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Session 3.2:
Transport Fares and Costs

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Topics

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1. Background
2. Different Modes of Transport
3. Modelling Vehicle Operating Costs
4. Cost Comparisons Between Africa & Asia
5. Reasons for High Costs in Africa
6. Factors behind low costs in Pakistan
7. Importance of Density of Demand

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BACKGROUND

When analysing Transport Costs there are three major issues to consider:

Mode of Transport: Because there are considerable economies of scale, there is a big variation in transport costs, expressed per tonne/km, between different modes.

Road Characteristics: The alignment and type and quality of road surface will affect transport costs, through the effects on speed, fuel consumption and maintenance cost. This is a major consideration when road investments.

The Geographical Dimension: A number of studies have shown, for the same type of transport, that African transport costs are many times higher than transport costs in Asia.

IMPORTANT DEFINITIONS

- **Vehicle operating costs (VOC)** include the various direct costs the transport provider must pay to operate a given vehicle, notably labor, capital, fuel, tyres, maintenance and depreciation cost of a vehicle.
- **Transport costs (TC)** are the costs the transport operator incurs when transporting a cargo. In addition to VOCs, transport costs includes other indirect costs, such as license fee, road blocks, etc.
- **Transport prices/tariffs (TP)** are the rates charged by a transport company or a freight forwarder to the shipper or importer. Transport prices normally cover transport costs, and the operator's overheads and profit margin.

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THE ADVANTAGES OF DIFFERENT MODES

Very short distances and small loads

Headloading, bicycles and hand trolleys have an advantage when moving small volumes of goods short distances. Although very expensive on ton/km basis, they can provide the lowest cost solution. Other vehicle types incur additional terminal costs and provide unused capacity so may be running nearly empty.

Intermediate distances and small to medium loads

Pack animals, animal carts, power tillers, tractors and pickups will provide the lowest cost solution

Long distance with small to medium loads

Small and medium trucks provide the lowest cost solution

Long distance transport of heavy loads

Trains, ships and heavy trucks provide the lowest long distance transport cost solution and lowest overall costs per ton/km

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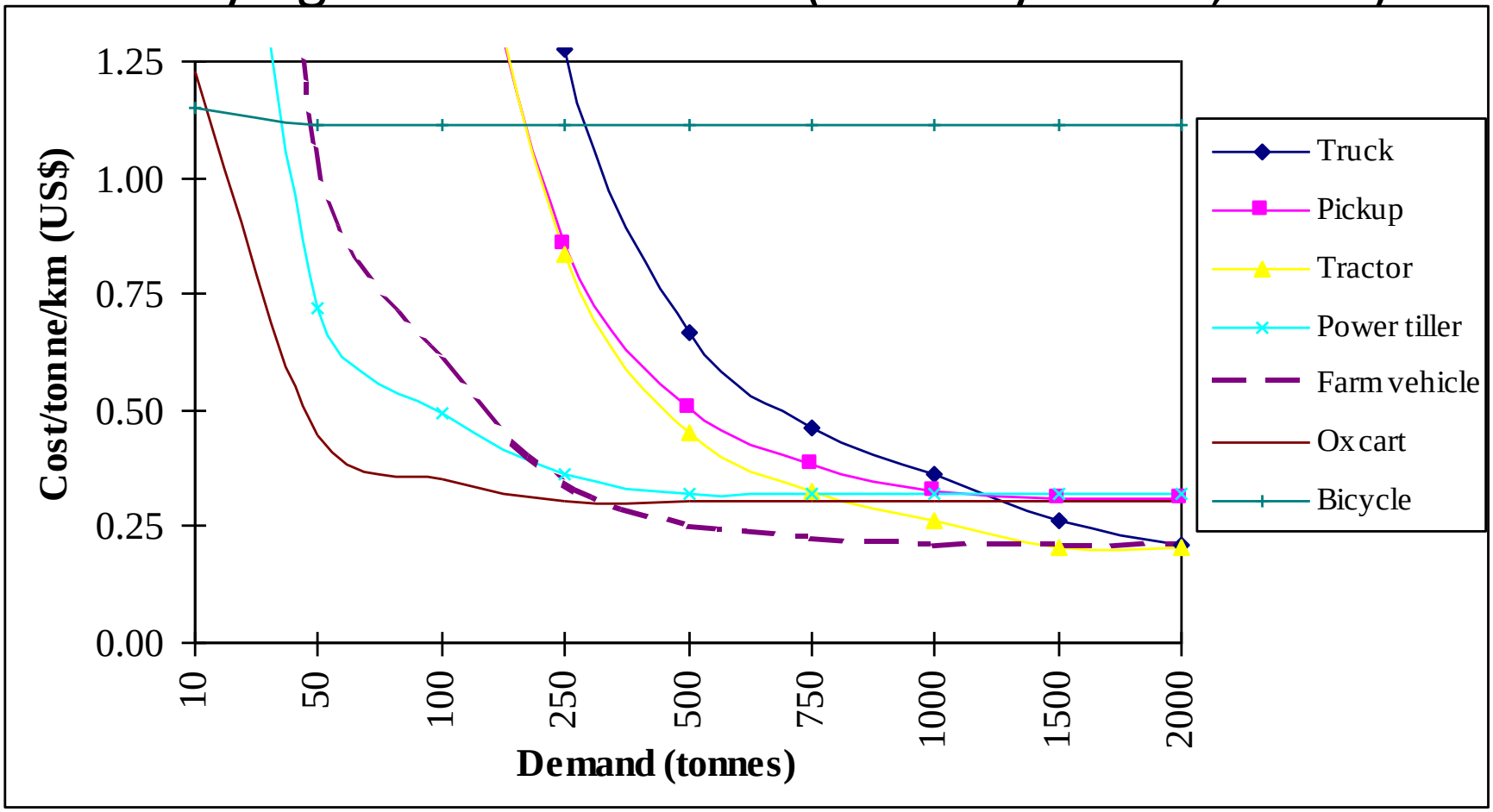
Vehicle operating costs model for moving 500 tonnes per year over various distances (Crossley & Ellis, 1996)

Distance (km)	5	10	20	30	40	50
Power Tiller	21.1	13.0	9.4	8.2	7.6	7.3
Tractor	42.1	22.1	12.2	8.9	7.2	6.2
Ox Cart	16.1	15.0	14.5	14.3	14.2	14.1
Motorcycle	103.9	71.7	55.6	50.2	47.5	45.9
Bicycle	58.6	54.5	53.2	52.5	51.8	51.3

Vehicle operating costs assuming a 10 km distance and varying levels of demand (Crossley & Ellis, 1996)



DIFFERENT MODES OF TRANSPORT

- Many factories in Thailand produce the Etan farm vehicle out second hand parts. They can give low transport costs for small loads travelling short and medium distances.
- The power tiller (or single axle tractor) is now an important means of transport, particularly in rural Asia.
- Both of these vehicles may not be licensed to operate in Africa.

MALAWI TRANSPORT COSTS

- A recent study by the World Bank found a 20 fold difference in transport charges between transport of tobacco between local towns and city compared with the charges for international transport to export ports.
- The main reasons identified were a combination of infrastructure issues, and segmented markets preventing competition.
- It was suggested that larger trucks would find it difficult to operate on rural roads, and there was likely to be higher empty running on shorter trips.

