Task 5.3 Report
Transferability of Urban Case Study Results

Authors Tuuli Järvi

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SPECTRUM

Study of Policies regarding Economic instruments Complementing Transport Regulation and the Undertaking of physical Measures

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Accompanying Measure

Task 5.3 Report
Transferability of Urban Case Study Results

Author: Tuuli Jarvi, VTT

WP 5 – Transferability of the Framework

Task 5.1: Methodology for assessing transferability
Task 5.2: Transferability of EU transport instruments and scientific methods to the Accession Countries
Task 5.3: Transferability of the case study results

Partners:
Institute for Transport Studies, University of Leeds (ITS)
University of Antwerp (UFSIA)
Transport studies unit, University of Oxford (OXFJQ)
Technical Research Centre of Finland (VTT)
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Institute of Transport Economics, Oslo (TOI)
University of Gdansk (UG)

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1 Introduction

1.1 Background

Transferability of transport policies from one city to another is a very interesting and challenging issue. The aim of this chapter is to give some introductory presentation and basic guidelines for the intra-EU transferability of urban transport policy instruments and instrument packages, especially for the transferability of the SPECTRUM case study results within the EU.

In looking at the *transferability of transport policy measures* from one European city to another we need to consider not only the differences between city characteristics, geographical location, cultural and legislative differences etc. but also at the source of the policy instrument or a package of instruments we would like to transfer. If it is a question of transferring *fully-implemented policy measures* with revealed beneficial results in other words copying running policies there are no doubts concerning the results. If in stead the results are based on a fully-implemented or partial *demonstration* there might be some sources of uncertainty in the implementation of the trial that bias the results and these must be considered as well. Dealing with results from a *modelling exercise* needs most cautious as the modelling environment is very complex and there a model always is more or less simplified picture of the reality. In summary, regarding transferability we need to be aware of all characteristics and conditions in the cities concerned as well as full basis of the results achieved by the policies in question, especially detailed information about field test arrangements or modelling approach.

Usually by transferability we mean *spatial transferability* i.e. transferring something from one place or site to another but the concept of *temporal transferability* exists as well. By temporal transferability we mean using older results later or e.g. transferability of short term modelling results to be used for medium or long term but in this context it could also be used for transferability between different development phases of the cities. However, discussing the transferability of SPECTRUM case study results we mainly mean spatial transferability.

The concept of transferability can be taken very strictly or more broadly in other words level of precision should be decided first. *Strict transferability* means that the results e.g. a city's transport policy would be transferable precisely as such as it is in the base city. Usually transferability is taken more broadly with *local modifications* and adjustments in the implementation to the target city e.g. levels of pricing instruments or adjusting time differentiation of a measure.

Very broadly taken the concept of transferability encompasses the *utilisation of adverse results* as well. In practice this means that a city can take advantage of unsuccessful policies in another city and avoid doing the same mistakes. In a case of a modelling exercise a city with a time consuming transport model can use the adverse results from another city with fast running models and leave corresponding model runs undone thus saving a lot of time.

1.2 Using the framework

The transferability framework presented in SPECTRUM Deliverable 11 table 2.3 is designed for the normal transferability question "Are the policies used in or modelled for the city A also valid in my city B?" However, the purpose of this chapter is to validate the results of the SPECTRUM urban case studies in terms of general transferability. For this use the framework has slightly been modified as in Appendix 1.

Regarding transferability we can state, that if nearly similar results can be found by comparing several different studies preferably both modelling studies and demonstration results we can conclude the measure to be classified generally as an easy to transfer as it seems to work everywhere. Putting it in the other way, extra caution should be used concerning odd single result, even if they would be very good in measurable terms.

In practice, if we really intend to transfer a policy package from one city to another we need to know the true answer for “why does the measure work/is good/is the best in the first place and will it work similarly in the place we would like to transfer it?". In this case we lack the target city and thus concentrate on the analysis of finding similar or back-upping results to our case studies from case study results.

2 Relevant factors in transferability

2.1 City characteristics

The key factors in spatial transferability are the characteristics of the core cities, especially the differences in the characteristics, such as

1. City size and land use
   - city size and status (e.g. capital, among the biggest cities, university city)
   - urban form (monocentric-polycentric, symmetric-asymmetric)
   - land use density (housing types)
   - geographic and topographic features (sea, river, hills, forest etc.)
2. Demographics of the citizens
   - distribution by gender and age
   - household size
3. Economy
   - income level
   - car ownership level
   - unemployment rate
   - number of workplaces by category (e.g. services-industry)
4. Transport system characteristics
   - car network
   - public transport network and modes
   - modal split
   - level of pedestrianisation
   - travel behaviour (rush hours)
   - fare levels and subsidies
5. other features specific for the city
   - any other special characteristic of the city (e.g. tourist attraction)

These characteristics have already been discussed in connection with discussion of sources of incompatibilities between the case studies. The means of discovering transport policy results does not cancel out the importance of the city characteristics as even in the case of using modelling results, a city's transport or transport and land use model is calibrated to reflect real-life travel behaviour in that specific city as closely as possible within the requirements.

2.2 Barriers

The common barriers for implementing new policy measures, legal, cultural, physical or financial are equally important independently of what is the origin of introducing a measure or package of measures. However, if the city already introduced the policies have experienced and overcome the same barriers the other city can make good use of this experience. In the short run, there might also exist new barriers like for instance need for dismounting existing infrastructure out of the way of new systems, including parking fee collection devices and public transport ticketing systems.

The financial barriers should play a somewhat less important role regarding transferability because usually we are looking of transferability of instruments or instrument packages that already have been proved to be acceptable, profitable and effective in one city and which in addition promote sustainability. However, problems rising from different operators and beneficiaries may be regarded as both legal and financial e.g.

