Effectiveness of Different Policies Aimed to Reduce Traffic Deaths

Data Exploration:

First, we organized and tried to comprehend the data which is based on 336 observations (N) from 48 States (Entities) through 7 time periods of years 1982-1988 (T).

We wanted to study what policies effectively reduce mraidall (alcohol-involved VFR), which is referenced as Vehicle Fatality Rate X 10,000 (**VFR**) from this point on. The policies we focused on while studying this data were: beertax (tax on case of beer in dollars), jaild (mandatory jail sentence), comserd (mandatory community service) and mlda (minimum legal drinking age).

Table 1.1 shows variables that we initially thought could be significant in our model with some transformed into logarithmic form for better readability and interpretation.

We began with the following control variables:

- State unemployment rate (%): unrate
- Log per capita personal income ($): lnperinc
- GSP rate of change: gspch
- % of drivers aged 15-24: yngdrv
- % residing in dry counties: dry
- Log Population: lnpop
- Log ave. mile per driver: lnvmiles
- Log population of 15-17 year olds: lnpop1517
- Log population of 18-20 year olds: lnpop1820
- Log population of 21-24 year olds: lnpop2124
- Per capita pure alcohol consumption (annual, gallons): spircons
- % Southern Baptist: sobapt
- % Mormon: mormon

Image 1.1 shows evidence that our panel data is balanced.

Table 1.2 displays the summary for all the variables mentioned above and we found that the mean VFR is **0.6593** and mean beertax was $**0.5132** per case of beer. On average, ~**28%** of the of the 48 continuous states had mandatory jail sentences and ~**18.5%** of the states had mandatory community service.

Next, we used graphical representations to interpret the policies and some relevant variables for insight on the data.

Graph 1.1 displays the mean mraidall (VFR) with respect to each state. The states with noticeable changes included *Mississippi, Montana, New Hampshire, Texas, Wyoming,* and *South Carolina*. The VFR in Mississippi experienced a sharp decline in the first 2 years followed by a sharp increase before it catches a constant rate. Montana had a bumpy decreasing trend as well as New Hampshire and Wyoming. Texas had a smooth decreasing trend from 1982 to 1988. South Carolina though had an increasing trend for four years before decreasing in the end.

Graphs 1.2- 1.5 imply that during the period where unemployment rate decreased, the VFR also decreased. When the logarithmic values of personal income increased, the VFR decreased. We expected that with the increase on beer tax, VFR would go down; however, this was not the case. VFR decreased even when beer tax decreased, suggesting that beer tax is not an effective policy.

Graphs 1.6 – 1.7 imply that mandatory jail sentences and mandatory community service helped reduce the VFR. However, when VFR peaks in 1986, so did mandatory jail time and community service, which implicates that these two variables may not be the most effective policies.

Graph 1.8-1.10 shows that if the beer tax is above the mean, then VFR was higher on average and had a fluctuating trend. If the beer tax is below the mean, then VFR was lower overall. If the minimum legal drinking age is 18, VFR had an upward trend over the years. At 19, VFR decreased before spiking up in 1987. For age 20, VFR decreased before bouncing up in 1984 and then increasing sharply in 1986 onwards. For age 21, it was an overall decrease throughout the years with a more stable pattern compared to the others.

Regression Analysis:

We ran a **pooled OLS model** with Cluster Robust standard errors that included all variables we thought would affect our dependent variable VFR. According to the results, we found that none of the variables were significant at the 5% level except lnperinc, spircons and mormon.

According to pooled model when other factors are kept constant, if per capita personal income increases by 1%, we expect VFR to decrease by approximately 0.00844 and a 1-gallon annual increase in the per capita consumption of pure alcohol is expected to increase the VFR by 0.062. A 1% increase in Mormon population is expected to decrease the VFR by 0.005.

This model though is not applicable to our data since there is an endogeneity problem.

We used the **fixed effects model** to control for unobserved heterogeneity with the same variables from the pooled model. The following are findings from the results compared to the pooled OLS:

- Magnitude for beertax has increased but is still insignificant even at the 10% significance level.
- Magnitude for jaild increased by more than twice its value from the pooled model. The coefficient for comserd increased by almost five times. These variables have now become statistically significant at the 5% level.
- If all factors are kept constant, a mandatory jail sentence is expected to increase VFR by 0.213 compared to if there was no jail time and mandatory community service is expected to decrease VFR by 0.2 compared to if there was no mandatory community service.
- Minimum legal drinking age is still insignificant.
- Spircons is even more significant, with its coefficient increasing by ~4 times. A 1-gallon annual increase in the per capita consumption of pure alcohol is expected to increase the VFR by 0.264.
- The magnitude for unrate is almost the same; however, it is now significant at the 10% level.
- lnperinc now has decreased by almost half and is not statistically significant anymore.
- The rest of the variables remain insignificant.

Next, we did an **entity and time fixed effects model** since omitted variables like the development and presence of safer cars might vary over time but not across economic entities. The results showed that jaild, spircons and comserd are significant at the 5% level but the rest are not. Even though beertax and mlda are not significant, we kept them in the model since they are the policies we are monitoring.

States with mandatory jail sentences are expected to have a higher VFR by 0.233 compared to states without and states with mandatory community service are expected to have a 0.22 lower VFR compared to those without, given all other variables are constant. A 1-gallon annual increase in the per capita consumption of pure alcohol is expected to increase the VFR by 0.311.

Then, we tested the significance of our time effects to see if they are jointly statistically significant. According to the test, we have a p-value of 0.0021 signifying that at least one year influences the model, so we continued to use the time variables.

We regressed a time fixed effect models without these insignificant variables: gspch, dry, pop, and vmiles **(restricted model 1)**. We saw that jaild, comserd, unrate and spircons are statistically significant. A mandatory jail sentence is expected to increase VFR by 0.24 more than if there was no jail time and mandatory community service is expected to decrease VFR by 0.21 more than if there was no mandatory community service, given all other variables are constant. A 1-gallon annual increase in the per capita consumption of pure alcohol is expected to increase the VFR by 0.299 and a 1% increase in unemployment rate is expected to decrease VFR by 0.03.

