SIKA Report 2007:2

Kilometre tax for lorries
Effects on industries and regions

Report on a government commission
in collaboration with ITPS

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Swedish Institute for Transport and Communications Analysis

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Foreword

SIKA and ITPS were commissioned in July 2006 by the Government to "….analyse the effect on industries and the consequences for regions of the introduction of a kilometre tax for heavy vehicles".

The commission has been jointly carried out by SIKA and ITPS with SIKA as co-ordinator.
Consultation has taken place with the National Institute of Economic Research, the Swedish Environmental Protection Agency, the Swedish Tax Agency, the National Board of Forestry, the Swedish Board of Agriculture, the Swedish Business Development Agency (Nutek) and the National Road Administration. Consultation has taken place at four consultation meetings and through the consultation agencies being given the opportunity of submitting points of view on the draft. Some consultation agencies have also submitted material to the commission.

Regions and industries and the relevant agencies have been given the opportunity to have insight into and to submit points of view on the work through a widely circulated invitation to a hearing, which took place on 31 January 2007. At the hearing, a number of interest organisations put forward points of view. SIKA and ITPS have also had direct contacts with several organisations.

SIKA and ITPS have submitted progress reports to the Government Offices (Ministry of Finance) on two occasions during the course of the commission's work. A number of representatives from the Government also participated in the hearing.

The present report is the final report from this commission. The work has been divided up so that ITPS has been the main author of Chapters 5, 6 and 9 while SIKA has had the corresponding role for the other chapters. SIKA and ITPS are in agreement on the consideration and recommendations in the report.

The project managers for the commission have been Göran Friberg from SIKA and Martin Flack from ITPS. SIKA's model analyses have been carried out by Petter Hill and Magnus Johansson with the assistance of Inge Vierth and John McDaniel, both subsequently consultants at the Swedish National Road and Transport Institute. Thomas Forsberg was responsible for ITPS's model analyses which were carried out with the assistance of Tommy Lundgren at Umeå University. Other participants were Per-Ove Hesselborn and Gunnel Bångman, SIKA.

Stockholm, March 2007

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Summary

Background

The Government has commissioned SIKA and ITPS to analyse the effect on industries and consequences for regions of the introduction of a kilometre tax for heavy vehicles.
The starting point for this analysis is that the kilometre tax is based on the marginal costs of the external effects of traffic.

One of the basis principles of transport policy is that pricing of transport is to be based on the marginal costs of the external effects of traffic, i.e. accidents, wear and tear on the infrastructure, congestion, emissions of air pollution and noise. A kilometre tax for heavy vehicles may be an efficient instrument to internalise these external costs.

The introduction of a marginal-tax based kilometre tax would also entail a shift in the conditions of competition for businesses in different industries and regions. Some impact on the location, level and composition of production can then be anticipated, as well as the development of employment, in particular in the longer term. There is a risk that this will conflict with the goal of regional development policy, which is that there are to be efficient and sustainable local labour market regions with a good level of service in all parts of Sweden. Even if the long-term structures are considered to be reasonable, there are still risks for considerable problems of adjustment in a short- and medium-term perspective. The commission primarily involves anticipating probable effects on industries and regions and proposing suitable countermeasures to dampen these effects.

Kilometre tax as an instrument of control

If kilometre tax is differentiated taking into consideration relevant characteristics of the vehicle and where and when the vehicle is driven, it may then be a considerably more efficient instrument for internalisation of the external effects of heavy traffic than the taxes and charges used today, i.e. diesel tax, vehicle tax and road charges. A kilometre tax makes it possible to charge foreign lorries and also entails that a distribution of income will comply with the distribution of traffic performance.

By clearly reflecting the social marginal costs, the kilometre tax contributes to giving the right signals both for the use of vehicles and the infrastructure and for the location and production decisions of enterprises that depend on road transport.

As regards the emissions of *carbon dioxide* from road traffic, fuel use is a better tax base since carbon dioxide emissions are directly proportional to fuel consumption and the carbon context of the fuel. We have therefore chosen to analyse a kilometre tax which reflects the external marginal costs excluding the cost of carbon dioxide emissions. However, a kilometre tax can be expected to lead to a reduction of carbon dioxide emissions even if it is not its main purpose.

According to a change in the EU "Eurovignette" directive, member states can now decide themselves upon road charges on the whole of the national road network. This directive provides scope for introducing a kilometre tax which is differentiated to take into consideration environmental class, place, time, and degree of overloading. If a kilometre tax is introduced, the current Eurovignette cannot be charged at the same time but must be terminated.

Some form of kilometre tax for heavy vehicles has existed for some time in four European countries, Switzerland, Austria, Germany and the Czech Republic. The reasons for its existence and the design of the tax vary. There are plans to introduce similar solutions in a number of other countries, including the United Kingdom, the Netherlands and Russia.

A marginal-cost based kilometre tax

To be able to assess the effects on industries and regions, a number of calculations have been made within the framework of the commission. The first step was to construct tax schedules where the marginal-cost based kilometre tax is differentiated with respect to the weight and environmental class of the vehicle. Driving in an urban or rural area is another basis for differentiation in the schedules.

These calculations are based on information in the Road Traffic Tax Commission's report. An estimate has been made of the composition of the vehicle fleet as regards environmental classes in 2010. The average marginal-cost based kilometre tax has been estimated at around SEK 1.40 per vehicle kilometre. The average marginal-cost based kilometre tax for rural driving has been estimated at around SEK 1 per kilometre and at SEK 2.80 for driving in urban areas. This information is based on 2001's prices.

The analyses have been carried out partly by letting marginal costs only be covered by a kilometre tax and partly by taking into consideration the fact that energy tax contributes to internalising costs and that the kilometre tax is used to cover the remaining portion. In the latter case, the average kilometre tax would amount to an average of around SEK 1 per kilometre. This is the main alternative in the model calculations of the effects on industries and regions.

Transport cost effects of a Swedish kilometre tax

With the aid of the Samgods model system, a calculation is then made of the relative change in transport costs for different types of commodities to and from different regions. The average increase in costs for all types of commodities and

regions was calculated at around three per cent, if a marginal-cost based kilometre tax is levied in addition to existing taxes. In the event of a reduction of kilometre tax corresponding to energy tax, the average increase in transport costs would be around two per cent. This increase varies between different types of commodities and regions.

The results of these model calculations do not provide a direct answer to the questions posed in the commission. An important basis to be able to interpret the results is information about how large a part of the total production costs consist of transport costs. The official statistics have been used here, complemented with information from representatives of various industries. Special attention should be paid in the assessment of consequences to types of commodities that have a relatively high component of transport costs and which moreover can be expected to have a relatively high increase in transport costs as a result of kilometre tax. A combination of this kind can be an indication that effects on production and employment can be noticeable, even this is not the sole criterion for such effects.

Round timber is a type of commodity with this kind of combination. Although information from different sources about the proportion of production costs accounted for by transport costs differs, it is evident that the proportion is high compared with other types of commodities or industries. The increase in transport costs is also clearly above average for all types of commodities. *Food products* is the type of commodity that is estimated as having the highest increase in transport costs although, on the other hand, it shows a relatively modest proportion of transport costs in relation to total production costs. The type of commodity *High-value products*, which includes a large proportion of technological products, also shows a relatively large increase in transport costs.

The estimated increases in transport costs are generally largest in Northern and Southern Sweden, although variations within these large areas seem to be very large. Some concentration of relatively high cost increases can be discerned in Inland Norrland and Inland Götaland. There is a marked concentration to Southern Sweden for food transport.

The estimated average increase in transport costs appears to be little. Since variations in different industries and regions are large, it cannot, however, be excluded that noticeable effects may arise for the output of particular production units and employment.

Effects on production and employment

In a third step, the effects on production and employment were calculated with the aid of a factor demand model. Furthermore, a Salter analysis was carried out to estimate the extent to which each industry risks having a negative gross profit due to kilometre tax and thus the short-term effects that can be expected on production.

Overall, the expected effects on industries and regions were small, and not clearly negative. In certain industries, for instance, Food Products, the kilometre tax

would seem to lead to a restructuring where work would be substituted for transport which is expected to increase employment by a couple of per cent. The clearest negative effects were for the Wood Products industry, but even these are relatively small. Output is expected to decrease to a negligible effect throughout Sweden. The same applies to employment (it is expected to fall by a half per thousand).

The effects on regions (NUTS2) depend on the nature of the business structure regionally. Regions with a large proportion of enterprises in industries where the effects are expected to be noticeable can be assumed to be most affected. As in the case of industries at the national level, the effects for the whole of industry at the regional level are very small. Output falls in five of eight national areas, although at most by only just under just under one per thousand (in Western Sweden). The largest change is positive and is to be found in Southern Sweden, where output increases by just over one per thousand. The pattern of substitution between transport and capital on the one hand and work on the other hand recurs at the regional level as well. Use of labour increases in five regions at the same time as use of capital decreases, which moreover causes a fall in output in four regions, albeit marginal: Stockholm, Eastern Central Sweden, Western Sweden and Northern Norrland (in all cases by less than one per thousand).

Profits are largely unchanged for manufacturing industry as a whole, both nationally and regionally.

Measures to soften the effects

The report includes a discussion on whether it is possible to soften the effects of a kilometre tax while retaining the expected positive effects. A first step in this discussion is to regard the *energy tax* on diesel oil as part of the internalisation of the external marginal costs. This can take place by a reduction of energy tax and/or kilometre tax so that together they cover the marginal cost. Vehicle tax also has an internalising role, which could justify a reduction.

In the analyses, a weighted average of marginal cost has been used for driving in urban and rural areas. A reduction of the tax in such a way that it corresponds to rural driving would reduce the burden on transport in sparsely populated areas.

The transport subsidy is allocated to industrial enterprises in the four northernmost counties with a view to reducing the costs of long transport for these countries and to promote refinement of production. Depending on the design of the subsidy, a kilometre tax can only be partly compensated for with an increased transport subsidy.

Welfare gains and costs

The purpose of a kilometre tax is to obtain an instrument that leads to various adaptations to achieve a socially efficient use of the infrastructure. The kilometre tax is accordingly expected to lead to welfare gains in the form of reduced external effects. A kilometre tax system is in addition associated with costs for

investments and operation, which must be weighed against the welfare gains the system is expected to produce.

A kilometre tax is expected to lead to a slight reduction in traffic performance, which in turn will mean a decrease in emissions of carbon dioxide to the atmosphere and air pollution. There will moreover be an effect due to kilometre tax being differentiated in relation to the environmental class of the car, which is expected to lead to a faster replacement of the vehicle fleet by vehicles with lower emissions of nitrous oxides, hydrogen oxides and particles. However, this effect will decrease as the vehicle fleet becomes cleaner.

Wear and tear on the roads increases rapidly with increased axle load. A differentiation which takes into account the weight of the vehicle and the number of axles could lead to a reduction in wear and tear and lower maintenance costs.

If a kilometre tax was introduced for all road vehicles, reduced congestion could be expected, if the tax was differentiated according to where and when congestion arises. However, no major effects are expected as long as the system only applies to heavy vehicles.

Kilometre tax produces income, which, through a tax shift, could be used to reduce those taxes that have a distorting effect.

In a few years' time, it is expected that there will no longer be any technological barriers to extensive differentiation. However, it is difficult to estimate the system costs in advance, and they are highly dependent on the design and control systems selected. It has been estimated that an all-embracing system that makes it possible to distinguish between different areas and road types could be very expensive. There is therefore reason to investigate whether simpler solutions may be more justified from the point of view of social efficiency, even if the welfare gains are not so large. An idea is presented in the report on how a simplified system of this kind may be designed.

The effect on central government finances

The income from a kilometre tax introduced in 2010 is expected to be in the range of SEK 6 billion per year. The reduced income from diesel tax, which will result from reduced traffic performance, must be deducted from this amount, around SEK 1 billion. Furthermore, the income from the Eurovignette must be deducted, amounting to around SEK 0.6 billion per year. In addition, there will be reduced income from vehicle tax. The National Road Administration has estimated the system costs to be around SEK 0.9 billion per year. However, the National Road Administration emphasises that the estimates are very uncertain and that the prerequisites can change very quickly.

Considerations and proposals

There is a considerable measure of agreement that a kilometre tax would be a good instrument in many ways for internalisation of external marginal costs, and

many support the principle of marginal cost pricing. This also applies to representatives of parts of the business sector. Some countries have already introduced a kilometre tax system, and more countries seem to be in process of doing so. It seems as if kilometre taxes will be common in Europe in a few years time. There is therefore a reason for Sweden to prepare for the introduction of a system of this kind as well.

Our analyses of the importance of a kilometre tax for transport costs and production and employment show that the effects will generally be small. However, it cannot be excluded that transport increases could lead to reductions in output and closures in a few years unless compensatory measures are introduced. There is therefore reason to choose a cautious introduction of kilometre tax.

Kilometre tax should be differentiated taking into consideration the weight of the vehicle, the number of axles (axle load), and environmental class in accordance with the principles used in our calculations of a marginal-cost based kilometre tax.

We have based our calculations on a weighted average value for marginal costs for driving in rural and urban areas. We recommend that the level for driving in rural areas is used for kilometre tax. The average tax rate for driving in rural areas is estimated at around SEK 1 per kilometre, i.e. SEK 0.40 lower than the weighted average. In other words, this means a relief for transport in sparsely populated regions, compared with the tax rate used in the analyses. The marginal cost for driving in urban areas has been estimated at around SEK 2.80 per kilometre. Internalisation of the external marginal costs of driving in urban areas can be better dealt with by special solutions for metropolitan areas such as congestion tax, environmental zones or similar.

A further step in a cautious introduction of kilometre tax for heavy vehicles could consist of the level being adapted so that energy tax is regarded as part of internalisation. If energy tax on diesel oil is reduced, this will affect the light vehicles using this fuel. Today, the internalisation rate[1] is low for light diesel-driven vehicles, and there is therefore reason to increase the variable cost by increased energy tax (compensated by reduced vehicle tax). A kilometre tax system would be most effective if it covered both heavy and light road vehicles. Pending the inclusion of light vehicles as well, it is possible to increase the internalisation rate for light diesel-driven vehicles by increasing energy tax on diesel oil. However, this solution requires repayment of energy tax to owners of heavy vehicles, if a kilometre tax is introduced.

There may be reasons to make use of kilometre tax to achieve some internalisation of the costs of carbon dioxide emissions. This then assumes that it is still not possible to use other means that are in principle superior, for this internalisation and that carbon dioxide internalisation is removed when these measures are introduced.

Bearing in mind that vehicle tax also plays a part in internalisation, a reduction to the minimum level stated in the EU Road Transport Directive, can be justified.

[1] The portion of external costs covered by variable taxes and charges.

The level of vehicle tax is retained for cars and (other) light vehicles and used as an instrument to internalise external costs which do not depend on the quality of the fuel but on the vehicle.

A cautious introduction of the kilometre tax further assumes that it is not regarded as an instrument for financing in addition to the income resulting from marginal cost adaptation.

In order for it to be justified from the point of view of social efficiency to continue to develop a proposal on marginal-cost based kilometre tax, it is required that the welfare gain of the instrument outweighs the system costs. No calculation of the welfare gain has previously been made. The National Road Authority has calculated the costs for a kilometre tax system with a technically advanced system. Since the social income can be moderate in relation to the costs of a system of this kind, it is important to study simpler solutions.

1 The main points of the commission

The Government has in various contexts stated that a kilometre tax for heavy vehicles may contribute to a sustainable development of the transport sector and to achieving the environmental quality goals. Recently, two transport policy commissions (the Road Traffic Tax Commission and the Goods Transport Delegation) have pointed to kilometre tax as an effective instrument for internalising the external marginal costs of road traffic in accordance with earlier transport policy positions of the Government and the Riksdag. However, both commissions considered that the tax level should be assessed on the basis of competition.

In the Government Bill "*Modern Transport*" (Government Bill 2005/06:160), the Government considers that a kilometre tax will be introduced provided that a tax of this kind will not have unreasonable consequences for regions and industries. The Riksdag has concurred in this assessment. The Government has therefore commissioned SIKA and ITPS to analyse the effect on industries and the consequences for regions of the introduction of a kilometre tax for heavy vehicles.

According to the commission, the analysis is to be based on the work on marginal costs presented in the Road Traffic Tax Commission's final report (SOU 2004:63). The consequence analyses concern a kilometre tax based on the average marginal costs for transport in different areas but also broken down according to transport in and outside larger urban areas. Furthermore, analyses are to be made on the assumption that marginal costs are only covered by a kilometre tax, and taking into consideration that energy tax contributes to internalising marginal costs.

The design of a traffic tax system in other countries is to be regarded from a competition perspective. Special attention is to be given to the effects on Forest, Food Products and the Mining industry. The effect on regions in the sparsely populated parts of the country should be carefully evaluated.

These analyses are to relate to a kilometre tax system that applies to all public roads and private roads within area subject to local plans. The system is to apply to all lorries with a total weight of over 3.5 tonnes which use these roads.

The commission is to result in proposals on a suitable design of the tax and appropriate tax levels and other measures that can soften the effects of a kilometre tax for industries and regions that are particularly sensitive to the imposition of a tax of this kind. Current EC rules must be taken into consideration. The proposals shall contribute to achieving the transport and environmental policy goals to the greatest possible extent. Administration expenses and the effects on central government finances shall be taken into consideration.

2 The role and prerequisites of the kilometre tax

2.1 What are the benefits of a kilometre tax?

One of the basic principles of transport policy is that pricing of transport is to be based on marginal costs for the external effects of traffic. This then above all concerns external costs for accidents, wear and tear on the infrastructure, congestion, emissions of air pollution and noise.

The introduction of a kilometre tax for heavy vehicles would entail several advantages from a control point of view:

- It would provide *better opportunities to internalise the external marginal costs of heavy traffic* and thus over time be able to provide substantial reductions of the social costs of transport by various adaptations.

A kilometre tax for heavy vehicles provides good opportunities for efficient pricing, if the tax is differentiated taking into consideration relevant characteristics of vehicles and where and when the vehicle is driven. This could be done by differentiating the tax taking into consideration the weight of the vehicle, the number of axles, environmental and safety aspects, type of roads, population density along the road, and the time of day.

The kilometre tax can be differentiated according to differences in marginal cost that depend on varying characteristics of the infrastructure. Differentiation with respect to differences in the quality and load capacity of the roads has been less discussed to date than differentiation according to vehicle characteristics. However, considerable benefits may be obtained through differentiation by type of road in terms of reduced costs for re-investments and maintenance/operation.

- It would create *fair terms of competition* between domestic and foreign lorries.

If diesel tax were to be used instead as an instrument for internalisation of the external costs of heavy traffic, this could be partly avoided by refuelling abroad.

- It would provide *improved opportunities for internalising the external marginal costs of diesel cars.*

The energy tax on diesel fuel could be increased to a level that would correspond to the marginal cost of diesel cars. However, this can be separated as an instrument for internalisation of the external marginal costs of diesel cars only if it can be reimbursed to heavy vehicles.

In addition, benefits arise from

- a *fairer international distribution* of tax revenue than what would follow from a corresponding control with the aid of fuel tax.

The distribution of income would comply with the distribution of traffic performance for international goods transport. If fuel tax were to be used as an instrument, this distribution would be more determined by where the vehicle was refuelled, which would be determined to a great extent by where tax was lowest. This benefit is particularly great for countries with a large proportion of transit traffic but is hardly negligible for a country like Sweden.

and from

- income from kilometre tax creating scope for *a reduction in taxes that distort*, in particular on labour, what is known as a dual efficiency gain.

Sometimes, the kilometre tax has also been regarded as an instrument for *financing the road infrastructure*. Thus the Commission on Road Charges on the E6 Highway discussed in its report (SOU 2006:33) the possibility of using a marginal-cost based kilometre tax system by a temporarily increased kilometre tax as regional co-financing of road projects.

In order for it to be socially justified to continue with a proposal on a marginal-cost based kilometre tax, it is necessary that the welfare gain of the instruments outweigh the system costs. No calculation of the welfare gain has been previously made. The National Road Authority has had the costs of a kilometre tax system calculated with a technically advanced solution. Since the income can be moderate in relation to the costs of such a system, it is important to study simpler solutions as well. SIKA has therefore within the framework of the commission produced overview information on welfare gains and system costs, including the costs of a simplified form of Swedish kilometre tax, see Chapter 3 and Chapter 11.

2.2 The goal conflict which is to be clarified

It is usually claimed that the purpose of a marginal-cost based kilometre tax is to achieve a socially efficient use of the road infrastructure. A differentiated kilometre tax can also be expected to lead to a socially more efficient transport economy. The impact of the tax on transport costs can thus be softened by choice of new vehicles (clean vehicles lead to a lower kilometre tax), change to another mode of transport, another choice of route, increased load factor, etc.

However, the introduction of a marginal-tax based kilometre tax also means that the competitive conditions are shifted for businesses in different industries and regions.
In general, a structural transformation is initiated in the direction from industries and regions with high transport costs to industries and regions with low road

transport costs. Some effect on the location, level and composition of production can also be expected, in particular in the long term. This risks coming into conflict with the aim for regional development policy, which is that there are to be well-functioning and sustainable local labour market regions with a good service level in all parts of Sweden. Even if the effects of the long-term structural transformation were considered to be reasonable, the risks remain for considerable adjustment problems in a short- and medium-term perspective. The task is primarily about attempting to anticipate probable effects on industries and regions and recommending appropriate countermeasures to dampen these effects.

It should be underlined here that it cannot be assumed in advance that transport policy should only be formulated on the basis of the requirement of social efficiency (which assumes charging a marginal-cost based kilometre tax), and that any countermeasures should be obtained from other policy areas than transport policy (such as industrial and labour market policy). While there may be strong reasons not to distort the use of resources through permanent subsidies of transport costs, there may be reasons to soften effects on structural transformation of changed transport costs. It is also assumed that transport policy can be designed in such a way as to contribute to positive regional development.

2.3 Kilometre tax in relation to other traffic-related taxes

A road charge (Eurovignette) differentiated according to the number of vehicle axles and exhaust class is levied for heavy lorries and lorry and trailers with a total weight of at least 12 tonnes. This charge, which is levied on Swedish and foreign lorries, is paid for a set period and is thus not related to the distance driven. According to the Eurovignette directive, this charge must terminate if a kilometre tax is introduced (see Chapter 5).

For heavy vehicles, a diesel tax is charged in addition (energy tax + carbon dioxide tax) and a differentiated vehicle tax. The design of these taxes should be viewed in the light of a kilometre tax taking over part of the internalising role of these taxes. This is reflected in the terms of reference of the commission through the analysis including an alternative where consideration is taken to the internalisation of external costs by energy tax. It is assumed in the Road Traffic Tax Commission's report that environmental control of vehicle tax can be removed if a Swedish kilometre tax is introduced and that vehicle tax for heavy goods vehicles can then be reduced to the EU minimum tax level.

Even if vehicle tax for heavy vehicles is now differentiated taking into consideration the environmental aspects of vehicles, the control effect is limited through it being independent of the distance driven. While the energy tax is indirectly linked to the distance driven, it has limitations as an instrument for marginal cost pricing due to the same type of fuel also being used for cars, for which the marginal costs are considerably lower. Compared with both these forms of tax, kilometre tax offers better opportunities for reflecting differences in marginal costs for different vehicles and depending on where and when the vehicle is driven. Another advantage is that a kilometre tax affects all heavy vehicles on Swedish roads, i.e. not only Swedish-registered vehicles.

As regards the emissions of *carbon dioxide* of road traffic, the use of fuel is a better tax base, since carbon dioxide emissions are directly proportional to fuel consumption and the carbon content of the fuel. We have therefore chosen to analyse a kilometre tax that reflects the external marginal costs excluding the cost of carbon dioxide emissions.

A kilometre tax can, even if it is not its main purpose, still be expected to lead to a reduction of carbon dioxide emissions. This should in turn reduce the need for control by instruments that are directly targeted on carbon dioxide emissions.

A carbon dioxide component could be added to the kilometre tax. To be effective, it should in this case be differentiated taking into consideration the carbon dioxide emissions of the vehicle. An advantage of this compared with carbon dioxide tax is that it is not possible to avoid the tax by refuelling abroad. Since carbon dioxide emissions are not included in the definition of environmental classes, it is, however, doubtful whether a differentiation of this kind is compatible with EC rules for road charges.

At present, a proposal is being prepared at the Government Offices for a new tax on vehicle insurance. The proposal entails a proportional tax of 32 per cent on the insurance premium. A tax of this kind has an internalising role with regard to the costs of accidents, without, however providing a clear incentive to adaptations that reduce accident risks. The kilometre tax used in our analyses includes marginal costs for the risks of accidents.

3 Implementation of the commission

To be able to calculate the different kinds of effects ensuing from the introduction of a kilometre tax, an inventory was made at an early stage of the work on what different available model tools could contribute as regards shedding light on the questions taken up in the terms of reference of the commission. This led to the following calculation process being decided upon.

The first step was, based on the marginal costs presented in the report of the Road Traffic Tax Commission, to construct tax schedules where the marginal-cost based kilometre tax is differentiated according to the weight and environmental class of the vehicle. Driving in urban/rural areas is another basis for differentiation in the tables. This is dealt with in section 8.1 and further developed in a special memorandum from SIKA (2007a).

Thereafter, the relative increase of total transport costs (for transport by all modes of transport) for different types of commodities and regions is calculated with the aid of the Samgods model system. This is taken up in section 8.2 and developed further in a special memorandum from SIKA (2007b).

As a third step, production and employment effects are calculated with the aid of a factor demand model. Furthermore, a Salter analysis has been carried out to estimate how large a part of each industry risks having a negative gross profit due to the kilometre tax and thus the short-term effects on production that can be expected. These calculations and analyses are presented in Chapter 9.

The results from the model calculations do not provide direct answers to the questions posed in the commission. An important basis for being able to interpret the results is information on how large a part of the total production costs consists of transport costs. For this, the official statistics have been used complemented with information from representatives of various industries. This is dealt with in Chapter 7.

According to the commission, any needs for and forms of measures to soften the effect of the kilometre tax are also taken up, see Chapter 10. Welfare gains and system costs are taken up in Chapter 11, and a summary calculation of the effects on central government finances in Chapter 12. Finally, Chapter 13 includes recommendations on the design of a kilometre tax based on a number of aspects.

To obtain a foundation for an assessment of whether a kilometre tax is justified in terms of social efficiency, SIKA has commissioned an analysis of Per Kågeson for an overview description of the size of the welfare gain and the system costs for a simplified form of Swedish kilometre tax (Kågeson 2007). This is taken up in Chapter 11.

This commission has been carried out by SIKA and ITPS with SIKA acting as co-ordinator. Consultation has taken place with National Institute of Economic Research, the Swedish Environmental Protection Agency, the Swedish Tax Agency, the National Board of Forestry, the Swedish Board of Agriculture, the Swedish Business Development Agency (Nutek) and the National Road Administration. This consultation has been carried out at four consultation meetings and through the consulted agencies being given the opportunity to submit points of view on the draft text. Some of the agencies consulted have also submitted material to the commission:

- The Tax Agency on administrative costs
- The National Road Agency on system design and system costs
- Nutek on transport subsidies
- The Swedish Environmental Protection Agency on the possibilities of environmental differentiation of the kilometre tax.

Regions and industries and affected agencies have been given the opportunity to insight into and the opportunity to submit points of view on the work by a broadly distributed invitation to a hearing, which took place on 31 January 2007. A number of organisations put forward points of view at the hearing in the form of prepared contributions (The Association of Swedish Engineering Industries, the Swedish Forest Industries Federation, the Federation of Swedish Farmers (LRF), the Swedish International Freight Federation, Scania, the Swedish Society for Nature Conservation). SIKA and ITPS have also had direct contacts with a number of organisations (The Association of Swedish Engineering Industries, Näringslivets Transportråd för transportköpare [The Business Transport Council for Transport Purchasers], the Swedish Forest Industries Federation, the Federation of Swedish Farmers (LRF), Lantmännen, the Swedish Hauliers' Association). In conjunction with the hearing and other contacts, written submissions and other material have been submitted from the Swedish Forest Industries, the Association of Swedish Engineering Industries, the Swedish International Freight Federation, the Swedish Hauliers' Association and the Federation of Swedish Farmers (LRF).

In the course of work, contacts have taken place with other commissions of enquiry which have in some way dealt with kilometre tax for heavy vehicles.

- The National Institute of Economic Research's investigation into the consequences for the forest industry of a kilometre tax (Hammar 2006).
- A proposed kilometre tax from the Swedish Environmental Protection Agency (2007)
- The ARENA project
- Climate, transport and regions (Swedish Environmental Protection Agency 2007).

SIKA and ITPS presented the work on the commission at a session on kilometre tax during the Transport Forum in Linköping in January 2007. On this occasion, the parties concerned were invited to submit supplementary information of interest for the implementation of the commission.

4 The road network, vehicle fleet, traffic performance and taxes

The *length of roads* in the total Swedish road network, amounts to over 420,000 kilometres. Of this, the private road network constitutes 67 per cent, the municipal road network 10 per cent and the state road network 23 per cent. Around 70 per cent of traffic performance with heavy lorries (total weight over 3.5 tonnes) takes place on the state road network. In all, *traffic performance* with heavy vehicles on the state road network amounts to around 4.2 billion vehicle kilometres. Foreign vehicles account for around 10 per cent of this distance (Sundberg 2007).

According to SIKA (2006b), there were over 76,000 *lorries* with a total weight over 3.5 tonnes registered and on the road in Sweden at the end of 2005. The kilometre tax system which is to be analysed shall also include vehicles that are not registered in Sweden. In a documentation memorandum for the commission, the Tax Agency estimates that kilometre tax will be applied to a total of around 100,000 Swedish and foreign vehicles. The *average distance* driven for Swedish-registered heavy vehicles which have been on the road at some time during the year (over 80,000) was around 50,000 kilometres (SIKA 2006d). 10 per cent of the traffic performance of Swedish lorries is international traffic. 24 per cent of the traffic performance within Sweden are empty runs (SIKA 2006c).

According to SIKA's most recent *forecast* (SIKA 2006a), goods transport performance (in tonne kilometres) in Sweden is estimated to increase by 30 per cent between 2001 and 2020. The corresponding transport performance (in vehicle kilometres) is expected to increase by 33 per cent during the same period.

For diesel oil of environmental class 1, *energy tax* is 1.06 per litre and *carbon dioxide tax* 2.66 per litre from 1 January 2007.

Vehicle tax for heavy lorries varies according to weight, towing equipment, the number of axles and exhaust class. Vehicle tax is reduced for vehicles subject to road charges.

For lorries and lorries and trailers with a total weight of at least 12 tonnes, shall (with certain exemptions) pay *road charges* (Eurovignette). The charge varies between SEK 6,831 and SEK 14,117 per year depending on the number of axles and exhaust class. The road charge certificate for foreign vehicles can be purchased by day, week, month or year.

5 The European regulatory framework

5.1 Road charge (Eurovinjette)

The design of the Swedish road charge system is substantially controlled by the current EC rules in this field and by agreements entered into between countries. The provisions on tax on vehicles and the use of infrastructure which are applicable for heavy vehicles are primarily to be found in the Directive of the European Parliament and European Council 1999/62/EC on the charging for heavy goods vehicles for the use of certain infrastructures, known as the Eurovignette directive. This directive was amended in May 2006 by Directive 2006/38/EC. The new directive contains provisions on road tolls, road charges and vehicle taxes for motor vehicles or leading motor vehicle combinations over 3.5 tonnes and consists of four basic principles (T & E 2006):

- The directive establishes that member states are free to decide upon road charges on the national roads.
- The directive contains the rules to be applied by the member states who decide to introduce road changes for vehicles over 3.5 tonnes which are driven on the Trans-European Road Network (TEN).
- Member states are free to introduce road charges for vehicles and roads in addition to the above. In these cases, however, the general rules in the EU treaty apply.
- Income from road charges may not in principle exceed the costs for the infrastructure although there are important exceptions (see below).

The directive specifies the possibilities that individual member states have to introduce road charges and how a system of this kind should be designed. What is new in the new directive is that member states are permitted to levy charges on the *whole road network*, unlike previous version of the directive that only applied to motorways. However, the directive only regulates the rules that apply to the TEN network, beyond that only the national rules apply as long as they do not conflict with the EU treaty (competitive neutrality, promotion of trade, etc,). No demands are made on member states to introduce charges outside the TEN network.