- road prising versus parking prising which sometimes are fully substitutive commonly have different collectors, public authority versus private business
- the system of full deregulation and privatisation of bus transport, as existing in the UK (apart from London), may lead to problems in realisation of public transport instruments due to the relatively weak public control over bus services.

2.3 Intranational transferability - international transferability within the EU

Usually the transferability of the results within the same country is much higher than transferability of the results from one country to another as there should not exist any or not at least many cultural or legal barriers. This is usually true for both copying a real-life policy and using model based results. If a policy is in use near by it usually has gained both the political and public acceptability and the early stage difficulties have already been overcome.

Depending on the policy instrument, the decision making level varies and may play a very important role in the implementation process of a new instrument.

2.4 Specific questions regarding transferability of modelled results

For transferability the same issues are of great concern as for the sources of incompatibilities between the case studies discussed in great detail earlier in this chapter.

In addition to the city characteristics the modelling results significantly depend on the model type and time horizon, model structure and specifications, methodology and formulation, variables and parameters included, zonal division as well as the calibration. By calibration we mean the process of fixing the model parameters to present the overall transport system and travelling behaviour in that specific city. The model should be able to present and treat correctly both present and future transport infrastructure, public transport demand and supply, policy measures in use and in testing phase, present prising policies for car and public transport including concessionary fares and subsidies, mobility patterns etc. Finally, it should be ensured that the modelling results have been correctly evaluated. It is recommended that if only possible the receiving city should check the policies to be transferred with its own models, even simple, or any other means available.

As is generally understood, a transport or a transport-land use model always is a simplification of the very complex reality. Presently there exists a vide range of different model types for different analysis and forecasting purposes, ranging from land use transport model with a time horizon of tens of years to short term car routing models. Therefore regarding transferability it is essential to know the model characteristics, assumptions, simplifications and other basic elements of the model the favourable policy results we want to transfer are produced. It should also be checked that the assumptions behind the model also hold in the target city we want to transfer the results to be more assured to get similar policy outcomes than in the original city modelled. The use of transport models and their requirements and implications have been more thoroughly discussed in Deliverable 8 (SPECTRUM 2005).

Some of the present model suits incorporate a specific sensitivity analysis part. Using such a model (e.g. MARS in Leeds case study) it is possible to carry out a vast amount of sensitivity analysis around the best performing policies. This kind of information is very useful regarding transferability. Through these analyses it is possible to see and understand the relations between instruments and the effects, gains and losses achieved by using those instruments in these specific circumstances. Thinking of transferability if the effect of a certain instrument is more flat than a peak it is much safer to transfer such a policy to another city.

In addition to the differences between model structures there might be great differences in the levels of model parameters (e.g. values of time and externalities) between cities using a model. However, this problem is not relevant if the model output is detailed enough and different elements of the cost benefit calculations can be separated and evaluated independently as well. In transferability analysis the guidelines given on measurement and treatment of high level impacts in Deliverable 6 (SPECTRUM 2004) can be used as a check list.

3 Common features of the best SPECTRUM case study results

3.1 Introduction of the best schemes

The best performing policy packages regarding the objective function tested in the SPECTRUM case studies are presented in Table 1. All packages, whether a multimodal study or a road sector study incorporate a road pricing scheme, two of the case studies a distance base scheme alone, one a cordon charging scheme and one a cordon charging scheme combined with a distance base scheme. In the Oslo study and Leeds road sector study the road pricing scheme alone turned out to be the best scheme. In the others the road pricing scheme was accompanied by a positive measure, either a public transport measure (increasing frequency or introducing bus lanes or bus only streets), and in one case study by traffic signal optimisation for increasing fluency. Although the combined scheme in the Oslo study was the second best but as they were nearly equally beneficial and the combined scheme is much more acceptable this second best scheme is used for comparison.

In the Oslo multimodal study the package includes two pricing measures, a time differentiated cordon charging (toll ring) scheme and increase of fuel tax combined with an increase of public transport frequency. The Leeds multimodal road sector study introduces a package of distance-based charging with bus lanes. The short term road sector studies suggest lower level of road prising measures. In Leeds the best measure is distance-based charging combined with corridor charging. In York the package consists of Inner Ring Road cordon charging and signal optimisation.

In summary, the best performing packages among the fairly large number of packages tested in the studies seem to be very similar the differences depending on the size of the city and the present situation. This gives good prospects that there would be great potential for transferability for packages like these tested.

3.2 Detailed comparison of the schemes

The time horizons of the cost benefit calculations of the case study results differ from each other. Oslo is run for a target year, Leeds multimodal study for the whole 30 year period and the road case studies for a peak period. For comparison the main results have been harmonised to represent annual revenues and costs (Appendix 2). For the time-marching MARS model used in the Leeds multimodal study an average year has been calculated from the original costs for the whole 30 year period. For the SATURN road sector studies in Leeds and York for the morning peak hour the transformation has been to multiply the morning peak to represent all the peak periods in the year. Although the transformations may not be accurate compared to reality they still give better values for comprehensive assessment and do not change any relative costs within a study. The cost benefit calculations of the case studies give a good example of the effects of the model type and elements included (benefits for walking and cycling, congestion costs etc.) as well as levels of prising factors. However, this does not prevent the transferability analysis if the model descriptions and output is adequate.