Malawi Transport Costs for Tobacco

Origin	Destination	Distance Km	Load ton	Price Kwacha	Price Kwacha ton/km	Price US $ ton/km
Ag. town	City	85	2.5	19,323	228.4	$ 2.10
Ag. town	Export port	2272	24.6	23,462	10.3	9.5 Cents
City	Export port	2012	19.9	24,433	12.1	11.2 Cents

Explaining High Transport Costs within Malawi - Bad Roads or Lack of Trucking Competition?
Policy Research Working Paper 5133, *Somik V. Lall, Hyoung Wang, Thomas Munthali* – World Bank, 2009

MODELLING VEHICLE OPERATING COSTS IN RELATION TO ROAD CHARACTERISTICS

- Road Appraisal Models such as HDM4 and RED calculate vehicle operating costs as a function of road alignment, road width, traffic volume and road roughness. The models are used to estimate the benefits of upgrading earth and gravel roads to a paved bitumen standard.
- The models predict vehicle speeds, fuel consumption and maintenance costs. Generally the smoother, wider and better aligned the road surface so the lower the operating costs. Speed is calculated by complex formula whereby the key limiting factor (gradient, curvature, roughness, traffic volume etc) determines the speed. Fuel is dependent on speed and gradient. Vehicle maintenance is dependent on road roughness.

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VOC Modelling with HDM4 & RED

The models help calculate the costs of the following:

Speed & Congestion

Fuel consumption

Tyre consumption

Oil consumption

Maintenance Parts

Maintenance Labour

Utilisation & Service Life

Capital Costs

Crew Hours

Overheads

Passenger time

Cargo time

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VEHICLE TYPES AVAILABLE IN RED & HDM4 MODELS

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- Motorcycle
- Car Small
- Car Medium
- Car Large
- Delivery Vehicle
- Goods Vehicle
- Four-Wheel Drive
- Truck Light
- Truck Medium
- Truck Heavy
- Truck Articulated
- Bus Mini
- Bus Light Bus
- Medium Bus
- Heavy Coach
- Bicycle
- Rickshaw
- Animal Cart
- Pedestrian

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TRAFFIC DATA REQUIREMENTS
HDM-4

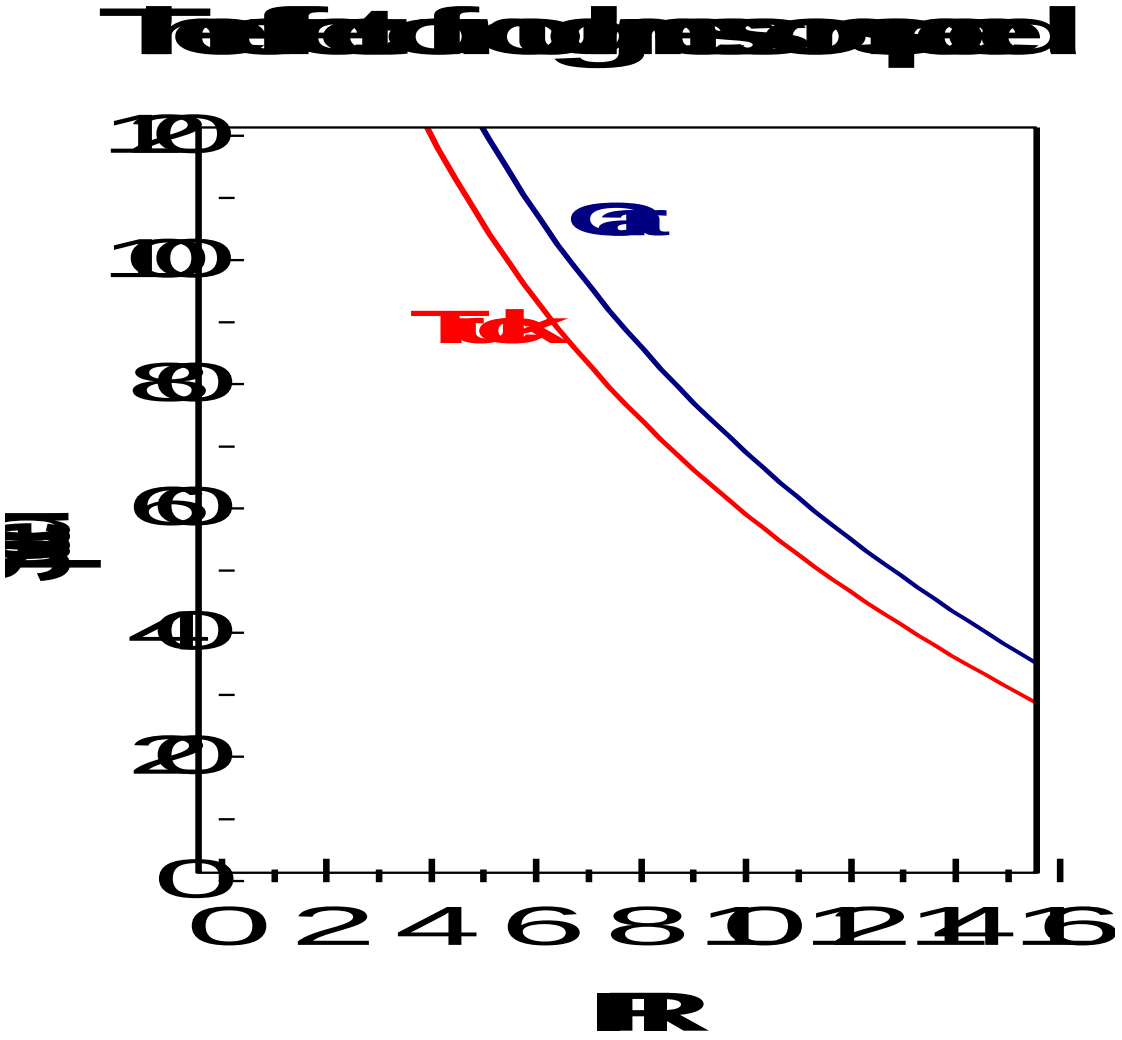
- **Traffic Categories:**
  - Normal,
  - Diverted
  - Generated Traffic
- **Traffic Composition**
- **Volumes and**
- **Growth Rates**
- **Traffic Composition**

- **Volumes**
- **Growth Rates**
- **Hourly Flow Distribution**
- **Axle Loads**
- **Equivalent Standard Axles**
- **Load Factors**
- **Cumulative Loading**

THE PREDICTION OF VEHICLE SPEEDS

Uncongested speeds are limited by the following:

- Desired Speed
- Driving Power
- Breaking
- Gradient
- Road Curvature
- Road Roughness
- Road Width
- Traffic Volume
- Speed Limits and Enforcement


