Busyness Analysis

September 3, 2021

1 Key Takeaways

- **Baseline Service Rate Estimates:** I used a simple linear regression model to estimate μ_p and μ_t. The model seems to fit the data well (R^2=0.97) and yields estimates of 4.88 days per trial, and 6.25 pleas per day.
- **County-level Analysis:** I created a simple measure of a county's business that incorporates the number of pleas, trials, and assigned GS days. I ranked the counties according to this measure, and it appears that roughly 90% of the action (pleas, trials, GS days) happens in the top 28 (out of 46) counties. I also find that above median busy counties have 6.4 average pleas per day, while below median busy counties have less than 3 average pleas per day.
- **Clean Day Analysis:** I studied what was driving the difference in average number of pleas between GS days and clean days. It seems to be entirely driven by our restriction that Judges hear more than 10 pleas on clean days. The other restrictions don't seem to affect the average number of pleas processed per day very much, which I think could support an argument for dropping the restrictions. I also looked at the distribution of clean days across judges and counties, and the clean days seem to be more equally distributed amongst judges than amongst counties.

2 Baseline Service Rate Estimates

I thought it might be useful to establish some very simple baseline estimates for μ_t and μ_p. These could help us when we are trying to ballpark different quantities. For each county, I counted the total number of GS days that judges were assigned to that county. I also counted the number of pleas and trials that were sentenced in that county on GS days. Having constructed this dataset, I then regressed the number of assigned days on the number of pleas and trials. The model specification is: $\text{Days}_c = \beta_1 \text{Pleas}_c + \beta_2 \text{Trials}_c + \epsilon_c$. I also estimated a similar model, but where the unit of observation is the judge. The model specification is: $\text{Days}_j = \beta_1 \text{Pleas}_j + \beta_2 \text{Trials}_j + \epsilon_j$. Note that given an estimate of the trial service, we can calculate a group's λ, that is the group's plea demand per day. To do this, we calculate the expected number of trial days by multiplying the number of trials by the trial service rate, and subtracting this quantity from the total number of days to get the expected number of plea days. We can then divide the number of pleas by the expected number of plea days for each group. This is the Lambda that appears in the tables. I estimated the models using two samples. The first one included all judges/counties. The second sample excluded judges/counties with no trials. The second one seems to fit the data slightly better, so it is what I use in the rest of the analysis. However, present the results from both for completeness.

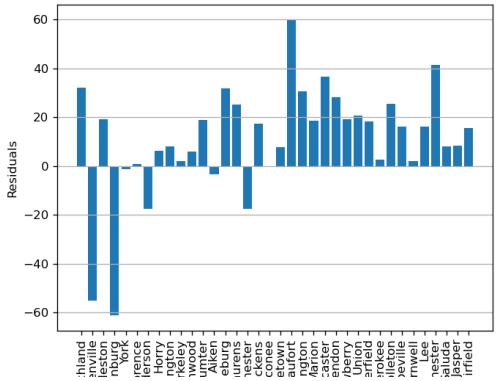
Table 1: Regression results, using all judges/counties

Model	β_1	β_2	R^2	R^2 Adj
JudgeID	6.48	0.15	0.91	0.90
County	4.23	0.17	0.96	0.96

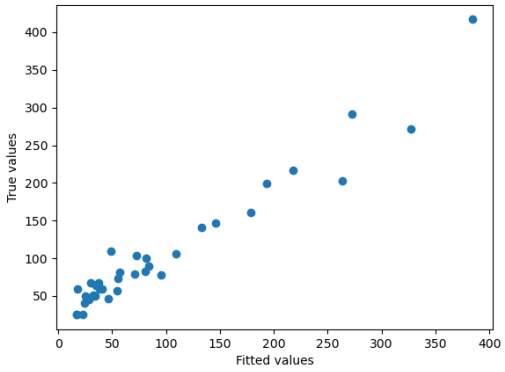
Table 2: Regression results, excluding judges/counties with no trials.

Model	β_1	β_2	R^2	R^2 Adj
JudgeID	0.15	6.51	0.91	0.91
County	0.16	4.88	0.97	0.96

2.1 County Model



(a) Plot of the residuals for each county, here, the counties are ordered by the number of pleas processed, with the county with the most pleas being first.

