COST RECOVERY RATIOS OF FINNISH ROAD TRAFFIC ON PUBLIC ROADS

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Abstract

This paper describes the cost recovery ratios of Finnish road traffic on public roads. Both marginal cost recovery and full cost recovery ratios were calculated. The analysis was based on 1998 data on traffic, socio-economic costs of traffic, vehicle fleet and taxes imposed on fuel, traffic and vehicles. The aim was to calculate cost recovery ratios for different road categories, for different vehicle types and for different regions of Finland. In 1998, the total costs of road traffic yielded to 1.7 billion EUR. This figure included 770 million of infrastructure costs, 470 million of accident costs and 420 million of pollution costs. The tax revenues constituted 1.5 billion from fuel (gasoline and diesel) taxes, 17 million from additional taxes on fuel, 700 million from car and motor cycle taxes, 130 million from diesel vehicle tax and likewise 130 million from annual vehicle tax. This yielded to 2.5 billion EUR in total. The marginal cost recovery ratio for public roads was well above 100%. Especially private cars and vans covered their marginal costs whereas buses and trucks did not. Taking all main roads (classes I and II) the marginal cost recovery was 125% and full cost recovery 135%. On lower class roads, the cost recovery ratios were lower, but still over 100%. Regional analysis revealed no great differences between Road Regions with regard to cost recovery. This analysis found no arguments for revised road pricing schemes. The EU Commission's principles on infrastructure pricing, stated in the White Paper, were by and large realized already in 1998 on Finnish public roads.

Keywords: Marginal cost; Full cost; External costs; Road traffic
Topic Area: C7 Traffic Simulation Models

1. Introduction

There are two relevant cost recovery definitions: marginal and full cost recovery. For practical purposes it is useful to simplify:

Full cost recovery ratio = (fixed and variable revenues) / (fixed and variable costs)
Marginal cost recovery ratio = (variable revenues) / (variable costs)

However, it should be borne in mind that this simplification is incorrect from a pure theoretical point of view. For instance, marginal costs may (and evidently will) include also fixed costs. Some simplification is nevertheless necessary in order to yield practical results.

Marginal cost recovery ratio is interesting from the viewpoint of road (and transport in general) pricing. The problem with these concepts is the division of revenues and costs into fixed and variable components. For example, many costs are fixed in the short-term, but may be variable in the long-term. What is fixed within one year may well be variable in the ten year horizon. According to economic theory, the concept of cost recovery can be used to determine such levels of taxes and other payments where the road users, i.e.

motorists in this case, pay for all the costs they cause on society as a whole. This means that also external costs, such as accident and environmental costs, need to be covered. In a theoretically optimal situation, motorists pay all the marginal (variable) costs they cause. This is the objective of the Commission of the European Union as the Common Transport Policy (CTP) pursues an efficient but at the same time a sustainable transport system (1, 2). For the road sector, this means at least the following:

- Infrastructure is utilized optimally and unnecessary trips are avoided (optimal capacity)
- Those who move or use the infrastructure, pay all the related costs of their movements (optimal choice of mode).

The EU's White Paper on infrastructure pricing (European Commission) suggests a phased approach in infrastructure pricing (3). The main idea is to create a charging framework for all modes based on socio-economic marginal costs thus leading to a close-to-optimum status of the use and provision of the infrastructure. The proposal on charging heavy goods vehicles on a common basis is already on its way (4).

In Finland, there has been numerous research efforts to determine the cost recovery of road traffic as well as cost recovery of other modes of transport. The latest analysis is from 1998 (5). Table 1 shows how the cost recovery framework was constructed for this analysis. It is noteworthy, how the cost/revenue framework still includes many "holes" and items that are absent from the framework. This just implies how difficult and complex the whole issue of cost recovery really is. It is also important to notice that all the external effects (costs) are considered as variable cost items.

Table 1. Revenues and costs of Finnish Road Traffic, 1998 Analysis

Revenue Items	Cost Items	Included in the Analysis Framework?
Fixed taxes and payments • car and motorcycle tax (tax paid by the buyer when new vehicle is purchased) • vehicle tax (annual vehicle tax paid by vehicle owners) diesel car tax (paid annually by the diesel vehicle owners)	Fixed costs • part of infrastructure costs	Yes
Variable revenues • taxes on fuels (paid by motorists when fuel is purchased) extra tax (for crisis management, paid when fuel is purchased)	Variable costs • part of infrastructure costs • accident costs (external) pollution costs (external)	Yes
External benefits, examples • access opportunities • increased revenue from economic activity (e.g. corporate taxes) • etc.	Other external costs, examples • vibration, dust, noise • accidents of fauna • ground water pollution • barrier effects	No

New work is also proceeding under the leadership of the Ministry aiming at implementing the principles of White Paper.

2. Objectives and methods

The objective of this paper is to provide answers to the following questions:

- Do the motorists pay for the use of infrastructure and negative effects they cause on Finnish public roads?

- To what extent the costs are covered in different road categories?
- Are the motorists treated equally across different regions of the country?
- Carry the users of different vehicle types an equal tax and payment burden?