0
20
40
60
80
100
120
0 2 4 6 8 10 12 14 16

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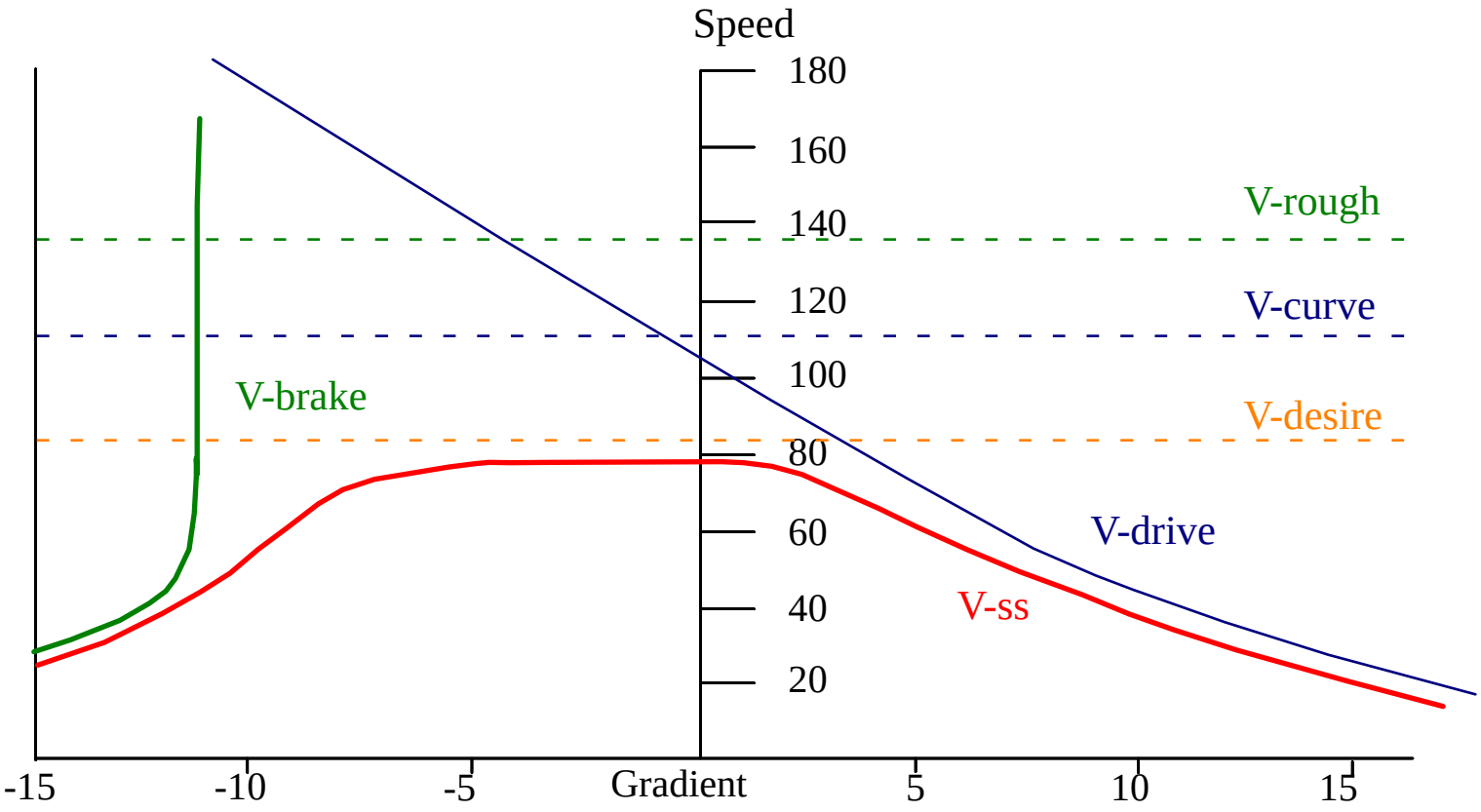
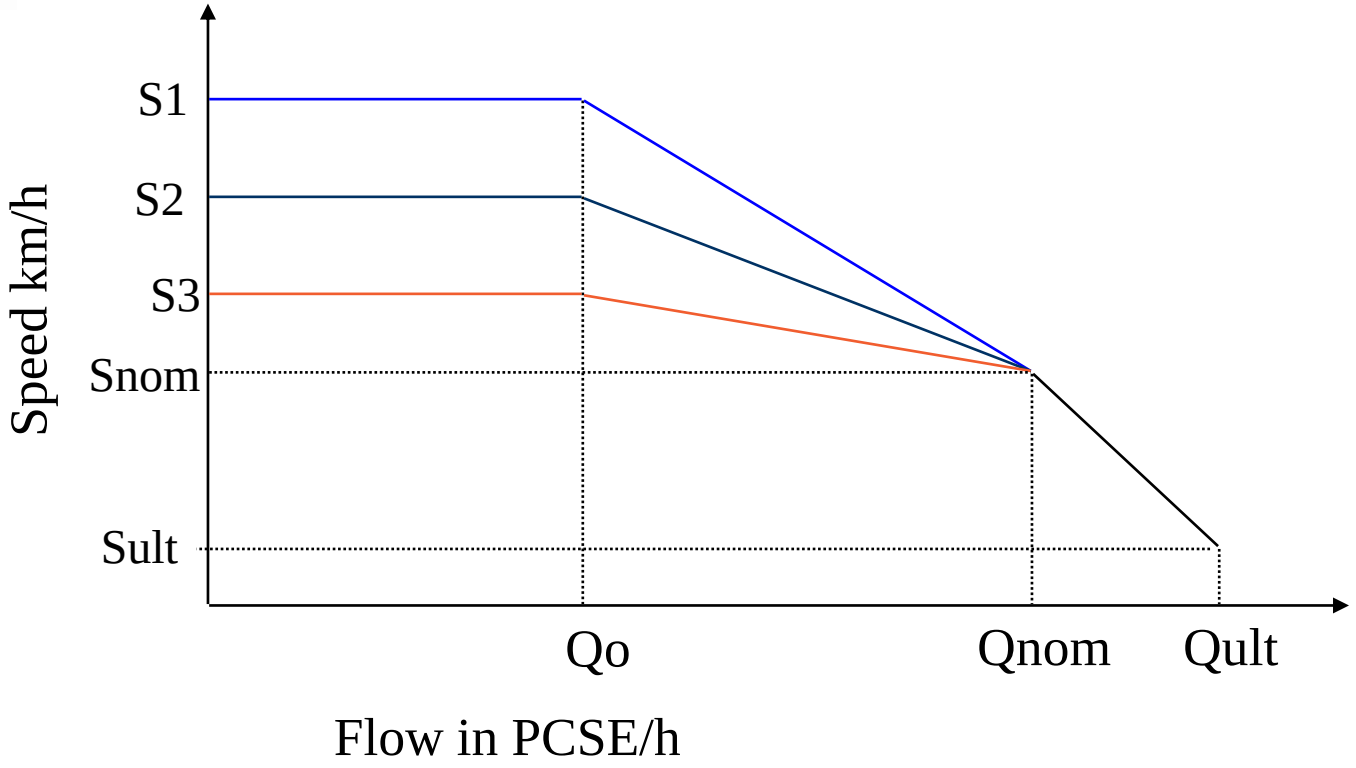


V-ss (Steady state speed)

= minimum of (V-drive, V-brake, V-rough, V-curve, V-desire)

HDM-4 Speed Flow Model

- **Integrates HDM free speed model with congestion model**
- **Use three-zone HDM-Q model**
- **User defines capacities and the critical flows where speeds are influenced**