The coefficients for the different population ages and yngdrv are only insignificant at the 10% level so they were removed from the model and we proceeded with our new time fixed effect model **(restricted model 2).**

In this model, we have variables beertax, jaild, comserd, mlda, unrate and spircons. At the 5% level, jaild, comserd, spircons and unrate are still significant but beertax and mlda are not. The coefficients for this model have not changed much from restricted model 1. The time variables also show that each year compared to 1982 had a reduction in VFR that was statistically significant at the 5% level except 1986 at the 10% level.

Moving forward, we took restricted model 2 variables from a time fixed effects and fitted them into a random effects model to see which one is better for our data and which variables explain our dependent variable well.

In our **random effects model**, we finally saw beertax become significant but only at the 10% level. Jaild is significant at the 5% level but comserd and unrate are only significant at the 10% level while mlda is still insignificant.

Mandatory jail sentence is expected to increase VFR by 0.205 and mandatory community service is expected to decrease VFR by 0.15, given all other variables are constant. Under the same conditions, a 1% increase in unemployment rate is expected to decrease VFR by 0.0256.

In the last part of our regression analysis, we performed a **Hausman Test** to determine which model to choose – fixed (entity and time) or random – with the following explanatory variables: beertax, jaild, comserd, mlda, unrate, spircons and time variables. We rejected the null hypothesis that there is no endogeneity and selected the entity time fixed effects model.

Summary and Conclusion:

After analyzing the models taken to observe how different factors and policies affected the alcohol-involved vehicle fatality rate, we concluded that the entity time fixed effects model was the most suitable approach **(restricted model 2).** This model controls for omitted variable bias and observed/unobserved heterogeneity, and is not randomly sampled data; therefore, the estimators will be unbiased and consistent.

The controlling variables that significantly impacted the VFR were per capita pure alcohol consumption and the unemployment rate. As alcohol consumption in a state increased annually by 1-gallon, the VFR increased by 0.264. A 1% increase in the unemployment rate resulted in a 0.032 decrease in VFR. While these factors are not policies, they can influence how states make policies to reduce alcohol-involved VFR.

All time indicator variables were significant at the 5% level except 1986 which was still significant at the 10% level. We saw that the VFR decreased each year when compared to 1982.

The beertax and minimum legal drinking age policies did not show to have a significant impact on the alcohol-involved VFR on this data. The policies that did significantly impact the alcohol-involved VFR were mandatory jail sentence and mandatory community service. States with a jail sentence had higher VFR on average than states without by 0.236; therefore, implementing a mandatory jail sentence is not an effective policy to reduce the alcohol-induced VFR. Having a mandatory community service though reduced the VFR by 0.195, so more states should consider implementing this policy.

Appendix

Table 1.1

Display **of organized data set**

	state	year	VFR	beertax	jaild	comserd	mlda	unrate	lnperinc	gspch	yngdrv	dry	lnpop	lnpop1517	lnpop1820	lnpop2124	lnvmiles
1	AL	1982	.78498	1.539379	0	0	19	14.4	9.263327	-.0221248	.211572	25.0063	15.1872	12.25009	12.30842	12.57764	8.886532
2	AL	1983	.86322	1.788991	0	0	19	13.7	9.281059	.0465583	.210768	22.9942	15.19176	12.21602	12.2974	12.57764	8.966528
3	AL	1984	.76428	1.714286	0	0	19	11.1	9.315492	.0627978	.211484	24.0426	15.19905	12.19096	12.28638	12.57072	9.019542
4	AL	1985	.6882401	1.652542	0	0	19.67	8.9	9.335442	.02749	.21114	23.6339	15.20704	12.18075	12.27536	12.55673	9.074167
5	AL	1986	.89066	1.609907	0	0	21	9.8	9.364049	.0321429	.2134	23.4647	15.21423	12.22587	12.26434	12.47991	9.099728
6	AL	1987	.90233	1.56	0	0	21	7.8	9.387984	.0489764	.215527	23.7924	15.22234	12.23076	12.25008	12.46458	9.123289
7	AL	1988	.72726	1.501444	0	0	21	7.2	9.422918	.0353918	.218328	23.7924	15.22698	12.21106	12.17045	12.47991	9.177231
8	AZ	1982	.59948	.2147971	1	1	19	9.9	9.418092	-.0431819	.209012	0	14.87918	11.85651	11.96004	12.29225	8.82617
9	AZ	1983	.66137	.206422	1	1	19	9.1	9.44887	.0762055	.203855	0	14.90643	11.84223	11.96732	12.29683	8.792929
10	AZ	1984	.69128	.2967033	1	1	19	5	9.492954	.106214	.209127	0	14.93784	11.83501	11.9746	12.30138	8.81135
11	AZ	1985	.70858	.3813559	1	1	21	6.5	9.527098	.0781956	.188428	0	14.97459	11.8494	11.98188	12.30138	8.820443
12	AZ	1986	.74055	.371517	1	1	21	6.9	9.55445	.0677125	.171539	0	15.00305	11.90497	11.98916	12.25961	9.003194
13	AZ	1987	.71406	.36	1	1	21	6.2	9.56388	.0641113	.168724	0	15.03516	11.9117	11.99535	12.26434	9.145338
14	AZ	1988	.68281	.346487	1	1	21	6.3	9.575544	.0265678	.161005	0	15.06512	11.90497	11.96401	12.29225	9.191741
15	AR	1982	1.17668	.650358	0	0	21	9.8	9.23672	-.0347338	.204903	36.7128	14.65146	11.71178	11.70577	11.964	8.883017
16	AR	1983	1.06605	.6754587	0	0	21	10.1	9.252776	.0401444	.194169	36.4301	14.65923	11.67844	11.70105	11.97666	8.878486
17	AR	1984	.7788	.5989011	0	0	21	8.9	9.298029	.0835973	.18638	36.104	14.66822	11.65269	11.69632	11.99535	8.865709
18	AR	1985	.83999	.5773305	0	0	21	8.7	9.319138	.0046022	.189292	35.905	14.67375	11.63514	11.6916	11.98916	8.889297
19	AR	1986	1.00176	.5624355	0	0	21	8.7	9.341314	.0297692	.161957	39.5696	14.67882	11.65269	11.68688	11.88449	8.918516
20	AR	1987	.92925	.545	0	0	21	8.1	9.353314	.00193	.164132	39.2879	14.68597	11.66135	11.66994	11.86358	8.944529
21	AR	1988	.87201	.5245429	0	0	21	7.7	9.372489	.0337335	.167541	39.2879	14.6889	11.64395	11.60823	11.89136	8.990271
22	CA	1982	.55641	.1073986	0	0	21	9.9	9.667583	-.011686	.190196	0	17.02579	13.96134	14.0939	14.45367	8.83327
23	CA	1983	.49449	.103211	0	0	21	9.7	9.678479	.0530367	.183569	0	17.04675	13.93418	14.08543	14.44997	8.884096
24	CA	1984	.5512	.0989011	0	0	21	7.8	9.716562	.072461	.174131	0	17.06569	13.91536	14.07696	14.44359	8.938423
25	CA	1985	.47181	.095339	0	0	21	7.2	9.740096	.0483305	.167896	0	17.08755	13.91626	14.06849	14.43339	8.97133
26	CA	1986	.48513	.0928793	0	0	21	6.7	9.761696	.0466814	.164371	0	17.11139	13.97422	14.06002	14.38479	8.991551
27	CA	1987	.5175	.09	0	0	21	5.8	9.789535	.0697363	.160682	0	17.13561	13.96651	14.05296	14.37741	9.009525
28	CA	1988	.44032	.0866218	.	.	21	5.3	9.80085	.0490204	.148684	0	17.15887	13.93507	14.02089	14.38649	9.051578
29	CO	1982	.71535	.2147971	0	1	21	7.7	9.62128	.012043	.229148	.113151	14.93784	11.8706	12.0433	12.41309	8.954524
30	CO	1983	.69021	.206422	0	1	21	6.6	9.624559	.0291794	.207658	.090822	14.9626	11.8494	12.02977	12.40082	8.943254
31	CO	1984	.63618	.1978022	0	1	21	5.6	9.647744	.0553472	.192155	.075862	14.97553	11.82774	12.01623	12.38422	8.949995

