Appendix 1A: SD model Formula

Abstainers[Gender,Age15]= INTEG (

    Abstainers becoming 15[Gender]-Abstainers aging[Gender,Age15]-Abstainers becoming
drinkers
  [Gender,Age15],
    Abstainers 0[Gender,Age15])
Abstainers[Gender,All but 15]= INTEG (
    Abstainers aging[Gender,pAge]-Abstainers aging[Gender,All but 15]+Drinkers becoming
abstainers
  [Gender,pAge]-Abstainers becoming drinkers
    [Gender,All but 15],
    Abstainers 0[Gender,All but 15])
  Units: Person

Abstainers 0[Gender,Age]=
  Frac abstainers 1982[Gender,Age]*Population 1982[Gender,Age]
Units: Person

Abstainers 18=
  Sum(Abstainers[Gender!,Age18])
Units: Person

"Abstainers 19-20"=
  Sum(Abstainers[Gender!,Age19]) + Sum(Abstainers[Gender!,Age20])
Units: Person

"Abstainers 21-22"=
  Sum(Abstainers[Gender!,Age21]) + Sum(Abstainers[Gender!,Age22])
Units: Person

"Abstainers 23-24"=
  Sum(Abstainers[Gender!,Age23]) + Sum(Abstainers[Gender!,Age24])
Units: Person

Abstainers aging[Gender,Age]=
  (1-frac of Abstainers becoming drinkers[Gender,Age])*Abstainers[Gender,Age
]/Cohort length
Units: Person/Year

Abstainers becoming 15[Male]:INTERPOLATE::=
  GET XLS DATA('DataAgeGender.xlsx' , 'Population' , 'B1' , 'B49')
Abstainers becoming 15[Female]:INTERPOLATE::=
    GET XLS DATA('DataAgeGender.xlsx' , 'Population' , 'B1' , 'B51')
  Units: Person/Year

Abstainers becoming drinkers[Gender,Age]=
  frac of Abstainers becoming drinkers[Gender,Age]*Abstainers[Gender,Age]/Cohort length
Units: Person/Year

Alcohol impaired drivers 0[Gender,Age]=
    Population 1982[Gender,Age]*Frac Alcohol impaired drivers 1982[Gender,Age]
 - Never DWI again 0[Gender,Age]
Units: Person

Alcohol impaired drivers aging[Gender,Age]=
    max(0,(Drinkers who drive after drinking[Gender,Age]/Cohort length - Drinkers stopping DWI
after arrest
[Gender,Age])*(1-frac of DWIs stopping DWI[Gender,Age]))
Units: Person/Year

Alcohol impaired drivers becoming 15[Male]:INTERPOLATE::=
    GET XLS DATA('DataAgeGender.xlsx' , 'Population' , 'B1' , 'B64')
Alcohol impaired drivers becoming 15[Female]:INTERPOLATE::=
        GET XLS DATA('DataAgeGender.xlsx' , 'Population' , 'B1' , 'B65')
    Units: Person/Year

Alcohol truth campaign=
    1+RAMP(-0.1, 2025 , 2027)
Units: Dmnl
1-0.2*PULSE(2023, 5)

"Alcohol-impaired driving laws"= INTEG (
    new DWI laws,
        37)
Units: Law

Alternative transportation=
    1+RAMP(-r, 2025 , 2027)
Units: Dmnl

Average number of riders per DWI trips[Male,Age]=
    1.22,1.3,1.23,1.11,0.97,0.91,0.82,0.76,0.7,0.66
Average number of riders per DWI trips[Female,Age]=
        1.57,1.37,1.19,1.05,0.93,0.83,0.75,0.76,0.7,0.67
    Units: RWI trip/Trip

Cohort length=
    1
Units: Year

Crash DWI trips[Gender,Age]=
    DWI trips[Gender,Age]*fraction of DWI trips resulting in crash[Gender,Age]
Units: Trip/Year

Current frac DWI trips Caught by parents[Male,Age]=
    0.3,0.2,0.1,0.05,0.04,0.03,0.02,0.01,0.01,0.01
Current frac DWI trips Caught by parents[Female,Age]=
        0.3,0.2,0.1,0.05,0.04,0.03,0.02,0.01,0.01,0.01
    Units: Dmnl

Desired DWI laws=
    DWI laws*Pressure to legislate DWI laws + Switch laws*new laws campaign*DWI laws
*Pressure to legislate DWI laws
Units: Law

Discrepancy=
    Desired DWI laws-"Alcohol-impaired driving laws"
Units: Law

Drinkers becoming abstainers[Gender,Age]=
    frac becoming Abstainers[Gender,Age]*Drinkers who do not drive after drinking
[Gender,Age]/Cohort length
Units: Person/Year

Drinkers becoming DWI[Gender,Age]=
    Drinkers who do not drive after drinking[Gender,Age]*"frac of non-DWI drinkers becoming
DWI"
[Gender,Age]/Cohort length
Units: Person/Year

Drinkers stopping DWI after arrest[Gender,Age]=
    min(DWI arrests[Gender,Age]*Fraction stopping DWI after arrest,Drinkers who drive after
drinking
[Gender,Age]/Cohort length)
Units: Person/Year
max(0,DWI arrests[Gender,Age]*Fraction stopping DWI after arrest)

Drinkers who do not drive after drinking[Gender,Age15]= INTEG (
    "Non-DWI drinkers becoming 15"[Gender]-"Non-DWI drinkers aging"[Gender,Age15
]-Drinkers becoming abstainers[Gender,Age15]-Drinkers becoming DWI[Gender,Age15
],
        "Non-DWI drinkers 0"[Gender,Age15])
Drinkers who do not drive after drinking[Gender,All but 15]= INTEG (
        "Non-DWI drinkers aging"[Gender,pAge]+Abstainers becoming drinkers[Gender
    ,pAge]+DWIs stopping DWI[Gender,pAge]-"Non-DWI drinkers aging"[Gender,All but 15
    ]-Drinkers becoming abstainers[Gender,All but 15]-Drinkers becoming DWI[Gender
    ,All but 15],
            "Non-DWI drinkers 0"[Gender,All but 15])
    Units: Person

Drinkers who drive after drinking[Gender,Age15]= INTEG (
    Alcohol impaired drivers becoming 15[Gender]-Alcohol impaired drivers aging
[Gender,Age15]-DWIs stopping DWI[Gender,Age15
    ]-Drinkers stopping DWI after arrest[Gender,Age15],
        Alcohol impaired drivers 0[Gender,Age15])
Drinkers who drive after drinking[Gender,All but 15]= INTEG (
        Alcohol impaired drivers aging[Gender,pAge]-Alcohol impaired drivers aging
    [Gender,All but 15]+Drinkers becoming DWI[Gender
        ,pAge]-DWIs stopping DWI[Gender,All but 15]-Drinkers stopping DWI after arrest
    [Gender,All but 15],

Alcohol impaired drivers 0[Gender,All but 15])
    Units: Person

Driver per trip=
    1
Units: Person/Trip

DWI arrests[Gender,Age]=
    Probability of arrest[Gender,Age]*DWI trips[Gender,Age]*Driver per trip
Units: Person/Year

DWI laws=
    86
Units: Law

DWI trips[Gender,Age]=
    Frequency of DWI[Gender,Age]*Drinkers who drive after drinking[Gender,Age]
Units: Trip/Year

"DWI trips 16-20"=
    Sum(DWI trips[Gender!,Age16]) + Sum(DWI trips[Gender!,Age17]) + Sum(DWI trips
[Gender!,Age18]) + Sum(DWI trips[Gender!,Age19]) + Sum(DWI trips[Gender!,Age20
])
Units: Trip/Year

"DWI trips 21-24"=
    Sum(DWI trips[Gender!,Age21]) + Sum(DWI trips[Gender!,Age22]) + Sum(DWI trips
[Gender!,Age23]) + Sum(DWI trips[Gender!,Age24])
Units: Trip/Year

DWI trips caught by parent[Gender,Age]=
    frac DWI trips caught by parents[Male,Age]*DWI trips[Gender,Age]
Units: Trip/Year

DWIs stopping DWI[Gender,Age]=
    max(0,(Drinkers who drive after drinking[Gender,Age]/Cohort length-Drinkers stopping DWI
after arrest
[Gender,Age])*frac of DWIs stopping DWI[Gender,Age])
Units: Person/Year