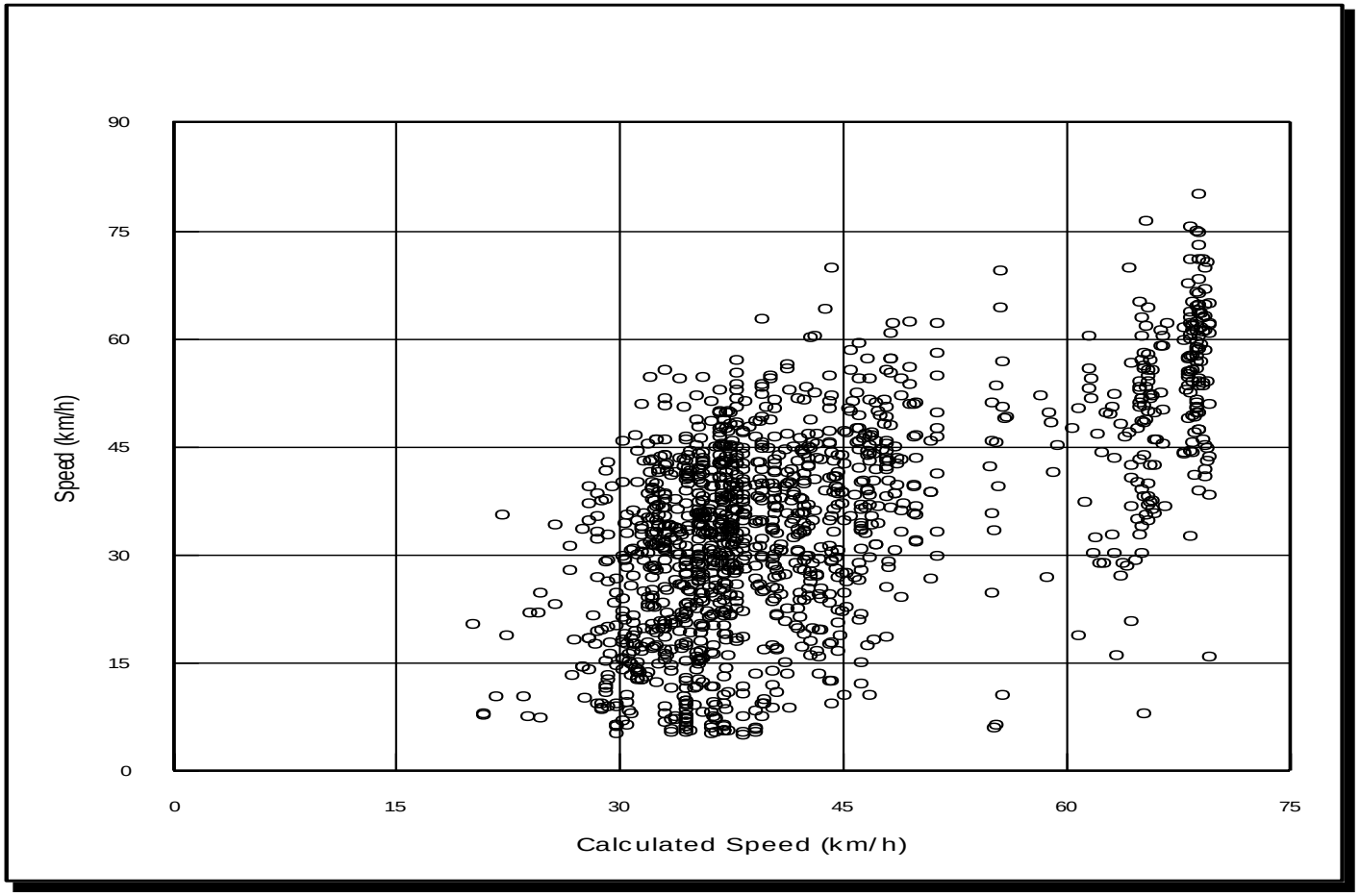


Qo	=	Flow below which traffic interactions do not affect speed
Qnom	=	Nominal capacity of the road
Qult	=	Ultimate capacity of the road
S_1,S_2,S_3	=	Free flow speeds of different vehicle types
PCSE	=	Passenger car space equivalent

SPEED FLOW PARAMETERS

ROAD TYPE	Width (m)	Qo	Qnom	Qult
Single Lane Road	**< 4**	**0**	**420**	**600**
Intermediate Road	**4 to 5.5**	**0**	**420**	**1800**
Two Lane Road	**5.5 to 9**	**280**	**2520**	**2800**
Wide Two Lane Road	**9 to 12**	**640**	**2880**	**3200**
Four Lane Road	**> 12**	**3200**	**7600**	**8000**

Observed to Calculated Speed for a Light Vehicle on a Congested Road



HDM4

The Calculation of Fuel Consumption

FUEL CONSUMPTION

Uses the ARFCOM model - an instantaneous model of engine power requirements which includes

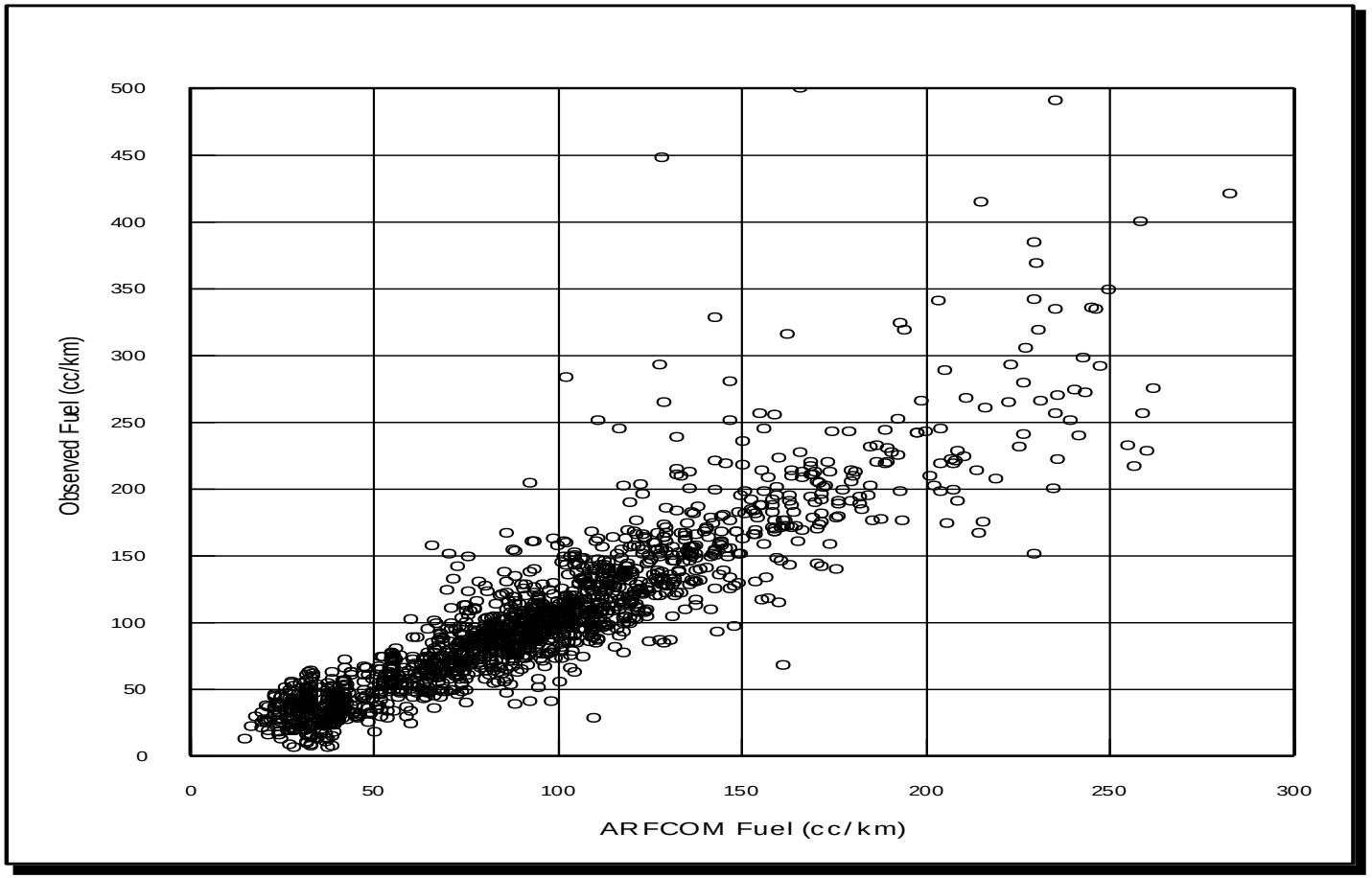
- Tractive power to overcome resistance to motion
- Accessory power
- Internal engine resistance

