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# Fuel Economy of Vehicles – Design & Operation considerations

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## Benefits of Fuel Economy

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- **Personal Level** – Saves Money
- **National Level** – Increases Energy Security
- **Global Level** – ♦ Reduces the consumption of fossil fuels
  - ♦ Pollution is reduced
  - ♦ Green house gases are reduced

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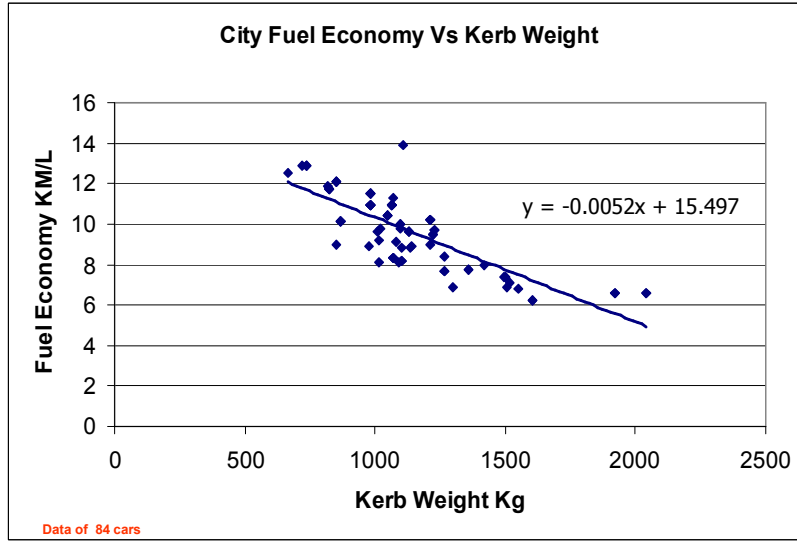
**Design Parameters which influence Fuel Economy**

Parameters	Effect on Fuel Economy km/l	
• Kerb Weight	↓	↑
• Aerodynamic drag	↓	↑
• Engine Displacement	↓	↑
• Maximum Power	↓	↑
• Maximum Torque	↑	↑
• Engine Ratio	↑	↑
• V/1000	↑	↑

**Passenger Cars studied -**

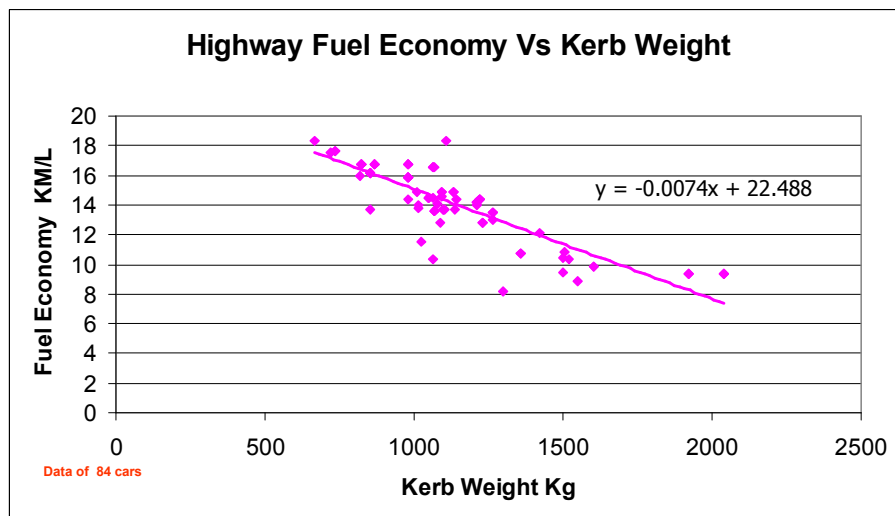
Test reports published in magazine for 84 cars  
manufactured in India

