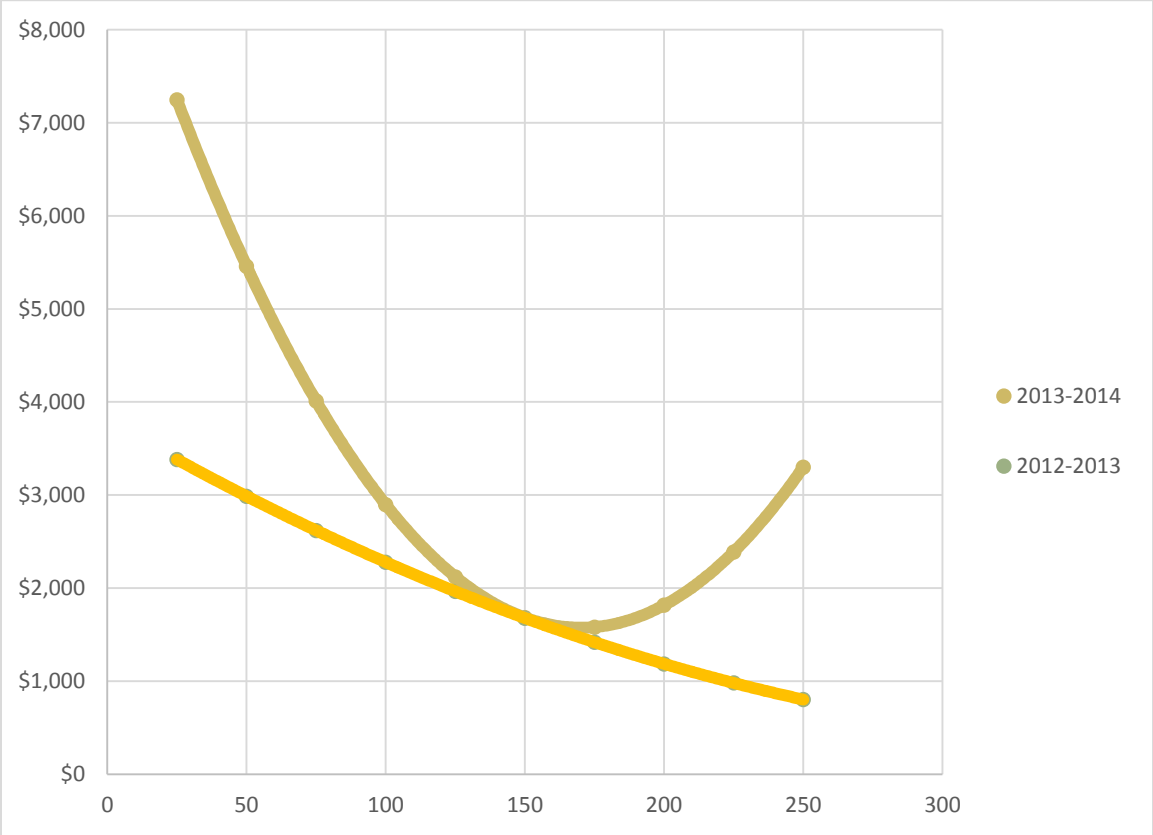


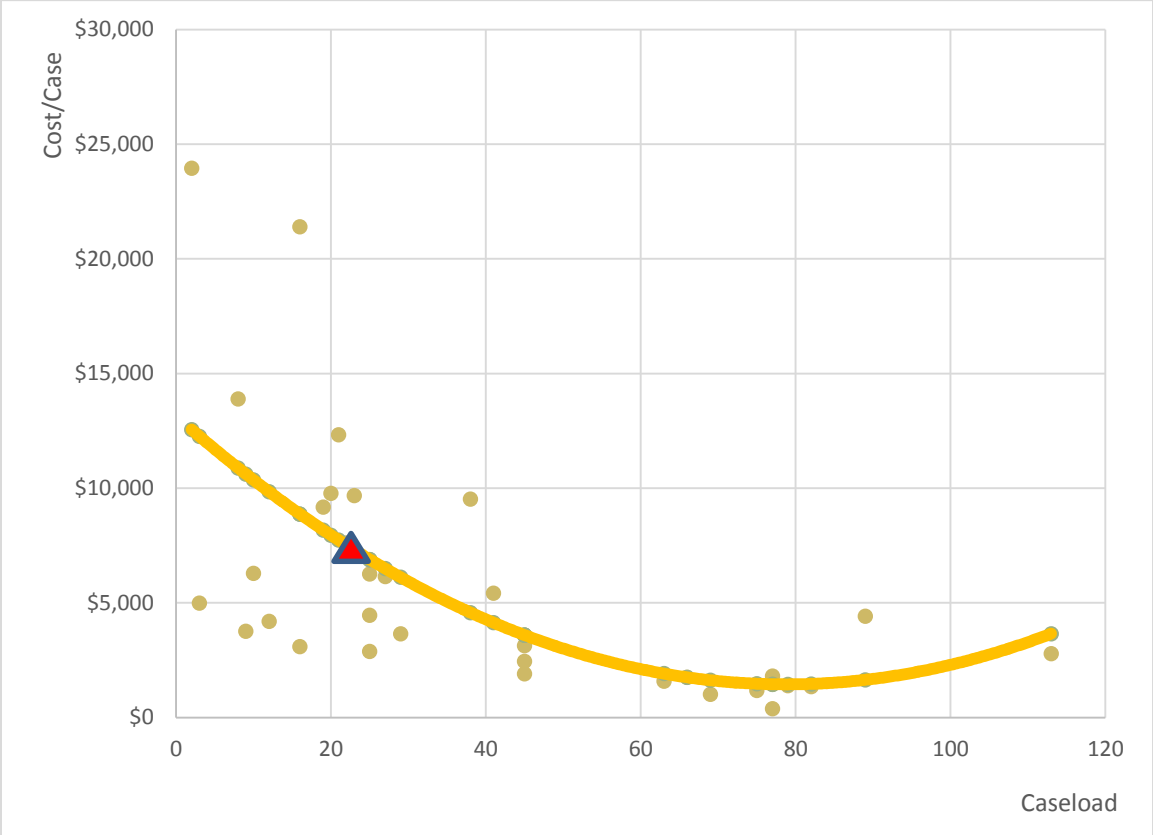
Figure 42: Gun Shot Residue Efficient Frontier over Time



The estimated cost efficient performance across time is fairly consistent. The figure above highlights the estimate from the 2012-2013 FORESIGHT submissions with the 2013-2014 FORESIGHT submissions. The estimated efficient frontier across years is nearly identical when laboratories operate near perfect economies of scale. Discrepancies across time are greater at more extreme caseloads.

Marks & Impressions Analysis

Figure 43: Marks & Impressions Analysis Average Total Cost



Foresight Project 2013-2014, West Virginia University, Morgantown, WV, USA

LABORATORY ABC Performance (Relative Efficiency Deviation 0%)

Figure 44: Laboratory ABC Marks & Impressions Analysis "Real" Cost per Case (2013.12 = 100)