ACCELERATION NOISE

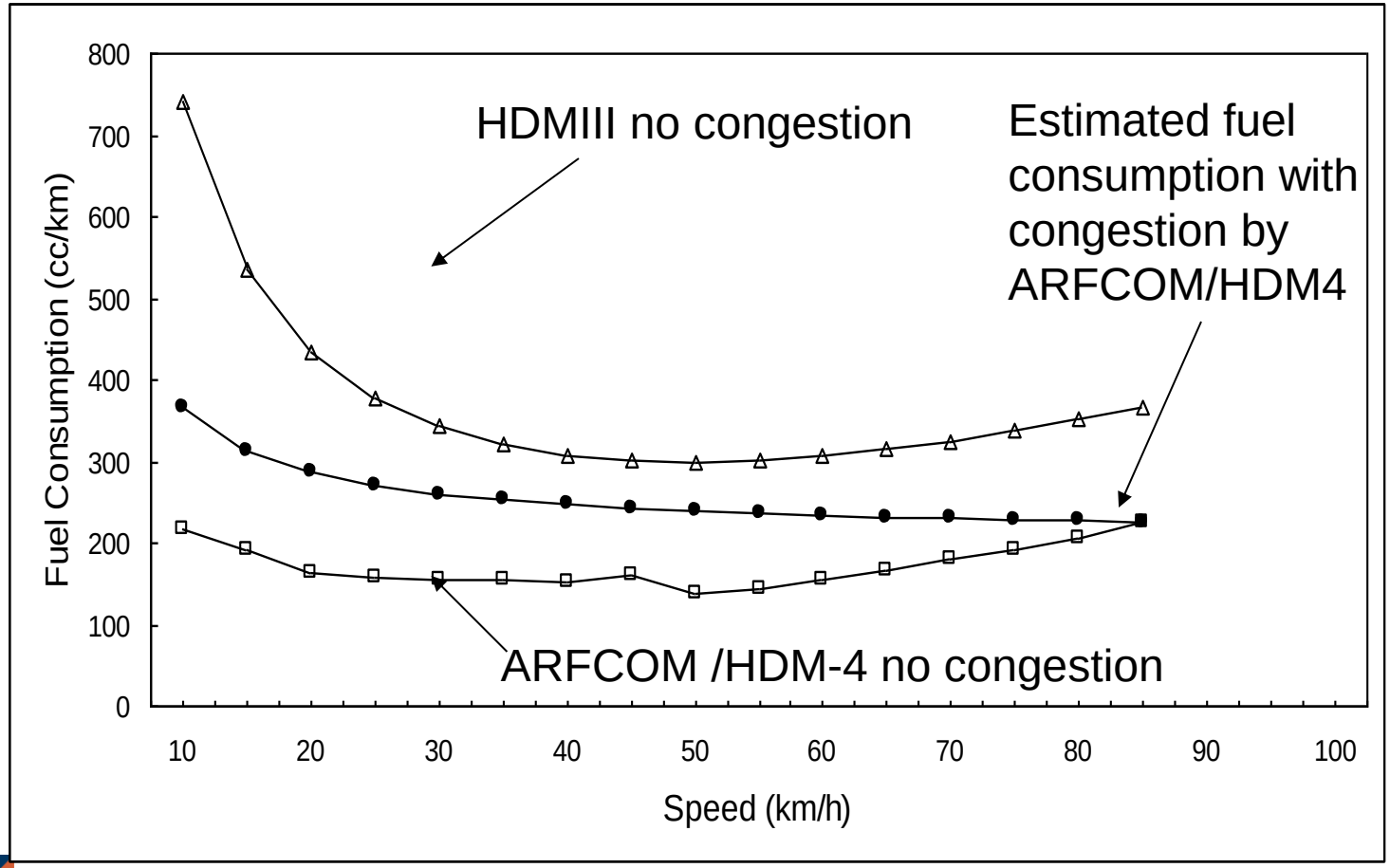
Speeds in congested traffic conditions are not constant and speed variations need to be included in the fuel consumption model

Light Vehicle Fuel Consumption in Indonesia:

Observed to Predicted ARFCOM Results



Medium Truck Fuel Consumption (Flat Straight Road in Indonesia)



HDM-4

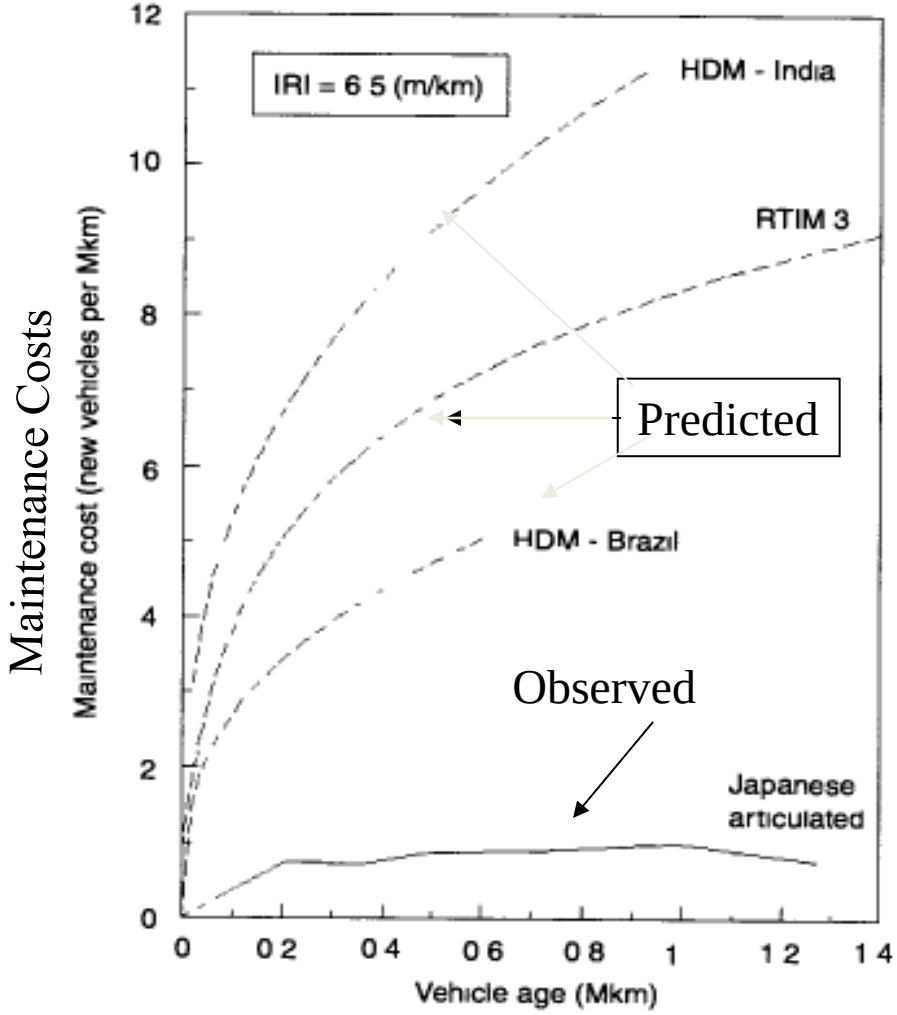
MAINTENANCE PARTS CONSUMPTION

- The most important component of road user costs
- The most 'variable' and most difficult to model
- Function of new vehicle price, vehicle age and road roughness
- HDM-4 relationships less sensitive to roughness
- Essential to calibrate