Image 1.1

Panel Data Set up

```
. xtset state year

Panel variable: state (strongly balanced)
 Time variable: year, 1982 to 1988
         Delta: 1 unit
```

Table 1.2

```
. xtsum
```

Variable		Mean	Std. Dev.	Min	Max	Observations
state	overall	30.1875	15.30985	1	56	N = 336
	between		15.44883	1	56	n = 48
	within		0	30.1875	30.1875	T = 7
year	overall	1985	2.002983	1982	1988	N = 336
	between		0	1985	1985	n = 48
	within		2.002983	1982	1988	T = 7
VFR	overall	.6592957	.2596777	.23372	1.77202	N = 336
	between		.2286467	.2606729	1.420347	n = 48
	within		.1268445	-.2769114	1.134474	T = 7
beertax	overall	.513256	.4778442	.0433109	2.720764	N = 336
	between		.4789513	.0481679	2.440507	n = 48
	within		.0552203	.1415352	.7935126	T = 7
jaild	overall	.280597	.449963	0	1	N = 335
	between		.4280223	0	1	n = 48
	within		.1491349	-.5765458	.7091684	T = 6.97917

comserd	overall	.1850746	.388939	0	1	N = 335
	between		.3691987	0	1	n = 48
	within		.1308	-.6720682	.6136461	T = 6.97917
mlda	overall	20.45563	.8990255	18	21	N = 336
	between		.674607	18.78571	21	n = 48
	within		.6010849	18.74134	22.66991	T = 7
unrate	overall	7.346726	2.533405	2.4	18	N = 336
	between		1.953377	4.1	13.2	n = 48
	within		1.634257	4.046726	12.14673	T = 7
lnperinc	overall	9.525574	.15817	9.160495	10.00755	N = 336
	between		.1500003	9.204648	9.875391	n = 48
	within		.054043	9.367712	9.669338	T = 7
gspch	overall	.0253135	.0431732	-.1236415	.1423609	N = 336
	between		.0297138	-.0652201	.0787735	n = 48
	within		.0315725	-.0801624	.10419	T = 7
yngdrv	overall	.1859299	.0248736	.073137	.281625	N = 336
	between		.017161	.1375446	.222699	n = 48
	within		.0181513	.1215223	.2513753	T = 7
dry	overall	4.267074	9.500901	0	45.7921	N = 336
	between		9.563572	0	42.21479	n = 48
	within		.6658347	1.155888	7.844387	T = 7

lnpop	overall	14.96255	.9772593	13.07946	17.15887	N = 336
	between		.9858179	13.12888	17.09024	n = 48
	within		.0245966	14.87011	15.06737	T = 7
lnp~1517	overall	11.90349	.9846742	9.952279	13.97422	N = 336
	between		.9928369	10.0112	13.94328	n = 48
	within		.0388974	11.77784	12.00098	T = 7
lnp~1820	overall	11.98732	.9713251	9.952276	14.0939	N = 336
	between		.9789808	10.08469	14.06552	n = 48
	within		.0472697	11.82639	12.08473	T = 7
lnp~2124	overall	12.28173	.9728019	10.30896	14.45367	N = 336
	between		.9797092	10.47877	14.41847	n = 48
	within		.0608647	12.11193	12.40561	T = 7
lnvmiles	overall	8.960302	.1562787	8.428656	10.17154	N = 336
	between		.1275165	8.539781	9.266268	n = 48
	within		.0919447	8.71565	10.00649	T = 7
spircons	overall	1.75369	.6835745	.79	4.9	N = 336
	between		.6734649	.8614286	4.388572	n = 48
	within		.147792	1.255119	2.265119	T = 7
perinc	overall	13880.18	2253.046	9513.762	22193.46	N = 336
	between		2122.712	9950.87	19515.82	n = 48
	within		806.8547	11432.6	16557.82	T = 7

