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VTI model for estimating the annual
traffic mileage in Sweden

Transmitted by the Government of Sweden

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1. Introduction

By commission of the Swedish Institute for Transport and Communication Analysis SIKa, at the end of the 1990s, VTI and Statistics Sweden SCB jointly developed an estimating model for the annual traffic mileage in Sweden, expressed in terms of vehicle km by road, for the period 1950-1997. This model is documented in VTI Report No 439, 1999. Since then, VTI has, by commission of SIKa, annually estimated the annual traffic mileage for different vehicle types in Sweden, figure 1.

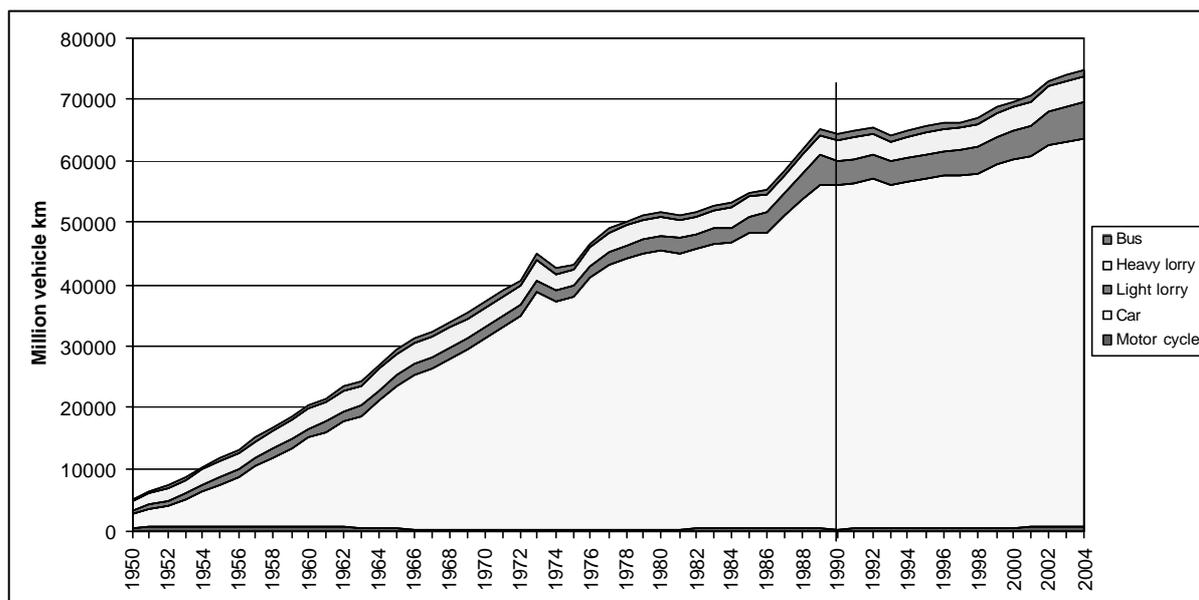


Figure 1. Vehicle mileage 1950 – 2004.

Prior to estimating the traffic mileage on Swedish roads in 2004, it was found necessary to describe the changes made to the model since it was presented in 1999. The time series presented for the period 1950-1997 was augmented, already in the report, with the years 1998 and 1999. A number of minor modifications were made, but in 2003 there was a major change since data from SCB and Swedish Motor Vehicle Inspection Company were available. With access mainly to information concerning heavy traffic, the model was modified back to 1990. Total traffic mileage with motor vehicles in Sweden has not changed appreciably, while the breakdown among vehicle types has altered.

Even in the brief time perspective, changes of an almost revolutionary character occurred. Data that were considered rough estimates can today be estimated with high precision (vehicle data) while other data (traffic data) have deteriorated owing to lack of resources. What is unique, for instance, is that information on distances driven is recorded for all vehicles annually inspected by Swedish Motor Vehicle Inspection Company.

In 1999, the estimates were based on

- The traffic censuses by Swedish Road Administration
 - Number of vehicles of different types in traffic each year (Mean of active vehicles on 1.1 and 31.12)
 - Annual UVAV (Goods transport by lorry) surveys by SCB
- and
- Travel pattern surveys on annual level, 1978 and 1985, and annual interview surveys
 - Annual traffic accident statistics
 - Samples of distance-driven data from Swedish Motor Vehicle Inspection Company
 - Other vehicle and traffic information.