Effect of alcohol consumption on frequency of DWI[Gender,Age]= WITH LOOKUP
(
    Ratio of current to normal alcohol consumtion[Gender,Age],
        ([(0,0)-(4,3)],(0,0.001),(0.1,0.05),(0.25,0.1),(0.5,0.5),(0.7,0.7),(1,1),
(1.5,1.5),(2,2),(3,3),(4,3)))
Units: Dmnl
([(0,0)-(3,1.5)],(0,0.1),(0.1,0.7),(0.25,0.9),(0.5,0.93),(1,1),(1
    .5,1.07),(2,1.14),(3,1.14))
    ([(0,0)-(3,1.5)],(0,0.1),(0.1,0.1),(0.2,0.3),(0.5,0.6),(0.9,0.9),
    (1,1),(1.1,1.1),(1.5,1.2),(2,1.3),(3,1.3))

effect of alcohol marketing on abstainers starting drinking= WITH LOOKUP (
    Discrepancy between normal and current movie alcohol exposure,
        ([(-7,0)-(5,2)],(-7,0.75),(-1,0.92),(0,1),(1,1.15),(2,1.3),(3,1.45),(4,1.45
)))
Units: Dmnl
Sargent reported crude OR=1.33, adjusted OR=1.14

Effect of binge drinking on fraction who start DWI[Male,Age]= WITH LOOKUP (
    "Frac of non-DWI who binge"[Male,Age],
        ([(0,0)-(10,10)],(0,0.5),(0.1,0.6),(0.2,0.8),(0.3,1),(0.4,1),(0.5,1),(0.6
,1.05),(0.7,1.1)))
Effect of binge drinking on fraction who start DWI[Female,Age]= WITH LOOKUP
    (
        "Frac of non-DWI who binge"[Female,Age],
            ([(0,0)-(10,10)],(0,0.5),(0.1,0.6),(0.2,0.9),(0.3,1),(0.4,1)))
    Units: Dmnl

Effect of binge drinking on frequency of DWI[Male,Age]= WITH LOOKUP (
    Frac of DWI drinkers who binge[Male,Age],
        ([(0,0)-(1,2)],(0,0.7),(0.1,0.7),(0.2,0.75),(0.3,0.8),(0.4,0.85),(0.5,0.9
),(0.6,1),(0.7,1.1),(0.8,1.15),(1,1.2)))
Effect of binge drinking on frequency of DWI[Female,Age]= WITH LOOKUP (
        Frac of DWI drinkers who binge[Female,Age],
            ([(0,0)-(1,2)],(0,0.7),(0.1,0.75),(0.2,0.85),(0.3,1),(0.4,1.05),(0.5,1.1
    ),(0.6,1.2),(0.7,1.25),(0.8,1.3),(1,1.3)))
    Units: Dmnl

Effect of DWI laws on DWI[Gender,Age]=
    0.2+0.8/(1+EXP(Impact of age on law effectiveness[Age]*Frac of legislated DWI laws
-5))
Units: Dmnl

Effect of enforcement visibility on starting DWI= WITH LOOKUP (
    Perception will get caught,
        ([(0,0)-(1,2)],(0,1.5),(0.3,1.5),(0.5,1.4),(0.8,1.2),(1,1)))
Units: Dmnl

Effect of enforcement visibility on stopping DWI= WITH LOOKUP (
    Perception will get caught,
        ([(0,0)-(3,5)],(0,0.5),(0.3,0.5),(0.5,0.65),(0.7,0.8),(1,1),(2,2),(3,2))
)
Units: Dmnl

Effect of fatality statistics on legislation= WITH LOOKUP (
    Proportion of DWI fatalities,
        ([(0,0)-(0.5,10)],(0,1),(0.25,1),(0.3,1.2),(0.35,3),(0.45,4.5),(0.5,5)))
Units: Dmnl

Effect of near crashes[Gender,Age]= WITH LOOKUP (
    Near crash ratio[Gender,Age],
        ([(0,0)-(4,2)],(0,0.7),(0.5,0.8),(1,1),(2,1.3),(4,1.3)))

Units: Dmnl

Effect of parental monitoring on starting DWI[Gender,Age]= WITH LOOKUP (
    Parental influence not to DWI[Gender,Age],
        ([(0,0)-(4,2)],(0,1.1),(0.2,1.1),(0.5,1.02),(1,1),(2,0.88),(4,0.75)))
Units: Dmnl

Effect of parental monitoring on stopping DWI[Gender,Age]= WITH LOOKUP (
    Parental influence not to DWI[Gender,Age],
        ([(0,0)-(4,2)],(0,0.67),(0.5,0.83),(1,1),(2,1.28),(4,1.42)))
Units: Dmnl

Effect of peer drinking on frac becoming drinkers[Gender,Age]=
    Ratio of perceived peer drinking to reference peer drinking[Age]^Strenght of peer influence
on alcohol initiation
[Age]
Units: Dmnl

Enforcement intervention=
    1+RAMP(0.25, 2025 , 2027)
Units: Dmnl

Fatal DWI trips[Gender,Age]=
    1000*Fraction of Crash DWI trips fatal[Gender,Age]*Crash DWI trips[Gender,
Age]
Units: Trip/Year
This is Drivers in fatal crashes

"Female Abstainers aged 19-22"=
    Abstainers[Female,Age19] + Abstainers[Female,Age20] + Abstainers[Female,Age21
] + Abstainers[Female,Age22]
Units: Person

"Female Abstainers aged 23-24"=
    Abstainers[Female,Age23] + Abstainers[Female,Age24]
Units: Person

Frac abstainers 1982[Male,Age]=
    0.34,0.3,0.26,0.22,0.18,0.18,0.18,0.18,0.18,0.18
Frac abstainers 1982[Female,Age]=
        0.41,0.38,0.35,0.3,0.26,0.26,0.26,0.26,0.29,0.29
    Units: Dmnl [0.1,1,0.05]
    The fractions were obtained from Monitoring the Future.
        Assumptions: For 14 years old, I used average of 13 and 15; For
        15 to 17 years old, I estimated values 1982 using 1991 (see the
        spreadsheet). 19 to 22 and 23 to 26 were reported together.

Frac Alcohol impaired drivers 1982[Male,Age]=
    0.14,0.161,0.23,0.234,0.269,0.31,0.42,0.3,0.32,0.264
Frac Alcohol impaired drivers 1982[Female,Age]=
        0.09,0.08,0.11,0.118,0.165,0.129,0.215,0.232,0.268,0.175

Units: Dmnl [0,1,0.001]
The fractions come from the National Susrvey of Drinking and
    Driving Attitudes and Behavior (NHTSA 1995-2008). Assumptions:
    Fractions in 1995 used for 1982 (bad assumption; it needs to be
    calibrated). NHTSA did not report 15 years old and aggregate
    them into three age groups.

frac becoming Abstainers[Male,Age]=
  0.1, 0.1, 0.1, 0.1, 0.1, 0.1, 0.1, 0.1, 0.1, 0.1
frac becoming Abstainers[Female,Age]=
    0.1, 0.1, 0.1, 0.1, 0.1, 0.1, 0.1, 0.1, 0.1, 0.1
  Units: Dmnl [0,1]
  0.04, 0, 0.03, 0, 0.07, 0, 0.08, 0.02, 0.4, 0.06 0.08, 0, 0.37,
      0, 0.16, 0.03, 0.4, 0.21, 0, 0.39 Optimized female 0.29066 ,
      3.59724e-005, 0, 0, 0.2354 , 0.0996862, 0, 0.4, 0.00793238 ,
      0.311404 optimized male 0, 0, 0, 0, 0, 0.2398, 0.0304, 0.3525,
      7.21662e-005, 0.196528 Version 2 0.1057, 0.1842, 0.0644, 0.1999,
      0.0531, 0.0126, 0.0179, 0.0814, 0.0397, 0.1415

frac drinking[Male,Age]=
  0.198,0.197,0.05,0.17,0.37,0.29,0.17,0.39,0.08,0.4
frac drinking[Female,Age]=
    0.037,0.2,0.076,0.2,0.3,0.3,0.1,0.24,0.2,0.3
  Units: Dmnl [0,1]
  0.25,0.31,0.4,0.52,0.43,0.43,0.43,0.43,0.43,0.43
      0.18,0.21,0.26,0.3,0.21,0.21,0.21,0.21,0.26,0.26 0.08, 0.35,
      0.06, 0.08, 0.37, 0.43, 0.26, 0.1, 0.45, 0.45 0.05, 0.27, 0.1,
      0.19, 0.17, 0.23, 0.45, 0.05, 0.07, 0.07 0.08, 0.1, 0.14, 0.18,
      0.1, 0.15, 0.15, 0.35, 0.8, 0.8 0.05, 0.06, 0.13, 0.17, 0.1,
      0.59, 0.43, 0.1, 0.37, 0.37 Next: 0.0843, 0.1474, 0.2369,
      0.1995, 0.3413, 0.191, 0.0569, 0.1582, 0.0857, 0.0446

frac DWI[Male,Age]=
  0.158,0.13,0.027,0.115,0.1,0.208,0.001,0.126,0.008,0.02
frac DWI[Female,Age]=
    0.095,0.058,0.022,0.072,0.001,0.204,0.116,0.037,0.074,0.102
  Units: Dmnl

frac DWI trips caught by parents[Gender,Age]=
  (1-Switch Parental monitoring)*Current frac DWI trips Caught by parents[Gender
,Age]
  +
  Switch Parental monitoring*Current frac DWI trips Caught by parents[Gender
,Age]*Parental intervention
Units: Dmnl
0.3,0.2,0.1,0.05,0.04,0.03,0.02,0.01,0.01,0.01

