SI 618 Homework 8

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Getting Data from SQLite Database (10 points)

In the data preparation step, a SQLite database has been created and populated with vehicle data. Now the data in the database is retrieved using R package DBI and RSQLite and stored in a data frame named vehicles. Here are the first 10 rows of the data frame, and the summary.

```
##    year       make               model          VClass cylinders displ
## 1  1985 Alfa Romeo  Spider Veloce 2000     Two Seaters         4   2.0
## 2  1985    Ferrari          Testarossa     Two Seaters        12   4.9
## 3  1985      Dodge             Charger Subcompact Cars         4   2.2
## 4  1985      Dodge B150/B250 Wagon 2WD            Vans         8   5.2
## 5  1993     Subaru    Legacy AWD Turbo    Compact Cars         4   2.2
## 6  1993     Subaru              Loyale    Compact Cars         4   1.8
## 7  1993     Subaru              Loyale    Compact Cars         4   1.8
## 8  1993     Toyota             Corolla    Compact Cars         4   1.6
## 9  1993     Toyota             Corolla    Compact Cars         4   1.6
## 10 1993     Toyota             Corolla    Compact Cars         4   1.8
##             trany city08 highway08 comb08
## 1     Manual 5-spd     19        25     21
## 2     Manual 5-spd      9        14     11
## 3     Manual 5-spd     23        33     27
## 4  Automatic 3-spd     10        12     11
## 5     Manual 5-spd     17        23     19
## 6  Automatic 3-spd     21        24     22
## 7     Manual 5-spd     22        29     25
## 8  Automatic 3-spd     23        26     24
## 9     Manual 5-spd     23        31     26
## 10 Automatic 4-spd     23        30     25
```

```
##       year          make              model              VClass
##  Min.   :1984   Length:35719       Length:35719       Length:35719
##  1st Qu.:1990   Class :character   Class :character   Class :character
##  Median :1999   Mode  :character   Mode  :character   Mode  :character
##  Mean   :1999
##  3rd Qu.:2008
##  Max.   :2016
##    cylinders          displ          trany               city08
##  Min.   : 2.000   Min.   :0.600   Length:35719       Min.   : 6.00
##  1st Qu.: 4.000   1st Qu.:2.200   Class :character   1st Qu.:15.00
##  Median : 6.000   Median :3.000   Mode  :character   Median :17.00
##  Mean   : 5.743   Mean   :3.328                      Mean   :17.54
##  3rd Qu.: 6.000   3rd Qu.:4.300                      3rd Qu.:20.00
##  Max.   :16.000   Max.   :8.400                      Max.   :53.00
##    highway08         comb08
##  Min.   : 9.00   Min.   : 7.00
##  1st Qu.:20.00   1st Qu.:16.00
##  Median :23.00   Median :19.00
##  Mean   :23.68   Mean   :19.79
##  3rd Qu.:27.00   3rd Qu.:22.00
##  Max.   :61.00   Max.   :53.00
```

Converting to Factors (10 points)

To make downstream analysis easier, we convert the data in columns vehicles$make, vehicles$VClass, vehicles$cylinders, and vehicles$trany into factors. Here is the summary of the data frame after the conversion.

```
##       year                make           model          
##  Min.   :1984   Chevrolet: 3635   Length:35719      
##  1st Qu.:1990   Ford     : 2958   Class :character  
##  Median :1999   Dodge    : 2465   Mode  :character  
##  Mean   :1999   GMC      : 2306                     
##  3rd Qu.:2008   Toyota   : 1821                     
##  Max.   :2016   BMW      : 1518                     
##                 (Other)  :21016                     
##                           VClass        cylinders         displ      
##  Compact Cars               : 5160   4      :13596   Min.   :0.600  
##  Subcompact Cars            : 4643   6      :12522   1st Qu.:2.200  
##  Midsize Cars               : 4035   8      : 7938   Median :3.000  
##  Standard Pickup Trucks     : 2354   5      :  759   Mean   :3.328  
##  Sport Utility Vehicle - 4WD: 2090   12     :  505   3rd Qu.:4.300  
##  Two Seaters                : 1734   3      :  195   Max.   :8.400  
##  (Other)                    :15703   (Other):  204                  
##              trany           city08        highway08         comb08     
##  Automatic 4-spd:11035   Min.   : 6.00   Min.   : 9.00   Min.   : 7.00  
##  Manual 5-spd   : 8252   1st Qu.:15.00   1st Qu.:20.00   1st Qu.:16.00  
##  Automatic 3-spd: 3151   Median :17.00   Median :23.00   Median :19.00  
##  Manual 6-spd   : 2206   Mean   :17.54   Mean   :23.68   Mean   :19.79  
##  Automatic (S6) : 2201   3rd Qu.:20.00   3rd Qu.:27.00   3rd Qu.:22.00  
##  Automatic 5-spd: 2179   Max.   :53.00   Max.   :61.00   Max.   :53.00  
##  (Other)        : 6695                                                  
```

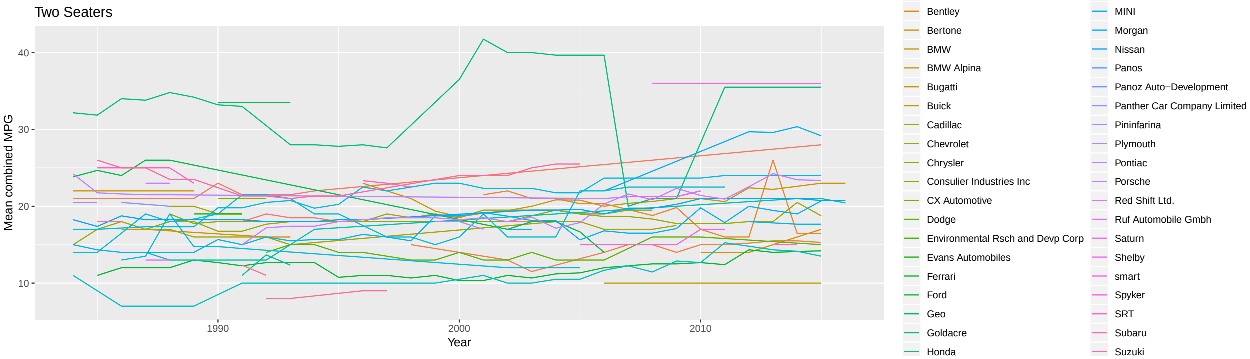
Filter Down Data (30 points)

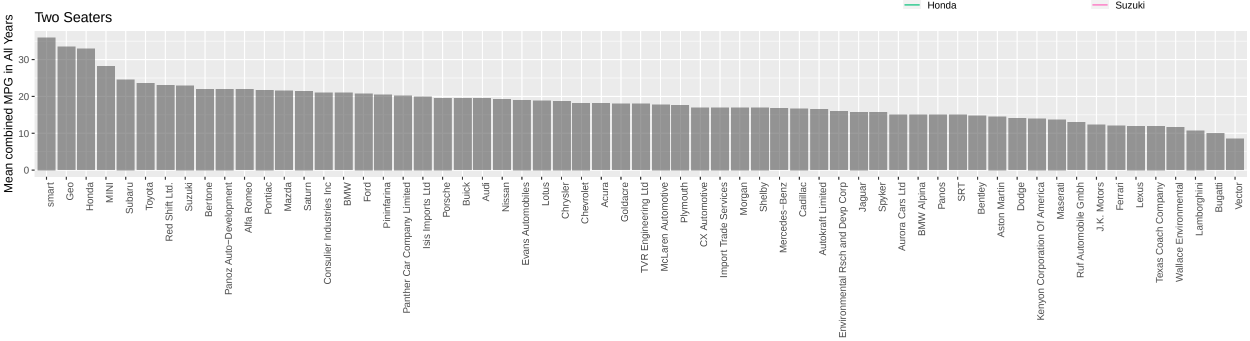
We will filter down the data such that only 'VClass' with more than 40 vehicles are kept. Here is the summary of the data frame after this subsetting step.

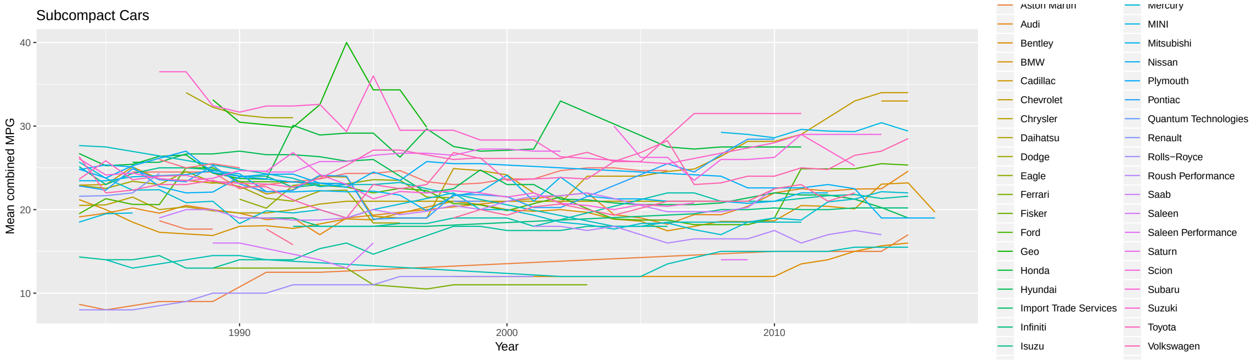
```
##       year                make           model          
##  Min.   :1984   Chevrolet: 3633   Length:35708      
##  1st Qu.:1990   Ford     : 2958   Class :character  
##  Median :1999   Dodge    : 2465   Mode  :character  
##  Mean   :1999   GMC      : 2302                     
##  3rd Qu.:2008   Toyota   : 1821                     
##  Max.   :2016   BMW      : 1518                     
##                 (Other)  :21011                     
##                           VClass        cylinders         displ      
##  Compact Cars               : 5160   4      :13594   Min.   :0.600  
##  Subcompact Cars            : 4643   6      :12518   1st Qu.:2.200  
##  Midsize Cars               : 4035   8      : 7933   Median :3.000  
##  Standard Pickup Trucks     : 2354   5      :  759   Mean   :3.328  
##  Sport Utility Vehicle - 4WD: 2090   12     :  505   3rd Qu.:4.300  
##  Two Seaters                : 1734   3      :  195   Max.   :8.400  
##  (Other)                    :15692   (Other):  204                  
##              trany           city08        highway08         comb08     
##  Automatic 4-spd:11026   Min.   : 6.00   Min.   : 9.00   Min.   : 7.00  
##  Manual 5-spd   : 8250   1st Qu.:15.00   1st Qu.:20.00   1st Qu.:16.00
##  Automatic 3-spd: 3151   Median :17.00   Median :23.00   Median :19.00
##  Manual 6-spd   : 2206   Mean   :17.54   Mean   :23.68   Mean   :19.79
##  Automatic (S6) : 2201   3rd Qu.:20.00   3rd Qu.:27.00   3rd Qu.:22.00
##  Automatic 5-spd: 2179   Max.   :53.00   Max.   :61.00   Max.   :53.00
##  (Other)        : 6695
##    vclass.ct
##  Min.   :  45
##  1st Qu.:1143
##  Median :2090
##  Mean   :2629
##  3rd Qu.:4643
##  Max.   :5160
##
```

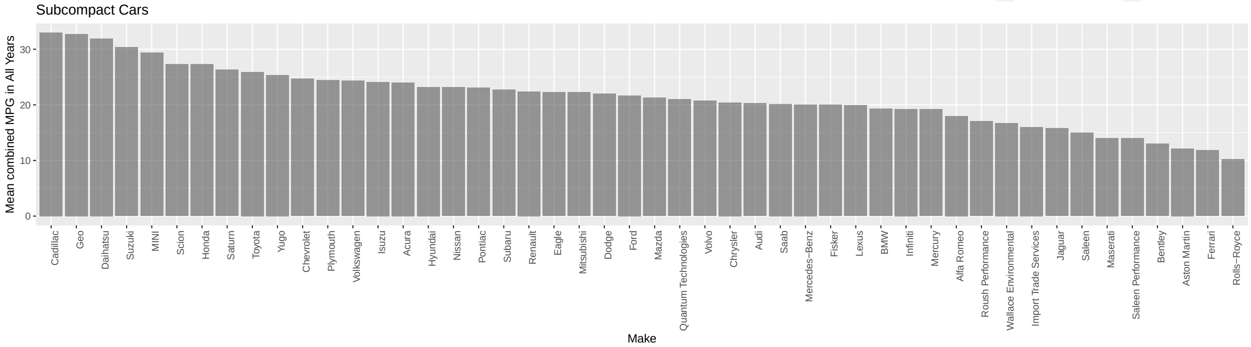
Fuel Economy of Vehicles of Different Makes (50 points)

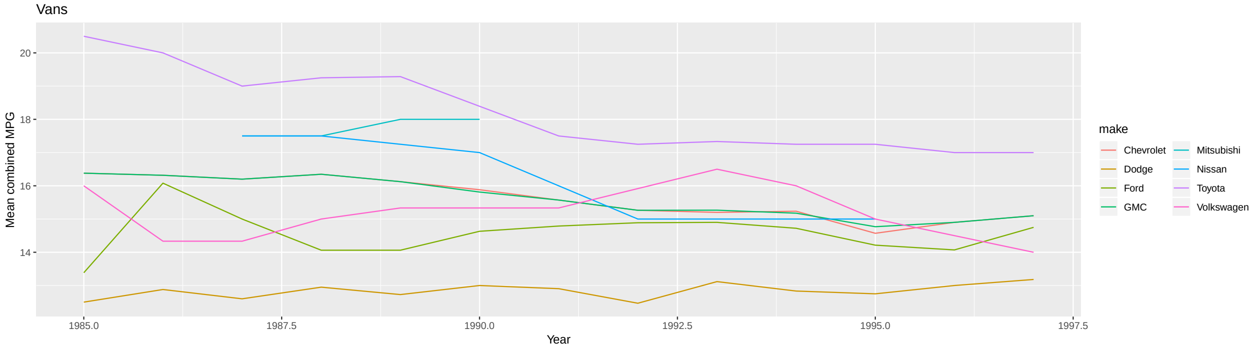
For each vehicle class in filtered down data, we plot the mean combined MPG (average of data in vehicles$comb08) for each vehicle maker every year. And then, we compute the mean combined MPG in all years for each vehicle maker, and plot it. Both charts are created with ggplot(). Note how the vehicle makers are ranked in the second plot. Use **fig.width=16**. To suppress messages from ggplot regarding groups with only one observation, set **warning=FALSE, message=FALSE** (we recommend setting this option only once your code is complete).