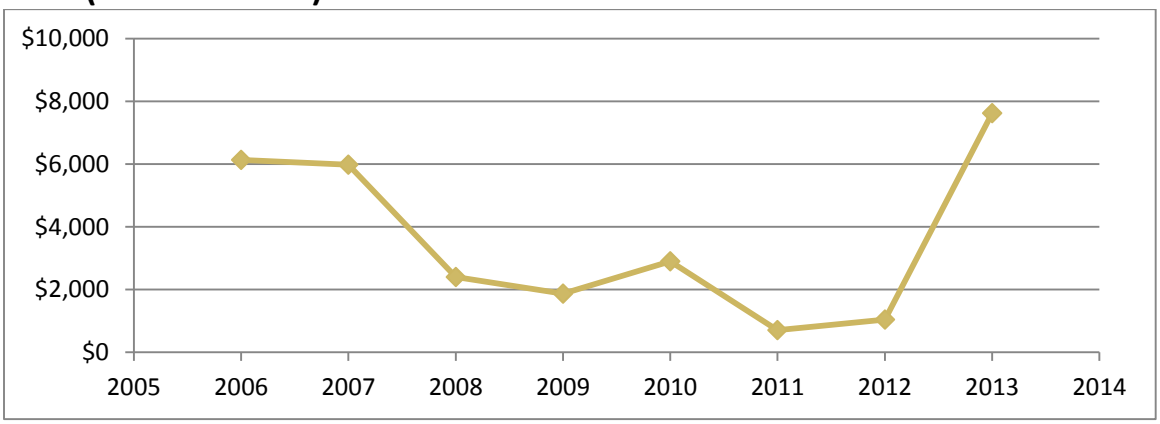


Figure 45: Laboratory ABC Marks & Impressions Analysis Cases per FTE

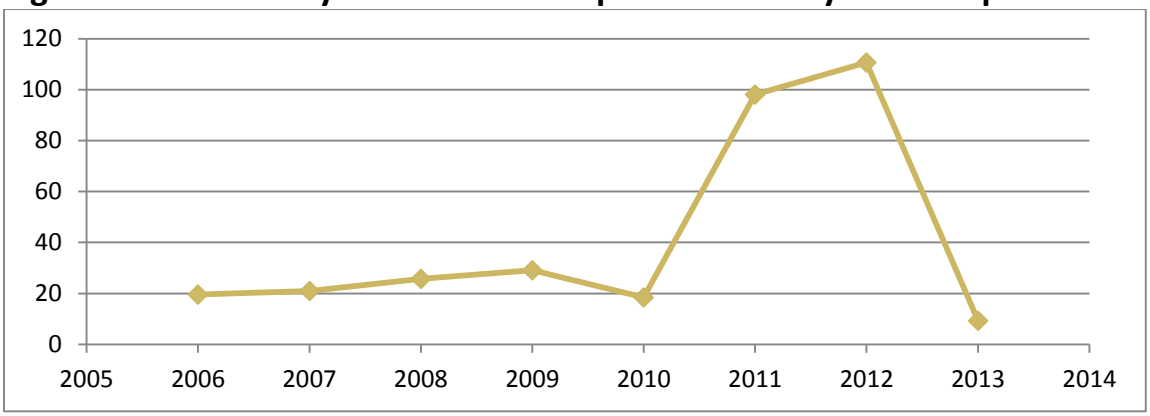
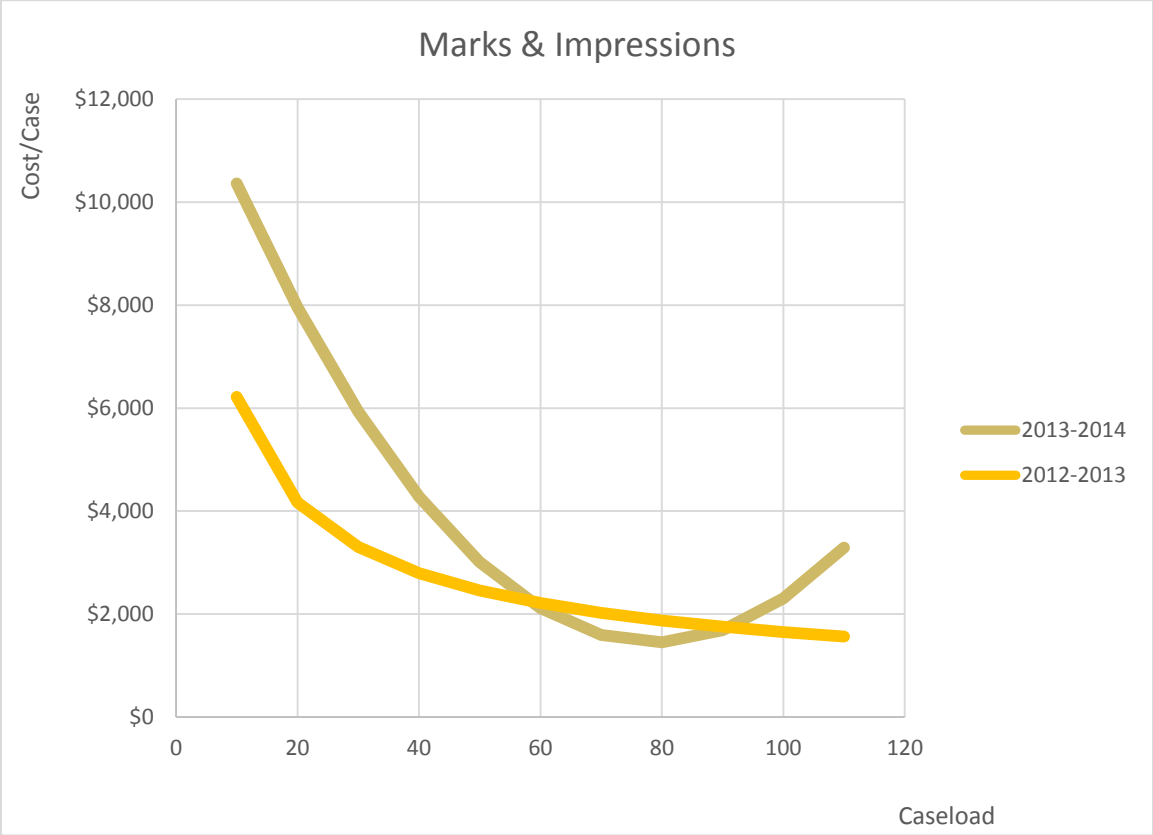


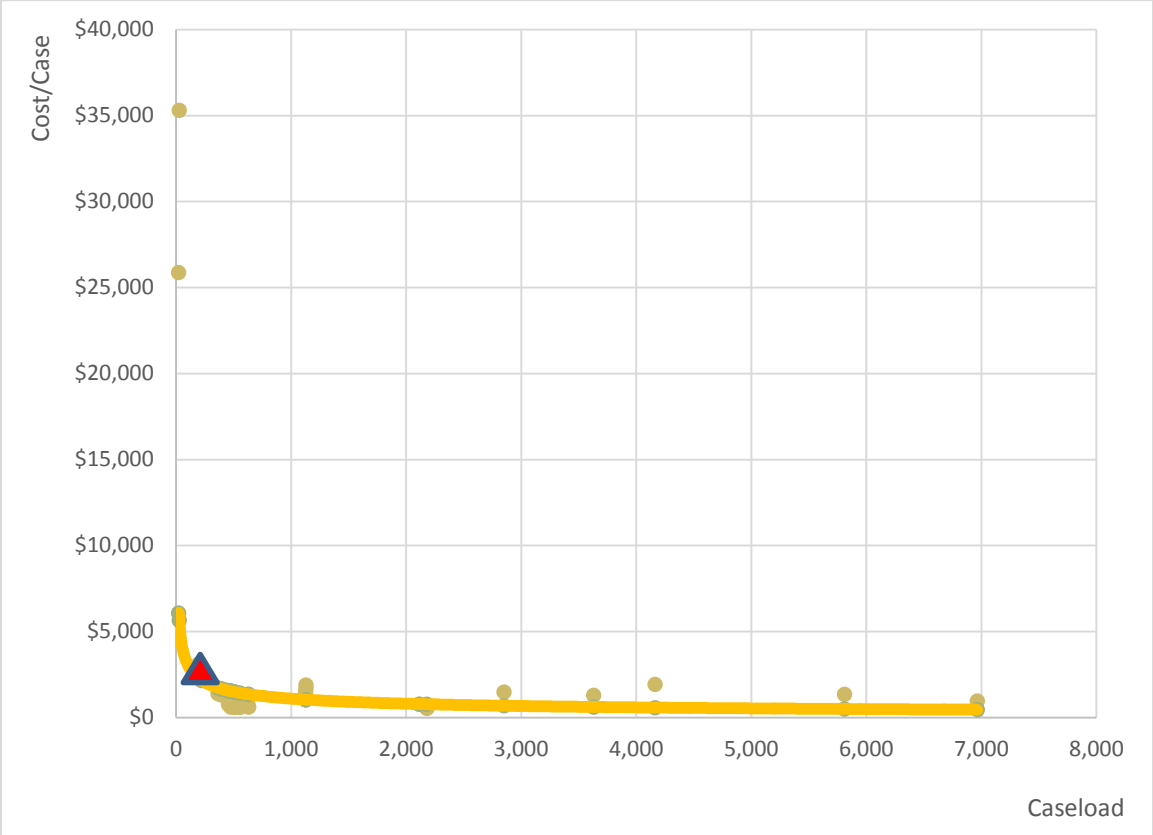
Figure 46: Marks & Impressions Efficient Frontier over Time



The estimated cost efficient performance across time is fairly consistent. The figure above highlights the estimate from the 2012-2013 FORESIGHT submissions with the 2013-2014 FORESIGHT submissions. The estimated efficient frontier across years is nearly identical when laboratories operate near perfect economies of scale. Discrepancies across time are greater at more extreme caseloads.

Serology/Biology

Figure 47: Serology/Biology Average Total Cost



Foresight Project 2013-2014, West Virginia University, Morgantown, WV, USA

LABORATORY ABC Performance (Relative Efficiency Deviation 0%)

Figure 48: Laboratory ABC Serology/Biology Analysis "Real" Cost per Case (2013.12 = 100)