Frac near crash=
  0.1
Units: Dmnl

"Frac non-DWI drinkers 1982"[Male,Age]=
    1-Frac abstainers 1982[Male,Age]-Frac Alcohol impaired drivers 1982[Male,Age
]
"Frac non-DWI drinkers 1982"[Female,Age]=
        1-Frac abstainers 1982[Female,Age]-Frac Alcohol impaired drivers 1982[Female
    ,Age]
    Units: Dmnl

frac of Abstainers becoming drinkers[Gender,Age]=
    min(1,Fraction initiate drinking[Gender,Age]*(1-"switch-peer drinking")*effect of alcohol
marketing on abstainers starting drinking
 +"switch-peer drinking"*Fraction initiate drinking[Gender,Age]*effect of alcohol marketing on
abstainers starting drinking
*Effect of peer drinking on frac becoming drinkers[Gender,Age])
Units: Dmnl

frac of DWIs stopping DWI[Gender,Age]=
    frac stopping DWI[Gender,Age]*Effect of parental monitoring on stopping DWI
[Gender,Age]*Effect of near crashes[Gender,Age]*(1-Switch enforcement visibility
)+

    Switch enforcement visibility*frac stopping DWI[Gender,Age]*Effect of enforcement visibility
on stopping DWI
*Effect of parental monitoring on stopping DWI[Gender,Age]*Effect of near crashes
[Gender,Age]
Units: Dmnl

Frac of legislated DWI laws=
    "Alcohol-impaired driving laws"/Maximum DWI laws
Units: Dmnl

"frac of non-DWI drinkers becoming DWI"[Gender,Age]=
    frac DWI[Gender,Age]*Effect of binge drinking on fraction who start DWI[Gender
,Age]*Effect of DWI laws on DWI[Gender,Age
    ]*Effect of parental monitoring on starting DWI[Gender,Age]*(1-Switch enfo visi
)

     + frac DWI[Gender,Age]*Effect of binge drinking on fraction who start DWI
[Gender,Age]*Effect of DWI laws on DWI
    [Gender,Age]*Effect of enforcement visibility on starting DWI*Effect of parental monitoring on
starting DWI
[Gender,Age]*Switch enfo visi
Units: Dmnl

frac stopping DWI[Gender,Age]=
    0.1
Units: Dmnl
0.2326, 0.0034, 0.001, 0.25, 0.232, 0.1933, 0.25, 0.1363,
        0.0872, 0.0747

Fraction initiate drinking[Gender,Age]=

(1-Switch alcohol truth campain)*frac drinking[Gender,Age] + Switch alcohol truth campain
*Alcohol truth campaign*frac drinking[Gender,Age]
Units: Dmnl

Fraction of Crash DWI trips fatal[Male,Age]=
   0.03, 0.03, 0.03, 0.03, 0.03, 0.03, 0.03, 0.03, 0.03, 0.03
Fraction of Crash DWI trips fatal[Female,Age]=
     0.03, 0.03, 0.03, 0.03, 0.03, 0.03, 0.03, 0.03, 0.03, 0.03
   Units: Dmnl
   I need to find this from the litretur. Is it affected by age and
      gender?

fraction of DWI trips resulting in crash[Male,Age]=
   0.00156,0.001159,0.00085,0.00064,0.00081,0.00069,0.00076,0.00071,0.00054,0.00056
fraction of DWI trips resulting in crash[Female,Age]=
     0.00129,0.0016,0.0011,0.00065,0.00067,0.00059,0.00068,0.00062,0.00055,0.00055
   Units: Dmnl [0.0001,0.004,5e-05]
   Zaloshnja, Miller and Blincoe (2013) estimated that 1 crash per
      788 impaired driving trips "Estimated crashes at BAC >=.08
      totaled 1,820,094, with 1 crash per 788 impaired driving trips. "

Fraction stopping DWI after arrest=
   0.4*(1-Switch Ignition Interlock)+ 0.4*Switch Ignition Interlock*Ignition Interlock
Units: Dmnl

Freq of DWI[Gender,Age]=
   (1-Switch alternative transportation)*Normal Frequency of DWI[Gender,Age]
+ Switch alternative transportation*Alternative transportation*Normal Frequency of DWI
[Gender,Age]
Units: Trip/(Person*Year)

Frequency of DWI[Gender,Age]=
   Freq of DWI[Gender,Age]*Effect of DWI laws on DWI[Gender,Age]*Effect of binge drinking on
frequency of DWI
   [Gender,Age]*Effect of alcohol consumption on frequency of DWI[Gender,Age]
Units: Trip/Person/Year

Ignition Interlock=
   1+RAMP(0.5, 2025 , 2027)
Units: Dmnl

Impact of age on law effectiveness[Age]=
   10.7,13.4,11.7,10.6,9.7,9.6,9.6,10.6,11,11.5
Units: Dmnl
1.4,1.4,1.4,1.4,1.4,0,0,0,0,0

Initial pressure=
   1.5
Units: Dmnl

"Male Abstainers aged 19-22"=

Abstainers[Male,Age19] + Abstainers[Male,Age20] + Abstainers[Male,Age21] +
 Abstainers[Male,Age22]
Units: Person

"Male Abstainers aged 23-24"=
   Abstainers[Male,Age23] + Abstainers[Male,Age24]
Units: Person

Maximum DWI laws=
   500
Units: Law

Near crash normal[Male,Age]=
   106,720,2200,4500,3900,4900,5400,5200,6200,5400
Near crash normal[Female,Age]=
      24,123,293,726,807,812,754,768,996,650
   Units: Trip/Year

Near crash ratio[Gender,Age]=
   Near crashes[Gender,Age]/Near crash normal[Gender,Age]
Units: Dmnl

Near crashes[Gender,Age]=
   Frac near crash*"non-crash DWI trips"[Gender,Age]
Units: Trip/Year

Never DWI again[Gender,Age15]= INTEG (
   Never DWI becoming 15[Gender]-Never DWI again aging[Gender,Age15],
      Never DWI again 0[Gender,Age15])
Never DWI again[Gender,All but 15]= INTEG (
      Drinkers stopping DWI after arrest[Gender,pAge]+Never DWI again aging[Gender
   ,pAge]-Never DWI again aging[Gender,All but 15],
         Never DWI again 0[Gender,All but 15])
   Units: Person
   I think Drinkers stopping DWI after arrest[Gender,pAge] should
         be for 15 years old and the rest for all but 15, it should not
         be pAge

Never DWI again 0[Male,Age]=
   0.293, 1.748, 4.887, 11.823, 17.198, 21.066, 25.92, 26.616, 26.899, 27.21
Never DWI again 0[Female,Age]=
      0.074, 0.308, 0.657, 1.561, 2.242, 2.832, 3.628, 3.576, 3.738, 3.684
   Units: Person
   I estimated these from arrest data. Jim Fell told us around 40%
         of those who are arrested stop DWI. see Arrest worksheet.