The answers give implications to what extent the "user pays" principle is realized in Finland. Another objective is to provide background information for Finnish transport authorities when they revise the Finnish transport and infrastructure charging regime. Thus this analysis should serve as one basis for the transport policy formulations in Finland. Finally, the objective is to experiment to what extent cost recovery calculations can be disaggregated into more detailed level.

The whole analysis is based on the previous work carried out by the Ministry (5). The results and data from that analysis was further refined by combining data from the following sources:

- Finnish National Road Administration's (Finnra) statistics (6),(7)
- Other statistics on e.g. vehicle fleet (8)
- Internet sites of Statistics Finland, Finnish Automobile Association, Ministry of Finance, etc.

This paper is based on findings of Leviäkangas (9) as Finnra was preparing for the measures due to the early versions of White Paper.

3. Input data

3.1. Costs of Road Traffic

For road category division, the standard Finnra administrational classification system was used: Class I and II main roads, regional highways and connecting roads. For different type vehicles, the total fleet was divided into 1) private cars and vans, 2) buses, 3) trucks and 4) motor cycles. The regional division was done according to the boundaries of Road Regions, which are 9 altogether.

The total costs of road traffic on public roads yielded to 1 673 million EUR in 1998. Table 2 shows the division of these costs.

Table 2. Estimated Costs of Public Roads Traffic in 1998

Cost Item	Million EUR	Fixed / Variable Cost
Infrastructure costs (administration, engineering, construction, maintenance)	774	Partly fixed, partly variable
Accident costs (deaths, injuries, material damages)	477	Variable
Pollution (exhaust emissions)	422	Variable

The variable costs were divided according to vehicle kilometers of travel of different types of vehicles to the road network of different Road Regions. Also the fixed costs had to be divided among vehicle types, road categories and regions. The vehicle kilometers of travel, the regional distribution of vehicle fleet and vehicle type composition on different roads and regions were used as keys to allocate fixed costs. Especially the infrastructure costs were difficult to divide into fixed and variable components since each infrastructure cost component were given a separate allocation key, i.e. which part of e.g. winter maintenance costs were considered fixed and which part variable. Furthermore, these sub-components (e.g. fixed bridge maintenance and variable bridge maintenance) had to be divided according to e.g. vehicle kilometers of travel, road length or vehicle type composition or a combination of these allocation keys. Thus the process was complex and

involved many potential sources of error. However, at certain aggregate level (e.g. regional total infrastructure costs) the input figures could be considered as very reliable.

Figure 1 shows how the fixed and variable costs were distributed regionally across the Road Regions. The more scarcely populated region is in question, the larger share has the fixed cost component of the total costs. This is an obvious result, since lower traffic volumes result in lower variable costs. Figure 2 illustrates the costs divided among vehicle types. It is clear, that major emphasis is on private cars, vans and trucks. Other type of vehicles' share of the costs is relatively insignificant. Buses represent only minor share of costs on public roads, but their share would be higher on streets, where a significant portion of the bus traffic takes place. It is also visible from Figure 2 how important item is pollution cost. Figure 3 shows how infrastructure, accident and pollution costs are formed regionally. The more scarcely populated area is viewed, the portion of infrastructure costs rises in relation to total costs. The explanation is the same as with Figure 1, since only infrastructure costs are partially regarded as fixed costs, other costs rise in accordance with traffic volumes.

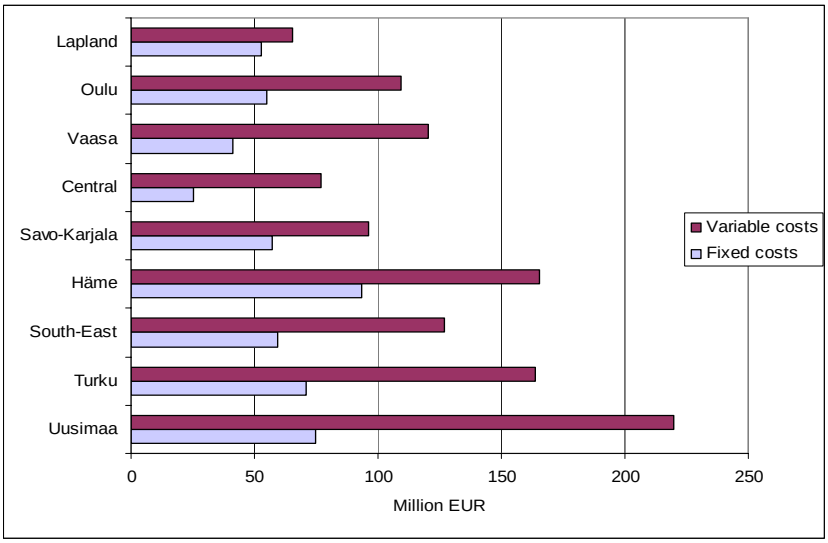


Figure 1. Estimated Costs of Public Roads Traffic per Region in 1998. "Uusimaa" is the Capital Region.

