Analysis of Heavy-Duty Diesel Truck Activity and Fuel Economy based on Electronic Control Module Data

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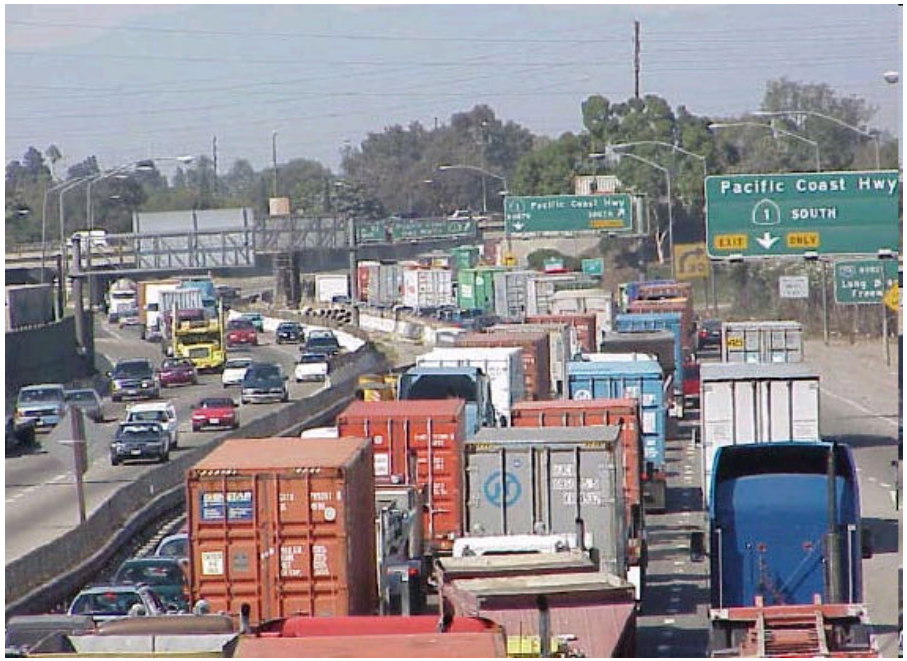
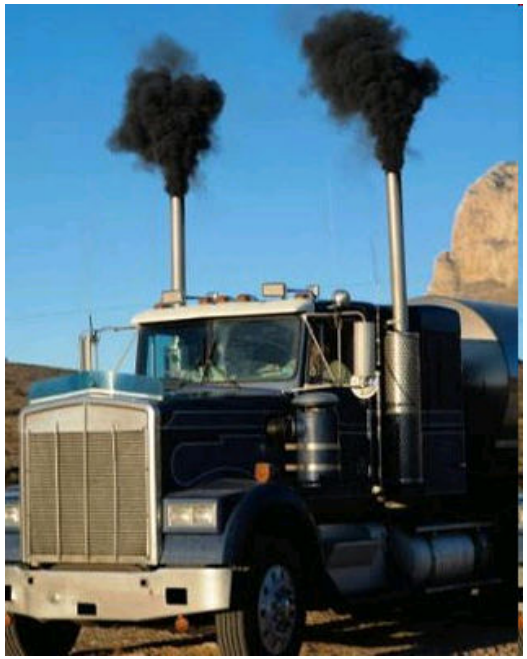
Background

- HDDTs account for 15-20% of GHG emissions from on-road mobile sources.
- High annual mileage + low fuel economy
- Need accurate characterization of these items