Table 1. SPECTRUM case study modelling results, three best performing policy packages

SPECTRUM Model City Population (present)	**Modal share** (ref. scenario morning peak)	**Economic instruments**	**Other instruments**	**Changes in modal share Car Public Transport Walk & Cycle**	**Economic benefits Total**
RETRO Oslo 960 000	Car: 73% PT: 18% W&C: 9%	Cordon charging (toll ring) - peak: 2.5 times present - off-peak: present Fuel taxes (distance-based charging): 1.5 times present		Share: C:72%, PT:19%, W&C:9% Demand*: C:-5/-3%, PT:+10/+1%, W&C:+9/+1%	+53 million € p.a. = 55 €/inh.
		Fuel taxes (distance-based charging): 1.5 times present		Share: C:72%, PT:19%, W&C:9% Demand*: C:-4/-3%, PT:+7/+1%, W&C:+6/+1%	+50 million € p.a. = 52 €/inh.
		Cordon charging (toll ring) - peak: 2.5 times present - off-peak: present Fuel taxes (distance-based charging): 1.5 times present	Increase in PT frequency: 1.058 times present	Share: C:71%, PT:20%, W&C:9% Demand*: C:-5/-3%, PT:+11/+1%, W&C:+9/+1%	+50 million € p.a. = 52 €/inh.
MARS Leeds 750 000	Car: 56% PT: 22% W&C:22 %	Distance-based charging 1.5€/km	Bus lanes / Bus only streets 20-25 km (PT speed +25%)	share: C:47%, PT:29%, W&C:24% demand: C:-5%, PT:+44%, W&C:+20%	+448 million € p.a. = 597 €/inh.
		Distance-based charging 1.13€/km	PT frequency +150%	share: C:50%, PT:26%, W&C:24% demand: C:-10%, PT:+51%, W&C:-6%	+249 million € p.a. = 332 €/inh.
		Public transport fare -100% (free)	Bus lanes / Bus only streets 20-25 km (PT speed +25%)	share: C:54%, PT:26%, W&C:20% demand: C:+4%, PT:+25%, W&C:-4%	+246 million € p.a. = 328 €/inh.
SATURN Leeds 750 000		Distance-based charging (medium level) 0.1125 €/km + corridor charging 1.2€		Demand for car: -21% **	+20 million € p.a.*** = 27 €/inh.
		Distance-based charging (medium level) 0.1125 €/km		Demand for car: -21% **	+20 million € p.a.*** = 27 €/inh.
SATURN York 180 000		IRR cordon charging 1.6€	Signal optimisation	n.a.	+3 million € p.a.*** = 16 €/inh.
		IRR cordon charging 1.6€ + increase in short term parking charges		n.a.	+2 million € p.a.*** = 10 €/inh.

* peak/off-peak periods ** PT:n.a. W&C:n.a. *** only peak periods

The actual charges of the road pricing policy vary distinctly between the studies, the multimodal studies with long time horizon suggest far higher prices than the short term road studied (1.5€/km respective 0.11€/km). This is partly due to the time horizon itself but part of it can seen as the effect of the different model structure and model characteristics. There are also differences in the time values used (Appendix 3). In the Oslo case study the time values used are approximately half the values used in the other studies, walk and waiting times even less. This causes undervaluing of the time benefits or losses compared to the other studies, and thus affects the results as well.

4 Introduction of other project results for transferability analysis

4.1 Introduction

The four recent projects have been chosen for reference in the transferability analyses as their aim has been to study the performance of policies and policy packages in urban areas in the EU-15. PROPOLIS and FATIMA are modelling projects whereas TransPrice and PROGRESS include both modelling and real life demonstration case studies. It should be mentioned that in most of the demonstrations the instruments have not been fully implemented but have been tested by a number of volunteers.

4.2 PROPOLIS

The objective of PROPOLIS was to research, develop and test integrated land use and transport policies, tools and comprehensive assessment methodologies in order to define sustainable long term urban strategies and to demonstrate their effects in European cities. The project was modelling exercise carried out in seven case study cities (Helsinki, Dortmund, Inverness, Naples, Vicenza, Bilbao and Brussels) during years 2000-2004 using both city specific and common modelling suites (PROPOLIS 2004). The single policies and policy packages tested were predefined and included both common and city specific policies. For this comparison four of the common policies have been picked up and thereto the relevant city specific policies. (Table 2.)

The results of the PROPOLIS-project confirm that the best improvement in all dimensions of sustainability, even social, could be achieved by using policy combinations i.e. push and pull measures consisting of car prising policies and simultaneous improvements of public transport through reduced fares and improving speed and service. In the PROPOLIS-project it was also found out that the synergy effects of combining especially car pricing policies and public transport policies are clear. In many cases the effect of their combination is better than the sum of the effects of the individual policies (PROPOLIS, 2004) i.e. these policies have synergy. However, the results from the seven case study cities point out that the optimum level of the pricing actions is city specific. Bigger, more congested cities seem to need more radical actions than smaller cities.

Table 2. PROPOLIS case study modelling results, policies similar to SPECTRUM best results

