Supplementary Materials: The Climate Change-Road Safety-Economy Nexus: A System Dynamics Approach to Understanding Complex Interdependencies

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1. Concept:

As it is discussed in the manuscript, this study is tried to have a holistic investigation on the issue of road safety by linking different parameters playing role in this field. In order to strengthen the discussions in the manuscript and address reviewer's comment this supplementary document is provided. This document includes different sub-models used to achieve the goal of this study and perform several policy analysis as well in one frame all together. At the end of this document, the whole model formulations related to different sub-models are shown in order to better understand the process in which the authors have gone through to construct the stock and flow diagram.

During this study, several sub-models were developed. In each of these sub-models, it was tried to concentrate on one aspect of the road safety and we have been trying to investigate the relationship between different parameters mentioned in this study. for example in the first model (driver's safety model), it is tried to highlight the main reasons of accident occurrence including; speeding, alcohol, driving under influence, any kind of distraction and also the number of lives saved as a result of fastening the seat belt [1]. In this regard, it is tried to use the data prepared by National Highway Traffic Safety Administration, USDOT Bureau of Transportation Statistics and U.S census. In these databases, the data gathered from 1994 to 2014 is used to find trend to project future situation of road safety. Meaning that what would happen if the current trend that we have had from 20 years ago, continues. In this regard, four major causes of accidents including; alcohol, speed, aggressive driving and distraction are investigated in detail. Other fatal accidents that are due to any other factor other than what is mentioned above is considered as "Fatal accidents due to other factors". The rates are expressed in "per 100 M VMT". The obtained rate, are multiplied by vehicle miles travelled to obtain the total number of fatalities. Or in the second model (motor vehicle safety model), it is tried to focus on the role of increasing safety features in vehicles to save more lives in fatal accidents. As the safety features in vehicles increase, the total cost of the vehicle also increases. At the same time, increasing the number of lives saved as a result of increasing safety features can compensate some of the costs that was already added to the cost of the vehicle. NHTSA is trying to help the customers to find safer vehicles by setting standards for safety and define a 5 star safety rating system.

As can be seen in all sub-models, it has been tried to use historical data and the data provided by government organizations and agencies to establish the relationship between different parameters involved in the issue of road safety.

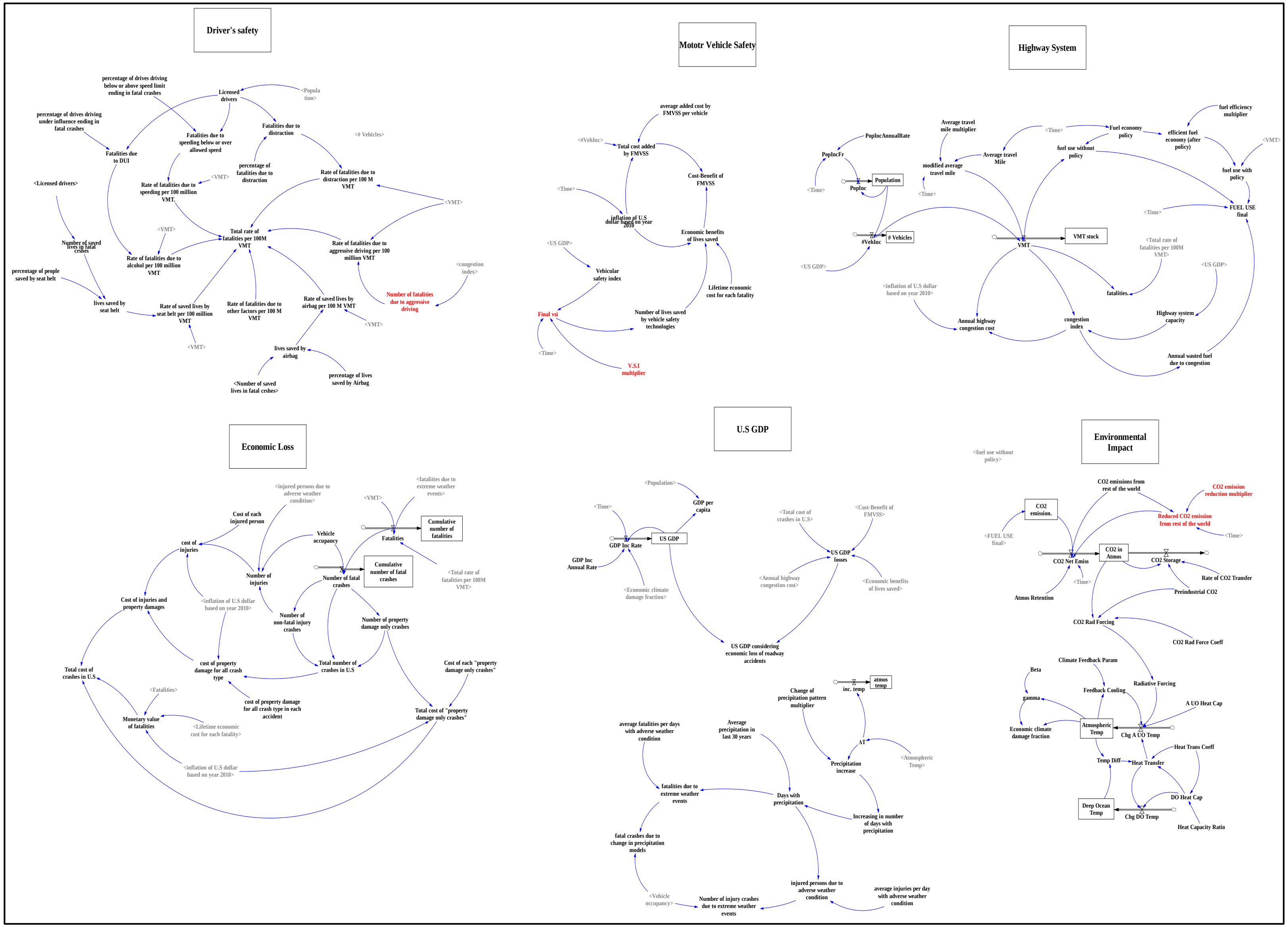

Figure S1. General view of stock and flow diagram.

2. Model Formulation

In this section, it is tried to present the formulations used to establish a connection between different parameters involve in the issue of road safety. In some of below formulations, regression analysis is used to establish a connection between these parameters. In order to perform regression analysis, it is tried to mostly use the data provided by National Highway Traffic Safety Administration (NHTSA) and other reports published by U.S DOT.

- **Annual highway congestion cost** = A FUNCTION OF (Annual highway congestion cost, congestion index, "inflation of U.S dollar based on year 2010", VMT)
- **Annual highway congestion cost** = ((2.13929×10^{12} × congestion index × congestion index × congestion index − 6.56078×10^{12} × congestion index × congestion index + 6.70881×10^{12} × congestion index − 2.28684×10^{12})/$(1.03)^2$ × ("inflation of U.S dollar based on year 2010") + (10^{-15} × VMT × VMT − 0.00494571 × VMT + 6.28422×10^9) × "inflation of U.S dollar based on year 2010"