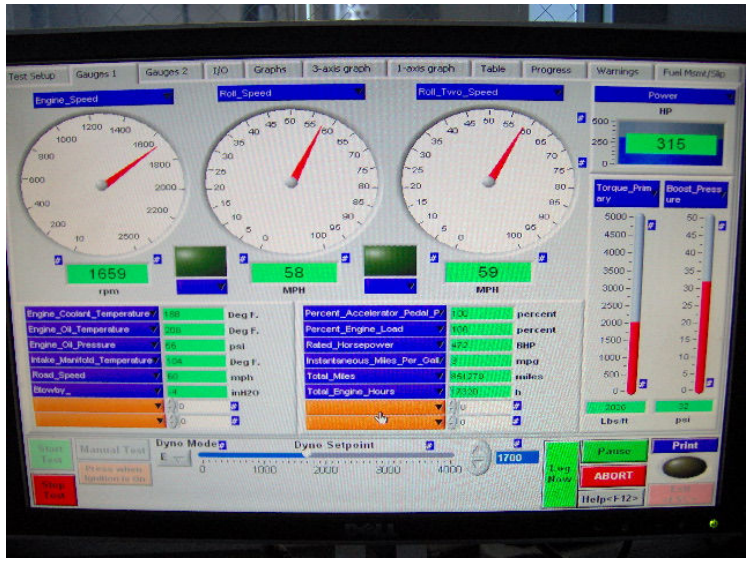


Traditional Data Sources

- HDDT activity
  - Highway Performance Measurement System (HPMS)
  - Freight flow models (e.g. FHWA's Freight Analysis Framework)
  - Specialized studies (e.g. using GPS data loggers)
- HDDT fuel economy/CO_2 emissions
  - Surveys (e.g. Census Bureau's TIUS/VIUS)
  - Public records (e.g. FHWA's Highway Statistics, International Fuel Tax Association)
  - Engine or chassis dynamometers
  - On-board testing (e.g. PEMS)

Electronic Control Module Data

- Promises
  - Readily available on most diesel engines
  - Readily accessible through manufacturer-specific software
  - Contain a rich set of engine & vehicle operating data
  - Relatively cheap to obtain ($20-$50 per download)



- Challenges
  - How to acquire, process, & analyze them?
  - What information can be extracted from the data?

Examples of Data Items

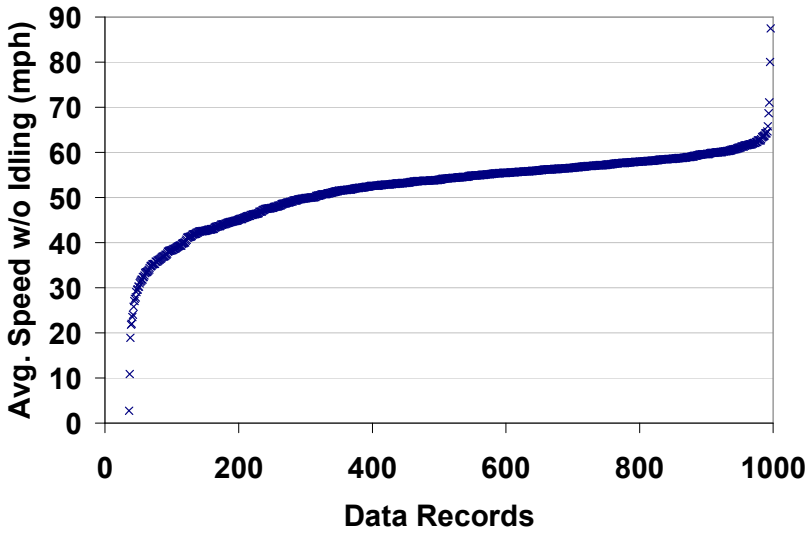
- Identification info
  - Manufacturer
  - Engine model
  - Engine serial number
  - VIN
  - Etc.
- Engine info
  - Governed speed & RPM
  - Rated peak torque
  - Tachometer calibration
  - Warm-up mode idle RPM
  - Idle RPM limit
  - Low idle RPM
  - Etc.
- Operating info
  - Total time & fuel
  - Total idle time & fuel
  - Total power take-off (PTO) time & fuel
  - Total distance
  - Lifetime engine revolutions
  - Etc.
- Others
  - Exhaust brake mode
  - Diagnostic codes
  - Logged event codes
  - Etc.