PROPOLIS City Population (present)	**Modal share** (horizon year 2021 ref. scenario)	**Economic instruments**	**Other instruments**	**Changes in modal share** **C**ar **P**ublic **T**ransport **W**alk & **C**ycle	**Feasibility** e**N**vironmental **S**ocial **E**conomic
Helsinki MA Finland 950 000 (1 200 000)	Car: 37% PT: 42% W&C: 21%	Increase car operating cost (fuel tax) +100%		C-, PT+, W&C+	N+, S+, E+
		Cordon prising peak low (0.85€)		C-, PT+, W&C+	N+, S+, E+
		Cordon prising peak high (2.25€)		C--, PT+, W&C+	N+, S+, E+
		Increase car operating cost (fuel tax) +75%, public transport fare reduction of 50%	Speed up PT by 5%	C--, PT+++, W&C--	N+, So, E+
		Distance-based charging 0.1, 0.07, 0.03€/km (zonal system as in PROGRESS)		C-, PT+, W&C+	N+, S+, E+
		Distance-based charging 0.1, 0.07, 0.03€/km public transport fare reduction of 20%	Speed up PT by 5%	C-, PT++, W&C-	N+, S+, E+
Dortmund Germany 2 500 000	Car: 80% PT: 13% W&C: 7%	Increase car operating cost (fuel tax) +100%		C-, PT+, W&C+	N+, S+, E-
		Cordon prising peak low (2€)		C-, PT+, W&C+	N-, S-, E-
		Cordon prising peak high (6€)		C-, PT+, W&C+	No, S-, E+
		Increase car operating cost (fuel tax) +75%, public transport fare reduction of 50%	Speed up PT by 5%	C-, PT+, W&C-	N+, S+, E+
		Increase car operating cost (fuel tax) +300%		C---, PT++, W&C++	N+, S+, E-
Inverness United Kingdom 130 000	Car: 89% PT: 9% W&C: 2%	Increase car operating cost (fuel tax) +100%		C--, PT+++, W&C+++	N+, S+, E-
		Cordon prising peak low (+20min time)		C--, PT+++, W&C+++	N+, S+, E+
		Cordon prising peak high (+60min time)		C--, PT+++, W&C+++	N+, S+, E+
Naples Italy 3 000 000	Car: 62% PT: 31% W&C: 7%	Increase car operating cost (fuel tax) +100%		C--, PT+++, W&C++	N+, S+, E+
		Cordon prising peak low (+20min time)		C-, PT+, W&C-	N+, So, E+
		Cordon prising peak high (+60min time)		C-, PT++, W&C-	N+, S-, E+
		Increase car operating cost (fuel tax) +50%, public transport fare reduction of 50%	Speed up PT by 5%	C--, PT+++, W&C--	N+, S-, E+
Vicenza Italy 790 000	Car: 89% PT: 9% W&C: 2%	Increase car operating cost (fuel tax) +100%		C--, PT+++, W&C++	N+, S+, E-
		Cordon prising peak low (+20min time)		Co, PTo, W&Co	N+, So, E+
		Cordon prising peak high (+60min time)		C-, PT+, W&C+	N+, So, E+
		Increase car operating cost (fuel tax) +25%, public transport fare reduction of 50%	Speed up PT by 5%	C--, PT+++, W&C+	N+, S+, E+
Bilbao Spain 1 140 000	Car: 45% PT: 23% W&C: 32%	Increase car operating cost (fuel tax) +100%		C--, PT+++, W&C++	N+, S+, E-
		Cordon prising peak low (1.76€)		Co, PTo, W&Co	N+, So, E+
		Cordon prising peak high (5.28€)		C-, PT+, W&C+	N+, So, E+
		Increase car operating cost (fuel tax) +25%, public transport fare reduction of	Speed up PT	C--, PT+++, W&C+	N+, S+, E+

		50%	by 5%		
Brussels Belgium 2 950 000	Car: 64% PT: 36% W&C: n.a.	Increase car operating cost (fuel tax) +100%		C-, PT+, W&C n.a.	N+, S+, E+
		Cordon prising peak low (+20min time)		Co, PTo, W&C n.a.	N+, So, E+
		Cordon prising peak high (+60min time)		C-, PT+, W&C n.a.	N+, S+, E+
		Increase car operating cost (fuel tax) +50%, public transport fare reduction of 50%	Speed up PT by 5%	C--, PT+++, W&C n.a.	N+, So, E+

+,++,+++ small, medium, high positive effect
-, --, --- small, medium, high negative effect
o no effect

4.3 TransPrice

TransPrice is based on actions and analyses in eight European cities: Athens, Madrid, Como, Leeds, York, Goteborg, Helsinki and Graz, thus covering a wide range of urban areas, in terms of both geography and typology. (TransPrice, 1999)

Cross-site comparisons of the *modelling results* have been made towards identifying guidelines at pan-European level for the implementation of transport pricing measures. In terms of cordon pricing (based on analysis for Athens, Como, Helsinki, Goteborg and Graz), these show that reductions of 5-20% in total distance travelled by private car are possible for cordon toll levels of between 1 and 3 EUR (after allowing for Purchase Power Parity differentials between EU member states). In terms of the number of private cars entering inner urban areas, reductions of between 5% (Helsinki) and 40-50% (Como, Athens) can be expected, depending on toll levels (around the 1-3 EUR range) and city characteristics. It is evident that the higher the present level of congestion, the more the scope for road use pricing. Regarding parking pricing measures, reductions in distance travelled by private car of 8-48% (and 8-49% reduction in the number of cars entering the controlled zones) can be expected for parking charges of 5-10 EUR (based on analysis for Leeds and Como). Main results are presented in Table 3.

Demonstration of pricing measures by real life application and experimental initial limited field trials of systems and measures is included in Athens, Como, Madrid, Leeds and York.

In **Athens** the results of the road use pricing trial indicated that 25% of car users transferred to Park & Ride, 5.5% to Public Transport and 0.5% to other modes, for charge levels of 1.5-2.2 EUR. These results suggest that, on a network-wide basis, up to 15% of car drivers could transfer to Park & Ride with a 5:1 pricing regime in favour of Park & Ride. The price elasticity for road use pricing was estimated at -0.2 from the limited sample of users that took part in the road use pricing demonstration. Attitudinal research suggested that a vignette-based system of area pricing would be more acceptable to the public and politicians than electronic cordon charging. Demand for the all Public Transport modes travel card has stabilised at about 10% of all public transport ticket sales.