Every member state is also permitted to establish systems to combat congestion and pollution (for example, as has been done in Stockholm with the congestion charge) in addition to the general road charges. Such road charges that are introduced can be differentiated according to the day of the week and time of the day and also according to environmental class (Euroclass) of the vehicle. The road charge is permitted to vary by 100 per cent for every factor so that a lorry in Euroclass 0 (the highest emission level) which is driven a particular distance on

Monday morning during rush hour pays four times as much as a lorry of Euroclass 5 (the lowest emission level) which is driven the same route on a Sunday afternoon when the traffic is light. After 2010, the principle also applies that member states must differentiate according to environmental class with certain exceptions.

Furthermore, the directive states that the countries that implement a road charge after 2012 must include *all vehicles over 3.5 tonnes (total weight)* driven on the TEN road network, unlike the earlier directive where the requirement only applied to vehicles over 12 tonnes. Until 2012, it is, however, still voluntary to include vehicles between 3.5 and 12 tonnes in a charge system. There are two exceptions to this requirement:

1. If inclusion of vehicles under 12 tonnes has a negative effect on the traffic flow, the environment, noise or health, and
2. If the administrative costs exceed 30 per cent of the additional income.

In mountainous areas and other sensitive environments, it is permitted to apply a mark-up to the charge of up to 25 per cent, provided that the additional income is used for investments in the TEN network in the region. However, there is no requirement for earmarking other income, as was the case in previous versions of the directive. However, it is recommended that money is invested to support the transport sector and to make the whole transport system more efficient.

The directive also stipulates the maximum levels for how much road charges may cost per year. At present, the maximum levels only apply to vehicles of Euroclass 0, 1 and 2 (the "worst" classes) while after 1 January 2008, all classes and included and the charge will then be limited to the amounts in the table below. The maximum charge per day is now EUR 8 although after 1 January 2008, this will be increased to EUR 11. The annual maximum charges will be increased at the same time.

Table 5.1. Annual maximum charges for road charges after 1 January 2008 according to the Eurovignette directive Source: Council Directive 2006/38:EC

Euroclass	*Up to three axles*	*Four or more axles*
0	1,332	2,233
1	1,158	1,933
2	1,008	1,681
3	876	1,461
4 and over	792	1,329

Finally, the directive underlines the importance of the member states which introduce road charges ensuring that implementation is as problem-free as possible for all those involved and that monitoring and application is as efficient as possible.

The change in the Eurovignette directive accordingly means that member states can decide themselves on road charges on the whole national road network. The

directive provides scope for introducing a kilometre tax which is differentiated to take into consideration environmental class, location, time, and degree of overloading. The directive also stipulates how much road charges may cost for different types of vehicle per year. If a kilometre tax is introduced, the present Eurovignette cannot be charged at the same time but must be terminated. Another limitation in the Eurovignette directive is that the income from road charges (with some exceptions) may not exceed the costs for the infrastructure. No basis is available to estimate the level at which this ceiling would be in the case of Sweden.

5.2 Vehicle tax

The above description concerns the principles that control taxation of road use. In Chapter 2 of the existing Eurovignette directive (1999/62/EC), the rules are stipulated that determine the possibilities for taxing vehicles by a special vehicle tax. A basic rule is that every vehicle should only be taxed in the country where it is registered. The additional provisions stipulate in the first place minimum levels which *must be charged* by a member state. The minimum levels vary between different types of vehicle and are determined by the number of axles the vehicle has and its permitted gross weight. Some examples are shown in the table below.

Table 5.2. Minimum tax classes for motor vehicles and vehicle combinations according to Directive 1999/62/EC

Maximum permissible gross laden weight in tonnes		*No. of axles*	*Minimum rates of tax (EUR per year).*	
not less than	*less than*		*Driving axle(s) with air suspension or recognised equivalent*	*Other driving-axle(s) suspension systems*
15	18	2	121	274
25	26	3	222	345
31	32	4	362	537
36	38	2+2	465	706
38	40	2+3	515	700
40	44	3+3	336	535

5.3 Energy tax

In addition to the Eurovignette directive, there are also rules that set limits for what is permitted in the field of transport policy in the European Parliament and Commission Directive 2003/96/EC on restructuring the community framework for the taxation of energy products and electricity. This directive stipulates among other things that every member state is free, provided that the tax is not less than the minimum level (see Table 5.3) to itself decide upon the tax rates that are to apply to products used for motor vehicle or fuels for heating and electricity. The current minimum levels came into force on 1 January 2003 and apply until 1

January 2010, whereupon new rules that have already been decided upon apply. Thereafter a new decision will be needed for the period after 1 January 2013. Table 5.3 shows the minimum tax levels that apply for motor fuel.

The minimum level for diesel oil will thus be increased after 2010 to EUR 330 per 1,000 litres, which corresponds to SEK 2.98 per litre (at an exchange rate 9.03). Today (March 2007), diesel tax in Sweden is SEK 3.72 per litre.

Differentiation of tax on fuel is permitted in certain circumstances, for instance, linked to the quality of the product and when the differentiated tax rates are based on quantitative consumption levels of electricity and energy products which are used for heating. Differentiation is also permitted for certain specific areas of use, among others, local public transport (including taxis), waste management, defence and public administration, disabled persons and for ambulance transport and between vocational and non-vocational use of energy products and electricity. Products used within the pilot project for technical development of more environmentally friendly products and fuels from renewable energy sources may be wholly exempted from tax according to the directive.

In addition to this, certain member states have been granted permission during a transitional period to apply reduced tax levels, among them Germany, France and Belgium. However, it is extremely doubtful whether the Commission would approve reduced fuel tax only for certain industries or regions, since this could be regarded as a form of government assistance. In all circumstances, the region would be obliged to send advance notice to the Commission before introducing this kind of measure. For a more detailed examination of the energy tax directive and its significance for introduction of a kilometre tax in Sweden, see Chapter 5 of the Road Traffic Tax Commission Report (SOU 2004:63) or the EU Commission's website (http://eur-lex.europa.eu/sv/index.htm).

Table 5.3. Minimum tax levels for motor fuels. Source: Council Directive 2003/96, Annex 1

	1 January 2004	*1 January 2010*
Leaded petrol (EUR per thousand litres)	421	421
Unleaded petrol (EUR per thousand litres)	359	359
Diesel fuel (EUR per thousand litres)	302	330
Natural gas (EUR per gigajoule gross added value)	2.6	2.6
Diesel fuel for special purposes* (EUR per thousand litres)	21	21
Natural gas for special purposes* (EUR per gigajoule gross added value)	0.3	0.3

* Special purposes refers to agriculture, horticulture, fish cultivation, and forestry, stationary engines, mechanical equipment in construction and public works and vehicles that are not intended to be used on public roads.

5.4 Exhaust emissions

The EU exhaust emission directive for heavy vehicle engines (1999/96/EC) contains rules on how tax may be differentiated in relation to environmental classes. The principle is that tax reduction for new vehicles may take place in relation to a set requirement level which is not yet compulsory during the period until it becomes compulsory. The Road Traffic Tax Commission report proposed the change that now applies to vehicle tax where these requirement levels are given different tax rates. The kilometre tax proposal is constructed in the same way, with lower tax for a better environmental class.

5.5 Harmonisation

In the white paper on European transport policy until 2010, there are clear goals for flexibility and safety in traffic. An important component in this is well-functioning systems for payment of road charges that are compatible between countries. Today, most countries which have introduced some form of electronic road toll system or which have introduced electronic charge payment for use of the road network use different variants (i.e. different wavelengths) of microwave technology for short distances (DSRC). However, these different systems are not wholly compatible, which means that users who travel in different countries have to install several different types of apparatus in their vehicles to comply with the law. This is, of course, unnecessarily expensive and inefficient and constitutes an artificial obstacle for the functioning of the internal market.

In the light of this, the directive of the European parliament and Commission 2004/52/EC of 29 April 2004 was drafted on interoperability of electronic fee collection systems in the Community. It is established here that a European system for electronic road tolls is to be established. The directive also points to three technical solutions which are considered to be most suitable for inclusion in this system

- Satellite-based position location
- Mobile communication according to the GSM/GPRS standard
- DSRC with 5.8 GHz microwaves

The countries that introduce electronic road charge systems after adoption of the directive but prior to 1 January 2007 are *urged* to use one of these three. After this date, one or more of them *must* be used for road toll transactions. Furthermore, member states must ensure that personal integrity is maintained in connection with treatment of personal particulars, in accordance with Community provisions on protection of the rights and privileges of natural persons, including the right to a private life (see Directives 95/46/EC and 2002/58/EC).

On 30 November 2006, the Swedish government presented a bill to the Riksdag on introduction of legislation on an electronic road charge system in accordance with the provisions in the EU directive (Government Bill 2006/07:25). To sum up, the law provides that:

"electronic road charge systems of this kind which are taken into commission after 28 February 2007 shall comply with certain technical requirements (specified in the Directive). The intention is to secure technical standards for electronic road charge systems. Electronic road charge system means systems which are used for electronic payment of charges that are levied for journeys with motor vehicles on roads or on road ferries".

The Bill also includes a proposal on an agency to supervise implementation of the legislation.

6 International experiences

There has been some kind of kilometre tax for heavy vehicles for some time in three European countries, Switzerland, Austria and Germany. Table 6 shows an overview with various information about these systems.

Table 6.1. Kilometre systems in Switzerland, Austria and Germany – design, income and expenses. Source: Presentation material from ECMT's conference on road charges of 1 June 2006, supplemented with updates from the respective country's responsible agencies/organisations (see reference list).

	Switzerland	Austria	Germany
Start of operations	2001	2004	2005
Road network with charges	All roads	Motorways and some other main roads	Motorways and certain main roads
Vehicles subject to charges	HGV > 3.5 tonnes	HGV > 3.5 tonnes	HGV > 12 tonnes
Grounds for differentiation	- distance -weight - emission class	- distance - axles	- distance - axles - emission class
Technical solution	GPS/DPRC after manual input	DSRC (compulsory OBU)	GPS/GSM after manual booking
Investment cost	EUR 240m	EUR 370m	No information
Operating cost	EUR 35m per year	EUR 35m per year	EUR 620m per year
Average kilometre tax level EUR/vehicle km (40 tonne lorry)	0.67*	0.22	0.12
Average cost for transport example (300 km)	SEK 1,259	SEK 501	SEK 318
Income	EUR 800m/year	EUR 770m/year	EUR 3,000m/year
Costs as % of income	5-7	10-12	20-22

** According to the calculation by Gustafsson et al (2000)*

At the turn of the year 2006/07, a similar system was also introduced in the Czech Republic. Introduction is being discussed in a number of other countries. In addition, there is a long list of countries that use other forms of road charges and tolls for, for instance, particular stretches of road or bridges for both goods and passenger vehicles. However, these are outside the scope of this review. In the following section, a brief description is provided of the reasons behind, solutions and effects with regard to kilometre taxes which are used today in Europe or which are planned to be introduced in the near future.

6.1 Switzerland

Switzerland was the first country in Europe and the world to introduce a successful electronic driving distance-based charging system. This system, known as LSVA (Leistungsabhaengige Schwerverkehrabgabe) was commissioned in January 2001 and means that all transport vehicles over 3.5 tonnes are to pay a charge on all roads in the Swiss road network. In the past decades, two trends have characterised the development of goods transport in Europe: the total quantity is growing rapidly and an increasing large proportion of transport takes place by road (Rapp and Balmer 2003).

This means increased costs for road construction and maintenance and also an increased burden on the environment, more accidents, increased congestion and increased noise. At the end of the 90s, the Swiss population expressed a desire in a number of opinion polls to change this development by gradually transferring goods from the roads to railways. In autumn 1998, approval was given in a referendum by a broad margin to introduce the current system (LSVA) and two-thirds of the income from the transport system was to be used to finance new rail construction and modernisation. The investment in the rail system at the same time as the charge was introduced was crucial for the broad acceptance of the proposal (Rapp and Balmer 2003).

Other factors also played an important role in the initial phase of the process, for instance, certain special characteristics of the Swiss political system, the simplicity of the solution adopted, the choice of an experience and committed operator (the Swiss Customs) and not least what is referred to as “the window of opportunity”, Swiss public authorities consider that one cannot sufficiently emphasise the importance of choosing the right opportunity to push through such a sensitive project as the introduction of kilometre tax and that preparations for this occasion must be very careful so that no mistakes are made when the situation is crucial (Balmer 2005).

As in Sweden, there was widespread concern in Switzerland about the potential negative effects of a kilometre tax for certain industries and regions. According to information from Ueli Balmer at the federal agency for infrastructure planning, ARE (Federal Office for Spatial Development), there was in the long run no scientific basis for this concern although agencies regarded it as of overarching importance to obtain as high acceptance as possible and therefore introduced a number of supporting measures for certain sensitive industries and regions. These broadly meant that cantons with sensitive/mountainous regions receive a larger share of the total income and that milk and timber transport pay a lower charge than other transport. Agricultural transport is moreover wholly exempted from the charge. It should be added that the cantons that receive additional support are not obliged to pass these on to regions that are considered as being sensitive but are free to decide themselves how the resources should be used.

Besides public opinion, the Swiss charge system has, according to the federal agency for environment, transport, energy and communication (DETEC), a number of economic/financial motives. This applies above all to the aforesaid general cost increases for maintenance and extension of the road network but also

to more specific projects such as the new rail tunnel system NEAT (New Alpine Rail Transversal) which will play a crucial part in the future European transport system. In addition, there was a need to compensate for the increase in traffic and cost which an increase in the vehicle weight restriction, a compromise in transport negotiations in the EU, from 28 to 40 tonnes is expected to entail (DETEC and ARE 2004).

LSVA has three main aims:

- to limit the increase of lorry traffic on the Swiss roads,
- to favour transfer of traffic from roads to railways,
- to internalise the external costs of transport (mainly environmentally-related costs)

In order for these to be met, it is required that the level of charges should be determined in a correct way and that control of the vehicles subject to payment and transport is effective. As mentioned above, LSVA applies to goods vehicles with a weight exceeding 3.5 tonnes and the charge is paid according to three criteria:

- the number of kilometres driven on Swiss roads
- the highest permitted total weight (including load)
- the vehicle's emission of pollution

It is important to note that it is not the vehicle's actual weight or load that is crucial but the maximum permitted weight including load according to the vehicle's registration certificate. A system where the weight of each individual vehicle had to be registered would be very complicated to use. The solution chosen also encourages hauliers to choose the solution of sing the vehicle's load capacity fully and to avoid empty runs.

The charge is thus determined by the transport distance (in kilometres), which is multiplied by the registered weight and the set charge which is differentiated with respect to the vehicle's environmental performance according to three environmental criteria (see table below). Detailed cost calculations carried out by ARE serve as the basis for the charge levels (see ARE's website). On 1 January 2005, the level of charges was increased, among other reasons, to compensate for the adjustment of the weight limitation (DETEC and ARE 2004).

Table 6.2. Charge per tonne km in the Swiss system differentiated according to environmental class (2006) Source: DETEC

Charge category	*Charge per tonne km*	
	CHF	*SEK**
I (corresponds to EURO 0-1)	*0.0288*	*0.1699*
II (EURO 2)	*0.0252*	*0.1487*
III (EURO 3 to 5)	*0.0215*	*0.1269*

** Note: According to exchange rate (SEK/CHF in August 2006)*

Examples of what different types of transport pay in kilometre charge are shown in the table below. The amount varies greatly depending on the size and environmental class of the vehicle, which is also the intention with a marginal-cost based tax system. There is also an important exception to the kilometre charge which consists of the fixed charge paid by buses/coaches and caravans/cars. This charge only varies with the vehicle's weight and amounts to at most CHF 4,000 per year, which is considerably less than the average amount paid by vehicles to LSVA.

Table 6.3. Examples of charges in Switzerland for different types of vehicles and a distance of 300 km. Source: DETEC

CHF							
Charge level (environmental class)				*Freight distance (km)*		*Vehicle*	*Charge in CHF*
1	*2*	*3*					
0.0288			*	300	*	Lorry without trailer	*18 tonnes	155,50 (= SEK 917)
	0.0252		*	300	*	Lorry with trailer	*30 tonnes	226,80 (=SEK1,338.12)
		0.0215	*	300	*	Lorry with trailer, 37 tonnes	*40 tonnes	258,00 (=SEK1,522.2)

Pricing is part of a successful kilometre tax system, payment control another. In the Swiss system, control and collection of data that determines the charges takes place in an electronic system consisting of a number of collaborating parts. Every vehicle is equipped with what is known as an "on-board unit" (OBU) which registers the distance driven and which is automatically switched on and off by special DSRC sensors erected over the road when the vehicle passes the Swiss frontier. All information about the weight and environmental class of the vehicle is stored in the OBU. Every month, the operator sends the data collected to the customs authority, either by posting them on a special memory card or directly on the Internet. The customs agency examines and when necessary changes the information and invoices the operator for the charge calculated.

The system has largely been a success in its almost five years of operation. The growth of traffic has been slowed down and some adaptation of the vehicle fleet to vehicles with better environmental performance and more effective use of the load capacity can be seen. Up to 2007, emissions of carbon dioxide and nitrogen fell by six to eight per cent compared with earlier systems. The anticipated increase in vehicles of over 28 tonnes after the increase in the maximum permitted weight has in principle not taken place. Despite kilometre tax being used by hauliers to justify increased transport costs, prices for the consumer have only been marginally affected. However, transport by rail has not increased to any significant extent, although bearing in mind the already record high share of rail transport (1/3 of the total tonne km and 2/3 of the trans-alp traffic), the short time

since the introduction of the system and the large railway projects that are still not completed, this is not particularly surprising. (DETEC and ARE 2004). The most important factors for this success are considered to be (SOU 2004:63):

- A well prepared transport plan was available
- There was a good legal basis for the system
- Transport statistics as a basis for calculations of costs and income were available
- Constructive negotiations with the European Commission.

Table 6.1 shows some of the details concerning the LSVA system's costs, income and daily operation. As can be seen, LSVA generates substantial income and the operating and collection costs only amount to between 5 and 7 per cent of these annually.

To sum up, some of the foremost experiences from the process in Switzerland are as follows (Balmer 2005):

1. The traffic situation must be considered by the public as being a problem and in need of improvements for the introduction of a kilometre tax to be possible.
2. The solution to the problem must be simple to understand and relatively uncomplicated to administer.
3. Acceptance for a road tax can increase markedly if income is earmarked for improvements in the infrastructure and investments in other modes of transport (railway).
4. The technical solution should be developed at an early stage and should be as simple as possible to start with and then be gradually developed.
5. The best proposal will fail if the political situation is not suitable. Make use of the "window of opportunity" when it occurs!

6.2 Austria

In January 2004, a new system for kilometre-based road charges was taken into use after the previous Ecopoint system was discontinued. The new system, GO-Maut, applies to all vehicles over 3.5 tonnes and applies on all motorways and on certain other parts of the road system. It is noteworthy that all vehicles over 3.5 tonnes are liable to pay not just goods vehicles as in Switzerland and Germany (see below). Buses/coaches and heavy caravans are accordingly subject to kilometre tax in Austria. The new charges are levied in addition to the existing charges (for instance, the Eurovignette) which also deviates from the solution adopted in the other two countries and means that the total costs for road charges is considerably higher in Austria than in Germany (Einbock 2006).

The state-owned company Austrian Motorway Company, ASFINAG, was responsible for design and implementation of the system and is also responsible for collection of charges, operation and maintenance. According to ASFINAG's information, kilometre tax generates around EUR 770m annually in extra income, which together with other road charge income is earmarked for maintenance and extension of the road network. The total investment cost was EUR 370m and

maintenance and operation costs around EUR 35m per year. Costs thus correspond to between 10-12 per cent of income, almost double as much as in the Swiss system.

The charge is differentiated with respect to the number of axles (see table below), but no distinction is made between vehicles with different environmental performance or different weights (this is captured indirectly though the axle number differentiation). This is due to the charge not primarily being to internalise the external costs of transport, which is the case in both Germany and Switzerland. However, a discussion is under way in Austria on expansion of the system in future with a differentiation according to environmental performance (Einbock 2006). The charges levied are shown in the table below (technically the charge is not considered to be a tax in the Austrian system and 20 per cent value-added tax is therefore payable in addition to the amounts in the table).

Table 6.4. Charges on Austrian motorways differentiated according to the number of axles, EUR/km respective SEK/km* Source: Road Traffic Tax Commission Report (SOU 2004:63)

Category 2 (2 axles)		*Category 3 (3 axles)*		*Category 4 (4+ axles)*	
EUR	*SEK*	*EUR*	*SEK*	*EUR*	*SEK*
0.1300	1.1973	0.1820	1.6762	0.2730	2.5143

* The exchange rate SEK/EUR was around 9.21 in August 2006.

Table 6.5. Examples of charges for a journey from Vienna to Salzburg (298 km) in EUR and SEK for different categories of vehicles. Source: wwww.go-maut.at and own calculations.

Category 2		*Category 3*		*Category 4*	
EUR	*SEK*	*EUR*	*SEK*	*EUR*	*SEK*
36.10	332.481	50.90	468.789	76.20	701.802

The average charge level is EUR 0.22/km although higher charges are levied on certain stretches of road, where the infrastructure costs are higher (for instance, certain roads over the alps). There is a tool (Toll calculator) on the GO-system's website (www.go-maut.at) which calculates what the total cost will be for journeys to between different places. According to this tool, a journey from Vienna to Salzburg, for instance (298 km and about 3½ hours) would cost between EUR 36.10 and EUR 76.20 depending on type of vehicle.

Registration of the distance driven by each vehicle is taken care of wholly electronically via obligatory OBU's (called GO box) and a nationwide system of microwave sensors (DSRCs) which are located at every road junction. The distance and the vehicle's characteristics are registered in the GO box and the operator can choose between two systems for payment of the estimated total charge.The operator either pays the journey in advance by "loading" the GO box with an optional amount between EUR 50 and 500 from which the charges are automatically deducted. This is suitable for those who do not use the road network

on which charges are levied particularly often. The other alternative means that the operator registers in the system and pays in the amount established by ASFINAG afterwards from a designated account on the Internet or special pay stations. Around 85 per cent of the transactions take place through the latter alternative.

A great advantage of the GO system is that it is compatible with similar systems in the first place in Switzerland but work is in process to expand interoperability to Italy, Slovenia and France as well. After updating of the German OBU, it is expected to also be able to include Germany in the multinational system. The issue of interoperability is discussed in more detail below.

Since the Austrian system has been in operation for a relatively short period, it is still not possible to definitely survey its effects. One comment is that the foremost goal of the GO-maut is to generate income for infrastructure investments and maintenance, which must be considered as having been fulfilled (see Table 6.1 above). However, it is still not clear how the traffic volume has been affected by the kilometre tax. One effect which can be seen is an improvement in the efficiency of road transport and the logistics sector as a result of many companies making an effort to avoid empty runs. A side effect of this is that many small companies have disappeared from the market in favour of larger firms. In Austria, only certain parts of the road network are subject to tax, which has created an incentive for hauliers to avoid these sections leading to consequent overuse of parallel routes. Steps have been taken to avoid this, for instance, prohibitions against lorry traffic have been introduced in some areas.

In 2006, a study of the effects of the GO-maut system for businesses in Austria was published (Einbock 2006). This study is largely based on a questionnaire from autumn 2003, thus four months before the system was commissioned, of the expected cost and competitiveness effects on enterprises. A distinction is made between direct and indirect effects of the kilometre tax, where the direct effect is the actual charge and the indirect effect various administrative and risk-related costs. The conclusion of the study is that the direct and indirect tax costs lead to higher transport costs, although the effects differ between industries and regions (although more between industries than between regions). It is reasonable to assume that the kilometre tax has the largest effect in industries with a high transport cost component such as the Logistics sector and the Earth and Stone industry. In the former, the expected increase in transport costs is 17.7 per cent and in the latter 14.2 per cent. The smallest increase, 9.3 per cent, as expected in the construction sector (Einbock, 2006).

The differences were smaller between regions and only one region, Northern Austria, deviated significantly from the others with an average estimated increase in costs of 13.6 per cent compared with between 11 and 12 per cent for the others. Despite relatively significant increases in transport costs, it is estimated in the study that final consumer prices will only increase marginally, at most by 0.63 per cent. One explanation of this is that most enterprises state that they cannot increase prices without losing a large part of demand, which indicates that they are operating on markets with relatively well functioning competition and price pressure. The effect will thus be are reduced profit margin for producers.

However, Einbock points out that many companies can be expected to adapt to reduce costs, both direct and indirect. Examples of such adaptations are *changed vehicle fleet,* working out new more efficient strategies for the logistics system. This may, for instance, entail changed frequencies of delivery, a changeover to regional deliveries, limitations of supplies to metropolitan areas or that companies review their location situation.

6.3 Germany

Germany left the Eurovignette collaboration (see above), in August 2003, before the planned start of a national kilometre tax system for heavy lorries (LKW-Maut). However, the introduction of the system has been accompanied by a number of technical problems that have greatly delayed the starting date from the date originally planned, 2003, to January 2005.

The starting point for the changeover from Eurovignette to the present system in Germany was the insight that something had to be done to meet the increased external costs caused by increased heavy goods traffic. Germany's character as a transit country means that a great part of the external costs are moreover not created by domestic hauliers. With a kilometre tax for all vehicles on German roads, it was hoped to also capture the costs caused by foreign hauliers.

Germany is also special due to the size of its population and the enormous quantities, both domestic and foreign, of vehicles on its roads. According to the federal transport authority, (BMVBS, Bundeministerium für Verkehr, Bau und Stadtentwicklung.), around 1.5 million heavy lorries circulate on the German roads every year and clock up a total distance of around 22.7 billion kilometres. The total costs for maintenance of the infrastructure which can be attributed to heavy traffic amount to EUR 3.4 billion annually (Schultz 2006). With the previous system (Eurovignette combined with various taxes and tolls), only a small part of these costs was internationalised by the transport sector, leading to overuse. By pricing transport according to the social marginal costs, the "user pays" principle, it was desired to achieve a more efficient use of the infrastructure. At the same time, it was desired to reduce emissions and achieve a fairer competitive situation between road and rail transport.

The German kilometre tax system differs from the Swiss on a couple of points. For instance, "heavy" traffic has been defined in Germany as all vehicles over 12 tonnes (compared with 3.5 tonnes in Switzerland) with differentiation according to the number of axles and exhaust emissions. The table below shows that division into vehicle categories used in Germany. In the future, it will also be possible to differentiate according to location and time. An additional difference is the scope of the system. In Germany, the fee is only charged for transport on motorways, not as in Switzerland on the entire road network.

Table 6.6. The German division into vehicle categories.
Source: Road Traffic Tax Commission Report (SOU 2004:63)

	Category A	*Category B*	*Category C*
- 30.09.2006	EURO 4-5 and EEV class 1	EURO 2-3	EURO 0-1 and vehicles which do not belong to any exhaust class
1.10.2006-30.09.2006	EURO 5 and EEV class 1	EURO 3-4	EURO 0-2 and vehicles which do not belong to any exhaust class
1.10.2009-	EEV class 1	EURO 4-5	EURO 0-2 and vehicles which do not belong to any exhaust class

The maut for the individual vehicle is thus paid according to the distance travelled on the roads charged for, multiplied by the relevant charge. This is in turn determined by the number of axles and the vehicle's exhaust class. On average, the charge is EUR 0.124/km but depending on the vehicle's characteristics it varies between EUR 0.09 and EUR 0.14/km (see table below).

Table 6.7. Kilometre tax on German motorways differentiated according to number of axles and environmental class. Source: Source: Road Traffic Tax Commission Report (SOU 2004:63)

No of axles of the vehicles	*Category A*		*Category B*		*Category C*	
	EUR	SEK*	EUR*	SEK	EUR	SEK*
At most four axles	0.09	0.83	0.11	1.01	0.13	1.20
Four or more axles	0.10	0.92	0.12	1.11	0.14	1.29

* According to the exchange rate in August 2006

To achieve comparability, the charges calculated by ITPS are shown below for the various categories of vehicles for a distance of 300 km.

Table 6.8. Examples of charges in Germany for a distance of 300 km in EUR and SEK for different vehicle categories.

No of axles of the vehicles	*Category A*		*Category B*		*Category C*	
	EUR	SEK*	EUR*	SEK	EUR	SEK*
At most four axles	27.0	248.7	33.0	303.9	39	359.2
Four or more axles	30.0	276.3	36.0	331.6	42	386.8

There are three alternatives for registration of the distance driven in Toll Collect's system: automatically via a built-in charge calculator, On-Board Unit (OBU), manually via the special road charge terminals and manually via Internet.

The automatic alternative means that the vehicle and its drivers are registered at Toll Collect, and the vehicle is then equipped with an OBU that registers the distance driven with the aid of a global positioning system (GPS) and other complementary microwave sensors (DSRC). The operator also inputs information into the OBU on the vehicle's exhaust class and the number of axles and on the basis of this the unit calculates the correct charge and subsequently sends this information through the GSM network to Toll Collect's data centre in coded form. The amount established is then withdrawn from the account registered by the operator.

The manual alternative consists of a booking system where the operator "purchases" a certain number of kilometres distance driven on the German road network through the Internet. Random checks (both automatic and manual) and fines of up to EUR 20,000 for breaches have been introduced to minimise incorrect information with great success. Almost 90 per cent of transactions take place through the automatic system, which is also the most cost-effective (BAG 2006).

The cost for operation and maintenance of the system is EUR 620 million annually (almost 20 times more than the Swiss system), of which a large part is for the almost 1,300 employees. The charges generate a total of around EUR 3 billion per year in income (EUR 2.86 billion in 2005), which means that costs correspond to around 20 per cent of income (compared with 5-7 per cent in Switzerland).

Since the German LKW-Maut at the time of writing has only been in operation for just over two years, it is too early to draw any far-reaching conclusions about the results. However, there are certain tendencies that point towards the system being successful in achieving the targets to date. The number of loaded runs has increased by 2.1 per cent to total 82.1 per cent while the number of empty runs has diminished by around 15 per cent. The railway has also experienced an increased quantity of transport of around 7 per cent (Schultz 2006).

6.4 Effects of kilometre tax in Europe

To date certain general effects can be identified from the introduction of kilometre taxes in the three countries (this review has been largely taken from T & E 2006, see list of references).

- Vehicle kilometres: In Switzerland, a sharp annual rise in the number of vehicle kilometres in the past three decades has clearly slackened off. The first year after the introduction of the kilometre tax, traffic decreased by around 5 per cent. Part of this fall can be explained by a downward trend in the economy in particular during the years when the tax was introduced, although,

according to Swiss sources, the kilometre tax probably played an important part. In Germany and Austria, it is still too early to draw any definite conclusions, but there are also tendencies in this direction here.

- The road transport and logistics sector: In all three countries, the sector has become more efficient, although the trend is strongest in Switzerland. Companies make efforts to avoid empty runs, in among ways by collaborating with other companies. Many small and medium-sized actors have disappeared in favour of larger more efficient enterprises.

- The vehicle fleet: In Germany and Switzerland, a change has taken place in the composition of the vehicle fleet, towards smaller and more environmentally friendly alternatives. In 2000, sales of new transport vehicles increased sharply in Switzerland in the run-up to the introduction of the tax and since the tax was introduced in Germany, sale of vehicles with a maximum weight of 10-12 tonnes has increased by 20 per cent. In Austria where the charge is not differentiated by environmental class, this development has not been seen.

- Emissions: In Switzerland, model calculations have been carried out which indicate a reduced emissions of carbon dioxide and nitrous oxides by around 6-8 per cent as a consequence of carbon dioxide tax. There are no ready calculations of this type in other countries.

- Changed traffic flows: In Austria and Germany, where only parts of the road network are charged for, a considerable part of hauliers try to avoid payment by changing their routes to the “free” roads. The authorities have attempted to prevent this by introducing prohibitions against lorries on certain roads and in Germany the charge road network was expanded in 2006 with the addition of three roads. In certain cases, traffic flows have moved across country borders, as for instance in the French region of Alsace where the heavy traffic has increased by 20 per cent since charges were introduced on German roads onto the other side of the border. Also in Switzerland where the whole network is “charged for” route selection effects have been registered and traffic has to some extent “spilled over” to neighbouring countries.

- Modal shift: There are few signs to indicate any substantial transfer between roads and other modes of transport. In Germany, however, higher growth has been noted for rail transport than for road transport since the Maut was introduced.

- Consumer prices: Consumer prices have not been noticeably affected to date in any of the countries.