Effect of Kerb Weight on Fuel Economy - City



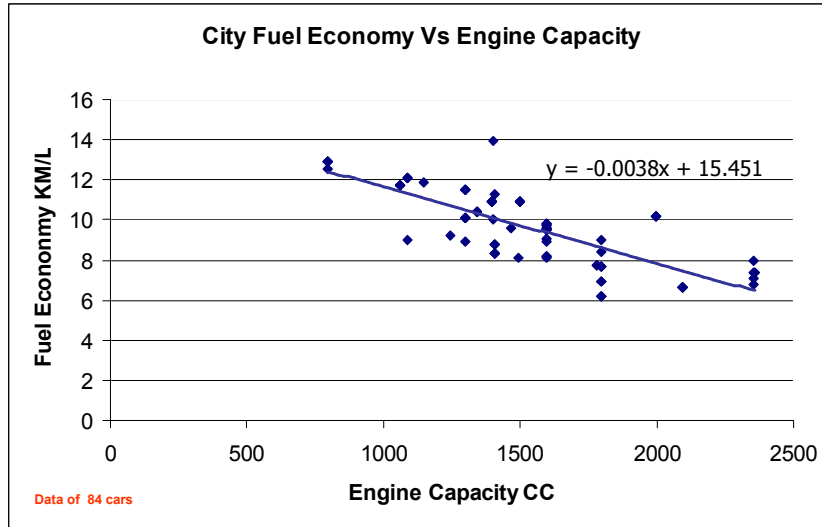
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Effect of Kerb Weight on Fuel Economy – Highway



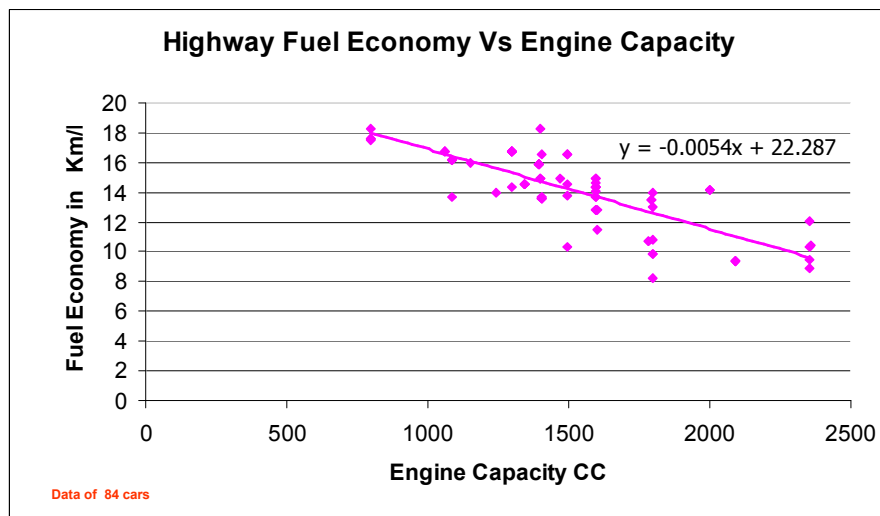
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## Effect of Engine Capacity on Fuel Economy - City



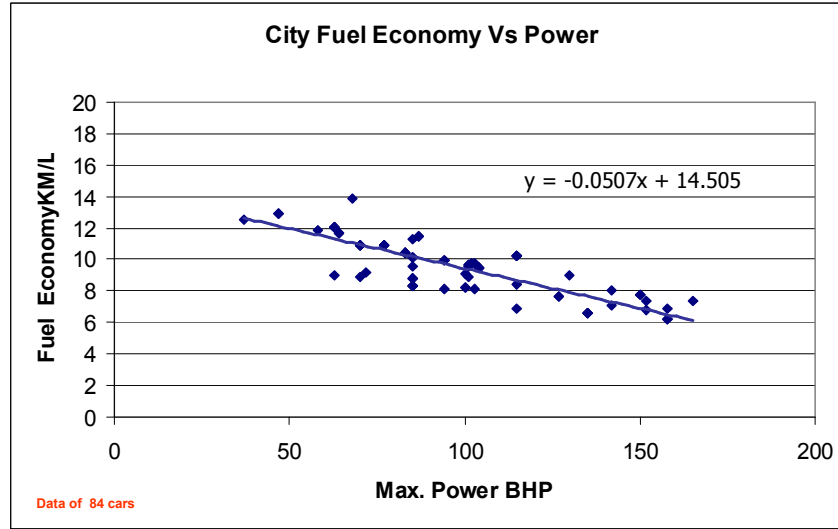
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## Effect of Engine Capacity on Fuel Economy - Highway