Never DWI again aging[Gender,Age]=
   Never DWI again[Gender,Age]/Cohort length
Units: Person/Year

Never DWI becoming 15[Male]:=

GET XLS DATA('DataAgeGender.xlsx' , 'Population' , 'B1' , 'B61')
Never DWI becoming 15[Female]:=
    GET XLS DATA('DataAgeGender.xlsx' , 'Population' , 'B1' , 'B63')
  Units: Person/Year

new DWI laws=
  max(0,Discrepancy/Time to legislate laws)
Units: Law/Year

new laws campaign=
  RAMP(0.07, 2023 , 2030)
Units: Dmnl

"non-crash DWI trips"[Gender,Age]=
  (1-fraction of DWI trips resulting in crash[Gender,Age])*DWI trips[Gender,
Age]
Units: Trip/Year

"Non-DWI drinkers 0"[Gender,Age]=
  "Frac non-DWI drinkers 1982"[Gender,Age]*Population 1982[Gender,Age]
Units: Person

"Non-DWI drinkers aging"[Gender,Age]=
  (1-frac becoming Abstainers[Gender,Age]-"frac of non-DWI drinkers becoming DWI"
[Gender,Age])*Drinkers who do not drive after drinking[Gender,Age]/Cohort length
Units: Person/Year

"Non-DWI drinkers becoming 15"[Male]:=
  GET XLS DATA('DataAgeGender.xlsx' , 'Population' , 'B1' , 'B57')
"Non-DWI drinkers becoming 15"[Female]:=
    GET XLS DATA('DataAgeGender.xlsx' , 'Population' , 'B1' , 'B59')
  Units: Person/Year

Normal annual DWI arrests=
  460
Units: Person/Year

Normal DWI trips caught by parents[Male,Age]=
  320,1400,2200,2300,1500,1500,1000,500,600,540
Normal DWI trips caught by parents[Female,Age]=
    73,250,290,360,320,240,150,77,100,65
  Units: Trip/Year

Normal Frequency of DWI[Male,Age]=
  3.802,22.56,44.2,92.17,69.84,73.36,63.99,77.41,90.38,99.62
Normal Frequency of DWI[Female,Age]=
    1.47,7.68,12.97,28.02,22.32,28.63,14.99,14.39,15.03,14.63
  Units: Trip/(Year*Person)
  2.7, 8.2, 17.9, 47.1, 59.9, 51.3, 66.2, 65.2, 62.8, 57.4 1.3,
      4.1, 9, 24, 30, 25, 33, 32.5, 31, 29

Normal probability of arrest[Male,Age]=
    0.0007,0.0007,0.0008,0.0009,0.0014,0.0014,0.0016,0.0016,0.0013,0.0014
Normal probability of arrest[Female,Age]=
      0.0008,0.0008,0.0009,0.001,0.0014,0.0013,0.0017,0.0017,0.0015,0.0015
    Units: Dmnl [0.0001,1,0.0001]
    0.0007,0.0007,0.0008,0.0009,0.0014,0.0014,0.0016,0.0016,0.0013,0.
        0014
        0.0008,0.0008,0.0009,0.001,0.0014,0.0013,0.0017,0.0017,0.0015,0.0
        015

Parental influence not to DWI[Gender,Age]=
    SMOOTH(Parental monitoring[Gender,Age], Parental response time)
Units: Dmnl

Parental intervention=
    1+RAMP(0.15, 2023 , 2030)
Units: Dmnl

Parental monitoring[Gender,Age]=
    DWI trips caught by parent[Gender,Age]/Normal DWI trips caught by parents[
Gender,Age]
Units: Dmnl

Parental response time=
    1
Units: Year

Passengers of drivers in fatal crashes[Gender,Age]=
    1000*RWI trips[Gender,Age]*Fraction of Crash DWI trips fatal[Gender,Age]*fraction of DWI
trips resulting in crash
[Gender,Age]
Units: **undefined**

Perception will get caught=
    SMOOTH(Visibility of enforcement, Time to create perception of enforcement
)
Units: Dmnl

Population 1982[Male,Age]=
    1833, 1841, 2014, 1990, 1971, 2043, 1913, 2125, 2045, 1996
Population 1982[Female,Age]=
      1692, 1854, 1897, 2034, 2028, 2045, 2169, 2134, 2146, 2206
    Units: Person

Population by gender and age[Gender,Age]=
    Abstainers[Gender,Age]+Drinkers who do not drive after drinking[Gender,Age
]+Drinkers who drive after drinking[Gender,Age]+Never DWI again[Gender,Age]
Units: Person

Pressure to legislate DWI laws=
    SMOOTH3I(Effect of fatality statistics on legislation, Time to build pressure

, Initial pressure)
Units: Dmnl

Probability of arrest[Gender,Age]=
    (1-Switch enforcement)*Normal probability of arrest[Male,Age] + Switch enforcement
*Enforcement intervention*Normal probability of arrest[Male,Age]
Units: Dmnl [0.0001,0.01,0.0001]

Proportion of DWI fatalities=
    "Total fatal DWI trips 15-24"/("Total fatal DWI trips 15-24"+"Total fatal non-DWI trips 15-24"
)
Units: Dmnl

r=
    0.1
Units: **undefined**

RWI trips[Gender,Age]=
    DWI trips[Gender,Age]*Average number of riders per DWI trips[Male,Age]
Units: RWI trip/Year

Switch alcohol truth campain=
    0
Units: Dmnl

Switch alternative transportation=
    0
Units: Dmnl [0,1,1]

Switch enfo visi=
    1
Units: Dmnl [0,1]

Switch enforcement=
    0
Units: Dmnl [0,1,1]

Switch enforcement visibility=
    1
Units: Dmnl [0,1,1]

Switch Ignition Interlock=
    0
Units: Dmnl [0,1,1]

Switch laws=
    0
Units: Dmnl

Switch Parental monitoring=
    0

Units: Dmnl

"switch-peer drinking"=
    1
Units: Dmnl [0,1,1]

Time to build pressure=
    10
Units: Year

Time to create perception of enforcement=
    5
Units: Year

Time to legislate laws=
    5
Units: Year

Total abstainers=
    Sum(Abstainers[Gender!,Age!])
Units: Person

"Total annual DWI arrests 15-24"=
    Sum(DWI arrests[Gender!,Age!])
Units: Person/Year

Total drinkers who drive after drinking=
    Sum(Drinkers who drive after drinking[Gender!,Age!])
Units: Person

"Total fatal DWI trips 15-24"=
    Sum(Fatal DWI trips[Gender!,Age!])
Units: Trip/Year

"Total fatal non-DWI trips 15-24":=
    GET XLS DATA('DataAgeGender.xlsx' , 'Fatality' , 'B1' , 'B25')
Units: Trip/Year

Total Passengers of drivers involved in fatal crashes=
    Sum(Passengers of drivers in fatal crashes[Gender!,Age!])
Units: **undefined**

Total population=
    Sum(Abstainers[Gender!,Age!]) + Sum(Drinkers who do not drive after drinking
[Gender!,Age!]) + Sum(Drinkers who drive after drinking[Gender!,Age!]) + Sum
(Never DWI again[Gender!,Age!])
Units: Person

"Total RWI trips with drivers aged 15-24"=
    Sum(RWI trips[Gender!,Age!])
Units: RWI trip/Year

Visibility of enforcement=
    "Total annual DWI arrests 15-24"/Normal annual DWI arrests
Units: Dmnl

 Bias tward binge drinking[Gender,Age]=
      1.1
    Units: Dmnl [0,2,0.01]

Binge drinkers[Gender,Age]=
    Binge drinkers who do not drive after drinking[Gender,Age]+Binge drinkers who drive after
drinking
[Gender,Age]
Units: Person

Binge drinkers who do not drive after drinking[Gender,Age]=
    "Frac of non-DWI who binge"[Gender,Age]*Drinkers who do not drive after drinking
[Gender,Age]
Units: Person

Binge drinkers who drive after drinking[Gender,Age]=
    Drinkers who drive after drinking[Gender,Age]*Frac of DWI drinkers who binge
[Gender,Age]
Units: Person

Binge reduction campaign=
    1+RAMP(-0.1, 2025 , 2027)
Units: Dmnl

Current frac of DWI who binge[Gender,Age]=
    (1-Switch binge campaign)*Normal frac of DWI who binge[Gender,Age] + Switch binge
campaign
*Binge reduction campaign*Normal frac of DWI who binge[Gender,Age]
Units: Dmnl

"Current frac of non-DWI who binge"[Gender,Age]=
    (1-Switch binge campaign)*"Normal frac of non-DWI who binge"[Gender,Age] +
 Switch binge campaign*Binge reduction campaign*"Normal frac of non-DWI who binge"
[Gender,Age]
Units: Dmnl

Drinkers who do not drive after drinking[Gender,Age15]= INTEG (
    "Non-DWI drinkers becoming 15"[Gender]-"Non-DWI drinkers aging"[Gender,Age15
]-Drinkers becoming abstainers[Gender,Age15]-Drinkers becoming DWI[Gender,Age15
],
      "Non-DWI drinkers 0"[Gender,Age15])

Drinkers who do not drive after drinking[Gender,All but 15]= INTEG (
    "Non-DWI drinkers aging"[Gender,pAge]+Abstainers becoming drinkers[Gender
    ,pAge]+DWIs stopping DWI[Gender,pAge]-"Non-DWI drinkers aging"[Gender,All but 15
    ]-Drinkers becoming abstainers[Gender,All but 15]-Drinkers becoming DWI[Gender
    ,All but 15],
        "Non-DWI drinkers 0"[Gender,All but 15])
    Units: Person