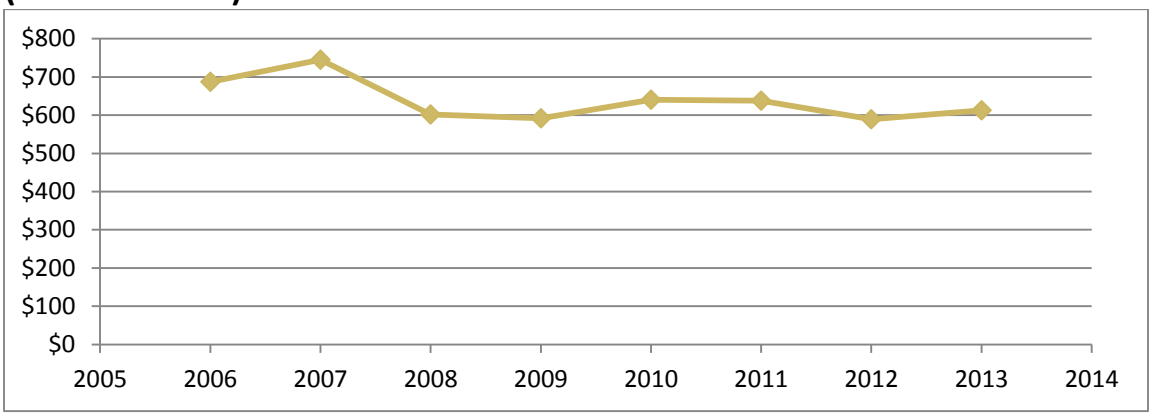


Figure 49: Laboratory ABC Serology/Biology Cases per FTE

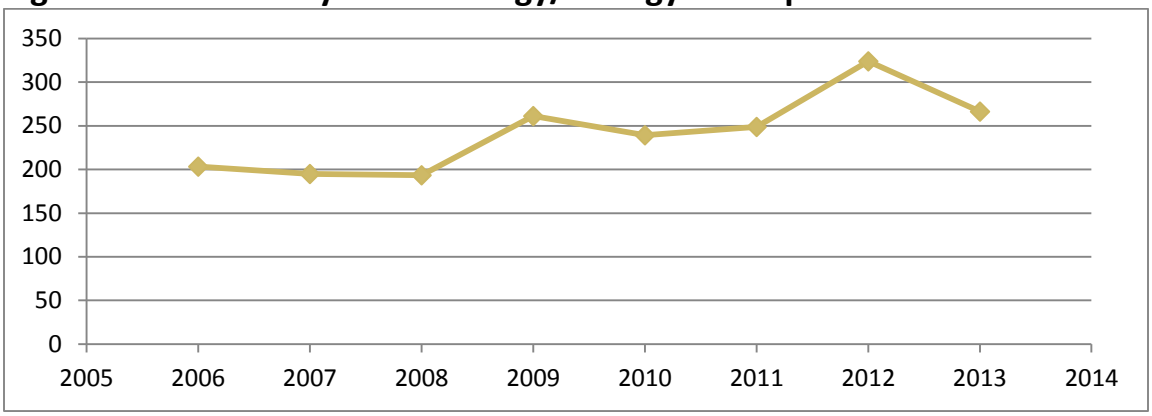
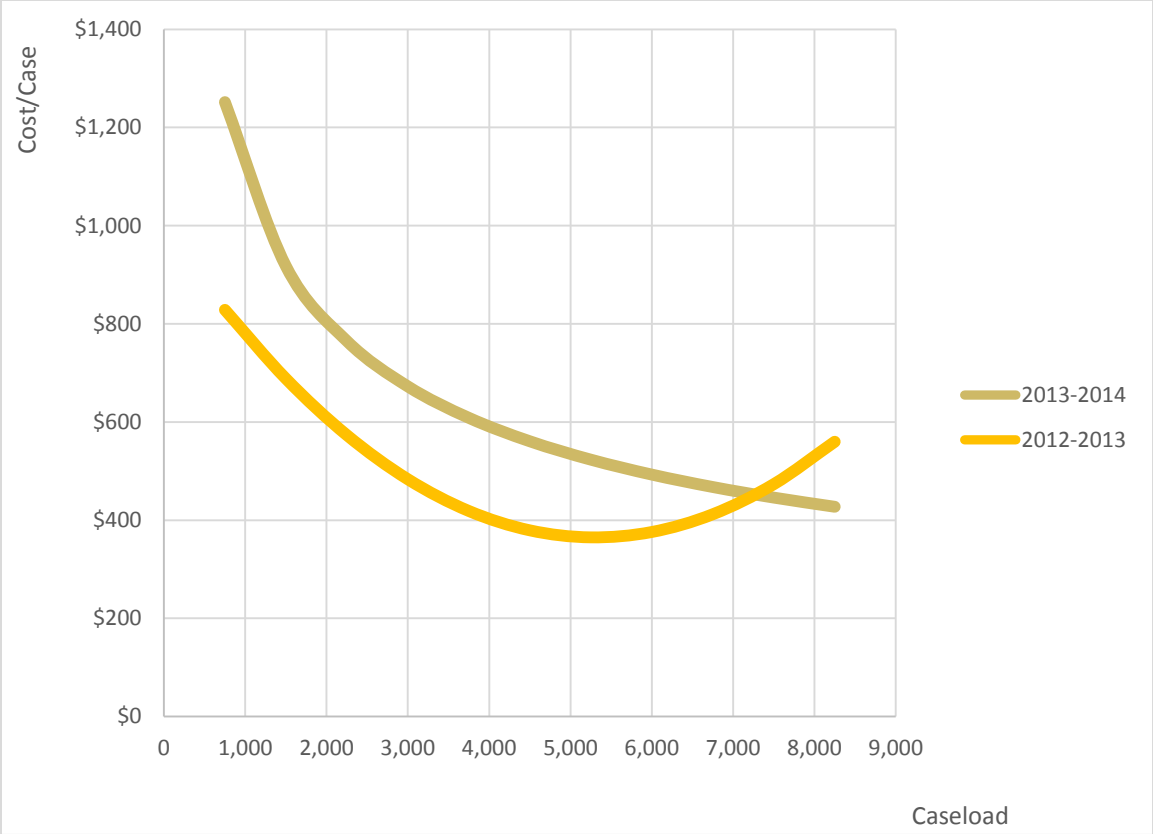


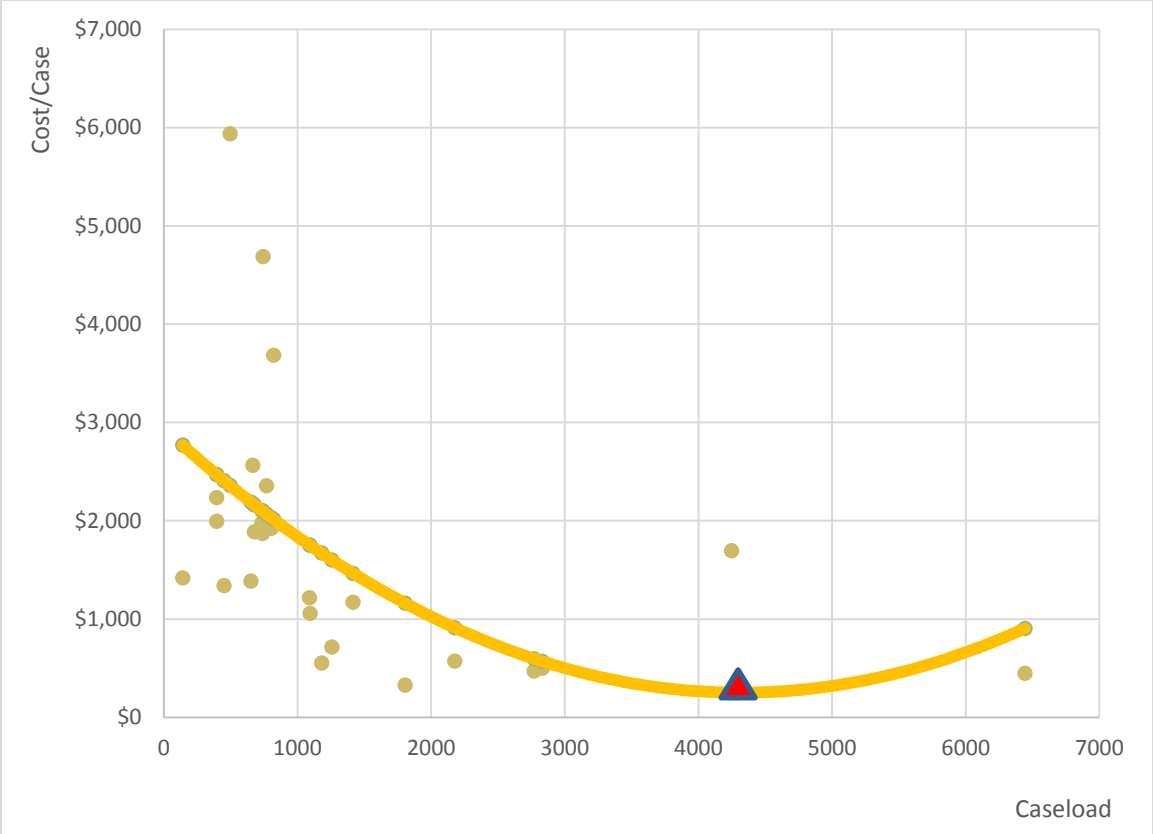
Figure 50: Serology/Biology Efficient Frontier over Time



The estimated cost efficient performance across time exhibits the expected shape, but the effect of an increase in smaller laboratory participants shows that the efficient frontier has greater definition at lower caseloads. The figure above highlights the estimate from the 2012-2013 FORESIGHT submissions with the 2013-2014 FORESIGHT submissions.

Toxicology Analysis ante mortem

Figure 51: Toxicology ante mortem Average Total Cost



Foresight Project 2013-2014, West Virginia University, Morgantown, WV, USA

LABORATORY ABC Performance (Relative Efficiency Deviation 0%)

Figure 52: Laboratory ABC Toxicology ante mortem "Real" Cost per Case (2013.12 = 100)