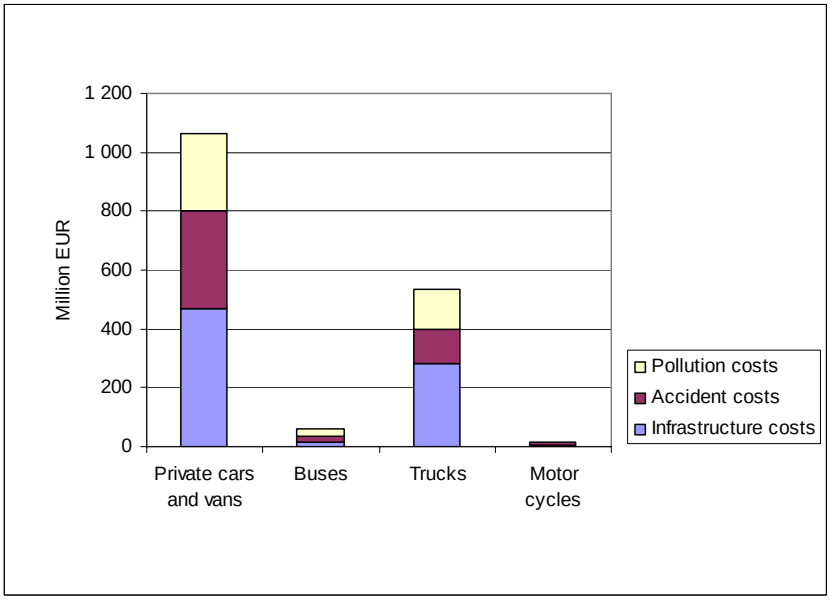


Figure 2. Estimated Costs of Public Roads Traffic according to Vehicle Type in 1998.

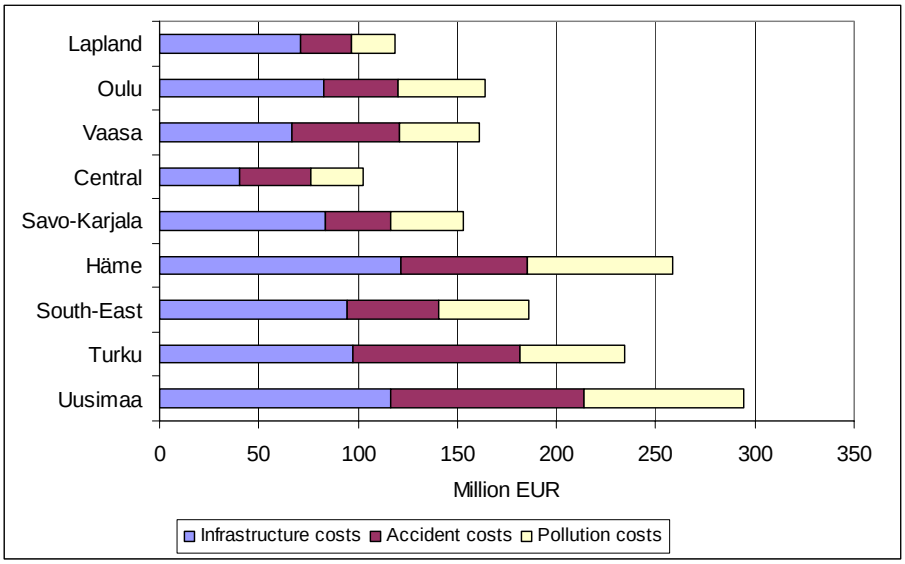


Figure 3. Cost Breakdown in Road Regions in 1998.

3.2. Revenues from Public Roads Traffic

In 1998, the total revenues from traffic on public roads were 15.1 billion FIM. The more detailed breakdown of the revenues is shown in Table 3. Roughly 2/3 of the revenues came from fuel taxes and car and motor cycle taxes. Fuel tax revenues were very easy to allocate according to vehicles, road categories and regions since they quite explicitly depend on the amount of vehicle kilometers of travel. Fixed revenues were allocated either according to vehicle fleet (regional allocation) or vehicle kilometers of travel (road category and vehicle type allocation) Figure 4 demonstrates how the revenues were broke down according to the road categories. Class I main roads traffic generated most of the revenues. Figure 5 shows how different vehicle types generated revenues. Private cars and vans form a lion's share. Regional revenue distribution is visible from Figure 6. It is no surprise that densely populated areas with higher volumes of traffic dominate the revenue flow.

Table 3. Estimated Revenues from Public Roads in 1998.

All Vehicles Million EUR			**Cars & Vans**	**Buses**	**Trucks**	**MCs**
Tax on gasoline	1 028	Variable	1 242	42	267	12
Tax on diesel fuel	518	Variable				
Crisis reserve tax	18	Variable				
Vehicle tax	698	Fixed	875	0	64	15
Diesel vehicle tax	128	Fixed				
Annual vehicle tax	127	Fixed				
Total	**2 518**		**2 118**	**42**	**331**	**27**

Table 3 notes: Tax on gasoline and diesel are paid when drivers purchase fuel. Crisis reserve tax is paid likewise. Vehicle tax is paid when new vehicles are purchased. Diesel tax is paid yearly for diesel engines. The same applies to annual vehicle tax. Buses are excluded from fixed annual taxes on vehicles. All the revenues were first taken from national accounts and then distributed between public roads, private roads and streets according to annual vehicle kilometers traveled on these infrastructures by each vehicle type.