Drinkers who drive after drinking[Gender,Age15]= INTEG (
    Alcohol impaired drivers becoming 15[Gender]-Alcohol impaired drivers aging
[Gender,Age15]-DWIs stopping DWI[Gender,Age15
    ]-Drinkers stopping DWI after arrest[Gender,Age15],
        Alcohol impaired drivers 0[Gender,Age15])
Drinkers who drive after drinking[Gender,All but 15]= INTEG (
    Alcohol impaired drivers aging[Gender,pAge]-Alcohol impaired drivers aging
    [Gender,All but 15]+Drinkers becoming DWI[Gender
    ,pAge]-DWIs stopping DWI[Gender,All but 15]-Drinkers stopping DWI after arrest
    [Gender,All but 15],
        Alcohol impaired drivers 0[Gender,All but 15])
    Units: Person

Effect of binge drinking on fraction who start DWI[Male,Age]= WITH LOOKUP (
    "Frac of non-DWI who binge"[Male,Age],
        ([(0,0)-(10,10)],(0,0.5),(0.1,0.6),(0.2,0.8),(0.3,1),(0.4,1),(0.5,1),(0.6
,1.05),(0.7,1.1)))
Effect of binge drinking on fraction who start DWI[Female,Age]= WITH LOOKUP
    (
        "Frac of non-DWI who binge"[Female,Age],
        ([(0,0)-(10,10)],(0,0.5),(0.1,0.6),(0.2,0.9),(0.3,1),(0.4,1)))
    Units: Dmnl

Effect of binge drinking on frequency of DWI[Male,Age]= WITH LOOKUP (
    Frac of DWI drinkers who binge[Male,Age],
        ([(0,0)-(1,2)],(0,0.7),(0.1,0.7),(0.2,0.75),(0.3,0.8),(0.4,0.85),(0.5,0.9
),(0.6,1),(0.7,1.1),(0.8,1.15),(1,1.2)))
Effect of binge drinking on frequency of DWI[Female,Age]= WITH LOOKUP (
        Frac of DWI drinkers who binge[Female,Age],
        ([(0,0)-(1,2)],(0,0.7),(0.1,0.75),(0.2,0.85),(0.3,1),(0.4,1.05),(0.5,1.1
),(0.6,1.2),(0.7,1.25),(0.8,1.3),(1,1.3)))
    Units: Dmnl

Effect of peer on binge drinking[Gender,Age]= WITH LOOKUP (
    Perceived to norm binge drinking[Gender,Age],
        ([(0,0)-(4,2)],(0.1,0.85),(0.5,0.9),(0.8,0.95),(1,1),(1.2,1.15),(1.5,1.25
),(2,1.4),(2.5,1.7),(3,1.8),(4,1.8)))
Units: Dmnl

Estimated binge drinking[Age,Gender]=
    Bias tward binge drinking[Gender,Age]*Ratio of binge drinkers to total population
[Gender,Age]
Units: Dmnl

Frac of DWI drinkers who binge[Gender,Age]=
    Current frac of DWI who binge[Gender,Age]*Effect of peer on binge drinking
[Gender,Age]
Units: Dmnl

"Frac of non-DWI who binge"[Gender,Age]=
    "Current frac of non-DWI who binge"[Gender,Age]*Effect of peer on binge drinking
[Gender,Age]
Units: Dmnl

Initial frac[Male]=
    0.5
Initial frac[Female]=
        0.3
    Units: Dmnl

Normal binge drinking[Male,Age]=
    0.5,0.5,0.5,0.5,0.5,0.5,0.5,0.5,0.5,0.5
Normal binge drinking[Female,Age]=
        0.3,0.3,0.3,0.3,0.3,0.3,0.3,0.3,0.25,0.25
    Units: Dmnl

Normal frac of DWI who binge[Male,Age]=
    0.7,0.7,0.7,0.7,0.7,0.7,0.7,0.7,0.7,0.7
Normal frac of DWI who binge[Female,Age]=
        0.5,0.5,0.5,0.5,0.5,0.5,0.5,0.5,0.5,0.5
    Units: Dmnl
    Based on the NEXT data, DWIers are more likely to binge. For men
        1.2 and for women 1.3

"Normal frac of non-DWI who binge"[Male,Age]=
    0.5,0.5,0.5,0.5,0.5,0.5,0.5,0.5,0.5,0.5
"Normal frac of non-DWI who binge"[Female,Age]=
        0.3,0.3,0.3,0.3,0.3,0.3,0.3,0.3,0.3,0.3
    Units: Dmnl
    Fig 84, Monitoring teh future

Perceived peer binge drinking[Gender,Age]=
    SMOOTHI(Estimated binge drinking[Age,Gender], Time to perceive , Initial frac
[Gender])
Units: Dmnl

Perceived to norm binge drinking[Gender,Age]=
    Perceived peer binge drinking[Gender,Age]/Normal binge drinking[Gender,Age
]
Units: Dmnl

Population by gender and age[Gender,Age]=
    Abstainers[Gender,Age]+Drinkers who do not drive after drinking[Gender,Age
]+Drinkers who drive after drinking[Gender,Age]+Never DWI again[Gender,Age]

Units: Person

Ratio of binge drinkers to total population[Gender,Age]=
    min(1, Binge drinkers[Gender,Age]/Population by gender and age[Gender,Age]
)
Units: Dmnl

Switch binge campaign=
    0
Units: Dmnl

Time to perceive=
    2
Units: Year

Total binge drinkers=
    Sum(Binge drinkers[Gender!,Age!])
Units: Person

Total population=
    Sum(Abstainers[Gender!,Age!]) + Sum(Drinkers who do not drive after drinking
[Gender!,Age!]) + Sum(Drinkers who drive after drinking[Gender!,Age!]) + Sum
(Never DWI again[Gender!,Age!])
Units: Person

Average perceived peer drinking by age[Age]=
        Sum(Perceived peer drinking[Gender!,Age])/2
    Units: Dmnl

Bias toward peer drinking=
    1
Units: Dmnl

Drinkers by age and gender[Gender,Age]=
    Drinkers who do not drive after drinking[Gender,Age]+Drinkers who drive after drinking
[Gender,Age]+Never DWI again[Gender,Age]
Units: Person

Drinkers who do not drive after drinking[Gender,Age15]= INTEG (
    "Non-DWI drinkers becoming 15"[Gender]-"Non-DWI drinkers aging"[Gender,Age15
]-Drinkers becoming abstainers[Gender,Age15]-Drinkers becoming DWI[Gender,Age15
],
        "Non-DWI drinkers 0"[Gender,Age15])
Drinkers who do not drive after drinking[Gender,All but 15]= INTEG (
        "Non-DWI drinkers aging"[Gender,pAge]+Abstainers becoming drinkers[Gender
    ,pAge]+DWIs stopping DWI[Gender,pAge]-"Non-DWI drinkers aging"[Gender,All but 15
    ]-Drinkers becoming abstainers[Gender,All but 15]-Drinkers becoming DWI[Gender
    ,All but 15],
            "Non-DWI drinkers 0"[Gender,All but 15])
    Units: Person

Drinkers who drive after drinking[Gender,Age15]= INTEG (
    Alcohol impaired drivers becoming 15[Gender]-Alcohol impaired drivers aging
[Gender,Age15]-DWIs stopping DWI[Gender,Age15
    ]-Drinkers stopping DWI after arrest[Gender,Age15],
        Alcohol impaired drivers 0[Gender,Age15])
Drinkers who drive after drinking[Gender,All but 15]= INTEG (
        Alcohol impaired drivers aging[Gender,pAge]-Alcohol impaired drivers aging
    [Gender,All but 15]+Drinkers becoming DWI[Gender
        ,pAge]-DWIs stopping DWI[Gender,All but 15]-Drinkers stopping DWI after arrest
    [Gender,All but 15],
            Alcohol impaired drivers 0[Gender,All but 15])
    Units: Person

Effect of peer drinking on frac becoming drinkers[Gender,Age]=
    Ratio of perceived peer drinking to reference peer drinking[Age]^Strenght of peer influence
on alcohol initiation
[Age]
Units: Dmnl

Estimated peer drinking[Gender,Age]=
    Bias toward peer drinking*Ratio of drinkers to total population[Gender,Age
]
Units: Dmnl