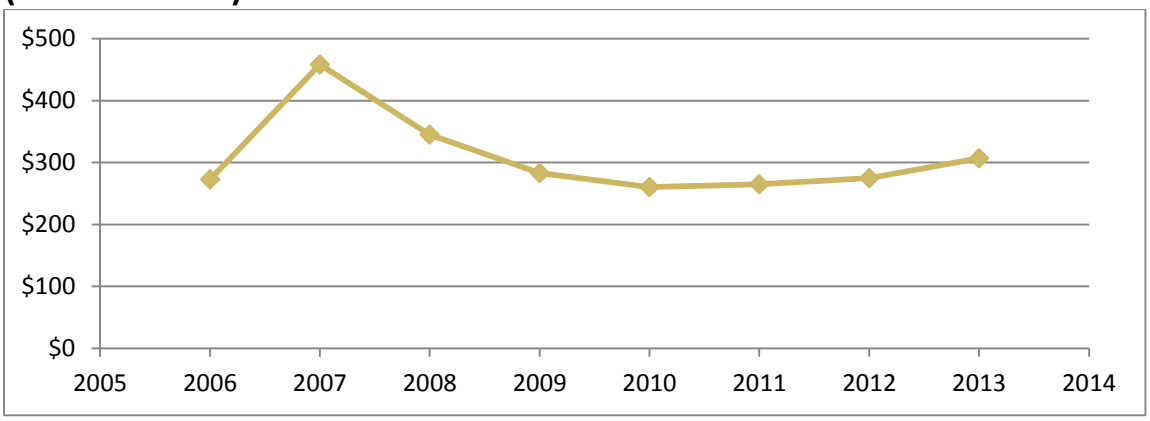


Figure 53: Laboratory ABC Toxicology ante mortem Cases per FTE

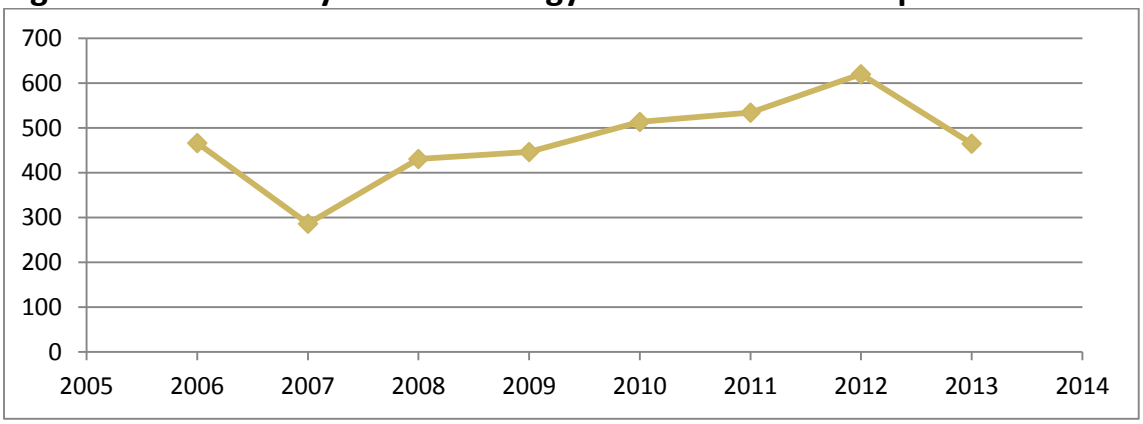
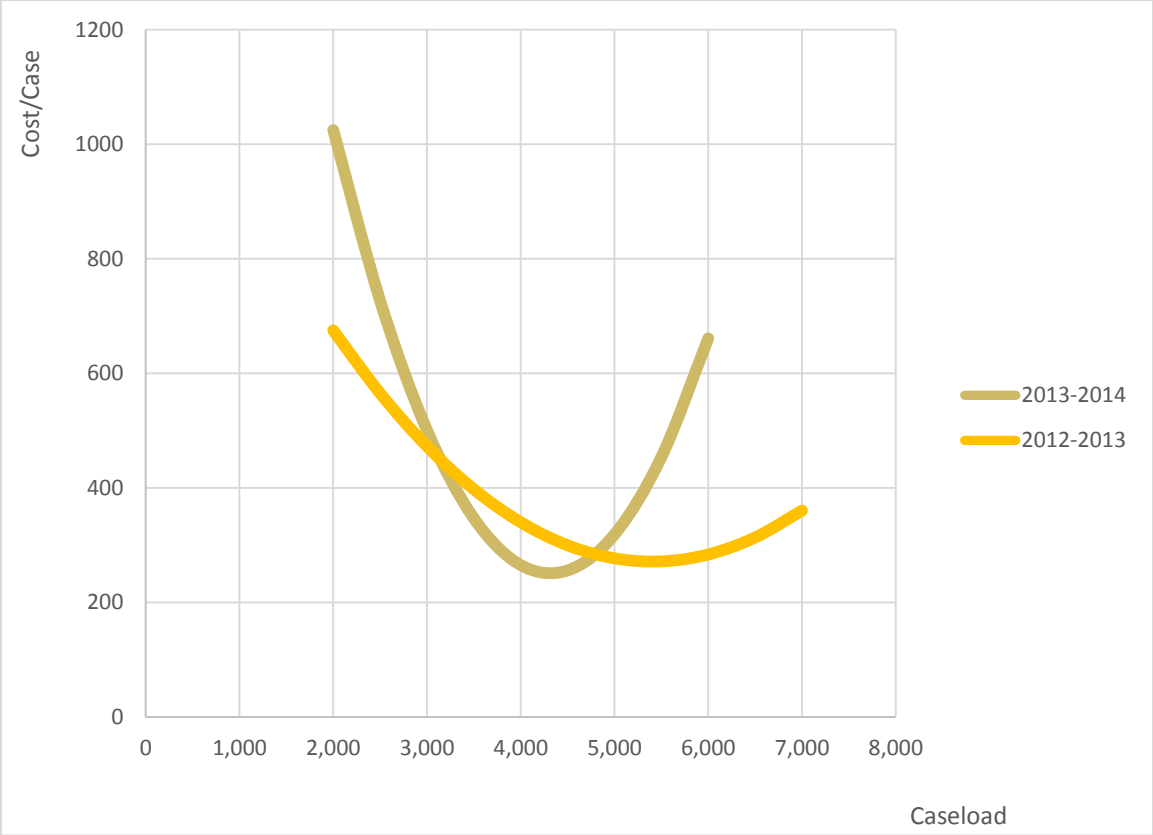


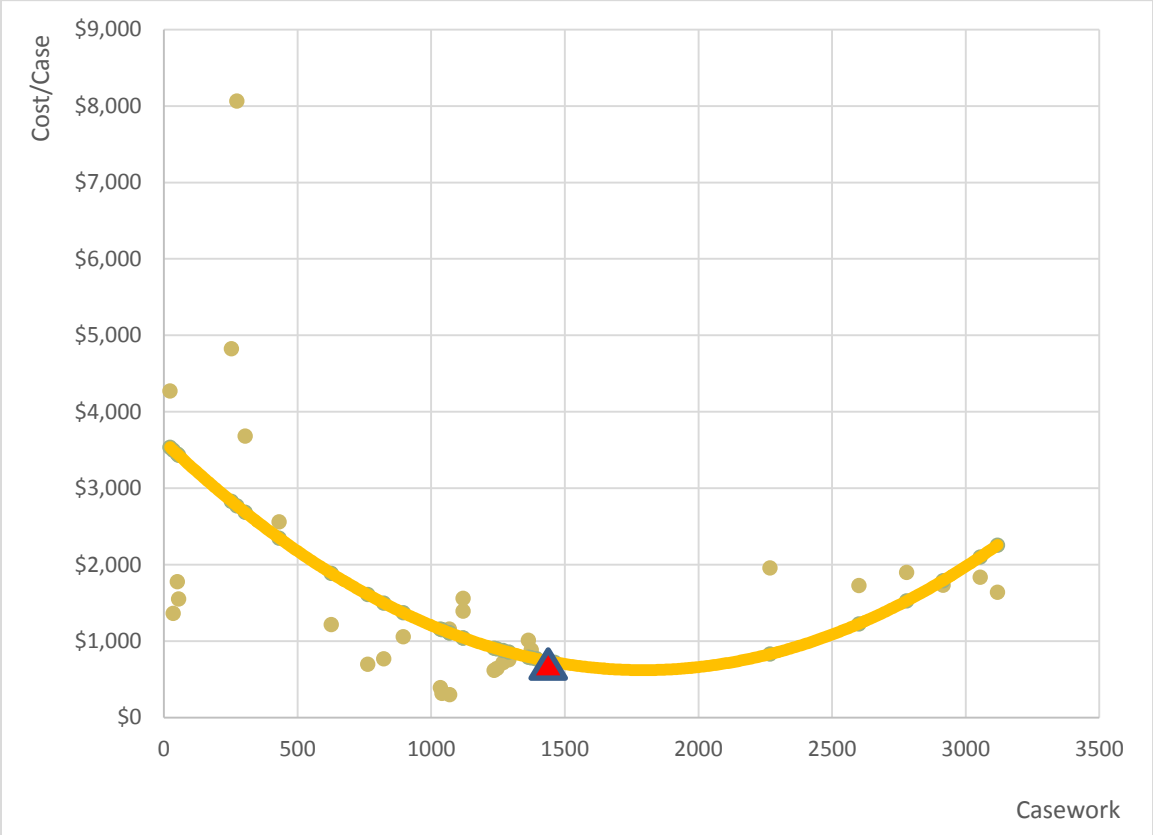
Figure 54: Toxicology ante mortem Efficient Frontier over Time



The estimated cost efficient performance across time is fairly consistent. The figure above highlights the estimate from the 2012-2013 FORESIGHT submissions with the 2013-2014 FORESIGHT submissions. The estimated efficient frontier across years is nearly identical when laboratories operate near perfect economies of scale. Discrepancies across time are greater at more extreme caseloads.

Toxicology Analysis post mortem

Figure 55: Toxicology post mortem Average Total Cost



Foresight Project 2013-2014, West Virginia University, Morgantown, WV, USA

LABORATORY ABC Performance (Relative Efficiency Deviation 0%)

Figure 56: Laboratory ABC Toxicology post mortem "Real" Cost per Case (2013.12 = 100)