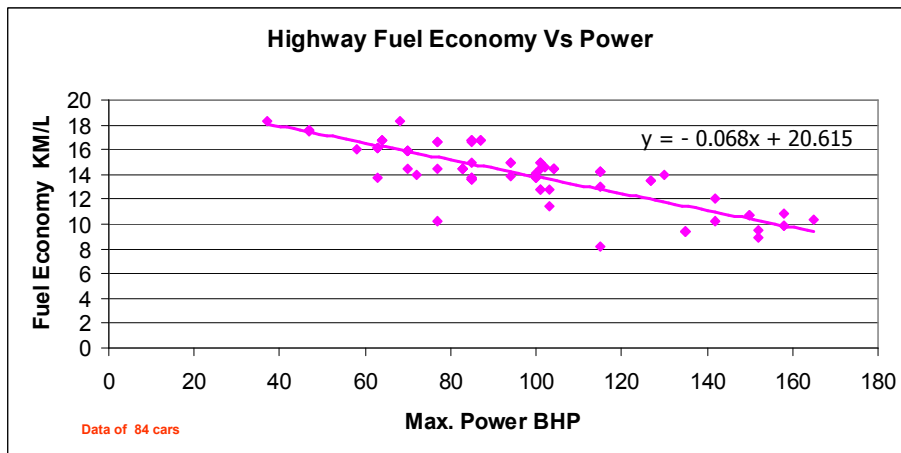
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Effect of Maximum Power on Fuel Economy - City



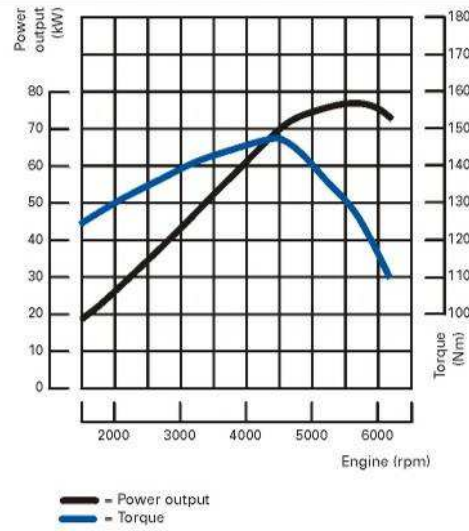
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Effect of Maximum Power on Fuel Economy - Highway



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## Power, Torque Vs RPM



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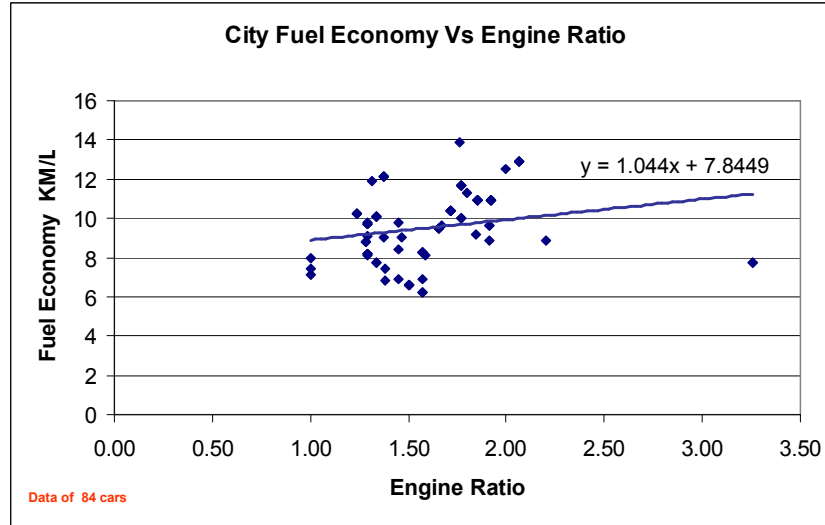
## Engine Ratio - Definition