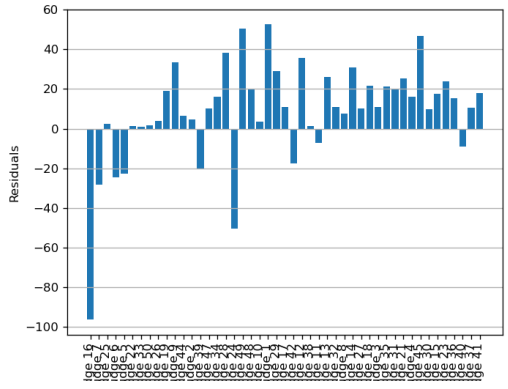


(b) True vs Fitted values for the county model

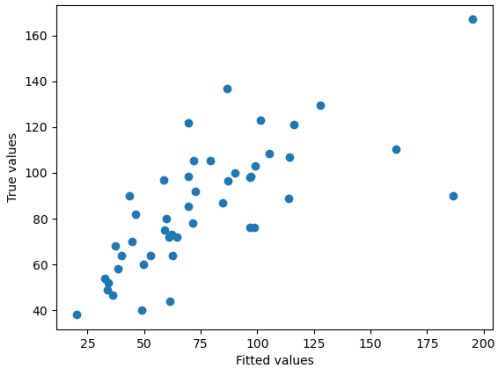
Table 3: Lambda Estimates, County Model

County	Plea	Trial	Days	TrialDays	PleaDays	Lambda
Richland	1633	25	417.00	122.07	294.93	5.54
Greenville	1608	14	272.00	68.36	203.64	7.90
Charleston	1329	12	291.50	58.59	232.91	5.71
Spartanburg	1063	19	202.50	92.77	109.73	9.69
York	777	19	216.50	92.77	123.73	6.28
Florence	754	5	146.50	24.41	122.09	6.18
Anderson	655	15	161.00	73.24	87.76	7.46
Horry	655	18	199.50	87.89	111.61	5.87
Lexington	644	6	141.00	29.30	111.70	5.77
Berkeley	382	4	83.00	19.53	63.47	6.02
Greenwood	370	5	90.00	24.41	65.59	5.64
Sumter	353	5	100.00	24.41	75.59	4.67
Aiken	343	11	105.50	53.71	51.79	6.62
Orangeburg	327	4	104.00	19.53	84.47	3.87
Laurens	293	2	82.00	9.77	72.23	4.06
Dorchester	291	10	78.00	48.83	29.17	9.97
Pickens	254	3	73.00	14.65	58.35	4.35
Oconee	230	2	46.50	9.77	36.73	6.26
Georgetown	230	7	79.00	34.18	44.82	5.13
Beaufort	183	4	109.00	19.53	89.47	2.05
Darlington	172	2	68.00	9.77	58.23	2.95
Marion	171	1	51.00	4.88	46.12	3.71
Lancaster	158	1	67.00	4.88	62.12	2.54
Clarendon	158	2	63.50	9.77	53.73	2.94
Newberry	149	1	48.00	4.88	43.12	3.46
Union	147	3	59.00	14.65	44.35	3.31
Chesterfield	131	4	59.00	19.53	39.47	3.32
Cherokee	128	7	57.50	34.18	23.32	5.49
Colleton	124	1	50.50	4.88	45.62	2.72
Abbeville	118	2	45.00	9.77	35.23	3.35
Barnwell	113	1	25.00	4.88	20.12	5.62
Lee	91	2	40.50	9.77	30.73	2.96
Chester	79	1	59.00	4.88	54.12	1.46
Saluda	74	1	25.00	4.88	20.12	3.68
Jasper	73	1	25.00	4.88	20.12	3.63
Fairfield	62	5	50.00	24.41	25.59	2.42

2.2 Judge Model



(a) Plot of the residuals for each Judge, here, the judges are ordered by the number of pleas processed, with the judge with the most pleas being first.