The most important information for monitoring developments between different years is that relating to changes in traffic at the continuous traffic census sites of the Road Administration.

The representativeness of this for the Swedish road network, and the problem of missing data, are open to discussion.

The calculations are carried out in an Excel sheet shown in figure 2.

1998				Vehicle type	Number (1.1+31.12)/2
Vehicle mileage on national roads				Motorcycle	137 466
44 637				Car	3 745 933
* 1.51 =	1.51	67 401.45	= Total vehicle mileage	Lorry <3t maximum load	269 860
				Lorry >3t maximum load	59 782
Light vehicles		National roads	44 637	Bus	14 881
<3.3 m axle spacing		Municipal roads	20 069	Totals	4 227 921
61 724	0.04	Private roads	2 696	UVAV	Vehicle mileage
Heavy vehicles		Totals	67 401	*1.47	
>3.3 m axle spacing				Lorry >3.3m<3 tonnes	1 100
5 677	1.25	~ UVAV & taxation register for lorries		Lorry 3-16 tonnes	1 132
	0.85	~ foreign lorries in Sweden		Lorry >16 tonnes	2 313
					4 545
Motorcycles		Cars	Lorries <3.3 m	Lorries >3.3 m	Buses
613	0.30	57 005	4 107	4 545	1 131
Fuel category					
Type of vehicle and fuel		Number of vehicles	Petrol powered	Distance driven	Distance driven per vehicle
Cars					
Petrol		3 600 619	3 600 619	54 002	14 998
"Diesel- factor":	1.38	144 492	199 399	2 991	20 697
Other		822	822	12	14 998
Totals		3 745 933	3 800 839	57 005	15 218
Lorry <3t maximum load					
Petrol		191 653	191 653	3 574	18 647
"Diesel- factor":	1.20	72 833	87 400	1 630	22 376
Other		171	171	3	18 647
Totals		264 657	279 224	5 207	19 673
Lorry 3-16 t maximum load					
Petrol		437	437	8	17 649
"Diesel- factor":	1.41	56 609	27 937	493	24 885
Lorry >16t maximum load					
"Diesel- factor":	3.73	7 939	166 859	2 945	65 829
Lorry totals					
		329 642	195 233	8 652	26 247
Buses					
Petrol		794	794	32	40 859
"Diesel- factor":	1.95	13 486	26 297	1 074	79 675
Other		602	602	25	40 859
Totals		14 881	27 692	1 131	76 035
Totals, motorcycle excluded		4 090 455	4 023 764	66 789	16 328

Figure 2. Model for the annual vehicle mileage in Sweden – original version.

The total vehicle mileage is obtained from the estimation regarding national roads. The total mileage is distributed among different vehicle types mainly in relation to their numbers.

The model is subject to two question marks. The first refers to the proportion of traffic outside the State maintained road network which was regarded as constant at 33.8%, and the proportion of heavy lorry traffic. Over the years it was found that the proportion of traffic outside the State maintained road network is slightly smaller than that estimated by the model, and that estimates of heavy lorry traffic by SCB cannot be used.

The large breakthrough occurred when Motor Vehicle Inspection Company began to save (in 1998) all records of driven distances registered at the time vehicles were inspected. In this way SCB was able to estimate the traffic mileage for groups of vehicles which visited Motor Vehicle Inspection during a certain year, e.g. the total distance driven by cars which were inspected by Motor Vehicle Inspection in 2000. Even though this is not the same as the annual distance driven, agreement is very good. On average, data from SCB/Motor Vehicle Inspection Company are six months old, which should only have marginal significance but implies an overestimate of the distance driven, since the distance driven decreases with the age of the vehicle.

The new information revealed that the estimates of heavy lorry traffic in the VTI model were erroneous, and that the estimates of bus and motor cycle traffic should also be adjusted. In the new VTI model it is not the SCB estimates of the traffic mileage for the different vehicle types that are used directly, but the breakdown of traffic mileage over the different vehicle types.

It was generally found that the total annual traffic mileage estimated with the VTI model was of the same order as that obtained by adding up the annual traffic mileage estimated by SCB from the Motor Vehicle Inspection Company data for motor cycles, cars, lorries and buses.