In **Como** the demonstration results suggest that the introduction of parking charges (an early stage of city centre road pricing) reduced the traffic entering the designated area and corresponding improvements on congestion levels. There has been a positive change in modal split from cars to motor bikes and bicycles.

In **Leeds** the introduction of the multi use smart card was not seen as a prime reason for modal shift, but it was seen as an important element when considered in conjunction with tariff increases for parking and improved public transport services.

In **York** the differential changes in tariffs for city centre parking and Park & Ride have resulted in increased Park & Ride patronage. City Centre parking tariffs were increased by 20% while Park & Ride by 9%; this resulted in a 6% reduction in city centre parking demand and a 12% increase in Park & Ride demand. The introduction of a smart card with discounts for regular travellers resulted in about 5% of the car trips involved in the demonstration transferring to Park & Ride from city centre car parks.

In **Madrid** only the effects of introducing a multimodal travel card for Public Transport and a Park & Ride and integrated ticketing system was studied and therefore has been excluded from this analysis.

Table 3. TransPrice case study results, policies similar to SPECTRUM best results

TransPrice City	**Population**	**Economic instruments**	**Other instrument**	**Effect on modal share**	**M**odel/ **D**emo
Athens	750 000 (2 000 000)	Cordon pricing 1.5 - 2.2 €	Integrated ticketing and payment system for Park&Ride	25% car => P&R 5.5% car => PT	D
Como	80 000	Introduction of parking charges		small change from car to motor cycle and bicycle	D
Leeds	440 000 (750 000)	Increase in parking charges and improved public transport services	Integrated ticketing and payment system for Park&Ride	small decrease in car use	D
York	140 000 (180 000)	Increase of City Centre parking charges by 20% and P&R by 9%	Integrated ticketing and payment system, Park&Ride	shift from City Centre parking to P&R	
Athens, Como, Gothenburg, Helsinki, Graz		City centre cordon prising 1-3 €		reductions both in distance travelled by car (5-20%) and city centre congestion (5-50%) depending on the toll and circumstances	M
Como, Leeds		Parking charges 5 - 10 €		reductions both in distance travelled by car and city centre congestion (8-48%)	M

4.4 PROGRESS

PROGRESS was a demonstration project carried out in 2000-2004 researching urban road pricing in eight European cities. The main goal of PROGRESS was "to demonstrate and evaluate the effectiveness and acceptance of integrated urban transport pricing schemes to achieve transport goals and raise revenue". To research this, one existing road pricing scheme was extended, one was introduced, and five trials of different pricing technologies were carried out. Supporting this, detailed modelling work was undertaken, the social and political acceptance of such schemes was examined, and their effectiveness was evaluated. (PROGRESS 2004)

The main results relevant for SPECTRUM transferability analysis from the PROGRESS project are shown in Table 4. (CUPID 2004, PROGRESS 2004)

Table 4. PROGRESS case study results, policies similar to SPECTRUM best results

PROGRESS/ CUPID City	**Population**	**Economic instruments**	**Other instrument**	**M**odel/ **D**emo
Bristol	550 000	City centre cordon charge morning peak 1.6-3.2 € y 2015: 8 €		D
Copenhagen	1 800 000 (1 120 000)	Distance-based charge, time and zone differentiated 0.07 - 1.61 €/km	Metro, phase 3	D
Edinburgh	1 100 000 (450 000)	City centre cordon charge working hours, outer cordon morning peak 3 €		D
Genoa	650 000	City centre cordon charge 0.7-1.5 €	Park&Ride +shuttle line	D
Gothenburg	500 000	City centre cordon charge day time, outer cordon morning peak, 1 - 1.3 €	Mobile parking service incl. preinformation	D
Rome	4 000 000 (2 550 000)	City centre cordon charge full day, yearly charge 150 €, evening 1-3 €/entry	City centre access control working hours, Park& Ride, PT express lines	D
Trondheim	180 000	Hourly toll at cordon points working hours, base fee 1.4 €	Electronic ticketing, Info system	D
Helsinki MA	1 200 000 (950 000)	Distance-based (cordon tolls between 8 zones) working hours, basic zone-zone fee 1.7 €, morning peak higher; reduction of parking fees; reduction of public transport fares	improving PT (frequency & fares)	M

4.5 FATIMA

Project FATIMA was conducted 1997-1998 (FATIMA 1998) and was a direct continuation to the project OPTIMA. The aim of the project was to find optimal urban transport strategies, and especially to identify the benefits to the private sector and the potential for obtaining private sector funding for transport. Thus the project involved several objective functions for the modelling work. In this comparison the results corresponding to the so called Constrained Objective Function (COF) has been used. It maximises the balance of economic efficiency and sustainability but assumes that public finance is constrained to the do-minimum level. This was designed to reflect the reality for most city authorities, who find it difficult to obtain additional financial support and supports SPECRUM goal as well as the best results are economically feasible.

The project is based on altogether nine case study cities (Edinburgh, Eisenstadt, Helsinki, Liverpool, Oslo, Salerno, Torino, Trømsø and Wien) all of them using their own transport models but only the cities from UK and Norway obtained such results for COF that they can be used here. (Table 5.)