(b) True vs Fitted values for the Judge model

Table 4: Lambda Estimates, Judge Model

JudgeID	Plea	Trial	Days	TrialDays	PleaDays	Lambda
Judge 16	1041	5	90.00	32.53	57.47	18.11
Judge 7	572	17	167.00	110.59	56.41	10.14
Judge 25	527	1	87.00	6.51	80.49	6.55
Judge 6	505	6	89.00	39.03	49.97	10.11
Judge 5	492	4	76.00	26.02	49.98	9.84
Judge 22	480	4	98.50	26.02	72.48	6.62
Judge 33	479	4	98.00	26.02	71.98	6.65
Judge 50	469	9	129.50	58.55	70.95	6.61
Judge 26	450	5	103.00	32.53	70.47	6.39
Judge 19	404	2	92.00	13.01	78.99	5.11
Judge 9	398	2	105.50	13.01	92.49	4.30
Judge 44	395	2	78.00	13.01	64.99	6.08
Judge 2	390	9	121.00	58.55	62.45	6.24
Judge 39	389	6	76.00	39.03	36.97	10.52
Judge 47	388	5	100.00	32.53	67.47	5.75
Judge 34	355	1	75.00	6.51	68.49	5.18
Judge 28	353	1	97.00	6.51	90.49	3.90
Judge 24	341	17	110.50	110.59	-0.09	-3666.06
Judge 49	321	6	137.00	39.03	97.97	3.28
Judge 48	317	2	80.00	13.01	66.99	4.73
Judge 10	315	9	108.50	58.55	49.95	6.31
Judge 1	293	4	122.00	26.02	95.98	3.05
Judge 29	293	4	98.50	26.02	72.48	4.04
Judge 17	288	3	73.00	19.52	53.48	5.38
Judge 42	283	3	44.00	19.52	24.48	11.56
Judge 12	268	1	82.00	6.51	75.49	3.55
Judge 38	247	4	64.00	26.02	37.98	6.50
Judge 11	244	12	107.00	78.07	28.93	8.43
Judge 13	228	7	105.50	45.54	59.96	3.80
Judge 32	226	3	64.00	19.52	44.48	5.08
Judge 8	215	5	72.00	32.53	39.47	5.45
Judge 14	208	1	68.00	6.51	61.49	3.38
Judge 27	204	3	60.00	19.52	40.48	5.04
Judge 18	202	11	123.00	71.56	51.44	3.93
Judge 3	193	5	72.00	32.53	39.47	4.89
Judge 35	176	1	54.00	6.51	47.49	3.71
Judge 31	171	2	58.00	13.01	44.99	3.80
Judge 21	170	3	70.00	19.52	50.48	3.37
Judge 4	162	7	85.50	45.54	39.96	4.05
Judge 45	161	3	90.00	19.52	70.48	2.28
Judge 30	147	10	96.50	65.05	31.45	4.67
Judge 15	144	2	52.00	13.01	38.99	3.69
Judge 23	139	3	64.00	19.52	44.48	3.12
Judge 36	139	2	49.00	13.01	35.99	3.86
Judge 40	112	5	40.00	32.53	7.47	14.99
Judge 37	112	3	46.50	19.52	26.98	4.15
Judge 41	91	1	38.00	6.51	31.49	2.89