- Effects on other industry: According to estimates from German authorities[2], the kilometre tax has continued to small price rises of certain products: 0.16 per cent for timber and wood products, 0.10 per cent on pulp and paper, 0.09

[2] Information from BMVBS, http://www.bmvbs.de/-, 1436.22466/Weitere-Informationen-zur-Lkw-.htm#10

per cent on food, and 0.11 per cent on tobacco. On average, the price rise due to kilometre tax is 0.15 per cent, i.e. relatively marginal. No studies have been made about the effects on industry otherwise in the form of employment and output. One major difficulty has been that it has not been possible to distinguish effects on output and employment of kilometre tax from other important determining factors such as energy prices, fuel prices (diesel), and important macroeconomic variables.

- Regional effects: A discussion has been introduced in all countries around this problem. There has been concern in Germany and Switzerland that remote regions would be harder hit by the kilometre tax than more centrally located regions. In Switzerland, an equalisation system has been introduced (see above) to compensate certain areas of the country where it could be anticipated that they would experience a negative development. No concrete studies have been made, however, in this area in any of the countries.

Table 6.9 Effects of kilometre taxes in Europe. Source: Gustafsson et al. 2006

Effects	*Switzerland*	*Austria*	*Germany*
Choice of road	No effects. Charges on all roads.	Some tendencies to redirection of traffic to secondary roads which are not charged for. Around 2-3 per cent increase in traffic on these secondary roads	Some tendencies to redirection of traffic to secondary roads where non-charge roads run parallel to motorways, have motorway standard and do not entail considerable delays. Around 6.6 per cent increase in traffic on secondary roads
Modal Split	A lot of small effects, partly due to the increase in the weight ceiling for lorries	Limited effects	Small effects overall although some tendencies among medium-sized hauliers (+3.1 per cent rail transport)
Logistics	Concentration in transport sector. Fewer empty runs	Reorganisation and efficiency improvement in transport sector	Increased efficiency in transport sector. Reduction of empty runs by 15 per cent.
Vehicle fleet	Adaptation of fleet towards cleaner vehicles and weight and size optimisation (upwards or downwards according to customer requirements)	No differentiation between different vehicle types (besides the number of axles)	Increased interest for Euro 5-classified vehicles

6.5 Experiences from other countries, some examples

Switzerland, Austria and Germany are the three countries which have to date introduced a nationwide kilometre tax system, although there are plans for similar solutions in a number of other countries. It is noteworthy that neither Denmark nor Finland has any plans to introduce distance-based vehicle taxes (T&E 2006).

The Czech Republic

A kilometre tax was introduced for heavy traffic in the Czech Republic from 1 January 2007. The system in the Czech Republic is substantially the same as in Austria: It only applies on motorways, is based on microwave technology and differentiated only in respect of vehicle weight and number of axles. However, heavy vehicles are defined as those with a weight exceeding 12 tonnes. Discussions are in process on gradually extending the system so as to also apply to secondary routes and also be complemented with a more advanced solution for position determination, in line with the technology used in Switzerland. It is still to early to say anything about the effects that the kilometre tax in the Czech Republic will have, although the Czech Republic is a transit country like the three countries where the system is already operating (and unlike Sweden). A large part of the traffic on the Czech roads is of foreign origin and these hauliers do not pay for the full extent for the congestion and wear and tear that they cause. The kilometre tax is thus a tool to obtain resources for extension and maintenance of the road network.

Denmark

Denmark, like Sweden, participates in the Eurovinjett collaboration, which means that foreign vehicles have to pay a charge for transport on the Danish motorways. Only vehicles over 12 tonnes are included and the charge depends on the time transport work takes place within the Danish frontiers, the environmental class of the vehicle and how many axles it has. The charge itself is paid before travel on a charge road starts by purchase of a special road charge certificate. This certificate can be purchased for a day, week, month or year and must accompany the vehicle on every journey. If the driver cannot show a charge certificate when checked by the police, a fine will be imposed. The cost of an annual certificate varies between DKK 5,591 for a vehicle in Euroclass 2 with three axles to DKK 11,555 for a vehicle of Euroclass 0 with four or more axles. The monthly and weekly certificates vary in as similar way while a daily certificate costs DKK 59 regardless of the environmental class and the number of axles of the vehicle.

In Denmark, there are a number of separate road charges for instance, for transport across bridges between the different islands.

United Kingdom

Work towards a modern road charge for lorry transport in the United Kingdom (UK) started in earnest in 2001 when the Government adopted a goal that all lorry operators in the British Isles should contribute to the costs caused by transport. Since then, the problem has been studied in detail and it was noted in a status report from 2004 (HM Treasury 2004) that a distance-based charge system called (Lorry Road User-Charge) would probably be introduced in 2008, after careful tests and trials during 2006 and 2007. During the summer of 2005, this project was scrapped, however due to changed priorities on the part of the Government and to doubts about the design of the proposed system.

What mainly capsized the project as it was initially conceived was largely that a kilometre tax for heavy vehicles was not considered to solve the problems it was intended to solve. The main problem in the U,K. is congestion, which is not mainly caused by heavy vehicles but by cars, A kilometre tax focused only on the former can therefore not be regarded as an effective instrument against congestion.

At present, discussions are in progress on the future of the kilometre tax in the UK and the main track seems to be a wholly new system which would apply not only to heavy lorries but also to cars.

Netherlands

In the Netherlands (NL), a number of attempts have been made with different types of road charges in the past 20 years. The latest was a kilometre-based charge called “Kilometerheffing”, which was tested between 2001 and 2004. To date, however, none of the systems has been sufficiently successful to be permanently adopted, although the Dutch government aims to do this in the future. In 2006, a new document on future transport (Mobility Paper) was produced where the focus is on pricing rather than taxation as in the present system. A committee of enquiry has been appointed to examine the various alternatives in detail and make proposals on possible roads forward (Platform Anders Betalen voor Mobiliteit).

The aim of the careful preparations is a system that apportions the charges in a fair way (based on use and not on ownership of the vehicle), increases accessibility and reduces congestion and improves the environment and road safety. At present, detailed studies and consultations with the business sector and other parties are taking place in order for the system finally adopted to be as efficient and generally accepted as possible. The plan is for the future charge to apply to the whole road network and to be distance-based and differentiated according to the time of day, place and environmental impact. The requirements made are high, among others as regards minimisation of investment and operating costs and user friendliness and personal integrity.

The kilometre tax shall in part replace today’s vehicle tax but a number of choices still remain before the details of this system’s design are clear, for instance, how to deal with infrequent users, what differences should be made between cars and lorries and how the allocation of responsibility for the system should be (private-

public). Given these remaining tasks, the transport and waterways authority (Ministerie van Verkeer en Waterstaat) has set 2012 as a possible date for implementation (www.vananaarbeter.nl/abvm). As a first step towards this goal, results were published on 15 September 2006 on a study of potential investment costs and levels for a kilometre tax by the Dutch transport ministry (2006). In this study, 15 enterprises have been commissioned to estimate the costs of different parts of the total system, such as monitoring, design of an OBU and others. The conclusion is that costs probably can be reduced markedly compared with earlier estimates, which naturally increased the probability that the plans for a kilometre tax in the Netherlands will be realised.

Russia

A discussion is also taking place in Russia on introducing a kilometre tax for heavy vehicles although it is at an earlier stage than in the UK and the Netherlands. Russia has major problems with poor roads and insufficient budget appropriations 8thenumber of vehicles per thousand people has more than doubled since 1993 while the appropriations have almost halved in the past five years) and regards a kilometre based road charge as a part of the solution (Donchenko 2006).

Three alternatives are being discussed at present:

- A Russian “vignette”: Charges based on the time that a vehicle uses the federal Russian road network.
- A kilometre-based charge with semi-automatic control (the drivers are responsible for part of registration and payment).
- A kilometre-based charge with automatic control (as in Switzerland, Austria and Germany).

A concrete proposal produced by Russian experts means that a charge should be taken on all domestic and foreign vehicles between 12 and 44 tonnes which travel on the Russian road network. In the initial stage, the charge should be a combination of Russian vignette (time-based) and, on more heavily trafficked routes, a kilometre charge with a semi-automatic control. Gradually, the road network subject to the kilometre charge should expand and the semi-automatic control be replaced by automatic control. It is also proposed that the charge be differentiated in the first place with respect to the number of axles. Vehicles over 44 tonnes are covered by special provisions and granted transport licences from case to case and agricultural transport exempted wholly from the kilometre tax according to the proposal.

7 The significance of transport costs

Information about how large a share of the total production costs is accounted for by transport costs can be obtained from official statistics (Statistics Sweden's economic statistics). They only refer to the costs for purchased transport. However, many companies only purchase part of the transport which needs to be carried out by external entrepreneurs and thus also have costs for transport carried out "in house". These are not captured by official statistics, which probably leads to an underestimation of the total transport cost for certain industries (or parts of industries).

The official statistics shows that the average transport cost share in the manufacturing industry is just over three per cent. Here transport costs mean the total costs for transport by the same mode of transport, i.e. not only road transport.

The share varies between different industries. Figure 7.1 shows the shares for, among others, the industries mentioned in the terms of reference of the commission. The highest share (over 12 per cent) is accounted for by extraction of metal ores. On the other hand, the share of road transport is relatively low here. The share is over 8 per cent for pulp and paper manufacture where road transport accounts for approximately half. Other industries in the figure have lower transport costs although road transport, on the other hand, is wholly predominant.

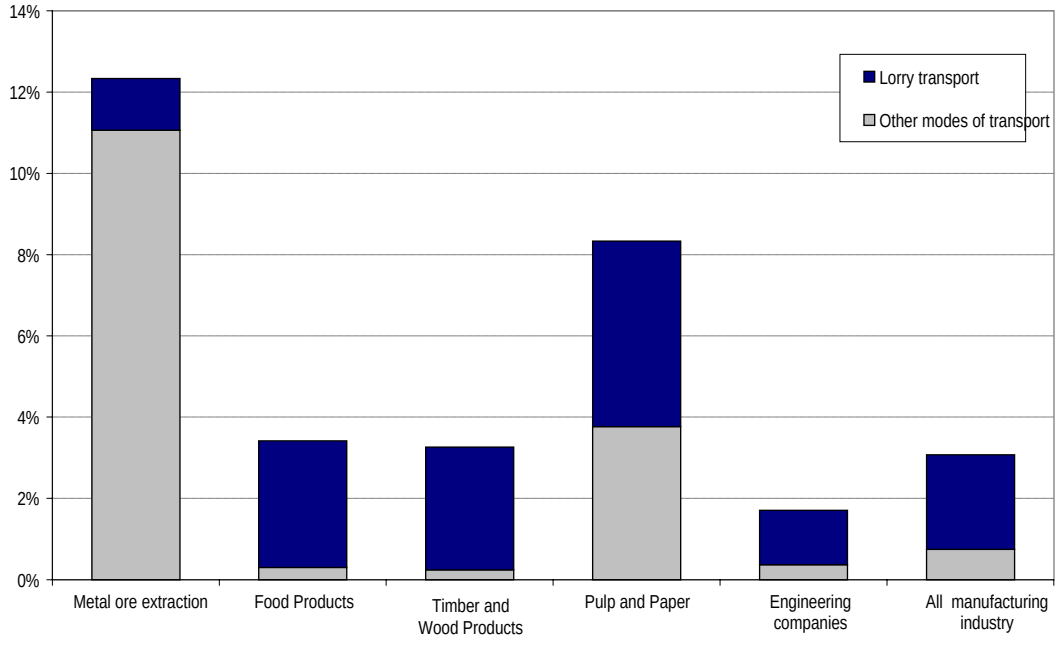

Figure 7.1. Costs for transport purchased as a share of total production costs. Source: Statistics Sweden's economic statistics.

The National Institute of Economic Research's report on consequences for the forest industry of a kilometre tax (Hammar 2006) states that the costs of road transport purchased in relation to the total operating costs (for work, capital, electricity, fuel, road transport and material) are around five per cent for the Wood Products industry and around one per cent for the Pulp and Paper industry. This information has been obtained from the official statistics.

Industry representatives for the Forest industry have claimed that the information in the official statistics greatly underestimates the actual transport costs, since it does not include transport that enterprises carry out themselves. This applies in particular to round timber commodities where the cost share is said to be considerably higher.

The following cost information relates to all transport, where costs for road transport only account for a part.

According to a cost questionnaire carried out by Skogforsk, the transport cost share for 2005 for forest products was around 25 per cent calculated as SEK per m^3 fub (firm m^3 under the bark), if acquisition costs are not included ("own forest"). For standing timber and felling assignments, the share of transport costs was 13.5 per cent. Timber transport accounts for around 11-14 per cent of the industry's raw material cost for timber. In Northern Sweden, the share was lower than in Southern Sweden. For pulpwood, timber transport accounts for just over 20 per cent of the industry's raw material cost. (Information from Skogforsk).

Transport costs account for 19 per cent of the manufacturing costs for newspaper paper at Hylte bruk according to information from the Swedish Forest Industries Federation.

The share of transport costs of industrial turnover in Austria is 11.5 per cent on average for all industries according to a questionnaire in 2005 at Vienna University (Einbock 2005). The proportion varies between 4 and 20 per cent for different industries.

Information about transport costs and commodity values (= prices of commodities excluding taxes) for different types of commodities used as input data for the Samgods model (see section 8.2). Information about transport costs has been obtained from the industry organisation the Swedish Hauliers' Association and the transport agencies and reported in SIKA (2002). Information about value of commodities has been obtained from the commodity flow survey (domestic) and foreign trade statistics. This information indicates that the transport cost shares of the commodities round timber, iron ore, stone and sand, crude oil and other wood products are considerably higher than the official statistics indicate. For food products, there is better agreement with the official statistics. The official statistics show, however, that there are considerable regional differences.

The importance of transport costs for the different industries is also dealt with in Chapter 9.

8 The effects on transport costs of a Swedish kilometre tax

This section presents the calculations of the relative change of enterprises' transport costs resulting from a marginal-cost based kilometre tax. As a basis for these calculations, tax schedules were first prepared where the marginal-cost based kilometre tax has been differentiated with respect to the weight and environmental class of the vehicle. With the aid of the Samgods model, the relative change of transport costs is then calculated for different types of commodities and to and from different regions. A more detailed account of the calculations is provided in two special memoranda from SIKA (2007a and 2007b).

8.1 Calculation of a marginal-cost based kilometre tax

The kilometre taxes used in this analysis have, in accordance with the commission, been calculated on the basis of the marginal costs and principles presented in the Road Traffic Tax Commission. These marginal cost estimates derive in turn from various reports in SIKA (2004). All costs relate to 2001's prices.

Table 8.1. Estimated marginal costs for road transport: SEK per vehicle kilometre for lorries between 3.5 and 16 tonnes. Source SIKA Report 2004:4

	Rural areas	*Urban areas*
Wear and tear and deformation	0.02-0.04	0.02-0.04
External accident costs	0.35	0.61
Noise disturbance	0.06	0.39
Emissions excl. CO_2	0.33	1.10
Total excluding CO_2	0.76-0.78	2.12-2.14

Note: Noise assessment made for less densely populated urban area (Landskrona)

Tabell 8.2. Estimated marginal costs for road transport: SEK per vehicle kilometre for lorries over 16 tonnes. Source SIKA Report 2004:4

	Rural areas	*Urban areas*
Wear and tear and deformation	0.05-0.12	0.05-0.12
External accident costs	0.35	0.61
Noise disturbance	0.14-0.31	0.89-1.40
Emissions excl. CO_2	0.69	1.66
Total excluding CO_2	1.23-1.46	3.21-3.79

Note: Noise assessment made for less densely populated urban area (Landskrona). The interval applies for high and low speed respectively.

Carbon dioxide is not included in the marginal costs used in the analyses for reasons presented in Chapter 2. The estimates of marginal costs reported must be regarded as preliminary for the time being. Newer estimates are available, among other places in the Swedish National Road and Transport Research Institute (VTI 2007), in particular as regards wear and tear and deformation and emissions of air pollution, but they have still not been inspected for quality to a sufficient extent to serve as a basis for a kilometre tax proposal. New (quality inspected) estimates should, however, serve as the basis for a future kilometre tax system.

It has been necessary in this commission to make some simplifications with regard to the design of the kilometre tax which is analysed. This differentiation has, as in the Road Traffic Tax Commission report, been limited to the weight and environmental class of the vehicle. The estimated tax rates (see Tables 8.3-8.5) refer to rural driving, driving in urban areas, and a weighted average of 82 per cent rural driving and 18 per cent driving in urban areas. (This proportion is the same as that used by the Road Traffic Tax Commission).

Table 8.3 Estimated total marginal cost in rural areas (excluding CO_2); SEK per vehicle kilometre in 2001's prices

Total weight	*Euro 0*	*Euro I*	*Euro II*	*Euro III*	*Euro IV*	*Euro V*
3,5 - 5.9	0.96	0.73	0.70	0.63	0.57	0.52
6.0 - 7.9	1.00	0.75	0.72	0.64	0.58	0.53
8.0 - 9.9	1.03	0.77	0.73	0.65	0.59	0.53
10 - 11.9	1.07	0.79	0.75	0.66	0.60	0.54
12 - 17.9	1.13	0.82	0.78	0.68	0.61	0.55
18 - 23.9	1.48	1.13	1.08	0.97	0.89	0.81
24 - 31.9	1.59	1.19	1.13	1.01	0.91	0.83
32 - 39.9	1.72	1.26	1.20	1.05	0.95	0.85
40 - 43.9	1.82	1.32	1.24	1.08	0.97	0.86
44 - 49.9	1.90	1.36	1.28	1.11	0.99	0.87
50 - 54.9	1.99	1.41	1.33	1.14	1.01	0.89
55 -	2.12	1.48	1.39	1.18	1.04	0.90

Table 8.4. Estimated total marginal cost in urban areas (excluding CO_2); SEK per vehicle kilometre in 2001's prices

Total weight	*Euro 0*	*Euro I*	*Euro II*	*Euro III*	*Euro IV*	*Euro V*
3.5 - 5.9	4.14	2.61	2.01	1.71	1.39	1.27
6.0 - 7.9	4.23	2.66	2.04	1.73	1.40	1.28
8.0 - 9.9	4.31	2.70	2.07	1.75	1.41	1.28
10 - 11.9	4.39	2.74	2.09	1.77	1.41	1.29
12 - 17.9	4.55	2.82	2.14	1.80	1.43	1.30
18 - 23.9	5.63	3.78	3.06	2.69	2.30	2.16
24 - 31.9	5.91	3.92	3.14	2.75	2.33	2.18
32 - 39.9	6.23	4.08	3.24	2.82	2.37	2.20
40 - 43.9	6.47	4.20	3.32	2.87	2.39	2.22
44 - 49.9	6.67	4.30	3.38	2.92	2.41	2.23
50 - 54.9	6.88	4.42	3.45	2.96	2.44	2.25
55 -	7.19	4.57	3.54	3.03	2.47	2.27

Table 8.5. Estimated total marginal cost (excluding CO_2); SEK per vehicle kilometre in 2001's prices –weighted average where rural traffic accounts for 82% and traffic in urban areas 18%

Total weight	*Euro 0*	*Euro I*	*Euro II*	*Euro III*	*Euro IV*	*Euro V*
3.5 - 5.9	1.54	1.07	0.94	0.82	0.72	0.66
6.0 - 7.9	1.58	1.09	0.95	0.83	0.73	0.66
8.0 - 9.9	1.62	1.12	0.97	0.85	0.74	0.67
10 - 11.9	1.66	1.14	0.99	0.86	0.74	0.67
12 - 17.9	1.75	1.18	1.02	0.88	0.76	0.68
18 - 23.9	2.23	1.60	1.43	1.28	1.14	1.05
24 - 31.9	2.37	1.68	1.49	1.32	1.17	1.07
32 - 39.9	2.54	1.77	1.56	1.37	1.20	1.09
40 - 43.9	2.66	1.84	1.62	1.41	1.22	1.10
44 - 49.9	2.76	1.89	1.66	1.44	1.24	1.12
50 - 54.9	2.88	1.95	1.71	1.47	1.27	1.13
55 -	3.03	2.03	1.78	1.52	1.30	1.15

The weighted average is used in the analysis since it has not been possible to divide the road network into rural and urban areas in the model calculations. The difference between urban and rural areas is instead dealt with by rough approximate calculations. No consideration to wear-and-tear costs being different for different types of road has been taken into account in the calculations[3].

An average marginal cost is worked out for every type of commodity taking into consideration the vehicle fleet of the type of commodity. (Information about this is obtained from vehicle statistics and the lorry survey). The composition of the

[3] Analyses with different kilometre taxes for different roads depending on whether they are located in urban or rural areas are at present being carried out by the National Road Authority. It is expected that these analyses will be completed in April 2007. The National Road Authority is studying there route choice changes and the possibilities for steering lorry traffic to roads with low wear-and-tear costs through the kilometre tax.

vehicle fleet as regards environmental classes is based on figures from 2005 and has been estimated on that basis for 2010. The average kilometre tax has thus been calculated at SEK 1.40 per vehicle kilometre. A rough calculation shows that the average kilometre tax for rural driving would be around SEK 1 per kilometre and for driving in urban areas around SEK 2.80 per kilometre. This information is at 2001's prices.

Analyses were made in accordance with the terms of reference for the commission partly by letting the marginal costs be covered only by a kilometre tax and partly by taking into consideration that energy tax contributes to internalising the costs and that the kilometre tax is used to cover the part of the marginal cost that is not covered by the energy tax. (Diesel tax consisting of energy tax and carbon dioxide tax, cannot be reduced more than to the minimum level specified in the EC Directive on taxation of energy products and electricity, 2003/96/EC. The carbon dioxide tax does not alone amount to the minimum level, which is why energy tax cannot be wholly removed.) In terms of calculation, this alternative has been carried out so that the marginal-cost based kilometre tax has been reduced to a level that is corresponded to by a removal of the energy tax. The kilometre tax reduced in this way amounts on average to around SEK 1 per kilometre.

It is assumed that the Eurovignette will be terminated when a kilometre tax is introduced. It is assumed that the kilometre tax will apply to the whole of the analysed road network. Prices (and thus internalisation costs) in the other modes of transport have been assumed to be unchanged. As regards other countries, it has been assumed in the calculations that only Switzerland, Germany and Austria have introduced kilometre tax.

8.2 Calculation of changes in transport costs

The Samgods model has been developed by SIKA and the transport agencies to be able to analyse effects on the transport market ensuing from changes in infrastructure, policy instruments and different business environment factors. The model allocates transport flows to modes of transport (excluding air) and routes according to a cost minimisation principle. Cost generalisations relate to generalised costs and they accordingly include both operational and qualitative costs. The latter derive from transport times, reloading, delivery reliability, etc. and reflect the tied-up capital of the goods during transport. The model handles flows of goods in twelve groups of goods between municipalities in Sweden and 173 zones outside Sweden. Short-distance transport (within a municipality or under 25 kilometres) and transport by light lorries and service transport are not included. The infrastructure is described with the aid of a network which within Sweden consists of the state network of major highways, the rail network and some 70 ports.

Table 8.6. Groups of goods in the Samgods model.

Code	*Designation*
1	Agriculture
2	Round timber
3	Wood products
4	Food products
5	Crude oil and coal
6	Oil products
7	Iron ore and scrap
8	Steel products
9	Paper and pulp
10	Iron, stone and construction
11	Chemicals
12	High-value products

The introduction of a differentiated kilometre tax for heavy lorries can be expected to lead to various types of adaptations, such as less transport, shorter transport, reallocation between modes of transport, changed route selection, efficiency improvement (increased load factor), and faster replacement of the vehicle fleet, (cleaner vehicles = lower kilometre tax). Of all these conceivable variants, the current Samgods model only deals with the reallocation between modes of transport and choice of route. Other parameters have to be dealt with outside the model, e.g. by assumptions on different load factors. (Extensive development work is at present in process to be able to deal with such factors as well within the model). In reality, other adaptations will accordingly take place than those that have been able to be taken into account in the Samgods model. These adaptations are made to counteract the increase in costs. This means in turn that the cost increases should have been overestimated slightly in the calculations.

Figure 8.1 shows that calculations of the relative increase in transport cost for different types of commodities ensuing from a marginal-cost based kilometre tax. The relative increase in transport costs in the figure concerns generalised transport cost. These costs refer to transport with all modes of transport, with and without a reduction corresponding to the amount of energy tax.

At the aggregated level, it has little importance that calculations take place with a generalised or operating transport cost. The difference in result is negligible. However, it can be of greater importance in individual relations, due to the Samgods model taking into account certain adaptations as regards choice of mode of transport. In certain cases, the operating costs will decrease due to a kilometre tax depending on it being assumed that transport could take place with a mode of transport that costs less but at the price of use of more time. We have therefore chosen to report the result as generalised cost.

The average increase in cost for all types of commodities has been calculated at around three per cent, if a marginal-based kilometre tax is levied on top of existing taxes. In the event of a reduction of the kilometre tax corresponding to the energy tax, the average increase in transport costs will be around two per cent.

As shown in Figure 8.1, the increase varies between different types of commodities. The largest increase is received for food products. The foremost

explanation is that the share of lorry transport is relatively high for this type of commodity. An additional explanation can be that adaptation opportunities in the form of transfer to another mode of transport or changed route are relatively few. The group designated high-value products contains, in relation to the other groups of commodities, a relatively large number of commodities with high added value and thus commodities where the value per unit is high. Commodities with a lot of tied-up capital and commodities of a food character are dependent on fast transport and are therefore transported by lorry to a great extent. Both food and high-value products also have a relatively large input of sales to final consumption, which means that the freight pattern is spread over practically every region of Sweden.

Besides this transport, it is mainly transport of round timber that is affected overall more than other groups of commodities. Also in the case of transport of round timber, it is mainly because a very large share of transport takes place by lorry which is the part of transport performance in question for kilometre tax. Among commodities where transport is less affected by a kilometre tax are paper and pulp, oil products, iron ore, scrap and crude oil and coal. In these cases, transport costs by lorry account for a small part of total transport costs.

The total traffic performance for all types of commodities (in vehicle kilometres) is expected to decrease by over 15 per cent at the higher kilometre tax level and by over 10 per cent at the lower.

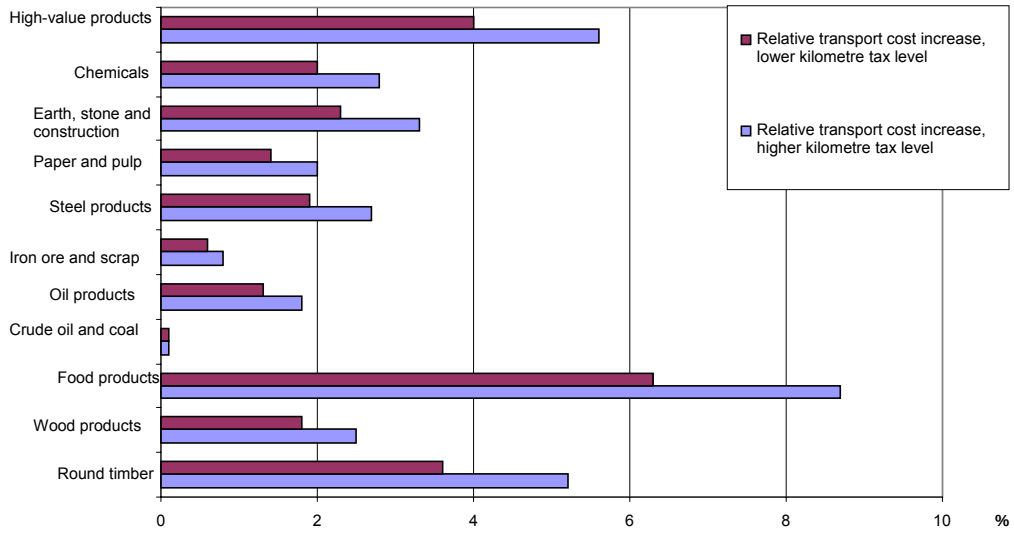

Figure 8.1. Relative increase in transport cost (%) for different types of commodities due to a kilometre tax.

Figure 9.15 shows the estimated transport cost increases broken down by industries according to the SNI code categorisation.

Figures 8.2, 8.3 and 8.4 show how the relative increase in transport costs varies between different FA regions[4] for transport to and both to and from the respective region. Figures 8.5 and 8.6 show how the increase in transport costs for the types of commodities round timber and food products varies between different counties for transport to and from the respective county. The relative increase in transport cost in all figures refers to generalised transport cost for all transport with all modes of transport and the higher kilometre tax level.

The increase varies between different FA regions and in some regions, it approaches ten per cent. There are regions with relatively large cost increases both in Northern and Southern Sweden. The pictures look different depending on whether transport is grouped in transport from or to the respective region. In both cases (Figure 8.2 and 8.3), there are regions with relatively large cost increases both in Northern and Southern Sweden. This is also the case if the calculation is limited to the types of good round timber (Figure 8.5). The higher cost increases estimated for food transport are concentrated in Southern Sweden (Figure 8.6).

A detailed presentation of the calculation results can be found in SIKA (2007b).

[4] Functional labour market regions (72) drawn up by Nutek (FA, abbreviation in Swedish)

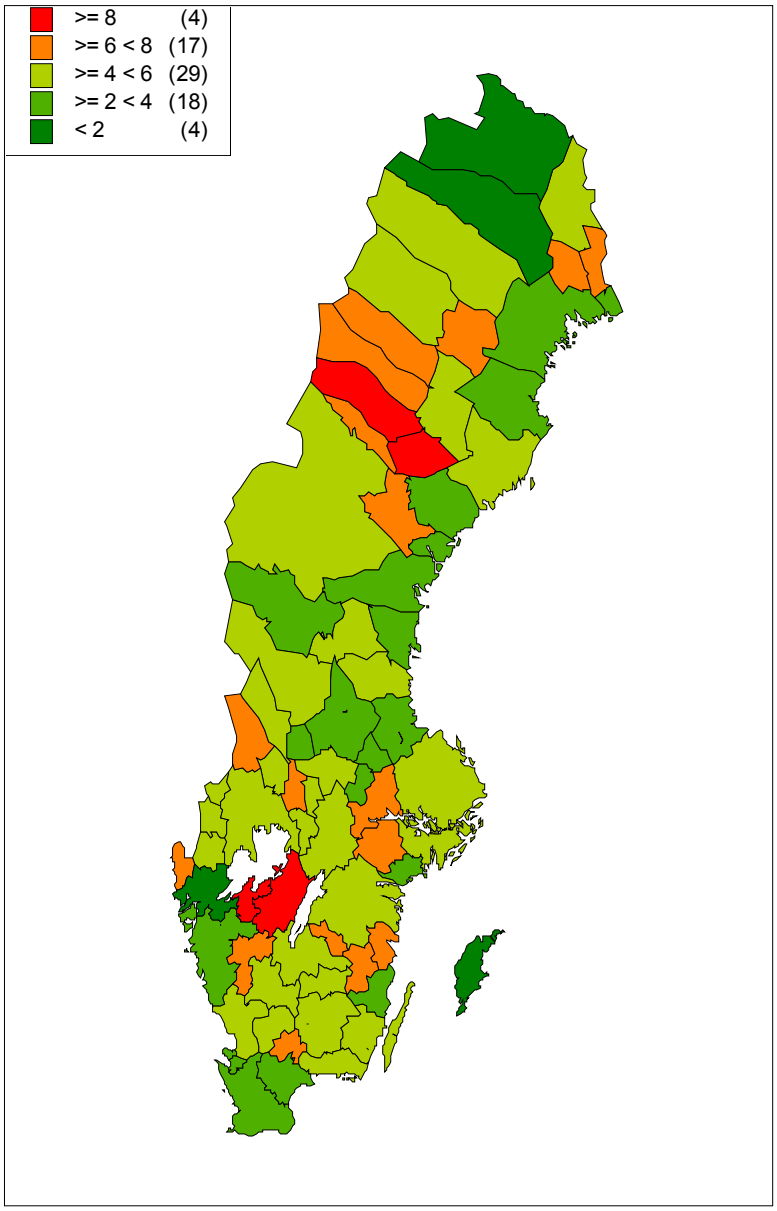

Figure 8.2. Change (in per cent) of total transport costs for transport from the respective FA region (higher kilometre tax level).