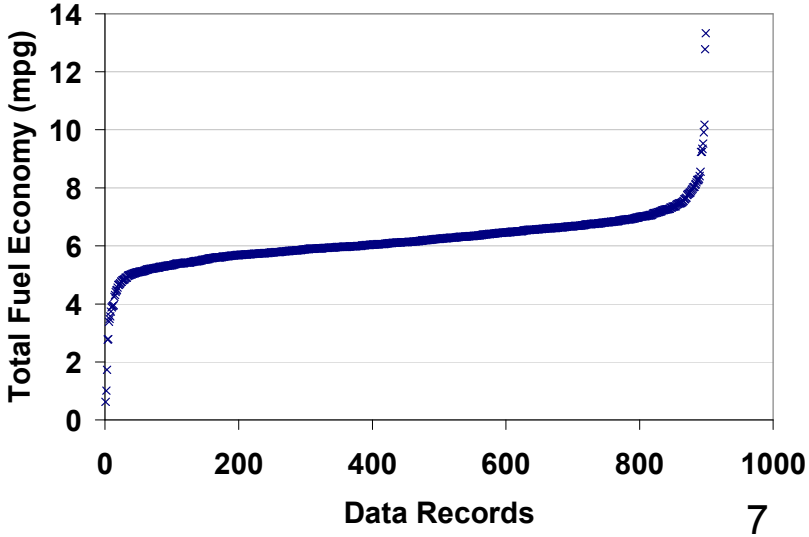
Data Acquisition

- Acquire necessary software/hardware and perform download, or
- Contract with truck repair shops to download

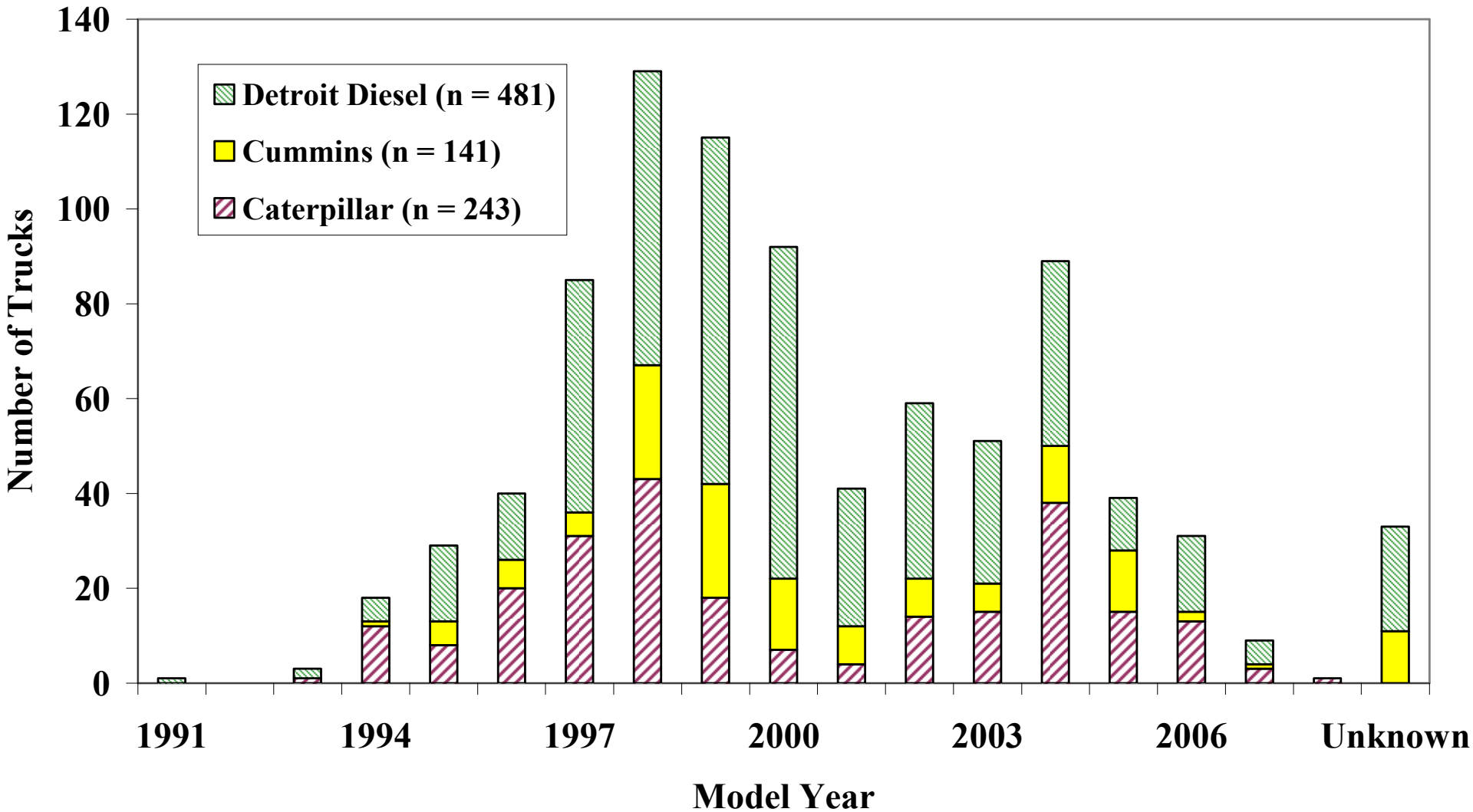
Data Processing

- Data digitization
- Data screening
  - Missing values
  - Outliers
  - 1,322 original total
  - 457 screened out (~35%)
  - 865 used for analysis
- Model year interpretation
  - Engine model year
  - Chassis/truck model year