Units: U.S Dollar

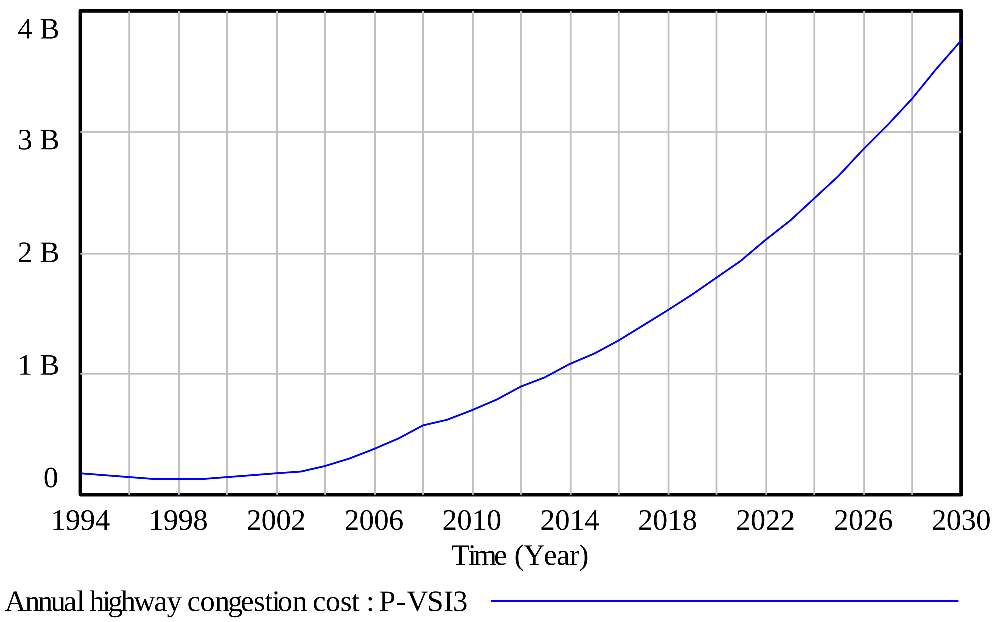

Figure S2. Annual highway congestion cost.

- **Annual wasted fuel due to congestion** = IF THEN ELSE ((congestion index = 0), 0, (1.93025×10^8 × congestion index × congestion index − 3.20771×10^8 × congestion index + 1.4234×10^8))

Units: million gallon

- **Atmosphere Retention** = 0.64

Units: Dmnl

Note: Atmospheric Retention Fraction [beta] (dimensionless) Fraction of Greenhouse Gas Emissions which accumulate in the atmosphere. [Cowles, pg. 21]

- **Atmospheric Temp** = INTEG (Change A UO Temp, 0.22)

Units: Degrees C

Note: Temperature of the Atmosphere and Upper Ocean [T] (degrees C) [Cowles, pg. 24] adjusted for 1980, http://data.giss.nasa.gov/gistemp/graphs_v3/Fig.A2.txt

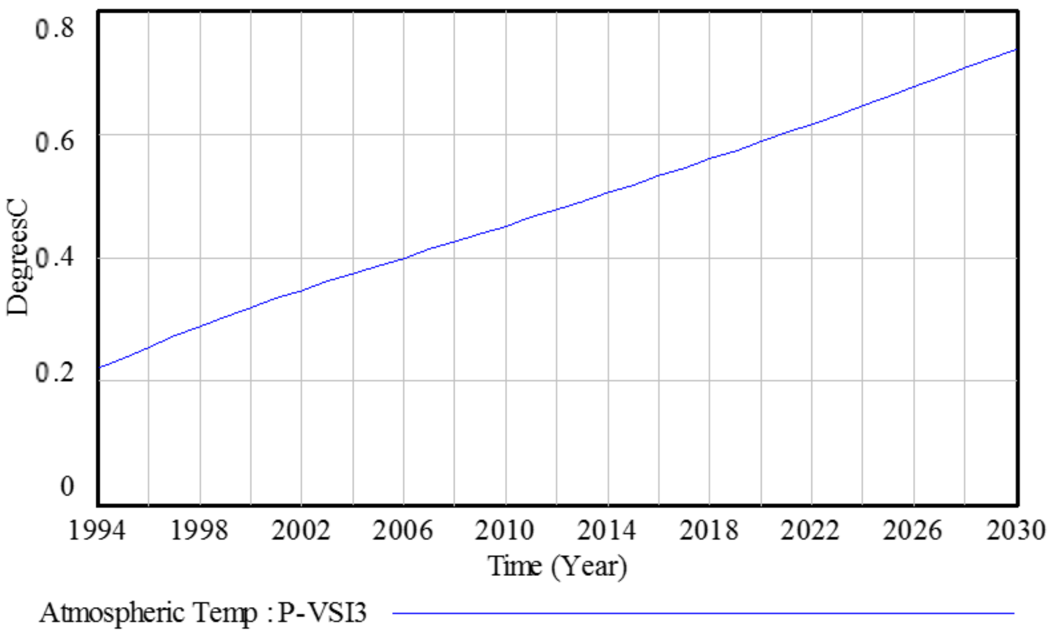

Figure S3. Atmospheric temperature change.

- **Average added cost by FMVSS per vehicle** = A FUNCTION OF (average added cost by FMVSS per vehicle)

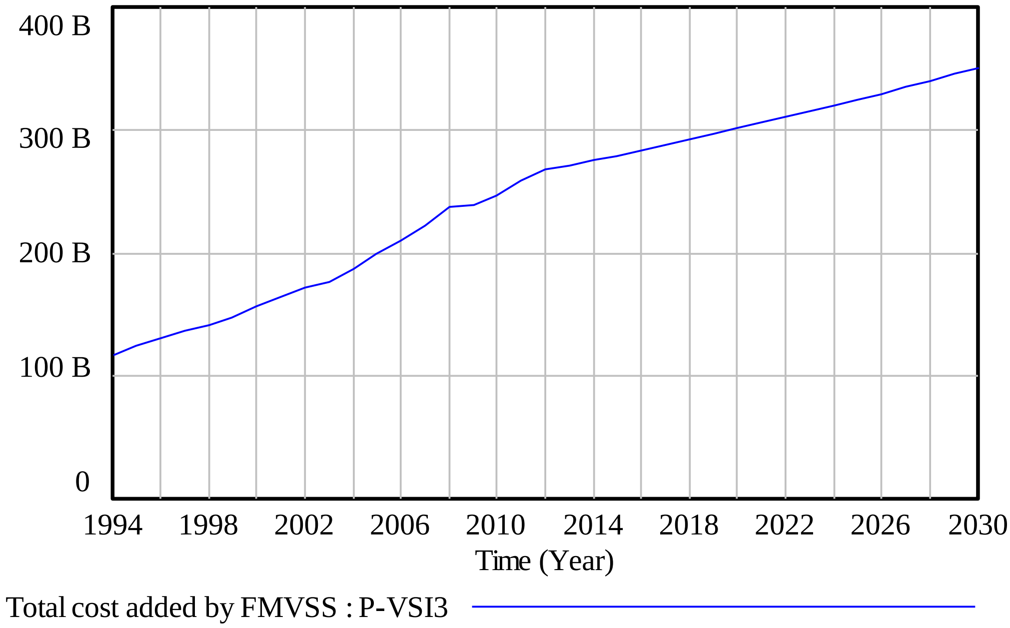

Figure S4. Total cost added by FMVSS.

- **Average added cost by FMVSS per vehicle** = 939.37

Units: U.S dollar

- **Average fatalities per days with adverse weather condition** = 165

Units: Individual

- **Average injuries per day with adverse weather condition** = 12674

Units: Individual

- **Average precipitation in last 30 years** = 37.9

Units: mm

- **Average travel Mile** = WITH LOOKUP (Time, ([(1975,0) (2012,20000)], (1980,9500), (1985,10020), (1990,11707), (1995,11902), (2000,12164), (2010,12164)))

Units: Miles
- **Beta** = **RANDOM** GAMMA (0.000628, 0.00321, 4.5, 0.0019, 0.00105, 0.000629)

Units: Dmnl
- **Change in the Atmosphere & Upper Ocean Temperature** = (Radiative Forcing-Feedback Cooling-Heat Transfer)/A UO Heat Cap

Units: Degrees C/Year
Note: Change in the Atmosphere & Upper Ocean Temperature (degrees C/yr) [Cowles, pg. 27]
- **Change in the Deep Ocean Temperature** = Heat Transfer/DO Heat Cap

Units: Degrees C/Year
Note: Change in the Deep Ocean Temperature (degrees C/yr) [Cowles, pg. 30]
- **Climate Feedback Parameter** = 1.41