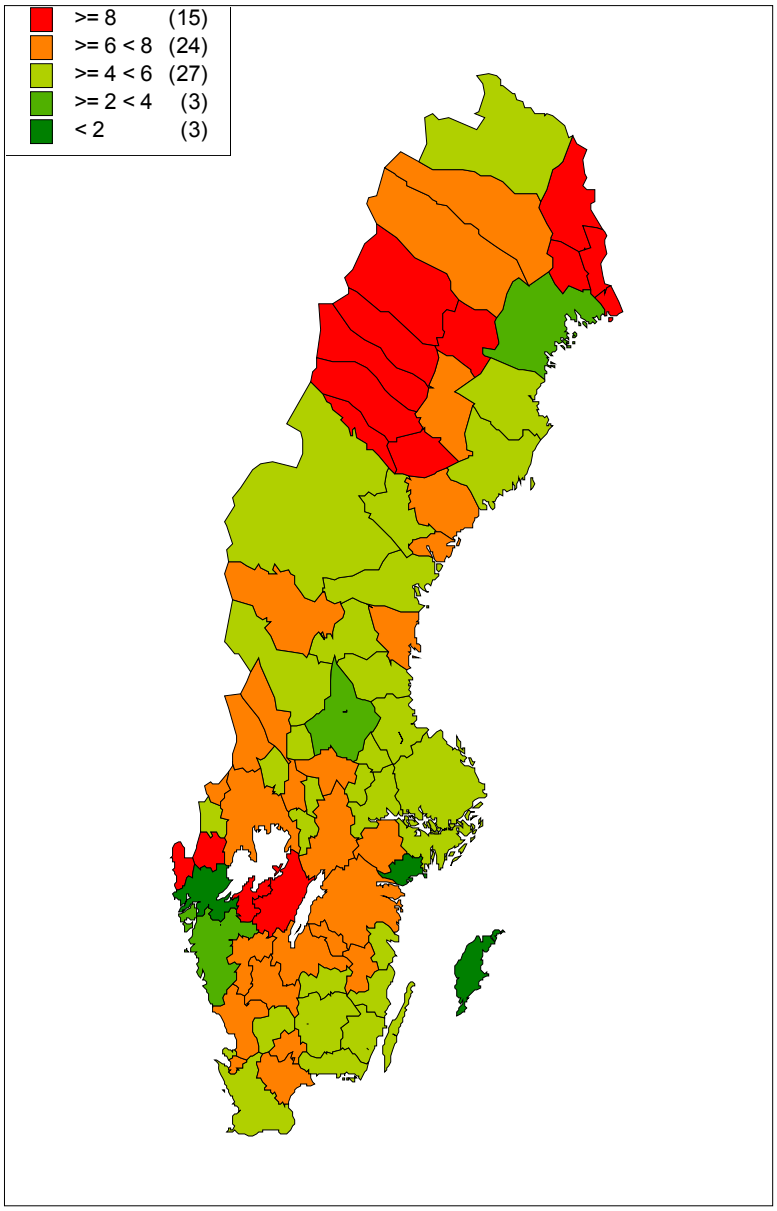

Figure 8.3. Change (in per cent) of total transport costs for transport to the respective FA region (higher kilometre tax level).

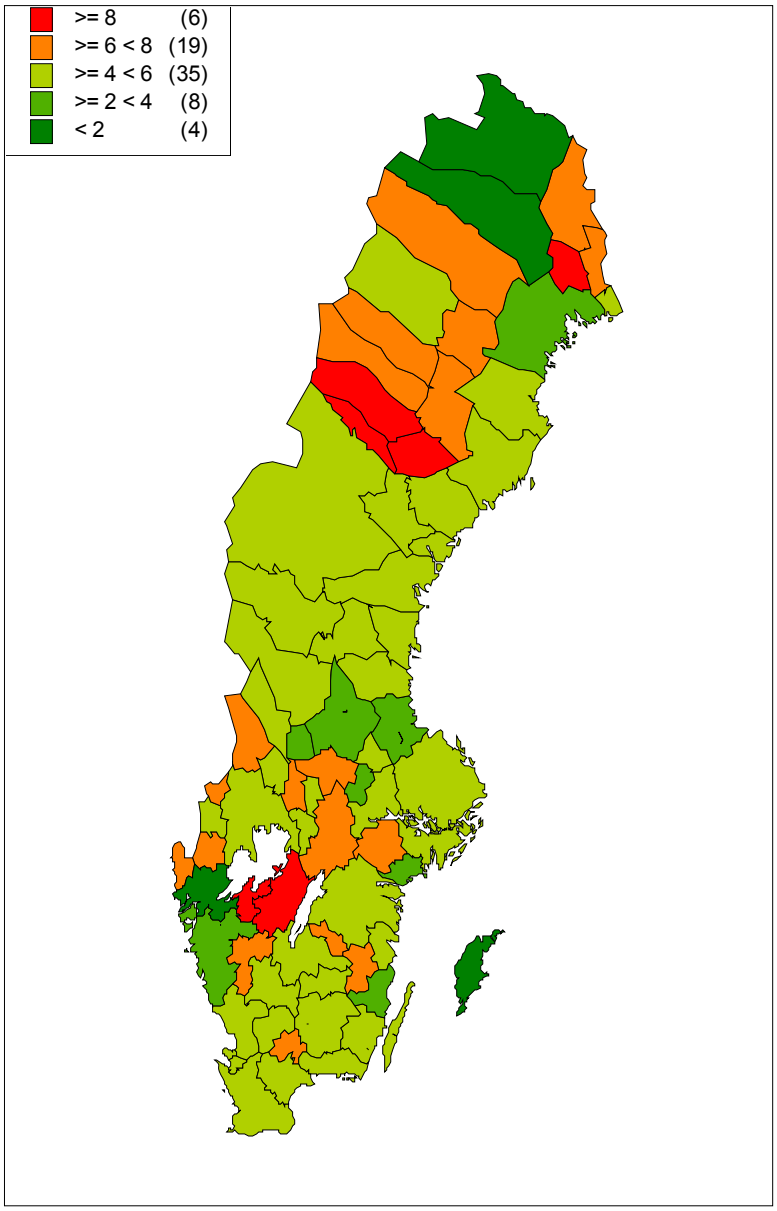

Figure 8.4. Change (in per cent) of total transport costs for transport for the respective FA region (higher kilometre tax level).

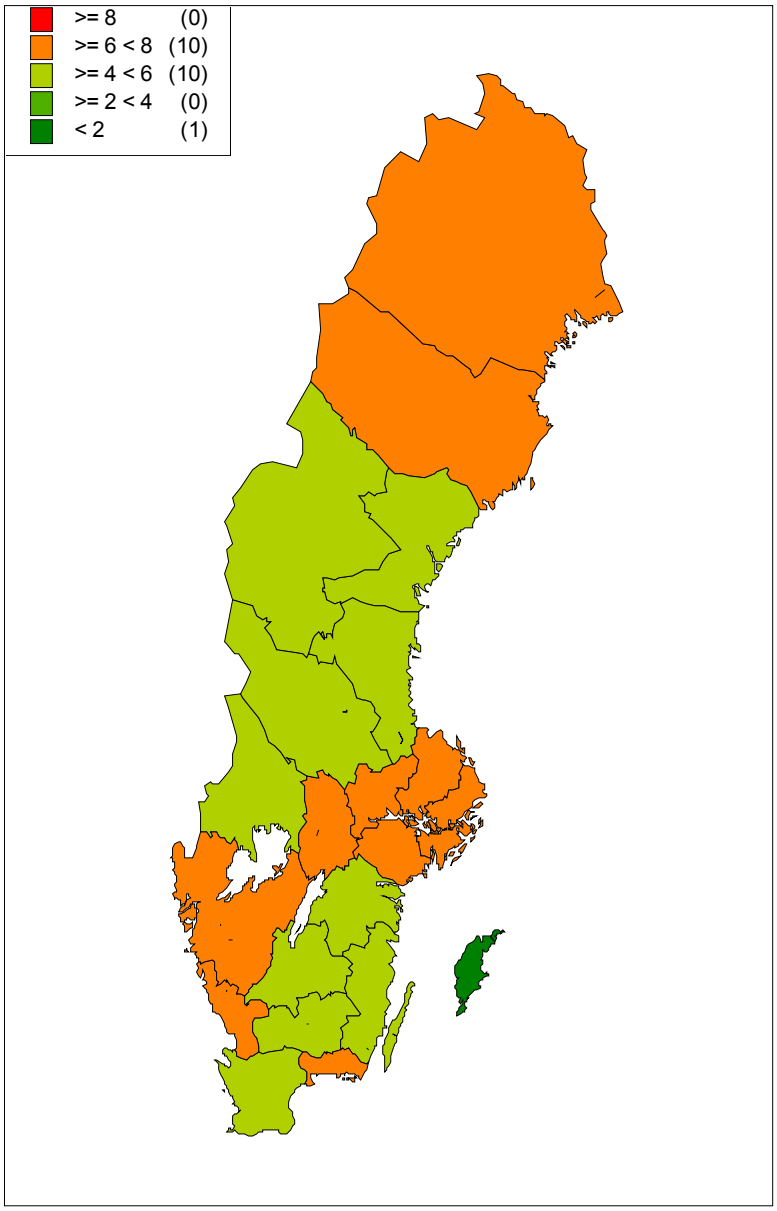

Figure 8.5. Change (in per cent) of total transport costs for transport for the respective county, type of commodity round timber (higher kilometre tax level).

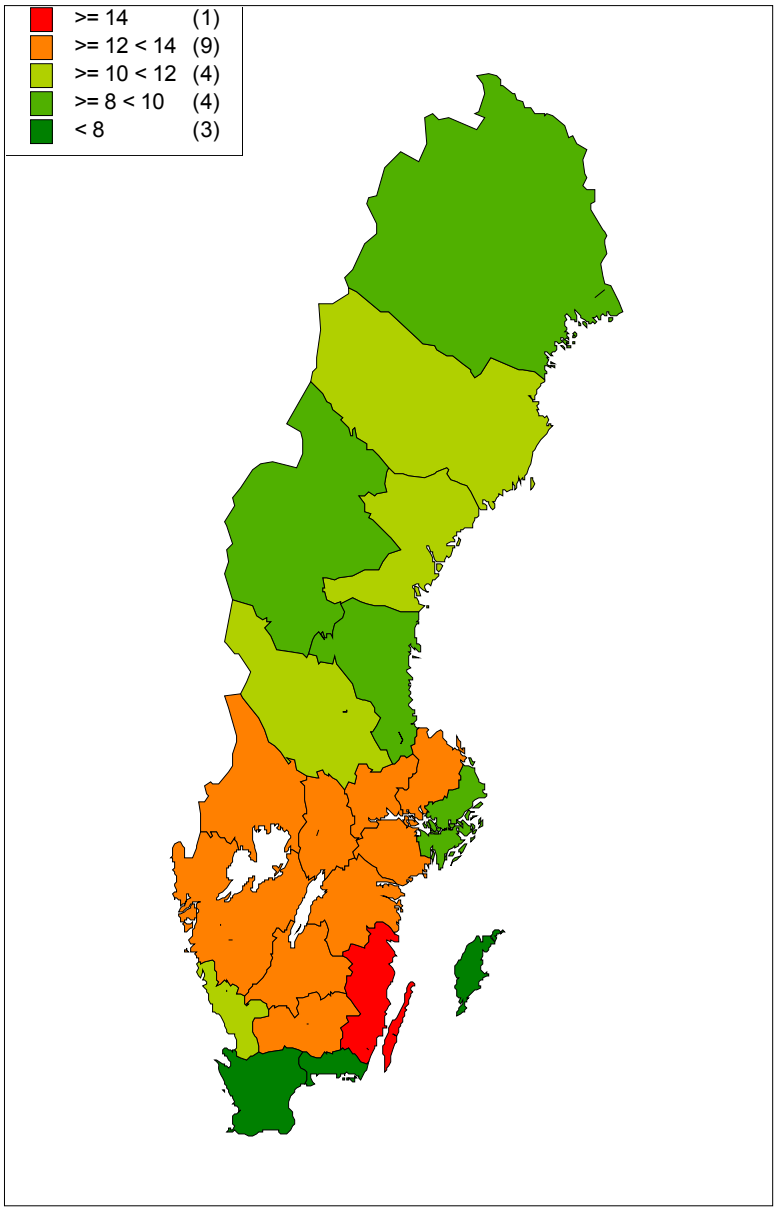

Figure 8.6. Change (in per cent) of total transport costs for transport for the respective county, type of commodity food products (higher kilometre tax level).

8.3 Comments on the result

Special attention should be given to types of commodities that have a relatively high share of transport costs and which moreover are expected to have a relatively high increase in transport costs due to kilometre tax in the assessment of consequences. A combination of this kind can be an indication that effects on production and employment may be noticeable even if it is far from the sole criteria for such effects arising.

Round timber is a type of commodity with a combination of this kind. Even if information from different sources on the share of transport costs of production costs differ, it is evident that the share is high compared with other types of commodities or industries. The increase in transport costs is also clearly above the average for all types of commodities.

Food products is the type of commodity which is expected to have the highest increase of transport costs although it shows, on the other hand, a relatively modest share of transport costs in relation to the total production costs.

The estimated increases in transport costs are generally estimated as being largest in Northern and Southern Sweden although there would seem to be very large variations in these large areas. Some concentration of relatively high cost increases can be discerned in Inland Norrland and Inland Götaland. There is a marked concentration in Southern Sweden for food products transport.

The estimated average increase in transport costs does not seem to be especially great, not even in the case of the higher level of kilometre tax when the increase is expected to be around 3 per cent. However, there are quite large variations around the average change between different industries and regions. This means that, marked effects on production and employment cannot be excluded in at least parts of certain industries and regions. This is taken up in more detail in the following chapter.

9 Effects on production and employment

9.1 Introduction

The purpose of this chapter is to describe the effects on the business sector and regions of an introduction of a kilometre tax designed in accordance with the recommendation in this report. In particular, the effects on four industries are examined: the Mining industry, the Food Products industry, the Forest industry and the Engineering industry. This selection has been made on the basis of the importance of these industries for the Swedish economy and to clarify the effects of the kilometre tax, which can be expected to be especially clear in these four cases.

However, it should be underlined already at this stage that the effects on all industries can be expected to be small according to the model calculations made. This has also been noted in earlier studies (see Hammar 2006 and the Swedish Environmental Protection Agency 2006) and since the kilometre tax level used in this report is considerably lower than in previous analyses, the effects will also be less.

Why has the haulage industry not been included?

Kilometre tax will be paid by those who use heavy vehicles for transport, i.e. the haulage industry and other enterprises that own vehicles and carry out transport themselves. According to estimates by Johnsson (2003), the haulage industry uses around 53 per cent of all diesel fuel used in heavy vehicles every year. The rest is used by enterprises that carry out transport themselves. In principle, this means that the haulage industry should pay around half of the total cost for kilometre tax, but since hauliers generally use heavier vehicles than companies that take care of their own transport, the proportion can be assumed to be slightly higher (The Swedish Society for Nature Conservation 2007).

A spontaneous reaction is that the haulage industry will therefore be hard hit by the kilometre tax, leading to decreased employment. However, this is a simplification which does not reflect the business sector’s great dependence on transport. The fact is that price sensitivity for transport is very low and the possibility for hauliers to take out the cost increase in the form of a higher price is relatively good.

It is thus reasonable to assume that the largest part of the cost for kilometre tax will be passed on to the haulage industry’s customers. Experience from all of the countries which have already introduced a kilometre tax point to this.

The above reasoning serves as the basis for the decision not to include the haulage industry in the analysis in this study.

The arrangement of the chapter

The effects of the kilometre tax are assumed to a great extent to depend on the competition situation in the respective market. Price mechanisms and the possibilities of passing on the cost are therefore discussed in general in section 9.2. Thereafter, some basic description information about the situation for the respective "focus industry" today is presented in section 9.3 as well as the conceivable effects of a kilometre tax. This qualitative approach is complemented in section 9.4 with a quantitative analysis. The effects of the kilometre tax at industry level are calculated with the aid of a factor demand model (FEM) and the distribution of effects within each industry is described by a Salter analysis (see below). Section 9.5 contains the concluding comment and a summary.

Description of the statistics

ITPS has been given access by Statistics Sweden to economic data for particular workplaces in the manufacturing industry (SNI 10-37). The sale value, value added, personnel cost, number of employees, investments, energy costs and costs for transport purchased have been obtained from Statistics Sweden's economic statistics for around 4,000 workplaces which are larger than five employees and for companies with at least 10 employees. Information on quantities and costs of electricity and fuel of various kinds have also been obtained from Statistics Sweden's energy statistics and added to the economic data for each workplace. Data for the years 1990 to 2001 have been used for this study. These data are confidential which means that ITPS may not present information unless at least a figure refers to at least three workplaces and that a single workplace may not stand for more than 50 per cent of the reported value. The secrecy requirement leads to data in certain case having to be aggregated so that the values for parts of industries that are of interest cannot be presented.

In brief on FEM and its limitations

A factor demand model is used to calculate the effects on production, employment, profits, use of capital and transport of a kilometre tax[5]. Statistics are used to estimate the elasticities of factor demand. The elasticities are used together with the transport increases calculated by SIKA to simulate the effects of alternative kilometre taxes. These elasticities are estimated by industry and the effects can be regarded as a description of the effect on an industry and not on a particular company or typical company. Reduced output in the simulation can be due either to structural transformation leading to closure of enterprises with heavy transport costs or that a number of enterprises in the industry reducing their output.

The factor demand model estimates elasticities at the national level for a number of manufacturing industries and at the national level (NUT2 level) for the whole of manufacturing industry without any division into industries. Estimates with a finer categorisation, for instance, estimates by industry at the national level

[5] See ITPS report. A2004:019 Basindustrin och Kyoto. Effekter på konkurrenskraften av handeln med utsläppsrätter, p. 103 pp (Base industry and Kyoto. Effects on competitiveness of trade in emission rights, in Swedish).

generally produce insignificant results which mean that these do not provide any information.

Salter analysis

The Salter analysis is used to describe industry structures. Unlike the average value for profitability, etc., the Salter analysis describes the allocation of profitability to workplaces. It shows the industries and how large parts of an industry which have good opportunities for new investment and to grow and which parts of an industry have poor profitability and therefore risk closure.

The analysis in this section aims at assessing the direct and immediate cost effect for each particular workplace of a change in transport costs without any adaptation to new conditions taking place. A presentation is made in diagram form of how the gross profit share[6] is changed for the workplace in an industry for a given increase in costs. The figures show changes in the ability to survive of the workplace and the profitability of the industry.

9.2 The kilometre tax and its effects, an introduction

The kilometre tax increases transport costs by an average of 3 per cent for the whole of industry. The effects that this has for particular industries and regions are determined by a number of factors, the most important of which are

- The importance of transport costs in relation to other production costs
- The ability to pass on a cost increase in the form of a higher price for the consumer
- In those cases, where there are few possibilities to do this (as is the case in an international market), the profitability situation in the industry as a whole and for particular companies
- What possibilities for adaptation are there for companies which incur increased costs
- The structure of the business sector is also of crucial importance for regions, in particular how many industries are represented. Regions with a high level of dependence on a few industries are more sensitive than others.

As regards the last point, it is also reasonable to assume that regions with a large share of transport-intensive industries risk being harder hit by a measure that increases transport costs, which is the case with a kilometre tax.

The purpose of the kilometre tax is a more correct pricing of transport to steer development into a more socially efficient direction. The structural transformation that can potentially arise when certain enterprises are affected and others favoured is thus desirable and in principle not a problem. At the same time, it is important to underline that structural transformation that takes place too quickly is not efficient either.

[6] Gross profit is defined as added value minus personnel costs (wages and social security contributions). Added value is defined as the sale value of output minus costs for intermediate goods. Gross profit share = gross profit/added value.

In the short term, increased costs can lead to significant consequences for some enterprises (relative to competitors in other countries in the first place). For instance, an increase in costs which arises due to a kilometre tax for heavy vehicles in Sweden can be difficult to pass on to the end customer if the market is global, which, all other things being equal, can lead to competitive disadvantages which risk affecting production and employment in Sweden negatively.

In the product segments, where price competition from other countries is stiff, a cost increase that specifically affects companies in Sweden, which is the case with the proposed kilometre tax, must be borne at some level of domestic industry. Price sensitivity in the world market does not permit any large increases without a reduction in demand and thus also the volume of exports. There is thus a risk that the increase in costs, at least in the short term will lead to reduced output, profit and employment. In extreme cases, in segments where the margins are especially small, parts of the business sector risk closure. In the long run, there is often potential for adapting the production process to make possible continued profitable production. Since this often requires large investment, companies with insufficient access to capital (in a broad sense) will find it difficult to take this road.

The extent to which price increases are possible to compensate for increased production cost is determined by competition and the price sensitivity of consumers for the goods concerned, which in turn is affected by the availability of close substitutes. Standardised products further down in the chain of value are generally under greater pressure since these are often relatively easy to replace, while more specialised products often have characteristics which make them substitution more difficult. The competition situation for the focus industries in this study is discussed below.

The state of competition in the focus industries in this study

In this study, the effects of a Swedish kilometre tax for heavy vehicles are analysed particularly carefully for four industries: The Mining industry (SNI 10-14), the Food Products industry (SNI 15+16), the Forest industry (SNI 20+21), and the Engineering industry (SNI 27-35)[7] .

The competition situation in each industry is briefly described here, which largely determines how the effects will be distributed between different parts of the producer level and the consumer. This discussion here is general and does not apply specifically to kilometre tax although it should be mentioned that the effects of the aforesaid tax can be expected to give rise to are small on average.

The Mining industry differs to some extent from the other industries in the sense that there is at present very little pressure in the world market. China’s strong expansion is pushing up demand for iron and steel and thus also for ore. Other

[7] The engineering companies really consist of SNI 28-35 but due to the categorisation used by Statistics Sweden, in regional statistics, SNI 27 Steel and metal plants is also included here.

metals are also in demand on the world market in greater volumes than can be produced today. Prices of above all metal ores have therefore accelerated in recent years which leads to it being easier to pass on cost increases that affect global industry (dearer extraction and energy costs, for instance) to the end customer to a great extent. However, the ability of Swedish producers to increase the relative price is greatly limited and cost increases that only affect enterprises in Sweden must therefore be borne by the industry. The kilometre tax is an example of this kind of specific cost increase.

The Food Products industry in Sweden has for a long time been protected from international competition and prices have therefore not been dependent on prices in other countries. Swedish food is among the most expensive in Europe, even if competition has increased in recent years, which has led to a narrowing of the difference with the rest of Europe. In particular, Swedish membership of the EU has led to improved competition. The retail trade market is to a great extent local: food consumers do not travel to Germany to purchase food and German food producers who sell food in Sweden do not have any reason to charge lower prices than is required by the competitive situation. Since competition is still relatively weak (the four largest everyday goods enterprises have almost 90 per cent of the market), price pressure on food prices in Sweden has been small.

The main market power is, however, not with the food producers but with the retail trade enterprises. The price of food is determined in negotiations between the retail trade and food producers and the latter have a very strong position in these negotiations because of their size. Price competition thus arises between different food producers rather than between retail enterprises, which pushes the purchasing price of agricultural goods and food down. In the event of an introduction of a kilometre tax, it is therefore probable that the producers will to a great extent be obliged to bear any cost increases not the retail enterprises. However, it is probable reasonable to assume some increase in consumer prices for food, even though it is difficult to predict the level of this.

The Forest industry has unlike the Food Products industry operated for a long time in an internationally competitive market with given prices. Companies in this industry cannot increase relative prices to any significant extent without becoming less competitive, which means that the cost of the kilometre tax must be borne by the producers in some way. In the short term, this will probably reduce the profit margins of enterprises and in the segments of the industry where margins today are very small, there is a risk that production will decrease in extent, be closed down or move.

Engineering companies are also in principle confronted by world market prices for their end products. However, market power exists in the large multinational companies that can often choose to purchase intermediate products from suppliers in several different countries. There is therefore considerable price competition between sub-contractors, which has led to a situation with small margins for many companies. The transport cost increases which the kilometre tax will lead to will largely be borne by just these companies, for which even marginal cost increases can cause problems. The engineering industry is thus one of the industries where the negative effects can be expected to be greatest in relative terms. Due to the

large export share of this industry, the situation of the engineering companies is also of interest from the perspective of social efficiency.

9.3 Focus industries for the commission, facts in brief

This section presents some basic descriptive information about the situation in the focus industries in the study: the Mining industry (SNI 10-14), the Food Products industry (SNI.15+16), the Forest industry (SNI 20+21), and the Engineering industry (SNI 27-35[8]).
This description provides indications of the extent of the effects that it is conceivable that kilometre tax generates. This quantitative approach is complemented in section 4 with a more qualitative analysis.

The regional statistics presented in this section have been obtained from Statistics Sweden's database Regional basic data for enterprises by region (county) and industry SNI 2002. This is accompanied by certain limitations primarily related to confidentiality provisions which necessitates a coarser categorisation by industry than would otherwise have been desirable[9] and to improve the analysis other information has also been used from a number of sources, such as industry organisations and foreign trade statistics.

Each industry is described both at national and regional level. The regions used here are those known as NUT2, which all consist of several counties and are eight in all: 1) Stockholm, 2) Eastern Central Sweden 3) Southern Sweden 4) Northern Central Sweden 5) Central Norrland 6) Northern Norrland 7) Småland and islands and 8) Western Sweden (see Annex 1 for map). In certain cases, there are special needs to take the analysis a further step, for instance, in the regions where the effects may be expected to be particularly great. This will be done wherever feasible.

[8] According to the current definition, the engineering industry covers SNI 28-35. However, SNI 27, Metal production, is also included in the regional database. SNI 27 accounts for almost 10 per cent of the total employment and value-added of the engineering industry.
[9] For instance, it would be more correct to divide the Mining industry into a number of segments and likewise separate SNI 27-28 and only include the latter in the Engineering industry.

Table 9.1. Overview of the focus industries in the study. Source: Statistics Sweden according to Regional basic data for enterprises by industry SNI 2002 and foreign trade statistics from 2006.

Industry (SNI-kod)	*No. of workplaces*	*No. of employees*	*Value of output (SEK)*	*Value added per employee (SEKm)*	*Share of total exports, %*
Mining industry (10-14)	784	7,106	17,590	1.09	0.9[(b)]
Food Products industry (15+16)	3,682	57,860	124,237	0.58	3.6
Timber and Wood Products industry (20)	6,964	34,382	72,128	0.49	2.5
Pulp and paper industry (21)	596	37,393	113,935	0.92	8.2
Engineering companies (27-35)	25,749	366,823	845,844	0.67	49.0
All industries	**777,842**	**2,225,637**	**3,776,155**	**0.67**	**100**

(a) Export share applies to 2006
(b) Only iron ore

The Forest industry (SNI 20 – 21)

Summary:
The number of workplaces in the Timber and Wood Products industry is relatively evenly distributed through Sweden, while the differences are greater in the Pulp and Paper industry. An important regional difference is that the workplaces in the northern areas of Sweden are generally larger and have higher productivity and profitability than those in southern Sweden. As regards employment, it is largest in Northern Central Sweden, Western Sweden and in Småland and islands. In particular, the latter two have at the same time a relatively low average profitability and are therefore vulnerable to cost increases.

A large part of the business sector's transport consists of forest and forest industry products. The Forest industry is also one of the industries with the highest share of transport costs, which makes it particularly vulnerable for increased transport costs. The official statistics probably underestimate the importance of transport in the production process and supplementary information from other sources is therefore necessary to provide a fair picture of the effects of the kilometre tax.

The Forest industry has for a long time been one of Sweden's most important industries and was one of the first to be industrialised at the beginning of the nineteenth century. Thanks to the good access to cheap raw materials and a long tradition of Swedish forest management and engineering, Swedish products were internationally successful at an early date.

Today, the Forest industry accounts for around 12 per cent of Sweden's total production value, value-added and employment (Statistics Sweden). The Pulp and

Paper industry accounts for half of the output, sawmills for just over 20 per cent, the wooden house and carpentry industry for 15 per cent and industry for paper conversion for 10 per cent. Just under two-thirds of the total output is exported and trade with Forest and Wood Products industry goods annually generates a trading surplus of around SEK 90 billion[10] (Swedish Forest Industries Federation). In 2006, the share of Forest industry of total Swedish exports was 11.4 per cent (Statistics Sweden). From an international perspective, Sweden is a great power in the Forest industry, as clearly shown in the table below.

Table 9.2. Swedish Forest and Wood Products industry internationally, 2005. Source: Swedish Forest Industries Federation.

	Share of world output and export per product (%)	*Position in world*	*Position in EU*
Paper pulp production	6.5	4	1
Paper pulp export	9	4	1
Paper and board production	3.5	7	3
Paper and board export	9.5	4	3
Production of sawn hardwood	5.5	4	2
Export of sawn hardwood	11	3	1

Like many other industries, the forest industry has undergone a marked structural transformation characterised by increased capital intensity, efficiency and productivity but also by falling employment. Between 1980 and 2005, the number of sawmills with a production of over 10,000 cu m per year fell from 283 to 175 while total output increased from 11.2 m3 to 17.8 m3. Output per sawmill has thus increased by more than 100 per cent during the past quarter of a century. The Pulp and Paper industry has also drastically increased its production capacity. In 1980, the average capacity for a paper factory was 115,000 tonnes per year and for a pulp factory 145,000 tonnes per year. Now 25 years later, the figure has risen to 263,000 and 290,000 tonnes per year, an increase of over 100 per cent here too (Federation of Forest Industries 2006).

At the same time, the number of those directly employed in industry has fallen markedly over the years. The total number of employed in the Forest industry (SNI 20 +21) was 68,353[11] in 2004 evenly distributed between the two sectors (50.3% in SNI 20 and 49.7% in SNI 21). The number of workplaces, i.e. production units, was 7,496 in the same year. Of these 6,964 were accounted for by the Timber and Wood Products industry (93%) and only 532 by the Pulp and Paper industry. A clear difference between the two sectors is accordingly that the latter on average engages in operations in considerably large production units in terms of employment. However, the size of these units varies between the two regions for them both, which is illustrated by the figure below. It can be seen that workplaces are consistently larger in northern than in Southern Sweden, in

[10] In 2005, the trading surplus was SEK 87 billion (Statistics Sweden)
[11] In addition, around 20,000 people work in forestry, i.e. furthest down in the chain of production.

particular in the Pulp and Paper industry. One explanation of this pattern is that the long distance in the north creates high transport costs which must be compensated for by the cost benefits that large plants usually have.

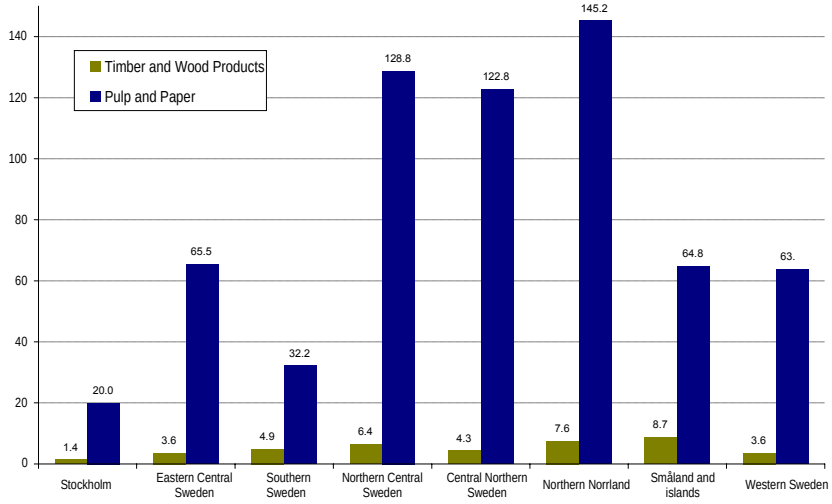

Figure 9.1. The number of employees per workplace in the Timber and Wood Products industry broken down by NUTS2 (2004). Source: Statistics Sweden, Regional basic data for enterprises by county and industry SNI

The Forest industry and international competition

The Forest industry as a whole consists of the Forest industry and forestry which provides the industry with raw material. The industry is mature in the sense that the enterprises that now exist have been operating for a long time and have made large long-term investments in both forest land and production facilities such as sawmills and pulp mills. Due to the large investments required, in particular in the Pulp and Paper industry, the barriers to entry are high and in principle no new facilities have been created in the Swedish market. Instead, large sums are invested in existing sawmills and plant with the intention of achieving increased productivity. The industry is also characterised by a clear vertical integration and forest companies often own both forest land, sawmills and plant. The prices of pulp wood, sawn timber, and cellulose chips are set in negotiations between purchasers and sellers in the mainly regional market[12]. The market for pulp and paper products is, however, almost global and prices in Sweden are affected to a large extent by the international prices.