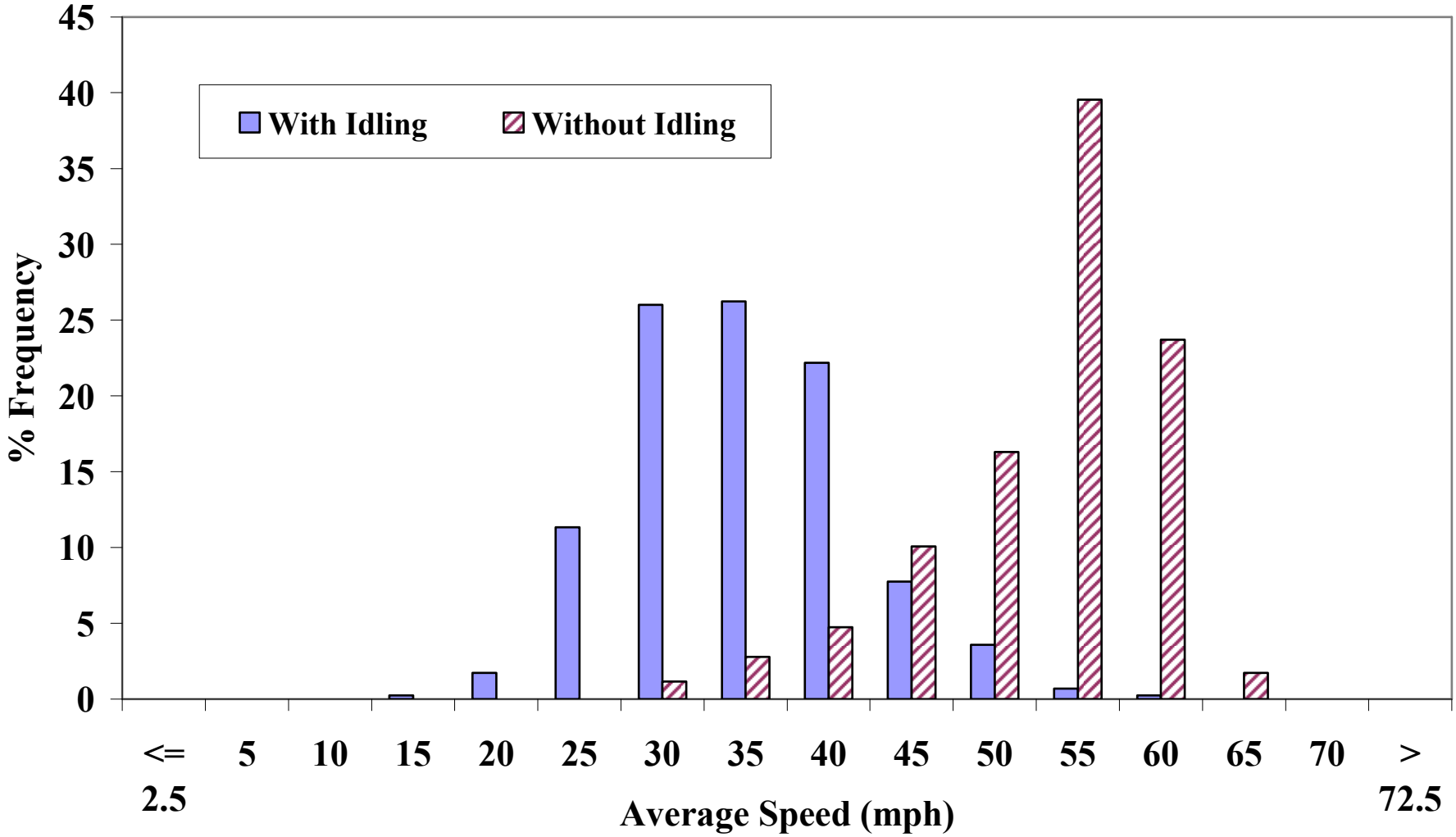
Breakdown of Data Samples