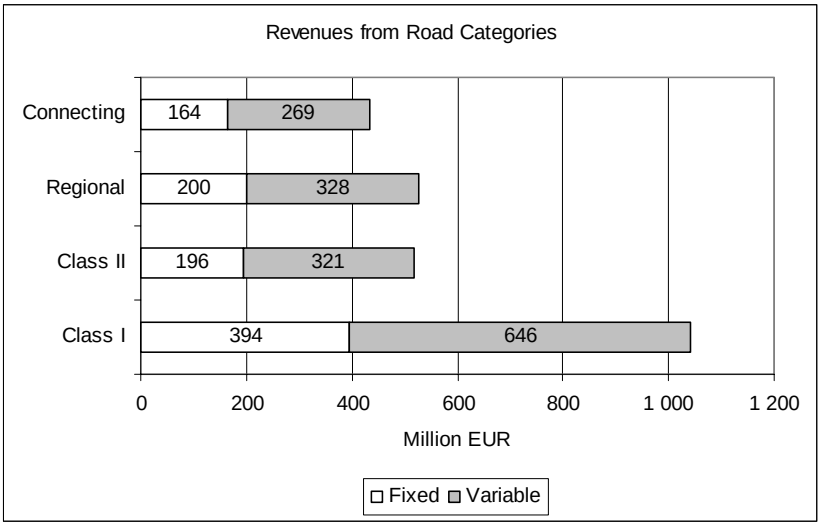


Figure 4. Estimated Revenues Generated from Public Road Categories in 1998.

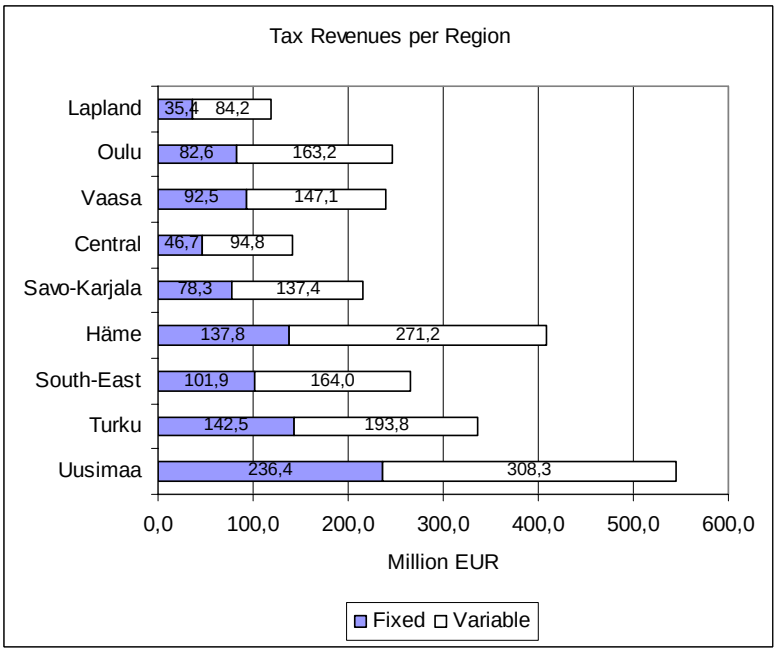


Figure 5. Estimated Revenues from Regions in 1998.

4. Cost recovery ratios

With complete input data it is now possible to estimate the marginal and full cost recovery ratios for traffic on Finnish public roads. The ratios are expressed as percentages. The results should be interpreted as follows:

1) If both marginal and full cost recovery ratios are less than 100%, the motorists do not pay for the costs they impose on infrastructure and society as a whole. This applies to both individual trips taken (marginal cost recovery) and at aggregate level including all costs (full cost recovery). Marginal cost recovery deficit leads to sub-optimal use of resources and motorists imposing costs they are not paying for; full cost recovery deficit leads to economic deficit of the whole transport system (or sub-system if specific region or road category is studied). The whole pricing regime (taxes, other payments) should be revised.

2) If both marginal and full cost recovery ratios are above 100%, motorists finance the transport system (in socio-economic sense, not necessarily in pure monetary terms!) (full cost recovery ratio) and pay for the costs that each trip results in (marginal cost recovery ratio). There is possibly grounds to lower the tax burden of motorists, if the State economy allows. In theory, excessive taxation of mobility may lead to loss of profitable opportunities created by it.
3) If marginal cost recovery exceeds 100% but full cost recovery is below that threshold, the costs of trips are covered by motorists but the total system faces deficit. There should be a revision of the tax system aiming at covering the deficit through fixed revenues (i.e. taxes that are not dependent on traffic volumes).
4) If marginal cost recovery is under 100% and full cost recovery above 100%, the motorists do not pay for the costs of their travel. This leads to sub-optimal (i.e. excessive) use of infrastructure. The whole transport system covers its total costs, however. Again, the tax system of road transport sector should be revised so that more weight would be put variable taxes, dependent on how much one travels.

The same interpretation can be applied to regional (the 9 Road Regions of Finnra) and categorical (road categories and vehicle types) analyses.