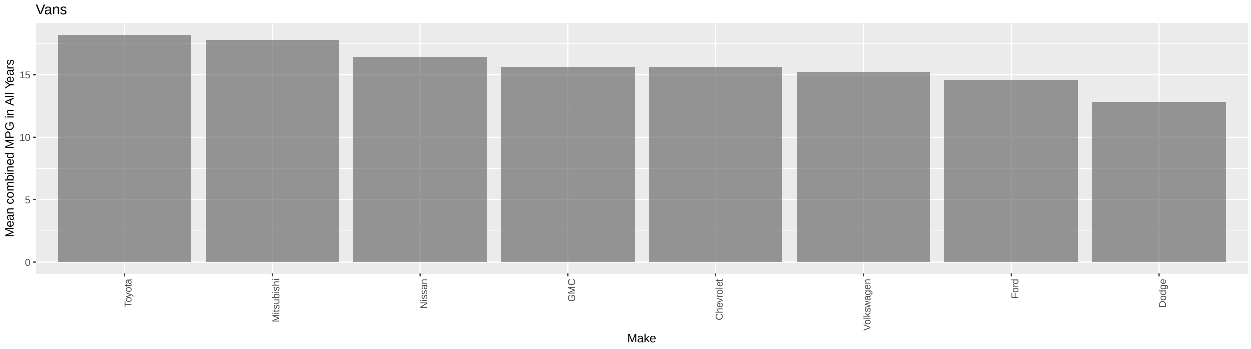


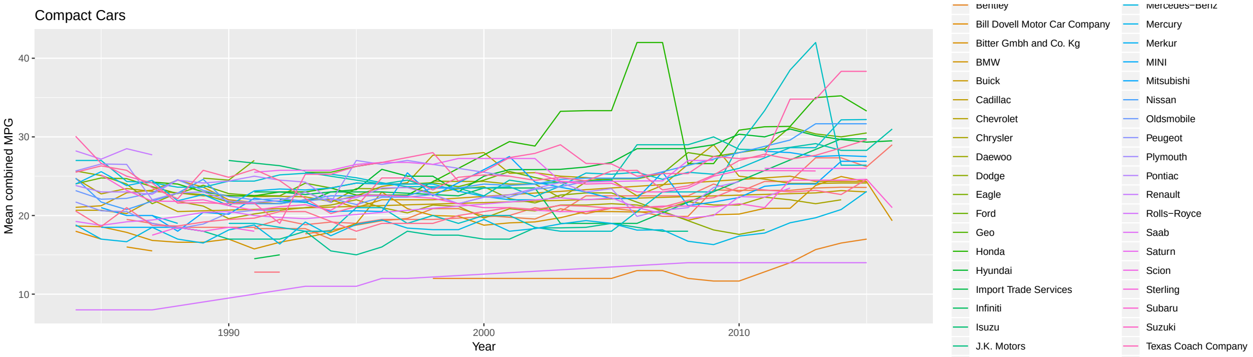


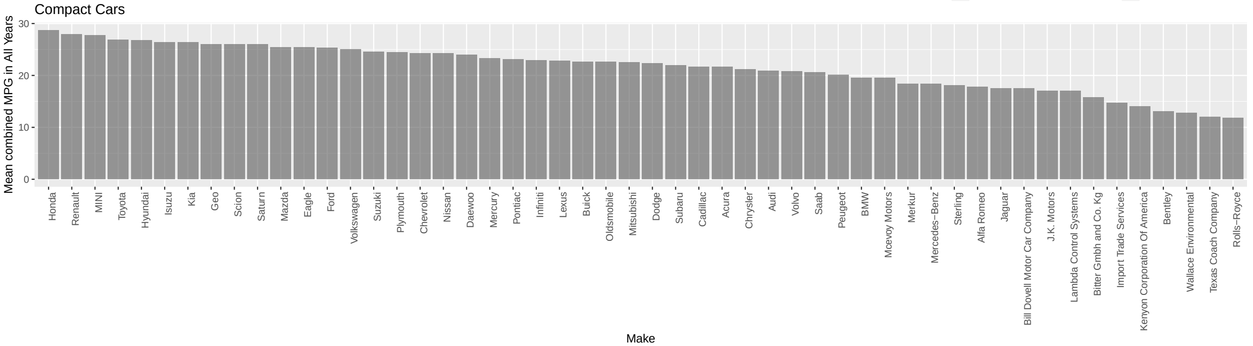

Subcompact Cars
Mean combined MPG
Year
10
20
30
40
1990
2000
2010
Aston Martin
Audi
Bentley
BMW
Cadillac
Chevrolet
Chrysler
Daihatsu
Dodge
Eagle
Ferrari
Fisker
Ford
Geo
Honda
Hyundai
Import Trade Services
Infiniti
Isuzu
Mercury
MINI
Mitsubishi
Nissan
Plymouth
Pontiac
Quantum Technologies
Renault
Rolls−Royce
Roush Performance
Saab
Saleen
Saleen Performance
Saturn
Scion
Subaru
Suzuki
Toyota
Volkswagen

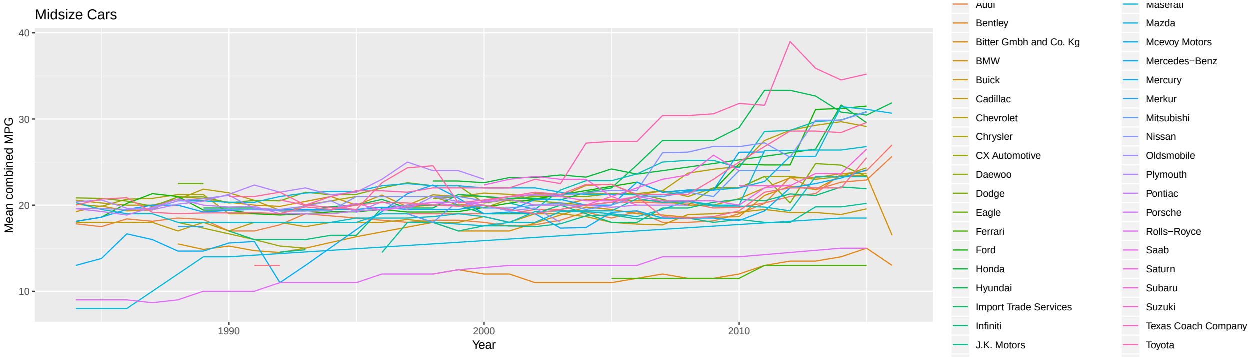

Subcompact Cars
Mean combined MPG in All Years
Make
0
10
20
30
Cadillac
Geo
Daihatsu
Suzuki
MINI
Scion
Honda
Saturn
Toyota
Yugo
Chevrolet
Plymouth
Volkswagen
Isuzu
Acura
Hyundai
Nissan
Pontiac
Subaru
Renault
Eagle
Mitsubishi
Dodge
Ford
Mazda
Quantum Technologies
Volvo
Chrysler
Audi
Saab
Mercedes−Benz
Fisker
Lexus
BMW
Infiniti
Mercury
Alfa Romeo
Roush Performance
Wallace Environmental
Import Trade Services
Jaguar
Saleen
Maserati
Saleen Performance
Bentley
Aston Martin
Ferrari
Rolls−Royce

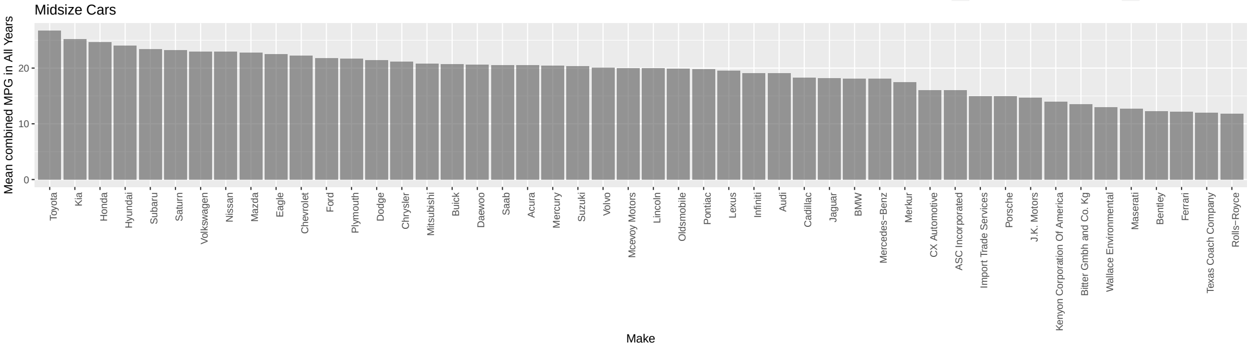

Vans
Mean combined MPG
Year
14
16
18
20
1985.0
1987.5
1990.0
1992.5
1995.0
1997.5
make
Chevrolet
Dodge
Ford
GMC
Mitsubishi
Nissan
Toyota
Volkswagen

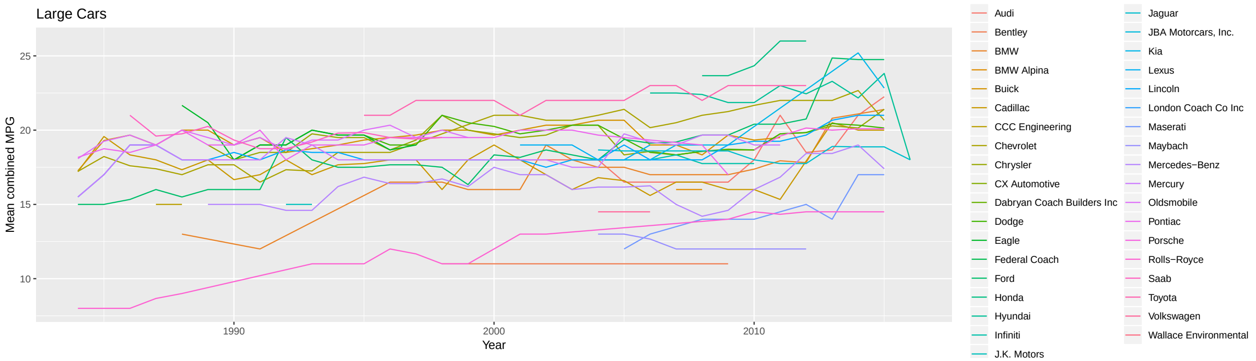

Vans
Mean combined MPG in All Years
Make
0
5
10
15
Toyota
Mitsubishi
Nissan
GMC
Chevrolet
Volkswagen
Ford
Dodge

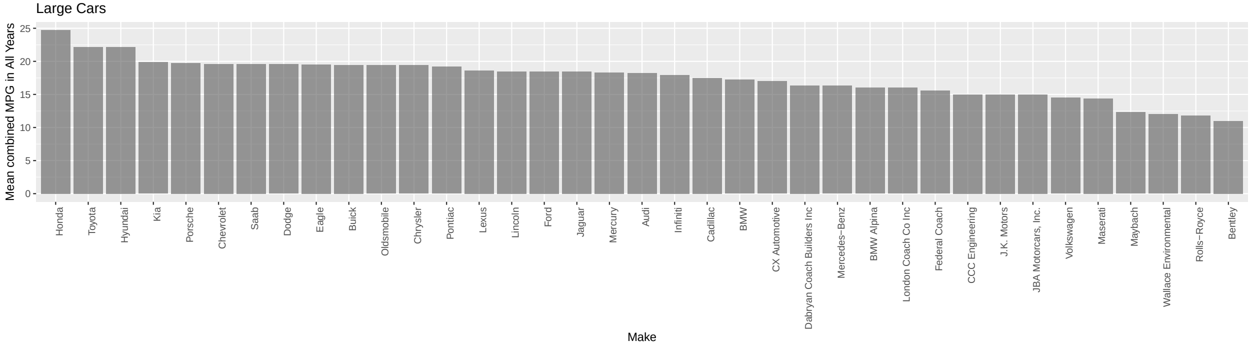

Compact Cars
40
30
20
10
Mean combined MPG
1990
2000
2010
Year
Bentley
Bill Dovell Motor Car Company
Bitter Gmbh and Co. Kg
BMW
Buick
Cadillac
Chevrolet
Chrysler
Daewoo
Dodge
Eagle
Ford
Geo
Honda
Hyundai
Import Trade Services
Infiniti
Isuzu
J.K. Motors
Mercedes−Benz
Mercury
Merkur
MINI
Mitsubishi
Nissan
Oldsmobile
Peugeot
Plymouth
Pontiac
Renault
Rolls−Royce
Saab
Saturn
Scion
Sterling
Subaru
Suzuki
Texas Coach Company