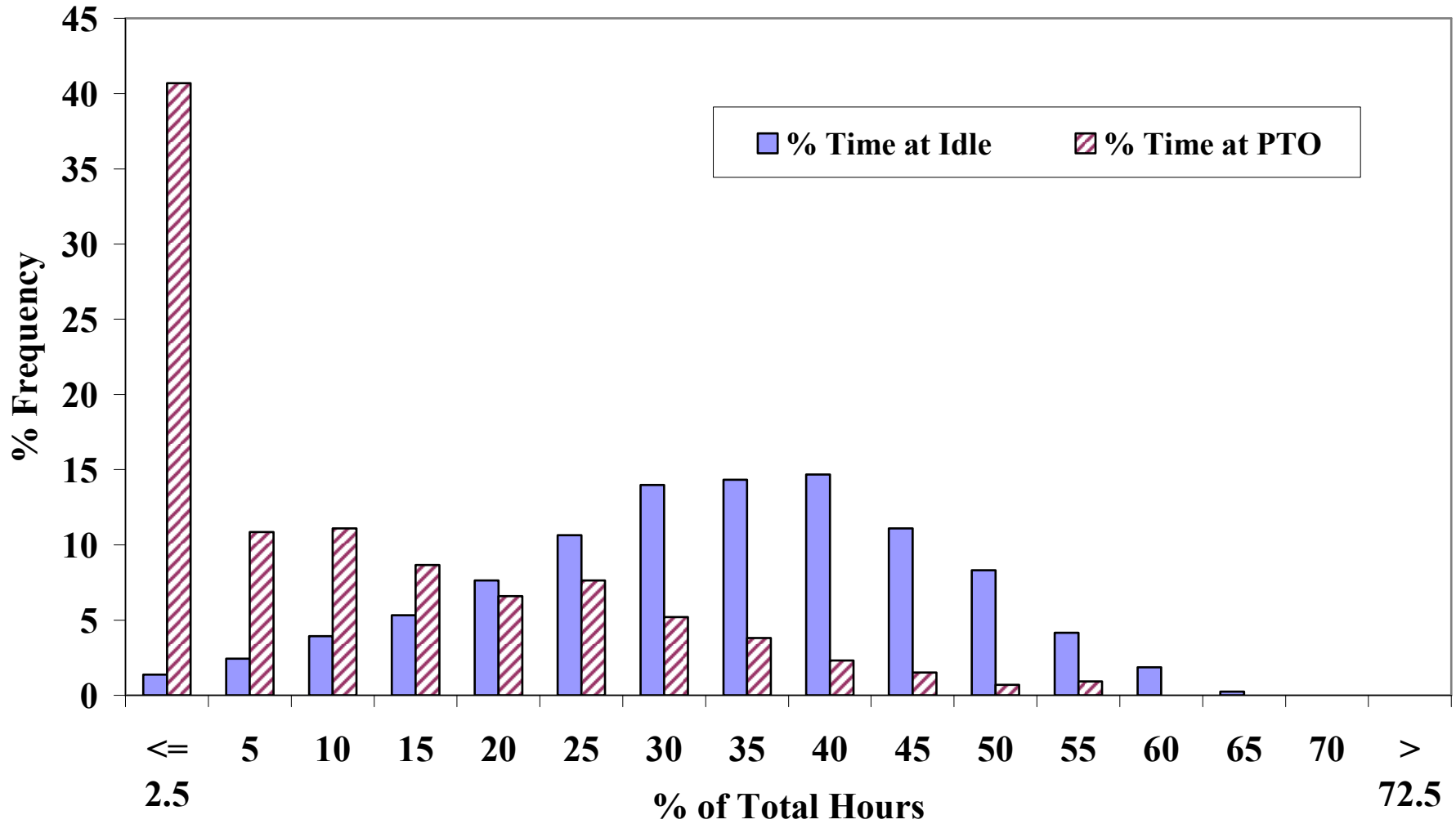
Fleet-Wide Results (N = 865)