Units: watt/meter/meter/Degrees C
Note: Climate Feedback Parameter [lambda] (W-m^2/degree C) The crucial climate sensitivity parameter—determines gain of feedback from temperature increase and thus determines equilibrium response to forcing. The Schneider-Thompson 2-stock model uses 1.33 [Cowles, Table III-B1]. [Managing Global Commons, pg. 21]
- **CO_2 emission** = (3.19559×10^{-20} × FUEL USE final × FUEL USE final − 7.45381×10^{-9} × FUEL USE final + 870.56) × 10^{6}

Units: ton
- **CO_2 emissions from rest of the world** = WITH LOOKUP (Time, ([(1994,0) − (2050, 6×10^{10})], (1994,1.63705×10^{10}), (1995,1.67412×10^{10}), (1996,1.70659×10^{10}),(1997,1.71442×10^{10}), (1998,1.71309×10^{10}), (1999,1.74799×10^{10}), (2000,1.8069×10^{10}), (2001,1.81328×10^{10}), (2002,1.85525×10^{10}), (2003,1.96342×10^{10}), (2004,2.0886×10^{10}), (2005,2.17674×10^{10}), (2006,2.2583×10^{10}), (2007,2.33063×10^{10}), (2008,2.37582×10^{10}), (2009,2.36234×10^{10}), (2010,2.53963×10^{10}), (2011,2.58575×10^{10}), (2012,2.63196×10^{10}), (2013,2.69017×10^{10}), (2014,2.75306×10^{10}), (2015,2.80893×10^{10}), (2016,2.87492×10^{10}), (2017,2.94031×10^{10}), (2018,3.00585×10^{10}), (2019,3.06768×10^{10}), (2020,3.12905×10^{10}), (2021,3.18907×10^{10}), (2022,3.25331×10^{10}), (2023,3.31545×10^{10}), (2024,3.37763×10^{10}), (2025,3.44642×10^{10}), (2026,3.51685×10^{10}), (2027,3.58833×10^{10}), (2028,3.66032×10^{10}), (2029,3.7325×10^{10}), (2030,3.80706×10^{10}), (2031,3.88453×10^{10}), (2032,3.96296×10^{10}), (2033,4.04097×10^{10}), (2034,4.11725×10^{10}), (2035,4.19455×10^{10}), (2036,4.28324×10^{10}), (2037,4.36856×10^{10}), (2038,4.45343×10^{10}), (2039,4.53813×10^{10}), (2040,4.62307×10^{10}), (2041,4.70691×10^{10}), (2042,4.79283×10^{10}), (2043,4.8806×10^{10}), (2044,4.96969×10^{10}), (2045,5.05821×10^{10}), (2046,5.14913×10^{10}), (2047,5.2402×10^{10}), (2048,5.32957×10^{10}), (2049,5.41988×10^{10}), (2050,5.51193×10^{10}))

Units: Ton C
- **CO_2 in Atmosphere** = INTEG (CO_2 Net Emission − CO_2 Storage, 7.18002×10^{11})

Units: Ton C
Note: Greenhouse Gases in Atmosphere [M(t)] (tons carbon equivalent) [Cowles, pg. 21]

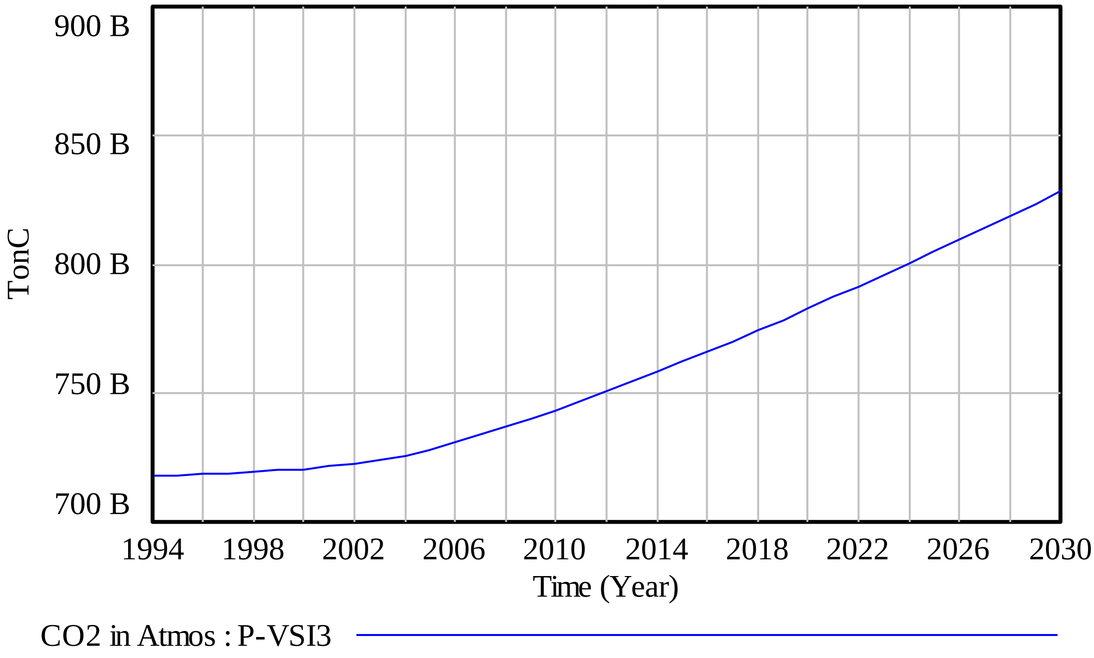

Figure S5. CO_2 in atmosphere.

- **CO_2 Net Emission** = Atmosphere Retention × ("CO_2 emission" + MIN ((CO_2 emissions from rest of the world (Time)), Reduced CO_2 emission from rest of the world))

Units: Ton C/Year

Note: Net Greenhouse Gas Emissions (tons carbon equivalent/year) Greenhouse gas emissions less short-run uptake from the atmosphere. [Cowles, pg. 21]

- **CO_2 Rad Force Coefficient** = 4.1

Units: watt/meter/meter

Note: Coefficient of Radiative Forcing from CO_2 (W/m ^{2}) Coefficient of additional surface warming from accumulation of CO_2. [Cowles, pg. 22]

- **CO_2 Rad Forcing** = CO_2 Rad Force Coefficient x LOG (CO_2 in Atmosphere/Preindustrial CO_2, 2)

Units: watt/meter/meter

Note: Radiative Forcing from CO2 [F (t)] (W/m ^{2}) Additional surface warming from accumulation of CO_2. [Cowles, pg. 22]

- **CO_2 Storage** = (CO_2 in Atmosphere − Preindustrial CO_2) × Rate of CO_2 Transfer)

Units: Ton C/Year

Note: Greenhouse Gas removal from the atmosphere and storage by long-term processes. (Tons carbon equivalent/year) [Cowles, pg. 21]

- **Congestion index** = IF THEN ELSE (($-2.25 + 2.69 \times 10^{-6}$ × Highway system capacity -1.64×10^{-12} × VMT -4.55×10^{-13} × (Highway system capacity) × Highway system capacity + 3.94×10^{-19} × Highway system capacity × VMT) < 0, 0, ($-2.25 + 2.69 \times 10^{-6}$ × Highway system capacity -1.64×10^{-12} × VMT -4.55×10^{-13} × (Highway system capacity) × Highway system capacity + 3.94×10^{-19} × Highway system capacity × VMT))

Units: additional travel time compared to normal traffic.