MAINTENANCE LABOUR

- Dependent on parts consumption

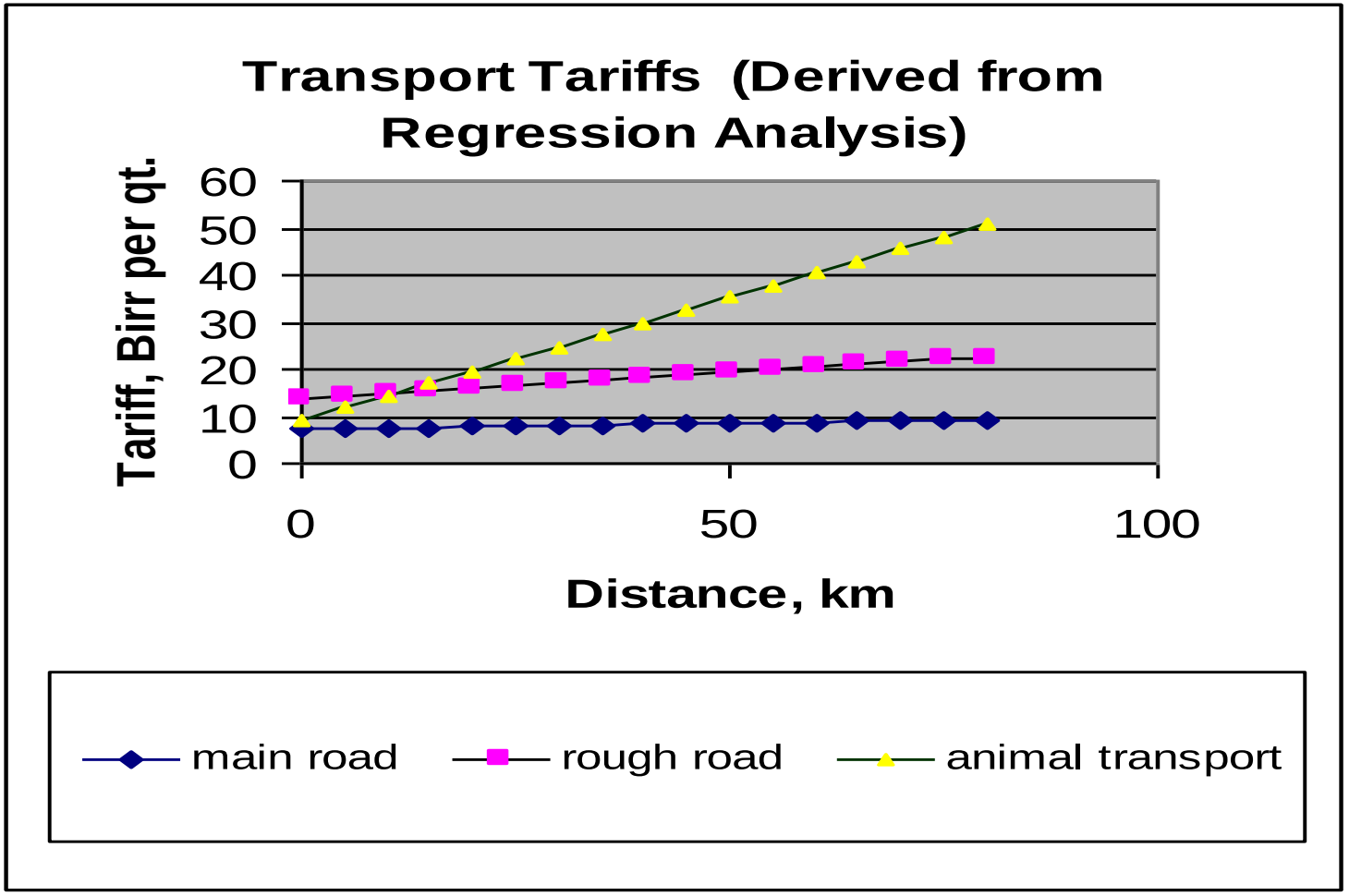
Observed and Predicted Vehicle Maintenance Costs- Articulated Truck



Maintenance Costs

Vehicle Age

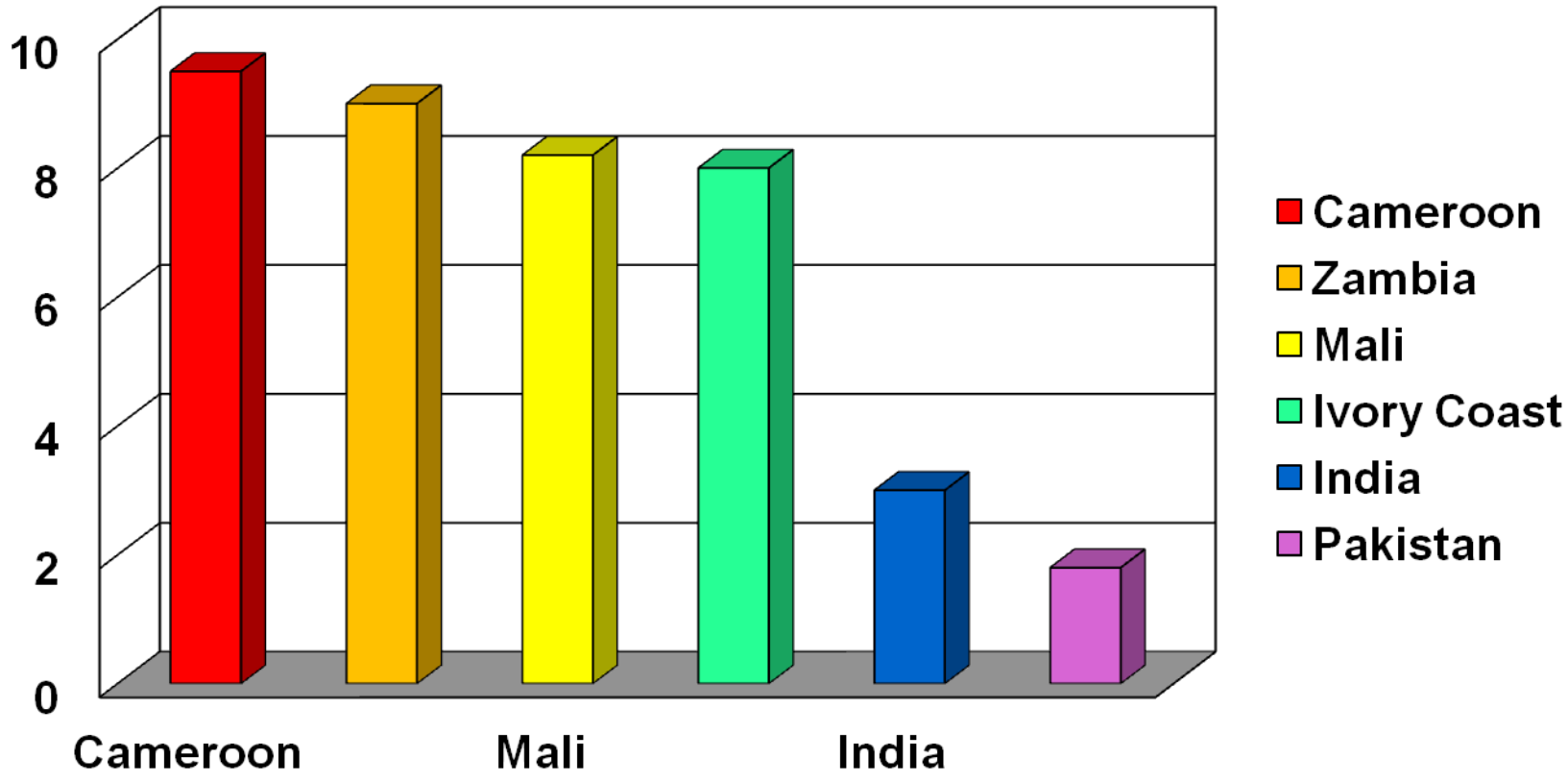
Transport Tariffs depend upon Distance, Mode and Road Surface: Evidence from Ethiopia



TRANSPORT COSTS IN AFRICA AND ASIA

- Over the past 25 years there have been at least five major comparative studies of transport costs in Africa and Asia
- The studies confirm that transport tariffs in Africa, for comparable journeys are many times higher than in Africa than in Asia
- However there are differences in the reasons behind the higher costs: earlier studies emphasised cost factors while the latest study by the World Bank (2009) puts more emphasis on very high profits.