	Mean	St. Dev
Total fuel economy (mpg)	6.2	0.6
Driving fuel economy (mpg)	6.5	0.7
Percent time at idle (%)	33.4	13.2
Percent time at power take-off (%)	11.6	13.4
Idling fuel rate (gal/hr)	0.6	0.2
Power take-off fuel rate (gal/hr)	1.3	3.3
Speed (mph)	34.9	6.7
Non-idling speed (mph)	52.9	6.7

Avg. Speed Distribution (N = 865)

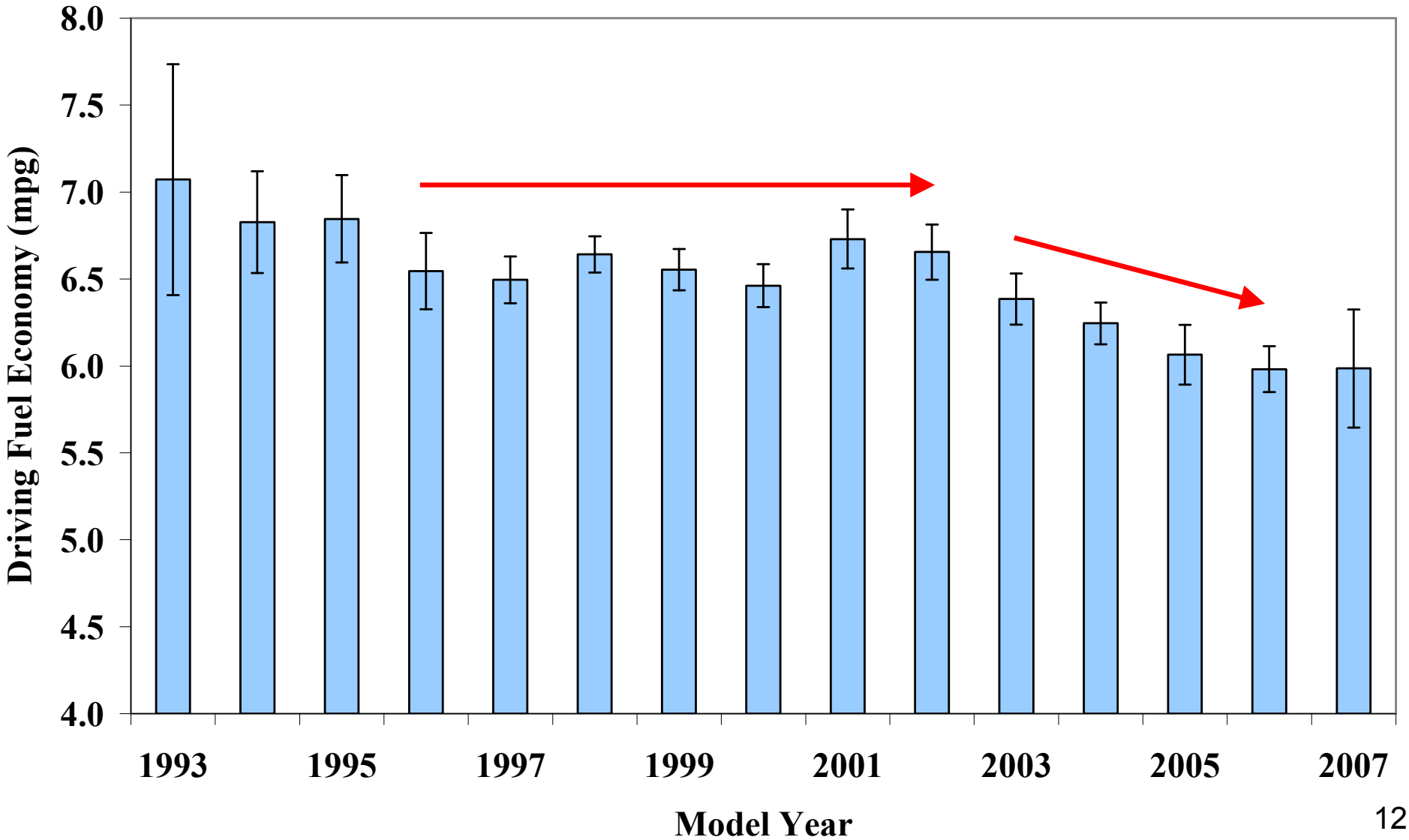


%Time at Idle and PTO* (N = 865)