The cost recovery ratios of different vehicle types can be observed from Figure 6. For private cars and vans the marginal cost recovery ratio was quite high, 168%, and the full cost recovery ratio even higher than that (199%). As to other vehicle types, these did not fully cover their marginal costs. Especially trucks' cost recovery was low (77%). The same result applies to full cost recovery ratios, except for motor cycles, whose full cost recovery was 157%. The implication is that the tax burden is perhaps too low for trucks and buses and too high for private cars and vans. Motor cycles are heavily taxed when they are purchased, but their use is not taxed quite enough.

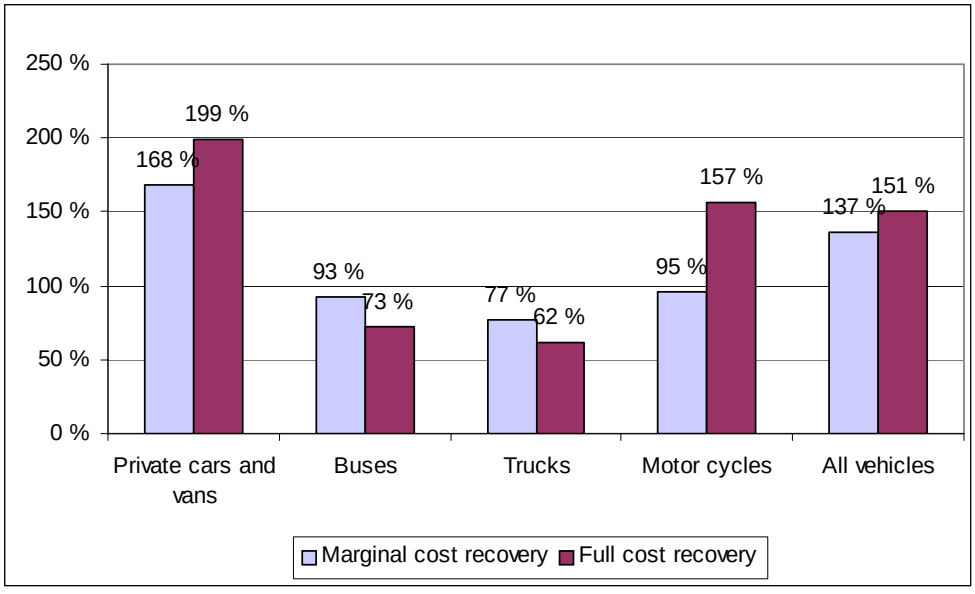


Figure 6. Cost Recovery Ratios of Different Vehicles.

Figure 7 shows the regional cost recovery ratios in Finnra's 9 Road Regions. As visible, there were no radical differences between the regions. In all regions, the traffic covered both their marginal and full costs. This means that drivers in do not "subsidize" each others across regions, at least very much. There is, however, a slight difference between the regions. In Lapland, for instance, the drivers do not pay quite as much for their

driving as drivers in southern Finland (e.g. Uusimaa Region). These differences are relatively small, however, and do not justify any immediate policy revisions.

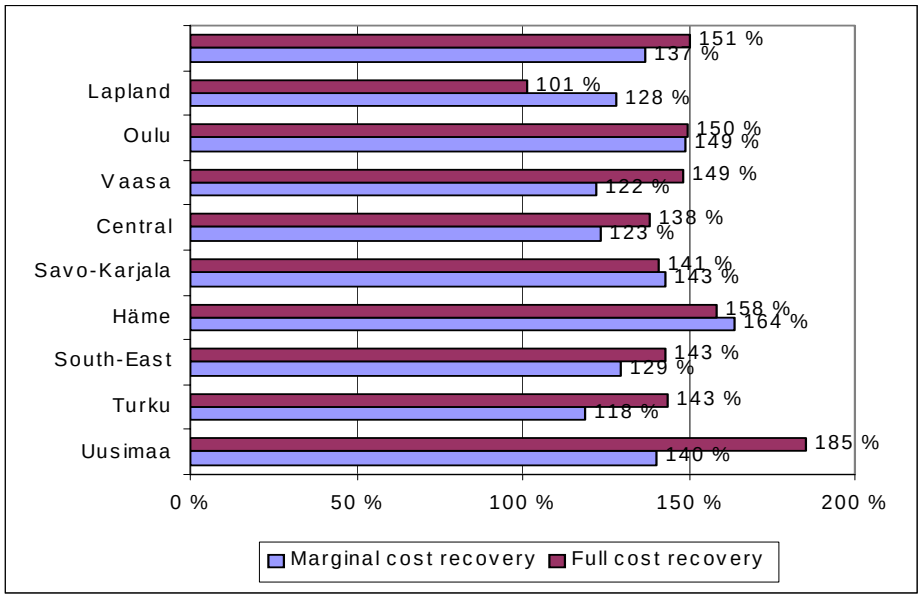


Figure 7. Cost Recovery Ratios in Road Regions.

All the results obtained are gathered in Table 4. This table is the most important output of this study. In the following chapter, the results are interpreted and translated into policy recommendations.