The focus in the Swedish Forest industry has been increasingly on products in the upper segment of the value scale, both in the timber and wood products industry and in the Pulp and Paper industry. Somewhat simplified, it can be said that quality has replaced quantity. Sawn and planed wood products account for almost a fifth of the total export value of the Forest industry (Statistics Sweden). The

[12] Due to the relatively high transport costs, which make up a large part of the price of timber, the markets for these products are regional. Production takes place to a large extent where the raw material is.

market for pulp and paper is as mentioned above to a great extent international and demand elasticity is accordingly still high despite successful differentiation to more high-value product segment. This also applies to a somewhat smaller extent for the Timber and Wood Products industry.

This means that it may be difficult for the Swedish Forest industry to pass on relative cost increases in normal circumstances. In the latter period, however, a strong increase in construction in the main market Europe has increased the demand for wood products at the same time as supply is limited, which has contributed to a marked increase in prices (Lindholm 2006). In the Pulp and Paper industry, the picture is fragmented. In general, the cyclical development has been positive in recent years, although certain goods such as fine paper face very tough competition with pressure on prices. However, the pulp industry has experienced a relatively stable rise of demand and prices have also increased. Since pulp is by far the largest component of the industry, both in terms of output and exports (Statistics Sweden), this is very important for the development of industry as a whole.

From what has been said, it is difficult to say how large a part of the increased transport costs must be borne by the Forest industry and how much can be passed on to the end customer. If the economy continues to develop well, it will be possible to charge a higher price, while at the same time, it is naturally not the nominal price which is of interest but the relative, i.e. the price of Swedish Forest industry products in relation to competitors. In this way, increased production costs play a crucial role for international competitiveness despite the buoyant state of the economy.

An additional important aspect is how the cost of the kilometre tax will be apportioned between different parts of the Forest industry or to put it another way which actors have the greatest market power and thus the greatest opportunities to pass on cost increases to later or earlier levels?

Due to the extensive vertical integration, this question is not completely easy to answer. A large part of the Swedish forest area is owned and operated by the forest owner associations which own and take care of the land, fell the forest, refine the forest raw material in their own sawmills and pulp factories and sell finished products such as wooden boards, paper pulp and paper products to the end customer. The forest enterprises in the Swedish market also often own their own forest which they fell, although not sufficient to meet the need for pulp wood for their own paper pulp industries. They purchase the deficit from one another and from “purchasing” sawmills which buy raw material from private forest owners and sell sawn timber, pulp wood and chips to industry.

To sum up, the relations between purchasers and sellers of forest good and products in the Swedish market are very complex and it is very difficult to make any general descriptions of distribution of market power. From experience, however, it can be expected that forest owners may initially be in a situation where prices are depressed with a falling net conversion value[13] as a consequence.

[13] Net conversion value is the gross value of timber (the total of timber price at the lorry road) minus costs of felling and terrain transport (driving).

Ultimately, however, these owners are able to restrict supply of forest raw material and thus push the price up again. Increased demand for forest raw material due to increased investment in the biofuel may also play an important role in this context. However, the effect that this will have on prices is a matter for further study and is not taken up here.

Location patterns and profitability in the regions

The size of workplaces differs then between different parts of Sweden. They are largest in northern Sweden and smallest in Stockholm. The location of Forest industry shows clear patterns for natural reasons.

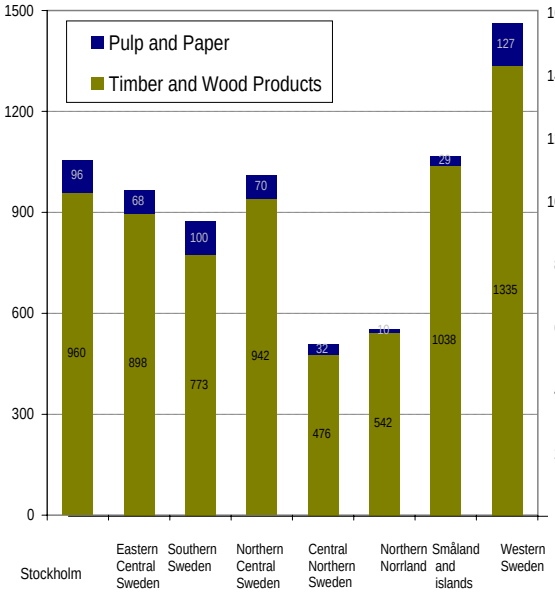

Figure 9.2. Number of workplaces in the Forest industry by NUT2 (2004).

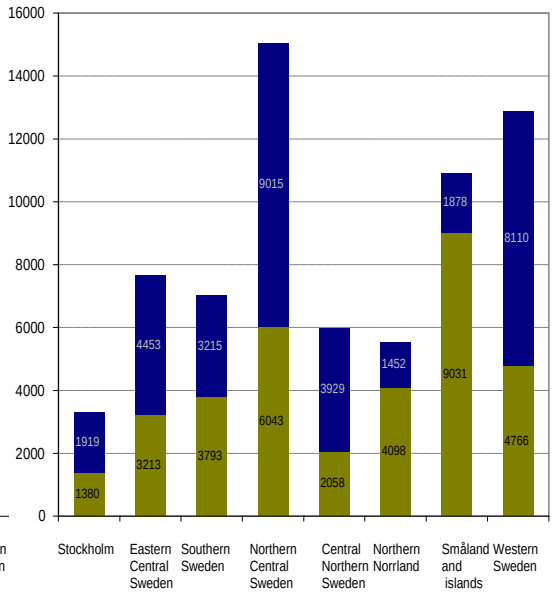

Figure 9.3. Number of employed in Forest industry by NUT2 (2004).

Source: Statistics Sweden, Basic data for enterprises by county and industry SNI 2002

Due to the relatively high transport costs for forest raw material, industry is often close to forest land, which is reflected in the location pattern. In general, industry is relatively evenly distributed over Sweden as regards the number of workplaces, with the exception of the two northern regions where there are considerably more workplaces and Western Sweden where there are a very large number of workplaces. The southern parts of the country predominate, with the exception of Northern Central Sweden, which has a relatively high concentration. The two northernmost regions, Central and Northern Norrland have the lowest concentration of workplaces, although as noted above the few units that exist employ a very large number of people. Despite the modest number of workplaces, the Forest industry employs as large a number of persons as in Eastern Central Sweden and Southern Sweden and double as many as in Stockholm.

Employment is thus more unevenly distributed. The above figures show in more detail how the number of employees varies between national areas and between industries.

What is of greatest interest is the total regional variations in employment, although it may also be of interest to look more closely at the two sub-sectors' respective presence in different regions. The Timber and Wood Products industry's employment is largest in Småland and islands and smallest in Stockholm. The Pulp and Paper industry employs most in Northern Central Sweden and Western Sweden and the lowest number in Northern Norrland and Småland and islands. Overall, employment is highest in Northern Central Sweden, Småland and islands and Western Sweden.

An additional important aspect is the profitability of the Forest industry and its variation between regions. A clear spread is visible in the above figure both between sectors and regions. A higher capital intensity and degree of added-value means that the Pulp and Paper industry is in general more productive and thus more profitable. The price of pulp and paper is around twice as high per m^3 as the price of wood products. The Pulp and Paper industry in Northern Norrland is most profitable which is also where the largest production units are (see Figure 3-1). Large factories tend to be more efficient and thus more profitable than small factories.

The profitability distribution between regions in the Timber and Wood Products industry is lower which can partly be explained by the size of workplaces not differing to the same extent as in the Pulp and Paper industry.

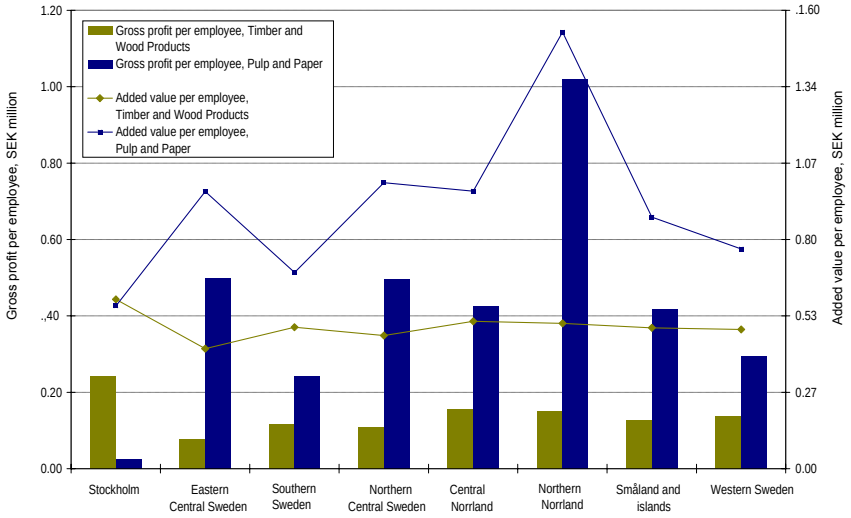

Figure 9.4. Gross profit and profitability in the Forest industry by NUTS2s, SEK million (2004).
Source: Statistics Sweden, Basic data for enterprises by county and industry SNI 2002

It can be noted from the figure that a given cost increase will probably affect the Forest industry differently in different regions. It is reasonable to assume that those with the lowest profitability will be harder hit than those with higher profitability. The kilometre tax recommended in this report will, however, not entail the same cost increase in the whole country and this must be taken into account to be able to say anything about its effects. This has been done as far as possible in the analysis in section five. An important factor in the analysis is the importance of transport costs in industry and their regional variation.

Road transport is important for the Forest industry

The Forest industry is the largest single haulier in Sweden and accounts for around 25 per cent of all land transport. Transport intensity is also relatively high, that is that transport accounts for a large part of the total production costs. During 2004, for instance, 42 million tonnes of round timber was transported by lorry, 5.2 million tonnes by railway and 0.4 million tonnes by ship (domestic and export). Over time the proportion of lorry shipments has increased markedly at the expense of other modes of transport. One explanation for this is that the latter has two highly valued characteristics where railway finds it difficult to compete, in particular over short distances, flexibility and reliability of delivery.

Round timber is only one of the products transported in the Forest industry, but is used as an example here partly because round timber accounts for over half of transport performance is with round timber (SIKA 2006:12) but also because round timber production is the most transport-intensive part of the value chain. At the same time, it is worth noting that round timber is generally transported shorter

distances by lorry[14] than for instance, sawn wood products and paper products (SIKA 2006:12), which may be thought to be important for how any effects of kilometre tax are distributed in the industry.

There has been extensive concern about the effects on the Forest industry in Sweden of the introduction of a kilometre tax since the Road Traffic Tax Commission published its final report (SOU 2004:63). Previous studies have produced contradictory responses to the question of the importance of transport costs (see, for instance, Skogforsk 2005 and Hammar 2006) and it can be noted that a large number of factors has made the analysis of the effect of a kilometre tax complicated (see Hammar 2006 for a more detailed discussion). Hammar (2006) also notes that the effects will probably be small even though certain regional differences may arise. This conclusion is supported by the results in section 9.4 above.

This study is mainly based on the public industrial statistics, which as described in the introduction only include purchased transport and in the current version only the manufacturing industry. In comparison with other operating costs, such as material cost, labour cost and capital cost are transport costs are generally of relatively small importance. For the Timber and Wood Products industry as a whole, the share was 3.26 per cent in 2004 and 8.33 per cent[15] for the Pulp and Paper industry (Statistics Sweden). However, of the total transport cost, only a part of the road transport cost is important from the point of view of the effects of kilometre tax. Over half of all pulp and paper transport takes place by lorry, 30 per cent by rail and the rest by ship. Lorry transport dominates in the Timber and Wood Products industry with over 90 per cent of transport performance. Compared with 2002, the transport cost share has risen by almost 80 per cent in the Pulp and Paper industry, while it has fallen slightly in the Timber and Wood Products industry. The increase is largely due to increased fuel prices and increased transport performance. Fuel consumption per tonne kilometre has, however, fallen gradually in recent years.

An important comment is that only public roads are proposed to be included in the kilometre tax system, not private forest roads. Only a part of the Forest industry's transport will therefore be subject to the kilometre tax.

It should be emphasised that this is an average for the whole industry and that there may be large variations between individual types of commodities and enterprises. One relevant comment in this context is also that since the share of transport costs of total costs can vary between companies, the effects of the kilometre tax will probably not only vary between industries but also between enterprises in the same industry. Enterprises with high transport intensity will experience a greater increase in cost in the event of the introduction of the tax and vice versa.

[14] This figure has been obtained from the National Board of Forestry's report "Skogstatistisk årbok 2006" [Forest statistics yearbook, in Swedish]. According to the Forest industry's research institute Skogsforsk, this is an underestimate of the actual volume, which Skogsforsk estimates at 65.3 million tonnes.

[15] The share of transport is the total of intermediate goods such as wood raw material, electricity and fuel and labour cost.

Transport costs' share of the total operating costs does not only vary between individual companies but also depending on the geographical situation. On average, road transport is most important for enterprises in the northern NUTS2 and in Eastern Central Sweden. To some extent, this pattern can be explained by operations being concentrated to a few large workplaces in Northern Sweden which entails longer transport and thus higher transport costs. For the sector as a whole, the share of transport cost is higher in the Pulp and Paper industry than in the Timber and Wood Products industry which means that the regions where the Pulp and Paper industry is important will have a higher transport cost share than those where the Timber and Wood Products industry is larger.

Purchased vis a vis total transport

The share of transport costs discussed above refers as said to purchased transport. Many companies only purchase a part of the transport they need to be performed by external entrepreneurs, however, and thus also have costs for transport performed "in house". These are not captured by the official statistics which will probably lead to an underestimate of the total transport cost for certain industries (or segments of industries). According to what ITPS has experienced, the Forest industry is an industry of this kind. The representatives of the Forest industry consider that transport represents a considerably larger share of production costs for certain types of commodities, in particular for round timber where the cost share is said to be between 15 and 33 per cent depending on method of calculation. According to Skogforsk, transport accounts for 26 per cent of all cost relating to the production and delivery of forest raw material to industry.
This large difference between public statistics and the values stated by Skogsforsk is naturally a matter of concern from an analytical perspective. To obtain a fair picture of the effects of the kilometre tax, it would be desirable to take into account the costs not captured by public statistics. The lack of alternative sources of statistics makes it difficult, however, to carry out quantitative studies of this.

The Mining and Mineral Extraction industry (SNI 10 – 14)

Summary:
The mining industry is dependent on ore for its production and location. This creates an uneven location pattern where certain regions employ several thousand persons and others very few. The areas where the mines are located are generally sparsely populated and largely lack alternative sources of income, which creates a great dependence on a few workplaces. At the same time, the industry is in principle impossible to move and the rapidly rising raw material prices have created good prerequisites to expand operations. In this perspective, sensitivity to price increases such as the kilometre tax can be expected to cause must be regarded as relatively low.

According to the official statistics, the Mining industry is the sector of the manufacturing industry which has the highest share of transport costs. However, the greatest share of transport takes place on the railway. The effects of the kilometre tax on transport cost can therefore be assumed to be marginal. According to information from the sector representatives, however, a considerable part of the total transport is carried out internally, which could increase the importance of the kilometre tax. The size of these internal costs is unclear, however.

The Mining industry can be roughly divided into three categories: metallic minerals, industrial minerals and construction material (Euromines, 2005). The most important products for the Swedish mining industry are iron ore, copper, lead, gold, silver and zinc[16]. In addition to the metallic ores, the official definition (SNI 10-14) also includes a number of other ores and minerals in the mining industry such as coal, lignite, peat, crude petroleum and natural gas, uranium and thorium ore and also a number of ancillary activities. All in all, with this definition, the mining industry provided employment for 7,106 people in the whole of Sweden in 2004.

Iron ore has for a long time been dominant in terms of production volume although in the course of time, the share of non-ferrous ore has increased considerably. In 2005, over 23 million tonnes of iron ore were extracted and almost 21 million tonnes of non-ferrous ore, compared with 1950, when 15 million tonnes of a total 17 million tonnes consisted of ferrous ore. The production value for the whole industry (SNI 10-14) was SEK 17.6 billion in 2004 and there were 7,106 employees, of which 4,353 worked in or in the vicinity of the mines.

Besides the reduced share of output of iron ore, the mining industry has changed above all in two ways: 1) The share of mines has decreased drastically and 2) output has risen as dramatically. At the turn of the century, there were around 400 mines in operation in Sweden, most of them iron ore mines. Today, there are 14 of these left and only two are iron ore mines (Kiirunavara and Malmberget). During the same time period, the production volume has increased more than ten times from just under 4 million tonnes to almost 50 million tonnes (SGU 2006).

[16] See Geological Survey of Sweden, SGU (2006), Bergverksstatistik 2005 for a more detailed review of the mining industry.

Apace with the number of mines, employment has also decreased. At most over 16,000 persons worked in the mines with ore mining and related activities. The peak was in 1957-58 while today only 4,000 are employed. The strong increase in productivity that this has been based on has been possible due to continuous investments in new labour-saving technology.

Today, large parts of work in the mine are carried out by computers and advanced machinery (SGU, 2006).

As in the Forest industry, the Mining industry in Sweden is an important player in the international arena. Swedish industry is particularly dominant in the iron ore industry, almost 90 per cent of the ore extracted in the EU25 area is mined in Sweden.

Table 9.3. Mining production of certain metals in Sweden and EU-25. Source: SGU, 2006

	Swedish output	*EU-25 total*	*Sweden's share %*
Iron (million tonnes ore)	23.3	26.0	89.4
Gold (tonnes content)	6.6	17.8	36.9
Lead (thousand tonnes metal content)	60.4	166.5	36.3
Zinc(thousand tonnes metal content)	215.7	802.0	26.9
Silver (tonnes metal content)	309.9	1,801.7	17.2
Copper (thousand tonnes, metal content)	87.1	722.7	12.0

A large part of the ore is, however, used in domestic industry, which means that iron ore only constitutes a small part of Swedish exports (0.9 per cent per year in 2006). All in all, mineral goods are still (including iron and steel) an important export good for Sweden, with an export share[17] of over 10 per cent (Statistics Sweden).

Swedish mining industry and international competition

The Mining industry in Sweden has internationally a special position due to the good access to high-quality raw material. This applies both to iron ore and other minerals such as zinc, copper and lead. In Europe, Sweden is wholly dominant as a producer of iron ore (SGU 2006). Sweden, as well as other countries with surplus capacity, has in recent years been favoured by the strong growth, in particular in China, which has created a high and rising demand for both metal ores and finished iron and steel products. Production capacity has to date not

[17] The export share is calculated by dividing the export value from one group of commodities by the export value for all groups of commodities. The engineering industry has the largest export share, 49 per cent, which includes vehicle manufacture, other machinery and telecom etc.

grown at the same rate as demand and prices have therefore been pushed up. This has brought about a situation where price sensitivity has decreased in the market and the possibilities of obtaining compensation for cost increases by a higher end price have increased for the market as a whole. However, the Swedish mining companies are dependent on the price negotiations that take place annually between the largest players in the industry, such as Japanese Nippon Steel (steel production) and Brazilian CVRD (Companhia Vale do Rio Doce (iron ore), where in practice the world market prices are set. In a negotiation between these two at the beginning of 2005, an agreement was concluded for a price increase of 71.5 per cent, which says something about the positive development for the Mining industry.

Despite the strong general price increases in recent years, Swedish industry is, however, to a great extent a price-taker on the world market. Swedish producers cannot obtain full compensation for a higher end price without losing demand and export volume. As in the case of the Forest industry, the price increases which the kilometre tax leads to must be borne at the level of production in the Mining industry. At present, however, margins are good, there is a very high level of demand and a high investment propensity, which, in combination with being tied to the raw material means that the effects on production and employment in Sweden can be assumed to be limited.

Location patterns and profitability in the regions

Due to the fact that the Mining industry is dependent to such a high extent on geographically immobile resources – ore – location is also highly dependent on the location of the mines.

As described above, only a few mines are in operation today, which means that both the number of workplaces and their distribution are very limited. Mining only takes place in four counties:

Table 9.4. Mining in mines in Sweden, 2005 Source: SGU, 2006

County	*Mines (mineowner)*		*Type of ore*
Örebro	Burkland	(Zinkgruvan Mining	Zinc, lead, silver
	Nygruvan	AB) (Zinkgruvan	Zinc, lead, silver
	Lovisagruvan	Mining AB)	Zinc, lead, silver
		(Lovisagruvan AB)	
Dalarna	Garpenberg	(Boliden Mineral AB)	Zinc, lead, silver
Västerbotten	Kristineberg	(Boliden Mineral AB)	Copper, lead, silver
	Svartiliden	(Dragon Mining AB)	gold
	Storliden	(North	copper, zinc
	Maurliden	Alt.Nat.Res.AB)	copper, lead, zinc
	Petiknäs	(Boliden Mineral AB)	copper, lead, zinc
	Renström	(Boliden Mineral AB)	copper, lead, zinc
	Björkdalsgruvan	(Boliden Mineral AB)	gold
		(Björkdalsguvan AB)	
Norrbotten	Malmberget	(LKAB)	Iron ore
	Kiirunavaara	(LKAB)	Iron ore
	Aitik	(Boliden Mineral AB)	Copper, gold

Due to special confidentiality provisions[18], the municipalities were excluded in the regional breakdown where one or a few enterprises totally dominated the market. One result of this is that both the number of employed and the production value are greatly underestimated for certain regions. A summing of the number of employees in all national areas gives the figure 3,522, which is just under half of the figure in the national statistics. In the same way, the production value is more than halved due to the regional breakdown, from 17.6 billion to 7.6 billion. This means that a comparison between regions based only on the official statistics will not be wholly fair, in particular not in the Mining industry where the number of workplaces is relatively small, since the regions that are most dependent on a particular or a few workplaces cannot be reported. Since the official statistics are none the less the best available, we have chosen to use them despite the above deficiencies. However, where possible, they will supplemented with figures form other sources.

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Figure 9.5 below shows the number of workplaces and employed in the mining industry distributed to NUTS2. Most workplaces and employed are in Eastern Central Sweden, which includes the county of Örebro (see Table 9.4 above). As regards location of workplaces, Western Sweden is in second place, thereafter Småland and islands. In general, the curve of the number of employees follows the number of workplaces, with one clear exception: Northern Norrland. Here there are almost as many employees ass in Eastern Central Sweden, despite there only being a third as many workplaces. In Northern Norrland, the average workplace employs almost 20 persons per workplace which is more than three times as many as in Southern Sweden, which is the NUT2 with the second largest plants.

[18] No workplace is, for instance, to constitute more than 50 per cent of output or employment in an area (municipality, county, NUTS2).

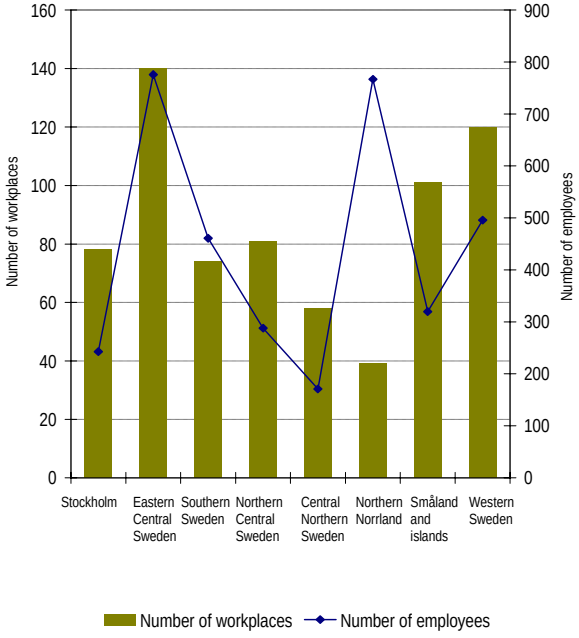

Figure 9.5. Number of workplaces with employees in the mining industry, broken down by NUT2, 2004

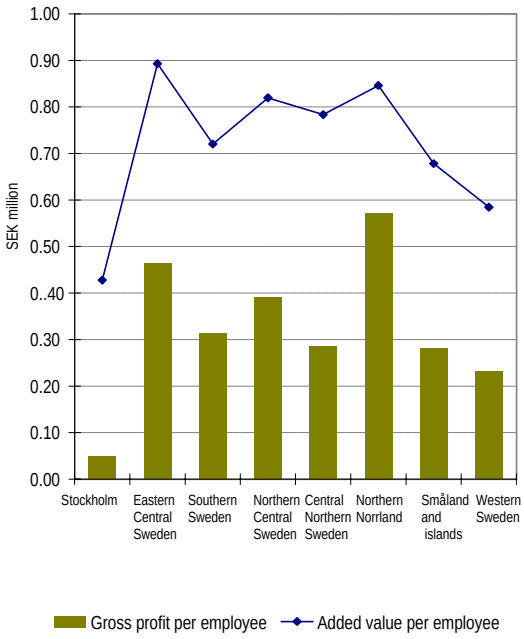

Figure 9.6. Gross profit and added value per employee in the mining industry broken down by NUTS2, 2004.

Source: Statistics Sweden according to Basic data for enterprises by county and industry SNI 2002

To complement the picture in the figure above, it can be said that LKAB according to its annual report for 2005 employed 2,938 persons in Sweden in 2005, of which an overwhelming majority were in Northern Sweden. According to the official statistics, however, only 767 persons work here. The interpretation of this is that the municipalities where LKAB operates, that is Gällivare and Kiruna, are not included in the aggregate for Northern Norrland and that both the number of employees and the value of output for this region are thus in reality considerably higher than stated by the statistics.

Likewise, Boliden has a large number of employees in Sweden (a total of 2,262 in 2005) which are probably not included in the regional statistics. The regions which are affected by this are Northern Norrland (Skellefteå and Aitik), and Northern Central Sweden (Garpenberg). The size of employment in these two regions are thus greatly underestimated in the above account and if the employees in LKAB and Boliden were included in the above diagrams, the curve would be considerably higher for them both.

Through a more detailed examination of the data material, we have, however, been able to note that the problem is largely restricted to Northern Norrland and Northern Central Sweden.

As regards productivity and profitability, the regional variation is relatively small, although there is an exception here. Workplaces in Stockholm have on average considerably lower productivity and profitability than in the rest of Sweden. One

explanation of this is that very little production takes place in Stockholm, but enterprises instead have their head offices here, which does not generate any real production value. The average productivity is highest in Eastern Central Sweden and Northern Norrland, although the distance to the others is as said not remarkable.

The importance of transport

As mentioned above, the share of transport costs is high in the Mining industry, over 12 per cent in 2004. Most purchased transport takes place by rail, however (over 90 per cent) and the kilometre tax may be assumed to only have a limited effect on the transport cost (this is also shown by the calculation results presented in section 9.5). It is, however, unclear how well the cost of purchased transport matches the total cost.

The Food Products industry (SNI 15 + 16)

Summary:
The Food Products industry in Sweden consists of many enterprises of very varying nature, everything from small local players with small-scale production to large industrial manufacturers with sales both throughout Sweden and abroad. Employment is concentrated to some extent in the southern regions, but there are also many enterprises in the north.

The share of transport costs is relatively high compared with other industries, although there are considerable regional differences. The share is highest in Stockholm, followed by Central Norrland, Southern Sweden and Northern Norrland. The long distances are the explanation for the high transport costs in the north, while Stockholm's and Southern Sweden's high share is probably due to their function as logistics centres.

Agriculture, the Food Products industry and the retail trade are a closely intertwined chain of production. It is therefore important to analyse not only the industry but also its relationship to earlier and subsequent stages to understand how the market works.

The Food Products industry in Sweden consists of a mixture of enterprises of very varied character, everything from small locally active private players to large multinational groups. The number of employees in the Swedish Food Products industry was 57,194 in 2006 and the total production value just over SEK 139 billion, which makes the Food Products industry Sweden's fourth largest manufacturing industry (Statistics Sweden).

The industry consists of some fifteen segments, of which the abattoir and cured meats industry, the dairy industry and the bakery industry are the largest. These together have around 60 per cent of the total number of employed (food products companies).

In 2006, there were just over 3,100 enterprises in the industry although around 1,300 of these were sole proprietorships. Small-sized enterprises generally predominated – only 356 enterprises had more than 19 employees in 2006. This represented just over a tenth of the total number of enterprises although 86 per

cent of the workforce were employed in these enterprises. More than half of the employees worked for 37 enterprises with more than 250 employees, which shows the importance of the larger companies. The five largest enterprises alone employed around 20,000 people, or a third of the total workforce. The dominance of the larger enterprises is even clearer in terms of production and added value, accounting for 40 per cent of the total value of output. Productivity is also around 60 per cent higher in the largest enterprises than in the smallest.

The structural transformation that has taken place for a long period in, among others, the Forest and Mining industries, has started to make its appearance in earnest in the Food Products industry in recent years. This has led to a relatively large reduction in employment, mainly in the three largest sectors and in the brewing industry (The Swedish Food Federation).

On the Swedish market, a few dominant retail trade companies have a very strong position. Prices are set in negotiations between the retail trade and food companies, where competition between suppliers pushes prices down. One way of dealing with this has been to differentiate the supply by producing new products with characteristics that justify a higher price, for instance, nutritious products with lower sugar and fat content.

The Swedish food products industry and international competition

The largest actor in the global food, agricultural products and beverage market is the EU which accounts for around 10 per cent of the world's exports and imports. The United States comes in second place and then Brazil, which has gradually overtaken Canada in recent years. Overall, the EU is a net importer of food and agricultural products, although the picture varies within the sector. The trade surplus in 2005 was almost SEK 100 billion for agricultural goods while the food and beverage industry generated a surplus of over SEK 40 billion (The Swedish Food Federation 2006).

Internationally, Sweden is a relatively small producer, with around two per cent of the total food products production. Since Sweden became a member of the EU, export has developed strongly, however. Between 1995 and 2006, the export value almost quadrupled from SEK 10.4 billion to SEK 39.1 billion and the share of food export that consists of refined food products has grown and now accounts for 70 per cent of food exports. Other export products consist of agricultural goods, for instance, grain and sugar, and fish. (Swedish Food Federation, Statistics Sweden). The trade balance, export/import has moved from the relation 1:3 on entry into the EU in 1997 to 1:1.8 in 2006 (Statistics Sweden).

An important comment on this figure is that a large part of both the EU's and Sweden's agricultural and food products industry receives large amounts in EU export aid. This aid amounts to SEK 25 billion annually, of which Sweden receives SEK 600 million primarily for export of dairy goods, sugar and grain to countries outside the EU. Ten per cent of Sweden's aid is paid to the Food Products industry for it to use European agricultural products in products that are to be exported. In combination with high import tariffs for the majority of non-European agricultural and food products, this creates a situation where European

producers are often protected from competition in the world market. On the common European market there is free competition, however, and the price of exported goods from Sweden is given by supply and demand in this market.

Unlike the Forest industry and the Mining industry, the Swedish Food Products industry has been protected for a long time from competition from other countries and is thus not sensitive to the same extent to rising production costs. Food prices in Sweden have also been among the highest in Europe for a long time. However, the situation for Swedish food producers was fundamentally changed when Sweden joined the EU. The European market which was previously largely closed now became a common market and competition increased dramatically. Prices in Sweden have been harmonised in relation to the rest of Europe even if they are still 5-6 per cent above average for the old EU countries (EU-15). The Swedish Competition Authority also notes in its report Konkurrensen i Sverige 2006 [*Competition in Sweden 2006, in Swedish*] that food has become cheaper since the mid-1990s. The price of food and non-alcoholic beverages has fallen by almost 10 per cent compared with the general price trend, the greatest change taking place directly after entry into the EU (Swedish Board of Agriculture 2006).

Contrary to what many feared, i.e. that Sweden would, in principle, cease food production, Swedish export of food has developed very positively since 1995. Refined foods, such as vodka, chocolate, bakery products, jam and non-alcoholic beverages have developed better than agricultural products, which is in line with the general trend towards a greater proportion of highly refined products in export (Swedish Food Federation).

However, import competition has also increased in the domestic market, which increases the driving forces for differentiation of the product range and increasing efficiency of production processes. Competition from own brands has risen due to increased internationalisation.

Structural changes in the Food Products industry have only contributed to improved productivity to a moderate extent and profitability has developed negatively since the beginning of the 1990s (Swedish Board of Agriculture 2004). Cost increases such as the kilometre tax entails can be expected to put further pressure on margins. The ability to pass on any costs increases arising from the kilometre tax to the end customer is regarded as relatively limited due to the increasing competition, even if some increase in consumer prices in Sweden cannot be excluded. For domestic consumption, product area specific factors will determine the distribution of effects between the consumer and producer. The commodities that are sold outside Sweden's borders will, however, encounter the given prices and the cost increase here will probably be borne by the manufacturers.

