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Comparing Fuel Efficiency and Technology Across Countries

Study Objectives

- Fuel economy of the new car fleet is widely different across countries but there is no analysis of all contributory factors.
- Some factors , like size differences, are obvious across countries, but it is not clear if there are consistent differences in technology application for fuel economy other than diesel engine penetration.
- We compared the new light duty vehicle fleet across 8 countries – USA, France, Germany, Australia in the developed world, and BRIC countries – in model year 2008.
- Analysis attempted to explain all the reasons for the new vehicle fleet fuel economy difference through data decomposition method.

Regional Preferences

- Income, taxes, fuel price, geography and infrastructure determine attribute valuations in different regions.
- US market has high valuation of comfort, size and convenience, with high income and relatively low vehicle and fuel price.
- European market has high valuation of performance, and diesel engine market is helped by reduced diesel fuel tax. Average car size is in the B/C class, but there are substantial differences between Northern and Southern Europe
- Many developing country markets have high valuation of vehicle and fuel cost due to relatively low income, but many also feature a large diesel fuel subsidy.
- Individual markets also affected by supply constraints and import taxes, especially in the developing world.

Inter Country Comparison

		USA	France	China	India
FC L/100km NEDC basis		9.8	5.3	7.5	5.6
Average Engine Size		3 to 3.5 L	1.2 to1.5L	1.3 to 1.6L	0.9 to 1.3L
Diesel Penetration		~0	81%	~0	35%
Manual Transmission		6%	92%	~40%	~60%

Data Issues

- Detailed data for all countries on a uniform basis presents a challenge.
- IEA obtained data from Polk for Europe and India, but had sales data for the US and China at the model/engine level. Vehicle specifications were generally obtained from published reports or manufacturer websites.
- Fuel economy data was obtained from official government listings, but test procedures are different across different countries. The fuel economy numbers were all "adjusted" to be equivalent to the European NEDC test results.
- Data had to be matched manually so all sales could not be included. Instead we focused on the top 60 to 70% of sales

Decomposition Analysis

- The decomposition analysis breaks down the fuel consumption average difference into its constituent parts.
- The analysis uses the German new vehicle fleet as the "reference" and it has CO2 emissions close to the EU average
- The first level of decomposition is by vehicle sales mix by size to answer the question: if all countries had the same sales mix by size as Germany, what would the average fuel consumption be? And, what is average fuel economy difference at the size class level?
- The second step of the analysis examines why vehicle fuel consumption differs at the size class level.

Size Mix and Vehicle Effects

COUNTRY	2008 FLEET FE (NEDC BASIS) L/100 km	DELTA RELATIVE TO GERMANY	DUE TO VEHICLE SALES MIX	DUE TO VEHICLE ATTRIBUTES
USA	9.85	+3.1 L/100km	+1.3	+1.8
FRANCE	5.65	-1.1 L/100km	-0.15	-0.95
AUSTRALIA	9.30	+2.55 L/100KM	+0.8	+1.75

Mix and Vehicle Effects -BRIC

COUNTRY	2008 FLEET FE (NEDC BASIS) L/100 km	DELTA RELATIVE TO GERMANY	DUE TO VEHICLE SALES MIX	DUE TO VEHICLE ATTRIBUTES
CHINA	7.95	1.2	-0.35	+1.55
INDIA	5.6	-1.15	-0.80	-0.35
BRAZIL	6.7	-0.05	-0.45	+0.40
RUSSIA	8.05	1.30	+0.05	+1.25

Class Specific Decomposition

- The next question was: Why are vehicle efficiencies so different – is it all due to dieselization or other factors?
- The decomposition process was to adjust for all the consumer selected variables
  - Choice of lighter models in class
  - Choice of performance levels as indicated by the HP/WT ratio
  - Choice of automatic transmissions
  - Choice of diesel engines
- The remaining "unexplained" differences were then allocated to technology differences in gasoline vehicles.
- If significant differences in gasoline vehicles were observed, we followed up by examining technology in specific cars.