Table 4. Summary of Cost Recovery Ratios
(MCR = Marginal Cost Recovery Ratio, FCR = Full Cost Recovery Ratio; PCs+Vs = Private Cars and Vans, MCs = Motor Cycles)

Road Region	Vehicle Type	Road Category									
		Class I		Class II		Regional highways		Connecting roads		All roads	
		MCR %	FCR %	MCR %	FCR %	MCR %	FCR %	MCR %	FCR %	MCR %	FCR %
Uusimaa	PCs+Vs	197	266	178	251	161	234	124	185	168	238
	Buses	84	71	68	60	111	92	244	163	95	79
	Trucks	75	69	80	74	90	84	69	69	77	73
	MCs	104	198	144	254	96	188	53	112	92	181
	All	153	195	145	191	142	191	111	155	140	185
Turku	PCs+Vs	162	216	262	362	154	204	77	103	145	194
	Buses	65	53	85	74	88	69	143	80	81	64
	Trucks	68	55	119	99	83	68	46	39	71	58
	MCs	77	150	121	245	82	153	50	88	76	145
	All	124	149	203	253	130	156	69	84	118	143
South-East	PCs+Vs	122	143	543	672	189	228	131	150	162	190
	Buses	52	42	300	244	147	110	224	124	93	72
	Trucks	48	40	339	272	119	96	68	59	74	62
	MCs	90	146	165	329	103	182	70	118	97	165
	All	92	101	470	536	168	187	112	122	129	143
Häme	PCs+Vs	169	173	401	439	220	254	163	186	202	217
	Buses	70	53	157	127	149	112	288	157	108	81

	Trucks	69	45	203	134	134	90	85	63	94	63
	MCs	131	183	199	325	116	193	76	127	121	188
	All	130	120	328	322	194	198	141	145	164	158
Savo-Karjala	PCs+Vs	189	191	258	273	160	175	130	128	178	184
	Buses	84	64	95	77	94	72	181	97	97	73
	Trucks	76	56	113	85	80	62	52	42	76	58
	MCs	112	152	164	227	94	137	79	102	107	147
	All	148	143	206	207	135	139	105	101	143	141
Central	PCs+Vs	116	135	340	425	217	257	121	138	152	179
	Buses	52	45	122	112	131	110	198	129	83	70
	Trucks	51	45	164	152	116	102	60	54	71	63
	MCs	77	122	103	188	97	165	67	106	83	136
	All	91	102	270	321	183	206	103	113	123	138
Vaasa	PCs+Vs	168	210	238	311	153	200	91	116	152	194
	Buses	68	58	91	81	88	74	155	99	85	71
	Trucks	68	62	119	110	80	74	48	46	71	66
	MCs	84	145	126	223	84	147	56	93	83	142
	All	127	152	192	237	127	157	78	95	122	149
Oulu	PCs+Vs	171	174	369	390	222	232	118	122	186	192
	Buses	70	56	136	115	132	102	189	107	101	78
	Trucks	67	55	169	139	113	90	57	48	81	67
	MCs	107	143	179	267	131	183	80	105	115	155
	All	130	130	294	301	186	187	100	101	149	150
Lapland	PCs+Vs	162	133	182	158	153	138	138	115	159	135
	Buses	68	46	86	61	89	61	198	87	85	56
	Trucks	58	33	91	50	71	43	54	35	64	38
	MCs	86	97	136	139	80	98	71	80	88	100
	All	125	95	155	123	129	107	113	89	128	101
The Whole Country	PCs+Vs	163	188	269	325	177	216	117	140	168	199
	Buses	68	55	106	89	113	88	201	116	93	73
	Trucks	65	51	131	105	97	78	60	51	77	62
	MCs	97	156	148	249	98	165	63	105	95	157
	All	125	135	219	246	152	171	101	113	137	151

5. Findings and policy recommendations

Private cars and vans covered both their marginal and full costs on Finnish public roads in 1998. Trucks and buses, however, did not cover their marginal nor their full costs. This implies that private cars and vans are taxed too heavily and trucks and buses receive too little of the tax burden. This is the strict theoretical conclusion. However, since the state economy requires tax revenues for other purposes than just traffic, it seems that the fiscal motives of the Ministry of Finance weigh significantly in the taxation regime considerations. Education and health care system need their finances and traffic has always been a good source of tax revenues for these purposes. From a wider perspective, this transfer of funds may well be justified. From the traffic economy viewpoint, however, the current system produces non-optimal patterns of traffic demand and supply. From the motorists' point of view, it might be justified to claim that the service level of the infrastructure is too low compared to the motorists' cost of using it.

As trucks and buses pay less than they cause costs to the society, this advantage should also be given to those operators in the other transport modes that compete with truck and bus transport, e.g. train operators and airline operators. This has indeed been the case in Finland. For example, the track use charge collected from the train operating company equals the marginal cost recovery of bus and truck traffic (i.e. the train operating

company covers equal proportion of their marginal costs for the company's freight and passenger traffic). This was in fact the basis for the rail infrastructure charging scheme.

Regional differences were surprisingly small, although remote region's motorists covered slightly less of their costs than motorists of densely populated areas. Even in Lapland, the motorists covered their marginal costs. Thus the tax and charging system treats equally the motorists of different regions.