Table 5. FATIMA case study modelling results, policies similar to SPECTRUM best results

FATIMA City Population (present)	**Modal share** (horizon year 2021 ref.scenario)	**Economic instruments**	**Other instrument**	**Changes in modal share** **C**ar **P**ublic **T**ransport **W**alk & **C**ycle	**Economic benefits** (value of OF)
Edinburgh United Kingdom 450 000	Car: 63% PT: 37% W&C: n.a.	Cordon prising peak & off-peak 1.6€, Parking charges +300%, Public transport fares peak -90%/off-peak -35%	PT frequency peak +85%/ off-peak +70%, road capacity +10%, new infrastructure	C: -11%-units PT: +11%-units W&C: n.a	+492 milj.€
		Cordon prising peak 3€, off-peak 2.5€, Public transport fares off-peak +10%, peak 0%	PT frequency peak +90%/ off-peak +80%, road capacity +7%	C: -8%-units PT: +8%-units W&C: n.a	+375 milj.€
Merseyside (Liverpool) UK 1 440 000	Car: 62% PT: 15% W&C: 23%	Cordon prising peak & off-peak 1€, Short term parking charges +200%, Public transport fares peak -65%/off-peak -40%	PT frequency peak +20%/ off-peak -50%, road capacity +10%, new infrastructure	C: -3%-units PT: +4%-units W&C: -1%-units	+404 milj.€
Oslo Norway 920 000	Car: 68% PT: 22% W&C: 10%	Cordon prising peak & off-peak 5€, Public transport fares peak -5%/ off-peak -15%	PT frequency peak -15%/ off-peak 0%, road capacity +10%, new infrastructure	C: -8%-units PT: +6%-units W&C: +2%-units	+696 milj.€
Tromso Norway 55 000	Car: 73% PT: 11% W&C: 16%	Cordon prising peak 2€, off-peak 3€, Parking charges -100%, Public transport fares peak -50%/ off-peak +40%	PT frequency peak +25%/ off-peak +15%, road capacity +5%	C: -5%-units PT: +2%-units W&C: +3%-units	+17 milj.€

5 Common features of the best case study results with the results of other projects

5.1 Oslo - Retro

The SPECTRUM case study area in Oslo has a population of nearly a million and the city of Oslo 510 000. In the Oslo multimodal case study there were three packages that were nearly equally beneficial. The highest level of total benefits were obtained with a package including only car pricing measures, cordon charge at the present city centre toll ring (2.5 times present charge during peak period and no change for off-peak) and a distance based charge in the form of fuel tax increase (1.5 times present). The second best package drops out the toll ring incorporating only fuel tax increase (50% or 1.5 times). The third best adds a positive measure in the form of public transport frequency increase of 5.8% to the pure car pricing package of toll ring and fuel tax increase.

The car pricing policy packages did not much change in the modal share, in the best package the share of car trips dropped from 73% to 71.5% with a 5% decrease in car trips during peak and 3% decrease during off-peak period. The share of public transport trips increased from 18% to 19% mainly during the peak period (10% increase during peak, 1% increase during off-peak). For walking and cycling there was a small change from car trips mainly during the peak period. For the package including a public transport measure the change to public transport use was somewhat bigger.

From the other modelling exercises the most similar instruments have been modelled in the PROPOLIS project as one of the common policies for all cities involved. The results of an 100% increase in car operating cost i.e. fuel tax shows a desirable change in modal share from car to public transport and walking and cycling in all seven case study cities whether they were big or small (Helsinki, Dortmund, Inverness, Naples, Vicenza, Bilbao and Brussels). In addition, the instrument is both environmentally and socially beneficial in all cities but economically beneficial only in three cities, namely in Helsinki MA, Naples and Brussels whereas e.g. in Bilbao and Dortmund the economic benefits are smaller than in the reference scenario. There is no clear explanation for this. It cannot for instance be explained by the size of the cities neither by the share of public transport or geographical location.

In PROPOLIS study also two of the city specific tests of Helsinki MA try similar instruments with the Oslo study. The first tests distance-based zone differentiated charging alone (8 zones, charges 0.1, 0.07 and 0.03 €/km, basic zone-zone fee 1.7 €) which closely is the same as toll ring with fuel tax increase. The second test adds two public transport measures to the car charging policy namely an increase of public transport speed by 5% and a fare reduction of 20% and can thus well be compared with the third best test in Oslo. The results of the Oslo and Helsinki studies are very similar as well, economically beneficial with a small change from car to public transport.

The modelling exercises of the TransPrice project convince the positive effect of cordon charging both in economy and modal share but no test have been made concerning distance-based charging which is the key measure in the Oslo study.

Of the PROGRESS demonstrations especially another Scandinavian city Copenhagen had ended up to similar results with Oslo, namely to a distance-based charging system which is time and zone differentiated with fairly high level charges. The zone differentiation acts in a corresponding way with the separate cordon charging instrument in Oslo (toll ring). Also both packages include a positive measure for public transport, in Oslo an overall increase in frequency and in Copenhagen new underground infrastructure.

5.2 Leeds - MARS

In the Leeds multimodal study the combination of distance based charge (1.5€/km) and 20-25 km bus lanes or bus only streets (driving speed of busses increases by 25% and the capacity for private cars decreases by 25%) seems to be the best package especially as in addition the two instruments show a very high degree of synergy. The second best strategy includes a somewhat lower distance based charge (1.13€/km) combined with a public transport frequency increase of 150%. The third best strategy involves only public transport measures, fare free service together with bus lanes or bus only streets and thus affects car drivers through capacity and restrictions on network usage.

The best package caused a significant change in the modal share, the share of car trips dropped from 56% to 47%. Public transport trips increased from 22% to 29% over the whole period in spite of the high increase of car ownership. Walking and cycling trips had a small increase as well, from 22% to 24%.