Location patterns and profitability in the regions

The Food Products industry is the geographically most spread industry in Sweden even if it is concentrated to some extent to Southern Sweden. Three-quarters of the workforce and two-thirds of the number of workplaces are in the four southern national areas (Southern Sweden, Småland and islands, Western Sweden and Stockholm). It is also here that the largest workplaces are situated with an average

workforce of 2.25 persons, which is 3.5 times the average workforce in a workplace in Northern Norrland.

As regards profitability and productivity, the distribution is fairly even throughout the whole of Sweden. Central Norrland deviates, however, from the others with high productivity for the industry. The difference between the “best” and “worst” region is only 43 per cent, however, while the most productive region in, for instance, the Pulp and Paper industry manages to create 2.7 times added value per employee than the least productive region.

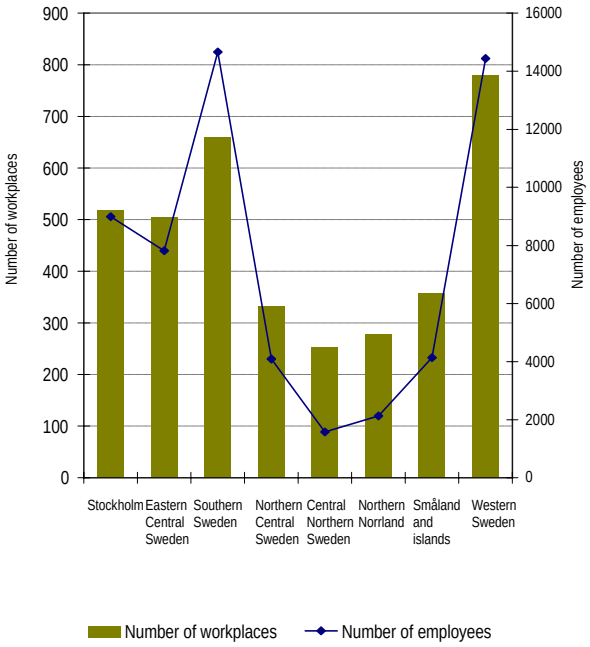

Figure 9.7 Number of workplaces and employees in the Food Products industry by NUT2, 2004.

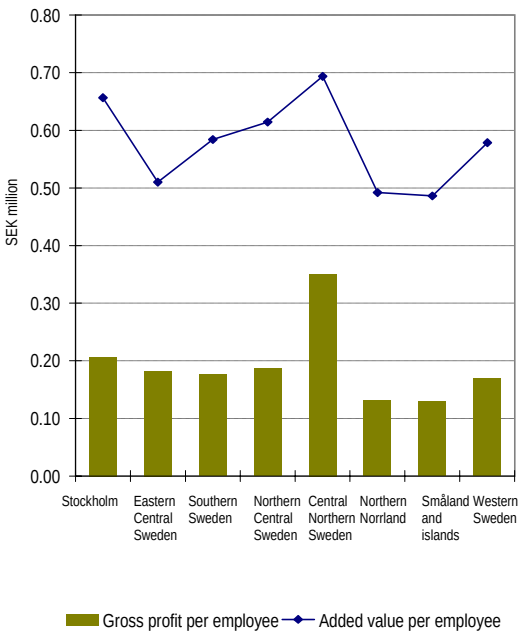

Figure 9.8 Profitability and productivity in the Food Products industry by NUTS2, 2004.

Source: Statistics Sweden, Basic data for enterprises by county and industry SNI 2002

The importance of transport

In the Food Products industry, as in most industries, transport is an integrated part of the production process. Grain, meat, dairy products and other agricultural products are transported from the farms to the Food Products industry enterprises where the raw material is refined and sold to the consumer in the form of, for instance, bread, breakfast cereals, and frozen convenience food.
The large number of small-sized enterprises in the Food Products industry often operate locally or regionally, and it can be assumed that transport costs are not generally a large part of the total costs for these enterprises. However, there are also many large undertakings that produce for the whole of the Swedish market.

According to the official statistics, transport costs accounted for 3.4 per cent of the total production costs in 2004, which is an increase of 0.4 percentage points compared with 2002. However, there are large regional differences and the NUTS2 with the highest transport cost, Stockholm, has almost three times as high share as the national area with the lowest share, Eastern Central Sweden [19]. The two northernmost areas have also high transport costs, but probably for different reasons than Stockholm and Skåne. The two latter areas serve as reloading places, which increases transport intensity, while the high share of transport costs of the northern areas is largely due to the distance to the large markets in Southern Sweden and Europe.

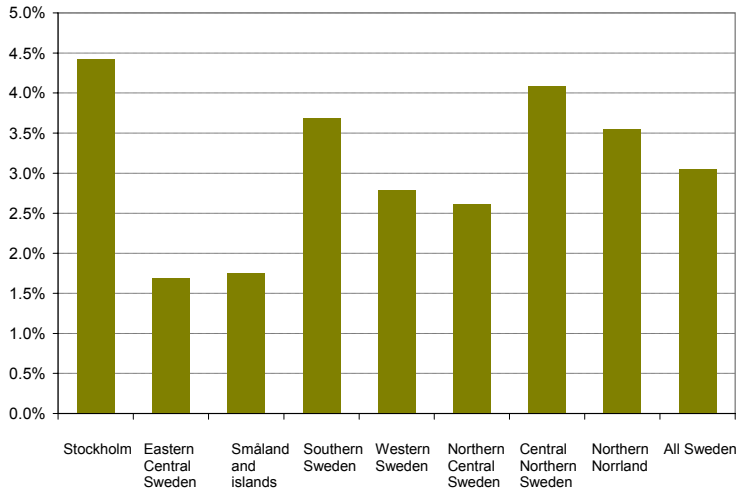

Figure 9.9 Share of transport costs in the Food Products industry by NUTS2, 2001.

A development that has begun in recent years is the large retail companies have increasingly taken over both control of the transport operation itself, for instance, all of ICA's meat is packaged for the consumer in Västerås and then distributed to ICA shops throughout Sweden. ICA has also started to take over the breweries' distribution of beer and soft drinks, in the first place Spendrups products. ICA's new distribution system is based on all goods being, in principle, distributed through ICA's warehouses and an end to direct distribution. The reason for this is to achieve economies of scale by co-ordination and more detailed planning, for instance, of deliveries to shops.

[19] The figures for the regional distribution of transport costs are from 2001, which is due to the statistics subsequently being reported in a way that makes comparisons with earlier years unsuitable.

Engineering enterprises (SNI 27-35)

Summary:
The engineering industry is responsible for a large part of Swedish industry's employment, production value and perhaps above all export. From the perspective of the business sector, what happens in the industry and how its competitiveness develops is therefore important. Operations are spread over large parts of Sweden, even though there are clear concentrations in Western Sweden and Eastern Central Sweden. Engineering enterprises accordingly employ many persons in sparsely populated regions, which also makes the industry important in a regional policy perspective.

It is therefore important to take into consideration the effects of the kilometre tax on the competitiveness of engineering enterprises. Since the share of transport costs is low in the industry, the effects can be assumed to be small in relative terms. Since many enterprises are already under pressure by high prices of intermediate goods and strong price competition for the end product, there is, however, a risk that even small increases in transport prices will, in the short term, lead to considerable effects on output and employment.

The Engineering industry consists really of a several industries or rather a large number of enterprises working within very varied areas. A common definition for this group is that used by the engineering industry's trade organisation, Teknikföretagen, i.e. SNI 28-35[20]. Due to the categorisation made by Statistics Sweden in the regional statistics, metal production (SNI 27) is also included in this study.

What typifies engineering enterprises is precisely the large dependence on technology and technological solutions in their products, which may be anything from mobile telephone switchboards and heavy lorries to office products and small optical instruments such as lenses and microscopes. High demands on technical expertise and specialised technical solutions create driving forces for investment in research and development. The industry is therefore one of industry's most research intensive and around half of the business sector's total research input originates from engineering enterprises.

Altogether, the approximately 24,000 enterprises in the industry have a turnover of SEK 845 billion and employ 366,000 persons or 16 per cent of the workforce in the private sector in Sweden. An overwhelming majority of these enterprises are, however, small, over 90 per cent have fewer than 20 employees and only 193 have more than 250 employees. Despite the small share of the corporate population, the largest enterprises account for a majority of both employment (57 per cent), production value (70 per cent) and value-added (67 per cent).

Around half of all Swedish exports originate from engineering enterprises and the industry accordingly has a special position in the Swedish business sector. The

[20] The metal goods industry (SNI 28), machinery industry (SNI 29), electrical , telecommunications products and instrument industry (SNI 30-33) and the transport industry (SNI 34-35).

industry's foreign trade generates a large trade surplus as well. In 2005, the value of export was over SEK 100 billion higher than the value of imports, in kronor (Statistics Sweden).
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The Engineering industry and international competition

The structure of the industry is complex and the internal relations between segments are difficult to describe in general terms. The figure below shows a simplified picture of reality, which aims at providing an overall understanding of the relationships of dependence that exist. In brief, it can be said that the industry consists of sub-contractors and end manufacturers. The former purchase intermediate goods such as ore, plastic and electronic components and refine these into semi-manufactured goods of various kinds. These are in turn used by the end manufacturer to produce the end product, which is sold on the world market at prices that are in principle given. As in the Food Products industry, the greatest market power lies with the end manufacturer, which is often a large enterprise with production not only in Sweden. Price competition is greatest between different sub-contractors and it is accordingly among these that margins are especially small.

It is difficult to pass on an increase in production costs in Sweden due to the kilometre tax but this must be borne by the manufacturers. Due to the strong position of the large enterprises it is reasonable to assume that they will pass on a large part of the cost to earlier stages. At the same time, it is not probable that sub-contractors can press down the price of intermediate products, since demand for especially metals globally is at record levels globally. At this end too, price competition is also to the disadvantage of the intermediate layer. Increased prices on intermediate products and higher demands for reduced prices from the end manufacturer place sub-contractors in a precarious situation. However, it is difficult to say what effects the kilometre tax will have in this context. Other factors probably play a greater role, although it is wholly conceivable that even a marginal increase in transport costs can entail major problems for certain enterprises.

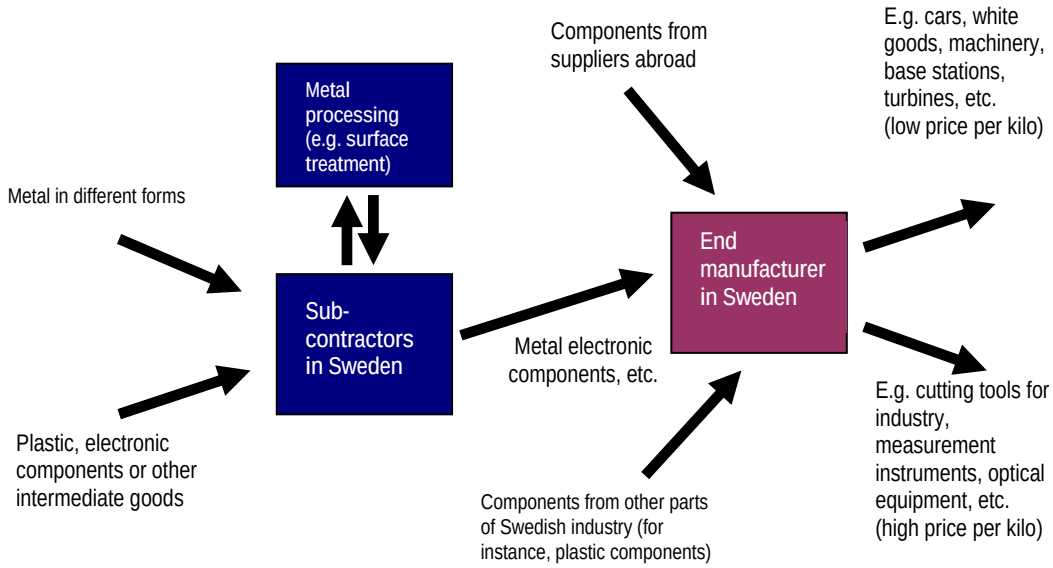

Figure 9.10. Generalisation of the chain of production in the engineering industry. Source: Teknikföretagen

Location patterns and profitability in the regions

The engineering companies are relatively strongly concentrated in southern Sweden, and then in particular Western Sweden, Eastern Central Sweden, and Stockholm. Gothenburg, Stockholm and Linköping/Norrköping have for a long time been industrial centres, not least within the vehicle industry. In recent years, activities in these places has been differentiated from almost exclusively consisting of the vehicle industry to also including other segments of the engineering industry.

Employment and the number of employees accord well with one another, as shown by the figure below, according to which the size of operation only varies marginally between regions. It is largest, however, in Eastern Central Sweden, where on average 17 people work at each workplace (Statistics Sweden).

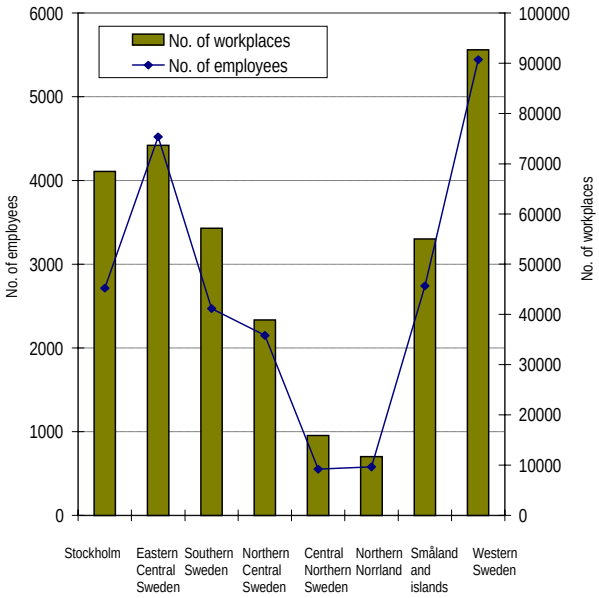

Figure 9.11 The number of workplaces and employed in engineering companies by NUTS2, 2004

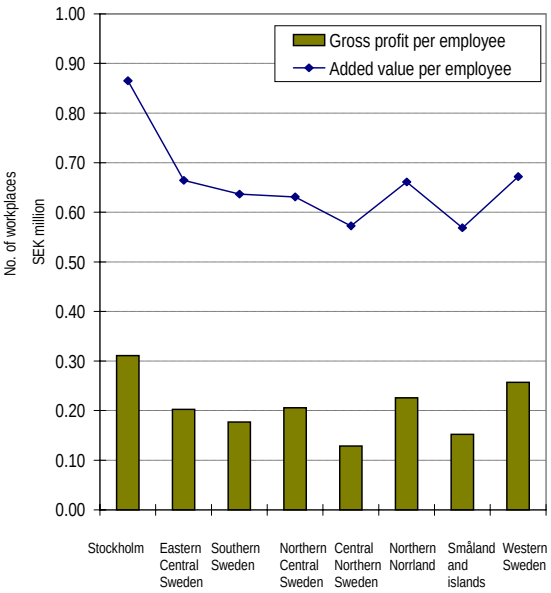

Figure 9.12 Added value and gross profit per employee in the engineering industry by NUTS2, 2004

Source: Statistics Sweden, Source: Statistics Sweden, Basic data for enterprises by county and industry SNI 2002

Large workplaces do not necessarily seem to be more productive than small in the engineering industry, since enterprises in Stockholm are both relatively small and most productive. Productivity does not generally differ markedly between regions and thus not either profitability. There is accordingly nothing that indicates that any region would be particularly sensitive to general cost increases, The share of transport costs is also on average relatively evenly distributed between regions, which indicates that the kilometre tax should not have any distorting regional effects to speak of (see below).

The importance of transport

The share of transport costs is relatively low compared with other focus industries and also compared with the national average. In 2004, purchases transport accounted for 1.7 per cent of the total production costs. The main part of the domestic transport consists, however, of road transport and due to the structure of the market and the location of the industry, a transfer to alternative modes of transport, mainly the railway, would not be an alternative in the short term in many cases. This means that a kilometre tax for heavy transport would probably mean a relatively large increased in transport costs, even if the level is low in absolute terms.

The importance of an increase in transport costs of this kind should not be exaggerated, however, in particularly not in comparison with other changes in costs, such as increased energy prices. The effects are studied more closely in section 9.4 below.

As mentioned above, there are no marked differences between regions as regards the importance of transport. The northern regions do not have larger costs for transport than the southern (in relative terms). The fact is that Småland and islands is the single region with the highest share of transport costs, followed by Stockholm. It is accordingly in these areas that the kilometre tax will have the largest cost effect. Since the engineering companies in Stockholm are also those with the highest productivity and profitability this allocation contributes to softening the effects of the kilometre tax for the industry as a whole.

Summary

This study primarily aims at describing the effects of the kilometre tax on industries and regions. The industries described above are of particularly great importance for mainly two reasons. They have relatively high transport costs in relation to the national average and/or are important for the Swedish economy both in terms of employment and in terms of output and export value. The first point is illustrated in Figure 9.13 and 9.14 below, where it is clearly shown that the share of transport costs of total production costs is higher than the national average in three of the four focus industries. In particular in the Mining industry and in the Paper and Pulp industry, the share his high and it has also increased markedly between 2002 and 2004. The Engineering industry has a low share but is included in the analysis due to its great importance for the Swedish economy. The increase in transport costs is also relatively high in the sectors included in this industry, which is shown by Figure 8.1 above where the engineering industries are largely included in the product group High-value products.

What is also shown by the figures above is that the share of total transport costs that relate to road transport (or a combination of road transport and other modes of transport) varies greatly between the different sectors The proportion of the transported weight in the Mining industry which is transported by road is relatively small while it constitutes almost the entire transport performance of the Food Products and the Timber and Wood Products industry. Road transport also accounts for the overwhelming part of transport for the Engineering industry.

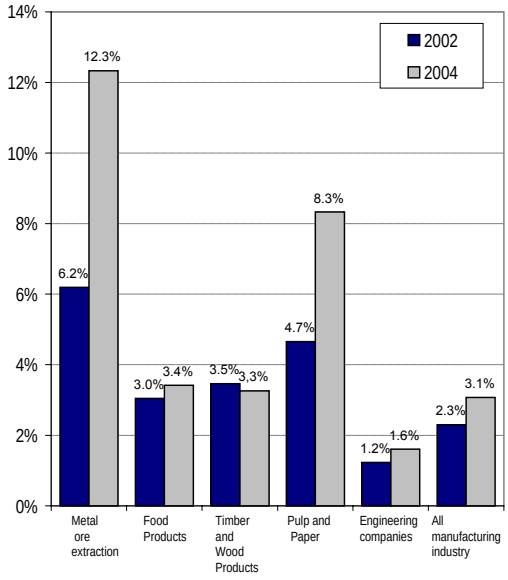

Figure 9.13. Total share of transport costs in the study's focus industries, 2003 and 2004.

Source: Statistics Sweden

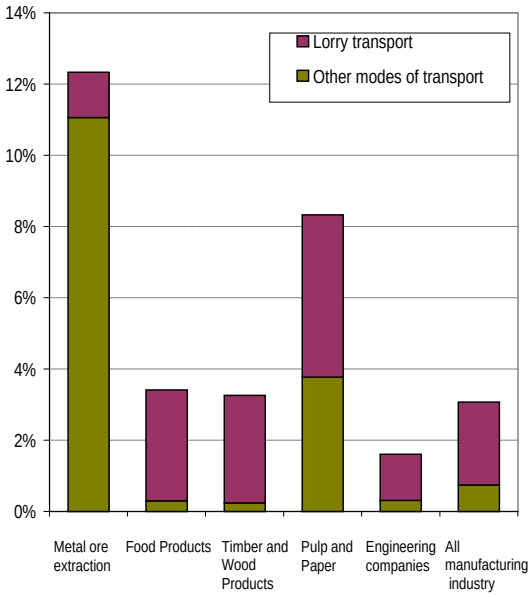

Figure 9.14. Share of transported weight by lorry and by other modes of transport, 2004.

Source: ITPS processing of statistics from Statistics Sweden and SIKA, VFU 2004/2005.

The above observations mean that the effects of the kilometre tax, which will only indirectly affect road traffic costs, will not be distributed evenly between the industries. Industries with a high share of road transport costs can reasonably be assumed to experience greater effects of the kilometre tax than those with lower road transport costs. However, this is not the entire truth. The above assumption is correct with regard to the effects of transport costs on the total production costs but other factors must be weighed in to be able to say anything about the effects the kilometre tax may be expected to have on production and employment (see section 9.4).

Some of these factors are dealt with in the description of the industries in this section, for instance, profitability and productivity, and how they are apportioned between regions of Sweden. This review shows that in certain industries, for instance, in the Pulp and Paper industry, there are large regional differences, which can be expected to be important for the companies' ability to bear the costs of kilometre tax. In, for instance, the Mining industry and the Food Products industry, the differences are not especially great, however and the effects can thus be expected to be spread relatively evenly over the country.

In the next section, the effects of the kilometre tax are analysed on, among other things, output and employment in different industries and regions in detail. However, the Mining industry is excluded from this part of the analysis since the change in road transport cost is so small so that no calculable effect can be found. This does not mean that the kilometre tax will have no effect but only that it is not possible to make a quantitative analysis of the effects.

9.4 Effects of the kilometre tax

Calculations of the expected effects of the kilometre tax on production, employment and profit for the study's focus industries are presented in this section. As mentioned above, the Mining industry is not included in this analysis, however, since the percentage increase in transport costs is too small for the factor demand model to provide any interesting information in this case. The figure below shows the percentage change of the transport costs for different industries. Changes are based on those presented for types of commodities in Chapter 8 above, although allocated to industries here in accordance with the SNI code categorisation. This is to enable calculations to be made in the factor demand model which uses SNI industries.

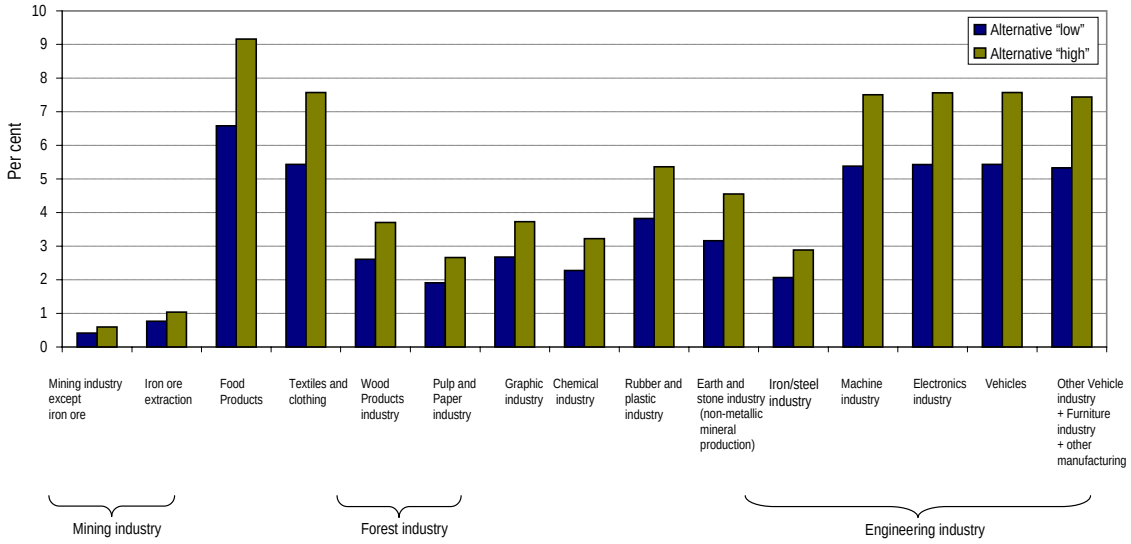

Figure 9.15. Transport cost increase in manufacturing industry due to the kilometre tax.

Source: SIKA and processing by ITPS

These calculations are based on the increase in transport costs caused by a kilometre tax where the internalising effect of the energy tax has been included (i.e. the "low" alternative). As described above, this is lower than if energy tax is left unchanged, approximately SEK 1 per km compared with SEK 1.4 per km.

The reasoning underlying this delimitation is that the "high" kilometre tax over-internalises the external effects and thus deviates from the marginal cost principle. For one industry, the Food Products industry, these results are presented for both alternatives, however in order to illustrate the difference between a high and low kilometre tax.

The factor demand model calculates the changes for each industry separately, which means that the variation in transport cost changes shown above (see Figures 8.1 and 8.2) affects the results in this analysis.

Two analyses are made in the following section: one where the effects on the production, employment and profit at the national level of the individual industries are presented and one where the effects are described for the whole of manufacturing industry, Limitations in the statistical basis make impossible a finer regional breakdown and an analysis of the effects on individual industries at the regional level.

National level

The table below shows the results of calculations of changes in the use of labour and capital and changes of production and profit for the Food Products industry, the Forest industry (broken down as before into two segments), and the Engineering industry (broken down into four segments here: Iron and Steel, Electrical/Electronic, Machinery and Vehicle).

What is not explicitly shown here is that increases in transport costs led to reduced demand for transport in general. We have also seen above that changes in costs differ between industries. The factor demand model calculates changes in transport demand but due to the small relative cost changes, these changes are not statistically significant (we cannot say whether they differ from zero or not). The effects presented here should be seen in the light of the reduced demand for transport.

Table 9.5 Percentage change in the use of work and capital and of production and profit due to a marginal-cost based kilometre tax[(a)]
Source: ITPS

	Labour	*Capital*	*Production*	*Profit*
Food Products (SNI 15+16), low alternative	2.74	-0.92	0.01	-0.05
Food Products (SNI 15+ 16), high alternative	3.81	-1.28	0.02	-0.06
Wood products (SNI 20)	-0.05	-0.09	-0.02	0.03
Paper and pulp(SNI 21)	-0.62	-0.02	0.02	0.05
Iron and steel (SNI 27+ 28)	0.17	-0.01	0.01	0.00
Machinery (SNI 29)	0.13	-0.23	0.02	0.02
Electrical/electronic (SNI 30-33)	0.56	-0.99	-0.15	0.07
Vehicle (SNI 34+ 35)	0.33	0.02	-0.02	-0.04

(a) Concerns a kilometre tax of around SEK 1 per km.

Production is changed extremely marginally in all industries. The largest change is in the electrical/electronic industry (part of the engineering industry) where production falls by 0.15 per cent. Otherwise, the change is less than a half per cent. Neither is profit affected to any significant extent, even if the change is somewhat larger here. *The results do not provide a clear negative picture of the effects of the kilometre tax. In several industries, in fact a small increase in profit can be observed after introduction.* However, it is important to point out that this is an analysis with a long-term perspective. Enterprises are expected to be able to adapt their production to the new circumstances by substituting for instance transport for labour and capital. The section below contains a discussion on the effects in the short term, without these opportunities for adaptation.

The clearest effect is that more expensive transport seems to lead to increased demand for labour. Only in the Forest industry, and then, in particular in the Pulp and Paper industry, does kilometre tax lead to lower employment. The interpretation of this is that transport and work serve as substitutes in production, except in the Forest industry. When transport becomes more expensive, the industry is restructured by road-traffic intensive enterprises reducing their output while labour-intensive companies increase theirs. A conceivable explanation is that greater efforts are made to reduce transport by locating production closer to the market.

Capital, however, is a complement to transport since the use of capital decreases in all industries except in the vehicle industry. The consequence will then be a structural transformation of industry towards a more labour-intensive and less capital and transport-intensive production. The reallocation of resources, as has been said, does not, however, affect production in the long run except to a marginal extent.

This increase in demand for labour is as a rule large compared with the change in production and profit. This is due to marginal production for both work and transport being relatively low (an additional unit of any production factor only produces a small increase in output).

The industry that loses most from the introduction of the kilometre tax is the Wood Products industry, which shows negative changes of both employment and production. However, profit increases slightly here too which can be explained by the efficiency improvements and restructuring that occur in the long term.

The foremost conclusion, however, is that the kilometre tax will probably only lead to very small effects on production, employment and profit in the study's focus industries at the national level. Based on the discussion in Chapter 9.3 above, the effects can be expected to vary, however, between regions although we have not been able to analyse this with the aid of model calculations.

The effects that none the less arise are long-term and are based on the fact that companies can adapt the production process according to changed circumstances. In the short run, this possibility is limited, however, and many enterprises do not

have the margins or resources required even in the long term. Profitability varies greatly both between industries and within industries and it is reasonable to assume that the least profitable companies risk being hardest hit by an increase in costs, which the kilometre tax gives rise to. How the effects are distributed within an industry can be described with what is known as a Salter analysis, where the distribution of profitability in an industry is illustrated graphically, for instance before and after the introduction of a kilometre tax.

Salter analysis

The Salter diagrams show the share of gross profit with and without tax for all workplaces in an industry. The gross profit share is added value without personnel cost in relation to added value, i.e. the part of added value which is compensation to capital.

The x axis shows the share of the workplace of the industry's added value and the y axis the share of gross profit of the workplace. If the gross profit share is equal to zero, the personnel cost will take up the whole added value and compensation to capital is zero. If the gross profit share is equal to zero, the whole added value is compensation to capital and the cost of personnel is equal to zero.

The curve without tax shows how large the gross profit share was in 2002 according to Statistics Sweden's industrial statistics.

The curve with tax shows how the workplace's gross profit share looks if it is affected by an increased transport cost due to a kilometre tax (low alternative). The increase in transport cost has been obtained from SIKA's Samgods model for every industry and national area, i.e. all workplaces within an industry and a national area have been assumed to have the same percentage increase in costs.

The appearance of the curve shows how sensitive an industry is to cost increases. The more it bends outwards from the origin (concave to the origin), the more robust the industry is and the more it bends towards the origin (convex to the origin), the more sensitive the industry is to cost increases.

Figure 9.16 shows the distribution of the gross profit share in the Food Products industry without kilometre tax and with kilometre tax. The change in gross profit is negative for large parts of the industry although the effect is consistently small. However, certain deviations are clearly visible from the general pattern. Individual workplaces are very greatly affected and lose a large part of the gross volume (a clear example is circled in the figure). However, these workplaces are, as said, only a marginal part of the industry's aggregate added value.
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To illustrate the difference between the two alternative levels of kilometre tax (with and without including energy tax), a figure is shown for the Food Products industry which also shows the effect of the high tax (Figure 9.17). The curves are similar although the workplaces that are hardest hit by the low tax show an even clearer reduction of gross profit with the high tax.

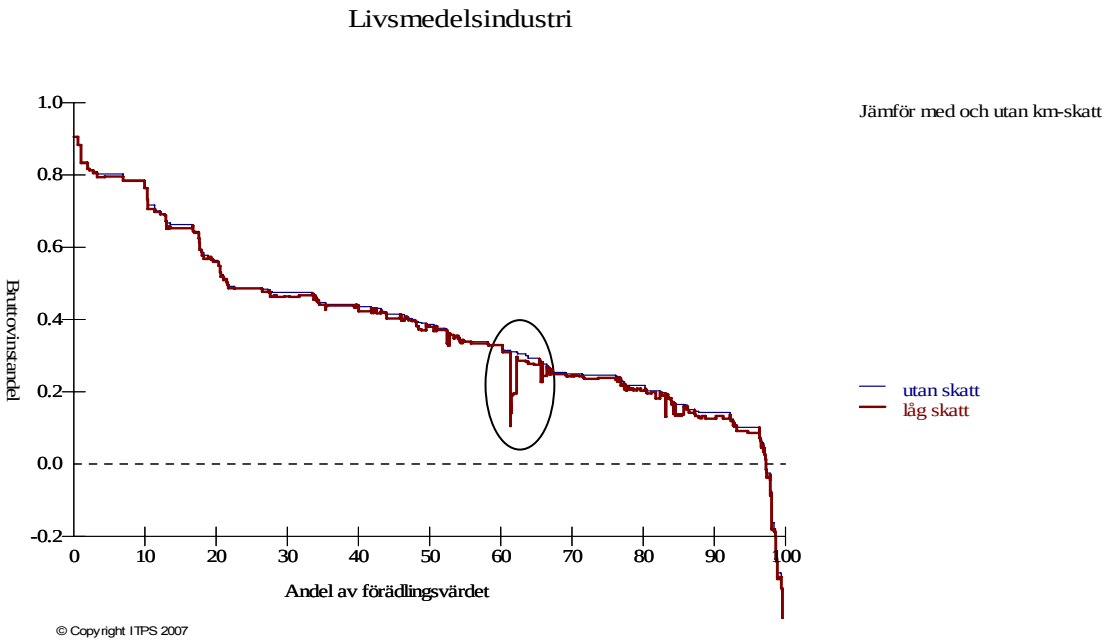

Figure 9.16 Allocation of gross profit before and after kilometre tax, low alternative, in the Food Products industry. Source: ITPS.