$$\text{Engine ratio} = \frac{\text{Max. Power rpm}}{\text{Max. Torque rpm}}$$

If the max. torque rpm is less, the engine ratio will be higher.  
 Higher gears can be employed from low road speeds onwards.  
 This will result in lower losses and hence better fuel economy.

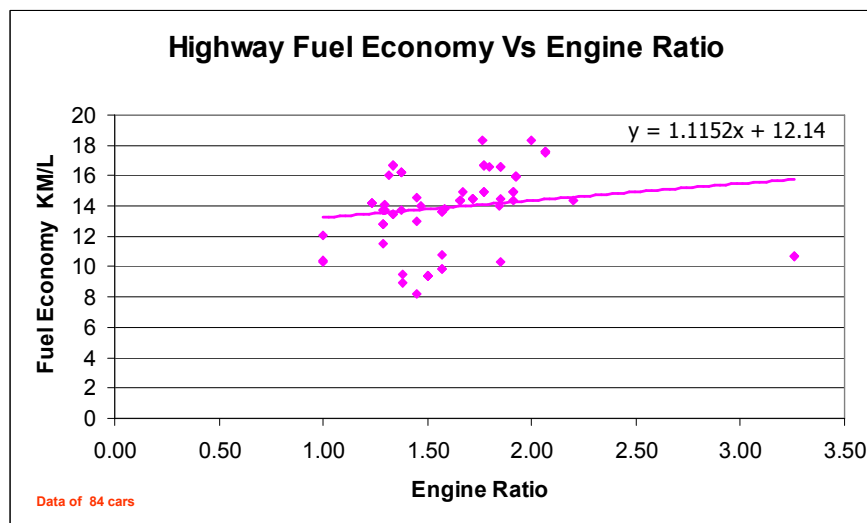
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## Effect of Engine Ratio on Fuel Economy - City



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## Effect of Engine Ratio on Fuel Economy - Highway



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V/1000

- It is the ratio of speed of car to engine revolutions
- **V/1000** = Velocity of car per 1000 RPM of engine  
(Km / hr per 1000 RPM )

Higher this number, lower will be the engine RPM for a given road speed – Hence reduced friction losses, better fuel economy.

Recently published report on two diesel cars

Technology and accessories used almost same

Model 1

- **Weight** : 1065-1075 kg
- **Max. power** : 75bhp at 4000 rpm
- **Max. Torque**: 19.37kgm at 2000 rpm
- **Top speed** : 160kph
- **0-60** : 5.43 secs
- **0-100** : 13.87 secs
- **City FE** : 14.4kpl
- **Highway FE** : 19.1kpl
- **Overall** : 16.75kpl