Initial frac drinking[Male,Age]=
    0.6,0.65,0.7,0.8,0.8,0.8,0.8,0.8,0.8,0.8
Initial frac drinking[Female,Age]=
        0.5,0.55,0.65,0.7,0.7,0.75,0.75,0.75,0.75,0.75
    Units: Dmnl

Never DWI again[Gender,Age15]= INTEG (
    Never DWI becoming 15[Gender]-Never DWI again aging[Gender,Age15],
        Never DWI again 0[Gender,Age15])
Never DWI again[Gender,All but 15]= INTEG (
        Drinkers stopping DWI after arrest[Gender,pAge]+Never DWI again aging[Gender
    ,pAge]-Never DWI again aging[Gender,All but 15],
            Never DWI again 0[Gender,All but 15])
    Units: Person
    I think Drinkers stopping DWI after arrest[Gender,pAge] should
        be for 15 years old and the rest for all but 15, it should not
        be pAge

Perceived peer drinking[Gender,Age]=
    SMOOTHI(Estimated peer drinking[Gender,Age], Time to perceive peer drinking
 , Initial frac drinking[Gender,Age])
Units: Dmnl

Population by gender and age[Gender,Age]=
    Abstainers[Gender,Age]+Drinkers who do not drive after drinking[Gender,Age
]+Drinkers who drive after drinking[Gender,Age]+Never DWI again[Gender,Age]
Units: Person

Ratio of drinkers 18=
    Sum(Drinkers by age and gender[Gender!,Age18])/Sum(Population by gender and age
[Gender!,Age18])
Units: Dmnl

Ratio of drinkers to total population[Gender,Age]=
    Drinkers by age and gender[Gender,Age]/Population by gender and age[Gender
,Age]
Units: Dmnl

"Ratio of drinkers to total population-19-20"=
    (Sum(Drinkers by age and gender[Gender!,Age19]) + Sum(Drinkers by age and gender
[Gender!,Age20]))/(Sum(Population by gender and age[Gender!,Age19]) + Sum(Population by
gender and age
[Gender!,Age20]))
Units: Dmnl

"Ratio of drinkers to total population-21-22"=
    (Sum(Drinkers by age and gender[Gender!,Age21]) + Sum(Drinkers by age and gender
[Gender!,Age22]))/(Sum(Population by gender and age[Gender!,Age21]) + Sum(Population by
gender and age
[Gender!,Age22]))
Units: Dmnl

"Ratio of drinkers to total population-23-24"=
    (Sum(Drinkers by age and gender[Gender!,Age23]) + Sum(Drinkers by age and gender
[Gender!,Age24]))/(Sum(Population by gender and age[Gender!,Age23]) + Sum(Population by
gender and age
[Gender!,Age24]))
Units: Dmnl

"Ratio of female drinkers to total population-19-22"=
    (Drinkers by age and gender[Female,Age19]+Drinkers by age and gender[Female
,Age20]+Drinkers by age and gender[Female,Age21]+Drinkers by age and gender
[Female,Age22])/(Population by gender and age[Female,Age19]+Population by gender and age
[Female,Age20]+Population by gender and age[Female,Age21]+Population by gender and age
[Female,Age22])
Units: Dmnl

"Ratio of female drinkers to total population-23-24"=
    (Drinkers by age and gender[Female,Age23]+Drinkers by age and gender[Female
,Age24])/(Population by gender and age[Female,Age23]+Population by gender and age
[Female,Age24])
Units: Dmnl

"Ratio of male drinkers to total population-19-22"=
    (Drinkers by age and gender[Male,Age19]+Drinkers by age and gender[Male,Age20
]+Drinkers by age and gender[Male,Age21]+Drinkers by age and gender[Male,Age22
])/(Population by gender and age[Male,Age19]+Population by gender and age[Male
,Age20]+Population by gender and age[Male,Age21]+Population by gender and age

[Male,Age22])
Units: Dmnl

"Ratio of male drinkers to total population-23-24"=
    (Drinkers by age and gender[Male,Age23]+Drinkers by age and gender[Male,Age24
])/(Population by gender and age[Male,Age23]+Population by gender and age[Male
,Age24])
Units: Dmnl

Ratio of perceived peer drinking to reference peer drinking[Age]=
    Average perceived peer drinking by age[Age]/Reference peer drinking[Age]
Units: Dmnl

Reference peer drinking[Age]=
    0.5
Units: Dmnl
0.25,0.25,0.37,0.6,0.7,0.4,0.5,0.9,0.9,0.9

Strenght of peer influence on alcohol initiation[Age]=
    1.24, 0.6, 1.99, 0.01, 0.01, 0.01, 0.01, 0.01, 0.01, 0.01
Units: Dmnl [0,20,0.5]

Time to perceive peer drinking=
    1
Units: Year

Additional tax=
      STEP(Additional tax size, 2025)
    Units: Dollar/Gallon [1,20,1]

Additional tax size=
    0
Units: Dollar/Gallon [0,20,2]

Alcohol advertising in films=
    "Fraction of marketing expenditure allocated for product placement (films)"
*Alcohol marketing expenditures per year
Units: Dollar/Year

Alcohol consumption per capita[Gender,Age]=
    SMOOTHI(Indicated alcohol consumption per capita[Gender,Age], Time to change alcohol
consumption
, alcohol cumsumption per capita uner 25[Gender,Age])
Units: Gallon/(Year*Person)

"alcohol consumption per capita 25+"=
    (1-Switch alcohol truth campain)*"Normal alcohol consumption per capita-aged 25+"
 + Switch alcohol truth campain*Alcohol truth campaign*"Normal alcohol consumption per
capita-aged 25+"
Units: Gallon/(Year*Person)

"Alcohol consumption per capita-aged 25+"=
    SMOOTHI("Indicated alcohol consumption per capita-aged 25+", Time to change alcohol consumption
 , "alcohol consumption per capita 25+")
Units: Gallon/(Year*Person)

alcohol cumsumption per capita uner 25[Gender,Age]=
    (1-Switch alcohol truth campain)*Normal alcohol consumption per capita[Gender
,Age] + Switch alcohol truth campain*Normal alcohol consumption per capita[
Gender,Age]*Alcohol truth campaign
Units: Gallon/(Year*Person)

Alcohol industry revenue per year=
    Total spending on alcohol per year by people aged 15 to 24+"Total spending on alcohol per
year by people aged 25+"
Units: Dollar/Year

Alcohol marketing expenditures per year=
    Alcohol industry revenue per year*Fraction of revenue for advertisement
Units: Dollar/Year

Alcohol price without tax=
    90
Units: Dollar/Gallon
If the price is $100, the revenue mathes the advertisement
    expenditure $5 billion

Alcohol truth campaign=
    1+RAMP(-0.1, 2025 , 2027)
Units: Dmnl
1-0.2*PULSE(2023, 5)

Current fraction of revenue for advertisement=
    0.09
Units: Dmnl

Desired revenue=
    5e+10
Units: Dollar/Year

discrepancy between current and normal alcohol advertising expenditure=
    "Per capita alcohol advertising in television, radio, newspaper, and outdoors"
-Normal expenditure per capita
Units: Dollar/(Year*Person)

Discrepancy between normal and current movie alcohol exposure=
    Movie alcohol exposure-Normal movie alcohol exposure
Units: Exposure/Year

dollar spent for each hour of movie alcohol exposure=

7e+07
Units: Dollar/Exposure
Table 4 in "Self-regulation in the Alcohol industry" $ spent on
    Film. I assumed in million dollar: 4.786e+007 To get 8 hours of
    exposure, I used 70 million dollars

Drinkers by age and gender[Gender,Age]=
    Drinkers who do not drive after drinking[Gender,Age]+Drinkers who drive after drinking
[Gender,Age]+Never DWI again[Gender,Age]
Units: Person

Effect of alcohol consumption on frequency of DWI[Gender,Age]= WITH LOOKUP
(
    Ratio of current to normal alcohol consumtion[Gender,Age],
        ([(0,0)-(4,3)],(0,0.001),(0.1,0.05),(0.25,0.1),(0.5,0.5),(0.7,0.7),(1,1),
(1.5,1.5),(2,2),(3,3),(4,3)))
Units: Dmnl
([(0,0)-(3,1.5)],(0,0.1),(0.1,0.7),(0.25,0.9),(0.5,0.93),(1,1),(1
    .5,1.07),(2,1.14),(3,1.14))
        ([(0,0)-(3,1.5)],(0,0.1),(0.1,0.1),(0.2,0.3),(0.5,0.6),(0.9,0.9),
        (1,1),(1.1,1.1),(1.5,1.2),(2,1.3),(3,1.3))

effect of alcohol marketing on abstainers starting drinking= WITH LOOKUP (
    Discrepancy between normal and current movie alcohol exposure,
        ([(-7,0)-(5,2)],(-7,0.75),(-1,0.92),(0,1),(1,1.15),(2,1.3),(3,1.45),(4,1.45
)))
Units: Dmnl
Sargent reported crude OR=1.33, adjusted OR=1.14