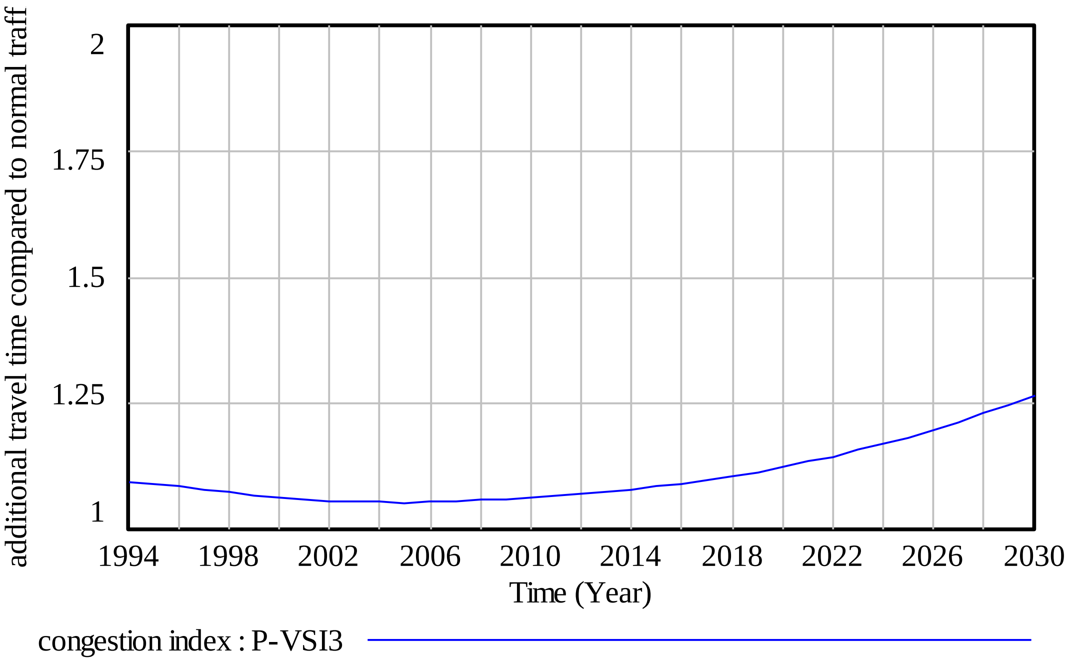

Figure S6. Congestion index.

- **Cost of property damage for all crash type** = cost of property damage for all crash type in each accident x "inflation of U.S dollar based on year 2010"

Units: undefined

- **Cost of property damage for all crash type in each accident** = A FUNCTION OF(cost of property damage for all crash type in each accident)
- **Cost of property damage for all crash type in each accident** = 13836.4

Units: {U.S dollar}

- **Cost-Benefit of FMVSS** = A FUNCTION OF ("Cost-Benefit of FMVSS", Economic benefits of lives saved, Total cost added by FMVSS)
- **Cost-Benefit of FMVSS** = Total cost added by FMVSS-Economic benefits of lives saved

Units: U.S dollar

- **Deep Ocean Temp** = INTEG(Chg DO Temp, 0.1)

Units: Degrees C

Note: Temperature of the Deep Ocean [Tx] (degrees C) [Cowles, pg. 24]

- **Deep ocean Heat Cap** = Heat Capacity Ratio × Heat Trans Coefficient

Units: watt × Year/Degrees C/meter/meter

Deep Ocean Heat Capacity per Unit Area [R2] (W-yr /m ^{2}/degrees C)

Note: Managing Global Commons uses. 44 × Heat Trans Coefficient = 220; Cowles report uses 223.7 (page 30). [Managing Global Commons, pg. 21]

- **Economic benefits of lives saved** = Number of lives saved by vehicle safety technologies × Lifetime economic cost for each fatality

Units: {U.S dollar}

- **Economic climate damage fraction**= gamma × Atmospheric Temp

Units: Dmnl

- **Fatalities** = (Total rate of fatalities per 100 M VMT × (VMT × 10^{-8}))

Units: Individual

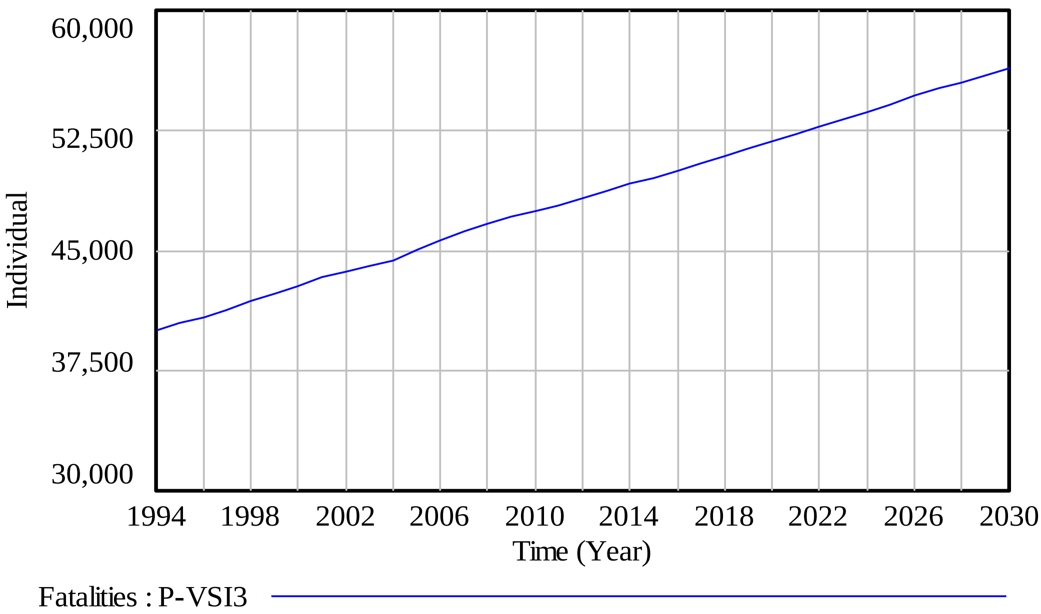

Figure S7. Number of road accident fatalities.

- **Fatalities due to distraction** = Licensed drivers × percentage of fatalities due to distraction

Units: Individual

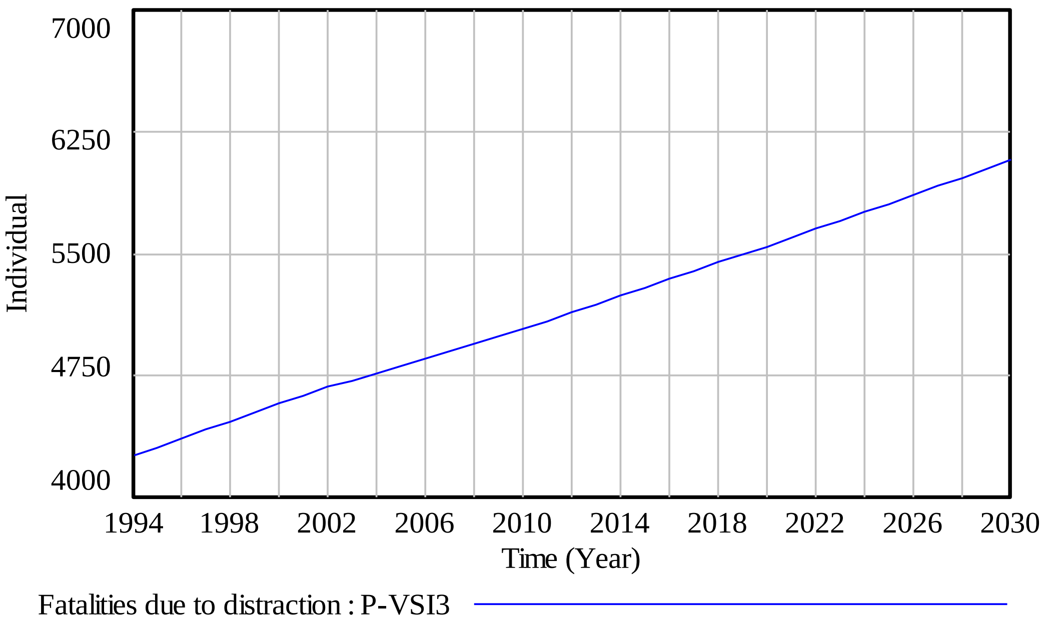

Figure S8. Number of fatalities due to distraction.