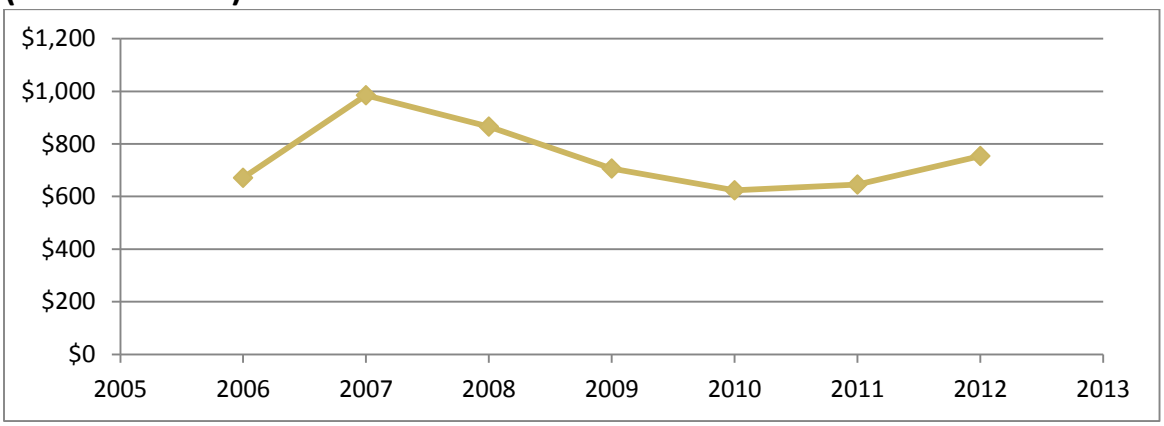


Figure 57: Laboratory ABC Toxicology post mortem Cases per FTE

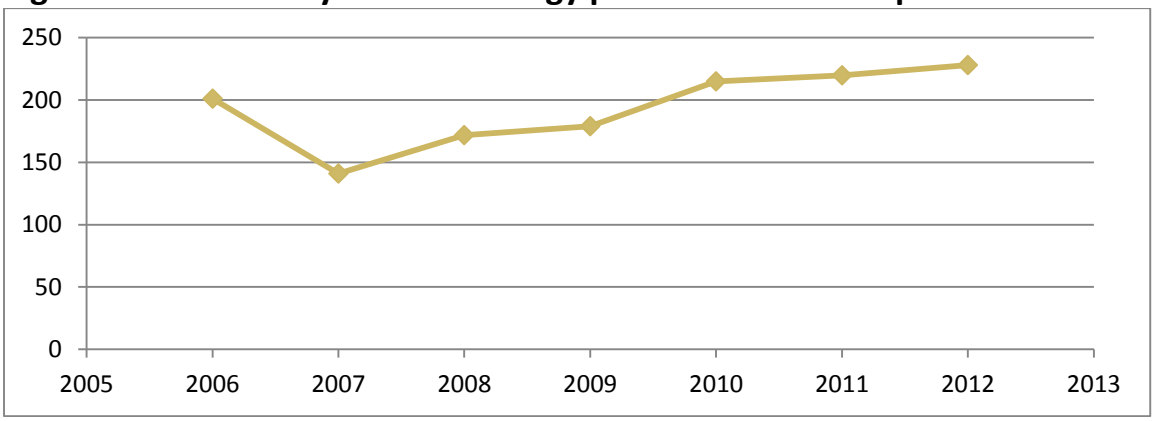
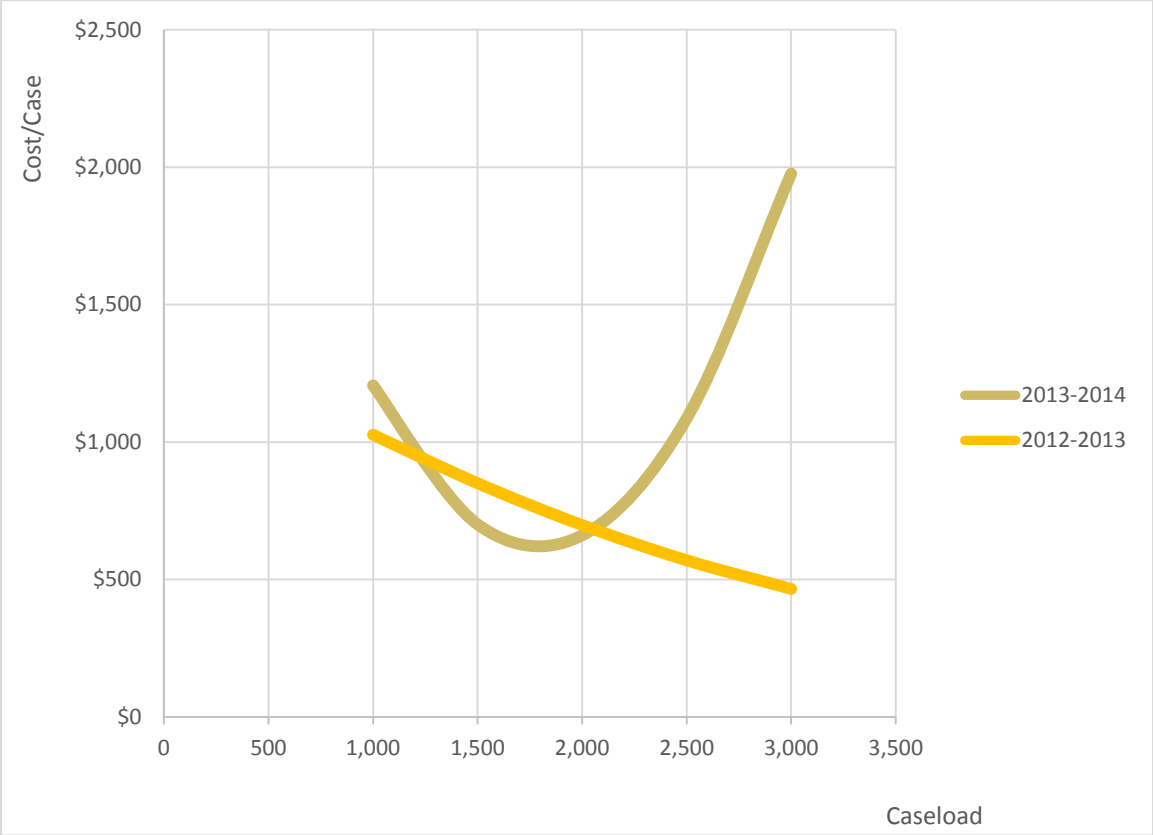


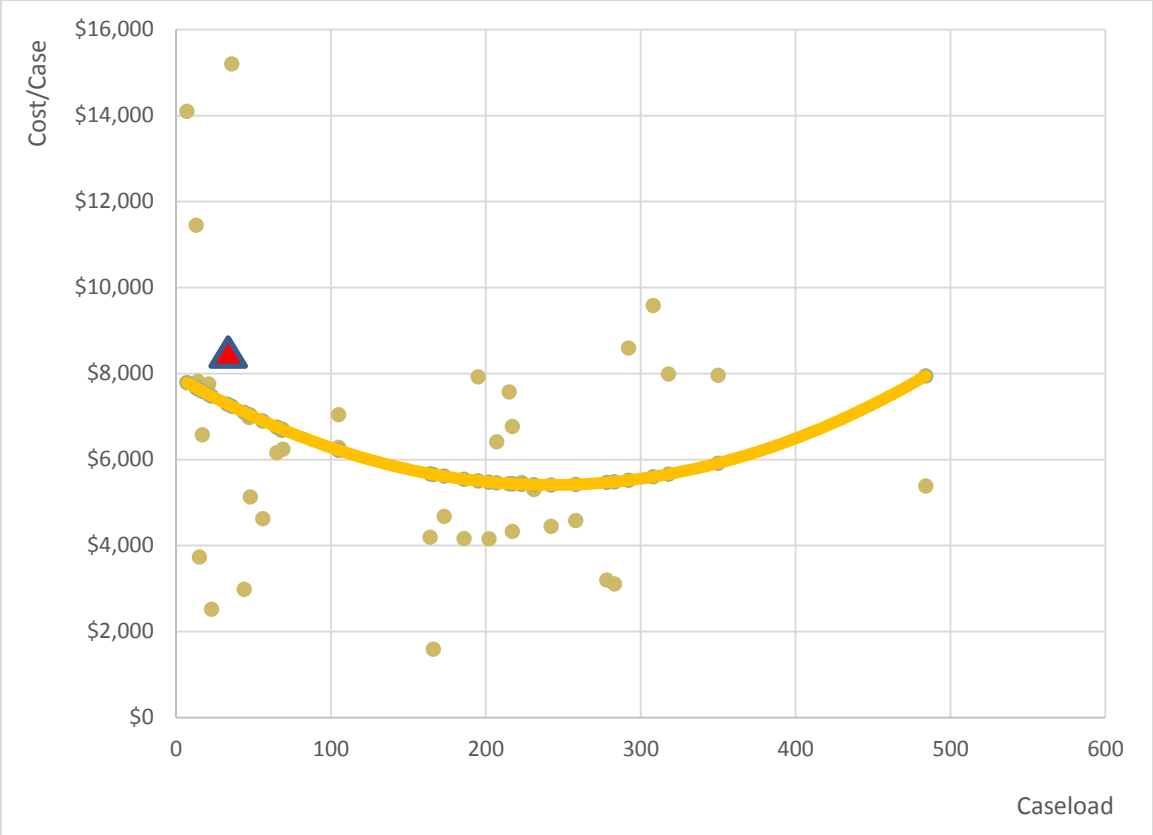
Figure 58: Toxicology post mortem Efficient Frontier over Time



The estimated cost efficient performance across time is effected by the smaller sample of laboratories in this area of investigation. The figure above highlights the estimate from the 2012-2013 FORESIGHT submissions with the 2013-2014 FORESIGHT submissions. The estimated efficient frontier across years is consistent for a small range; differences across time are greater at more extreme caseloads.

Trace Evidence Analysis

Figure 59: Trace Evidence Analysis Average Total Cost



Foresight Project 2013-2014, West Virginia University, Morgantown, WV, USA

▲LABORATORY ABC Performance (Relative Efficiency Deviation 10% - 15%)

Figure 60: Laboratory ABC Trace Evidence "Real" Cost per Case (2013.12 = 100)