3 County-level Analysis

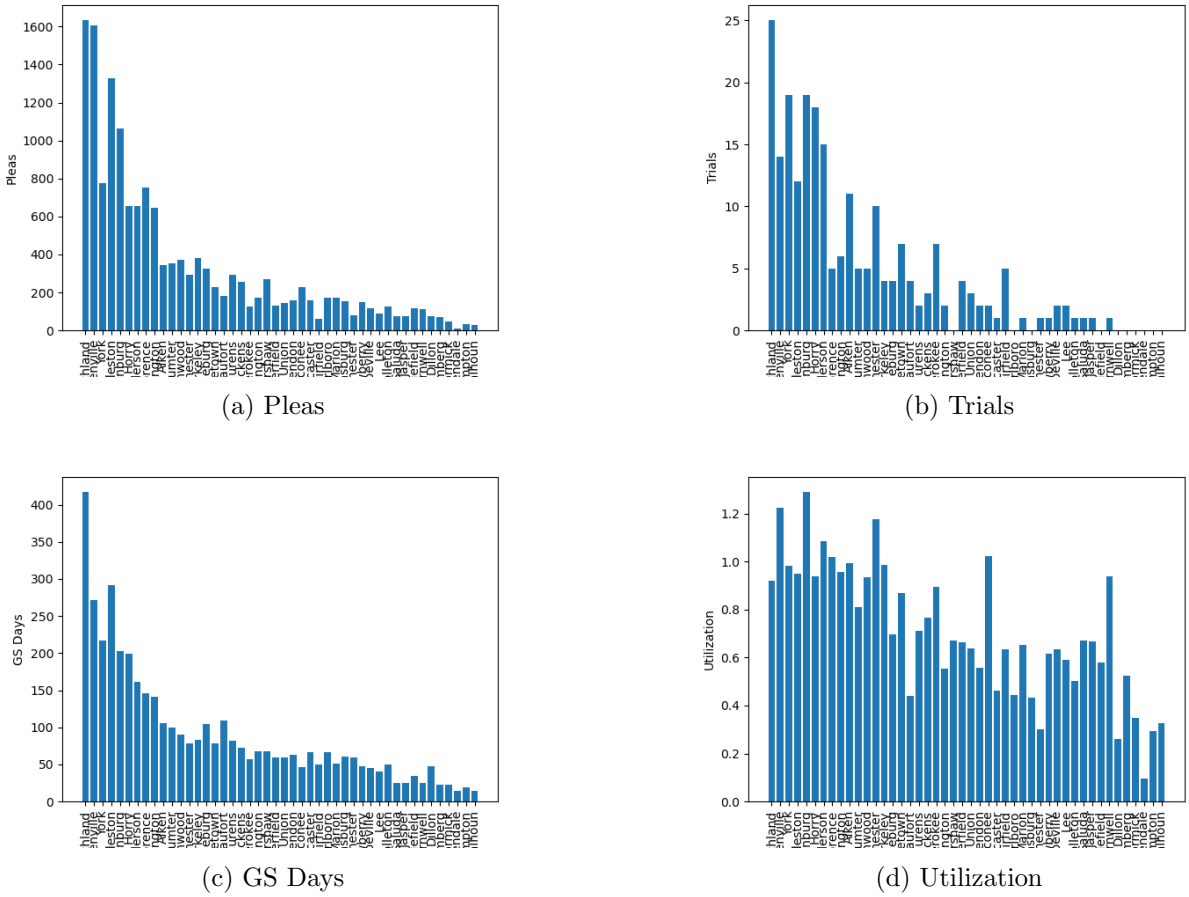
The goal of this exercise was to get a better idea of which are the busiest counties. I focused only on GS days. So when I say the number of pleas and number of trials, I mean those that happened on GS days. We have at least three measures of business: the number of pleas, the number of trials, and the number of GS days assigned to a county. I ranked the counties according to a measure that combined the three measures. To create this measure, I ranked all of the counties according to each measure. I then multiplied each county's score in each measure to create an overall measure. So, for example, if Richland had the most pleas, then its ranking according to pleas would be 1. If Richland had the second most trials, then its ranking according to trials would be 2. If it had the sixth most GS days, then its ranking according to GS days would be 6. Richland's overall measure would be $1 \cdot 2 \cdot 6 = 12$. This ranking can be seen in table 5. I also created bar charts of the number of pleas, trials, GS days, and the utilization for each county. I calculate the utilization by using the service rate estimates from the county model to calculate the expected number of days it took to process each county's pleas and trials. I then divide the expected number of days by the actual number of assigned days to get the utilization.