Looking at other modelling studies none of them suggest as high charging levels than the Leeds multimodal study. However, some of the PROPOLIS tests incorporate fairly similar elements of road prising and promoting public transport. One of the common tests in PROPOLIS consisted of an increase of fuel tax (75% in Helsinki MA and Dortmund, 50% in Naples and 25% in Vicenza and Bilbao), reduction of public transport fares (50%) and speeding up public transport by 5%. In addition Helsinki MA tested a combination of zone differentiated distance-charging, reduction of public transport fares by 20% and speeding up public transport by 5%. As in Leeds this kind of combinations show out to be both economically beneficial and have a significant effect on modal share in favour of public transport.

Also the Edinburgh study in the FATIMA project supports radical policy changes. The time-differentiated policy package consisted of six measures: cordon charging (peak and off-peak 1.6€), increase in parking charges (+300%), decreasing public transport fares (peak -90% and off-peak -35%), increasing public transport frequency (peak +85% and off-peak +70%), increasing road capacity (+10%) and having new infrastructure. This package led to high economic benefits and a decrease in car share from 63% to 52% of the motorised trips.

5.3 Leeds - Saturn

In the Leeds short term road sector case study there are two tests clearly above the others. The most beneficial instrument was a combination of distance-based charging at medium level (0.1125€/km) with corridor charging (1.2€) in seven corridors. However, the second best instrument is the distance-based charging alone being nearly as beneficial as the combination i.e. the corridor charging does not add much.

The Leeds Saturn study showed a 21% decrease in car trips for the peak period modelled.

The increase of fuel tax by 100% as a common test in the PROPOLIS project shows similar results with the Leeds and Oslo studies as discussed earlier. Of the three cities where the measure was economically beneficial (see Oslo study) only in Naples the change in car use was significant as in Leeds.

5.4 York - Saturn

In the York short term road sector case study IRR cordon charging (1.6€) combined with traffic signal optimisation led to the highest level of total benefits and a very high degree of synergy was found between the two instruments. The second best package was to combine IRR cordon charging with an increase of short term parking charges. To use all these three instruments together was also tested but the increase of parking charges did not have much effect compared to the best package as such. Actually it caused a small loss of total benefits.

Changes in car use have not been calculated in York but the best package, combination of cordon charging and traffic signal optimisation decreased total travel time for both cars and buses.

Both low and high pure cordon charging schemes were tested in PROPOLIS as a common test for all cities. The charge in York test can be classified here as low. The low cordon charging was economically beneficial in all other cities except in Dortmund. The other effects, effect on modal share and environmental and social effects were very small or there was no notable effect at all, except in Inverness where all benefits were significant.

According to the modelling exercises in TransPrice based on five cities a city centre cordon prising in beneficial in all terms of sustainability objectives. The level of benefits greatly depends on the city. The demonstration in Athens supports the modelling results. The demonstrations in the PROGRESS project suggest a city centre cordon charge of 1.5€ or more in Bristol, Edinburgh and Helsinki MA and a somewhat lower price for Genoa, Gothenburg and Trondheim.

6 Conclusions

Analysis of transferability within cities in the EU evidences that car prising policies seem to work in all kind of cities. For the smallest cities parking measures may be good enough but when they have been found to have exhausted their effectiveness road use pricing should be considered. Distance-based charging seems to be more beneficial in most cities, also regarding equity aspects. However, the equipment for other kind of charging systems than the uniform charging through fuel tax, are still under development. Therefore, in the near future the road pricing schemes will still be based of cordon charging of which there are several successful present examples and demonstrations.

Many of the results of the tests discussed confirm that the best outcome regarding all benefits, economic, environmental and social, could be achieved by using policy combinations i.e. push and pull measures consisting of car prising policies and simultaneous improvements of public transport through improving speed and service and reduced fares.

Analysis of transferability within cities in the EU shows that there is no specific policy measure or a package of measures that could be recommended as such without any adaptation to the target city. There was no proof that a certain policy could only be used under certain circumstances. On the contrary, it was found that very similar policies could be beneficial in cities that did not have too much in common; in North and South, in a small and big city, in a city with high car use and a moderate one etc. It is evident that the aggregate of all city characteristics is essential for the suitability of a policy in that specific city i.e. every city is unique. Beforehand it is very difficult to determine all main characteristics that are dominant for the success of a policy. For instance concerning the city form commonly special characteristics such as rivers (bridges), hills, sea shore are carefully looked at but there may be other characteristics like street layout (grid plan or asymmetric) or street width that are dominant as well.

For the best policies in the Oslo case study most positive reference was found from studies concerning other Scandinavian cities but also studies in Middle and Southern Europe had ended up to similar policies. All the cities were middle sized or big.

The Leeds multimodal study suggests quite extreme policies, high charges for car and or public transport free of charge. No similar policies were found in the other studies. This may be due to the unique MARS model used in Leeds which is a strategic multimodal time marching land use - transportation model with a time horizon of thirty years. However, the best performing instruments or packages but with less extreme levels of parameters get support from several other studies. Especially tests made in the PROPOLIS project are supportive, probably since also in this project multimodal time marching integrated land use - transportation models were used.

The road sector studies in Leeds and York do not give full evidence for transferability as it is not possible to assess the true modal shift from car to other modes. However, they give much more detailed information of the network effects due to road pricing policies than is possible to obtain using moth of the other models. The Leeds road sector case study is the only study introducing corridor charging together with distance charging. The other instruments and packages tested in Leeds or York get support from many multimodal studies. In addition, the level of cordon charging in York is supported by several demonstrations in the PROGRESS study.

