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] =
- 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)
 max(0, DWI arrests[Gender, Age]*Fraction stopping DWI after arrest)
 Units: Person/Year

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 (  
   - 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),(0,0.05),(0.25,0.1),0.5,0.55,0.7,0.75,1,1,
  (1.5,1.5),(2,2),(3,3),(4,3))
Units: Dmnl
([0,0)-[3,5]),(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)
  (3,2),(3,3))
  ([0,0)-[3,1.5]),(0,0.1),(0.1,0.3),(0.2,0.5),(0.3,0.9),(0.4,0.9),
  (0.5,0.95),(0.6,1),(0.7,1.1),(0.8,1.2),(0.9,1.3),(1,1.3))
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],
\[([0,0)-(4,2)],(0,0.7),(0.5,0.8),(1,1),(2,1.3),(4,1.3)\])
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]^Strength 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, 0.2398, 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, 0.26, 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 campain*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 literature. Is it affected by age and gender?

fraction of DWI trips resulting in crash[Male,Age]=
0.00156,0.001159,0.00085,0.00064,0.00069,0.00069,0.00076,0.00071,0.00054,0.00056
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,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]=
   106,720,220,4500,3900,4900,5400,5200,6200,5400
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, 0.0014, 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, 0.0014, 0.0017, 0.0017, 0.0015, 0.0015

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] =
Population 1982 [Female, Age] =
1692, 1854, 1897, 2034, 2028, 2045, 2169, 2134, 2146, 2206
Units: Person

Population by gender and age [Gender, Age] =
Units: Person

Pressure to legislate DWI laws =
SMOOTH3I (Effect of fatality statistics on legislation, Time to build pressure)
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 campaign =
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 toward 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 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,All but 15] = INTEG (  
  Alcohol impaired drivers becoming 15[Gender]-Alcohol impaired drivers aging[Gender,All but 15]-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),(0,0.85),(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 toward 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] =
Units: Person

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

Switch binge campaign =
  0
Units: Dmnl

Time to perceive =
  2
Units: Year

Total binge drinkers =
  \[ \sum(\text{Binge drinkers}[\text{Gender!}, \text{Age!}]) \]
Units: Person

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

Average perceived peer drinking by age[Age] =
  \[ \frac{\sum(\text{Perceived peer drinking}[\text{Gender!}, \text{Age}])}{2} \]
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

"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=
\[
\frac{\text{Sum(Drinkers by age and gender[Gender!,Age18])}}{\text{Sum(Population by gender and age [Gender!,Age18])}}
\]
Units: Dmnl

Ratio of drinkers to total population[Gender,Age]=
\[
\frac{\text{Drinkers by age and gender[Gender,Age]}}{\text{Population by gender and age[Gender ,Age]}}
\]
Units: Dmnl

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

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

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

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

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

"Ratio of female drinkers to total population-19-22"=
\[
\frac{(\text{Drinkers by age and gender[Male,Age19]} + \text{Drinkers by age and gender[Male,Age20 ]} + \text{Drinkers by age and gender[Male,Age21]} + \text{Drinkers by age and gender[Male,Age22 ]})}{(\text{Population by gender and age[Male,Age19]} + \text{Population by gender and age[Male ,Age20]} + \text{Population by gender and age[Male,Age21]} + \text{Population by gender and age [Male,Age22]})}
\]
Units: Dmnl
"Ratio of male drinkers to total population-23-24"=
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

Strength 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]=
   SMOOTH(Indicated alcohol consumption per capita[Gender,Age], Time to change alcohol consumption , alcohol consumption per capita under 25[Gender,Age])
Units: Gallon/(Year*Person)

"alcohol consumption per capita 25+"=
   (1-Switch alcohol truth campaign)*"Normal alcohol consumption per capita-aged 25+" + Switch alcohol truth campaign*Alcohol truth campaign*"Normal alcohol consumption per capita-aged 25+"
Units: Gallon/(Year*Person)
"Alcohol consumption per capita-aged 25+" =
  \( \text{SMOOTHI(\"Indicated alcohol consumption per capita-aged 25+,\" Time to change alcohol consumption
  ,\"alcohol consumption per capita 25+\")} \)
Units: Gallon/(Year*Person)

alcohol consumption per capita under 25[Gender,Age] =
  \((1 - \text{Switch alcohol truth campaign}) \times \text{Normal alcohol consumption per capita}[\text{Gender},\text{Age}] + \text{Switch alcohol truth campaign} \times \text{Normal alcohol consumption per capita}[\text{Gender},\text{Age}] \times \text{Alcohol truth campaign}\)
Units: Gallon/(Year*Person)

Alcohol industry revenue per year =
  \(\text{Total spending on alcohol per year by people aged 15 to 24+} \times \text{Total spending on alcohol per year by people aged 25+}\)
Units: Dollar/Year

Alcohol marketing expenditures per year =
  \(\text{Alcohol industry revenue per year} \times \text{Fraction of revenue for advertisement}\)
Units: Dollar/Year

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

Alcohol truth campaign =
  \(1 + \text{RAMP}(-0.1, 2025, 2027)\)
Units: Dmnl
1 - 0.2 \times \text{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 =
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 consumption[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

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-regulation-alcohol-industry-report-federal-trade-commission/140320alcoholreport.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 the 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 consumption per capita under 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/dollars 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
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
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
Perceived revenue gap =
  \( \text{SMOOTH3(Revenue gap, Time to perceive revenue gap)} \)
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 =
  \( \text{Alcohol price without tax} + \text{Tax} \)
Units: Dollar/Gallon

Ratio of current to normal alcohol consumption[Gender, Age] =
  \( \frac{\text{Alcohol consumption per capita[Gender, Age]}}{\text{Normal alcohol consumption per capita[Gender, Age]}} \)
Units: Dmnl

Revenue gap =
  \( \text{Desired revenue} - \text{Alcohol industry revenue per year} \)
Units: Dollar/Year

Spending on alcohol per year[Gender, Age] =
  \( \text{Drinkers by age and gender[Gender, Age]} \times \text{"Per capita revenue aged 15-24"[Gender, Age]} \)
Units: Dollar/Year

Switch alcohol truth campaign =
  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:

"Total population 25+" = 1.82e+08
Units: Person
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

Figure 1A. Residuals versus predicted values of passengers of drivers involved in fatal crashes with BAC≥0.01g/dL.
Figure 2A. Residuals over time