Table 5: Ranking of Counties by Busyness

	County	Plea	Trial	Days	OverallScore
1	Richland	1633	25	417.00	1
2	Greenville	1608	14	272.00	36
3	York	777	19	216.50	40
4	Charleston	1329	12	291.50	42
5	Spartanburg	1063	19	202.50	60
6	Horry	655	18	199.50	192
7	Anderson	655	15	161.00	245
8	Florence	754	5	146.50	672
9	Lexington	644	6	141.00	972
10	Aiken	343	11	105.50	1144
11	Sumter	353	5	100.00	2028
12	Greenwood	370	5	90.00	2464
13	Dorchester	291	10	78.00	2592
14	Berkeley	382	4	83.00	3000
15	Orangeburg	327	4	104.00	3024
16	Georgetown	230	7	79.00	3553
17	Beaufort	183	4	109.00	3570
18	Laurens	293	2	82.00	5520
19	Pickens	254	3	73.00	7524
20	Cherokee	128	7	57.50	8990
21	Darlington	172	2	68.00	11500
22	Kershaw	268	0	68.00	14637
23	Chesterfield	131	4	59.00	15390
24	Union	147	3	59.00	15834
25	Clarendon	158	2	63.50	16800
26	Oconee	230	2	46.50	16800
27	Lancaster	158	1	67.00	19448
28	Fairfield	62	5	50.00	20160
29	Marlboro	174	0	66.50	21758
30	Marion	171	1	51.00	23040
31	Williamsburg	156	0	61.00	24975
32	Chester	79	1	59.00	30044
33	Newberry	149	1	48.00	30492
34	Abbeville	118	2	45.00	32076
35	Lee	91	2	40.50	34632
36	Colleton	124	1	50.50	34720
37	Saluda	74	1	25.00	46740
38	Jasper	73	1	25.00	48360
39	Edgefield	116	0	34.00	49096
40	Barnwell	113	1	25.00	50400
41	Dillon	74	0	48.00	60996
42	Bamberg	70	0	22.67	70520
43	McCormick	47	0	23.00	75852
44	Allendale	8	0	14.00	82524
45	Hampton	33	0	19.00	87120
46	Calhoun	27	0	14.00	89100

3.1 Overall Figures

In figure 3, the counties are ordered according to the overall ranking described in the previous section.



(a) Pleas

(b) Trials

(c) GS Days

(d) Utilization

Figure 3: Number of Pleas, Trials, GS days, and utilization for each county.

3.2 CDF table

The purpose of this section is to get a better sense of what share of the overall action happens in the 'busy' counties. In table 6, the columns PleaShare, TrialShare, and GSShare contain the cumulative share of all pleas, trials, and GS days accounted for by the counties up to that row. So, for example, in the 10th row, if the value of PleaShare is 0.5, that means that the top 10 counties account for 50% of all pleas. Similarly, if in the 15th row the value of Trial share is 0.9, that means that the top 15 counties account for 90% of all trials. GS share refers to the share of all GS days assigned. The counties in table 6 are ranked using the measure described in the beginning of the section.