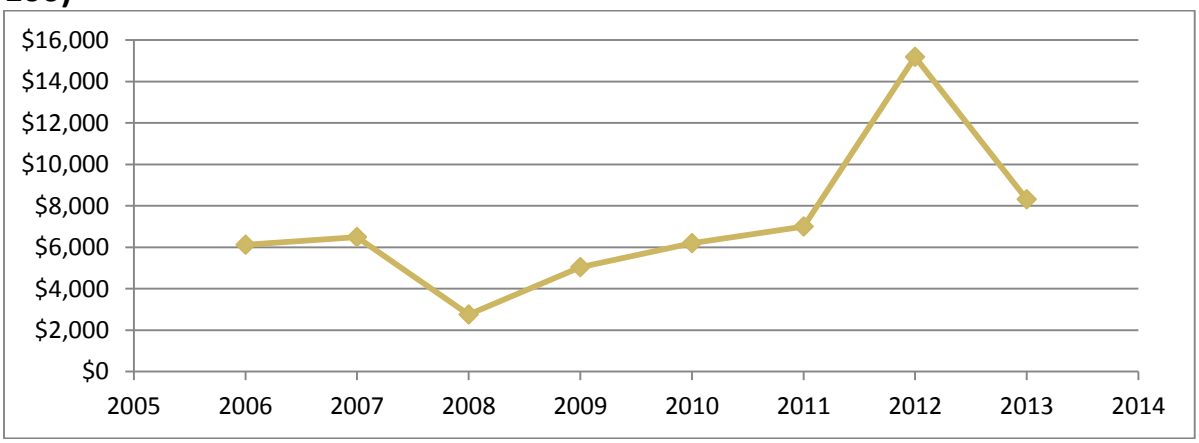


Figure 61: Laboratory ABC Trace Evidence Cases per FTE

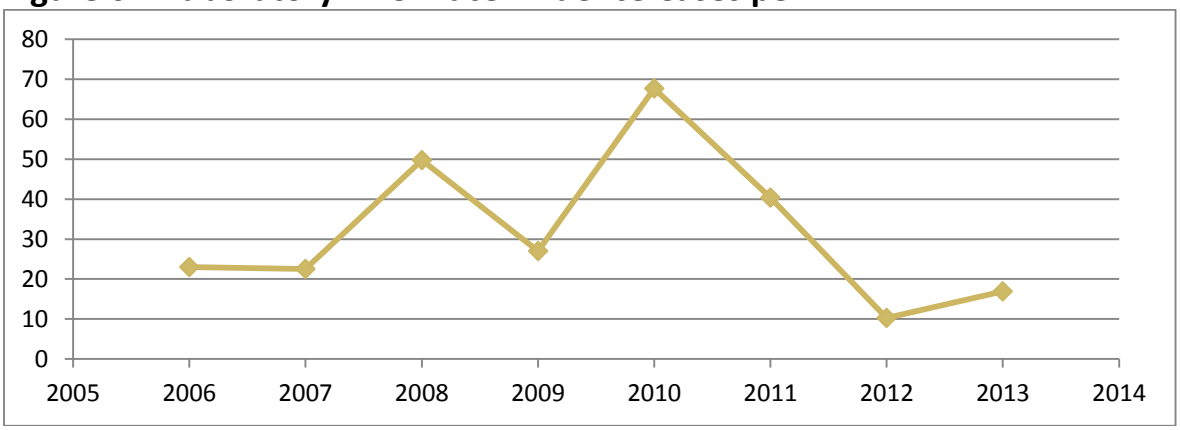
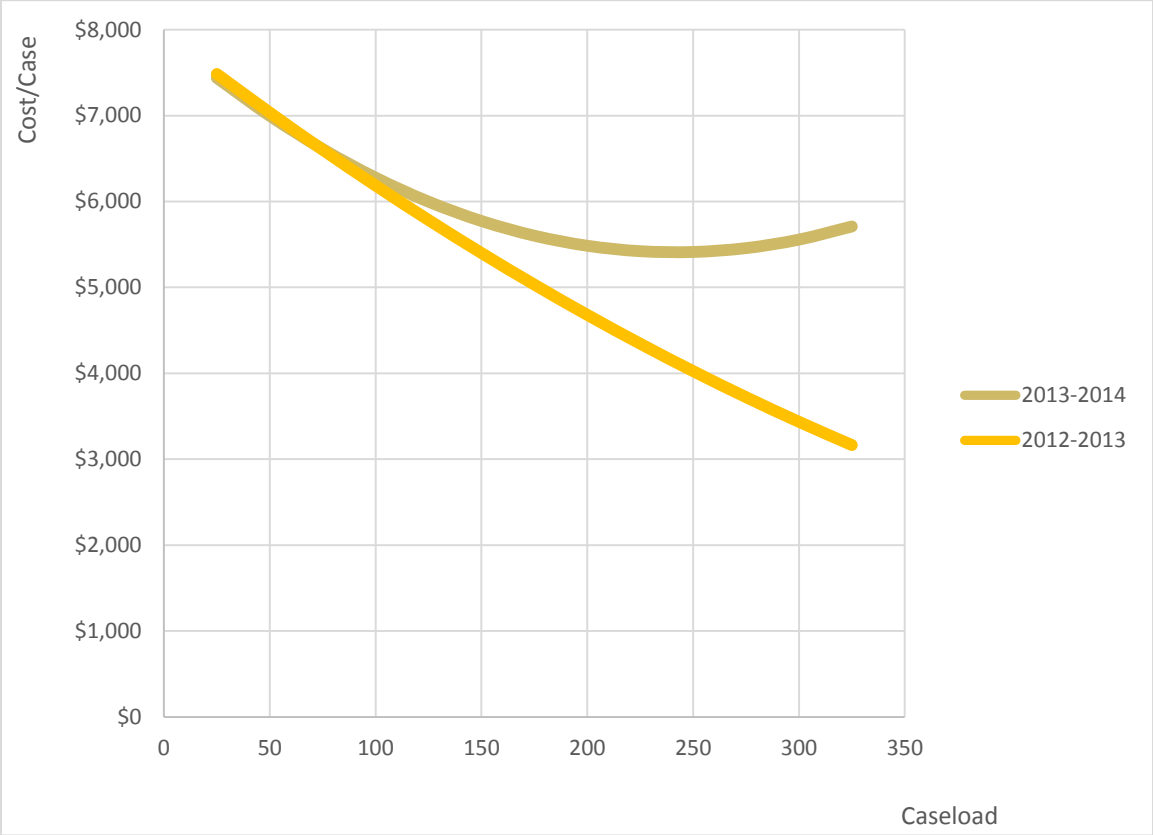


Figure 62: Trace Evidence Efficient Frontier over Time



The estimated cost efficient performance across time is effected by the smaller sample of laboratories in this area of investigation. The figure above highlights the estimate from the 2012-2013 FORESIGHT submissions with the 2013-2014 FORESIGHT submissions. The estimated efficient frontier across years is consistent for a small range; differences across time are greater at more extreme caseloads because of the small number of laboratories performing Trace Evidence Analysis for a large number of cases.

FORESIGHT Glossary

assistant / analyst	An individual carrying out general casework examinations or analytical tests under the instruction of a Reporting Scientist or Reporting Analyst and who is able to provide information to assist with the interpretation of the tests.
backlog	Open cases that are older than 30 days.
case - institute case	A request from a crime lab "customer" that includes forensic investigations in one or more investigative areas.
case - area case	A request for examination in one forensic investigation area. An area case is a subset of an institute case.
Case – as reported in the LabRat form	Cases reported in LabRat are “area cases”
casework	All laboratory activities involved in examination of cases.
casework time	Total FTE´s for operational personnel in an investigation area (in hours) subtracted by the hours of R&D and, E&T and support and service given to external partners.
crime	perceived violation of the law that initiates a case investigation.
direct salary	Compensation paid to employees, including salary, overtime, vacation salary, bonuses, etc.
facility expense	Sum of rents, cleaning and garbage collection, security, energy, water, communication, ICT infrastructure and facility maintenance.
floor area	Total of all floor area including office, laboratory and other.
full-time equivalent (FTE)	The work input of a full-time employee working for one full year.
full-time researcher	A forensic scientist whose primary responsibility is research and who is not taking part in casework.
investigation area	Area limited by item type and methods as they are listed in the ”definitions of investigative areas tab.
investment expense	Purchases of equipment, instruments, etc. with a lifetime longer than one year (alternatively capital expenses).
item	A single object for examination submitted to the laboratory. Note: one item may be investigated and counted in several investigation areas.
laboratory area	Floor area used for forensic investigation, including sample and consumable storage rooms.
non-reporting manager	An individual whose primary responsibilities are in managing and administering a laboratory or a unit thereof and who is not taking part in casework.

office area	Floor area of offices (square feet).
operational personnel	Personnel in operational units providing casework, research and development (R & D), education and training (E & T) and external support services. Non-reporting unit heads are included.
other floor area	Floor area of space not belonging to laboratories or offices, i.e. corridors, lunch corners, meeting rooms, etc. (square feet).
personnel expense	Sum of direct salaries, social expenses (employer contribution to FICA, Medicare, Workers Comp, and Unemployment Comp), retirement (employer contribution only towards pensions, 401K plans, etc.), personnel development and training (internal or external delivery, including travel), and occupational health service expenses (employer contribution only).
report	A formal statement of the results of an investigation, or of any matter on which definite information is required, made by some person or body instructed or required to do so.
reporting analyst	An analyst responsible in non-complicated cases (e.g. simple drugs analysis) for performing the examination of the items submitted, interpreting the analysis results, writing the analysis report and, if necessary, providing factual evidence for the court.
reporting scientist	The forensic scientist responsible in a particular case for performing or directing the examination of the items submitted, interpreting the findings, writing the report and providing evidence of fact and opinion for the court.
representation expense	The costs for hosting guests: lunches, dinners, coffees offered by the lab, and giveaway to guests or during visits abroad, etc.
sample	An item of evidence or a portion of an item of evidence that generates a reportable result.
scientist in training	An individual with no reporting rights being trained to become a reporting scientist.
support personnel	Forensic laboratory staff providing various internal support services. Management and administration personnel not belonging to the operational units are included.
test	An analytical process, including but not limited to visual examination, instrumental analysis, presumptive evaluations, enhancement techniques, extractions, quantifications, microscopic techniques, and comparative examinations. This does not include technical or administrative reviews.

Turn-around time	The number of days from a request for examination in an investigative area until issuance of a report. (Note that an area case may have multiple requests and each new request has a separate turn-around time.)
workload	Total time spent on all work related to job, including overtime.

Definitions: Investigative Areas

Blood Alcohol	The analysis of blood or breath samples to detect the presence of and quantify the amount of alcohol.
Crime Scene Investigation	The collection, analysis, and processing of locations for evidence relating to a criminal incident.
Digital evidence - Audio & Video	The analysis of multimedia audio, video, and still image materials, such as surveillance recordings and video enhancement.
DNA Casework	Analysis of biological evidence for DNA in criminal cases.
DNA Database	Analysis and entry of DNA samples from individuals for database purposes.
Document Examination	The analysis of legal, counterfeit, and questioned documents, excluding handwriting analysis.
Drugs - Controlled Substances	The analysis of solid dosage licit and illicit drugs, including pre-cursor materials.
Evidence Screening & Processing	The detection, collection, and processing of physical evidence in the laboratory for potential additional analysis.
Explosives	The analysis of energetic materials in pre- and post-blast incidents.
Fingerprint Identification	The development and analysis of friction ridge patterns.
Fire analysis	The analysis of materials from suspicious fires to include ignitable liquid residue analysis.
Firearms and Ballistics	The analysis of firearms and ammunition, to include distance determinations, shooting reconstructions, NIBIN, and toolmarks.

Forensic Pathology	Forensic pathology is a branch of medicine that deals with the determination of the cause and manner of death in cases in which death occurred under suspicious or unknown circumstances.
Gun Shot Residue (GSR)	The analysis of primer residues from discharged firearms (not distance determinations).
Marks and Impressions	The analysis of physical patterns received and retained through the interaction of objects of various hardness, including shoeprints and tire tracks.
Serology/Biology	The detection, collection, and non-DNA analysis of biological fluids.
Toxicology, ante-mortem	Toxicology involves the chemical analysis of body fluids and tissues to determine if a drug or poison is present in a living individual, to include blood alcohol analysis (BAC). Toxicologists are then able to determine how much and what effect, if any, the substance might have had on the person.
Toxicology, post-mortem	Toxicology involves the chemical analysis of body fluids and tissues to determine if a drug or poison is present in a deceased individual. Toxicologists are then able to determine how much and what effect, if any, the substance might have had on the person.
Trace Evidence	The analysis of materials that, because of their size or texture, transfer from one location to another and persist there for some period of time. Microscopy, either directly or as an adjunct to another instrument, is involved.

Project FORESIGHT Publications

FORESIGHT: A Business Approach to Improving Forensic Science Services, *Forensic Science Policy & Management: An International Journal* Volume 1, Issue 2, 2009, Max M. Houck, Richard A. Riley, Paul J. Speaker, & Tom S. Witt, pages 85-95

Abstract: Managers of scientific laboratories see themselves as scientists first and managers second; consequently, they tend to devalue the managerial aspects of their jobs. Forensic laboratory managers are no different, but the stakes may be much higher given the importance of quality science to the criminal justice system. The need for training and support in forensic laboratory management has been recognized for many years, but little has been done to transition the tools of business to the forensic laboratory environment. FORESIGHT is a business-guided self-evaluation of forensic science laboratories across North America. The participating laboratories represent local, regional, state, and national agencies. Economics, accounting, finance, and forensic faculty provide assistance, guidance, and analysis. The process involves standardizing definitions for metrics to evaluate work processes, linking financial information to work tasks, and functions. Laboratory managers can then assess resource allocations, efficiencies, and value of services—the mission is to measure, preserve what works, and change what does not. A project of this magnitude for forensic laboratories has not been carried out anywhere.