"effect of alcohol marketing on consumption per capita-age 15 to 24"= WITH LOOKUP
 (
    discrepancy between current and normal alcohol advertising expenditure,
        ([(-5,0)-(10,10)],(-5,0.85),(-2,0.94),(-1,0.97),(0,1),(1,1.03),(2,1.06),(
5,1.15)))
Units: Dmnl
Snyder et al. For every additional dollar per capita spent on
    advertising in the market, individuals consumed 3% more
    alcoholic beverages per month (event rate ratio,1.03; 95% CI,
    1.01- 1.05)

"effect of alcohol marketing on consumption per capita-age 25+"= WITH LOOKUP
 (
    discrepancy between current and normal alcohol advertising expenditure,
        ([(-5,0)-(20,10)],(-5,0.85),(-2,0.94),(-1,0.97),(0,1),(1,1.03),(2,1.06),(
5,1.1),(10,1.2),(15,1.3),(20,1.4)))
Units: Dmnl
(each additional dollar spent per capita raised the number of
    drinks consumed by 3% [event rate ratio,1.03; 95% confidence
    interval, 1.01- 1.05]) This is for people aged 15 to 26. I
    should find for above 25

effect of alcohol price on consumption=
    1+Price elasticity of demand*Additional tax/Price of alcohol with tax per gallon
Units: Dmnl

effect of revenue gap on advertisement= WITH LOOKUP (
    Perceived revenue gap,
        ([(-1000,0)-(-2.14748e+09,10)],(-1000,1),(0,1),(1e+06,1.05),(1e+07,1.1),(
1e+08,1.2),(1e+10,1.5)))
Units: Dmnl
([(-1000,0)-(-2.14748e+09,10)],(-1000,1),(0,1),(1e+06,1),(1e+07,1
        .05),(1e+08,1.2),(1e+10,1.5))

fraction drinkers=
    0.8
Units: Dmnl

"Fraction of marketing expenditure allocated for product placement (films)"
=
    0.12
Units: Dmnl
https://www.ftc.gov/system/files/documents/reports/self-regulatio
        n-alcohol-industry-report-federal-trade-commission/140320alcoholr
        eport.pdf Table 4: (375,000+55,746)/3,454,738=0.125 This
        captures expenditure from Jan to Jun. Also I am not sure if teh
        numbers in table 4 should be multiplied by 1000

"Fraction of marketing expenditure allocated for television, radio, newspaper, and outdoors"
=
    0.387
Units: Dmnl
Table 2 shows what percentage of advertising expenditure goes to
        TV, Radio, newspaper, and outdoors 22.54
        +2.93+3.66+2.42+.38+.84+5.96=

Fraction of revenue for advertisement=
    Current fraction of revenue for advertisement*effect of revenue gap on advertisement
Units: Dmnl

Indicated alcohol consumption per capita[Gender,Age]=
    alcohol cumsumption per capita uner 25[Gender,Age]*"effect of alcohol marketing on
consumption per capita-age 15 to 24"
*
    effect of alcohol price on consumption
Units: Gallon/(Year*Person)

"Indicated alcohol consumption per capita-aged 25+"=
    "alcohol consumption per capita 25+"*"effect of alcohol marketing on consumption per capita-
age 25+"
*effect of alcohol price on consumption
Units: Gallon/(Year*Person)

Indicated movie alcohol exposure=
   Alcohol advertising in films/dollar spent for each hour of movie alcohol exposure
Units: Exposure/Year

Movie alcohol exposure=
   SMOOTH(Indicated movie alcohol exposure, Time to change movie alcohol exposure
)
Units: Exposure/Year

Normal alcohol consumption per capita[Male, Age]=
   2.93, 2.93, 2.93, 3.95, 3.95, 3.95, 3.95, 3.95, 3.95, 3.95
Normal alcohol consumption per capita[Female,Age]=
      1.79, 1.79, 1.79, 1.82, 1.82, 1.82, 1.82, 1.82, 1.82, 1.82
   Units: Gallon/Person/Year
   NIAAA reports per capital ethanol consumption 1982 to 2019. It
         declined from 2.75 to 2.1 (24% decline). I divided values of
         2002 for age 12 to 17 and 18 to 24 by 0.76 to get values in 1982

"Normal alcohol consumption per capita-aged 25+"=
   3.95
Units: Gallon/Person/Year

Normal expenditure per capita=
   6.8
Units: Dollar/(Year*Person)
Source: Snyder et al (2006) Per capita spending ranged from
      $0.20 to $17.3, averaging $6.8 (95% CI,6.6-7.0). $1 in 2000 is
      equivalent in purchasing power to about $1.68 today so I use
      6.8*1.68=11.42

Normal movie alcohol exposure=
   8
Units: Exposure/Year
Sarget :Adolescents reported seeing a median of 16 movies (IQR:
      11-22) from the list of 50, and this translated into an
      estimated median exposure (to alcohol use in the entire sample
      of 601 movies) of 8.3 hours (IQR:4.6-13.5).

"Per capita alcohol advertising in television, radio, newspaper, and outdoors"
=
   "Fraction of marketing expenditure allocated for television, radio, newspaper, and outdoors"
*Alcohol marketing expenditures per year
   /Total adult population
Units: Dollar/Person/Year

"Per capita revenue aged 15-24"[Gender,Age]=
   Alcohol consumption per capita[Gender,Age]*Alcohol price without tax
Units: Dollar/Person/Year

"Per capita revenue-aged 25+"=
   "Alcohol consumption per capita-aged 25+"*Alcohol price without tax

Units: Dollar/Person/Year

Perceived revenue gap=
    SMOOTH3(Revenue gap, Time to perceive revenue gap)
Units: Dollar/Year

Price elasticity of demand=
    -0.7
Units: Dmnl
Elder and colleagues (2010) determined that median elasticities
    ranged from -0.51 to -0.90 in the 38 articles they reviewed.

Price of alcohol with tax per gallon=
    Alcohol price without tax+Tax
Units: Dollar/Gallon

Ratio of current to normal alcohol consumtion[Gender,Age]=
    Alcohol consumption per capita[Gender,Age]/Normal alcohol consumption per capita
[Gender,Age]
Units: Dmnl

Revenue gap=
    Desired revenue-Alcohol industry revenue per year
Units: Dollar/Year

Spending on alcohol per year[Gender,Age]=
    Drinkers by age and gender[Gender,Age]*"Per capita revenue aged 15-24"[Gender
,Age]
Units: Dollar/Year

Switch alcohol truth campain=
    0
Units: Dmnl

Tax=
    1
Units: Dollar/Gallon
https://alcoholpolicy.niaaa.nih.gov/ The highest tax is on
    spirits

Time to change alcohol consumption=
    0.5
Units: Year

Time to change movie alcohol exposure=
    2
Units: Year

Time to perceive revenue gap=
    1
Units: Year

Total adult population=
    2.43e+08
Units: Person
I used average of the US adult population 2009 to 2018 found
    here:
    https://datacenter.kidscount.org/data/tables/99-total-population-
    by-child-and-adult#detailed/1/any/false/37,871,870,573,869,36,868
    ,867,133,38/39,40,41/416,417

"Total population 25+"=
    1.82e+08
Units: Person
https://www.infoplease.com/us/census/demographic-statistics
    39.9+45.1+37.7+13.5+10.8+18.4+12.4+4.2=182

Total spending on alcohol per year by people aged 15 to 24=
    Sum(Spending on alcohol per year[Gender!,Age!])
Units: Dollar/Year

"Total spending on alcohol per year by people aged 25+"=
    "Per capita revenue-aged 25+"*"Total population 25+"*fraction drinkers
Units: Dollar/Year