Table 6: CDF table

	County	Plea	Trial	Days	OverallScore	PleaShare	TrialShare	GSDayShare
1	Richland	1633	25	417.00	1	0.11	0.11	0.10
2	Greenville	1608	14	272.00	36	0.21	0.17	0.17
3	York	777	19	216.50	40	0.26	0.26	0.22
4	Charleston	1329	12	291.50	42	0.35	0.31	0.29
5	Spartanburg	1063	19	202.50	60	0.42	0.40	0.34
6	Horry	655	18	199.50	192	0.46	0.48	0.38
7	Anderson	655	15	161.00	245	0.50	0.54	0.42
8	Florence	754	5	146.50	672	0.55	0.56	0.46
9	Lexington	644	6	141.00	972	0.60	0.59	0.49
10	Aiken	343	11	105.50	1144	0.62	0.64	0.52
11	Sumter	353	5	100.00	2028	0.64	0.66	0.54
12	Greenwood	370	5	90.00	2464	0.67	0.68	0.56
13	Dorchester	291	10	78.00	2592	0.68	0.73	0.58
14	Berkeley	382	4	83.00	3000	0.71	0.75	0.60
15	Orangeburg	327	4	104.00	3024	0.73	0.76	0.63
16	Georgetown	230	7	79.00	3553	0.75	0.80	0.65
17	Beaufort	183	4	109.00	3570	0.76	0.81	0.67
18	Laurens	293	2	82.00	5520	0.78	0.82	0.69
19	Pickens	254	3	73.00	7524	0.79	0.84	0.71
20	Cherokee	128	7	57.50	8990	0.80	0.87	0.72
21	Darlington	172	2	68.00	11500	0.81	0.88	0.74
22	Kershaw	268	0	68.00	14637	0.83	0.88	0.76
23	Chesterfield	131	4	59.00	15390	0.84	0.89	0.77
24	Union	147	3	59.00	15834	0.85	0.91	0.78
25	Clarendon	158	2	63.50	16800	0.86	0.92	0.80
26	Oconee	230	2	46.50	16800	0.87	0.92	0.81
27	Lancaster	158	1	67.00	19448	0.88	0.93	0.83
28	Fairfield	62	5	50.00	20160	0.89	0.95	0.84
29	Marlboro	174	0	66.50	21758	0.90	0.95	0.85
30	Marion	171	1	51.00	23040	0.91	0.96	0.87
31	Williamsburg	156	0	61.00	24975	0.92	0.96	0.88
32	Chester	79	1	59.00	30044	0.93	0.96	0.90
33	Newberry	149	1	48.00	30492	0.94	0.96	0.91
34	Abbeville	118	2	45.00	32076	0.94	0.97	0.92
35	Lee	91	2	40.50	34632	0.95	0.98	0.93
36	Colleton	124	1	50.50	34720	0.96	0.99	0.94
37	Saluda	74	1	25.00	46740	0.96	0.99	0.95
38	Jasper	73	1	25.00	48360	0.97	1.00	0.95
39	Edgefield	116	0	34.00	49096	0.98	1.00	0.96
40	Barnwell	113	1	25.00	50400	0.98	1.00	0.97
41	Dillon	74	0	48.00	60996	0.99	1.00	0.98
42	Bamberg	70	0	22.67	70520	0.99	1.00	0.98
43	McCormick	47	0	23.00	75852	1.00	1.00	0.99
44	Allendale	8	0	14.00	82524	1.00	1.00	0.99
45	Hampton	33	0	19.00	87120	1.00	1.00	1.00
46	Calhoun	27	0	14.00	89100	1.00	1.00	1.00

3.3 Comparing Busy and Idle Counties

The purpose of this section is to further investigate how 'busy' counties are different from 'idle' counties. To do this, I split the counties into above median and below median in terms of business. Here, business is measured according to the measure described in the beginning of the section.