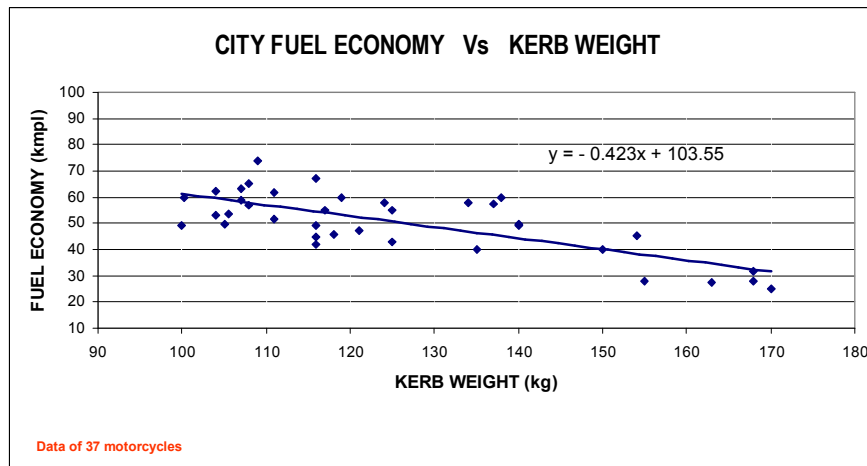
Model 2

- **Weight** : 1137 kg
- **Max. power** : 110bhp at 4000 rpm
- **Max. Torque**: 24kgm at 2000 rpm
- **Top speed** : 171kph
- **0-60** : 4.91 secs
- **0-100** : 11.32 secs
- **City FE** : 12.6kpl
- **Highway FE** : 16.2kpl
- **Overall** : 13.75kpl