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APPENDIX 1

Levels of analysis	Indicators for transferability analysis	Methods for considering transferability	Assumptions
9. Expert analysis of results from SPECTRUM case studies	10. • Analysis of output from SPECTRUM modelling exercises • Synthesis of answers to high level questions, concerning economic efficiency, political acceptability, practicality and equity	11. ➢ Comparison of SPECTRUM analyses with analyses from other projects and studies ➢ (SPECTRUM) expert analysis of transferability to other locations ➢ Analysis using results of interviews ➢ Analysis carried out using results from questionnaire surveys (e.g. as already carried out in Task 5.2)	12. ➪ Brief overview as to why certain cities are “similar” ➪ ?
5. Numerical output from SPECTRUM modelling exercises:	6. Changes in *transport output indicators* such as: • Values of high level objective function (HOF) • Ranking of packages by HOF • Traveller benefits (time and money) • External benefits • Government revenue • Intra-generational equity • Inter-generational equity • Transport indicators (Car trips, PT trips, Walking/cycling trips, Car vehicle kilometres, PT vehicle kilometres, Car speed, PT speed, etc.)	7. ➢ Comparison of SPECTRUM results with analogous results obtained by other projects (e.g. PROSPECTS, Optimal Strategies, FATIMA, TRENEN etc) ➢ Comparison of results from actual implementations (e.g. London)	8. ➪ Reporting of how case studies in other projects are “similar” ➪ Reporting of different parameters used in the HOF calculation, such as discount rate, values of time, marginal cost of public funds (MCPF); reporting on sensitivity analysis of such parameters (especially MCPF). ➪ Brief characteristics of cities in case studies in other projects ➪ ?
1. Policy packages with instruments such as: • Cordon/corridor charging • Distance charging • Public transport fare changes • Parking charges • Changes in speed limit • Bus only street/lane schemes • Public transport frequency	2. Changes in *transport input indicators* such as: • Charge levels for cars (fuel taxes, tolls, parking charges etc.) • PT fare changes • PT frequency changes • Speed limit changes • etc.	3. ➢ Consultation of reports from other projects. ➢ Consultation of reports from actual implementations ➢ Questionnaire surveys ➢ Interviews with experts	4. a) Specification of the time horizon and the geographical scope for the SPECTRUM policies; b) Specification of assessment period for the SPECTRUM case studies c) Brief characteristics of cities in SPECTRUM case studies

Logical Framework for transferability analysis for urban case studies

APPENDIX 2

Model **City** **Population**	**Economic instruments**	**Other instrument**	**Economic benefits** **- Total**	**Economic benefits** **- Consumer surplus**	**Economic benefits** **- Government & Producer surplus**	**External benefits**	**Modal share** **% low/PT/car** **- reference sc.** **- this policy**	**Type of inter-action**
RETRO **Oslo** 1 000 000	Cordon charging (toll ring) - peak: 2.5 times present - off-peak: present Fuel taxes (distance-based charging): 1.5 times present	Increase in PT frequency: 1.058 times present	+50 million € p.a. = 53 €/inh.	Total -465 million € p.a. = -489 €/inh.	Total +470 million € p.a. Operator (PT +4 m€, car +155 m€) Government +312 m€	+44 million € p.a.	9%/18%/73% 9%/20%/71%	Complementarity
MARS **Leeds** 750 000	Distance-based charging 1.5€/km	Bus lanes 20-25 km	+448 million € p.a. = 597 €/inh.	Total -1910 million € p.a. = -547 €/inh. Time +456 m€ p.a. (PT +304 m€, car +153 m€) Money -2366 m€ p.a. (PT 0 m€, car -2366 m€)	Total +2328 million € p.a. Operator (PT +88 m€, car +2270 m€) Government -30 m€	+29 million € p.a.	23%/24%/53% 25%/30%/45%	Synergy
SATURN **Leeds** 750 000	Distance-based charging (medium level) 0.1125 €/km	(Bus only streets 20-25 km)	+20 million € p.a.* = 27 €/inh. (+13 million € p.a = 17 €/inh.)	Total -74 million € p.a. = -99 €/inh. Time +12 m€ p.a. (PT +1 m€, car +11 m€) Money -86 m€ p.a. (PT 0 m€, car -86 m€) [Total -81 million € p.a. = -109 €/inh. Time +5 m€ p.a. (PT +1 m€, car +4 m€) Money -86 m€ p.a. (PT 0 m€, car -86 m€)]	Total +73 million € p.a. (Total +73 million € p.a.)	+21 million € p.a. * (+21 million € p.a.)		
SATURN **York** 200 000	IRR cordon charging 1.6€	Signal optimisation	+3 million € p.a.* = 15 €/inh.	Total +-0 million € p.a. Time +3 m€ p.a. (PT +2 m€, car +1 m€) Money -3 m€ p.a. (PT 0 m€, car -3 m€)	Total +3 million € p.a.	-0.1 m€ p.a.		Synergy

Best performing policies in each case study

APPENDIX 3

Transferability of SPECTRUM case study results according to relevant factors in transferability

	Population	**Car ownership**	**Modal share Walk/PT/Car**	**Value of time peak €/hour**	**Value of time off-peak €/hour**	**Note**
RETRO Oslo	950 000		13%/32%/55%	Car 5.64 €/h Public Transport - In-vehicle-time 4.70 €/h - Wait & transfer time 5.64 €/h		Cordon charging since 1989: the "Oslo toll ring" Year 2015
MARS Leeds	750 000		23%/24%/53%	In-vehicle-time 9.0 €/h Walk &Waiting time 18.0 €/h	In-vehicle-time 7.29 €/h Walk &Waiting time 14.58 €/h	Time span 30 years
SATURN Leeds	750 000			9.0 €/h		"road study" morning peak
SATURN York	200 000			11.32 €/h		"road study" morning peak