Key Performance Indicators and Managerial Analysis for Forensic Laboratories, *Forensic Science Policy & Management: An International Journal* Volume 1, Issue 1, 2009, Paul J. Speaker, pages 32-42

Abstract: Forensic laboratories generate a great deal of data from casework activities across investigative areas, personnel and budget allocations, and corresponding expenditures. This paper investigates ways in which laboratories can make data-driven managerial decisions through the regular extraction of key performance indicators from commonly available data sources. A laboratory's performance indicators can then be compared to peer laboratory performance to search for best practices, determine in-house trends, manage scarce resources, and provide quantitative support for the justification of additional resources.

The Decomposition of Return on Investment for Forensic Laboratories, *Forensic Science Policy & Management: An International Journal* Volume 1, Issue 2, 2009, Paul J. Speaker, pages 96-102

Abstract: For forensic laboratories, a detailed understanding of return on investment (ROI) is necessary for routine assessment, consideration of new legislative alternatives, and cost-benefit analysis for decision making. Converting performance data to ratio measures provides useful comparisons between an individual laboratory and the standards for excellence for the industry; these measures also permit an evaluation across time. Unfortunately, these same ROI measures are subject to abuse when overemphasis on a single measure leads to unintended consequences. In this paper, the ROI measure is broken down into various parts that can be tracked on a regular basis to reveal how a laboratory achieves its results. The tradeoffs between return and risk, efficiency, analytical process, and market conditions are outlined. The end product is a series of easily monitored metrics that a laboratory director may examine on a regular basis for continuous improvement.

Benchmarking and Budgeting Techniques for Improved Forensic Laboratory Management, *Forensic Science Policy & Management: An International Journal* Volume 1, Issue 4, 2010, Paul J. Speaker & A. Scott Fleming, pages 199-208

Abstract: Forensic laboratories are not immune from downturns in the worldwide economy. Recession and economic slowdowns, when coupled with the public's heightened sense of the capabilities of forensic science, put stress on the effectiveness of forensic laboratories. The resources available to forensic laboratories are limited, and managers are under greater pressure to improve efficiency and effectiveness. To this end, the use of internal and external financial and accounting metrics to plan, control, evaluate, and communicate performance is examined. Using data from the QUADRUPOL and FORESIGHT studies, we illustrate the use of external benchmarking through a calculation of laboratory return on investment and the internal development and use of a budget to enhance laboratory performance in light of limited resources.

Forensic Science Staffing: Creating a Working Formula, *Forensic Science Policy & Management: An International Journal* Volume 2, Issue 1, 2011, Joyce Thompson Heames & Jon Timothy Heames, pages 5-10

Abstract: The key issue facing forensic labs is "the classic economic problem—how to allocate limited resources with increasing demand for services, while maintaining high quality standards" (Speaker 2009). Employees are the biggest expense and most valuable resource that forensic labs possess, thus the question arises as to how to maximize human resource functions to best allocate resources through personnel. As the search is on to look for better practices to improve the operations as well as technical expertise of labs, human capital management is crucial to that objective. The purpose of this article is to process map some of the staffing issues facing forensic science labs, whether public or private, and to identify metrics from the FORESIGHT study (Houck et al. 2009) that might help lab directors create a working formula to better manage staffing (e.g., recruiting and selection) issues.

Managing Performance in the Forensic Sciences: Expectations in Light of Limited Budgets, *Forensic Science Policy & Management: An International Journal* Volume 2, Issue 1, 2011, Hilton Kobus, Max Houck, Paul J. Speaker & Richard Riley, pages 36-43

Abstract: For forensic service providers worldwide, the demand for high-quality services greatly outpaces available resources to meet those requests. The gap between the demand for services and the resource-restricted supply of those services has implications for managing performance: the effectiveness and efficiency of forensic science. The effectiveness of forensic science is directly related to the quality of the scientific analysis and the timeliness with which that analysis is provided, while efficiency is associated with attempts to minimize costs without negatively impacting quality. An inevitable result of the demand and supply gap is a backlog that results in downstream effects on timeliness, service, and quality. One important strategy to respond to the demand-supply imbalance is continual process improvement. Collaborative benchmarking as a basis for process improvement is another approach. This paper discusses the disjunction between perceived and actual value for forensic services and the rationale for providers to evaluate, improve, and re-tool their processes toward continual improvement given limited resources.

Strategic Management of Forensic Laboratory Resources: From Project FORESIGHT Metrics to the Development of Action Plans, *Forensic Science Policy & Management: An International Journal* Volume 2, Issue 4, 2011, Jonathan Newman, David Dawley, & Paul J. Speaker, pages 164-174

Abstract: The project FORESIGHT stated objectives begin with the development of metrics applicable to the activity of forensic science laboratories. These metrics enable a laboratory to assess how they fit within the forensic science industry and offer a glance at the levels of performance that they might be able to achieve. FORESIGHT's mission goes on to state the intent for laboratories to use those measurements to "preserve what works, and change what does not" (Houck et al. 2009, p. 85). This paper addresses the strategic implications of those additional aspects of the FORESIGHT mandate with a view of the strategic planning process for a forensic science laboratory. The keys to the development of an ongoing strategic planning and execution process are outlined, and then the actions of one laboratory, Ontario's Centre of Forensic Sciences, are examined to demonstrate the move from metrics to action. While there cannot yet be made a claim of "best practices," this Canadian example offers some guidance to "better practices" in the quest for continual improvement in the provision of forensic science services.

Forensic MAGAZINE

The Power of Information, *Forensic Magazine* April 10, 2012, Tom S. Witt & Paul J. Speaker

Abstract: When it comes to cost, the Foresight model was designed to overlook nothing. When we talk about the cost of doing something, we look at everything from equipment, telecommunications, heating, lighting, facility rent … everything. If a participant doesn't have access to the data, we can estimate those costs from other labs in our studies. We come up with an all-inclusive figure that tells participants what it costs to process a case. This leads to informed decisions. Take trace evidence cases, for example. You might find that processing one trace evidence case costs the same as processing two, three, or even four traditional DNA cases. While trace evidence is wonderful and powerful, if DNA alone will get you where you need to be, this cost factor will heavily affect your decision-making process. Foresight is not about cutting where it matters. It's about using resources wisely so that labs can do more and enhance the services they provide. Once you know the key metrics, you can make informed decisions.

Is Privatization Inevitable for Forensic Science Laboratories?, *Forensic Science Policy & Management: An International Journal* Volume 3, Issue 1, 2012, William McAndrew, pages 42-52

Abstract: Given the recent global recession, many national governments have been forced to implement austerity measures, and the forensic science industry has not been immune from such changes. Proposals to privatize some or all aspects of forensic science services have been bantered about for decades, but the recent economic climate has brought this idea back to the forefront of public debates. Although privatization has been shown to have many benefits in the provision of other goods and services, the idea of privatizing forensic services has been harshly criticized by scholars and practitioners. This paper explores some of those criticisms through the lens of economics, and arguments are offered regarding why market approaches in forensic science may be more successful than might have originally been imagined under certain conditions. On the other hand, recognition of those economic forces and reaction by forensic laboratories to address inefficiencies may provide the effective delivery of forensic services that forestalls privatization efforts.

The Balanced Scorecard: Sustainable Performance Assessment for Forensic Laboratories, *Science and Justice* Volume 52, 2012, Max Houck, Paul J. Speaker, Richard Riley, & A. Scott Fleming, pages 209-216.

Abstract: The purpose of this article is to introduce the concept of the balanced scorecard into the laboratory management environment. The balanced scorecard is a performance measurement matrix designed to capture financial and non-financial metrics that provide insight into the critical success factors for an organization, effectively aligning organization strategy to key performance objectives. The scorecard helps organizational leaders by providing balance from two perspectives. First, it ensures an appropriate mix of performance metrics from across the organization to achieve operational excellence; thereby the balanced scorecard ensures that no single or limited group of metrics dominates the assessment process, possibly leading to long-term inferior performance. Second, the balanced scorecard helps leaders offset short term performance pressures by giving recognition and weight to long-term laboratory needs that, if not properly addressed, might jeopardize future laboratory performance.

Efficiency and the Cost Effective Delivery of Forensic Science Services: In-Sourcing, Out-Sourcing, and Privatization, *Forensic Science Policy & Management: An International Journal* Volume 3, Issue 2, Chris Maguire, Max Houck, Robin Williams, & Paul J. Speaker, pages 62-69

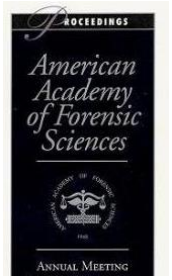
Abstract: Given the recent global recession, many national governments have been forced to implement austerity measures, and the forensic science industry has not been immune from such changes. Proposals to privatize some or all aspects of forensic science services have been bantered about for decades, but the recent economic climate has brought this idea back to the forefront of public debates. Although privatization has been shown to have many benefits in the provision of other goods and services, the idea of privatizing forensic services has been harshly criticized by scholars and practitioners. This paper explores some of those criticisms through the lens of economics, and arguments are offered regarding why market approaches in forensic science may be more successful than might have originally been imagined under certain conditions. On the other hand, recognition of those economic forces and reaction by forensic laboratories to address inefficiencies may provide the effective delivery of forensic services that forestalls privatization efforts.

Enhancing Employee Outcomes in Crime Labs: Test of a Model, *Forensic Science Policy and Management: An International Journal* Volume 3, Issue 4, 2012, David Dawley.

Abstract: This paper developed and tested a model identifying determinants of employee turnover intentions and desirable performance behaviors, including helping others and engaging in knowledge sharing. Data collected from 798 employees at ten FORESIGHT laboratories suggest that job satisfaction and embeddedness are the primary antecedents of turnover intentions and knowledge sharing, and that embeddedness is a stronger predictor variable of both outcomes. Embeddedness is driven by the employees' understanding of the lab's strategic vision. Moreover, job satisfaction and embeddedness are positively associated with helping behavior. Finally, we identified job autonomy as a primary determinant of job satisfaction. We discuss practical implications of these findings for managers.

Forensic Science Service Provider Models: Data-Driven Support for Better Delivery Options, *Australian Journal of Forensic Sciences* Volume 45, Issue 2, 2013, Paul J. Speaker.