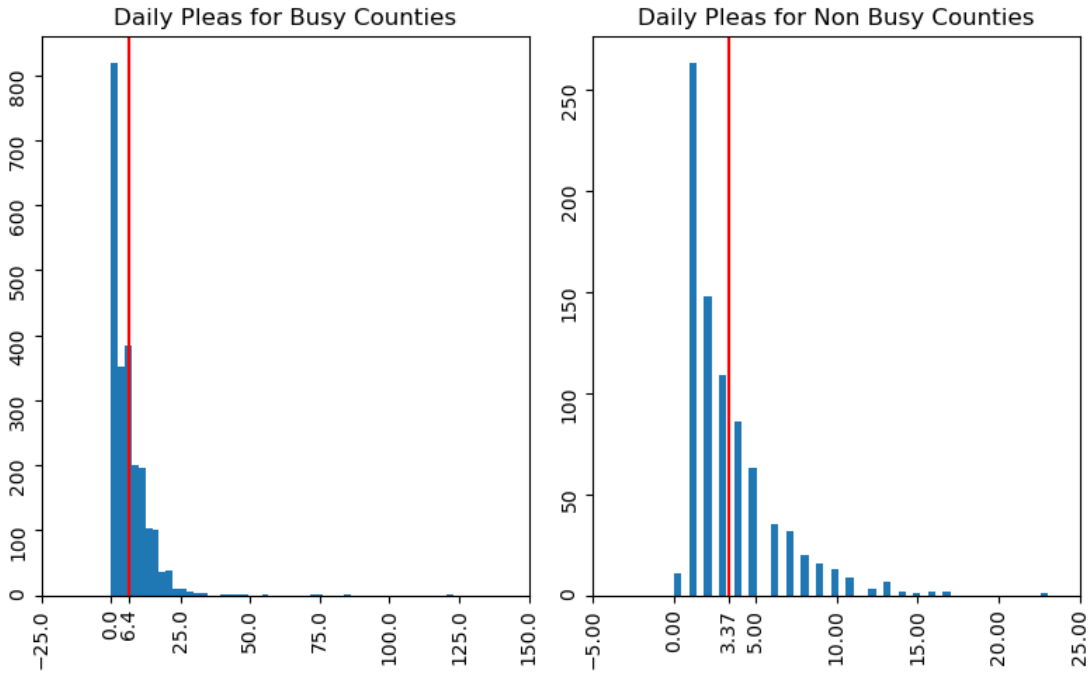


Figure 4: Histogram of pleas processed per day

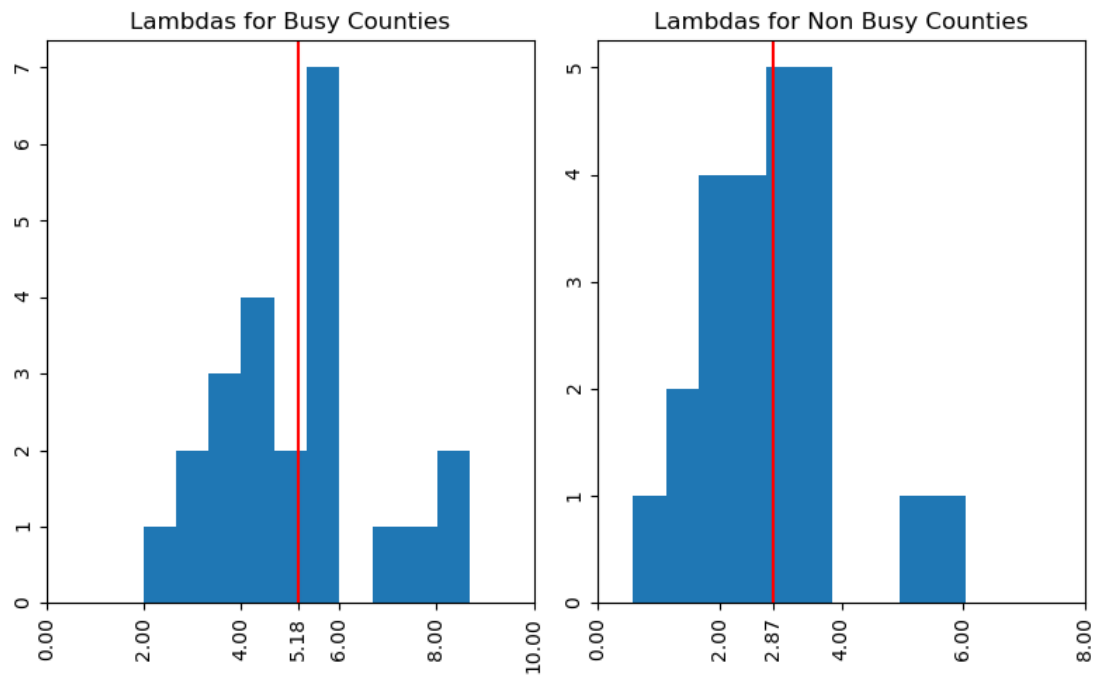


Figure 5: Histogram of estimated lambda

4 Clean Day Analysis

The purpose of this section is to better understand clean days. In our previous meeting, we wanted to know what exactly was driving the large difference in average number of pleas between clean days and GS days. As a reminder, the average number of pleas for GS days was around 5, and the average number of pleas for clean days was 14. It turns out that this was driven by our restriction that clean days have more than 10 pleas.

To better understand clean days, we first list our clean day restrictions and study how each of them affects the average number of pleas processed per day. Then, we examine how the clean days are distributed across judges and counties.

4.1 Clean Day Restrictions

- Exclude all days in which there is a conflict between the sentencing data and the calendar data.
- Exclude all non-GS days.
- Exclude all days in which a judge sentenced in more than one county.
- Exclude all days in which a judge was assigned to more than one county.
- Exclude all days in which a judge sentenced fewer than 10 events.

Table 7: Clean Day Restrictions. This table describes how the average number of pleas processed per day evolves as restrictions are added.