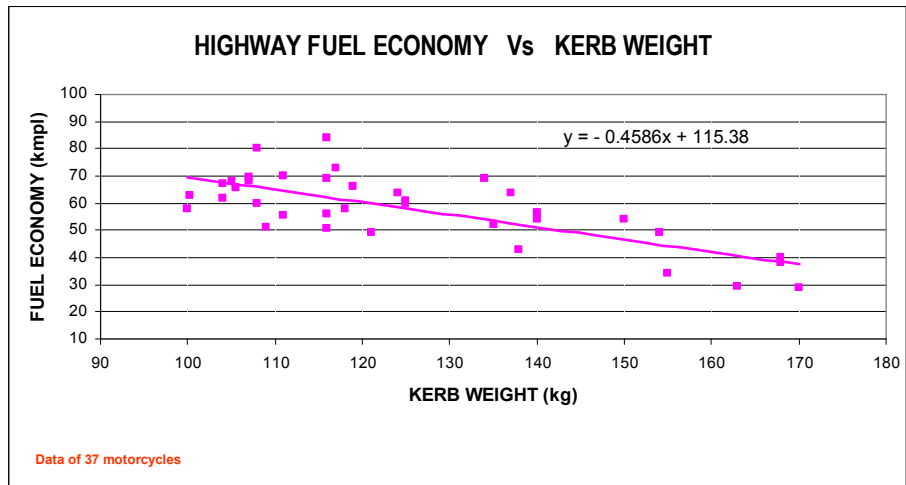
## Two wheelers - studied

Test reports published in magazine for 37 motorcycles  
manufactured in India

## Effect of Kerb Weight on Fuel Economy - City

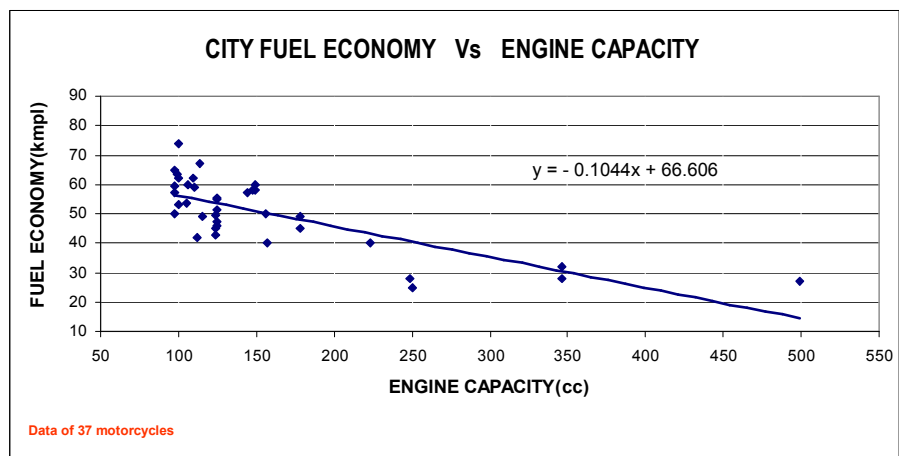


## Effect of Kerb Weight on Fuel Economy - Highway



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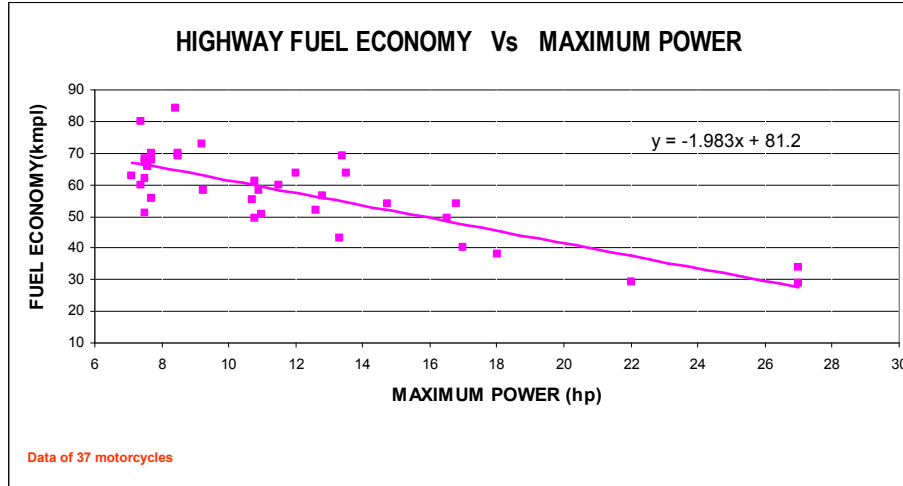
## Effect of Engine Capacity on Fuel Economy - City



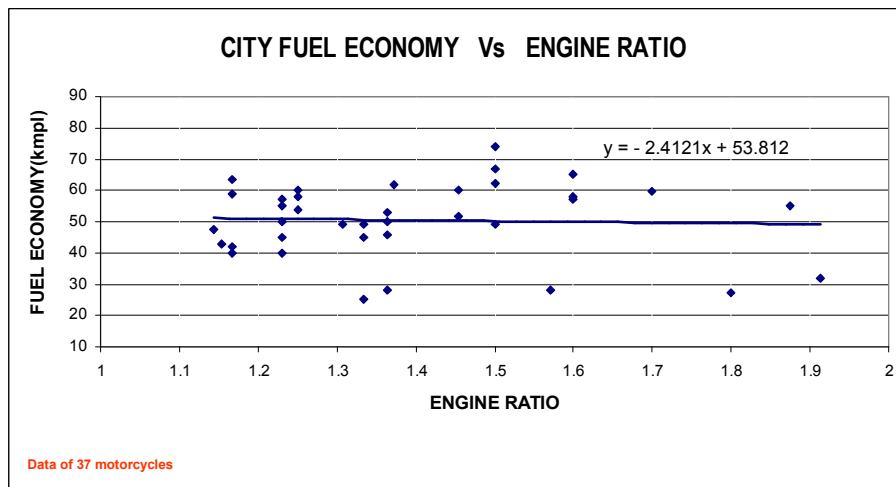
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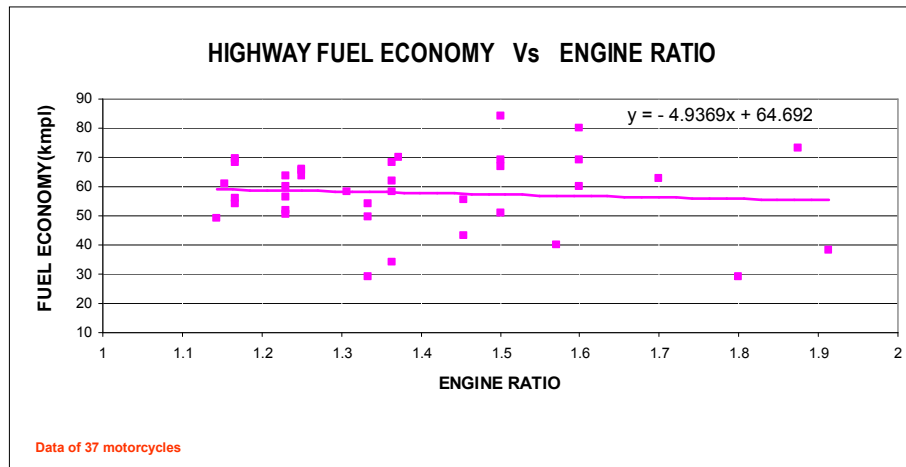
Effect of Maximum Power on Fuel Economy – Highway