sobapt	overall	7.156925	9.762621	0	30.3557	N = 336
	between		9.849453	0	30.28947	n = 48
	within		.185949	6.354682	7.974181	T = 7
mormon	overall	2.801933	9.665279	.1	65.9165	N = 336
	between		9.750385	.1	63.768	n = 48
	within		.2244279	.6929348	4.950431	T = 7
vmiles	overall	7890.754	1475.659	4576.346	26148.27	N = 336
	between		1018.511	5129.503	10592.69	n = 48
	within		1076.468	4722.285	23678.73	T = 7
allmort	overall	928.6637	934.0515	79	5504	N = 336
	between		937.6918	107.8571	5045	n = 48
	within		94.52131	456.6637	1449.235	T = 7
mrall	overall	.000204	.000057	.0000821	.0004218	N = 336
	between		.0000546	.000111	.0003653	n = 48
	within		.0000179	.0001456	.0002963	T = 7
allnite	overall	182.5833	188.4311	13	1049	N = 336
	between		188.4657	19.71429	914.8571	n = 48
	within		24.96232	29.29762	390.2976	T = 7
mralln	overall	.0000388	.000011	.0000172	.0000944	N = 336
	between		9.19e-06	.0000227	.0000681	n = 48
	within		6.08e-06	.0000123	.00007	T = 7

allsvn	overall	109.9494	108.5397	8	603	N = 336
	between		108.4998	12.71429	525.7143	n = 48
	within		14.8158	18.23512	219.2351	T = 7
a1517	overall	62.61012	55.72909	3	318	N = 336
	between		55.26257	7	272.5714	n = 48
	within		10.31876	22.03869	108.0387	T = 7
mra1517	overall	.0003034	.0000937	.0001163	.0006735	N = 336
	between		.0000739	.0001566	.0004865	n = 48
	within		.0000585	.0000682	.0004945	T = 7
a1517n	overall	12.2619	12.25341	0	76	N = 336
	between		11.64903	1.285714	57.71429	n = 48
	within		4.108133	-6.452381	30.54762	T = 7
mra1517n	overall	.0000598	.000033	0	.0002571	N = 336
	between		.0000192	.0000297	.000131	n = 48
	within		.0000269	-.0000172	.0001859	T = 7
a1820	overall	106.6607	104.2236	7	601	N = 336
	between		104.2461	13	567.5714	n = 48
	within		13.78232	52.08929	197.0893	T = 7
a1820n	overall	33.52679	33.23834	0	196	N = 336
	between		32.5065	3.714286	150.5714	n = 48
	within		8.187827	3.955357	79.09821	T = 7

mra1820	overall	.0004728	.0001522	.0001855	.0010952	N = 336
	between		.0001308	.0002679	.0009358	n = 48
	within		.0000798	.0001392	.0008032	T = 7
mra1820n	overall	.0001436	.0000613	0	.0005238	N = 336
	between		.0000418	.0000933	.0003121	n = 48
	within		.0000452	-.0000865	.0003554	T = 7
a2124	overall	126.872	131.7886	12	770	N = 336
	between		131.8842	17.42857	738.2857	n = 48
	within		16.92104	30.15774	230.1577	T = 7
mra2124	overall	.0004091	.0001225	.0002	.0008922	N = 336
	between		.0001044	.0002323	.0007501	n = 48
	within		.0000656	.000158	.0006783	T = 7
a2124n	overall	41.37798	42.93031	1	249	N = 336
	between		42.38749	5.714286	211	n = 48
	within		8.859577	-3.907738	88.09226	T = 7
mra2124n	overall	.0001284	.0000422	.0000222	.0003143	N = 336
	between		.0000263	.0000545	.0001916	n = 48
	within		.0000333	.0000114	.0002773	T = 7
aidall	overall	293.3332	303.5807	24.6	2094.9	N = 336
	between		298.4363	34.49	1525.471	n = 48
	within		68.49986	-197.6582	862.7617	T = 7

mraidall	overall	.0000659	.000026	.0000234	.0001772	N = 336
	between		.0000229	.0000261	.000142	n = 48
	within		.0000127	-.0000277	.0001134	T = 7
pop	overall	4930272	5073704	478999.7	2.83e+07	N = 336
	between		5114958	503428.5	2.65e+07	n = 48
	within		219679.6	3254075	6782127	T = 7
pop1517	overall	230815.5	229896.3	21000.02	1172000	N = 336
	between		231628.1	22285.71	1136572	n = 48
	within		12713.51	140673.2	305675.2	T = 7
pop1820	overall	249090.4	249345.6	20999.96	1321004	N = 336
	between		251240.7	24020.29	1284364	n = 48
	within		13486.92	174202.9	293807.6	T = 7
pop2124	overall	336389.9	345304.4	30000.16	1892998	N = 336
	between		347721.3	35714.24	1828428	n = 48
	within		22148.45	238532.4	400959.9	T = 7
miles	overall	37101.49	37454.37	3993	241575	N = 336
	between		37455.95	4670.143	205945	n = 48
	within		5000.848	1155.489	72731.5	T = 7

Graph 1.1

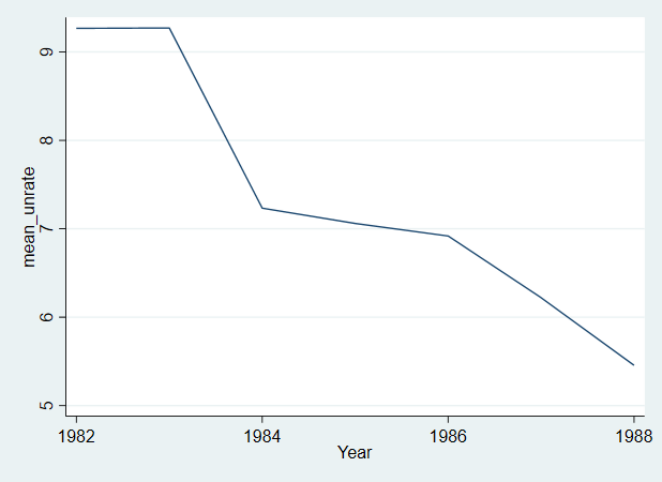
Alcohol Involved VFR by state:

Graph 1.2 – 1.5

Overall Alcohol Involved Vehicle Fatality Rate over time:

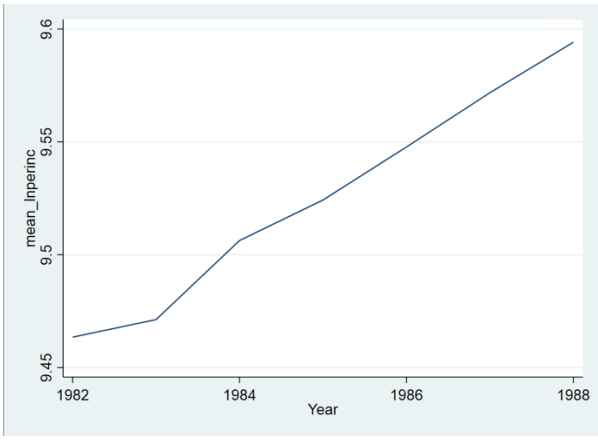
Graph 1.2

Overall State Unemployment Rate (%) over time:



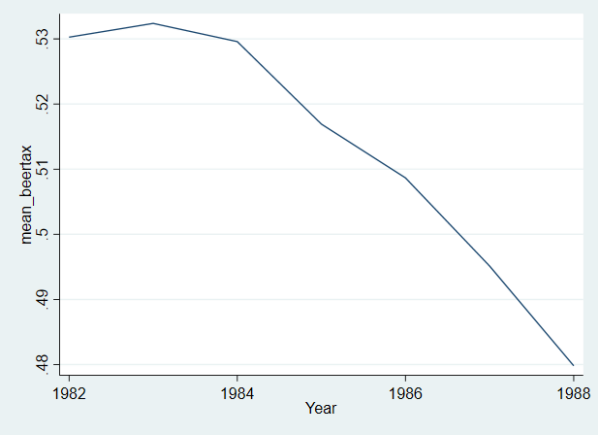
Graph 1.3

Log Per Capita Personal Income ($) over time:



Graph 1.4

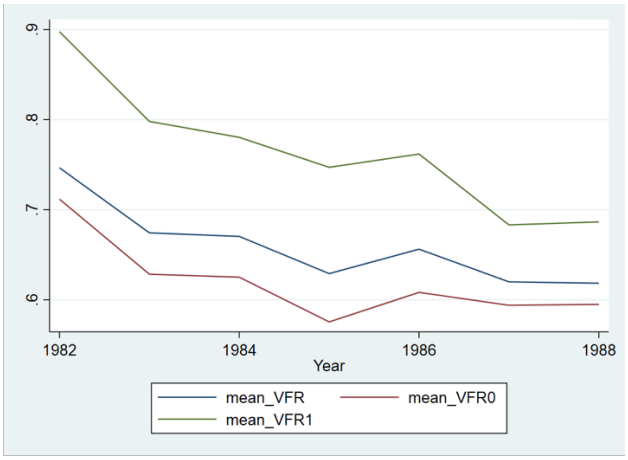
Overall Tax on Case of Beer ($) over time:



Graph 1.5

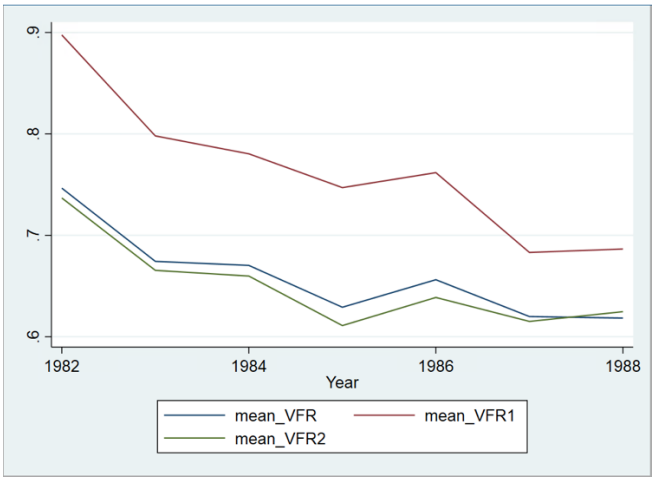
Graphs 1.6 – 1.10

Overall Alcohol Involved VFR over time by Mandatory Jail Sentence:



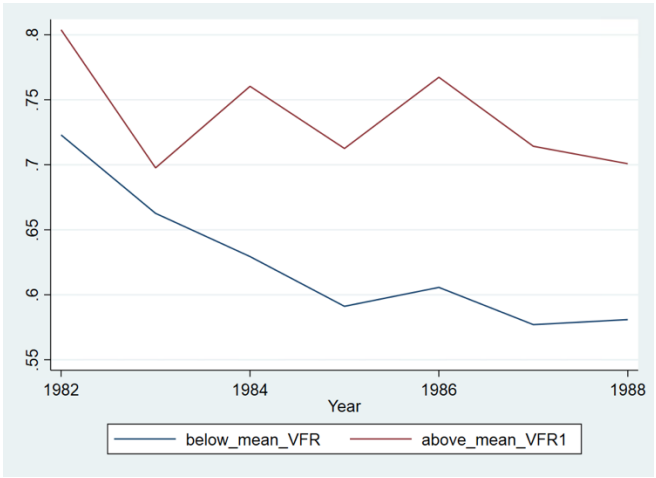
Graph 1.6

Overall Alcohol Involved VFR over time by Mandatory Community Service:



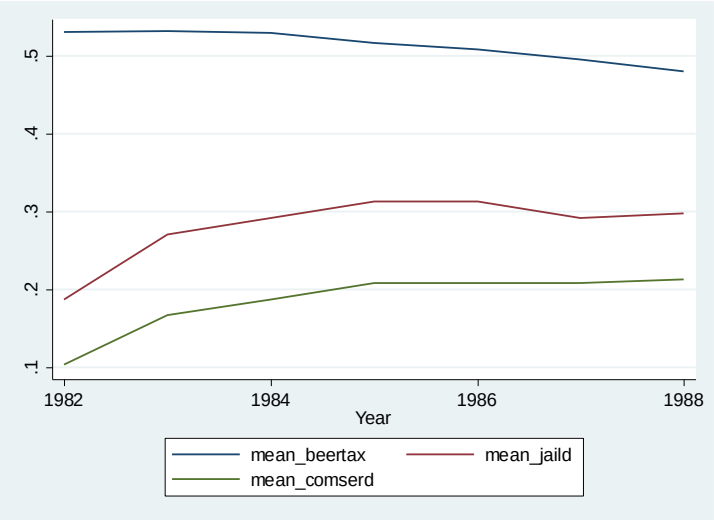
Graph 1.7

Overall Alcohol Involved VFR over time by Beer tax costs, above the tax mean and below the tax mean:



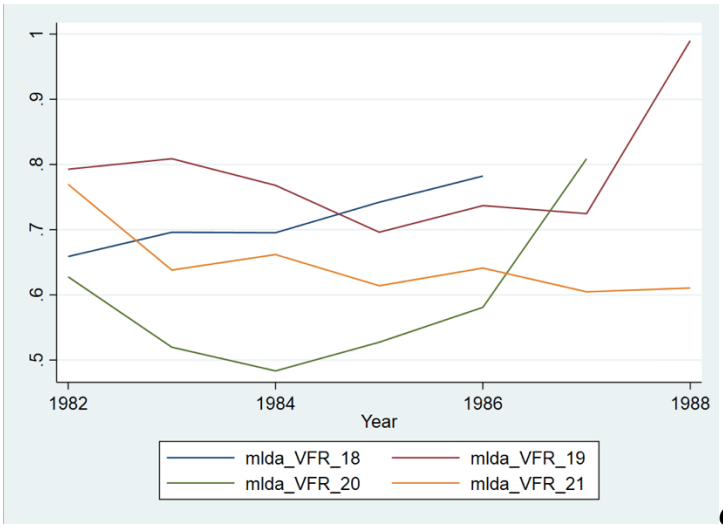
Graph 1.8

Overall Alcohol Involved VFR over time by Policy:



Graph 1.9

Overall Alcohol Involved VFR over time by Minimum Legal Drinking Age:



Graph 1.10

Pooled OLS Cluster Robust model

```
. reg VFR beertax jaild comserd mlda unrate lnperinc gspch yngdrv dry lnpop
lnpop1517 lnpop1820 lnpop2124 lnvmiles spircons mormon sobapt, vce(cluster state)

Linear regression                               Number of obs     =        335
                                                F(17, 47)         =       9.63
                                                Prob > F          =     0.0000
                                                R-squared         =     0.5173
                                                Root MSE          =     .18528

                                   (Std. Err. adjusted for 48 clusters in state)
------------------------------------------------------------------------------
             |               Robust
         VFR |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     beertax |  -.0804664   .0618557    -1.30   0.200    -.2049039    .0439711
      jaild |    .088616    .064984     1.36   0.179     -.042115    .2193469
     comserd |   .0415562   .0645087     0.64   0.523    -.0882186     .171331
       mlda |  -.0133454   .0214923    -0.62   0.538    -.0565822    .0298915
     unrate |  -.0143687   .0109095    -1.32   0.194    -.0363159    .0075784
    lnperinc |  -.8446345   .2636253    -3.20   0.002     -1.37498   -.3142887
      gspch |  -.4702759   .4122397    -1.14   0.260    -1.299595    .3590433
     yngdrv |    1.28328   .8838824     1.45   0.153    -.4948625    3.061422
        dry |  -.0007431   .0033982    -0.22   0.828    -.0075794    .0060933
      lnpop |  -.1486685   .3729984    -0.40   0.692    -.8990445    .6017076
   lnpop1517 |   .6403295   .3750191     1.71   0.094    -.1141117    1.394771
   lnpop1820 |  -.6705837   .3717515    -1.80   0.078    -1.418451    .0772838
   lnpop2124 |   .1699904   .3424886     0.50   0.622    -.5190078    .8589885
    lnvmiles |   .2729096   .1518297     1.80   0.079    -.0325324    .5783516
    spircons |   .0620481   .0284373     2.18   0.034     .0048395    .1192566
      mormon |   -.005345   .0019061    -2.80   0.007    -.0091795   -.0015105
      sobapt |   .0086388   .0052139     1.66   0.104    -.0018503    .0191278
       _cons |   6.820528   2.904737     2.35   0.023     .9769507     12.6641
------------------------------------------------------------------------------
```

Fixed Effects Model

```
. xtreg VFR beertax jaild comserd mlda unrate lnperinc gspch yngdrv dry lnpop
lnpop1517 lnpop1820 lnpop2124 lnvmiles spircons mormon sobapt, fe vce(cluster state)

Fixed-effects (within) regression               Number of obs     =        335
Group variable: state                           Number of groups  =         48
```

R-sq:
     within = 0.1981
     between = 0.0476
     overall = 0.0196

corr(u_i, Xb) = -0.8060

Obs per group:
                  min =   6
                  avg =   7.0
                  max =   7

F(16,47)   =   .
Prob > F   =   .

(Std. Err. adjusted for 48 clusters in state)

VFR	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
beertax	-.2136371	.2432033	-0.88	0.384	-.7028989	.2756248
jaild	.213851	.0166844	12.82	0.000	.1802863	.2474157
comserd	-.2005583	.0776259	-2.58	0.013	-.3567216	-.0443951
mlda	.0001963	.0210408	0.01	0.993	-.0421322	.0425249
unrate	-.0166716	.0088237	-1.89	0.065	-.0344227	.0010794
lnperinc	.4542481	.3670334	1.24	0.222	-.2841279	1.192624
gspch	-.0287489	.239672	-0.12	0.905	-.5109068	.453409
yngdrv	.5394726	.7048084	0.77	0.448	-.878419	1.957364
dry	.0047967	.0209808	0.23	0.820	-.0374112	.0470046
lnpop	-.7141909	.7008742	-1.02	0.313	-2.124168	.6957861
lnpop1517	.6221713	.3232042	1.93	0.060	-.0280317	1.272374
lnpop1820	.1713324	.3361131	0.51	0.613	-.50484	.8475048
lnpop2124	.1153901	.3032457	0.38	0.705	-.4946615	.7254417
lnvmiles	-.0026777	.0899731	-0.03	0.976	-.1836803	.1783249
spircons	.2641379	.1113284	2.37	0.022	.040174	.4881019
mormon	.0023131	.0381183	0.06	0.952	-.074371	.0789973
sobapt	.0153176	.0831018	0.18	0.855	-.1518617	.1824969
_cons	-4.326871	9.079105	-0.48	0.636	-22.59167	13.93793
sigma_u	.39417947					
sigma_e	.12646998					
rho	.90666711	(fraction of variance due to u_i)				