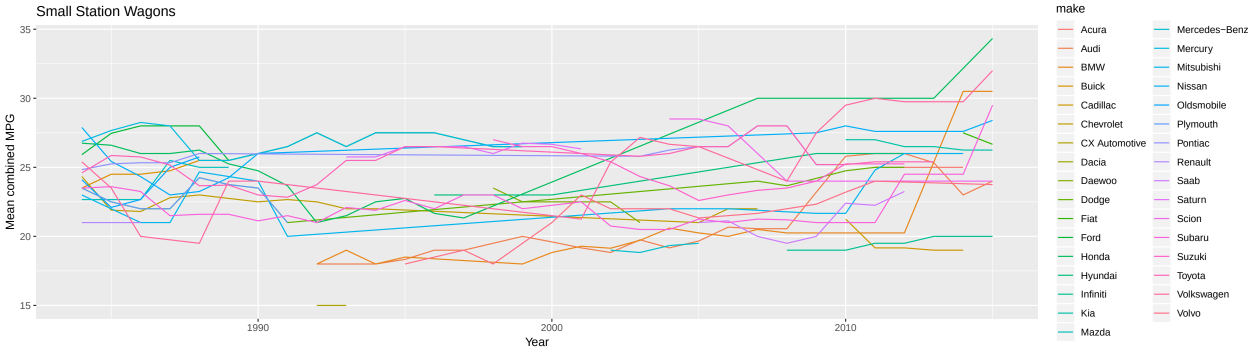

Compact Cars
30
20
10
0
Mean combined MPG in All Years
Honda
Renault
MINI
Toyota
Hyundai
Isuzu
Kia
Geo
Scion
Saturn
Mazda
Eagle
Ford
Volkswagen
Suzuki
Plymouth
Chevrolet
Nissan
Daewoo
Mercury
Pontiac
Infiniti
Lexus
Buick
Oldsmobile
Mitsubishi
Dodge
Subaru
Cadillac
Acura
Chrysler
Audi
Volvo
Saab
Peugeot
BMW
Mcevoy Motors
Merkur
Mercedes−Benz
Sterling
Alfa Romeo
Jaguar
Bill Dovell Motor Car Company
J.K. Motors
Lambda Control Systems
Bitter Gmbh and Co. Kg
Import Trade Services
Kenyon Corporation Of America
Bentley
Wallace Environmental
Texas Coach Company
Rolls−Royce
Make

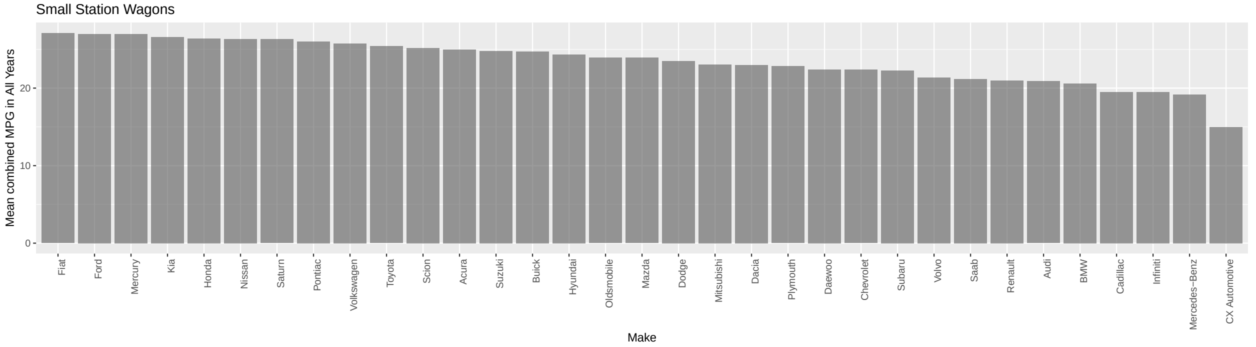

Midsize Cars
40
30
20
10
Mean combined MPG
1990
2000
2010
Year
Audi
Bentley
Bitter Gmbh and Co. Kg
BMW
Buick
Cadillac
Chevrolet
Chrysler
CX Automotive
Daewoo
Dodge
Eagle
Ferrari
Ford
Honda
Hyundai
Import Trade Services
Infiniti
J.K. Motors
Maserati
Mazda
Mcevoy Motors
Mercedes−Benz
Mercury
Merkur
Mitsubishi
Nissan
Oldsmobile
Plymouth
Pontiac
Porsche
Rolls−Royce
Saab
Saturn
Subaru
Suzuki
Texas Coach Company
Toyota


Midsize Cars
20
10
0
Mean combined MPG in All Years
Toyota
Kia
Honda
Hyundai
Subaru
Saturn
Volkswagen
Nissan
Mazda
Eagle
Chevrolet
Ford
Plymouth
Dodge
Chrysler
Mitsubishi
Buick
Daewoo
Saab
Acura
Mercury
Suzuki
Volvo
Mcevoy Motors
Lincoln
Oldsmobile
Pontiac
Lexus
Infiniti
Audi
Cadillac
Jaguar
BMW
Mercedes−Benz
Merkur
CX Automotive
ASC Incorporated
Import Trade Services
Porsche
J.K. Motors
Kenyon Corporation Of America
Bitter Gmbh and Co. Kg
Wallace Environmental
Maserati
Bentley
Ferrari
Texas Coach Company
Rolls−Royce
Make