Key to figure

Livsmedelsindustrin	(Food Products industry)
Bruttovinstandel	(Gross profit share),
Jämför med och utan skatt	(Compare with and without km tax)
Utan skatt	(Without tax)
Med skatt	(With tax)
Andel av förädlingsvärdet	(Share of added value)

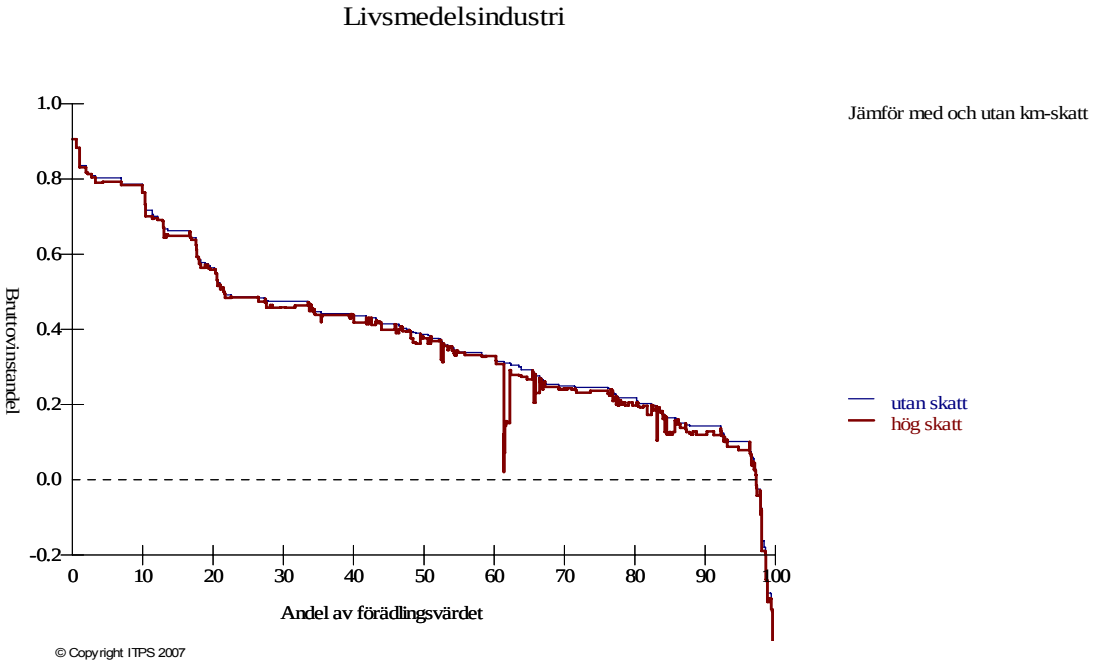

Figure 9.17 Allocation of gross profit before and after kilometre tax, high alternative, in the Food Products industry. Source: ITPS.

Key to figure: See key to Figure 9.16

Trävaruindustri

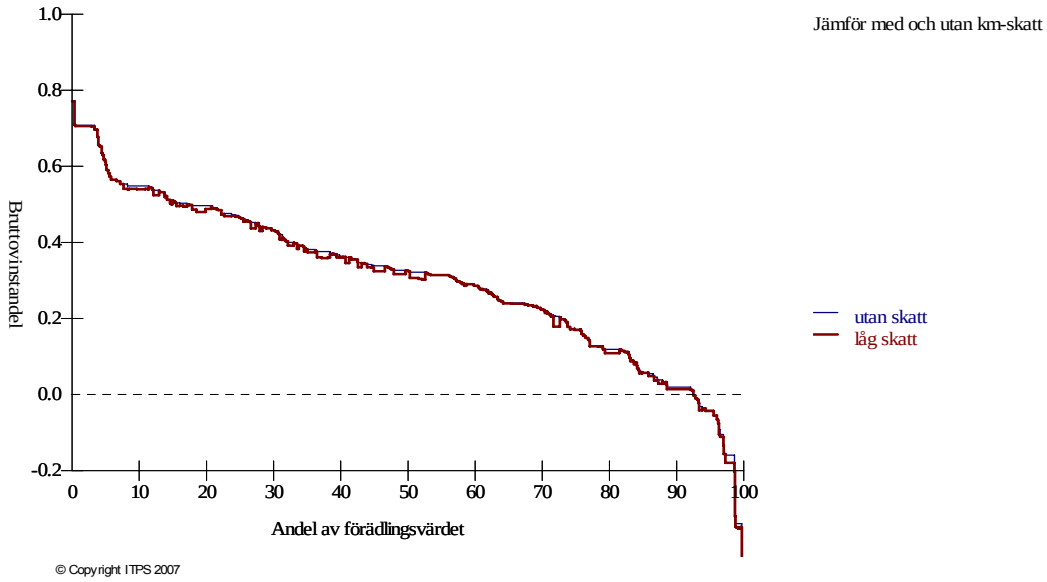

Figure 9.18. Gross profit distribution before and after kilometre tax in the Wood Products industry. Source: ITPS.

Key to figure: See key to Figure 9.16

The effects on gross profit are slightly less in the Wood Products industry than in the Food Products industry and there are not the same clear "extreme cases" here. Some workplaces lose more than the average but the effects overall are relatively evenly distributed. The effects in the Pulp and Paper industry are additionally slightly less. A clear difference between these two is that the latter shows a more robust structure (concave to the origin) which indicates lower sensitivity to external shocks.

Massa- och pappersindustri

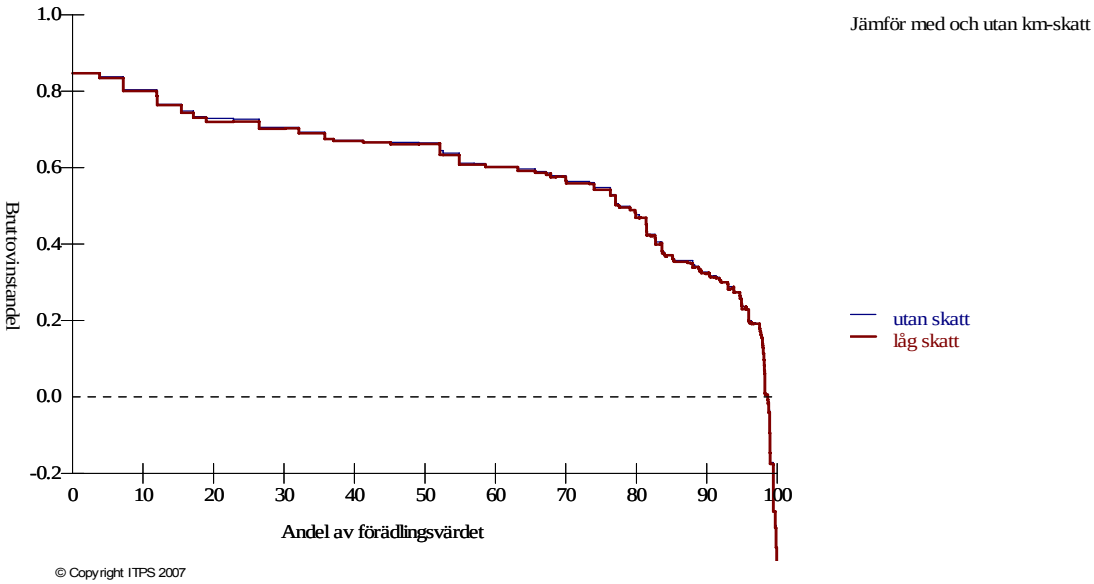

Figure 9.19 Gross profit distribution before and after kilometre tax in the Pulp and Paper industry. Source: ITPS.

Key to figure: See key to Figure 9.16

The Engineering industry is one of the industries where the change in transport costs seems to increase most on the introduction of a kilometre tax. Since the level is so low, this has, however, a very small effect on the gross profit of engineering companies. Individual workplaces are affected slightly more than average, although the effects are consistently small and evenly distributed in the industry. The workplace that experiences the greatest change has moreover already a negative gross profit.

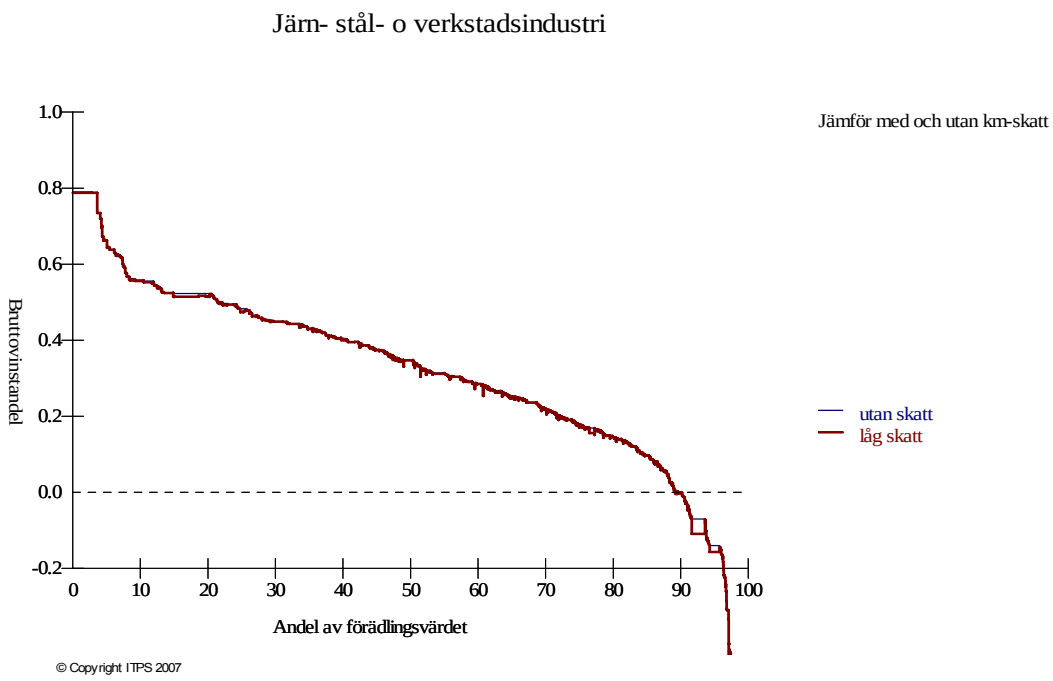

Figure 9.20 Gross profit distribution before and after kilometre tax in the Engineering industry. Source: ITPS.

Key to figure: See key to Figure 9.16

The Salter analysis in this section supports the results from the FEM calculations. The effect on gross profits will very little overall although particular workplaces will experience greatly reduced profitability. This applies especially in the Food Products industry. The effects on the gross profit of the Mining industry are not possible to report for reasons of confidentiality although the change in transport costs is so little in this industry that a Salter analysis would probably not provide any information of interest.

It is important to remember that a Salter analysis provides a “snapshot” of changes in the share of gross profit. Any adaptations of the production process, of the composition of intermediate goods, or of factor demand are not taken into account. It is in other words a short-term analysis. In the longer term, a large part of the enterprises with deterioration in gross profit can probably undertake adjustments to reduce the effects. The above analysis shall only be regarded as an indication of how large a part of each industry (or region in the analysis below) risks experiencing notable effects from the kilometre tax.

Regional level

The analysis in the previous section concerns as described the effects on the different industries at national level. To make the regional effect analysis, we have to restrict ourselves to only looking at the effects for the manufacturing industry as a whole[21]. The reason for this restriction is that the statistical base and the model tool cannot provide significant results for calculations at the regional level for individual industries.

Table 9.6. The percentage changes of the use of work and capital and change in production and profit for the whole of the manufacturing industry, broken down by NUTS2, Source: ITPS

	Work	*Capital*	*Production*	*Profit*
Sweden	0.26	-0.43	-0.05	0.00
RO1 Stockholm	0.09	-0.07	-0.03	0.00
RO2 Eastern Central Sweden	0.24	-0.48	-0.03	0.00
RO3 Småland and islands	-0.09	-0.27	0.00	0.00
RO4 Southern Sweden	0.50	-0.40	0.12	0.00
RO5 Western Sweden	0.37	-0.29	-0.09	0.00
RO6 Northern Central Sweden	0.00	-0.27	-0.05	0.00
RO7 Central Northern Sweden	-0.41	-0.19	0.10	0.00
RO8 Northern Norrland	0.30	-0.11	-0.03	0.00

As in the case of the effects on individual industries, *the changes in factor demand and production have been generally very small. Profit is also unchanged in all NUTS2* (<0.00 per cent). For the whole of Sweden, demand for labour increases by 0.26 per cent, while the use of capital decreases by almost the double. These can both be regarded as substitutes in the long term to some extent. An observation is that the marginal product is almost twice as high for capital as for work, which means that a substitution as that observed reduces the efficiency of the industry. Output also decreases by 0.05 per cent while profit is unchanged.

Demand for labour increases in most regions. Only in Småland and islands and Central Northern Sweden is the change negative. In the latter, employment decreases by a relatively significant 0.41 per cent. The use of capital decreases in all NUTS2, which has the effect that capital intensity also decreases regionally.

There does not seem to be any simple correlation between the effects on work and use of capital and the changes in production. The national area with the largest increase in employment, Southern Sweden, has in principle the same development as regards production as the national area with the greatest decrease in employment, Central Norrland. No more detailed analysis has been made of the cause of this and it is thus subject to further study.

[21] The statistical base does not allow model calculations for individual industries at the regional level. The results will be insignificant due to too few observations.

For the manufacturing industry as a whole, output reduces in the long run as a result of the kilometre tax, but only by a marginal 0.5 per cent. In two national areas, Southern Sweden and Central Norrland, production increases slightly. No national area reports both reduced employment and output.

Regional Salter analysis

To provide a more refined picture of how the average changes discussed above are distributed within a NUTS2, it is possible to apply the Salter analysis in the regional context as well. The curves then show ´the share of gross profit for every workplace within a NUTS2 with and without kilometre tax.

Due to the confidentiality provisions, it is not possible to report the distribution of gross profit for four of the eight national areas: Stockholm, Western Sweden, Central Norrland and Northern Norrland. In these regions, individual workplaces account for too large a part of the total added value of the manufacturing industry for anonymity to be maintained. In a further national area, Småland and islands, the change is so small that the situation before and after the kilometre tax can hardly be distinguished from one another. The Salter analysis therefore does not contribute any new information in this case. The distribution of gross profit of the three remaining national areas is presented below.

Gross profit is change in Eastern Central Sweden only marginally for the majority of workplaces. There are a few “losers” but these only constitute a very small part of the added value. However, it seems to be the case that profitability will be generally reduced in the event of the introduction of kilometre tax to judge from Figure 9.21.

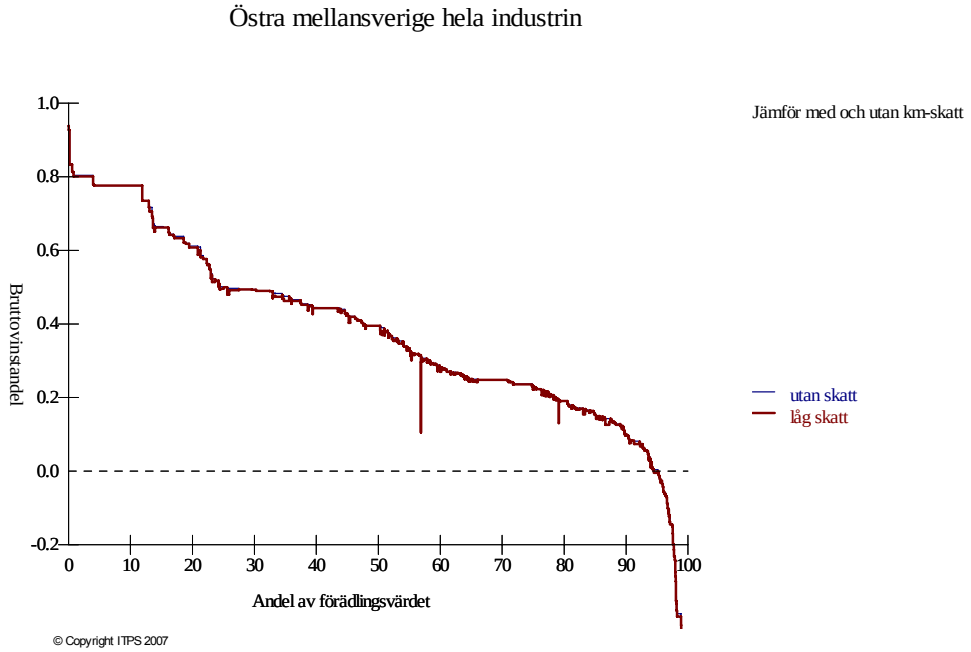

Figure 9.21. The distribution of gross profit before and after the introduction of kilometre tax in Eastern Central Sweden. Source: ITPS

Key to figure

Östra mellansverige, hela industrin:	Eastern Central Sweden, all industry
Bruttovinstandel:	Gross profit share
Jämför med och utan skatt:	Compare with and without km tax
Utan skatt:	Without tax
Låg skatt:	Low tax
Andel av förädlingsvärdet	Share of added value

Profitability is also practically unchanged in Southern Sweden for the lion's share of workplaces in the region. The pattern with individual workplaces which are hard hit can also be seen here.

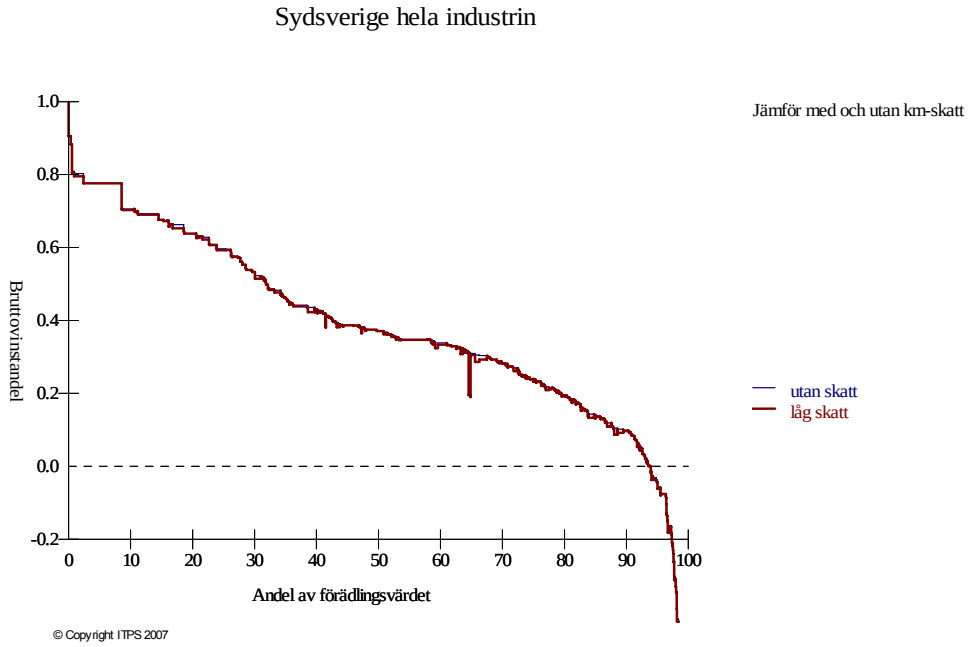

Figure 9.22. The distribution of gross profit before and after the introduction of kilometre tax in Southern Sweden. Source: ITPS

Key to figure

Sydsverige, hela industrin:	Southern Sweden, all industry
Bruttovinstandel:	Gross profit share
Jämför med och utan skatt:	Compare with and without km tax
Utan skatt:	Without tax
Låg skatt:	Low tax
Andel av förädlingsvärdet	Share of added value

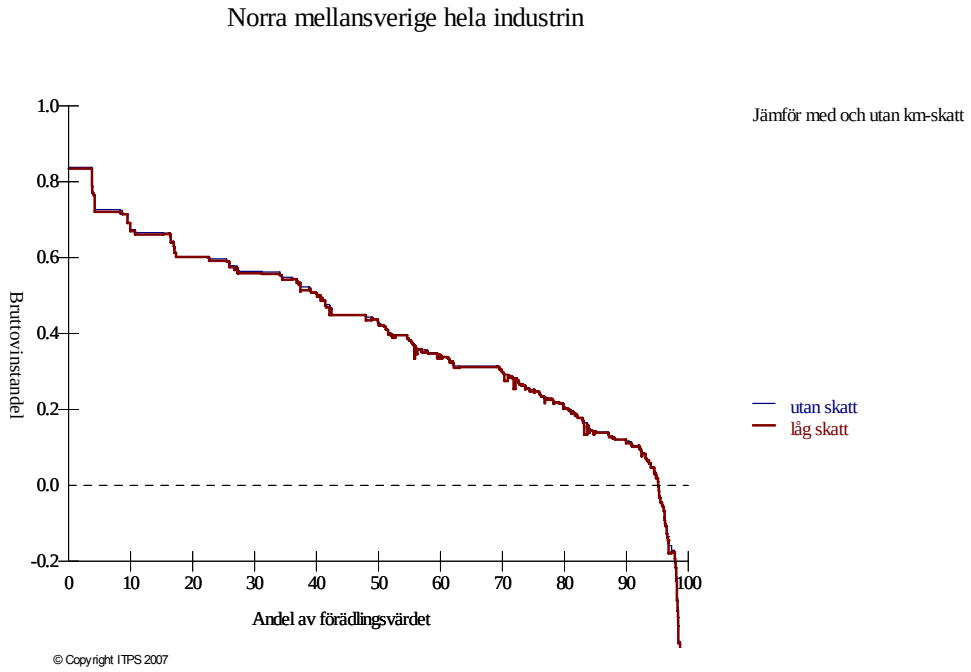

Figure 9.23. The distribution of gross profit before and after the introduction of kilometre tax in Northern Central Sweden. Source: ITPS

Key to figure

Norra mellansverige, hela industrin:	Northern Central Sweden, all industry
Bruttovinstandel:	Gross profit share
Jämför med och utan skatt:	Compare with and without km tax
Utan skatt:	Without tax
Låg skatt:	Low tax
Andel av förädlingsvärdet	Share of added value

The tendency is the same in Northern Central Sweden, but “extreme cases”, which are present in the other regions, are largely lacking here,

The picture that appears in Figures 9.21–23 generally coincides with the FEM calculations. The effects of the kilometre tax will be small for the regions, although particular workplaces can be affected in the form of reduced profitability in the short term.
In the longer term, when adaptations are possible, this will not necessarily lead to reduced output and employment, as we have seen. In Southern Sweden, output and employment are expected to increase after a restructuring of manufacturing industry towards more labour-intensive production. In Eastern Central Sweden and Northern Central Sweden, there will be a small drop in output even in the longer term while employment will change positively or be unchanged.

9.5 Summary and concluding discussion

The analysis in this study has shown that the effects of a marginal-cost based kilometre tax for heavy vehicles will only cause marginal effects on the production and employment of the manufacturing industry in Sweden. However,

there are differences between both industries and regions, which are presented below.

Effects in industries

Transport intensity, that is the share of transport costs of the total production cost, are, together with the distribution of transportation between different modes of transport, crucial.

The table below summarises the results.

The change in production varies between -0.15 per cent in the Engineering industry (Electrical and Electronics) and 2.74 per cent in the Food Products industry. Most industries show very small changes, however, which can be largely explained by the limited share of transport costs of total costs. It is reasonable to assume that a small change in a small cost only leads to small effects. This is the primary conclusion of the analysis.

Table 9.7. The effects of the kilometre tax, shares and change, in per cent Source: SIKA, ITPS and Statistics Sweden.

SIKA, ITPS och SCB

	Mining industry	*Food Products industry*	*Forest industry*		*Engineering industry*[a)]	*All manufacturing industry*
			SNI 20	SNI 21		
Share of road transport costs	1.27	3.11	3.02	4.56	1.30	2.33
Change in transport costs	0.41	6,58 (9.16)	2.61	1.91	≈ 5	2.97
Change in production	-	0.01 (0.02)	-0.02	0.02	-0.15→0.02	- 0.05
Change in employment	-	2,74 (3.81)	-0.05	-0.62	0.13→0.56	0.26

(a) *The engineering industry consists here, as in section 3, of SNI 27-35.*

(b) High alternative, including energy tax, in brackets

The Food Products industry deviates slightly, where the effects seem to be notable. This result is not surprising since the increase in transport costs is largest in the Food Products industry. However, it is noteworthy that the greatest effect on employment is not negative but positive. However, the largest effect, on production, on the Electrical and Electronics industry, is negative.

Both segments of the Forest industry have a high share of transport costs and also a relatively large relative change in costs and are therefore negatively affected by kilometre tax. However, the reduction in production is small and, like the reduction in employment (which is 62 per cent at most). The Pulp industry seems to increase its production slightly, however.

Otherwise, the effects are, as said, very small at the national level.

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Effects in regions

The section above describes how the kilometre tax affects production and employment in the study's focus industries at the national level, but what will the effects be regionally? We saw in section 9.3 that the location patterns of the industries differ, which affects the geographical distribution of effects. Regions with a very large population of enterprises in industries that are affected relatively greatly by the kilometre tax can be expected to experience noticeable effects, everything else being equal.

It is also important how profitability is in the regions. Where profitability is low, there is less scope to bear the costs of the kilometre tax and the risk for negative production and employment effects increases.

A further factor that affects the extent of the effects is the business sector structure in the regions. Where there is a high level of dependence on one or a few industries, there are fewer opportunities to transfer resources from affected sectors to the rest of the business sector.

To sum up, it can be said that regions with a lot of enterprises in, for instance, the Wood Products industry which also have low profitability, and where there are no real alternative sources of income will probably experience marked negative effects of the kilometre tax.

The calculations made show that the effects will be small even at the regional level. The region where employment is most affected is Southern Sweden, and the change is positive there. The largest negative effect can be expected in Central Norrland where the reduction in employment in the manufacturing industry has been calculated at 0.41 per cent.

It should be underlined that these calculations only apply to the manufacturing industry, which means that transfer effects to the service sector or to the public sector are to be taken into consideration. This means that the total effect can very well be less than the figures indicate if a transfer of labour takes place.

Production decreases in five of eight regions, although at most by 0.9 per cent. The largest change is positive here too, +0.12 per cent in Southern Sweden. Profit seems to be almost unchanged.

An interesting effect is that labour is substituted for capital when the kilometre tax is introduced and transport costs increase. Since labour has a lower marginal production than capital, this can be expected to lead to lower production and growth. This is the case for Sweden as a whole and for five of the eight national areas.

Again: the effects that arise are small and compared with other cost changes, for instance, due to increased electricity prices. A kilometre tax at the proposed level can therefore hardly be said to be a crucial factor for either industries or regions. The deviations from this conclusion, which can be found for individual businesses or smaller regions (municipalities) where: 1) they constitute an abnormally high

proportion of costs and 2) where dependence on individual workplaces is very high, so that negative effects at these places have large consequences.

10 Measures to soften the effects

10.1 The need

If a kilometre tax is introduced for heavy lorries, a number of adaptations to counteract the cost increase can be expected, as previously mentioned. In our calculations, we have been able to take into consideration adaptations in the form of changed routes and transfers to other modes of transport. The estimated changes in costs thus assume certain changes of this kind. However, it has not been possible to take into account expected changes in the form of increased load factors or a faster replacement of the vehicle fleet to cleaner vehicles, which can both contribute to reducing the cost increase.

A kilometre tax will none the less, despite all possible adaptations, to increased costs, even if the increase is less than expected. There is a thorough review in Chapter 9 of the possible effects of a change in costs. The result of the review leads to a discussion of the extent to which there are opportunities to soften the effects of the kilometre tax at the same time as its expected positive effects are retained to the greatest possible extent.

10.2 Energy tax

A reasonable first step in a discussion of this kind is to regard energy tax on diesel oil as part of the internationalisation of the external marginal costs and not as a purely fiscal tax. Theoretically, this could take place by energy tax being replaced by a marginal-cost based kilometre tax, whose average level in this commission has been estimated at SEK 1.40 per kilometre. A solution of this kind has both legislative limitations and restricted effectiveness. In the first place, energy tax cannot be removed wholly but only reduced so that the total diesel tax does not fall below the minimum level stipulated in the EU energy tax directive. Furthermore, a reduction of energy tax only concerns the vehicles affected by the kilometre tax. Since it is not possible to differentiate different use of fuel at the filling stations, the part of the energy tax in question must be repaid to owners of heavy lorries, as long as kilometre tax only applies to these vehicles. This involves expensive administration. A third argument against eliminating or greatly reducing energy tax is that a possibility is lost of differentiating taxation of fuel with regard to its energy characteristics. An argument for reimbursement of energy tax to owners of heavy vehicles is that one in this way frees up energy tax as an instrument for internalising the external marginal costs of light diesel vehicles. The degree of internalisation for these vehicles is only 30 per cent at present.
Another way of taking into consideration the internalising role of energy tax is to reduce the level of the marginal-cost based kilometre tax so much that it

corresponds to the size of the energy tax. For a lorry which has a fuel consumption of 4 litres per 10 km, this would mean a reduction of the kilometre tax by over SEK 0.40 per kilometre.

10.3 Vehicle tax

The annual vehicle tax for heavy vehicles is differentiated taking into consideration the weight of the vehicle and its environmental characteristics. This also means that this tax to some extent contributes to internalising the external effects. In this case as well, the EC rules limit the ability to take this into consideration since minimum levels are stipulated for the size of vehicle tax.

10.4 Differentiation between urban and rural areas

The kilometre tax we have used in our analyses is based on a weighted average value for marginal costs when driving in rural and urban areas. From the point of view of social efficiency, it would be advantageous if the kilometre tax could be differentiated depending on whether the vehicle was driven in or outside urban areas. The higher external costs of urban areas can also be internalised to a considerable extent by other solutions, such as environmental zones or congestion charges. A differentiation would provide considerable opportunities for adjustments and thus lower kilometre tax for a lot of transport. It would also mean a reduced burden on transport in sparsely populated areas. The average marginal-cost based kilometre tax is calculated at around SEK 1 per kilometre for traffic in rural areas.

10.5 The transport subsidy

This section is based on material received from Nutek.

The transport subsidy was introduced in 1970 and is distributed to manufacturing companies in the four northernmost counties with the intention of compensating for the long transport distances for enterprises and promote refinement of production. In 2006, the total cost amounted to SEK 495 million. The transport subsidy is provided at at least 15 and at most 45 per cent of the subsidy-based freight cost depending on zone and freight distance. It may be provided as a subsidy for the transport cost of goods transport by rail, commercial transport by road or sea. It can be given for outbound transport from places within the assisted area if the goods consist of such wholly or semi-manufactured products that have undergone considerable refinement within the assisted area. It can also be provided for inbound transport to places in the assisted area if the goods consist of raw materials and semi-finished goods that are to undergo considerable refinement in the assisted area in any of certain listed industries.

Lorry is the predominant mode of transport for the industrial companies in the assisted area.

The large part of the subsidy is received by industries with a relatively low level of refinement, with a clear overweight for the Wood Products industry. As regards the number of employees, the number of transport runs and turnover, the Wood Products industry is not over-represented, however. Industries with a high degree of further refinement receive a relatively small part of the subsidy. The medium-sized enterprises receive a large share of the transport subsidy.

Nutek has made a rough calculation of how the total sum for the transport subsidy would be affected by introduction of a kilometre tax of SEK 1.40. The calculation shows that the subsidy basis should increase by SEK 185-270 million per year. The support basis is the same as the freight prices that the enterprises apply for transport subsidy from outside. This would mean that SEK 55-80 million more than today would be paid per year in transport subsidies given the current conditions and provided that the tax had a full effect on transport prices. However, in Norrland, introduction of a kilometre tax which leads to increased transport costs can to a certain extent be compensated for by increased payments of transport subsidy. In this context, however, it is important to remember that the compensation only constitutes 15-45 per cent of the increased transport cost. Moreover, it would only apply to the types of commodities that were eligible for the subsidy. Another important basic prerequisite is that the transport subsidy also in future will have at least the same subsidy levels as at present.

If subsidy levels were reduced, business sector in the subsidy area would be doubly hit, i.e. both by the introduction of a kilometre tax and by reduced subsidies.