France vs. Germany 2008

France	Diesel	Weight	HP/Wt	Trans	Other Tech	**FCger-FCfr**
A	1.5%	-2.1%	0.9%	0.3%	-0.2%	0.0
B	14.7%	-2.7%	2.6%	0.5%	6.3%	1.1
C	11.9%	-0.3%	2.2%	0.2%	14.3%	1.4
D	8.1%	-1.1%	2.4%	0.4%	1.3%	0.6
E	3.8%	-2.3%	2.6%	-0.3%	2.2%	0.4
F	0.6%	-0.1%	2.2%	0.2%	2.7%	0.5
MICRO TRUCK	14.6%	-2.7%	4.7%	0.3%	10.4%	1.4
COMPACT TRUCK	8.0%	2.6%	2.8%	0.1%	5.4%	1.2
MEDIUM TRUCK	1.4%	-0.3%	4.2%	1.0%	1.7%	0.7
LARGE TRUCK	0.2%	0.0%	0.8%	0.1%	-0.3%	0.1

The France 2008 Fleet

- France and Portugal were the only major countries in Europe to meet the 140g/km CO_2 target in 2008.
- Sales of cars larger than C-class have been decimated in France and this partially explains why France had the highest fuel economy of major economies worldwide. In addition, sales have been shifted to the most efficient engines. The reason for the size mix is believed to be the fee/rebate system for low CO_2 cars called "Bonus Malus"
- France has among the highest diesel penetration in Europe, over 80% diesel in 2008. This could also be explained by the fee/ rebate system and by favorable diesel fuel prices.

US vs. Germany by Size Class

- The analysis shows that "other technology" effect is almost zero (± 2.5 percent or noise level), indicating no difference in gasoline engine technology between US and Germany except in luxury cars.
- This is a surprising conclusion since the large difference in fuel prices would suggest additional drivers for technology.
- Dieselization explains about 60% of the difference of class specific fuel economy, with higher performance, increased option content and much higher automatic transmission penetration explaining the other 40%.
- In C class cars, US is slightly better than Germany in fuel consumption due to significant hybrid sales!

China vs. Germany

- As noted, China has a larger average car size than France, but the "other technology" shows China lagging Germany by ~10% in fuel consumption at the size level.
- The A and B class difference is quite large due to the presence of older ,inefficient models and some low technology domestic models sold as price leaders, but even these vehicles have good fuel economy on an absolute basis.
- The E-class is exceptional as it shows a positive technology difference for China. This is due to the fact that German models with advanced technology dominate this class in China.
- China is now the largest market for German luxury cars!

India vs. Germany

- As in China Indian cars show about a 10% + fuel consumption differential due to "other technology" in the important A class and compact trucks, relative to Germany.
- India has some lower technology older models (like the Maruti 800) which are sold as price leaders in the A class but these are being gradually phased out.
- Sales in larger classes (C, D, E) are small and are dominated by sales of international specification models that are on par with global standards.
- In India, unlike China, there is very high demand for fuel efficiency that seems to be driving vehicle technology.

Brazil and Russia

- The Brazilian market has some similarity to the Chinese market with very few diesels and most of the sales in the B and C segment. E85 is the big story.
- Like China , B/C segment fuel economy in Brazil lags segment FC in Germany , but differences appear to be small (~5%) and may diminish in the future.
- Russia has a sales mix closer to Germany and is the largest European market for large US style SUVs. Fuel Consumption is about 5 to 10% higher in all classes.
- While Russian domestic models have worse fuel economy, sales on international models with near equivalent FC now dominate the market.

Conclusions

- Across countries, markets are very different due to both income and consumer preference differences.
- Even across BRIC countries demand for fuel economy from consumers varies significantly.
- In general, there appears to be very little technology difference between developed countries even with large fuel price differentials among the countries.
- There does appear to be some technology lag in smaller vehicles in the BRIC countries relative to similar vehicles in OECD countries, especially in the A and B class.
- Due to very low vehicle prices for small cars in developing countries, it may difficult to solve the technology lag problem easily.

Reccomendations

- Inter-country differences suggests that fuel economy policies should be tailored to the country situation, and developed country policies may not be optimal in developing country environments.
- The success of the Bonus Malus system in France is noteworthy as economic measures have not been tried in many countries.
- In countries with high demand for fuel economy, the fee-bate system may be helpful in fostering market forces.
- When attribute demand shifts to more luxury and space requirements, fuel economy regulation may prevent catering to the most negative aspects of consumer demand.