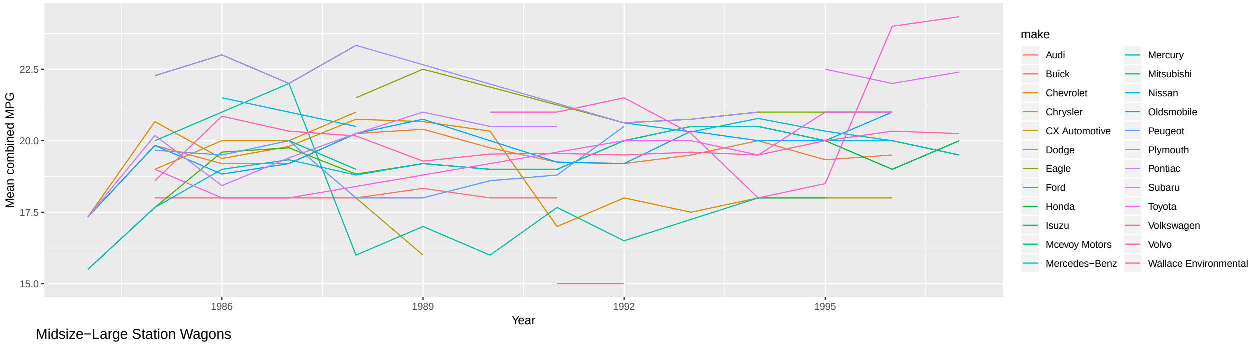

Large Cars


Large Cars

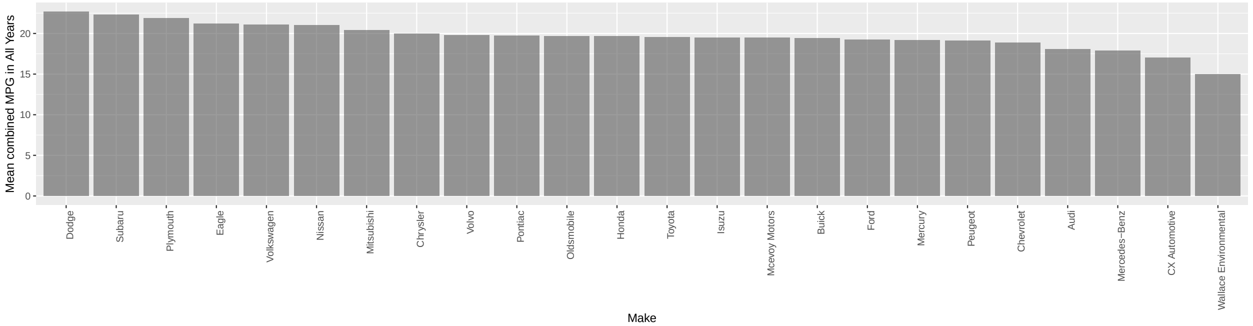

Small Station Wagons


Small Station Wagons

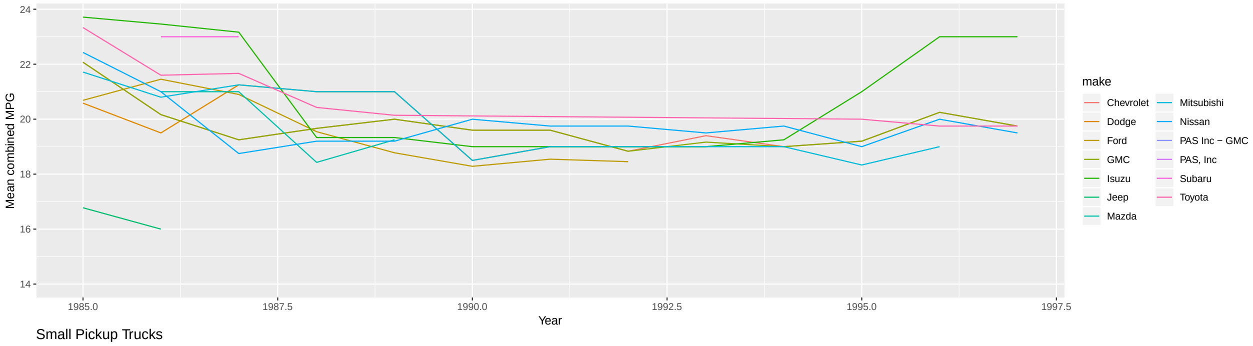
Midsize−Large Station Wagons



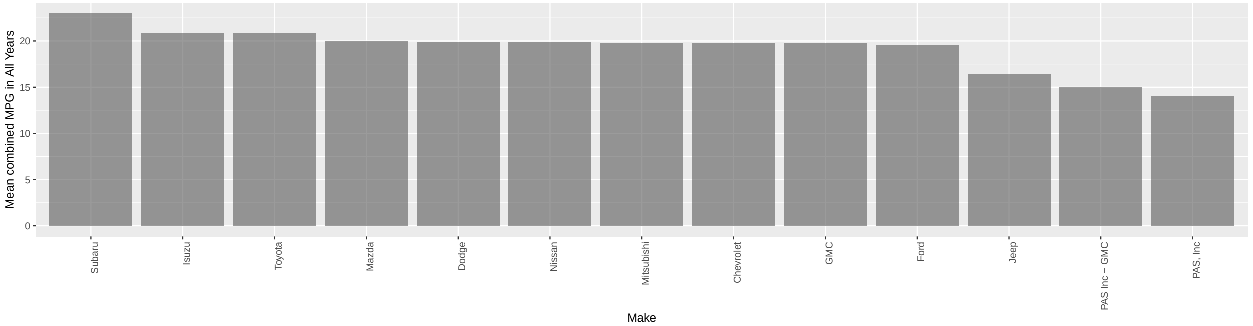
Midsize−Large Station Wagons



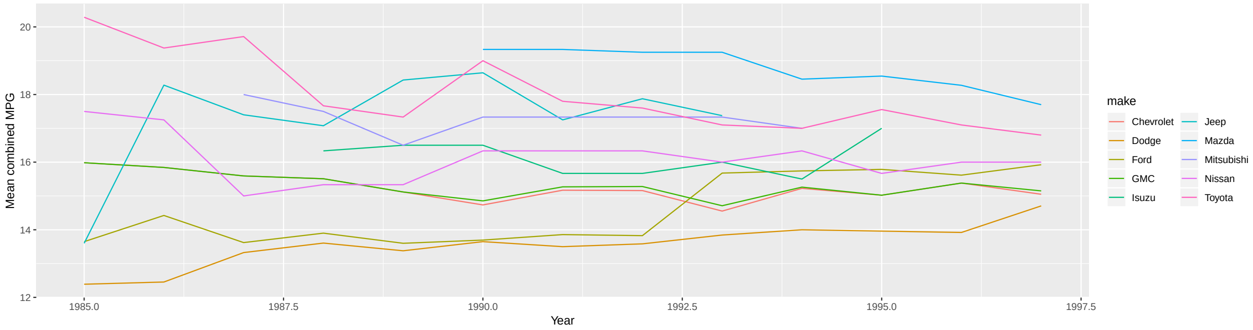
Small Pickup Trucks

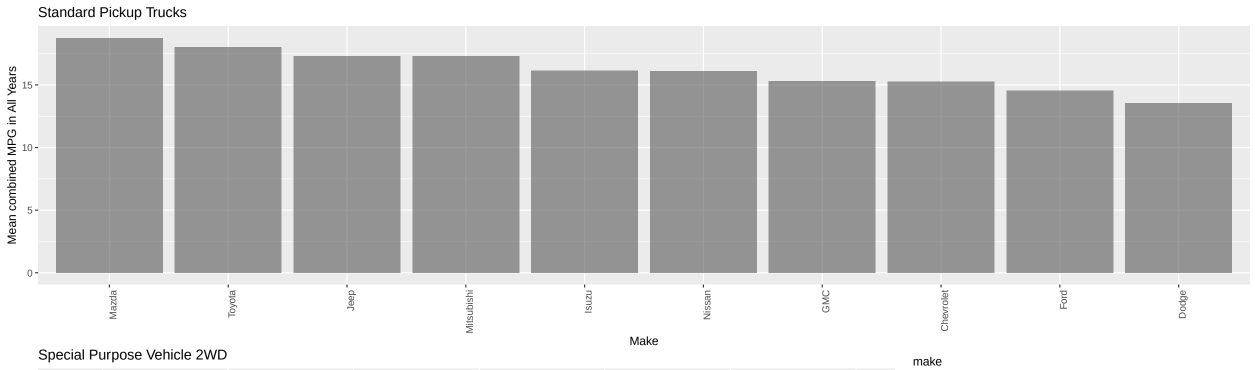


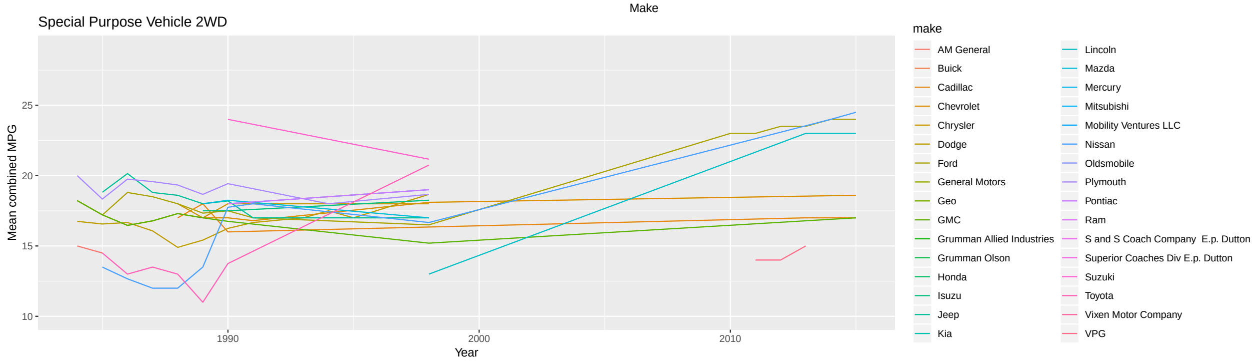
Small Pickup Trucks

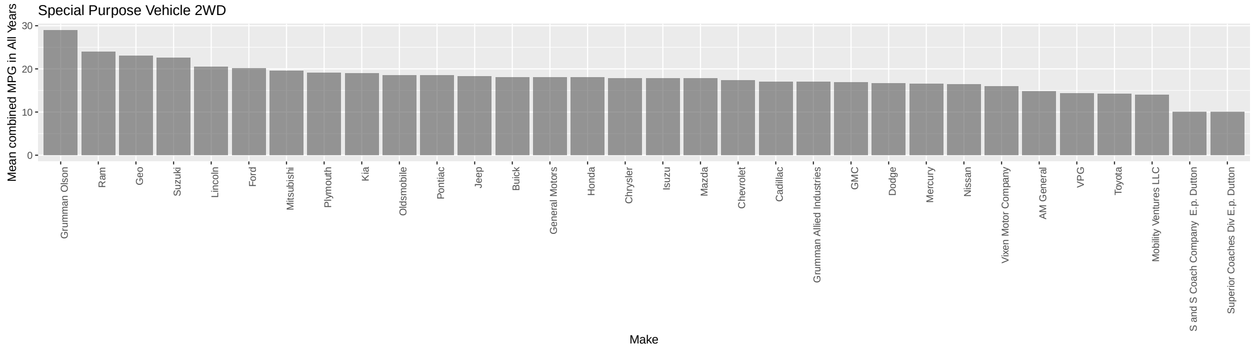


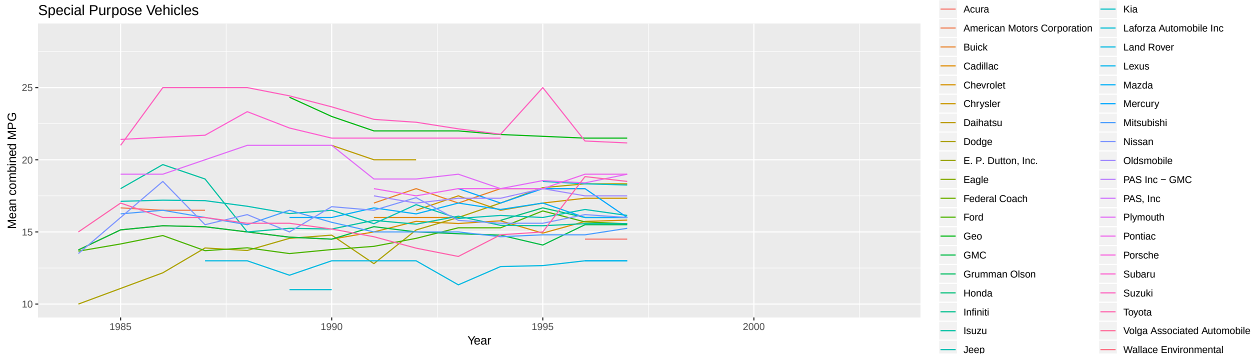
Standard Pickup Trucks

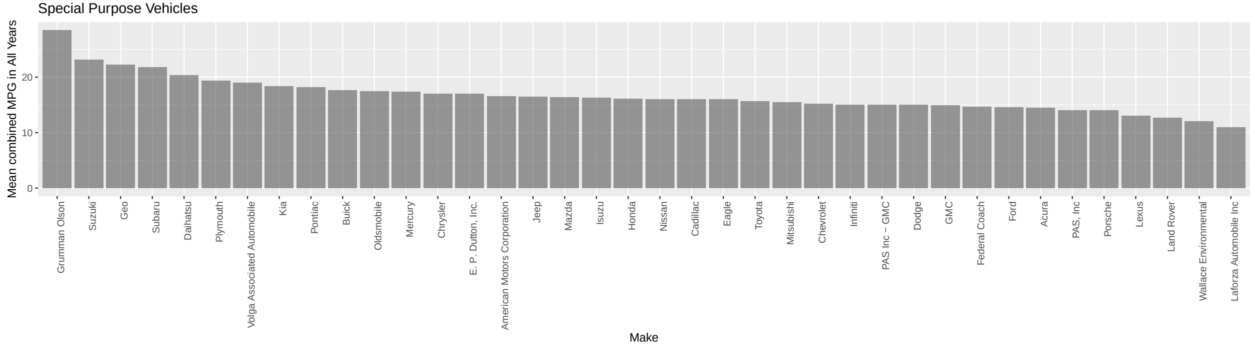


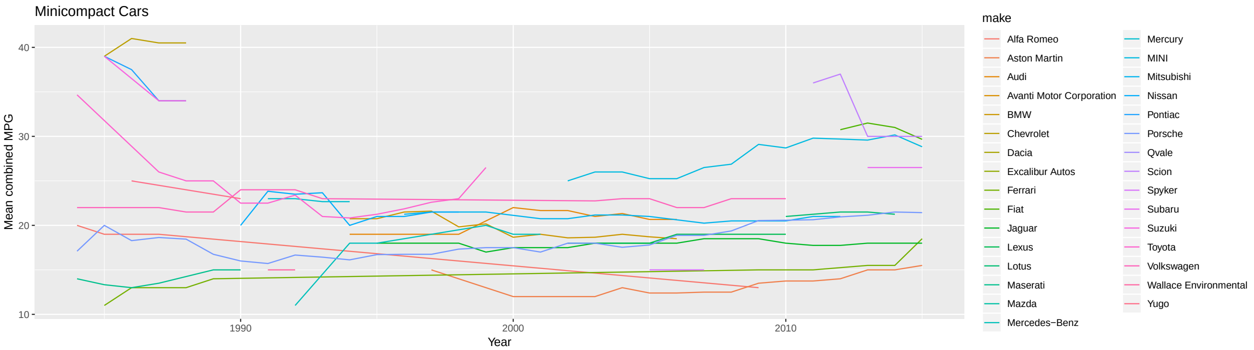

Standard Pickup Trucks

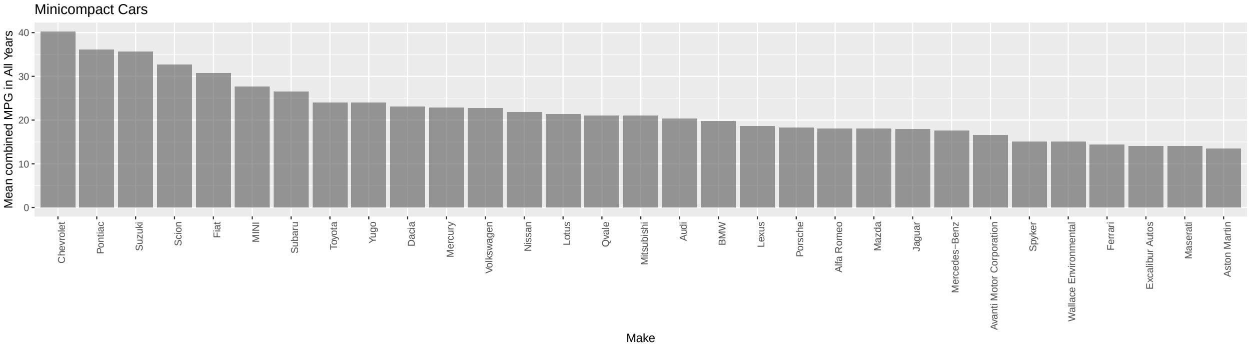

Special Purpose Vehicle 2WD

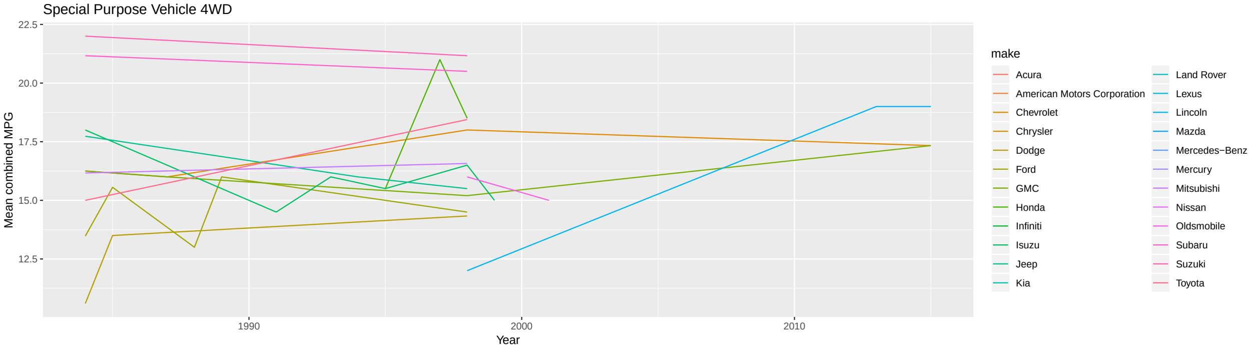

Special Purpose Vehicle 2WD

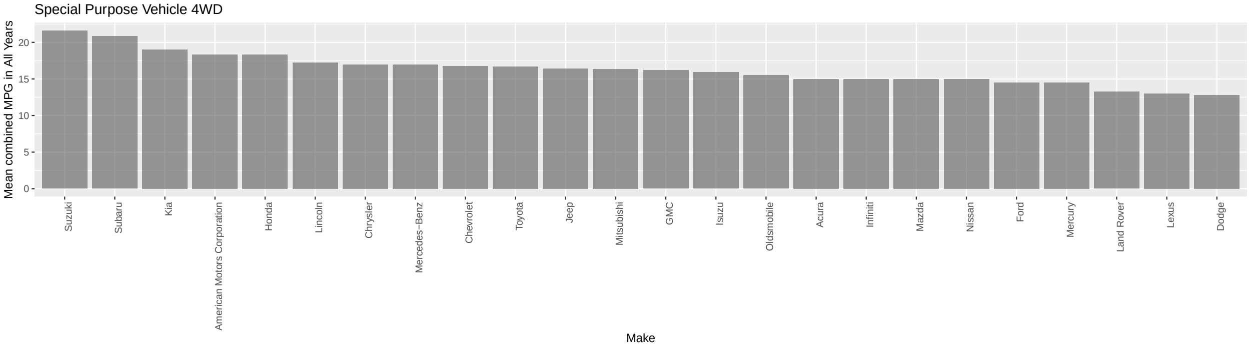

Special Purpose Vehicles

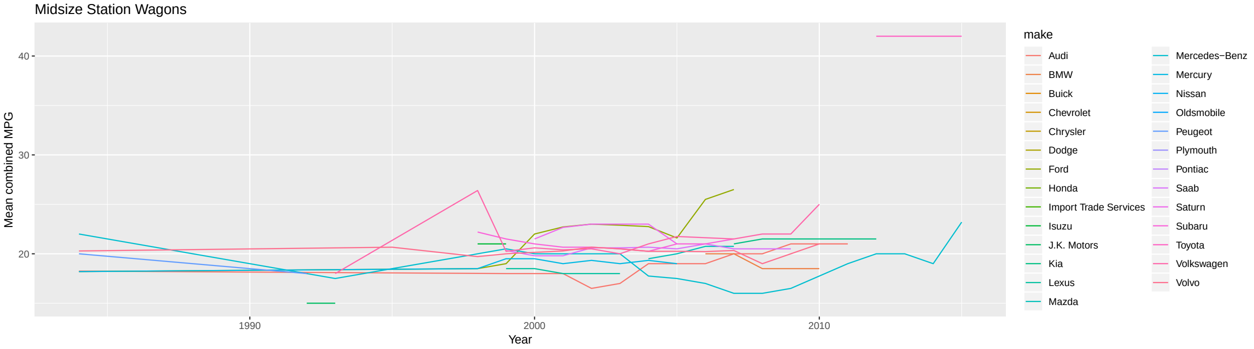

Special Purpose Vehicles

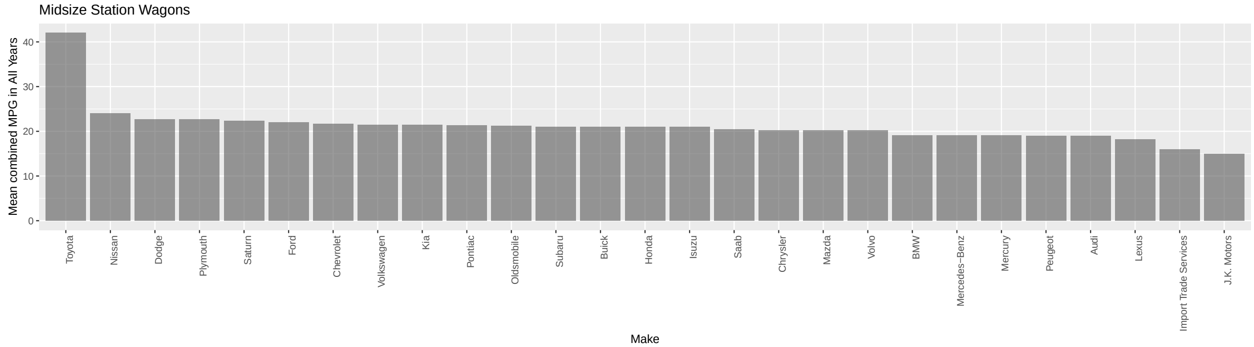

Minicompact Cars
Mean combined MPG
40
30
20
10
1990
2000
2010
Year
make
Alfa Romeo
Aston Martin
Audi
Avanti Motor Corporation
BMW
Chevrolet
Dacia
Excalibur Autos
Ferrari
Fiat
Jaguar
Lexus
Lotus
Maserati
Mazda
Mercedes−Benz
Mercury
MINI
Mitsubishi
Nissan
Pontiac
Porsche
Qvale
Scion
Spyker
Subaru
Suzuki
Toyota
Volkswagen
Wallace Environmental
Yugo

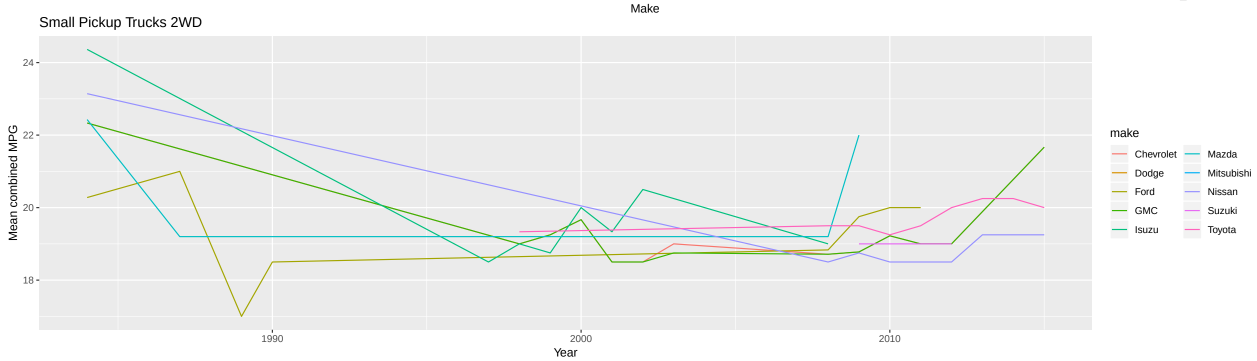

Minicompact Cars
Mean combined MPG in All Years
0
10
20
30
40
Chevrolet
Pontiac
Suzuki
Scion
Fiat
MINI
Subaru
Toyota
Yugo
Dacia
Mercury