Appendix 2: Residuals

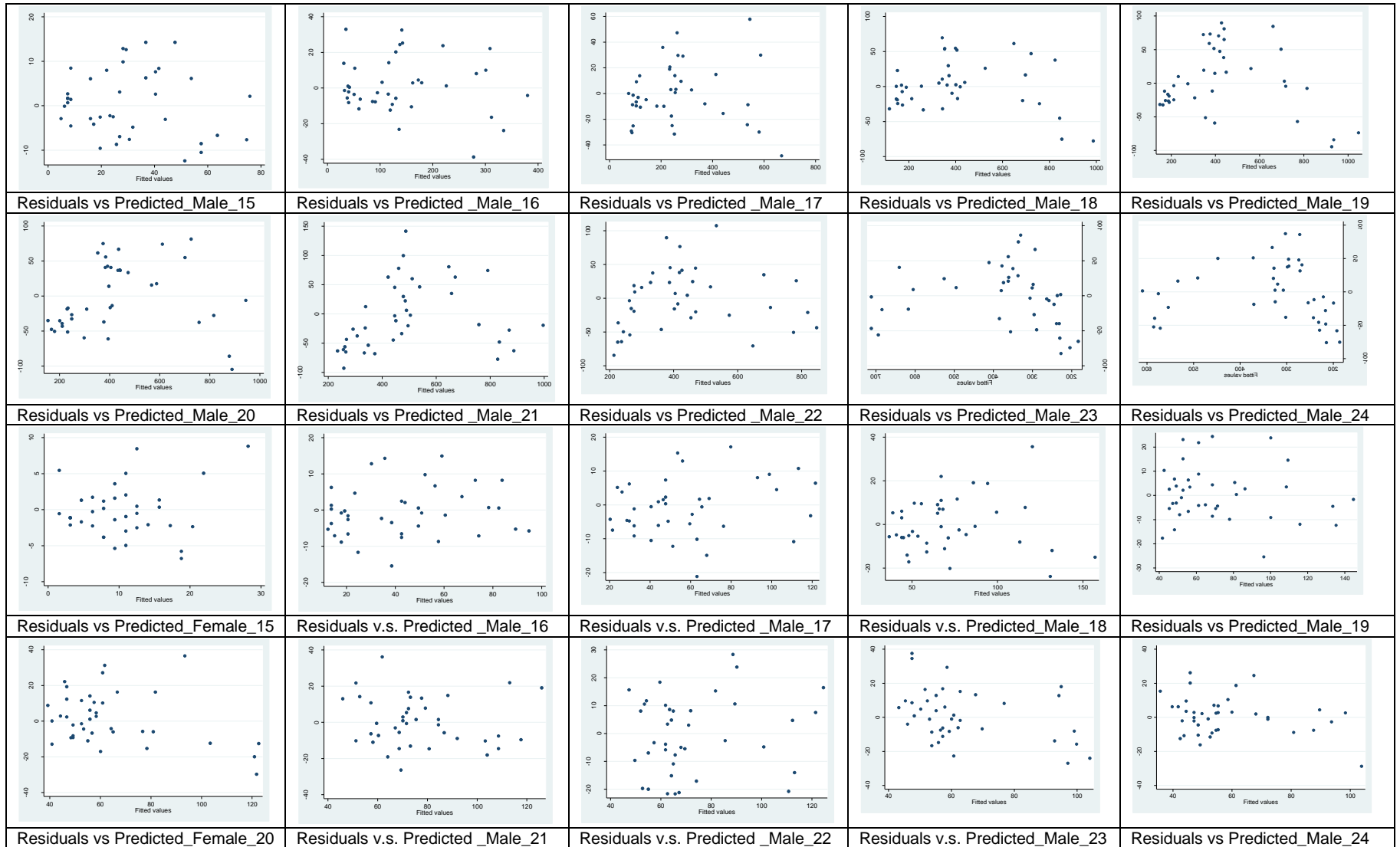| Residuals vs Predicted_Male_15	Residuals vs Predicted _Male_16	Residuals vs Predicted _Male_17	Residuals vs Predicted_Male_18	Residuals vs Predicted_Male_19
Residuals vs Predicted_Male_20	Residuals vs Predicted _Male_21	Residuals vs Predicted _Male_22	Residuals vs Predicted_Male_23	Residuals vs Predicted_Male_24
Residuals vs Predicted_Female_15	Residuals v.s. Predicted _Male_16	Residuals v.s. Predicted _Male_17	Residuals v.s. Predicted_Male_18	Residuals vs Predicted_Male_19
Residuals vs Predicted_Female_20	Residuals v.s. Predicted _Male_21	Residuals v.s. Predicted _Male_22	Residuals v.s. Predicted_Male_23	Residuals vs Predicted_Male_24

Figure 1A. Residuals versus predicted values of passengers of drivers involved in fatal crashes with BAC≥0.01g/dL

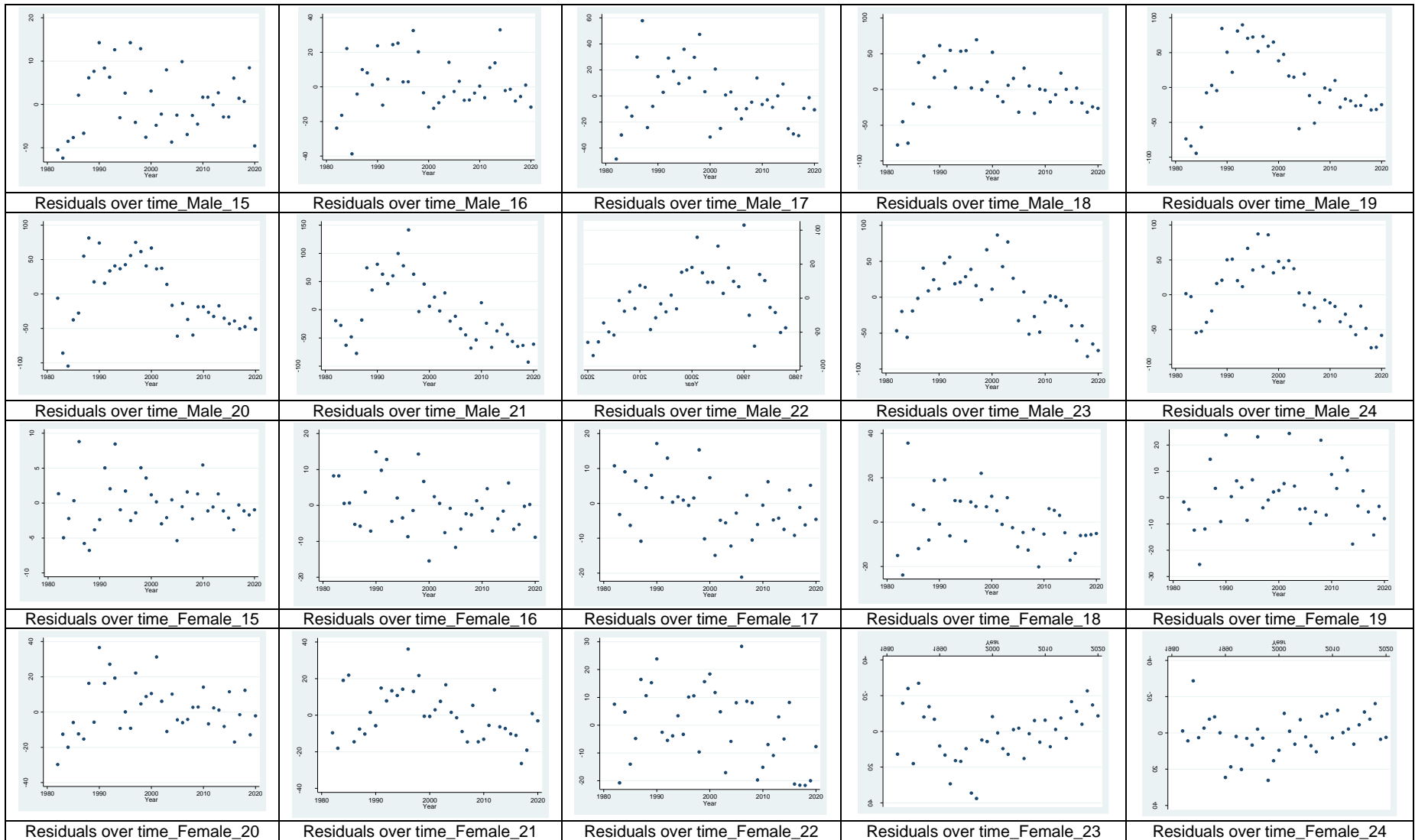|				
Residuals over time_Male_15	Residuals over time_Male_16	Residuals over time_Male_17	Residuals over time_Male_18	Residuals over time_Male_19
Residuals over time_Male_20	Residuals over time_Male_21	Residuals over time_Male_22	Residuals over time_Male_23	Residuals over time_Male_24
Residuals over time_Female_15	Residuals over time_Female_16	Residuals over time_Female_17	Residuals over time_Female_18	Residuals over time_Female_19
Residuals over time_Female_20	Residuals over time_Female_21	Residuals over time_Female_22	Residuals over time_Female_23	Residuals over time_Female_24

Figure 2A. Residuals over time