As regards industries, which are to be studied specially in this commission – the Mining industry, the Food Products industry and the Forest industry, it can be noted that the Mining industry is not entitled to transport subsidies. As regards this industry, the transport subsidy will thus not at all compensate for the negative effects of the kilometre tax on enterprises' transport costs.

Certain parts of the Food Products industry are, however, entitled to transport subsidies, for instance for transport of wild meat and berries. In this case, it can be said that the transport subsidy would compensate for the introduction of a kilometre tax to some extent.

The third industry, which is to be specially examined – the Forest industry – receives at present a large part of the transport subsidy. A large part of the transport subsidy to the forest industry is for sawn wood products. It is important to remember that only processed goods are eligible for the assistance, No transport subsidy is therefore payable for transport of round timber and pulp timber. Neither is transport subsidy paid for outbound transport of paper pulp, paper and cardboard. The conclusion is therefore that the Forest industry will only be partly compensated by increased transport subsidies in the area in question. This is because not all these products are eligible for assistance.

10.6 Calculation examples

To clarify the significance of different taxes and thus the effects of conceivable softening measures, a couple of highly simplified calculation examples are shown here.

A lorry with a driving distance of 120,000 km per year will at a kilometre tax of SEK 1.40 per kilometre be charged around SEK 170,000 per year. At an average fuel use of SEK 0.4 litres per kilometre, the annual energy tax will be SEK 50,000. Vehicle tax is in the range of SEK 10,000 to 20,000 per year. The Eurovignette costs just over SEK 10,000 per year although this will be abolished on introduction of a kilometre tax. If a differentiation of the kilometre tax could be made between driving within and outside urban areas, this difference between the weighted average and driving in rural areas only would mean a reduction of the annual kilometre tax by around SEK 50,000.

If the distance driven were instead 50,000 km, the annual kilometre tax will be SEK 70,000 at a kilometre tax of SEK 1.40 per kilometre. Energy tax in this case would be SEK 20,000.

11 Can a Swedish kilometre tax for heavy vehicles be socially efficient?

11.1 The costs of a kilometre tax system

The introduction of a kilometre tax system is associated with considerable costs for investments, operation and control. On behalf of the National Road Administration, SWECO/VBB (Sundberg 2007) has produced a conceivable outline design of the technical system for kilometre tax in Sweden. A rough estimate was also made then as part of the commission of the costs of a system of this kind. These costs are estimated as being in the range of SEK 900 million per year to cover reinvestment and operation. In addition, there would be administration costs for the Swedish Tax Agency which estimates costs of around SEK 4 million annually for its contribution plus a one-off cost of over SEK 4 billion.

The starting point for the National Road Administration's estimate is that a Swedish kilometre tax system shall be geographically complete, i.e. cover the whole of the state road network and parts of the municipal and private road network, It is assumed in the calculation that it will be possible to vary charges for different roads and that all vehicles over 3.5 tonnes will be included, foreign vehicles as well. The National Road Administration points out that the prerequisites for a cost estimate are very uncertain, among other things as regards design, flexibility, legal requirements on integrity and control. Furthermore, the technical development is fast, and wholly new technical prerequisites can exist within a short period of time.

The costs of the systems that are in operation in Switzerland, Austria and Germany vary a lot depending on the different designs of the systems. Above all, the extent and design of the control system is very important. The cost level for a Swedish system is determined to a great extent by how the question of control is solved and can be crucial for whether a kilometre tax system for heavy vehicles is socially efficient.

The British government had decided to introduce a kilometre tax on the whole national network a few years ago but then decided to shelve the plans because of the high expected costs for the system and concern that the effect on congestion would be negligible. To reduce congestion, the system would have to include both light lorries and cars, which was considered only to be possible in 10-15 years time.

Alan McKinnon, logistics professor from Edinburgh has subsequently proposed a simpler model for kilometre tax with considerably lower system costs than for the

model considered by the government (McKinnon 2006). The core of this proposal from McKinnon is that annual checks of the distance driven are made in connection with inspection of heavy vehicles that do not leave the country. Inspection is compulsory from the first year for heavy vehicles. For vehicles that leave or arrive in the United Kingdom, McKinnon proposes as one of several possible alternatives that tachograph data is photographed with a camera in connection with crossing the border as in Switzerland.

SIKA has commissioned Per Kågeson to roughly quantify the social net benefits of a kilometre tax for Sweden and to clarify the possibilities of designing a simplified form of Swedish kilometre tax, which would be socially efficient even if its advantages were regarded as moderate in relation to the cost of a technically more advanced system (Kågeson 2007). The result of Kågeson's analysis is summarised in this chapter. The memorandum, which has been produced in a short time at a late stage during the commission's work is not intended as a final analysis but as an outline idea of significance for further investigation if the Government decides to pursue the issue of a Swedish kilometre tax further.

11.2 A simplified form of Swedish kilometre tax

A simplified system of this kind could, according to Kågeson, be based on the annual distance driven which could be checked when visiting the vehicle inspection centre Svensk Bilprovning. There are a number of conceivable alternatives for Swedish and foreign cars that pass Sweden's borders.

As regards control of compliance, Kågeson considers that it is close to hand to use the supervision of the vehicle's tachograph which Sweden is obliged to carry out in accordance with the EU Regulation on control of compliance with driving and rest times. The control activity that already takes place could be replicated at a much lower cost than the costs for control of the system that SWECO/VBB has presented in its calculation. In addition, a better control of driving and rest times will be obtained and it will be possible to improve control that the vehicle complies with other rules, for instance, as regards load and hazardous goods. Tachograph data (which includes mileometer data) can also be used to check that the vehicle has not exceeded the highest speed permitted, which is a possibility seldom used today. An expanded control of drivers and vehicles which led to better compliance with driving and rest times and loading regulations and speed restrictions is thus considered to provide consider net social benefits indirectly in the form of improved durability of the roads, increased road safety, etc.

Already today, mileometers are manipulated. If collection of the kilometre tax were to be linked to tachograph data, there would be an increased incentive to cheat. The National Road Administration's experts consider, however, that manipulation of the electronic tachographs is complicated. The electronic tachograph stores, among other things, information on a vehicle's route for at least a year. If a kilometre tax is introduced in 2011, Kågeson considers that it can be expected that at least half of the vehicles concerned will be equipped with electronic tachometers and by 2015 three-quarters. If tachometers are used as a basis for collection of kilometre tax, the sanctions for manipulation may need to

be made more stringent. This may entail higher fines and for the police and the National Road Administration to have the right to temporary seize the vehicle for investigation.

One disadvantage of the simplified model for kilometre tax is that it does not allow a differentiation between roads with different characteristics and between geographical areas. A differentiation of this kind requires the vehicle to be equipped with GPS and digital units that register the distances driven in different area and on different types of roads.

If the cost of equipment of this kind becomes considerably lower than today, one could, according to Kågeson consider introducing kilometre tax for all types of vehicles. Since the total number of vehicles in a system of this kind would exceed 4.5 million, the costs of control will be spread over a lot more units. A transition from the simple alternative to a more advanced type of kilometre tax would, according to Kågeson, not have to be specially complicated.

11.3 The net social benefits of a kilometre tax

A kilometre tax, which is designed in such a way to clearly reflect the external marginal costs, is expected to contribute to the overall transport policy objective of achieving a socially efficient transport system and that welfare gains can therefore be expected. These gains are to be expected in the field of the environment, among others.

According to the calculations with the Samgods model, traffic performance (vehicle kilometres) by heavy lorries would decrease by over 15 per cent at the higher kilometre tax level and by over 10 per cent at the lower level. Even if the estimated transfer in not so great, there are indications that it is overestimated. On the other hand, the model calculations do not take into consideration the expected adaptations in the form of efficiency improvements in transport (less empty runs, increased load factor).

Emissions to the air of carbon dioxide and air pollution decrease as a result of reduced traffic performance. In addition, there will a further effect due to the differentiation of the kilometre tax in relation to the environmental class of the vehicles, which can be expected to lead to a faster replacement of the vehicle fleet to vehicles with lower emissions of nitrous oxides, hydrogen oxides and particles. This effect is difficult to calculate and decreases as the vehicle fleet is renewed.

The effects of the reduced traffic performance on road traffic's emissions of carbon dioxide, nitrous oxides and sulphur dioxide are shown in Figures 11.1-11.4. The bars over 2010 show the forecast emissions without kilometre tax. 2010a and 2010b refer to the estimated emissions with kilometre tax at the higher and lower level respectively. The forecasts are based on documentation from the traffic agencies and to SIKA's follow-up of the transport policy goal (SIKA 2006).

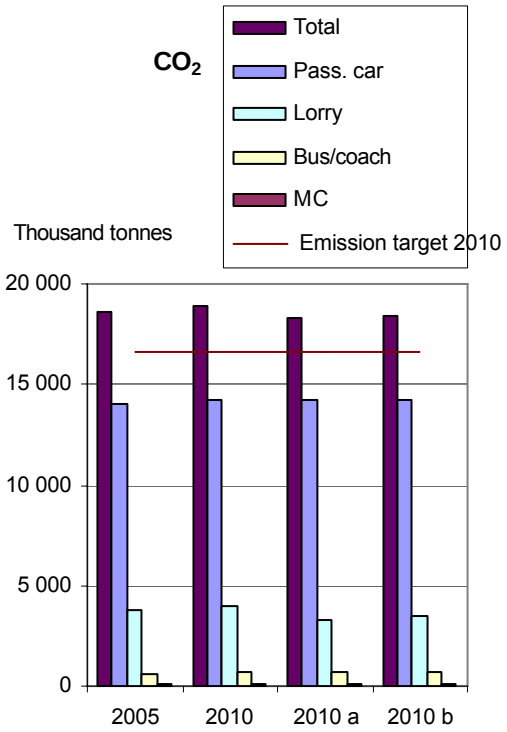

Figure 11.1. Reduced emissions of carbon dioxide due to a kilometre tax.

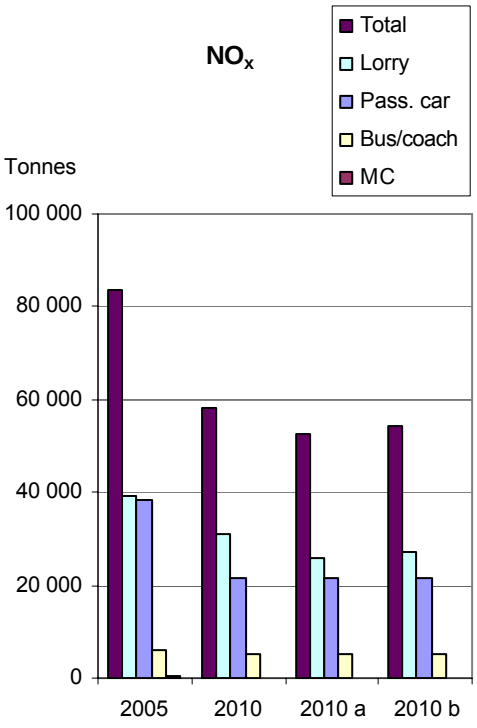

Figure 11.2. Reduced emissions of nitrous oxides due to a kilometre tax.

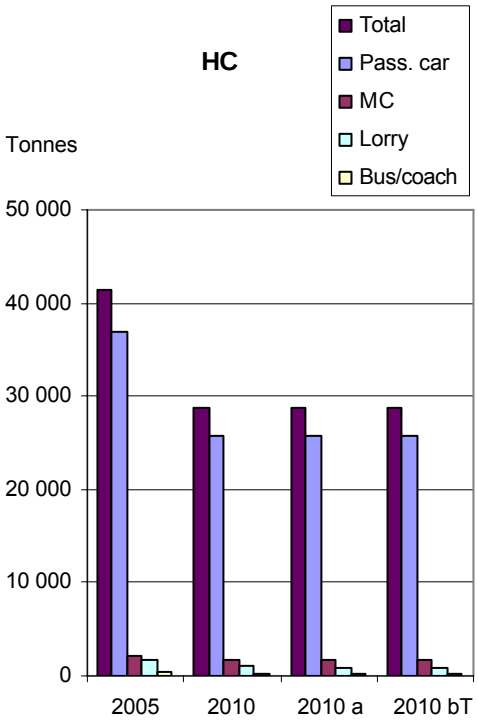

Figure 11.3. Reduced emissions of hydrogen oxides due to a kilometre tax.

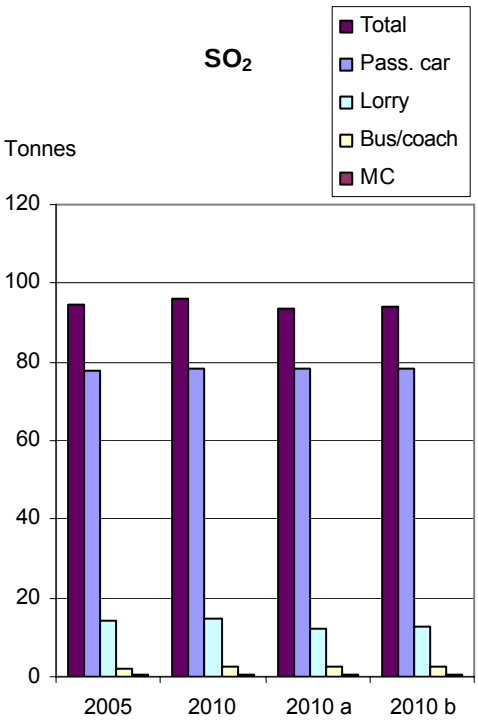

Figure 11.4. Reduced emissions of sulphur dioxide due to a kilometre tax.

The transport policy target for the carbon dioxide for the whole of the transport sector has been placed in the figure for carbon dioxide (unchanged emissions in 2010 compared with 1990). In the case with the lower kilometre tax level, carbon dioxide emissions are expected to decrease by over SEK 400,000 tonnes. With a carbon dioxide valuation corresponding to the present carbon dioxide tax, the value of the reduced carbon dioxide emissions will be around SEK 400 million in 2010. With the valuation of SEK 1.50 per kg carbon dioxide it will instead be around SEK 600 million.

Correspondingly, the value of the reduced carbon dioxide emissions can be calculated. Emissions are expected to decrease by over 3,000 tonnes. With a valuation of SEK 62 per kg, this corresponds to around SEK 200 million.

Provided that diesel tax over the minimum level is reimbursed to the owners of the vehicles subject to kilometre tax, favourable net social control effects could be achieved for diesel cars if energy tax was raised to the level that applies to petrol or to the higher level that corresponds to the external cost (excluding the cost of carbon dioxide emissions for an average of new diesel cars). The net social benefit of lower carbon dioxide emissions if diesel tax (energy tax) was introduced at the same level as petrol tax have been quantified by Kågeson at around SEK 300 million per year (with today's carbon dioxide tax as valuation).

Wear and tear on the roads increases rapidly with rising axle load. The kilometre tax can be differentiated so as to create an incentive among vehicle owners to spread the total weight on more axles. Since road wear increases with rising axle load, a differentiation of this kind can contribute to less damage and lower maintenance costs. As Kågeson underlines, it is primarily the heaviest vehicles and vehicle combinations that can be assumed to be affected. There is seldom any freedom of choice for lighter heavy vehicles. Since the heaviest vehicles give rise to the highest axle loads, this effect is considered to be important. However, the effect remains to be quantified.

If the kilometre tax applied to all road vehicles, *reduced congestion* could be expected, if the tax was differentiated according to where and when congestion arose. However, no major effects are scarcely to be expected as long as the system only applies to heavy vehicles. The effect will not occur in the simplified system.

The net social benefits of being able to compensate the tax income that kilometre tax is expected to give net in a *tax shift* with reduced distorting taxes should provide a considerable gain in social efficiency.

This rough calculation shows that it is not self-evident that the costs of an advanced system are outweighed by the gains in social efficiency. There is there reason to make more careful analyses of this and to investigate then whether a simpler system can be more justified from the point of view of social efficiency. It should be emphasised here that the gains in social efficiency will be greater in principle for the advanced system. A disadvantage with the simplified model for kilometre tax is that it does not allow differentiation between road with different characteristics or between geographical areas, nor for different times (year, day of the week, time of the day).

12 Effects on central government finances

Today, traffic performance with heavy lorries amounts to around 4.2 billion vehicle kilometres. According to SIKA's most recent forecast (SIKA 2006a), traffic performance with heavy lorries is estimated to increase by 33 per cent between 2001 and 2020. If this increase is assumed to be linear, the forecast means that traffic performance will increase to around 4.6 billion vehicle kilometres by 2010. On the other hand, the kilometre tax is expected to decrease traffic performance by over 15 per cent at the alternative levels used in the analyses.

With these assumptions, income from *kilometre tax* will be around SEK 6.0 billion per year at the higher tax level (i.e. without compensation for energy tax) and around SEK 5.7 billion at the lower tax level (i.e. with compensation).

The reduced income from *diesel tax* resulting from the reduction in traffic performance is to be deducted from this amount. Diesel tax is now SEK 3.72 per litre plus 25 per cent value-added tax. If the average use of fuel is 0.3 litres per kilometre, around SEK 1.1 billion less tax will be received per year at the higher tax level and around SEK 0.8 billion at the lower tax level.

Furthermore, income from the *Eurovignette* will no longer be received. Income from this amounts to today to just over SEK 0.6 billion per year, according to information from the Tax Agency.

It should also be taken into consideration that the number of registered vehicles may fall slightly leading to a fall in income from *vehicle tax*. However, this effect is difficult to estimate. A reduction of vehicle tax would further decrease income.

The National Road Authority has, as previously mentioned, estimated the system costs to be in the range of SEK 0.9 billion per year. However, this estimate is very uncertain.

Table 12.1. Summary of effects on central government finances of a kilometre tax (SEK billion per year).

	Kilometre tax, high	*Kilometre tax, low*
Kilometre tax	+ 6.0	+ 5.7
Diesel tax + VAT	- 1.1	- 0.8
Eurovinjette	- 0.6	- 0.6
System costs	- 0.9	- 0.9
Total	**+ 3.4**	**+ 3.4**

If one moreover opts to make use of the possibility of internalising the external marginal costs of diesel-powered cars by increasing diesel tax, this also means increased income, which is reduced, however, if it is decided to compensate the increased diesel tax by a reduced vehicle tax.

A further effect on central government finances is the increase in payment of transport subsidies which would be the consequence of a kilometre tax under the existing rules. If the tax has its full impact on transport prices, the higher kilometre tax level would mean that SEK 55-80 million was paid out according to an estimate by Nutek, see Chapter 10.

13 Considerations and recommendations

A goal conflict

A socially efficient geographical spread of the business sector in a market economy like the Swedish economy assumes that enterprises bear both their transport and other production costs. The transport costs that the enterprises should take into consideration are the socially efficient marginal costs. The kilometre tax discussed here aims at persuading the owners of heavy road vehicles – hauliers as well as enterprises with their own vehicles – to take into consideration external marginal costs as well. The effect of this on transport/freight prices shall then be able to give the correct signals not only for use of vehicles or the road infrastructure but also for the location and production decisions of the enterprises that depend on road transport.

Depending on which and how large production and location changes that the kilometre tax gives rise to, there will be possible adaptation and employment problems in a short- and medium-term perspective. This means that there is a potential goal conflict between introduction of a kilometre tax and the goal of regional development policy, which is that there is to be well-functioning and sustainable local labour market regions with a good level of service in all parts of Sweden. It is not then self-evident that transport policy should only be formulated on the basis of a desire for social efficiency (which would entail a marginal-cost based kilometre tax) and not either that any assistance measures should only be obtained from other policy areas than transport policy.

At the same time as there are strong reasons to avoid the distorting effect on resource use that permanent transport subsidies would produce, there may thus be reasons to at least soften the effects of the structural transformation by restraining increases in transport costs. Transport policy shall also, according to current transport policy decisions, be designed so as to contribute to a positive regional development.

There is reason to draw to attention that the transport subsidy has been offered for more than three decades to parts of industry in the regional policy assistance area. Through this form of assistance, it is clearly shown that there is a political will to counteract the complete impact on prices of the actual goods transport costs. The assistance is aimed at compensating for additional transport costs which are due to unfavourable location in relation to central markets for products and intermediate goods. The transport subsidy system is intended to stimulate further refinement and not raw material production and the subsidy does not provide complete compensation (see Chapter 10) for the increased (additional) transport costs that arise when the kilometre cost for heavy lorries is increased.

An increase in the kilometre tax for heavy road traffic can be a problem for enterprises with long transport distances to markets for end and intermediate products. The transport cost per kilometre is also important which is generally higher for heavy/voluminous products. At the same time, companies that sell on, or obtain their intermediate products from, a locally or regionally based market close to their own places of production obtain a competitive advantage in competition with enterprises from other parts of Sweden (or from abroad) due to the kilometre tax. It cannot either be excluded that the increased kilometre costs for particularly heavy and voluminous road transport can stimulate some refinement of raw-material based production in, for instance, Inland Norrland.

There is thus a potential conflict between the overall goal of efficiency expressed in transport policy and the regional policy efforts and there may be reason to be cautious about letting the effect of the kilometre tax be fully felt, in particular if it is a considerable increase and shall take place quickly.

The Forest and Food Products industries are most vulnerable

It is primarily parts of the Forest and Food Products industries that have no opportunity to change mode of transport for the vulnerable transport runs. The share of transport costs is considerably lower in a number of other industries.

The Forest industry is considered to be particularly vulnerable due to the long distances for transport of both raw material/round timber and of forest products. Sawn goods and Paper/Pulp are, of course, transported to a great extent by sea or by rail but still to some extent by lorry.

The increase in transport costs probably entails mainly a reduction in profit with small effects on production for raw material owners. At the same time, it cannot be excluded that cuts in production and employment will arise at individual production units.

However, the review does not indicate any unreasonable effects on any industry or region

The introduction of a marginal-based kilometre tax for heavy road vehicles would lead to a not inconsiderable increase in the transport cost per kilometre. However, this increase is not considered to generally mean any more substantial increases in relation to, for instance, the turnover of various industries regardless of their geographical location. In a long-term perspective, there is scarcely either a risk for more significant effects on production in different industries or regions.

The adaptation of enterprises to the increased kilometre tax is considered to primarily consist of choice of more economical transport solutions, for instance, change to another mode of transport/combi-transport, to other vehicles with a lower marginal cost/tax, to other choices of routes, etc. It is more abut adaptations which in various ways contribute to reducing enterprises' transport costs.

Kilometre tax should be phased in

It is difficult in advance to identify units in different problem industries/regions which could have problems and where reductions in production and employment are to be expected. This argues in favour of a cautious introduction of kilometre tax. A phased introduction to the marginal cost level is recommended. At the same time, one should, to avoid uncertainty, give clear signals that the intention is to reach the marginal cost level in the long term.

Differentiation of the kilometre tax

The kilometre tax should be differentiated taking into consideration the weight of the vehicle, the number of axles (axle load) and environmental class in accordance with the principles used in our calculations of a marginal-cost based kilometre tax.

From the point of view of efficiency, it is desirable that the kilometre tax is differentiated between traffic in urban and rural areas. In our calculations, we have assumed a weighted average value, due to it not being possible to distinguish urban from rural areas when running models. The average tax rate for driving in rural areas is estimated at around SEK 1 per kilometre, i.e. around SEK 0.40 lower than the weighted average. In other words, this means a relief for transport in sparsely-populated regions, compared with the tax rate used in the analyses. The marginal cost for urban driving has been estimated at around SEK 2.80 per kilometre. Internalisation of the external marginal costs of driving in urban areas can be better dealt with by special solutions for metropolitan areas, such as congestion tax, environmental zones or similar.

We thus recommend that the marginal cost level for driving in rural areas be applied for the kilometre tax. It is assumed that the external marginal costs for driving in urban areas can be internalised by other instruments.

Energy tax for heavy and light diesel-driven vehicles

An additional step in the cautious introduction of the kilometre tax for heavy vehicles could consist of the level being adapted so that the energy tax is regarded as a part of the internalisation. Chapter 10 contains reasoning on why consideration to the internalising effect of energy tax should take place by reducing the kilometre tax. One of the reasons stated is that
if tax on diesel oil is reduced, it will also affect light vehicles run with this fuel. Already at present the degree of internalisation[22] is low for light diesel-driven vehicles, and there are therefore reasons to increase the variable cost by increased energy tax (compensated by a cut in vehicle tax). In SIKA's most recent report on calculations of the marginal costs of traffic (SIKA 2007), it is stated that the degree of internalisation for light diesel vehicles is around 30 per cent. This means that energy tax would have to be tripled, i.e. increased by around SEK 2 per litre, to achieve full internalisation.
A kilometre tax system would be most efficient if it applied both to heavy and light road vehicles. Pending its extension to light vehicles, it would be possible to increase the extent of internalisation for light diesel vehicles by increasing the

energy tax on diesel oil. However, this solution presumes reimbursement of energy tax to owners of heavy vehicles, if a kilometre tax is introduced.

If one instead chooses the solution with a reduced kilometre tax corresponding to the size of energy tax, the average kilometre tax could be reduced by around SEK 0.40 per kilometre.

Additional measures for a cautious introduction

Bearing mind that vehicle tax also has a role as regards internalisation, a reduction to the minimum level stated in the EU Road Charge Directive can be justified. Vehicle tax is retained for cars and (other) light vehicles and used as an instrument to internalise external costs which are not due to the quality of fuel, but to the vehicle.

A cautious introduction of kilometre tax further assumes that it is not regarded as an instrument for financing in addition to the income that is a result of the adaptation to marginal tax.

Kilometre tax as carbon dioxide policy

In our analyses, we have assumed that the marginal-cost based kilometre tax does not include costs for carbon dioxide emissions. This is related to carbon dioxide emissions depending more on the use of fuel and on the carbon content of the fuel, and that fuel use is therefore a better tax base than the distance driven. Internalisation of heavy road traffic's other external costs none the less contributes indirectly to reducing the carbon dioxide emissions of road traffic. This internalisation can then be regarded as a very cost-effective way of limiting these emissions, since the kilometre tax is wholly motivated by other considerations than carbon dioxide emissions.

We do not either exclude that there may, for the time being, be reasons to use kilometre tax to achieve a certain internalisation of the costs of the carbon dioxide emissions as well. One way of increasing the efficiency may be to differentiate the kilometre tax taking into consideration the vehicle's carbon dioxide emissions, which, however, may be incompatible with EC rules. This then assumes that other appropriate means for this internalisation are not yet possible and that the carbon dioxide internalisation is removed when these means are introduced. An alternative to using the kilometre tax for internalisation of the carbon dioxide emissions is to differentiate the vehicle tax according to the carbon dioxide emissions of the vehicle, which is already the case for cars. At present, however, there is no basis to do this for heavy vehicles.

Design of a Swedish kilometre tax system for heavy lorries

Some countries in Europe have already introduced a kilometre tax system and more countries seem to be on the way to doing so. Since it seems as if kilometre

taxes will be generally used in Europe in a few years time, there is also reason in Sweden to prepare introduction of a system of this kind.

SIKA and ITPS have in the course of the commission's work experienced that there is quite considerably agreement that a kilometre tax is a good instrument for internalisation of the external costs of heavy traffic. Representatives of the business sector also give their support.

However, our review shows that it is not evident that the gains in social efficiency of introducing a marginal-cost based kilometre tax for heavy traffic in Sweden are sufficiently great to choose a technically more advanced system of the kind that SWECO/VBB has used for its calculations.

Kågeson (2007) has shown that there are instead prerequisites to choose a simplified system with considerably lower system costs based on annual readings of the distance driven in connection with inspection of the vehicles which do not leave Sweden and for, for instance, photographing of tachograph data in connection with crossing the border for other vehicles. The example is a British proposal.

One disadvantage of the simplified model of kilometre tax is that it does not allow differentiation between roads with different characteristics or between different geographical areas. A differentiation of this kind, like a differentiation in terms of time, assumes that the vehicle is equipped with GPS and digital units which register distances driven on different types of roads in different areas.

As Kågeson states, it is possible to move over to a more advanced form of kilometre tax in future without great complications.

Also the circumstance that the Road Traffic Tax Commission (2004) chose to only propose a limited differentiation of the kilometre tax according to vehicle characteristics – weight and vehicle class – is an argument in favour of the simpler variant. At the same time, it is important to underline the gains in social efficiency which there may be in future from expanded differentiation, for instance, being able to take into consideration differences in marginal cost between types of roads. In an advanced system, kilometre tax could vary according to the characteristics of the infrastructure. For instance, kilometre tax could be set at a lower rate on certain routes with central barriers (= lower external accident risk).

According to the documentation provided by the National Road Authority, technology should not be a barrier in a few years time for a far-reaching differentiation. It is stated that system costs are very difficult to estimate in advance, and they are to a great extent dependent on the design chosen. Before the final decision on introducing a kilometre tax system, system costs should be balanced against the gains in social efficiency that the system is expected to entail. An investigation of this kind should also take into consideration differences between system and transaction costs for different conceivable system solutions.

A prerequisite for the calculation that the National Road Administration had made is that the kilometre tax system should be comprehensive. Regardless of the

technical level chosen for the system's control function, it is important for the system's function that it includes at least the whole of the public road network to thus reduce the risk of driver choosing other routes that are less suitable for heavy traffic.

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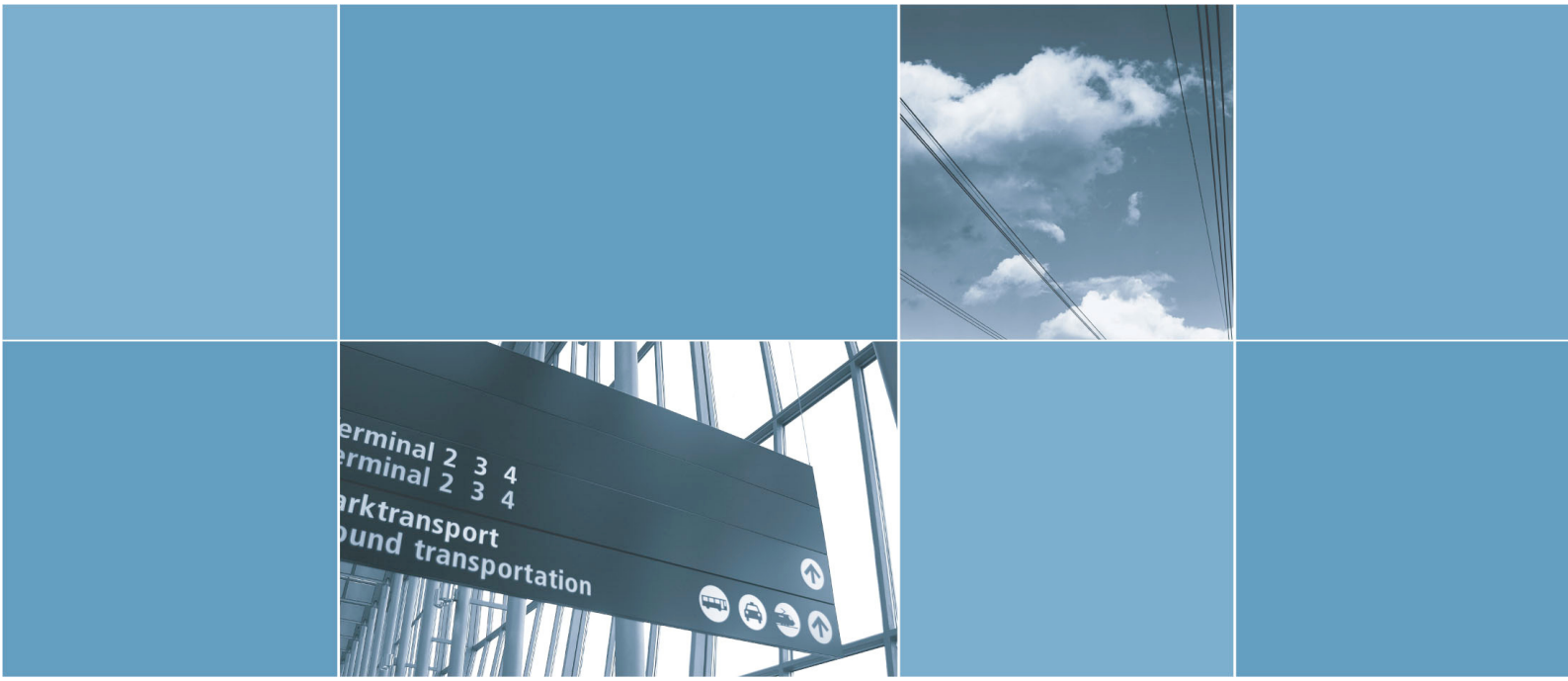

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