Volkswagen
Nissan
Lotus
Qvale
Mitsubishi
Audi
BMW
Lexus
Porsche
Alfa Romeo
Mazda
Jaguar
Mercedes−Benz
Avanti Motor Corporation
Spyker
Wallace Environmental
Ferrari
Excalibur Autos
Maserati
Aston Martin
Make

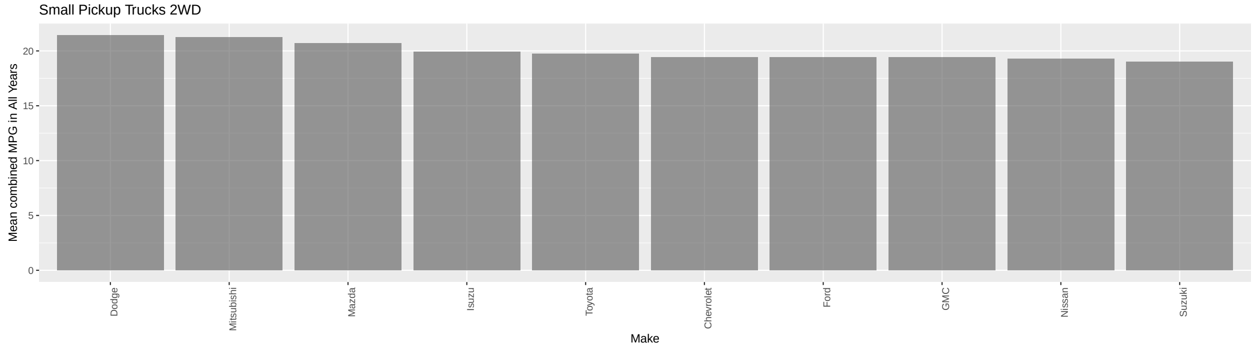

Special Purpose Vehicle 4WD
Mean combined MPG
22.5
20.0
17.5
15.0
12.5
1990
2000
2010
Year
make
Acura
American Motors Corporation
Chevrolet
Chrysler
Dodge
Ford
GMC
Honda
Infiniti
Isuzu
Jeep
Kia
Land Rover
Lexus
Lincoln
Mazda
Mercedes−Benz
Mercury
Mitsubishi
Nissan
Oldsmobile
Subaru
Suzuki
Toyota

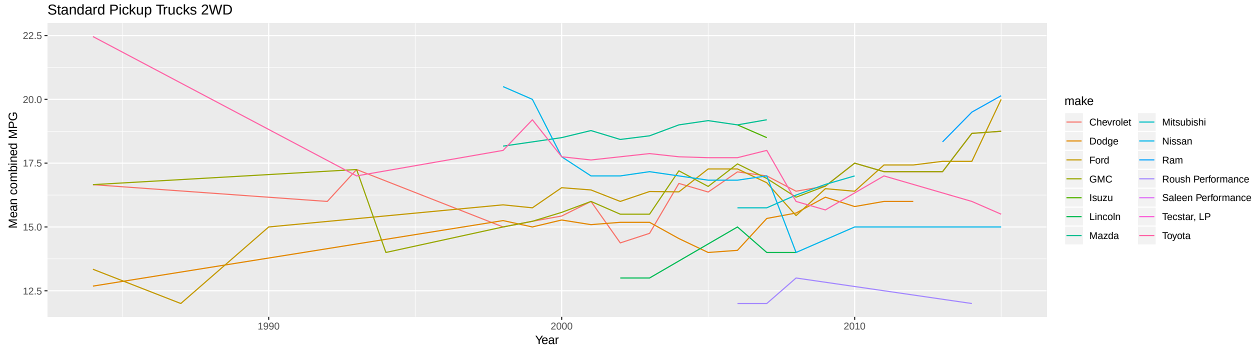

Special Purpose Vehicle 4WD
Mean combined MPG in All Years
0
5
10
15
20
Suzuki
Subaru
Kia
American Motors Corporation
Honda
Lincoln
Chrysler
Mercedes−Benz
Chevrolet
Toyota
Jeep
Mitsubishi
GMC
Isuzu
Oldsmobile
Acura
Infiniti
Mazda
Nissan
Ford
Mercury
Land Rover
Lexus
Dodge
Make

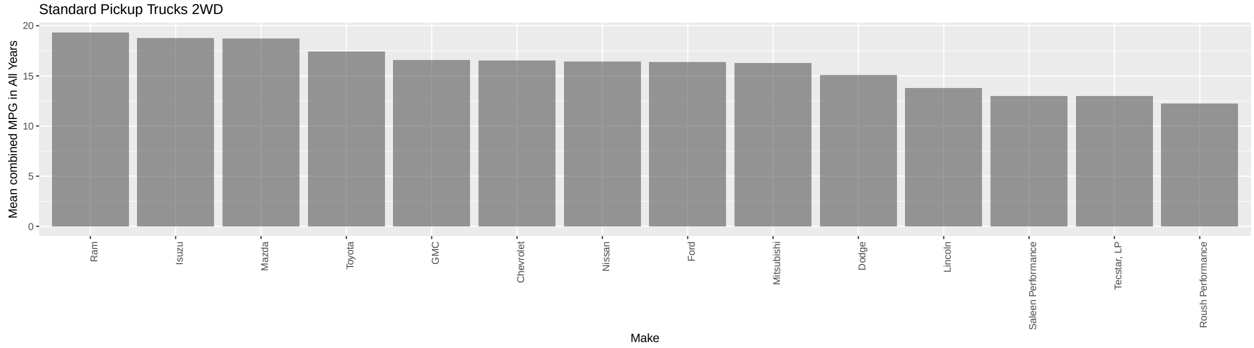

Midsize Station Wagons
Mean combined MPG
40
30
20
1990
2000
2010
Year
make
Audi
BMW
Buick
Chevrolet
Chrysler
Dodge
Ford
Honda
Import Trade Services
Isuzu
J.K. Motors
Kia
Lexus
Mazda
Mercedes−Benz
Mercury
Nissan
Oldsmobile
Peugeot
Plymouth
Pontiac
Saab
Saturn
Subaru
Toyota
Volkswagen
Volvo

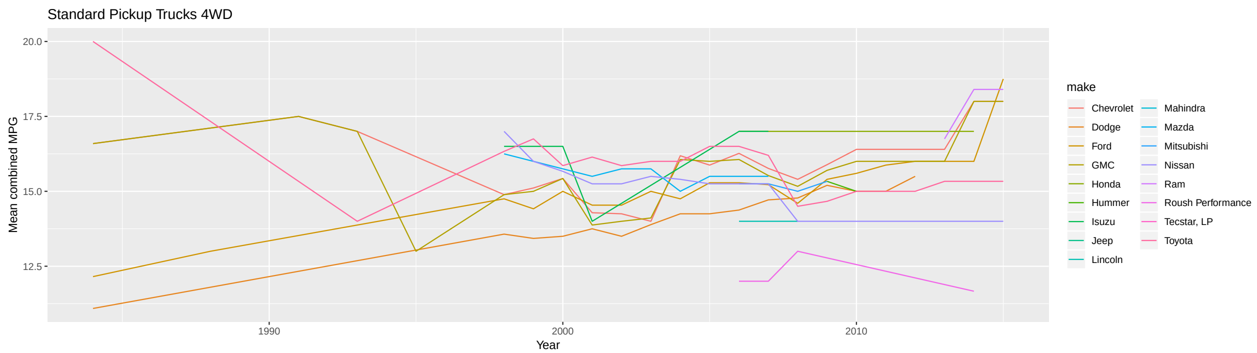

Midsize Station Wagons
Mean combined MPG in All Years
0
10
20
30
40
Toyota
Nissan
Dodge
Plymouth
Saturn
Ford
Chevrolet
Volkswagen
Kia
Pontiac
Oldsmobile
Subaru
Buick
Honda
Isuzu
Saab
Chrysler
Mazda
Volvo
BMW
Mercedes−Benz
Mercury
Peugeot
Audi
Lexus
Import Trade Services
J.K. Motors
Make