- **Fatalities due to DUI** = Percentage of drives driving under influence ending in fatal crashes × Licensed drivers

Units: Individual

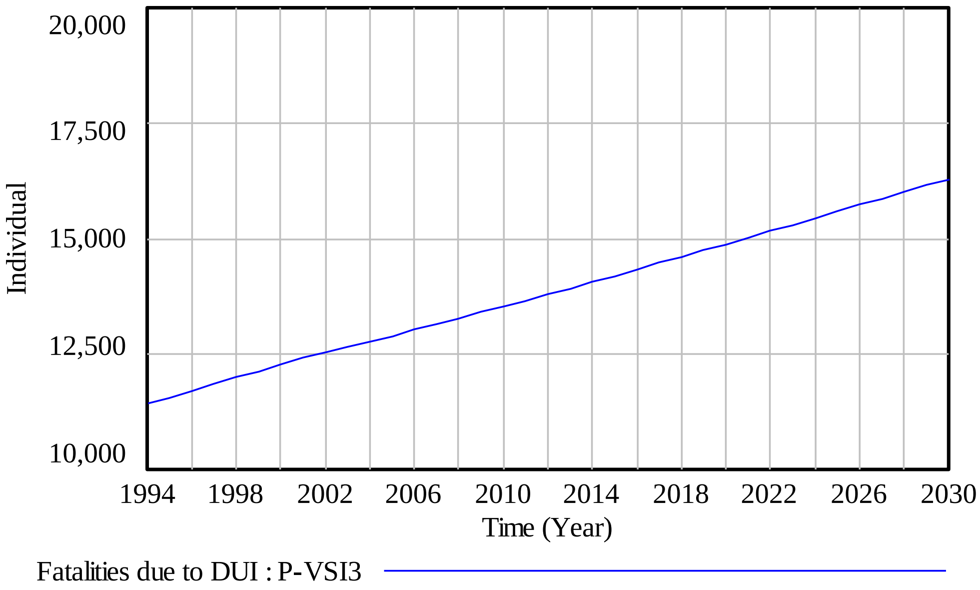

Figure S9. Number of fatalities due to DUI.

- **Fatalities due to extreme weather events** = average fatalities per days with adverse weather conditionx Days with precipitation

Units: Individual

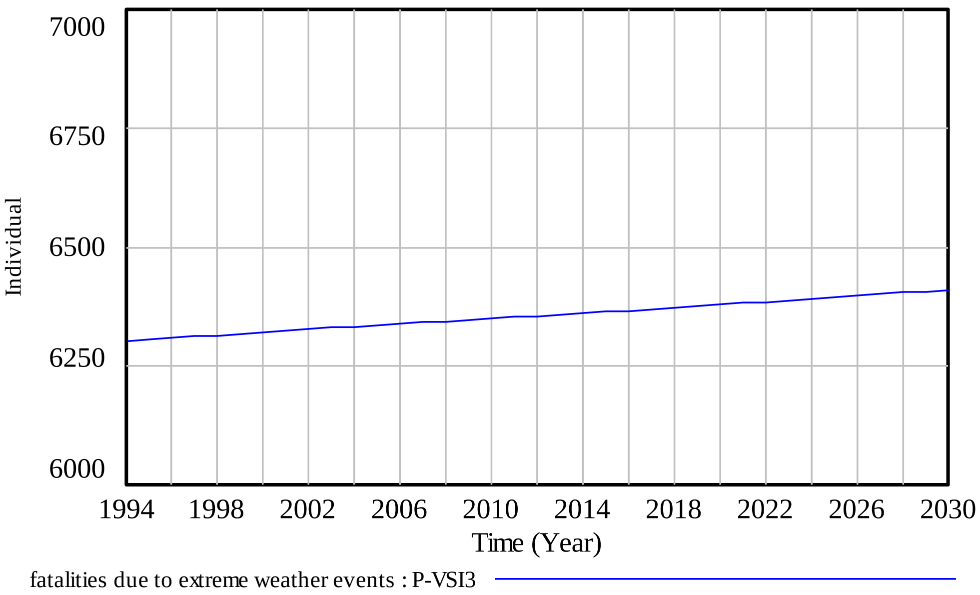

Figure S10. Number of roadway fatalities due to extreme weather condition.

- **Fatalities due to speeding below or over allowed speed** = Percentage of drives driving below or above speed limit ending in fatal crashes x Licensed drivers

Units: Individual

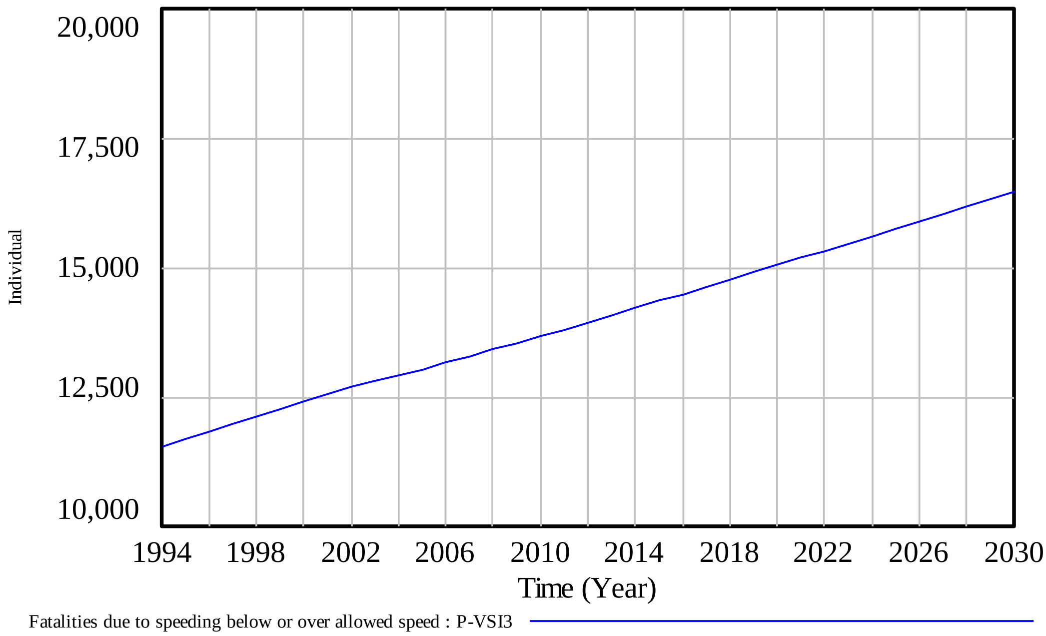

Figure S11. Number of fatalities due to driving below or above speed limit.