Comparison of Long Distance Tariffs: US$ per ton km, 1988



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Tariff Comparison

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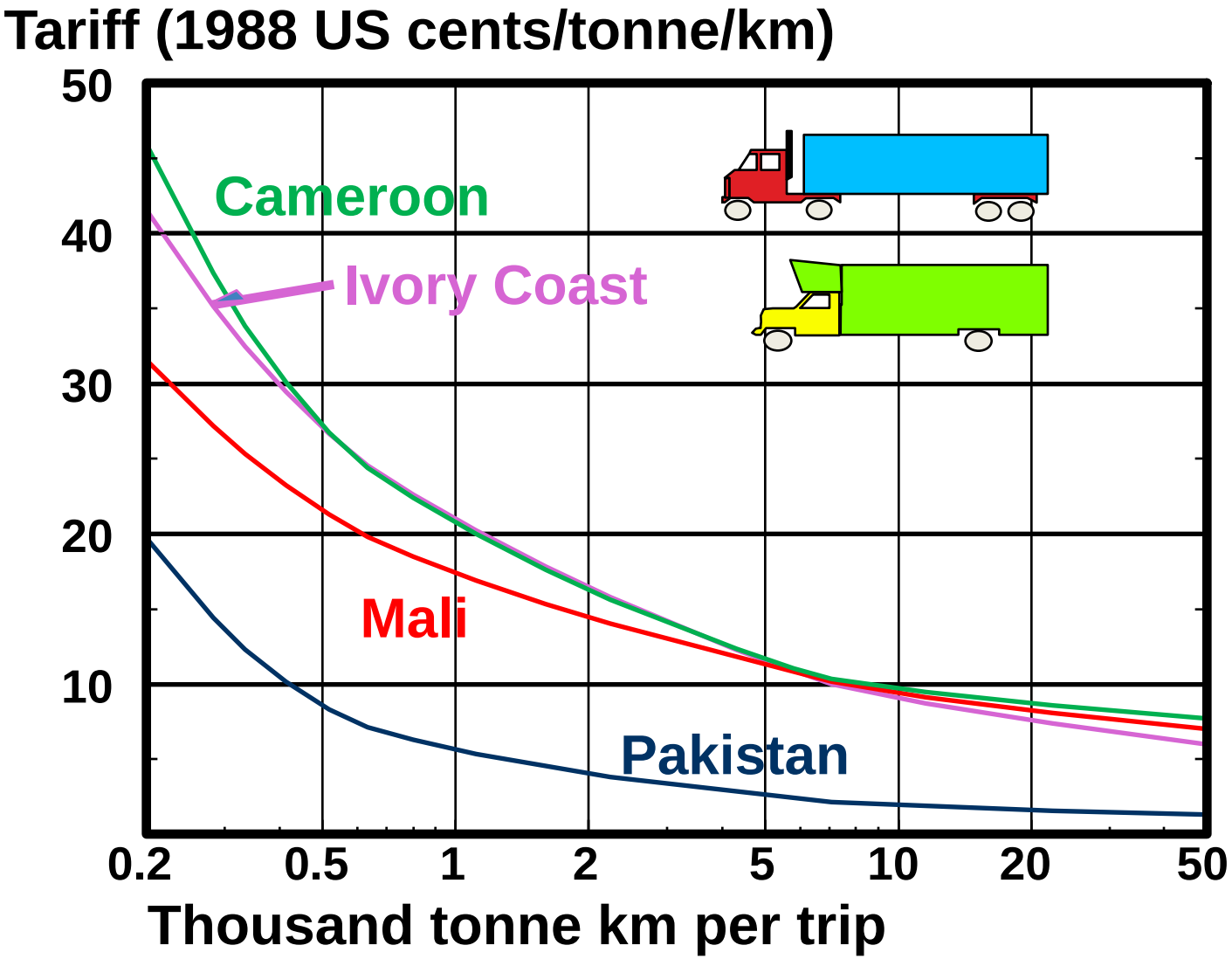

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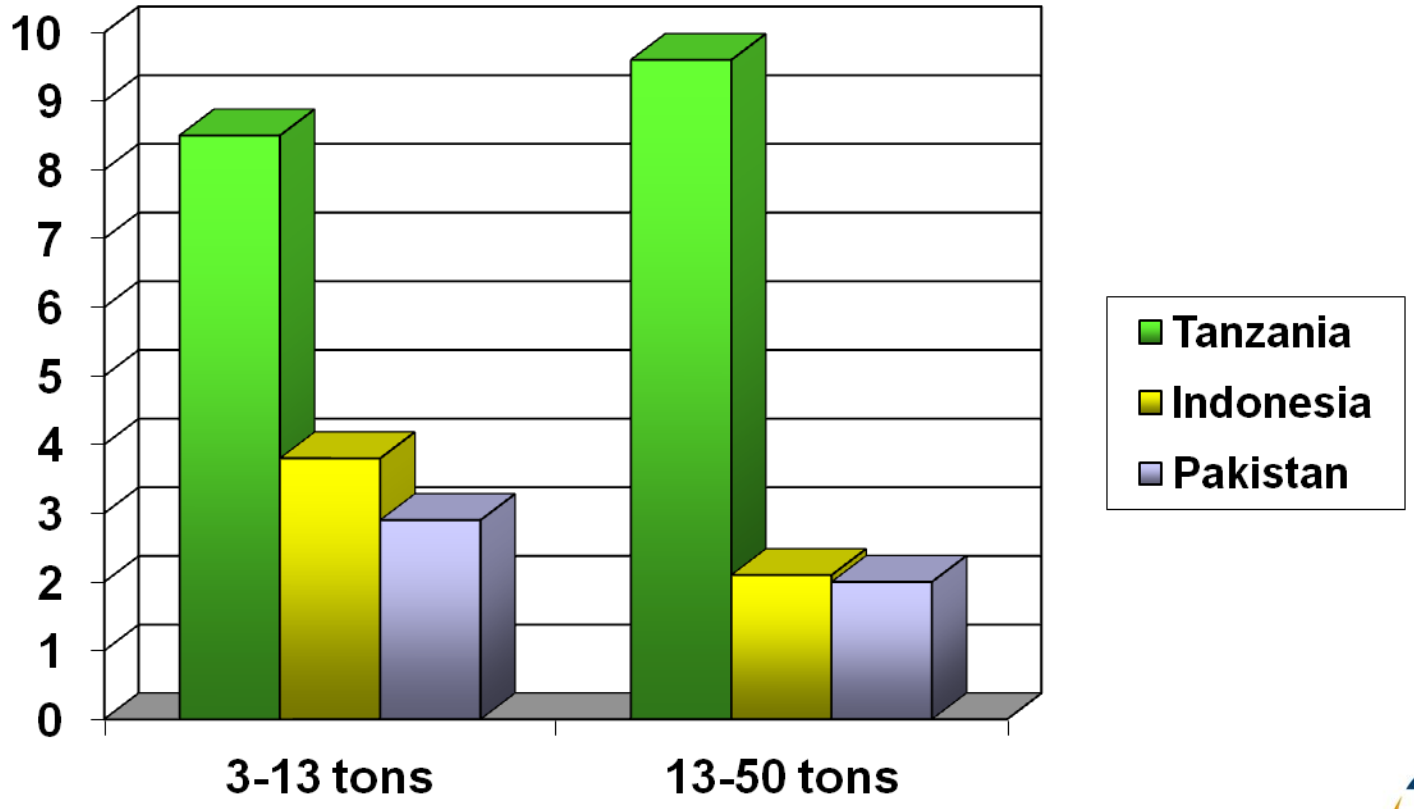
There are no more recent national and rural transport cost comparisons – the two following studies from 1988 and 1995 contain the most recent data!