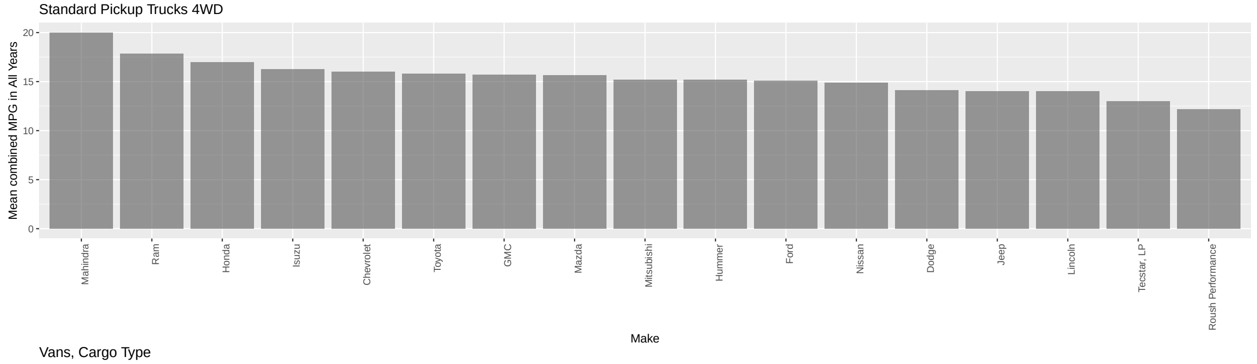

Small Pickup Trucks 2WD
Mean combined MPG
18
20
22
24
1990
2000
2010
Year
make
Chevrolet
Dodge
Ford
GMC
Isuzu
Mazda
Mitsubishi
Nissan
Suzuki
Toyota

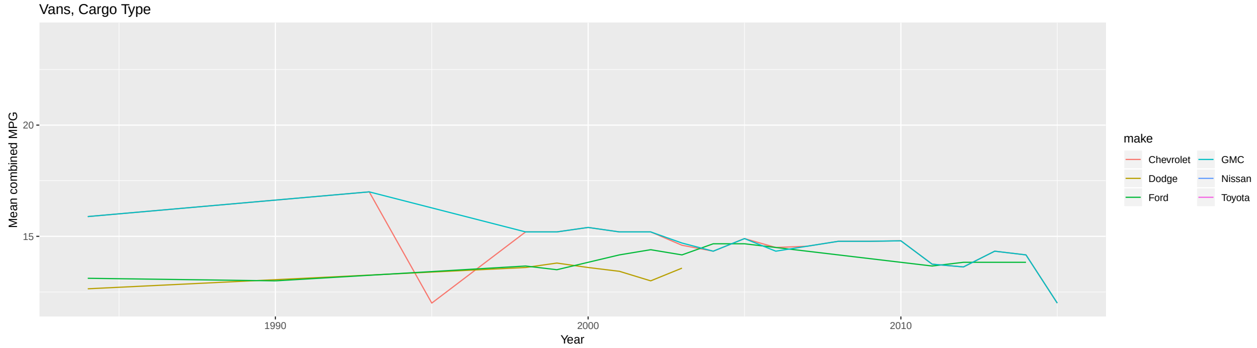

Small Pickup Trucks 2WD
Mean combined MPG in All Years
0
5
10
15
20
Dodge
Mitsubishi
Mazda
Isuzu
Toyota
Chevrolet
Ford
GMC
Nissan
Suzuki
Make

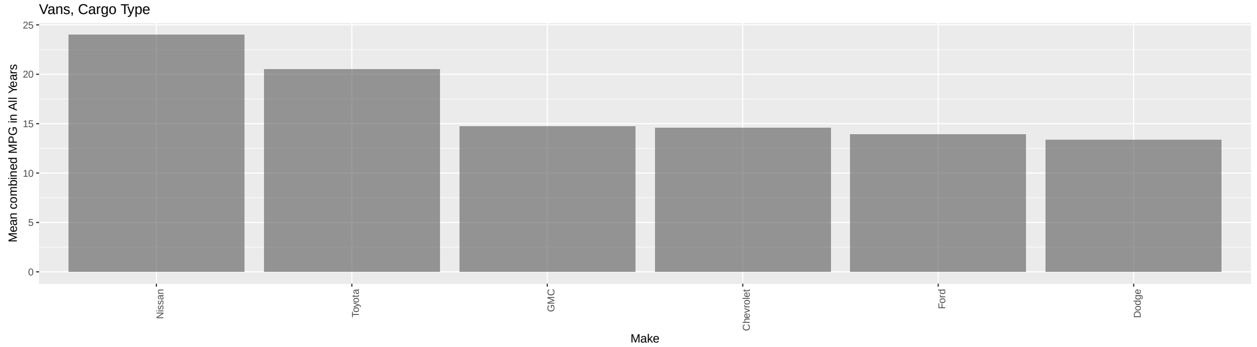

Standard Pickup Trucks 2WD
Mean combined MPG
12.5
15.0
17.5
20.0
22.5
1990
2000
2010
Year
make
Chevrolet
Dodge
Ford
GMC
Isuzu
Lincoln
Mazda
Mitsubishi
Nissan
Ram
Roush Performance
Saleen Performance
Tecstar, LP
Toyota

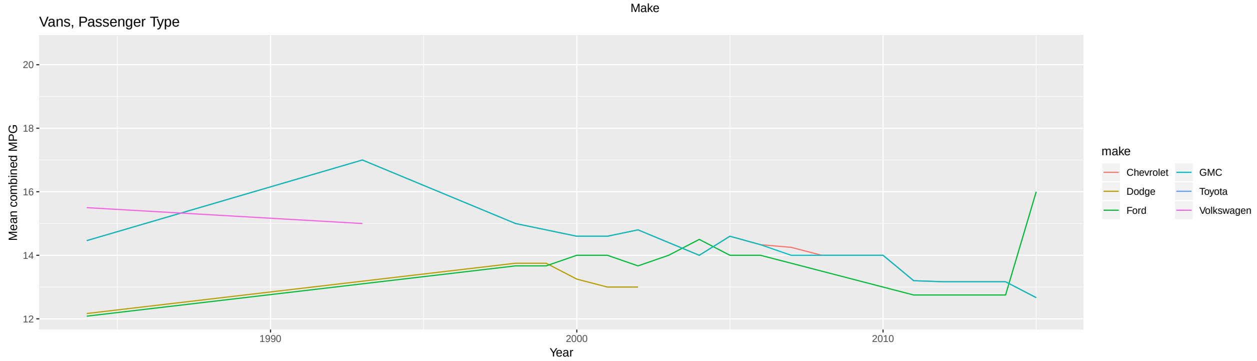

Standard Pickup Trucks 2WD
Mean combined MPG in All Years
0
5
10
15
20
Ram
Isuzu
Mazda
Toyota
GMC
Chevrolet
Nissan
Ford
Mitsubishi
Dodge
Lincoln
Saleen Performance
Tecstar, LP
Roush Performance
Make