- **Fuel economy policy** = WITH LOOKUP (Time, ([(1994,22)–(2008,25)], (1994,24), (1995,24.05), (1996,24.1), (1997,24.1), (2004,24.1), (2005,24.25), (2006,24.55), (2007,24.85), (2008,24.95)))
- **Fuel use final** = IF THEN ELSE((Time < 2008), (fuel use without policy + Annual wasted fuel due to congestion), MIN(fuel use with policy + Annual wasted fuel due to congestion, fuel use without policy + Annual wasted fuel due to congestion))

Units: million gallon

- **Fuel use with policy** = (-2.42×10^{10} + 1.32 × (VMT/"efficient fuel economy (after policy)"))

Units: million gallon

- **Fuel use without policy** = (-2.42×10^{10} + 1.32 × (VMT/Fuel economy policy)) × 0 + (1.39311 × (VMT/Fuel economy policy) + 3.71441×10^{9}) × 1

Units: million gallon

- **Gamma** = 1.79 × Beta × Atmospheric Temp/100

Units: Dmnl

- **GDP Inc Annual Rate** = WITH LOOKUP (Time, ([(1900,−0.2) − (2050,0.5)],(1980.13,−0.0925439), (1982,0.0402576), (1983,0.0863777), (1984,0.112283), (1985,0.0730208), (1986,0.0573066), (1987,0.061879), (1988,0.0769885), (1989,0.07464), (1990,0.0578831), (1991,0.0330033), (1992,0.0571717), (1993,0.0504215), (1994,0.0626893), (1995,0.046167), (1996,0.0572051), (1997,0.0629992), (1998,0.0538117), (1999,0.0599195), (2000,0.0595703), (2001,0.0318484), (2002,0.033942), (2003,0.047034), (2004,0.082875), (2005,0.0650186), (2006,0.0600954), (2007,0.0506149), (2008,0.021854), (2009,0.024), (2010,0.024), (2010.91,0.024), (2011.53,0.024), (2012.98,0.024), (2013.61,0.024), (2014.86,0.024), (2015.69,0.024), (2017,0.024), (2018,0.024), (2019,0.024), (2020,0.024), (2021,0.024), (2022,0.024), (2023,0.024), (2024,0.024), (2025,0.024), (2026,0.024), (2027,0.024), (2028,0.024), (2029,0.024), (2030,0.024), (2031,0.024), (2032,0.024), (2033,0.024), (2034,0.024), (2035,0.024), (2036,0.024), (2037,0.024), (2038,0.024), (2039,0.024), (2040,0.024), (2041,0.024), (2042,0.024), (2043,0.024), (2044,0.024), (2045,0.024), (2046,0.024), (2047,0.024), (2048,0.024), (2049,0.024), (2050,0.024))
- **GDP Inc Rate** = (GDP Inc Annual Rate (Time) − (Economic climate damage fraction) × 0) × US GDP
- **GDP per capita** = US GDP/Population
- **Highway system capacity** = 2×10^{-21} × US GDP × US GDP − 2.02307×10^{-8} × US GDP + 3.96387×10^{6}

Units: Miles

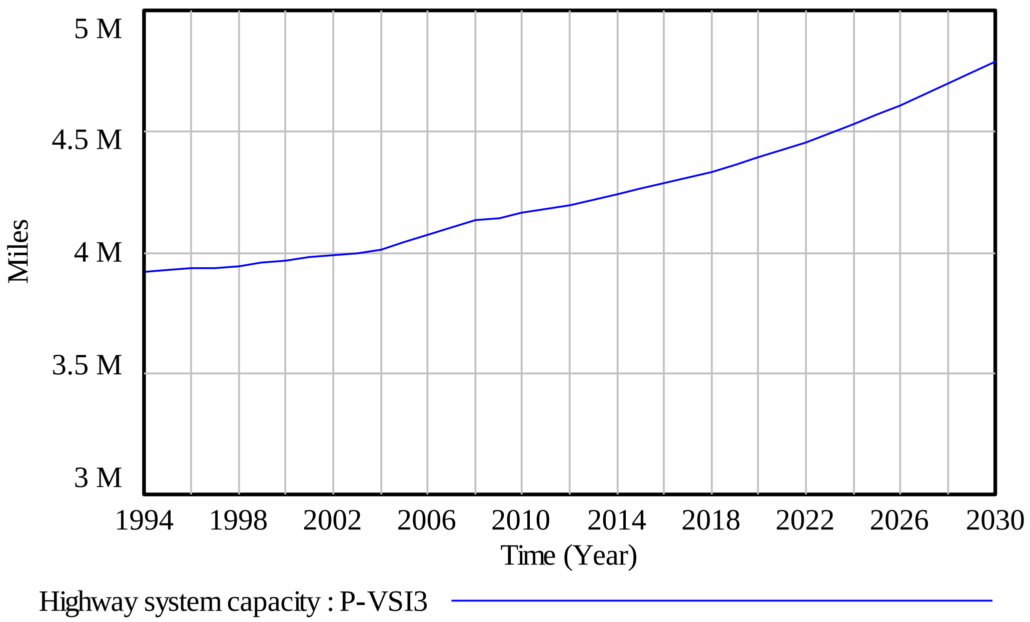

Figure S12. Highway system capacity.

- **Inflation of U.S dollar based on year 2010** = WITH LOOKUP (Time, ([(1994,0.6) – (2012,1.1)], (1994,0.68), (1995,0.7), (1996,0.72), (1997,0.74), (1998,0.75), (1999,0.76), (2000,0.79), (2001,0.1), (2002,0.83), (2003,0.84), (2004,0.87), (2005,0.9), (2006,0.92), (2007,0.95), (2008,0.99), (2009,0.98), (2010,1), (2011,1.03), (2012,1.05)))
- **Licensed drivers** = 0.00069 × Population − 4196.01

Units: Individual

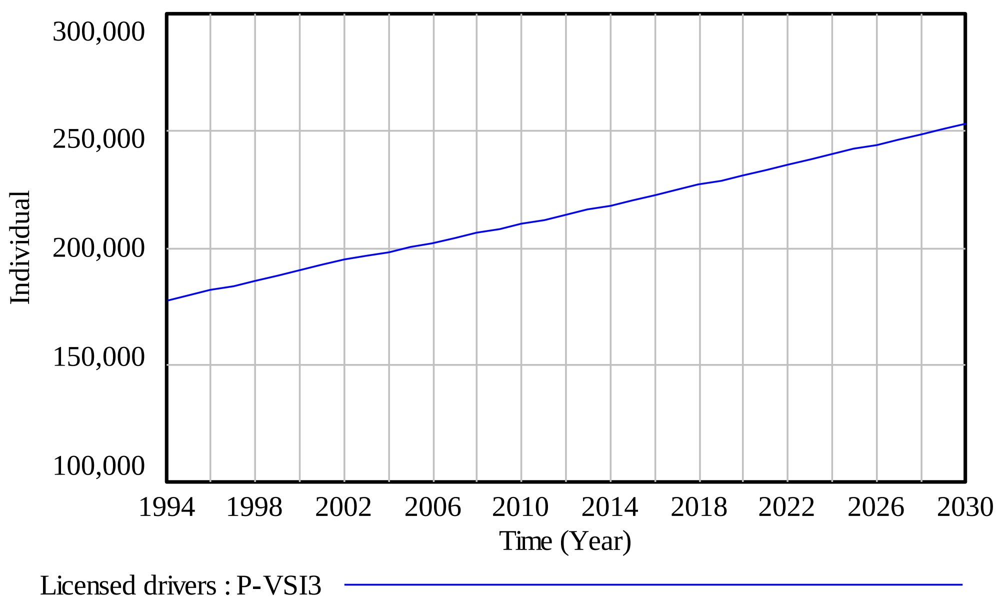

Figure S13. Number of licensed drivers.