Entity and Time Fixed Effects Model

```
. xtreg VFR beertax jaild comserd mlda unrate lnperinc gspch yngdrv dry lnpop
lnpop1517 lnpop1820 lnpop2124 lnvmil
> es spircons mormon sobapt i.year, fe vce(cluster state)

Fixed-effects (within) regression               Number of obs      =       335
Group variable: state                           Number of groups   =        48

R-sq:                                           Obs per group:
     within  = 0.2518                                         min =         6
     between = 0.1310                                         avg =       7.0
     overall = 0.0817                                         max =         7

                                                F(22,47)           =         .
corr(u_i, Xb)  = -0.9473                        Prob > F           =         .

                                         (Std. Err. adjusted for 48 clusters in state)
------------------------------------------------------------------------------
             |               Robust
         VFR |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     beertax |  -.2566403      .2404    -1.07   0.291    -.7402626    .2269821
       jaild |   .2336855   .0197134    11.85   0.000     .1940272    .2733438
     comserd |  -.2204709   .0847925    -2.60   0.012    -.3910514   -.0498905
       mlda |  -.0024559   .0203543    -0.12   0.904    -.0434035    .0384917
     unrate |  -.0240344   .0146982    -1.64   0.109    -.0536034    .0055346
    lnperinc |  -.0066958   .3564415    -0.02   0.985    -.7237637    .7103721
      gspch |   .5722916    .388845     1.47   0.148    -.2099637    1.354547
     yngdrv |   .3380146   .6142037     0.55   0.585    -.8976038    1.573633
        dry |   .0010948   .0204524     0.05   0.958    -.0400501    .0422397
      lnpop |   .1462484   1.055865     0.14   0.890    -1.977878    2.270375
   lnpop1517 |  -.2688584   .3523672    -0.76   0.449    -.9777299     .440013
   lnpop1820 |   .4020457   .6672841     0.60   0.550    -.9403567    1.744448
   lnpop2124 |   .1065147   .4156998     0.26   0.799    -.7297654    .9427947
    lnvmiles |  -.0235105   .0892354    -0.26   0.793     -.203029     .156008
    spircons |    .311773   .0999927     3.12   0.003     .1106136    .5129323
      mormon |  -.0330543   .0339257    -0.97   0.335    -.1013041    .0351955
      sobapt |  -.0081206   .0743452    -0.11   0.913    -.1576839    .1414426
             |
        year |
        1983 |  -.0944925   .0323231    -2.92   0.005    -.1595182   -.0294668
        1984 |  -.1533695   .0613539    -2.50   0.016    -.2767976   -.0299414
```

```
        1985 |  -.1587423   .0886892    -1.79   0.080    -.3371619    .0196773
        1986 |  -.0748311   .1314172    -0.57   0.572    -.3392085    .1895462
        1987 |  -.1049265   .1708138    -0.61   0.542    -.4485595    .2387064
        1988 |  -.1031417     .21632    -0.48   0.636    -.5383214     .332038
             |
       _cons |  -4.223813   8.298766    -0.51   0.613    -20.91878    12.47115
-------------+----------------------------------------------------------------
     sigma_u |  .70574478
     sigma_e |   .1235399
         rho |  .97026888   (fraction of variance due to u_i)
------------------------------------------------------------------------------
```

Time Effects Hypothesis test

$$H_0: all\ time\ effects = 0; \quad H_1: at\ least\ for\ one\ year\ the\ effect\ is\ \neq 0$$

```
. do "C:\Users\JMA200~1\AppData\Local\Temp\340\STD53c8_000000.tmp"

. testparm i.year

 ( 1)  1983.year = 0
 ( 2)  1984.year = 0
 ( 3)  1985.year = 0
 ( 4)  1986.year = 0
 ( 5)  1987.year = 0
 ( 6)  1988.year = 0

       F(  6,    47) =    4.12
            Prob > F =    0.0021
```

Restricted Model 1

```
. xtreg VFR beertax jaild comserd mlda unrate spircons yngdrv lnpop1517 lnpop1820
lnpop2124 i.year, fe vce(cluster state)

Fixed-effects (within) regression               Number of obs      =       335
Group variable: state                           Number of groups   =        48

R-sq:                                           Obs per group:
     within  = 0.2433                                         min =         6
     between = 0.2174                                         avg =       7.0
     overall = 0.1359                                         max =         7
```

```
                                                F(15,47)          =          .
corr(u_i, Xb)  = -0.9295                        Prob > F          =          .

                                    (Std. Err. adjusted for 48 clusters in state)
------------------------------------------------------------------------------
             |               Robust
         VFR |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     beertax |  -.2143359   .2247175    -0.95   0.345    -.6664091    .2377374
      jaild |   .2415373   .0148719    16.24   0.000     .2116189    .2714556
     comserd |  -.2104885   .0820478    -2.57   0.014    -.3755474   -.0454296
       mlda |   -.001835   .0179294    -0.10   0.919    -.0379042    .0342343
     unrate |  -.0303483   .0117827    -2.58   0.013     -.054052   -.0066445
    spircons |   .2989838   .0981135     3.05   0.004      .101605    .4963627
     yngdrv |   .1689624   .5457198     0.31   0.758    -.9288842    1.266809
   lnpop1517 |   -.147086   .2636389    -0.56   0.580    -.6774591    .3832871
   lnpop1820 |   .5982292   .4998909     1.20   0.237    -.4074215     1.60388
   lnpop2124 |   .0206503   .2987582     0.07   0.945    -.5803738    .6216743
             |
        year |
        1983 |  -.0608398   .0268285    -2.27   0.028    -.1148117   -.0068678
        1984 |  -.1100715   .0534971    -2.06   0.045    -.2176939   -.0024492
        1985 |  -.1353928   .0595096    -2.28   0.028    -.2551108   -.0156749
        1986 |  -.0610965   .0703016    -0.87   0.389    -.2025251    .080332
        1987 |  -.0914463   .0879144    -1.04   0.304    -.2683072    .0854146
        1988 |  -.0711227   .1141009    -0.62   0.536    -.3006641    .1584186
             |
       _cons |  -5.149056   5.787988    -0.89   0.378    -16.79299    6.494873
-------------+----------------------------------------------------------------
     sigma_u |  .59068366
     sigma_e |  .12262474
         rho |  .95868368   (fraction of variance due to u_i)
------------------------------------------------------------------------------
------------------------------------------------------------------------------
```