The VTI estimates relate to traffic mileage on the Swedish road network, while the estimate by SCB/Motor Vehicle Inspection Company relates to traffic mileage driven by Swedish vehicles irrespective of where they drive. In the latter case some of the distance is driven abroad. This distance driven is not included in the VTI estimate, but at the same time distances driven in Sweden by foreign vehicles are included in the VTI estimate. The assumption that traffic mileage abroad by Swedish vehicles is of the same order as traffic mileage by foreign vehicles in Sweden is a qualified truth. Swedish buses cover a greater mileage abroad than foreign buses do in Sweden. The situation concerning cars and lorries is not clear. Data are available on distances driven by Swedish lorries abroad, and on the involvement of foreign vehicles in traffic accidents in Sweden. Data concerning damage to Swedish vehicles, or damage caused by Swedish vehicles, abroad can eventually be obtained through National Federation of Swedish Insurance Companies/individual insurance companies.

Since new information is available only for recent years, the new model for estimating traffic mileage in Sweden has been updated back to 1990.

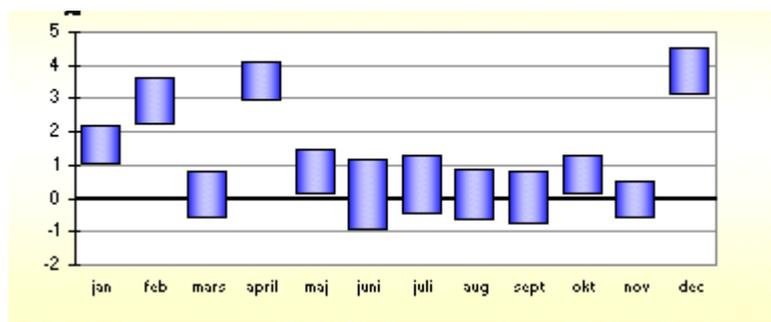
2. Data for the new model

The monthly Traffic Barometer published by Swedish Road Administration forms the basis for scaling up traffic mileage from year 0 to year 1, and is important. The January version each year sets out the change from the previous year. The Traffic Barometer also shows the change in traffic mileage by vehicles with wheelbases less than and greater than 3.3 m. The latter mainly refers to lorries and buses but should be treated with some caution since the Road Administration is increasingly using methods that detect iron masses instead of wheelbase.

January

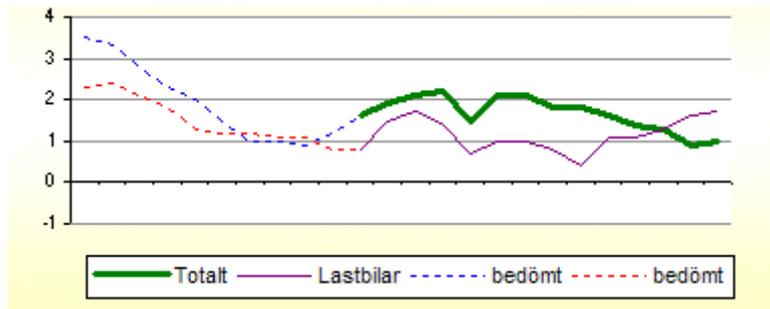
Traffic Barometer

Traffic increased by 1.0% in 2004



Change in traffic mileage in the last 12 months

The bars show the change in traffic with uncertainty intervals.
The zero line shows the level of traffic during the same period the year before.



**Change in traffic mileage
Means for 12 month periods**
Total Lorries Estimated Estimated

If the curve is above the zero line, traffic mileage increases. The last value on the curve is a mean value for the change in traffic mileage during the period 1.1.2004 – 31.12.2004.

Change in traffic mileage, means for the most recent 12 month period

Traffic mileage in 2004 compared with traffic mileage in 2003

	Cars	Lorries	Totals
European roads	+1.2% ± 0.7	+2.6% ± 1.5	+1.3% ± 0.6
Other trunk roads	+0.3% ± 0.7	+1.6% ± 2.7	+0.4% ± 0.7
Primary county roads	+0.6% ± 1.2	+0.7% ± 2.4	+0.5% ± 1.1
Other county roads	+1.5% ± 0.7	+2.0% ± 2.8	+1.5% ± 0.8
Overall change	+0.9% ± 0.4	+1.7% ± 1.2	+1.0% ± 0.4

The original model assumed that the increase in traffic on the State maintained road network and on other roads is the same. Over the years, however, there is a tendency for the proportion of traffic mileage on other roads not to increase at the same pace as on the State maintained road network. To obtain the total traffic mileage, traffic mileage was multiplied by 1.51 but this was gradually decreased to 1.48 for 2003. This means that traffic mileage on other roads has changed from 33.8% to 32.4% of the total traffic mileage.