- **Life expectancy** = WITH LOOKUP (Time, ([(1980,70) – (2050,90)], (1980,73.73), (1981,74.11), (1982,74.515), (1983,74.52), (1984,74.64), (1985,74.64), (1986,74.71), (1987,74.845), (1988,74.835), (1989,75.11), (1990,75.36), (1991,75.53), (1992,75.74), (1993,75.52), (1994,75.69), (1995,75.79), (1996,76.085), (1997,76.395), (1998,76.56), (1999,76.6), (2000,76.7), (2001,76.8), (2002,76.9), (2003,77), (2004,77.1), (2005,77.2), (2006,77.3), (2007,77.385), (2008,77.48), (2009,77.575), (2010,77.675), (2011,77.775), (2012,77.87), (2013,77.965), (2014,78.065), (2015,78.165), (2016,78.26), (2017,78.36), (2018,78.46), (2019,78.55), (2020,78.65), (2021,78.745), (2022,78.845), (2023,78.935), (2024,79.03), (2025,79.125), (2026,79.215), (2027,79.31), (2028,79.4), (2029,79.49), (2030,79.585), (2031,79.675), (2032,79.77), (2033,79.855), (2034,79.945), (2035,80.03), (2036,80.12), (2037,80.205), (2038,80.295), (2039,80.38), (2040,80.465), (2041,80.545), (2042,80.63), (2043,80.715), (2044,80.8), (2045,80.88), (2046,80.965), (2047,81.045), (2048,81.125), (2049,81.205), (2050,81.285))

Units: Year

- **Lifetime economic cost for each fatality** = A FUNCTION OF(Lifetime economic cost for each fatality)
- **Lifetime economic cost for each fatality** = 1.4×10^{6}

Units: U.S. dollar

- **Monetary value of fatalities** = A FUNCTION OF (Monetary value of fatalities, Fatalities, "inflation of U.S dollar based on year 2010", Lifetime economic cost for each fatality)

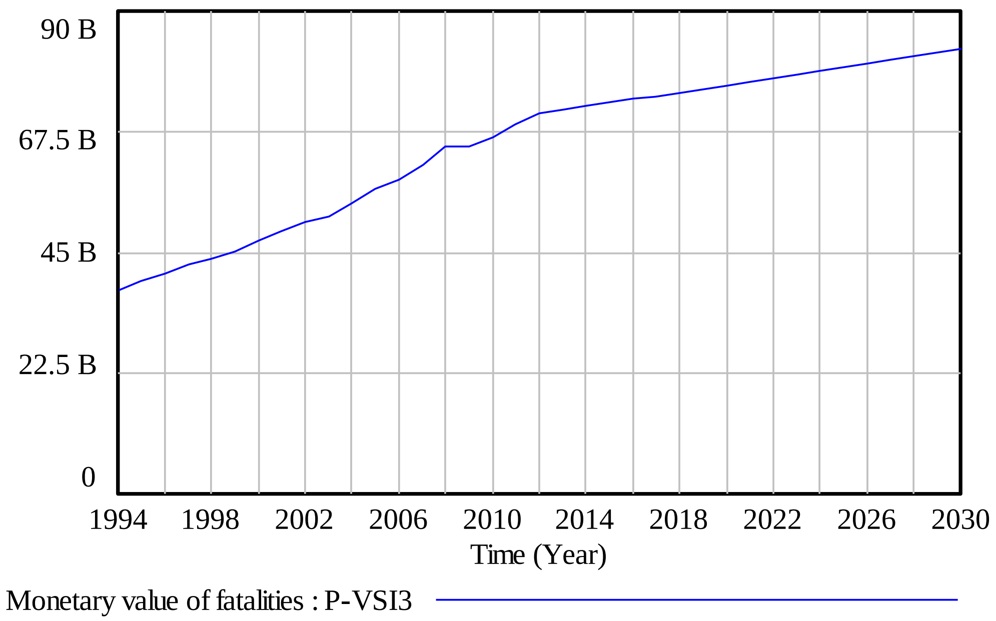

Figure S14. Monetary value of roadway accident fatalities.

- **Number of fatal crashes** = Fatalities/Vehicle occupancy
- **Number of fatalities due to aggressive driving** = IF THEN ELSE ((−21026.6 × congestion index × congestion index + 49180.3 × congestion index − 13131.2) < 0, 0, (−21026.6 × congestion index × congestion index + 49180.3 × congestion index − 13131.2))

Units: Individual

Note: in this study, it is tried to relate the congestion index with the probability of accident occurrence due to aggressive driving meaning that as the congestion increases, the drivers get more nervous which can result in increasing the number of accidents due to aggressive driving.

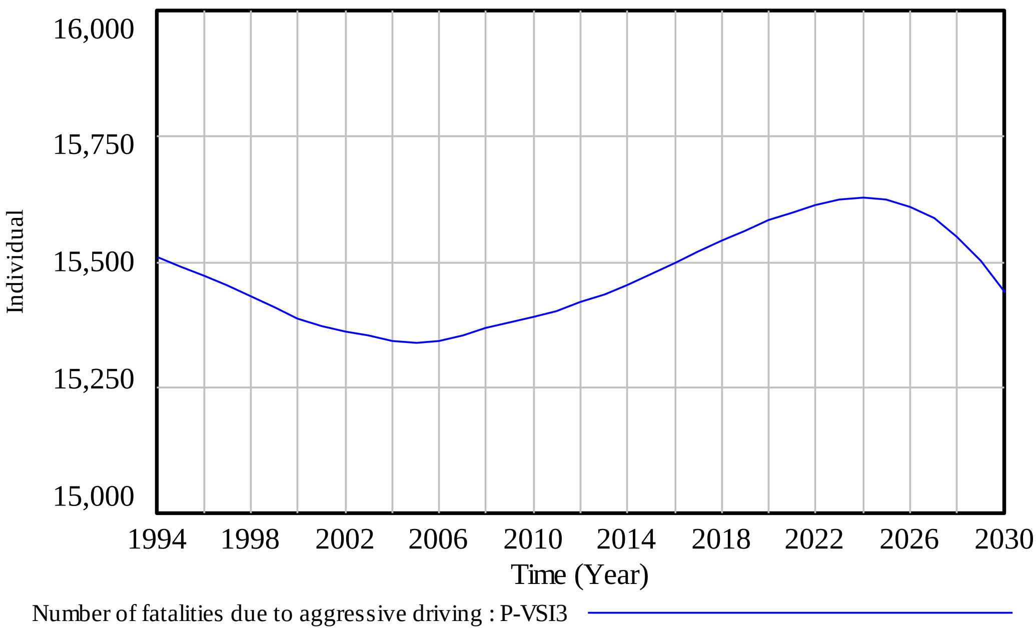

Figure S15. Number of fatalities due to aggressive driving.

- **Number of injury crashes due to extreme weather events** = injured persons due to adverse weather condition/Vehicle occupancy

Units: crashes

- **Number of non-fatal injury crashes** = (30.12/0.6) × Number of fatal crashes
- **Number of property damage only crashes** = (69.28/0.6) × Number of fatal crashes
- **Percentage of drives driving below or above speed limit ending in fatal crashes** = 0.0651

Units: Percent

- **Percentage of drives driving under influence ending in fatal crashes** = 0.0643953

Units: Percent

- **Percentage of fatalities due to distraction**= 0.024

Units: Percent

- **Percentage of lives saved by Airbag** = 0.0349

Units: Percent

- **Percentage of people saved by seat belt** = 0.227569

Units: Percent

- **Pop Inc Annual Rate** = WITH LOOKUP (Time, ([(1982,0) – (2050,2)], (1982,0.9), (1983,0.92), (1984,0.87), (1985,0.89), (1986,0.93), (1987,0.9), (1988,0.91), (1989,0.95), (1990,1.14), (1991,1.35), (1992,1.4), (1993,1.33), (1994,1.23), (1995,1.2), (1996,1.17), (1997,1.21), (1998,1.18), (1999,1.15), (2000,1.12), (2001,1.02), (2002,0.94), (2003,0.86), (2004,0.92), (2005,0.91), (2006,0.95), (2007,0.98), (2008,0.92), (2009,0.92), (2010,0.86), (2011,0.99), (2012,0.98), (2013,0.97), (2014,0.96), (2015,0.95), (2016,0.94), (2017,0.93), (2018,0.92), (2019,0.91), (2020,0.91), (2021,0.93), (2022,0.92), (2023,0.91), (2024,0.9), (2025,0.9), (2026,0.89), (2027,0.88), (2028,0.87), (2029,0.86), (2030,0.86), (2031,0.86), (2032,0.85), (2033,0.84), (2034,0.83), (2035,0.83), (2036,0.82), (2037,0.81), (2038,0.81), (2039,0.8), (2040,0.79), (2041,0.85), (2042,0.85), (2043,0.84), (2044,0.83), (2045,0.83), (2046,0.82), (2047,0.81), (2048,0.81), (2049,0.8), (2050,0.79))
- **Population** = **INTEG** (Pop Inc, 2.63×10^8)