Tariffs per ton/km 1995 prices



Component price US$, 1995

Item	Tanzania	Indonesia	Pakistan
2 axle truck	64 900	22 300	24 200
3 axle truck	97 400	n.a.	37 800
Artic	135 000	73 100	46 500
Truck tyre	292	142	169
Diesel/ltr	0.435	0.166	0.32
Oil/ltr	2.27	1.66	1.0
Maint. Lab.	2.11	2.19	0.7
Crew: 2 axle	136	219	320
Crew: Artic	203	263	400

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Comparison of operating tariffs 1995 for local rural transport vehicles

	Thailand	Sri Lanka	Pakistan	Ghana	Zimbabwe
Pickup Cents /t km	8.7	-	13.7	39.0	-
Truck (8-12 t.) Cents /t km	-	-	2.1	20.6	21.4
Tractor Cents/ hr	-	320	270	1 240	740
Power Tiller Cents/ hr	123	127	-	357	-

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Vehicle utilisation

	Thailand	Sri-Lanka	Pakistan	Ghana	Zimbabwe
Pickup km/yr	61 000	-	44 000	29 000	-
Tractor hr/yr	-	1 440	1 900	800	750
Power Tiller hr/yr	500	740	-	400	-
Ox cart hr/yr	-	875	2 000	-	400
Donkey cart km/yr	-	-	4 600	1 600	-

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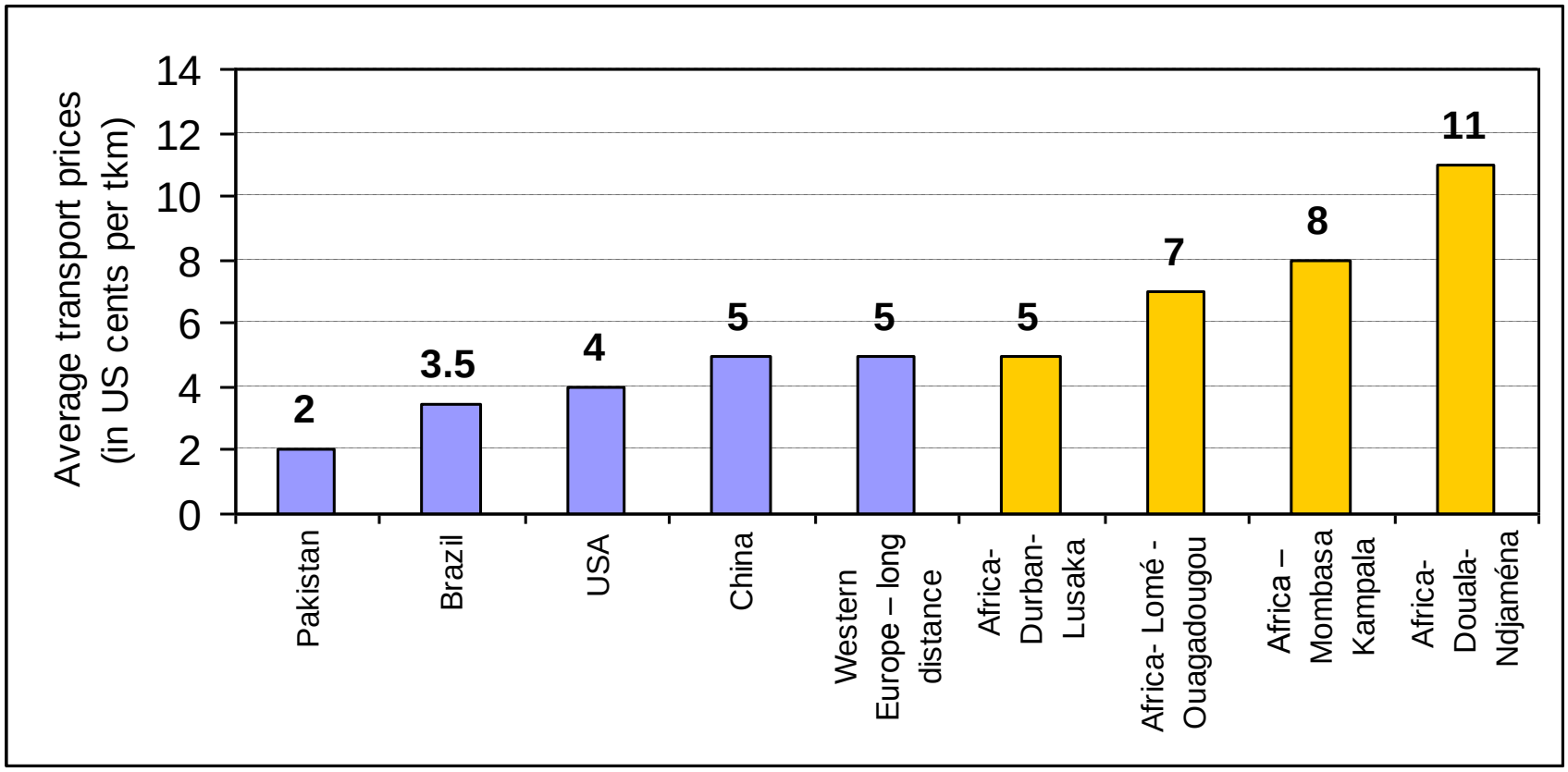
TRANSPORT TARIFFS US$ Per Ton Km 2007 (WORLD BANK STUDY): INTERNATIONAL ROUTES ONLY



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Estimated Costs from 2007 Study

Corridor	Route Gateway-Destination	Variable Cost (US$ / km)	Fixed Cost (US$ / day)	Yearly ratio FC/VC	Average yearly mileage	Average truck fleet age	Profit margin
Central Africa (Cameroon)	Douala-N'Djaména (Chad)	0.93	58	**25% - 74%**	60-70	12	**74%**
	Douala-Bangui (CAR)	0.92	80	**33% - 66%**	50-60	10	**120%**
	Ngaounderé-N'Djaména (Chad)	1.29	29	**24% - 75%**	50-60	15	**158%**
	Ngaoundéré-Moundou (Chad)	1.70	27	**29% - 70%**	10-20	19	**289%**
East Africa (Uganda and Kenya)	Kampala-Mombasa (Kenya)	0.90	65	**29% - 70%**	130-140	12	**42%**
	Mombasa-Kampala (Uganda)	0.62	92	**46% - 53%**	130-140	7	**107%**
West Africa (Burkina and Ghana)	Ouagadougou-Tema/Accra (Ghana)	1.01	30	**15% - 84%**	30-40	12	**183%**
	Tema/Accra-Bamako (Mali)	0.93	34	**17% - 82%**	20-30	9	**310%**

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HIGH TRANSPORT COSTS IN AFRICA

Earlier Studies Stressed:

- High initial input prices for vehicles, fuel, parts
- Exclusive dealerships, low demand
- Poor driver knowledge of vehicle maintenance
- Unnecessary fast driving speeds
- Poor road surfaces
- Little competition, particularly on rural routes
- Low utilisation caused by low density of demand and operation of operator cartels

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HIGH TRANSPORT COSTS IN AFRICA 2

Later studies emphasised:

- Most vehicles are imported second hand
- Low utilisation of vehicles
- High barrier costs on international routes
- Super profits being made by operators
- The presence of cartels preventing competition

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FACTORS PROMOTING LOW COST TRANSPORT IN PAKISTAN - OPERATIONAL

- On-the-job training for drivers
- Drivers given a lot of responsibility
- Continuous vehicle maintenance practiced
- Two drivers per vehicle achieve high utilization
- Oil changed frequently
- Slow driving speeds

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FACTORS PROMOTING LOW COST TRANSPORT IN PAKISTAN - ORGANISATIONAL

- Very competitive free market
- Little government regulation
- Efficient network of forwarding agents
- Low initial vehicle prices
- Many cheap parts made locally
- Many good local workshops

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WHAT CAN AFRICAN GOVERNMENTS DO TO LOWER TRANSPORT COSTS?

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The Importance of Density of Demand 1

1. The topic of Rural Transport embraces transport within the village, including access to farms, basic facilities, schools, clinics; Integrated Accessibility Planning; IMTs; rural mobility beyond the village; rural roads; and transport services.
2. The key problems of high human effort, hardship, inefficient, expensive and unavailable services, inaccessibility, poor access to information and badly maintained roads have an important common factor of Low Density of Demand.

The Importance of Density of Demand 2

3. Where density of demand is high (as in much of Asia) there is more scope to provide rural infrastructure, maintenance, IMTs and transport services in a competitive and efficient manner.
4. The worst rural transport problems occur in the most remote and most sparsely populated parts of the world. These areas need particular attention.
5. As rural populations rise, links with towns become stronger, and, if incomes grow, so the density of demand will rise and so we can expect rural transport problems to gradually improve.

Now look at Session 3.2 Notes!