Earlier data regarding the level of traffic mileage by heavy lorries and the breakdown of this on the basis of SCB/UVAV or SLIT (domestic and foreign traffic with Swedish lorries) have been completely replaced by SCB/Swedish Motor Vehicle Inspection Company data concerning lorries of total weight 3.5-16 tonnes, 16-26 tonnes and over 26 tonnes. This has avoided the different scaling-up procedures. Data from SCB show that the distance driven abroad by Swedish heavy vehicles is of the same order as the traffic mileage by foreign heavy vehicles in Sweden.

Before 1990, lorry traffic was described on the basis of light lorries of <3.3 m wheelbase, light lorries of >3.3 m wheelbase, 3.5-16 tonnes maximum load and >16 tonnes maximum load. This breakdown was found to be imperfect in regard to heavy traffic.

Original model	Motor cycle	Car	Light lorry etc < 3.3 metres	Light lorry etc >3.3 metres	Heavy lorry 3.5-16 tonnes maximum load	Heavy lorry >16 tonnes maximum load	Bus	Total
1990	445	54614	3598	1741	1310	1576	1025	64310

New model	Motor cycle	Car	Lorry ≤ 3.5 tonnes total weight	Lorry >3,5 - ≤16 tonnes total weight	Lorry >16 - ≤26 tonnes total weight	Lorry > 26 tonnes total weight	Bus	Total
1990	292	55808	3797	641	2334	471	966	64310

The new model is based on estimates from the beginning of this decade (SCB/Motor Vehicle Inspection Company) which were extrapolated back to 1990. Maximum load has been replaced by total lorry weight. Note that total weight refers to the total weight of the lorry (lorry + load including driver/passenger) and not to the total weight of the trailer, if any. A tractor and semi trailer is regarded as one lorry.

Traffic mileage by buses and motor cycles was revised after SCB/Motor Vehicle Inspection Company set out their estimates of their traffic mileage, which resulted in lower traffic mileage by motor cycles and lower traffic mileage by buses.

Figure 3 shows the new model. The structure has not been changed but the mileage for different vehicle types is calculated in a different way.

2004				Vehicle type	Number (1.1+31.12)/2
				Motorcycle	235 192
				Car	4 094 419
Vehicle mileage on national roads				Lorry =3.5t total weight	355 455
50 405				Lorry >3.5t&=16t total weight	25 658
* 1.48 =	1.48	74 599.09	= Total vehicle mileage	Lorry >16t&=26t total weight	28 113
				Lorry >26t total weight	21 547
Light vehicles		National roads	50 405	Bus	13 553
<3.3 m axle spacing		Municipial roads	21 210	Totals	4 773 937
69 554	0.04	Private roads	2 984		Vehicle mileage
Heavy vehicles		Totals	74 599		
>3.3 m axle spacing				Lorry >3.5t&=16t total weight	503
5 044.82				Lorry >16t&=26t total weight	1 669
74 599				Lorry >26t total weight	1 983
					4 155
Motorcycles		Cars	Lorries =3.5t	Lorries >3.5t	Buses
674		62 971	5 909	4 155	890

Figure 3. Model for the annual vehicle mileage in Sweden – new version.

The total mileage is obtained from then national roads, as in the original version. The distribution among the different vehicle types is calculated using the number of vehicles and data from SCB.

Table 1. Distribution of vehicle mileage among different vehicle categories, SCB.

Vehicle type	Proportion of vehicle mileage 2001-2003
Motorcycle	0,79
Car	84,91
Lorry = 3.5 tonnes total weight	7,42
Lorry >3.5 & = 16 tonnes total weight	0,73
Lorry >16 & = 26 tonnes total weight	2,47
Lorry >26 tonnes total weight	2,41
Bus	1,27
Total	100

The proportions in table 1 are used year 2002. Figures for other years are calculated in the following way, see formula (1) and (2). A_{ij} is the number of vehicles in category j year i . For instance, if the proportion of cars one year exceeds the value from 2002 this gives an initial $a > a_{2000}$ according to (1). Final values are calculated with the expression (2) to guarantee that the sum of proportions for different vehicle categories is equal to 1 every year.