Effect of Engine Ratio on Fuel Economy - City



## Effect of Engine Ratio on Fuel Economy – Highway



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## Study Results

- If engine capacity increases fuel economy decreases – due to more part load operation, pumping losses may be higher
- If Kerb weight increases fuel economy decreases – due to increase in power required to propel the car
- If maximum power increases fuel economy decreases – same as engine capacity because more part load operations will contribute to pumping losses.
- No appreciable effect on fuel economy for increasing engine ratio – it is expected that if maximum torque occurs at lower RPM then operations at higher gears are possible resulting in fuel economy. The study does not reveal the trend. However, we have to understand that scope exists.

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## Other Factors affecting Fuel Economy

- **Comfort features**
  - Accessories like A/C, Power Steering – cars only
  - Automatic Transmission
- **Road condition, mixed traffic, driver habit, lack of awareness etc.**
  - Harsh Acceleration
  - Sudden Braking
  - Overloading
  - Idle at traffic jams
  - Improper Maintenance

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## Actions and technologies for improving the Fuel economy – Design point of view

- Reducing vehicle weight by using materials such as aluminum, fiberglass, plastic, high-strength steel and carbon fiber instead of steel and iron.
- Optimised torque, power characteristics and transmission.
- Designing the exterior of the vehicle to reduce aerodynamic drag – effective at high speeds only.
- Using lower-viscosity lubricants (engine oil, transmission fluid, axle fluid)
- Replacing incandescent light bulbs with Light Emitting Diodes to reduce power consumption.

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## Actions and technologies for improving the Fuel economy – Design point of view contd..

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### Engine design improvement

- Variable length intake manifold for higher torque at low speeds.
- Stratified Charge combustion
- Lean burn combustion
- HCCI combustion
- Variable valve timing
- Supercharging (when coupled with a downsized engine)

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## 10 Ways of Saving Fuel – Operation point of view

UFSL

1. Buying a fuel efficient vehicle
2. Driving at optimum speed reduces fuel consumption.
3. Overdrive gears improve the fuel economy of the car during highway driving.
4. Anticipating driving situations.
5. Turn off the engine if a lengthy wait is expected
6. Avoid carrying unneeded items.
7. Keep tires properly inflated and aligned.
8. Check and replace air filters regularly.
9. Change oil regularly.
10. Keep the engine tuned.

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## Conclusion

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- Vehicle makers can definitely achieve realistic Fuel Economy standards – given their technological capability.
  - The benefit will be lost, if users do not take it seriously and do their bit.
  - Education of drivers and owners is important

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## Conclusion contd...

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- Overall objective of reducing Green House Gas Emissions and Fuel Conservation can be achieved only by
  - Improved Road infrastructure to ensure smooth traffic.
  - Reduced vehicle usage by improving public transport system

(A study some years back indicated that in the U.S., though CAFÉ figures were doubled in a time period there was an increase of 6% in the total fuel consumed. This was attributed to the increase in number of vehicles and distance travelled per vehicle.)

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**Thank you**