In different road categories, the differences were also very moderate. This implies that current tax and charging systems treats equally the motorists on different roads and no user group faces radically heavier tax burden than others.

In sum, the Finnish tax and charging system of transport sector, by and large, fulfills the requirements of the EU. In some cases, there is even room for lower taxes/charges posed on motorists provided that state e budget economy allows this option. One should be hesitant in "stirring up" a well-functioning system unless there are clear benefits to be achieved or unless there are significant discrepancies to be straightened up.

In the following section we will take a look how a totally different type of system could operate in theory – a Road Fund.

6. A road fund – would it work?

The authors envisioned a different type of financing structure for the road sector and the model was presented in Finnish Winter Road Seminar 2002 (10).

The structure of road funds is basically always the same, shown in Figure 8.

Road funds have been recognized as one mean of overcoming infrastructure financing problems, especially in third world countries. Road fund experiences, lessons and critical factors for successful implementation have been reported e.g. by Potter (11) and Heggie (12). Within current EU, road funds do not exist and discussion has been likewise very minimal. New accession countries might, however, introduce road funds and thus boost the development of road infrastructure.

Since we know that in our particular case, Finland, the road users cover all the costs of public road infrastructure, the money flows enable the self-financing of the road sector. The question is whether this is feasible and reasonable. We will try to assess this question by looking at one critical issue at a time.

Would there be enough money to cover all the costs of transport ? Yes there would as calculations show. In fact even the externalities would be covered. This fact could create problems since there would be a significant surplus after infrastructure costs had been covered. Either there would have to be a transfer mechanism where for example accident costs are covered by "insurance" payments included in current fuel tax, or the variable revenues would have to be less than at present. The latter alternative is easier to deploy. The former would mix the whole insurance market unless insurance companies are connected to Fund holding in some way.

Are the control and management tools available for Fund operation? Yes, they are. Current corporate legislation covers already now different types of funds which may or may not have profit seeking goals. Corruption would not be a problem either. Competent Board is easily established once the mission is clear.

Is there political willingness to significantly revise road sector financing? Since the current system seems function reasonably well, there has not been recognized needs to revise the existing road tax and financing system. So the answer is "no". This is a pity in a way because the current system completely lacks transparency. It is transparent only to dedicated experts and decision makers but the people nor the majority of politicians do not know for what they are paying for and how much they are getting in return. In the long run, this may be a non-sustainable state of things. In addition, some of the existing

administration structures would certainly oppose serious restructuring if they were to loose control and power in the change.

Would there be any serious drawbacks within the vicinity? No. In fact "commercialising" roads would be a natural continuum to present policies. Market principles have been introduced to almost all sectors of society, and the authors feel that it is more rational to commercialise roads than to commercialise schools or hospitals - even if there are excellent examples of the latter mentioned. Besides, many other infrastructures have already been commercialised in Finland: ports operate as limited companies owned by municipalities and industry, airports are owned by the state and operate as state-owned-enterprise (SOE) with partly commercial objectives, energy and telecom networks are operated fully commercially. There are no rational reasons not to assume that the same would not work for roads – nor railroads for that matter. One word of caution is also in place, however. Road Fund should not target for maximizing profits. Profit or value maximization fits poorly in the principles of long-term national wealth accumulation which should be the goal of Road Fund. But the plain truth is that the Finnish stock market provides average annual nominal returns of well above 10% whereas the current nominal discounting rate for infrastructure investments is 5% (i.e. we can expect nominal returns of 5% or more).

Are there any significant benefits coming with Road Fund? The answer is yes and no. Yes, there are grounds to assume that commercializing road assets would bring efficiency to road infrastructure management. Efficiency should also be improved because of increased transparency in sector financing. People would know what they are paying for. "No" we can say because radical sector restructuring does not necessarily accrue to increased efficiency or decreased cost. For instance, if we look at European railway restructuring in various EU countries we do not witness clear signals of improved efficiency or reduced cost thinking of the whole sector. In Finland the separation of rail infrastructure and operations and corporatization of former national rail operator has improved the efficiency of the operating company but the sector financing from state budget point of view has remained the same – the state still has to cover the cost of infrastructure and sector deficit is as it was before. We suspect, by the way, that this is the case in most European countries. However, in road sector there is a significant advantage the sector already being self-sufficient.