Restriction	Average Pleas Per Day
None	5.04
No conflicting days	4.89
Only GS days	4.86
No mutli-county days	4.86
No mutli-assignment days	4.87
No days with less than 10 events	14.57

4.2 Distribution of Clean Days Across Counties

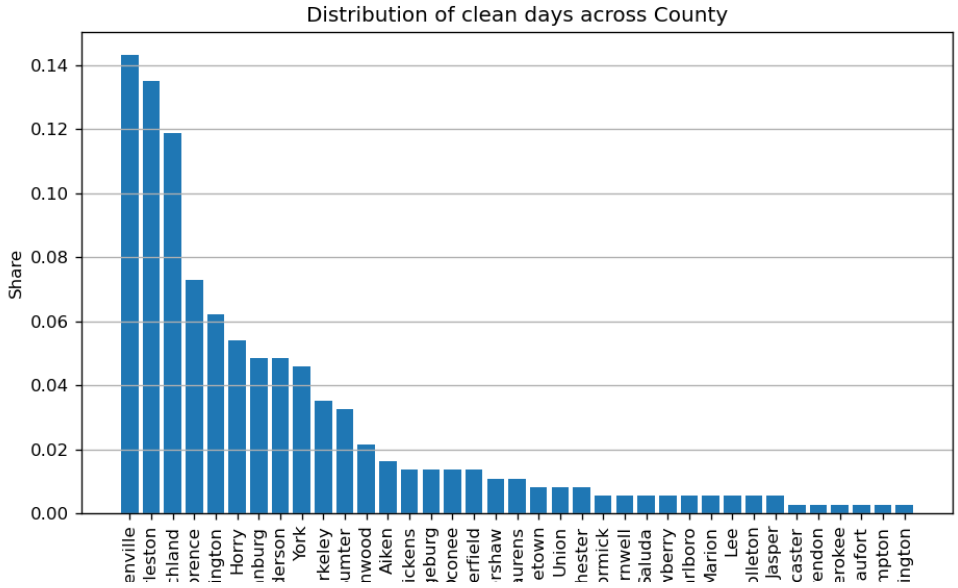


Figure 6: Distribution of clean days across counties

4.3 Distribution of Clean Days Across Judges

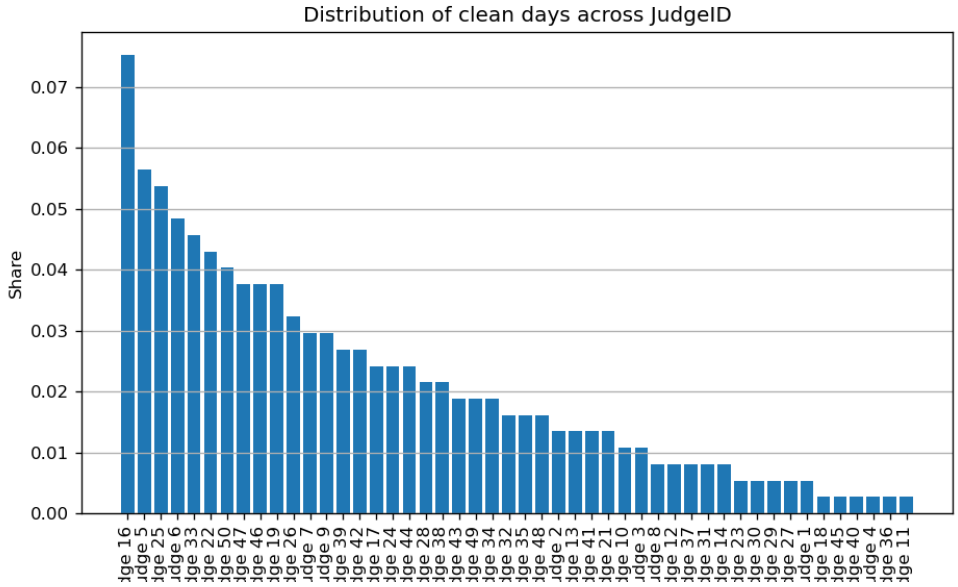


Figure 7: Distribution of clean days across counties