$$\hat{a}_{i,j} = a_{2002,j} \times \frac{A_{i,j}}{\sum_j A_{i,j}} / \frac{A_{2002,j}}{\sum_j A_{2002,j}} \quad (1)$$

$$a_{i,j} = \frac{\hat{a}_{i,j}}{\sum_j \hat{a}_{i,j}} \quad (2)$$

3. The desirability of further data

The data of SCB/Motor Vehicle Inspection Company now provide completely different opportunities to monitor e.g. traffic mileage with different fuels, and it is not necessary to base this on the number of vehicles and the sales statistics of petrol companies. The VTI model uses the relationship between distance driven by petrol and diesel vehicles in different vehicle groups. These "diesel factors" have not been changed in the estimating model since its inception, despite the fact that conditions have changed and that vehicles using other fuels perhaps differ as regards distance driven from vehicles with petrol as the fuel. In this respect, the distance-driven data of SCB/Motor Vehicle Inspection Company would probably be a better direct source. The question is whether these data should be included in the VTI model.

Table 2. Distances driven in 2004 by petrol cars and cars powered by other fuels.

Fuel	Distance driven in 2004		Distance driven per vehicle in 2004	Factor
	Km	%		
Petrol	55,260,375,700	90.2	13,650	1.0
Diesel	5,925,788,670	9.7	27,440	2.0
Electric	898,330	0.0015	6,191	0.5
LPG	39,770	0.0001	19,881	1.5
Producer gas	11,830	0.0000	1,970	0.1

Fuel	Distance driven in 2004		Distance driven per vehicle in 2004	Factor
	Km	%		
Ethanol	521,960	0.0009	13,041	1.0
Methanol	31,110	0.0001	10,370	0.8
LPG	411,050	0.0007	5,951	0.4
Natural gas	59,574,340	0.0973	21,950	1.6
Biogas	5,842,570	0.0095	20,790	1.5
Not known	1,526,770	0.0025	4,890	0.4

Source: Eriksson, J. *Distances driven in 2004 – Preliminary results and method. Statistics Sweden. Programme for Transport Statistics. 25.2.2005.*

Distances driven on petrol and on ethanol are equivalent. Diesel as fuel implies twice the distance driven on petrol. Cars with gas (LPG, natural gas or biogas) as fuel have a distance driven 50% longer than petrol cars. Distances driven on other fuels are less than half the distance driven by petrol cars. In Report No 439, the diesel ratio (ratio of distance driven on diesel to that on petrol) is 1.38 and the others 1.0. The similar ratios in 2004 are 2.0 and 1.4. These new ratios are available from 2000 and the question is whether they should be used in the VTI model. Since the intention from the outset was that they should be included, they ought to be included, but in that case data are required from SCB/Motor Vehicle Inspection Company annually for different vehicle types. One reason that they should be included in the model is that the quality of the data is much higher than before. One difficulty is that petrol and ethanol can be mixed. Petrol contains 5% ethanol and E85 contains 15% petrol, and at the same time some makes of car (or cars converted for this purpose) can be driven on both ethanol and petrol. A car intended for petrol can also be driven "illegally" on ethanol, while the opposite is not illegal.

The problem of the use of trailers in heavy traffic may perhaps also find a solution. It is thus doubtful whether a tractor with semi-trailer shall be defined as "lorry with trailer" as before. If only trailers for lorries are counted, the occurrence in 1995 is 52.6% and in 2003 56.8%. It may perhaps be useful to make a distinction between lorries and tractors in the future, since all lorries used in international traffic are tractors with semi trailers.

Table 3. Distances driven with respect to type of lorry.

	1995		2003	
	Distance driven, 1000 km	Per cent	Distance driven, 1000 km	Per cent
Lorry only	837,217	37.5%	690,999	31.5%
Lorry with trailer	1,165,751	52.2%	1,212,970	55.4%
Other lorry combinations	7,929	0.4%	30,429	1.4%
Tractor	5,456	0.2%	49,56	0.2%
Tractor + semitrailer	215,884	9.7%	241,514	11.0%
Other tractor combinations	1,781	0.1%	9,489	0.4%
Totals	2,234,017	100.0%	2,190,357	100.0%

Source: *Goods traffic by lorry and rail in 1995 (T30SM9603 SCB), and domestic and foreign traffic with Swedish lorries in 2003 (SSM005:0404 SIKÄ)*

Note that less than 60% of the total distance driven by heavy lorries is included in the above table. If account is taken of foreign lorries in Sweden, the breakdown of lorries on the Swedish road network would probably be "Lorry only" 30%, "Lorry with trailer" 50% and "Tractor + semi trailer" 20%.

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