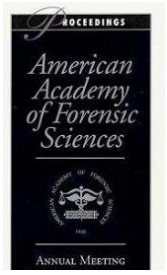
Abstract: There are a variety of models for the delivery of forensic science analysis in service to the justice system. In answer to the question as to whether there is a 'best' option for the delivery of forensic science services, New Zealand's Institute of Environmental Science and Research (ESR) has been offered as a model which demonstrates a comparative advantage over the delivery of forensic services in more traditional models. The support for that assertion rests in the ability of the ESR to react at the speed of business and avoid bureaucratic drag found too often in the public sector. This efficiency argument addresses one dimension of the search for 'best' delivery. The second dimension involves the discovery of the optimal scale of operation to take efficiency and turn it into cost effectiveness.



Improving the Effectiveness of Forensic Service: Using the Foresight Project as a Platform for Quality, *Proceedings of the American Academy of Forensic Sciences,* Volume XIX, Max M. Houck, Jay W. Henry, and Paul J. Speaker, February 2013, p.21.

Abstract: Forensic service providers are—in essence—non-profit, production-oriented organizations staffed largely by knowledge workers. Forensic scientists as knowledge workers take evidence and data and convert them into knowledge in the form of reports and testimony. They specialize in these transactions and, therefore, simplify them for the benefit of the criminal justice system; the investigators or attorneys do not need to find numerous individuals to conduct the specific examinations required for a case. As long as the costs of providing these services externally do not exceed the costs of their internal provision, for example, by a government forensic laboratory, then the organization can prosper. If the government laboratory costs are greater than the cost of finding private laboratories to provide services, then the organization may be reevaluated. Comparatively, non-profit and for-profit organizations are similar in some ways (money is an input for both) yet different (money, in the form of profits, is an output only for the private sector). Non-profits must therefore measure success in other ways, such as "low cost" or "cost effective." Forensic service providers and their parent organizations use terms such as "cost-effective" vaguely without reference to other disciplines which use these as well-defined technical terms in evaluative phrases or formulae. Despite the great concern and administrative angst over forensic service

providers' "performance" and "capacity," these metrics go undefined as industry standards.



Determinants of Turnover Intentions, Helping, and Knowledge Sharing in Crime Laboratories, *Proceedings of the American Academy of Forensic Sciences,* Volume XIX, David Dawley, February 2013, p.230.

Abstract: Forensic scientists are knowledge workers and are a laboratory's single greatest enduring expense. Therefore, it is imperative for forensic managers to find ways to retain employees, share knowledge, and create a cohesive, coherent team perspective. Based on a discussion with a group of FORESIGHT forensic laboratory directors in 2011, four major areas of research interest were identified: (1) reducing employee turnover; (2) increasing employees' helping behaviors with colleagues; (3) knowledge sharing among employees; and, (4) creating and disseminating a strategic vision to all employees.

Are Forensic Science Services Club Goods? An Analysis of the Optimal Forensic Science Service Delivery Model, *Forensic Science Policy and Management: An International Journal* Volume 3, Issue 4, 2012, William P. McAndrew, pages 151 – 158.

Abstract: Forensic science has been described as a public good by practitioners, legal professionals, and scholars, many of whom were suggesting that forensic science is simply something good for the public. It would indeed be difficult to argue otherwise. In an economic sense, the concept of a public good is defined differently from this colloquial meaning, however, leading to confusion in discussions between forensic scientists and business consultants concerning how to evaluate laboratory performance and ultimately consider strategic change from an economic or efficiency perspective. This article discusses what economists mean by a public or private good, with an application using the forensic science industry. Forensic science is likely neither a purely public or purely private good, but rather a club good that contains a degree of both the public and private. When calculated, the degree of publicness of this club good will aid in determining the appropriate institutional framework from which to provide forensic science services, as well as its optimal jurisdiction size and production level.

The Effects of Politics on Job Satisfaction in Crime Lab Employees, *Forensic Science Policy and Management: An International Journal* Volume 3, Issue 4, 2012, David Dawley & Timothy P. Munyun, pages 159 – 164.

Abstract: This study examined the effects of crime lab workers' perceptions of intra-lab politics on job satisfaction. In addition to finding that political behavior reduces employee job satisfaction, the study also identified ways in which crime lab managers can mitigate the negative effects of political behavior, increasing employee job satisfaction when political behavior is high within a given unit. Data collected from 874 employees at twelve FORESIGHT laboratories suggest that increasing crime lab worker job autonomy, job efficiency, strategic vision, and task significance are especially effective interventions that increase job satisfaction when political behavior is high. We discuss practical implications of these findings for crime lab managers. The purpose of this paper is to investigate how perceived political behavior affects the job satisfaction, or morale, of crime lab workers. The study was motivated by several interactions we had with forensic crime lab managers at the 2013 American Society of Crime Lab Directors (ASCLD) meeting. In ASCLD human resources and FORESIGHT meetings, we received consistent inquiries concerning the potential role of organizational politics as a detrimental factor on employee attitudes. These conversations highlight the unfortunate ubiquity of political behavior at work, including work in crime labs. Organizational politics often create disharmony among employees and can negatively affect employee job satisfaction and other attitudes (Breaux et al. 2009; Ferris et al. 1996). Thus, we sought to explore how political behavior affects the job satisfaction of crime lab employees, and potential managerial strategies that could be useful in mitigating for this potential negative effect.

Expanding Budgets via Strategic Use of Leasing, *Forensic Science Policy and Management: An International Journal,* Volume 3, Issue 4*, 2012,* William P. McAndrew & Paul J. Speaker, pages 169 - 179.

Abstract: An examination of the budgets of forensic laboratories reveals an unused or underused tool at the disposal of forensic laboratories. Equipment leasing offers an opportunity for a unilateral increase in the purchasing power of existing laboratory budgets and an immediate response to austerity measures. Rather than react to budget tightening with reductions in force, shared furloughs, or the forfeiture of unfilled positions, a laboratory director can forestall such measures and even see an effective increase in disposable income through a planned use of operating leases. If a public

laboratory makes an equipment purchase, the cost to the laboratory will be the full list price from the equipment supplier. However, when a private laboratory makes the same equipment purchase, it pays the supplier the full list price, but is able to deduct the expense from its income when it calculates its corporate income tax and ends up with a final expense, net of taxes, that is considerably less than the cost to the public laboratory. Leasing offers the opportunity for a private entity to purchase equipment and pass on some of the tax savings to the public laboratory through an operating lease. In this manuscript the leasing gains are explained and accompanied by a detailed example to illustrate the potential magnitudes of the gains. In this example, a representative laboratory is shown to experience nearly a twenty-five percent gain from the lease compared to the expense of a direct purchase

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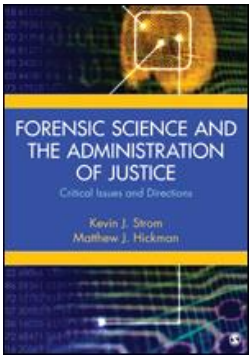

Developing New Business Models for Forensic Laboratories, Chapter 13 in *Forensic Science and the Administration of Justice*, Kevin J. Strom & Matthew J. Hickman editors, Max M. Houck & Paul J. Speaker, April 2014.

Abstract: Forensic service providers inhabit a unique, central place in the criminal justice system. Stakeholders in the forensic enterprise abound, from law enforcement to attorneys to the courts and even the public they all serve. The public orientation of these services and stakeholders necessitates forensic managers rely on providing sound performance at a reasonable cost. Certainly, the laboratory's jurisdiction will judge them on criteria such as accuracy, timeliness, and cost. Too much emphasis on quantitative outcomes, however, can create an imbalance that ignores longer-term issues, such as quality and value. Thus, efficiency, the extent to which time and effort are used to produce the desired outcome, can be mistaken for effectiveness, the attainment of that desired outcome, but they are intimately connected.

A Novel Approach to Forensic Molecular Biology Education and Training: It's Impact on the Criminal Justice System, *Australian Journal of Forensic Sciences* DOI:10.1080/00450618.2014.925974, 2014, Khalid M. Lodhi, Robert L. Grier, and Paul J. Speaker

Abstract: The managers of crime laboratories face significant hurdles when preparing new hires to become productive members of the laboratory. New hires require six months of training/experience in the crime laboratory before becoming a productive member of the Biology (DNA) section. To address this deficiency in forensic DNA education, a novel forensic education curriculum was developed and tested for three consecutive years in the forensic science program at Fayetteville State University, Fayetteville, NC. The curriculum used a CTS proficiency kit which is the same kit used to validate the proficiency of forensic scientists in crime laboratories in the US. A cost benefit analysis suggests that training students in a classroom instead of in a crime laboratory provides both direct savings to the laboratory and significant societal savings as more DNA profiles are entered into the database. The societal benefit from the combined reduction in the amount of training in a crime laboratory and increasing the number of DNA database profiles entered into a database suggests a societal saving of $8.28 million for each of these months of reduced training.

鑑識科學綜論
FORENSIC SCIENCE REVIEW

A Review of Forensic Science Management Literature, *Forensic Science Review 27*, Max M. Houck, William P McAndrew & B. Daview, 2015, 53-68.

Abstract: The science in forensic science has received increased scrutiny in recent years, but interest in how forensic science is managed is a relatively new line of research. This paper summarizes the literature in forensic science management generally from 2009 to 2013, with some recent additions, to provide an overview of the growth of topics, results, and improvements in the management of forensic services in the public and private sectors. This review covers only the last three years or so and a version of this paper was originally produced for the 2013 Interpol Forensic Science Managers Symposium and is available at *interpol.int*.

Financial Management of Forensic Science Laboratories: Lessons from Project FORESIGHT 2011-2012, *Forensic Science Policy and Management: An International Journal 6(1-2),* Paul J Speaker, 2015.

Abstract: Critical to the decision-making within an individual forensic science laboratory is an understanding of their efficiency and effectiveness. The NIJ-funded project, FORESIGHT, applies financial management techniques to avowed public sector goals and offers a common starting point for the comparison of individual forensic laboratories to the established standards in the industry through a review of financial ratios. Such ratios adjust for size differences and allow insight into several aspects of the operation including evaluation of efficiency, quality, risk, market nuances, and return on investment. This study offers insight into the financial performance, productivity, efficiency, and effectiveness of forensic science laboratories. Using data from the National Institute of Justice's Project FORESIGHT for 2011-2012, a variety of benchmark performance data is presented with analytical insight into the nature of that performance. The tabular and graphic presentations offer some insight into the current status of the forensic science industry in general and provide a basis by which individual laboratories may begin to assess their own performance with respect to both analytical efficiency and cost effectiveness.