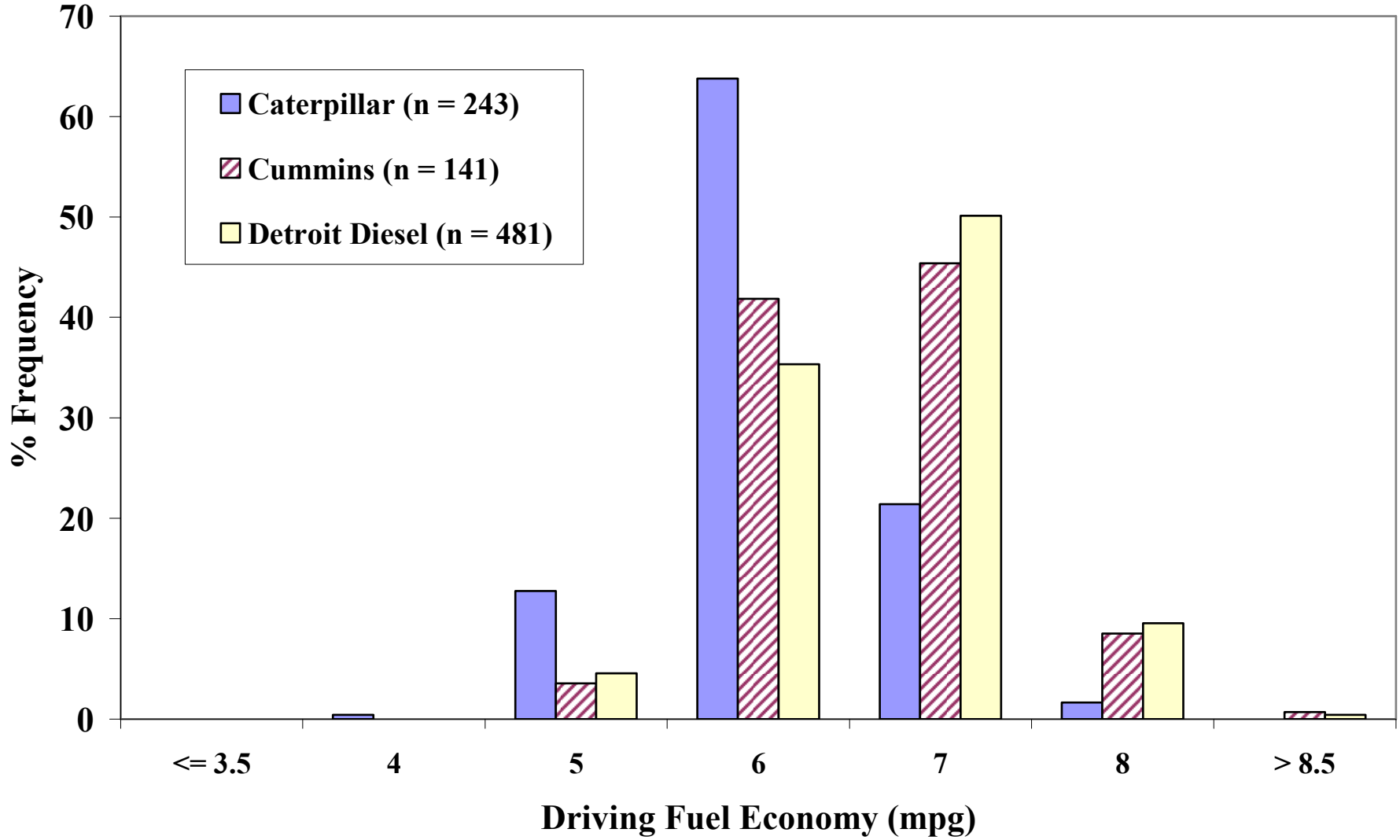


*Power take-off

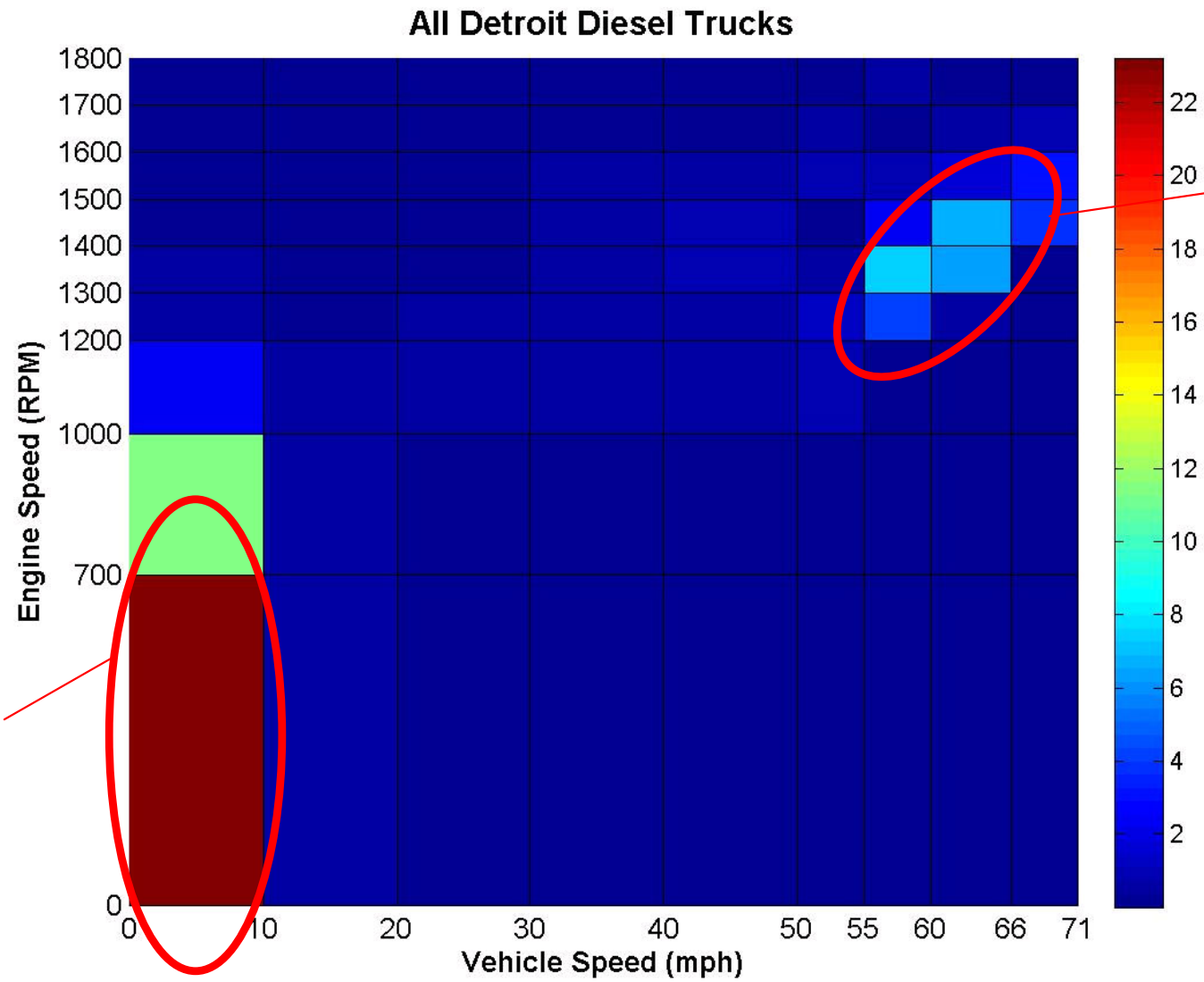
Fuel Economy by Model Year



Fuel Economy by Engine Manufacturer



Engine Operating Modes (N = 37)



Freeway driving *(Note: Truck speed limit in CA is 55 mph.)*

Idling *(at low RPM)*

Conclusions

- ECM data can be another source of HDDT activity and 'real-world, in-use' fuel economy data.
- Advantages
  - Readily available and accessible
  - Easily acquired in large scale, reducing sampling bias
  - Reasonable acquisition costs and time
- Considerations
  - High rate of invalid data records
  - Lack of spatial information
  - Temporally aggregated data

Acknowledgment & Reference

- Acknowledgment
  - California Air Resources Board (CARB)
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  - Jeremy Nelson and Daniel Hormozi of UC Riverside

- Reference

  - Barth, M., Boriboonsomsin, K., and Scora, G. (2009). "Evaluation and validation of CO_2 estimates of EMFAC and OFFROAD through vehicle activity analysis." Final report to the California Air Resources Board, November, 120 pp.

THANK YOU!

QUESTION?

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