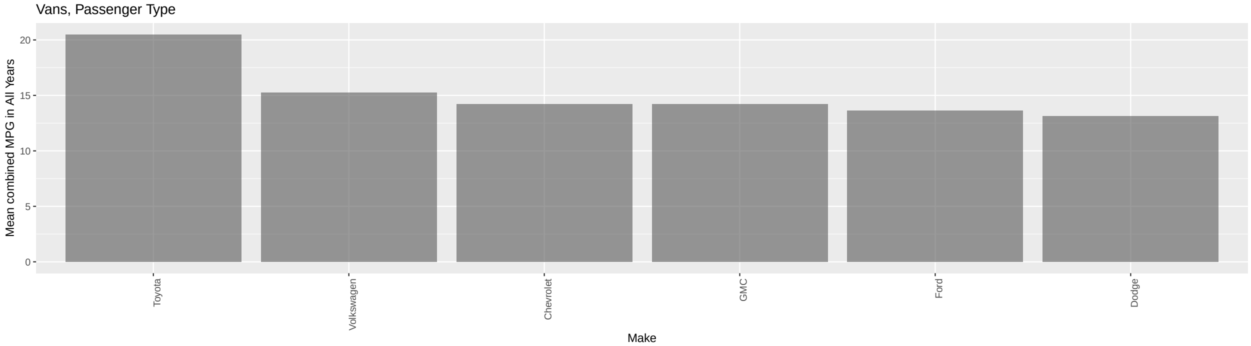

Standard Pickup Trucks 4WD

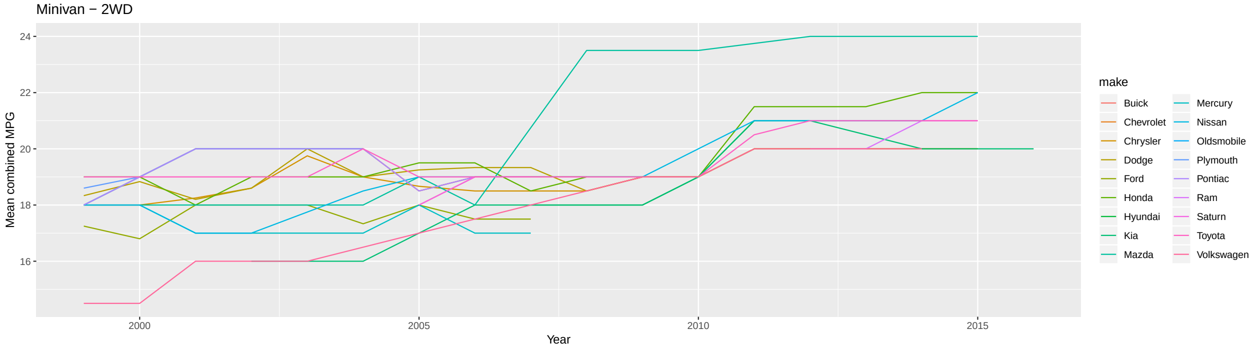

Standard Pickup Trucks 4WD

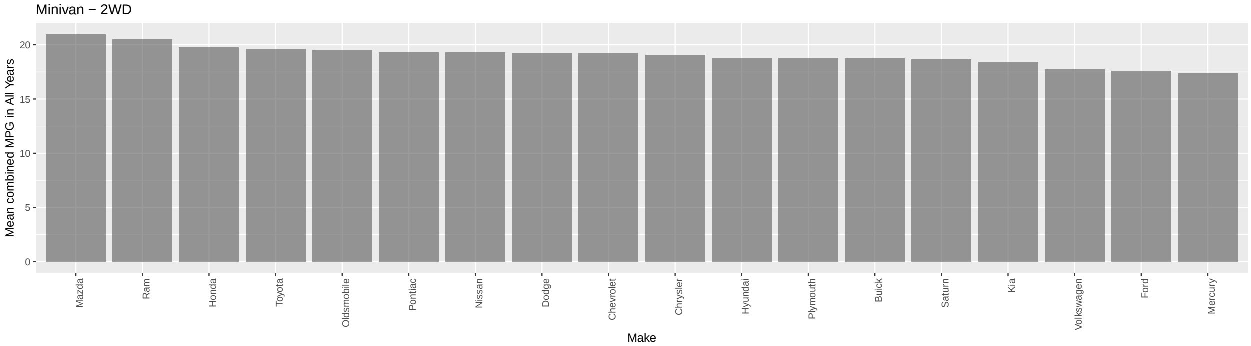

Vans, Cargo Type

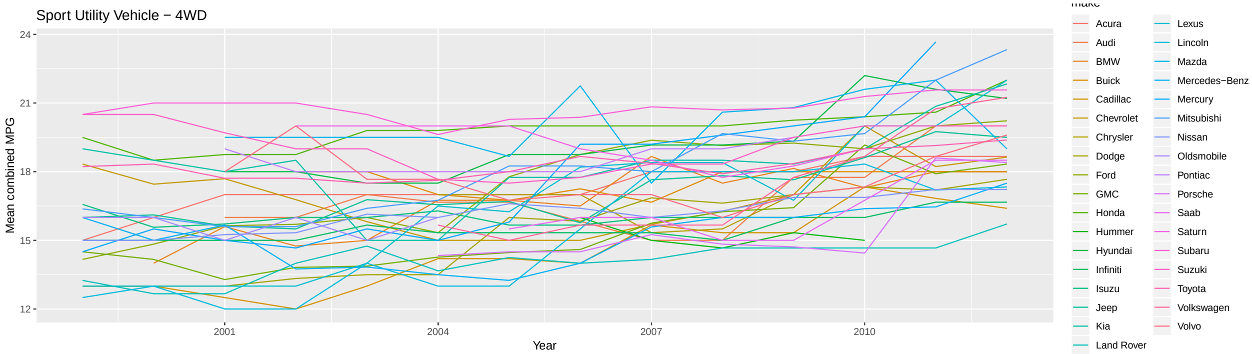

Vans, Cargo Type

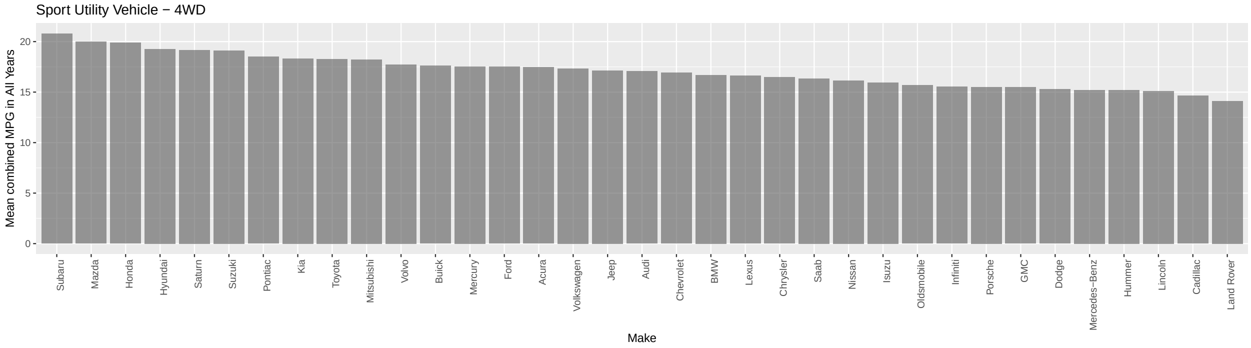

Vans, Passenger Type

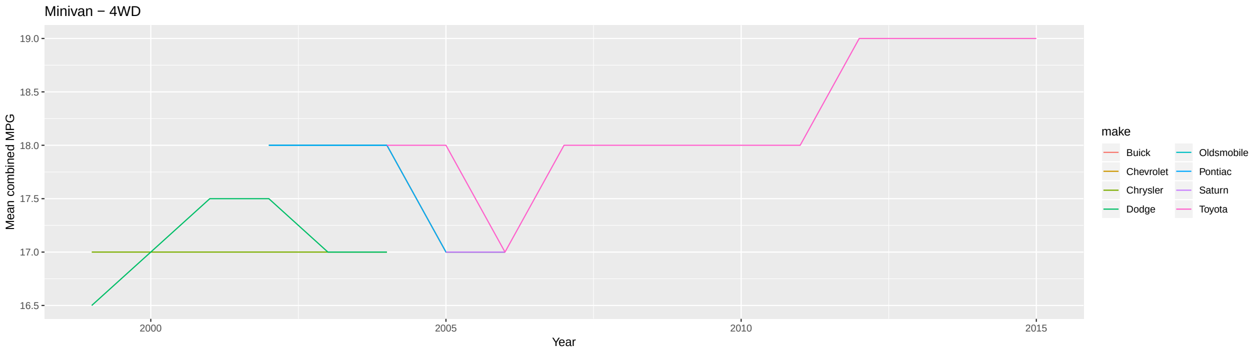

Vans, Passenger Type
Mean combined MPG in All Years
0
5
10
15
20
Toyota
Volkswagen
Chevrolet
GMC
Ford
Dodge
Make

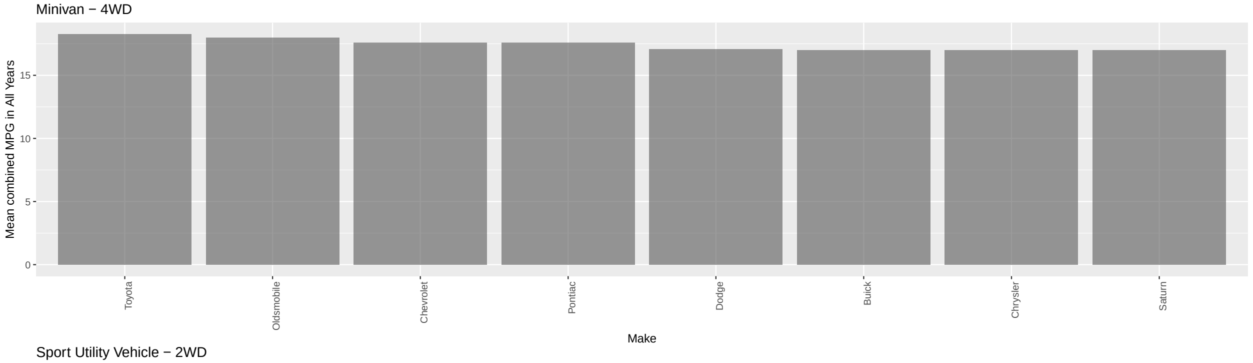

Minivan − 2WD
Mean combined MPG
16
18
20
22
24
2000
2005
2010
2015
Year
make
Buick
Chevrolet
Chrysler
Dodge
Ford
Honda
Hyundai
Kia
Mazda
Mercury
Nissan
Oldsmobile
Plymouth
Pontiac
Ram
Saturn
Toyota
Volkswagen

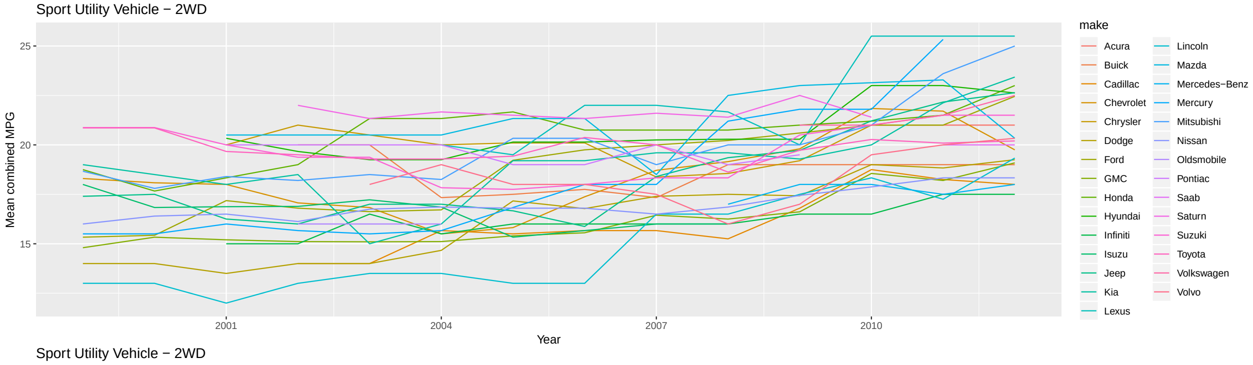

Minivan − 2WD
Mean combined MPG in All Years
0
5
10
15
20
Mazda
Ram
Honda
Toyota
Oldsmobile
Pontiac
Nissan
Dodge
Chevrolet
Chrysler
Hyundai
Plymouth
Buick
Saturn
Kia
Volkswagen
Ford
Mercury
Make

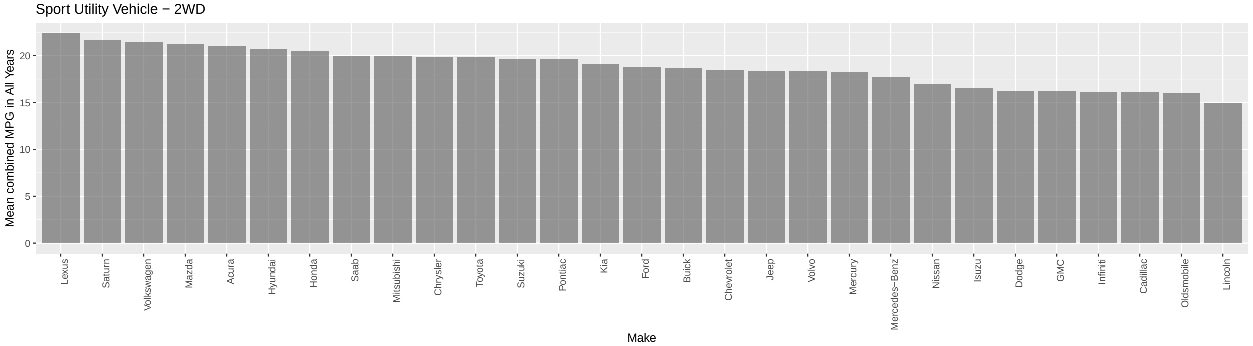

Sport Utility Vehicle − 4WD
Mean combined MPG
12
15
18
21
24
2001
2004
2007
2010
Year
make
Acura
Audi
BMW
Buick
Cadillac
Chevrolet
Chrysler
Dodge
Ford
GMC
Honda
Hummer
Hyundai
Infiniti
Isuzu
Jeep
Kia
Land Rover
Lexus
Lincoln
Mazda
Mercedes−Benz
Mercury
Mitsubishi
Nissan
Oldsmobile
Pontiac
Porsche
Saab
Saturn
Subaru
Suzuki
Toyota
Volkswagen
Volvo

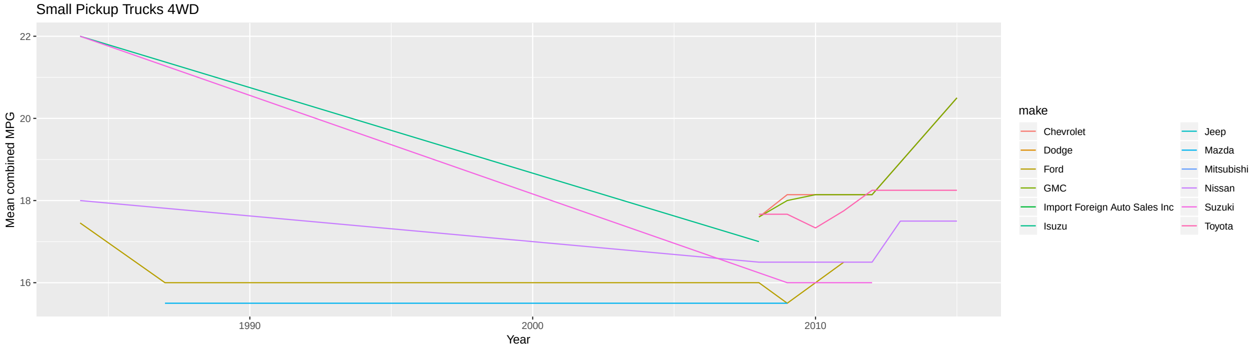

Sport Utility Vehicle − 4WD
Mean combined MPG in All Years
0
5
10
15
20
Subaru
Mazda
Honda
Hyundai
Saturn
Suzuki
Pontiac
Kia
Toyota
Mitsubishi
Volvo
Buick
Mercury
Ford
Acura
Volkswagen
Jeep
Audi
Chevrolet
BMW
Lexus
Chrysler
Saab
Nissan
Isuzu
Oldsmobile
Infiniti
Porsche
GMC
Dodge
Mercedes−Benz
Hummer
Lincoln
Cadillac
Land Rover
Make

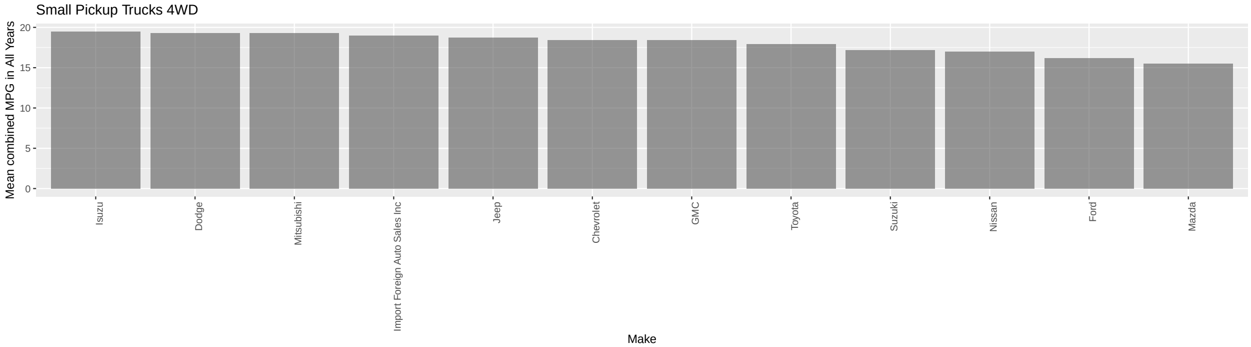

Minivan − 4WD
Mean combined MPG
19.0
18.5
18.0
17.5
17.0
16.5
2000
2005
2010
2015
Year
make
Buick
Chevrolet
Chrysler
Dodge
Oldsmobile
Pontiac
Saturn
Toyota


Minivan − 4WD
Mean combined MPG in All Years
15
10
5
0
Toyota
Oldsmobile
Chevrolet
Pontiac
Dodge
Buick
Chrysler
Saturn
Make

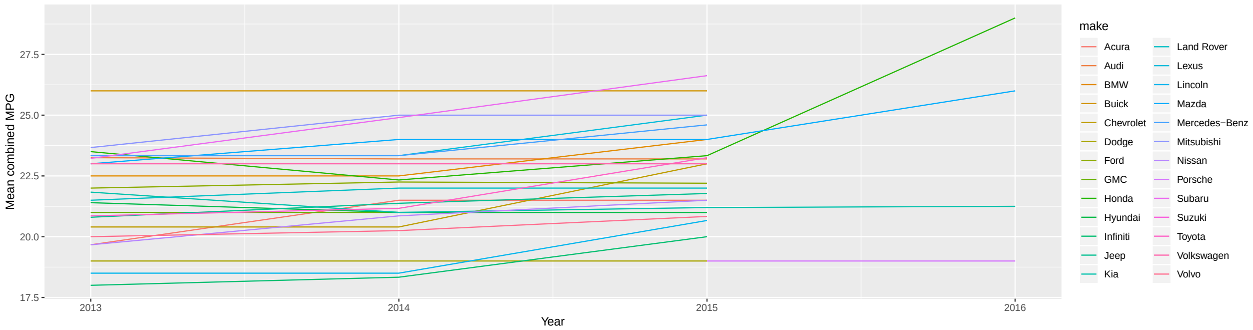

Sport Utility Vehicle − 2WD
Mean combined MPG
25
20
15
2001
2004
2007
2010
Year
make
Acura
Buick
Cadillac
Chevrolet
Chrysler
Dodge
Ford
GMC
Honda
Hyundai
Infiniti
Isuzu
Jeep
Kia
Lexus
Lincoln
Mazda
Mercedes−Benz
Mercury
Mitsubishi
Nissan
Oldsmobile
Pontiac
Saab
Saturn
Suzuki
Toyota
Volkswagen
Volvo