Restricted model 2

```
. xtreg VFR beertax jaild comserd mlda unrate spircons i.year, fe vce(cluster state)

Fixed-effects (within) regression               Number of obs      =       335
Group variable: state                           Number of groups   =        48
```

```
R-sq:                                           Obs per group:
     within  = 0.2354                                        min =         6
     between = 0.0771                                        avg =       7.0
     overall = 0.0315                                        max =         7

                                                F(11,47)          =         .
corr(u_i, Xb)  = -0.7947                        Prob > F          =         .

                                (Std. Err. adjusted for 48 clusters in state)
------------------------------------------------------------------------------
             |               Robust
         VFR |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     beertax |  -.2191313   .2199808    -1.00   0.324    -.6616755     .223413
       jaild |   .2362551   .0130923    18.05   0.000     .2099168    .2625934
     comserd |  -.1953402   .0800332    -2.44   0.018    -.3563462   -.0343342
        mlda |  -.0011711    .017152    -0.07   0.946    -.0356764    .0333342
      unrate |  -.0317377   .0119645    -2.65   0.011    -.0558071   -.0076683
    spircons |   .2644314   .0816639     3.24   0.002     .1001449    .4287179
             |
        year |
        1983 |  -.0670637   .0239062    -2.81   0.007    -.1151568   -.0189705
        1984 |  -.1258915   .0459793    -2.74   0.009      -.21839    -.033393
        1985 |  -.1607316   .0494188    -3.25   0.002    -.2601495   -.0613137
        1986 |  -.1070452   .0622678    -1.72   0.092    -.2323119    .0182216
        1987 |  -.1528763   .0735304    -2.08   0.043    -.3008003   -.0049522
        1988 |  -.1698523   .0805474    -2.11   0.040    -.3318928   -.0078118
             |
       _cons |   .6478674   .4134844     1.57   0.124    -.1839559    1.479691
-------------+----------------------------------------------------------------
     sigma_u |  .38257984
     sigma_e |  .12236879
         rho |  .90718987   (fraction of variance due to u_i)
------------------------------------------------------------------------------
```

Random Effects Model

```
. xtreg VFR beertax jaild comserd mlda unrate spircons i.year, re cluster(state)

Random-effects GLS regression                   Number of obs     =       335
Group variable: state                           Number of groups  =        48
```

```
R-squared:                                      Obs per group:
     Within  = 0.1851                                         min =         6
     Between = 0.0349                                         avg =       7.0
     Overall = 0.0606                                         max =         7

                                                Wald chi2(12)      =     64.52
corr(u_i, X) = 0 (assumed)                      Prob > chi2        =    0.0000

                                  (Std. err. adjusted for 48 clusters in state)
------------------------------------------------------------------------------
             |               Robust
         VFR | Coefficient  std. err.      z    P>|z|     [95% conf. interval]
-------------+----------------------------------------------------------------
     beertax |   .0995879   .0536098     1.86   0.063    -.0054855    .2046612
      jaild  |   .2045665    .053014     3.86   0.000      .100661     .308472
     comserd |  -.1475858    .077544    -1.90   0.057    -.2995693    .0043977
        mlda |  -.0064307    .016378    -0.39   0.695    -.0385309    .0256695
      unrate |  -.0258585   .0132601    -1.95   0.051    -.0518478    .0001309
    spircons |   .0056232   .0380779     0.15   0.883    -.0690081    .0802544
             |
        year |
        1983 |  -.0794518   .0234151    -3.39   0.001    -.1253446    -.033559
        1984 |   -.136258     .04781    -2.85   0.004    -.2299639    -.0425522
        1985 |  -.1804119   .0516694    -3.49   0.000    -.2816821    -.0791418
        1986 |  -.1537528    .063143    -2.43   0.015    -.2775108    -.0299948
        1987 |  -.2003318   .0745963    -2.69   0.007    -.3465379    -.0541258
        1988 |  -.2185893   .0832496    -2.63   0.009    -.3817556    -.0554231
             |
       _cons |    1.02838   .3828008     2.69   0.007     .2781044    1.778656
-------------+----------------------------------------------------------------
     sigma_u |  .20074109
     sigma_e |  .12236879
         rho |  .72907869   (fraction of variance due to u_i)
------------------------------------------------------------------------------
```

Hausman Test 1

H_0: *both FE and RE estimators are converging to* β_k *(no endogeneity),* $\quad b_{k,FE} - b_{k,RE} = 0$;

H_1: *FE and RE estimators are not converging to* β_k*(endogeneity),* $\quad b_{k,FE} - b_{k,RE} \neq 0$

```
. hausman fixed1 random1
```

	---- Coefficients ----			
	(b)	(B)	(b-B)	sqrt(diag(V_b-V_B))
	fixed1	random1	Difference	S.E.
beertax	-.2191313	.0995879	-.3187191	.1159886
jaild	.2362551	.2045665	.0316886	.0710853
comserd	-.1953402	-.1475858	-.0477543	.0810085
mlda	-.0011711	-.0064307	.0052596	.0017058
unrate	-.0317377	-.0258585	-.0058792	.0024735
spircons	.2644314	.0056232	.2588082	.083734
year				
1983	-.0670637	-.0794518	.0123882	.
1984	-.1258915	-.136258	.0103666	.0075842
1985	-.1607316	-.1804119	.0196803	.0136739
1986	-.1070452	-.1537528	.0467076	.0246531
1987	-.1528763	-.2003318	.0474556	.0292318
1988	-.1698523	-.2185893	.048737	.0345069

b = consistent under Ho and Ha; obtained from xtreg
B = inconsistent under Ha, efficient under Ho; obtained from xtreg

Test: Ho: difference in coefficients not systematic

chi2(12) = (b-B)'[(V_b-V_B)^(-1)](b-B)
= -50.07

Warning: chi2 < 0 ==> model fitted on these data
fails to meet the asymptotic assumptions
of the Hausman test; see suest for a
generalized test.

* Prob > chi2 = 0.0000