Units: Individual

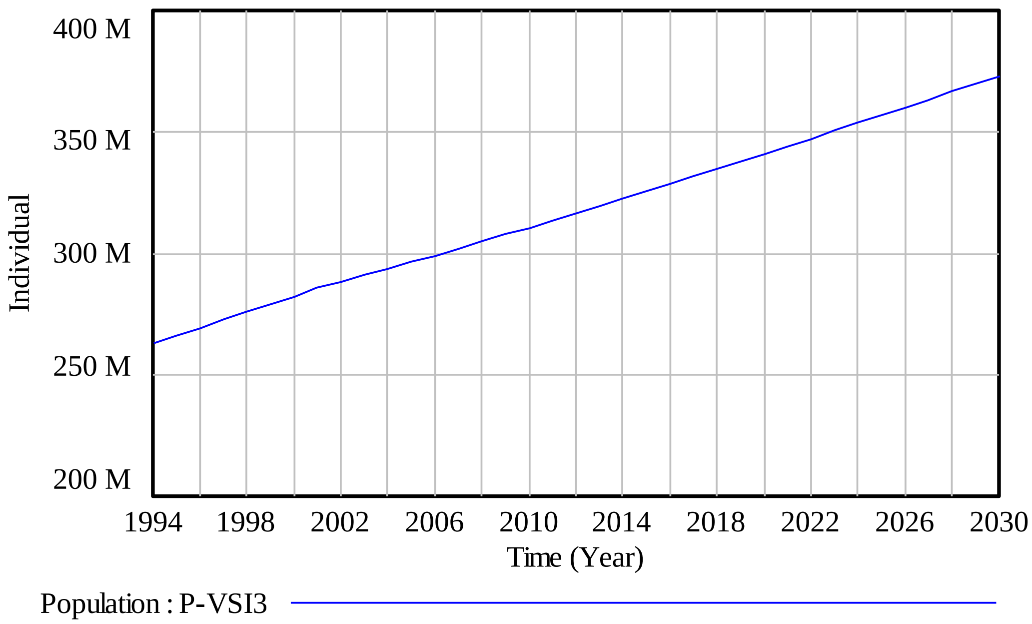

Figure S16. U.S. population over time.

- **Preindustrial CO_2** = 5.9×10^{11}

Units: Ton C

- **Radiative Forcing** = CO_2 Rad Forcing

Units: watt/meter/meter

Note: Radiative Forcing from All GHGs (W/m ^{2}) Additional surface warming from accumulation of CO_2 & CFCs. [Cowles, Sec. III.F]

- **Rate of CO_2 Transfer** = 0.08333

Units: 1/Year

Note: Rate of Storage of Atmospheric Greenhouse Gases [delta-m] (1/year) Inverse yields average residence time of gases (120 years). Note that, like the marginal atmospheric retention, the stability of this factor is questionable. [Cowles, pg. 21]

- **Rate of fatalities due to aggressive driving per 100 million VMT** = Number of fatalities due to aggressive driving/(VMT/ 10^8)
- **Rate of fatalities due to alcohol per 100 million VMT** = Fatalities due to DUI/(VMT/10^8)
- **Rate of fatalities due to distraction per 100 M VMT** = Fatalities due to distraction/(VMT/10^8)
- **Rate of fatalities due to other factors per 100 M VMT** = 0.5
- **Rate of fatalities due to speeding per 100 million VMT** = Fatalities due to speeding below or over allowed speed/(VMT/10^8)
- **Rate of saved lives by airbag per 100 M VMT** = lives saved by airbag/(VMT/10^8)
- **Rate of saved lives by seat belt per 100 million VMT** = lives saved by seat belt/(VMT/10^8)
- **Temp Diff** = Atmospheric Temp-Deep Ocean Temp

Units: Degrees C

Note: Temperature Difference between Upper and Deep Ocean (degrees C)

- **Total number of crashes in U.S** = Number of fatal crashes+ Number of non-fatal injury crashes+ Number of property damage only crashes
- **Total rate of fatalities per 100 M VMT** = Rate of fatalities due to alcohol per 100 million VMT+ Rate of fatalities due to speeding per 100 million VMT -Rate of saved lives by seat belt per 100 million VMT-Rate of saved lives by airbag per 100 M VMT +Rate of fatalities due to distraction per 100 M VMT +Rate of fatalities due to other factors per 100 M VMT+ Rate of fatalities due to aggressive driving per 100 million VMT

Note: as can be seen in figure below, the total rate of fatalities is decreasing from 1994 up to now and it is predicted that it will continue its decreasing trend until 2030 because of increasing safety measures over time but at the same time the number of roadway accident fatalities is increasing and that is because of the increasing number of population and licensed drivers.

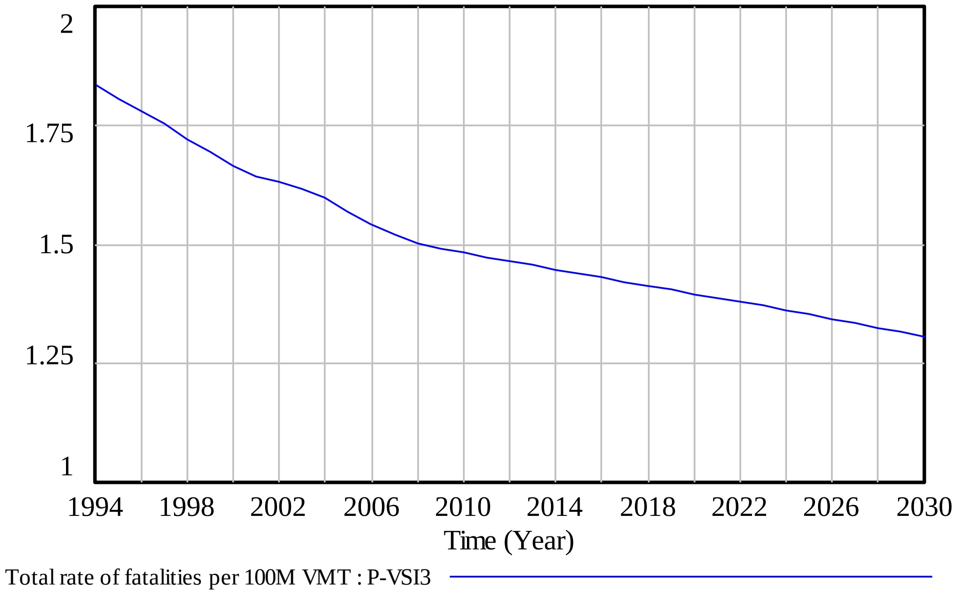

Figure S17. Total rate of fatalities per 100 M VMT.

- **US GDP** = INTEG (GDP Inc Rate 7.3 × 10^{12}) × GDP Inc Rate-0 × ("CO_2 emission" + congestion index+ Total crash) − "Cost-Benefit of FMVSS" − Total crash-Economic climate damage fraction)
- **US GDP considering economic loss of roadway accidents** = US GDP-US GDP losses
- **US GDP losses** = Annual highway congestion cost + "Cost-Benefit of FMVSS" + Economic benefits of lives saved + "Total cost of crashes in U.S"
- **Vehicular safety index** = 3.559 × 10^{-12} × US GDP − 2.35703
- ΔT = 1 × Atmospheric Temp

Units: Degrees C

Reference

1. Bureau of Transportation Statistics, Estimated Number of Lives Saved by Occupant Protection, Motorcycle Helmets, and Drinking Age Law, USDOT. Available online: http://www.rita.dot.gov/bts/sites/rita.dot.gov.bts/files/publications/national_transportation_statistics/html/table_02_31.html (accessed on 14 January 2017).