Sport Utility Vehicle − 2WD
Mean combined MPG in All Years
20
15
10
5
0
Lexus
Saturn
Volkswagen
Mazda
Acura
Hyundai
Honda
Saab
Mitsubishi
Chrysler
Toyota
Suzuki
Pontiac
Kia
Ford
Buick
Chevrolet
Jeep
Volvo
Mercury
Mercedes−Benz
Nissan
Isuzu
Dodge
GMC
Infiniti
Cadillac
Oldsmobile
Lincoln
Make

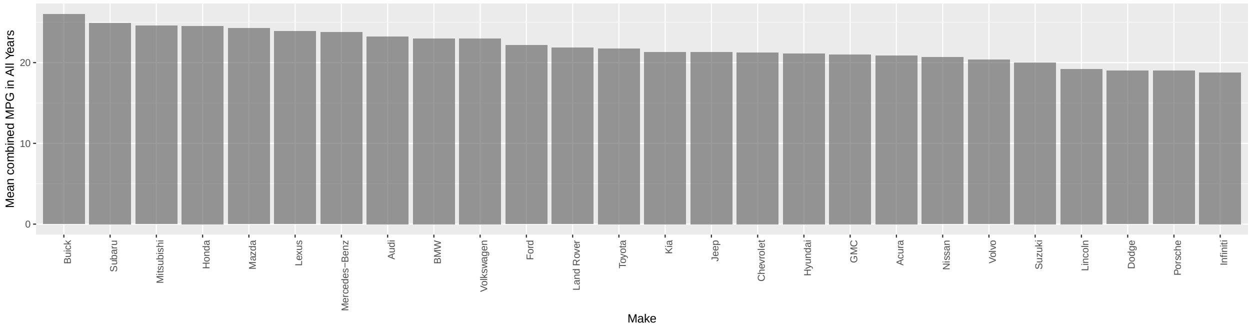

Small Pickup Trucks 4WD
Mean combined MPG
22
20
18
16
1990
2000
2010
Year
make
Chevrolet
Dodge
Ford
GMC
Import Foreign Auto Sales Inc
Isuzu
Jeep
Mazda
Mitsubishi
Nissan
Suzuki
Toyota



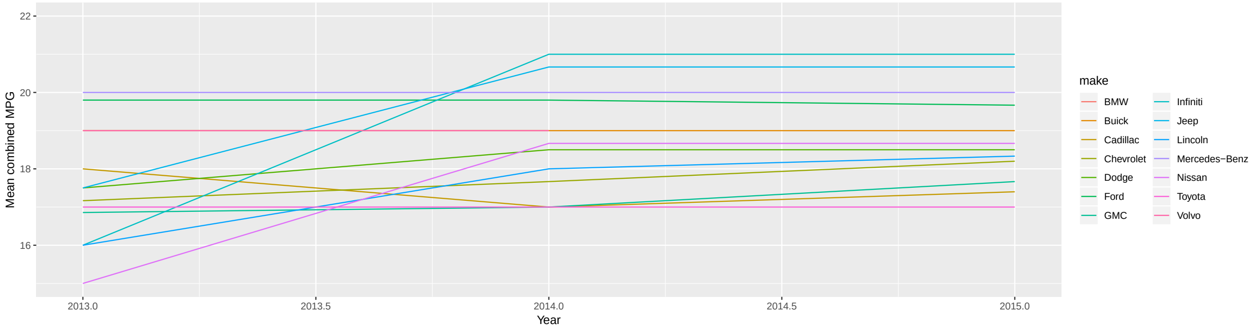
Small Pickup Trucks 4WD



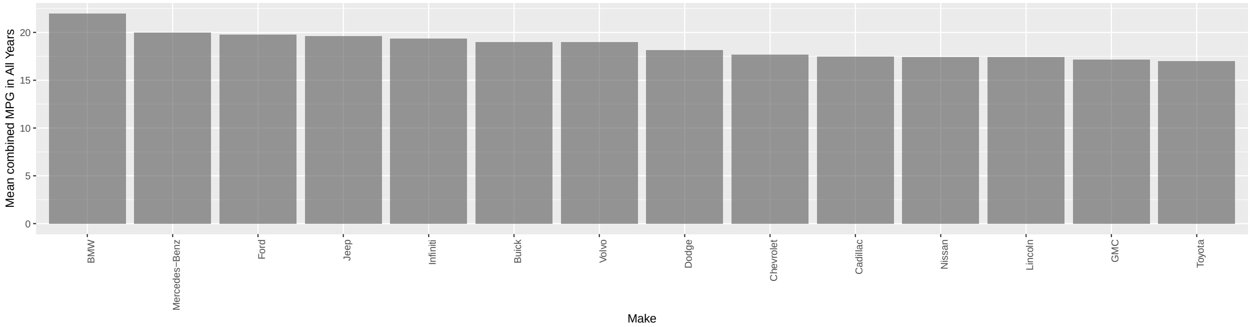
Small Sport Utility Vehicle 4WD



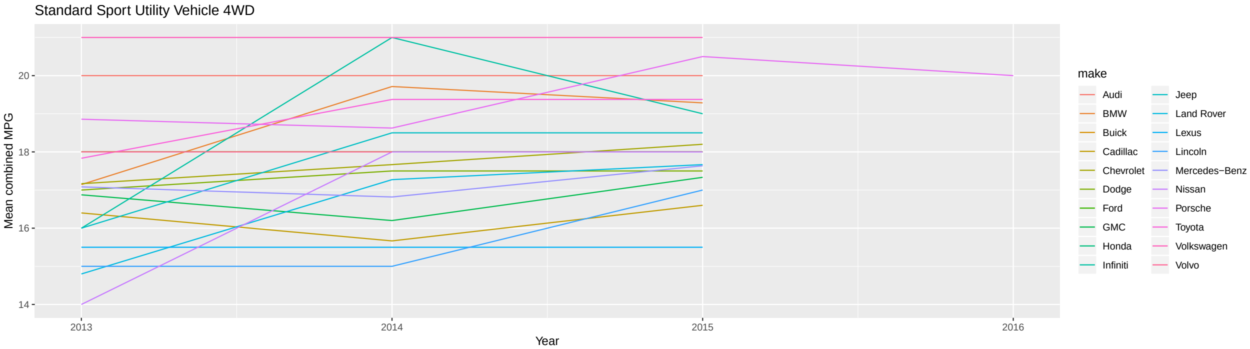
Small Sport Utility Vehicle 4WD

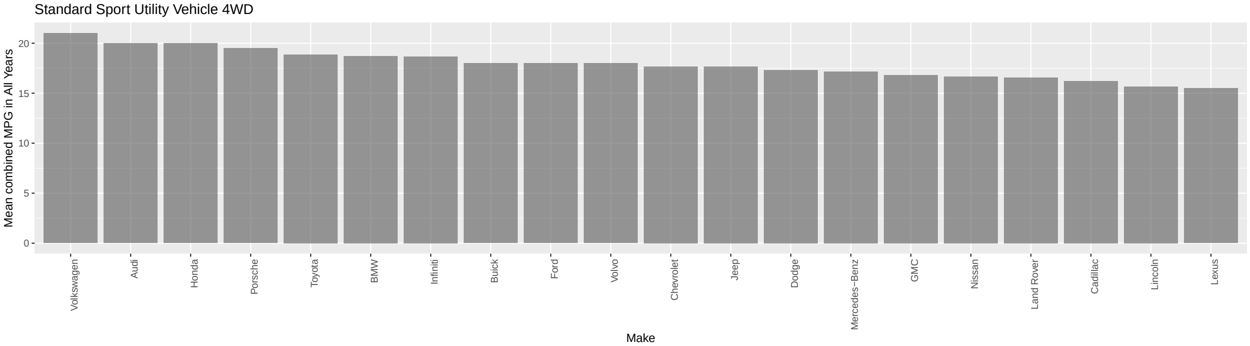


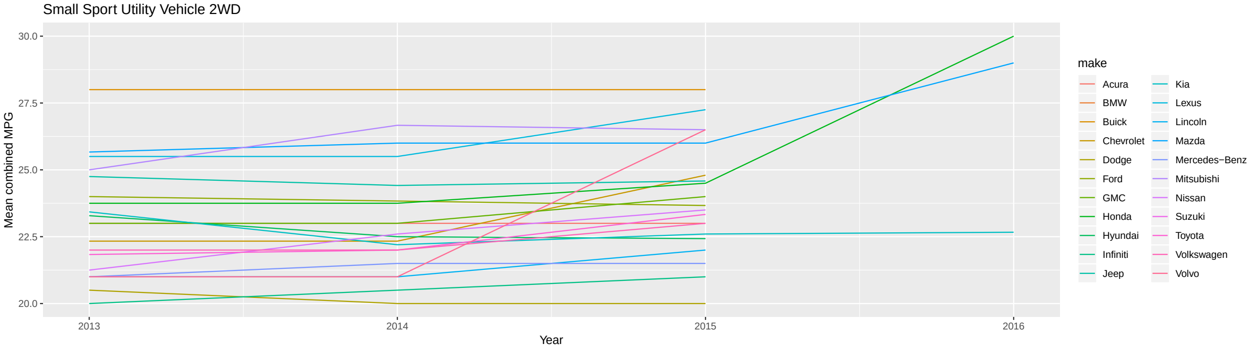
Standard Sport Utility Vehicle 2WD

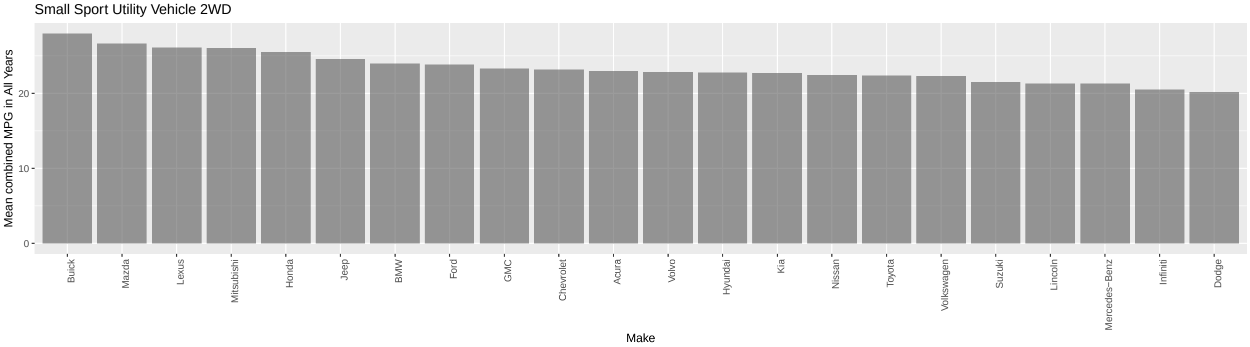


Standard Sport Utility Vehicle 2WD


Standard Sport Utility Vehicle 4WD
Mean combined MPG
14
16
18
20
2013
2014
2015
2016
Year
make
Audi
BMW
Buick
Cadillac
Chevrolet
Dodge
Ford
GMC
Honda
Infiniti
Jeep
Land Rover
Lexus
Lincoln
Mercedes−Benz
Nissan
Porsche
Toyota
Volkswagen
Volvo


Standard Sport Utility Vehicle 4WD
Mean combined MPG in All Years
0
5
10
15
20
Volkswagen
Audi
Honda
Porsche
Toyota
BMW
Infiniti
Buick
Ford
Volvo
Chevrolet
Jeep
Dodge
Mercedes−Benz
GMC
Nissan
Land Rover
Cadillac
Lincoln
Lexus
Make


Small Sport Utility Vehicle 2WD
Mean combined MPG
20.0
22.5
25.0
27.5
30.0
2013
2014
2015
2016
Year
make
Acura
BMW
Buick
Chevrolet
Dodge
Ford
GMC
Honda
Hyundai
Infiniti
Jeep
Kia
Lexus
Lincoln
Mazda
Mercedes−Benz
Mitsubishi
Nissan
Suzuki
Toyota
Volkswagen
Volvo


Small Sport Utility Vehicle 2WD
Mean combined MPG in All Years
0
10
20
Buick
Mazda
Lexus
Mitsubishi
Honda
Jeep
BMW
Ford
GMC
Chevrolet
Acura
Volvo
Hyundai
Kia
Nissan
Toyota
Volkswagen
Suzuki
Lincoln
Mercedes−Benz
Infiniti
Dodge
Make