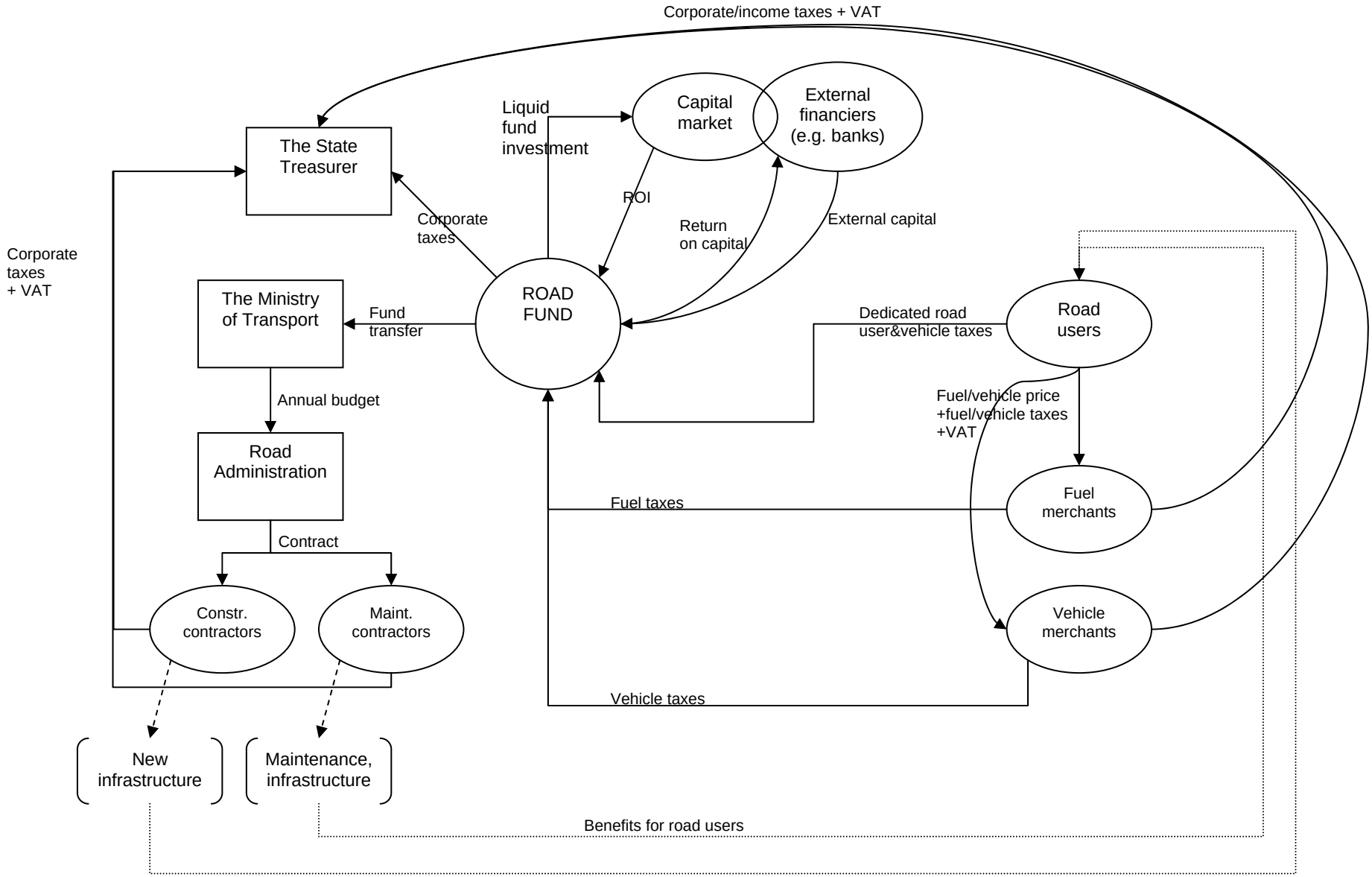
Some additional likely benefits can be identified. First, Road Fund would transfer a remarkable amount of capital to private sector if the Fund invested its surplus capital in the capital markets. This would probably be beneficial in the long-term, though in the short-term this could mean "a bubble" in the stock market unless the injection would not be done with care. Currently this money rotates within state economy with little effect in boosting capital markets. Secondly, there is an opportunity for leveraged infrastructure which might be useful for critical major projects. Currently this means a burden for state's balance sheet, i.e. national accounts and political willingness in Single Market Area to finance infrastructure with state debt is low, if existing at all. Thirdly, regarding roads as assets would offer efficient tools in measuring the returns and additional wealth provided by infrastructure. So far, this has been a more of a technical exercise than serious management and control function. Finally, it would appear that investments in new roads or upgrading would be based on more rational demand-oriented thinking than tied-up in political ambitions (which on the other hand may not be all bad!). Different types of financing arrangements like BOTs and shadow tolls would be easier to carry out as the Fund could have more lee-way in its arrangements than current state agencies.

7. Final remarks

This study showed that with good statistical basic data, it is possible to estimate the cost recovery ratios of transport with reasonable effort. In some respects, this study also pointed out where relevant information is still lacking in Finland. The main finding from the viewpoint of Finnra, was that the current cost accounting system does not very well serve road policy decision making. The system has been developed to serve construction and maintenance operations management, not strategic road management or road policy.

The costs of road usage are well covered all over the country, even in rural areas. This is relaxing information for political decision makers as there are no compelling needs to revise the tax system. Another question is how well the current taxation system serves the purpose of national competitiveness in the Single Market.

Road funds could be one alternative when (and if) weighing future options how to finance infrastructure and how to make money flows transparent. It is interesting to note that there are many arguments for road funds, but the first threshold has to be overcome - would it work, would there be enough money cycling around to cover the costs? For Finland the answer is yes, but for many countries that consider road funds this may not be that clear.



Road Fund Conceptual Architecture

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